UNIVERSITY OF HULL

A Grounded Theory of Medication Administration Safety in Palestinian Critical Care Units

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by

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Dedication

When I started my Ph.D. journey, the lockdown started, and I was unable to get back home. My sponsor stopped covering my tuition and life expenses, but from darkness, light shines. One of my cousins told me, "*No, don't get back; go on with your studies; don't worry about anything*."

He is one of those who believe in charity, and what someone gives with his right hand, his left hand should not know about it.

This work is therefore dedicated to this wonderful man and my great family.

Additionally, I dedicated this achievement to the soul of my father (Allah Yerhamouh).

Acknowledgments

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I am grateful to my family for their support, especially my sister, who took on the responsibility of caring for my mother instead of me during the last four years. And my deepest thanks to my sincere friends and colleagues at the Arab American University in Palestine who supported me in my tough times. My gratitude also goes to friends and neighbours in the UK who supported me or encouraged me through this journey.

Finally, I would like to thank the nurses who volunteered to be interviewed for this study, the

Palestinian Ministry of Health, as well as the managers in private hospitals who provided me access to their staff. The grounded theory discussed in this thesis is based on the words of experienced nurses. Without their willingness to participate, the theory would not be developed.

Publications and Conferences

I shared two presentations during the journey of my PhD study. The first one was by sharing in a seminar that was run by the doctoral college at the University of Hull. The developed themes of analysing the literature review concerning the study were presented in this seminar.

The second presentation was about sharing the findings of the study concerning factors influencing safe medication administration in Palestinian critical care units. The presentation was part of the ICAHR series of workshops that took place at the University of Hull.

The plan for future publications includes publishing the scope of the literature review, the findings and discussion, and the methodological methods of the study.

Abstract

Introduction

Administering medication is a critical skill that requires a professional nurse who understands the steps of the medication administration process and is highly skilled in calculating the medication dosage to ensure safe medication administration as well as the safety of the patient. However, critical care units are present in many Palestinian hospitals, offering care across a range of specialties that are allocated in separate areas of the hospital for managing and monitoring critically ill patients with life-threatening conditions.

Research aim and question.

This current study aims to answer the research question, "What are the factors that influence medication administration safety from the nurses' perception in Palestinian critical care units".

Methodology

This study adopted a constructivist grounded theory approach to explore the factors that influence medication administration in critical care units. Purposeful and theoretical sampling was used to guide the researcher in selecting the sample included in the study to obtain the data. The researcher used face-to-face interviews as the main data collection tool, twenty nurses were interviewed and included in this study who were working in critical care units, registered by the Palestinian Ministry of Health. Ethical approval was obtained from the University of Hull, as well as from the Palestinian Ministry of Health and the directors of the private hospitals. Open coding, axial coding, and selective coding were used to identify the core category and associated categories that provided the conceptual framework for a grounded theory of nurses' approach toward factors influencing medication administration safety.

Results

This study discusses medication administration safety in Palestinian critical care hospitals from the perspective of critical care nurses.

The core category that was identified based on the open coding was "The Primacy of Safety," and concurrently, this was the key consideration in medication administration in the critical care units. According to the continuous data analysis, six more associate categories have also emerged in the context of safety including knowledge and skills, process, technology, policies, environment, and healthcare providers.

Although the interviewees had a positive view of medication administration safety in the critical care environment, they described the challenges that they face to enhance safety during their practice administering the medications used in critical care units. They related the safety of medication administration to a variety of factors, as well as how these factors could impede safety.

According to the interviewees, if the negative factors influencing medication safety were managed appropriately, their influence would be minimized, they would not cause harm to the patient, and medications would be administered safely. Conversely, if even one of the factors influences safety negatively, the impeded factors will weigh more, and safety will be impeded. So, enhanced or impeded safety depends on how each factor influences safety and how comprehensively all factors could be controlled to enhance safety and prevent patient harm.

Conclusion

The grounded theory in this study determined that the primacy of safety is an important approach in critical care units to enhance medication safety as well as patient safety. Additionally, it helps nurses provide optimal care with minimal morbidity and mortality.

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Abbreviations

AF: Atrial Fibrillation

BMR: Basal Metabolic Rate

CASP: Critical Appraisal Skills Programme

CCU: Critical Care Unit

CPE: Continuous Professional Education

CPR: Cardio-Pulmonary Resuscitation

CV: Central Venous

ECG: Electrocardiogram

FHS: Faculty of Health Sciences

HAM: High Alert Medication

ICU: Intensive Care Unit

IV: Intravenous

Kcal: Kilocalorie

KCl: Potassium Chloride

Kg: Kilogram

MOH: Ministry of Health

NGOs: Non- Governmental Organizations

NHS: National Health Services

PCBS: Palestinian Central Bureau of Statistics

PHIC: Palestinian Health Information Centre

PPEs: Personal Protective Equipment

RASS: Richmond Agitation Sedation Scale

SAG: Sedative Agitation Scale

SCM: Swiss Cheese Model

SPICE: Setting. Perspective. Intervention. Comparison. Evaluation

TPN: Total Parenteral Nutrients

UNRWA: United Nations Relief and Works Agency

WBCs: White Blood Cells

WHO: World Health Organization

Glossary of Terms

Administration: is the range of activities connected with organizing and supervising the way that an organization or institution functions (Gonzalez-Garcia et al., 2021).

Administering medication: providing a patient with substances prescribed or intended for the diagnosis, treatment, or prevention of a medical illness or condition (Tonna et al., 2007).

Arrhythmia: irregular heart rhythm that needs medical attention.

Delegation: give the right for someone to practice a job.

Desaturation: the oxygen level in the blood is lower than normal.

Dispensing medication: to give out medicine and other necessities to the sick; to fill a medical prescription (Hitner et al., 2022).

Environment: the conditions that someone lives or works in and the way that they influence how someone feels or effectively can work (Watts et al., 2004).

Generic name: name of a particular medication or drug that does not include trade name or brand name (Thakkar & Billa, 2013).

Glasgow Coma Scale: a tool used to assess a patient's level of consciousness after brain injury (Basauhra Singh et al., 2016).

Guideline: information intended to advise people on how something should be done or what something should be (Watts et al., 2004).

Hemodynamics: a study of blood flows through the body and how it is regulated by haemostatic mechanisms (Muller et al., 2012).

Hypovolemic shock: a condition in which the heart can't provide the body with the blood and oxygen needs to function (Hill & Mitchell, 2020).

Manual handbook: a quick reference resource prepared by a specialized person in a certain field including guidelines and instructions to perform special tasks.

National Health Services: It refers to the Government-funded medical and health care services that everyone living in the UK can use without being asked to pay the full cost of the service (Millar, 2002).

NMC codes: professional standards of nurses' practice and behaviour (Goldsmith, 2011).

Policy: a set of ideas or a plan of what to do in particular situations that has been agreed to officially by a group of people, a business organization, a government, or a political party (Watts et al., 2004).

Preceptorship: a structural supportive period of transition from learning to applying a complex skill that requires a long period of education (Jochim & Rosengren, 2021).

Prescribing medication: advise and authorize the use of a medicine or treatment for someone (Tonna et al., 2007).

Simulation training: the creation of a true-of-life learning environment that mirrors real work environments and scenarios (Pol-Castaneda et al., 2022).

Strategy: an action that managers take to attain one or more of the organization's goals (Watts et al., 2004).

Trade name: a name given to a medication by the manufacturer or developer (Thakkar & Billa, 2013).

Chapter 1 INTRODUCTION, DEFINITIONS, AND BACKGROUND

1.1 Introduction

Medications given in critical care units are accountable for more than two-thirds of medication-related events that could increase harm to critically ill patients who are receiving polypharmacy (Armor et al., 2016; Woo et al., 2020). Unsafe medication administration could occur at any phase, starting from the prescribing phase to the phase of documenting. It was reported that many factors could enhance or impede safety throughout these phases, and training contributes to increasing the safety of medication administration in critical care units (Benoit et al., 2012). Many studies have focused on different factors that influence the safety of medication administration in adult critical care units. Some of these studies focused on strategies and guidelines used in critical care units (Gimenes et al., 2015; Gimenes et al., 2016; Halbesleben et al., 2010; Irajpour et al., 2019; Johansen et al., 2016; Johnson et al., 2017; Llapa-Rodriguez et al., 2017), while others focused on adopting educational programmes to enhance nurses' knowledge that influences their practice (Esfahani et al., 2016; Häggström et al., 2017; Irajpour et al., 2019; Johansen et al., 2016; Mansour, 2011; Nguyen et al., 2014; Sessions et al., 2019). Others described the environmental factors that impact the practice of medication administration (Gimenes et al., 2016; Llapa-Rodriguez et al., 2017; Sessions et al., 2019; Stamp, 2010; Xu et al., 2017) and the technological methods used in critical care units that support medication administration in critical care settings (Carayon et al., 2017; Carayon et al., 2014; Cavalaro et al., 2020; Maydana et al., 2017; Poon et al., 2010).

This study attempts to explore the factors influencing the safety of medication administration and to understand how these factors could enhance or impede safety in adult critical care units. This not only informs future implementation to manage factors to ensure safety, but the findings that

emerged from the study provide insight into healthcare providers' responsibilities and accountability to enhance the safety of medications given in adult critical care units.

1.2 Definitions

1.2.1 Intensive Care Units

Critical care units are defined as the highest-risk areas in hospitals that provide high-quality care for critically ill patients using invasive and non-invasive technological methods that support patients with life-threatening conditions (Falk, 2023; Varon & Acosta, 2010; Williams et al., 2015). The primary goal of critical care units is to prevent health condition deterioration and complications; this could be achieved by the collaboration of multidisciplinary healthcare providers and by implementing advanced technological methods (Marshall et al., 2017). The Palestinian Ministry of Health defined critical care units as the units that provide care for critically ill patients and life-threatening conditions; these units include general intensive care, neonatal, paediatric, and cardiac critical care units (MOH, 2018). Additionally, the Palestinian MOH reported that patients admitted to critical care units include those who need continuous monitoring, mechanical ventilation, and invasive arterial monitoring (MOH, 2018).

However, patients in intensive care units are classified according to their illness severity: level one patients are at risk of health condition deterioration and need additional care; level two patients require close observation and support intervention for organ failure; and level three patients require advanced respiratory support and support for multi-organ failure. The study described that the patient’s health status and the classified level determine the nurse-patient ratio as well as the nurses’ workload at each level (Masterson & Batchelor, 2019).

1.2.2 Medications are Given in Critical Care Units

A variety of pharmaceutical categories are employed in Palestinian critical care units, such as drugs that modify the strength of cardiac activity and others that regulate blood vessels. Dopamine, dobutamine, noradrenaline, and adrenaline are among the most commonly used drugs in intensive care units (Ramya et al., 2019). In Intensive Care Units (ICUs), neuromuscular agents, opioids, sedatives, antipsychotics, and medications meant to maintain and control systemic demands, such as nutrition and minerals, are frequently utilised (Burry et al., 2014). Therefore, the medications that are given in these units tend to be considered high-risk and may disrupt body systems if misused (El-Fattah et al., 2016). However, critically ill patients require medication management based on their health conditions and assessments, taking into consideration the pharmacokinetics and pharmacodynamics associated with their health conditions (Zagli et al., 2008). Pharmacokinetics is linked with the processes of absorption, distribution, metabolism, and excretion of medications, while pharmacodynamics is the effect of the medications and the impact of their mechanisms on the body systems (Rimmington, 2020; Shinde et al., 2023).

Additionally, to achieve the safety of medication administration in intensive care unit nurses should be qualified and have pharmacological knowledge, including indications, effects, and side effects, as well as be aware of the patient's physiological changes, including hemodynamic (El-Ata et al., 2019; Parry, 2012; Ramya et al., 2019).

1.2.2.1 Inotropic and vasopressor medications

Inotropes and vasopressors are important pharmacological agents used to treat a variety of cardiovascular disorders (Belletti et al., 2015; Overgaard & Dzavik, 2008) and to enhance circulation in patients with inadequate perfusion by increasing cardiac output and decreasing filling of the right and left ventricles (Bangash et al., 2012; Macit et al., 2015). Inotropic drugs are

generally used in intensive care units and are designed to cause vasoconstriction and increase cardiac contractility. Inotropes could also be utilised to lower cardiac output in cardiogenic shock caused by a myocardial infarction (Belletti et al., 2015; Parry, 2012). Additionally, inotropic drugs are classified as positive or negative inotropes based on their pharmacological action and the patient's health situation. β1 receptors cause the positive inotropes to increase the force of heart contractility and the impulses' conduction, while β2 receptors cause the negative inotropes to decrease the force of contraction and cause relaxation of smooth muscles. Dopamine, dobutamine, adrenaline, noradrenaline, isoprenaline, and milrinone are the most common inotropes given to support body system functions (Macit et al., 2015; Ramya et al., 2019). To administer inotropic medication safely, an equation is used to calculate the prescribed dose based on the patient's body weight (Parry, 2012).

Nitroglycerin is another vasoactive drug that relaxes the vascular smooth muscle and increases vasodilation, and it is usually used to treat life-threatening hypertension. Nitroglycerin is delivered intravenously (IV) in critical care units and is indicated to be diluted with five percent dextrose water to ensure medication stability and pH adjustment (Kim et al., 2023).

1.2.2.2 Sedatives and analgesics

Analgesics are pain relievers, while sedatives are medicines that depress the central nervous system and promote sleep (Hariharan & Garg, 2017). However, sedative and analgesic medicines are used to increase patient comfort and improve ICU care practices (Ostermann et al., 2000; Veličković & Palibrk, 2018). Short-term and long-term consequences of sedation are distinguished; Midazolam and Propofol are examples of short-term impacts, whereas Lorazepam and haloperidol are examples of long-term effects (Ostermann et al., 2000). Sedatives can also be classified based on their effect on the patient's level of consciousness: mild sedation depresses the level of

consciousness minimally; moderate sedation allows the patient to respond to verbal commands; and deep sedatives cause difficult arousal of the patient's consciousness (Hariharan & Garg, 2017). However, deep sedation should be avoided unless there is a clinical indication, and the use of non-benzodiazepine sedatives is intended to improve clinical outcomes in mechanically ventilated patients (Stollings et al., 2022; Veličković & Palibrk, 2018).

The level of sedative used is determined by monitoring the consciousness and arousal of critically ill patients, particularly those who are intubated. In life-threatening circumstances, neuromuscular blocking drugs, such as Rocuronium and Atracurium, are administered alongside sedatives to relax muscles and ensure the safety of the airway during tracheal intubation (Burry et al., 2014; Renew et al., 2020). The Sedative Agitation Scale (SAG) and the Richmond Agitation Sedation Scale (RASS) are assessment tools used to assess a patient's level of consciousness to select the appropriate sedative (Hariharan & Garg, 2017; Page & McKenzie, 2021).

1.2.2.3 Total parenteral nutritional (TPN)

Total parenteral nutrition means administering nutrients through the central venous catheter to provide the patient with the required energy. TPN is composed of separate components of lipid emulsions, dextrose, amino acids, vitamins, electrolytes, and minerals (Hamdan & Puckett, 2021; Hickman & Opole, 2021). TPN is recommended for critically ill patients in intensive care units because of an increase in basal metabolic rate and protein catabolism, as well as the fact that malnutrition is associated with impaired immune system function and muscle weakness in critically ill patients. As a result, this influenced the dependency on mechanical ventilation and the length of hospitalisation in critical care units (Macdonald et al., 2013). Furthermore, preparing and giving parenteral substances in intensive care units is associated with significant error rates (Tan et

al., 2017); therefore, to administer TPN appropriately, it should be calculated by considering a range of criteria, including the patient's body weight.

TPN requirements are 30–40 mL/kg/day of water and 30-35 kcal/kg/day of energy, and amino acid requirements vary between 1.0–2.0 g/kg/day, calculating the TPN requirements depending on the catabolism degree and energy expenditure. In addition, essential fatty acids, vitamins, and minerals are given based on the patient's health status and laboratory test results (Thomas, 2022).

1.2.3. Medications-Related Events in Critical Care Units

A medication-related event is defined as a medication-related failure that may occur at any phase of the process, including prescribing, distribution, administration, and monitoring (Biro et al., 2022; Camire et al., 2009; Kane-Gill et al., 2017). Medication-related events are one of the most common failure situations in healthcare, arising at any phase of medication administration and requiring the intervention of professional healthcare providers (Alves et al., 2017; Di Muzio et al., 2017). According to previous studies, medication-related events are considered a primary cause of morbidity and mortality in critically ill patients, and medication-related events are also influenced by the nurses' level of education, their experience, and attending training courses (Kerari & Innab, 2021). In intensive care units, medication-related events are considered a serious problem (Escrivá Gracia et al., 2019) that might occur for a variety of reasons, including lack of knowledge, the patient’s health condition, incorrect calculations, fatigue and stress from one's own life or workload, and environmental intensive care factors (Escrivá Gracia et al., 2021; Fry & Dacey, 2007; Gorgich et al., 2016).

1.2.4 Risk Factors Contributing to Medication-Related Events in ICUs.

A study described risk factors as threatening factors that were classified into four categories:

- Knowledge-based errors, which require an understanding of side effects.
- Rule-based errors, which necessitate performing the task in a manner different from standards.
- Activity-based errors, occur because of confusion between two medications that look alike.
- Memory-based errors, in which nurses administer medication based on what they know about the patient's history (Alrabadi et al., 2021).

However, lack of knowledge and skills, about dosage, and calculation were considered the major risk factors among healthcare providers contributing to medication administration events in critical care units (Agyemang & While, 2010; Cheragi et al., 2013; Di Muzio et al., 2017; Di Simone et al., 2018; Tan et al., 2017).

A study demonstrated that nurses' qualifications and experience are other factors that contribute to medication-related events (Marshall et al., 2017), in addition to the critically ill patient's health condition and the number of patients' system failures (Camire et al., 2009; WHO, 2016). Work-related stress in critical care units is a significant risk factor for medication-related events; the most common sources of stress include interrupted family life, extended work hours, night shift working hours, and working overtime (Salam et al., 2019). Nurses, conversely, had a negative perception of the causes of medication-related events in critical care units, as several factors contribute to medication-related events, including illegible handwriting, mental and physical health, interruption and distraction from patients and colleagues, a lack of pharmacological

knowledge with problems in calculations, a performance deficit, a lack of guidance, and a failure to follow protocols (Alrabadi et al., 2021; Ramya et al., 2019; Salam et al., 2019).

Medication-related events are frequent and serious problems in critical care units that threaten patients' lives. Studies by Di Simone et al. (2018), Fathy et al. (2020), and Ramya et al. (2019) described that with healthcare providers' collaboration, the factors influencing medication administration could be predicted and managed to improve patients' safety and reduce the incidence of medication-related events. However, the authors argued that the nurses' insufficient knowledge and skills hinder the safety of administering medications, and insufficient knowledge influences the nurses' ability to manage interruptions. Also, the ineffective use of technological methods, miscommunication with healthcare providers, and inability to comply with institutional policies and guidelines all hinder the safety of administering medication.

1.2.5 Safety of Administering Medication in Critical Care Units

Critical care units are highly complex and advanced environments that have an impact on the safety of patients (Nilsson et al., 2012). However, little is known about how nurses safely give drugs and how current protocols in critical care units improve or impede medication safety (McLeod et al., 2015). Medication safety is a significant challenge for healthcare professionals because of the complex processes involved, including calculating, mixing, titrating, and ensuring the correct medication is administered to the correct patient in the correct dose, at the correct time, and using the correct route (Lapkin et al., 2016). As a result, high-quality medication management is the responsibility of nurses to enhance medication safety and prevent errors (Muroi et al., 2017; Qin et al., 2017).

1.3 Palestinian Context

This section aims to provide an overview of Palestine, including the country's geography, population, and healthcare system background. The number of hospitals, the distribution of beds by specialty, and the number of nurses who provide care in each specialty area are all included in this. This study focuses on the challenges of nurses' approaches to safe medication administration in the context of the Palestinian critical care environment.

1.3.1 Geographical Background

Figure 1-1: Palestinian map free copyright ("Palestinian Map," 2007).

Palestine is a small Middle Eastern country (27 thousand square kilometres) separated into two regions: the West Bank (5,660 square kilometres) and the Gaza Strip (365 square kilometres). According to a recent census, there are 5,483,450 people in Palestine: 3,256,906 in the West Bank and 2,226,544 in the Gaza Strip (Palestinian Central Bureau of Statistics, 2023).

Palestine is geographically and politically divided. The Israeli occupation controls the border crossings between the West Bank and the Gaza Strip, as well as permitting entry into Jerusalem. All Palestinians, including those living in Jerusalem, should receive entry permits to the occupied Palestinian 1948 region, including east Jerusalem. Access is restricted to healthcare personnel, patients, and their companions (WHO, 2019).

Table 1-1: Distribution of Palestinian population according to the region

<table>
<tr><td rowspan="4">Palestinian Population</td><td rowspan="4">5,483,450</td><td rowspan="2">West Bank</td><td rowspan="2">3,256,906</td><td>Residents</td><td>2,356,906</td></tr>
<tr><td>Refugees</td><td>900,000</td></tr>
<tr><td rowspan="2">Gaza Strip including Jerusalem</td><td rowspan="2">2,226,544</td><td>Residents</td><td>456,544</td></tr>
<tr><td>Refugees</td><td>1,770,000</td></tr>
</table>

**Palestinian Central Bureau of Statistics (Statistics, 2023; WHO, 2023).*

1.3.2 Healthcare System Background

The construction of the separate wall, a 708-kilometre-long, 8-metre-high wall, is one of the key restrictions of the Palestinian effective healthcare system (Keelan, 2016). The fragmentation of the healthcare system between the West Bank, Gaza Strip, and East Jerusalem is influenced by geopolitical separation (WHO, 2022). Also, the Israeli occupation's frequent violence contributes to delivering appropriate healthcare by either influencing healthcare providers or gaining access to hospitals with high-quality facilities, including those in east Jerusalem (WHO, 2019). Physical aggression against healthcare personnel causes injuries as well as damage to ambulances and healthcare facilities. Throughout acts of violence, there is frequently obstruction to providing healthcare, and healthcare professionals are sometimes detained to delay providing healthcare, especially for critically ill patients. Obstacles and several checkpoints impede the transfer of critically ill patients from Palestinian hospitals to East Jerusalem hospitals. These obstacles are intended for transferring patients from ambulances back-to-back to get access to East Jerusalem

hospitals, and this delays the implementation of advanced interventions that influence the patients' safety as well as administering medications on time (WHO, 2019, 2022, 2023).

In occupied Palestine, there are three levels of health care: primary, secondary, and tertiary. Clinics, hospitals, and rehabilitation centres are located throughout Palestine, including towns, villages, and camps. These clinics and hospitals provide care in a variety of specialisations (MOH, 2022b). However, in Palestine, there are four major healthcare providers (Waterston & Nasser, 2017):

- Ministry of Health,
- United Nations Relief and Works Agency (UNRWA),
- Non-Governmental Organisations (NGOs), and
- Private sector.

The Palestinian Ministry of Health (MOH), non-governmental organisations (NGOs), the United Nations Relief and Works Agency for Palestine Refugees (UNRWA), and military medical services provide primary health care. Secondary healthcare services are delivered by hospitals operated by the Palestinian Ministry of Health and non-governmental organisations (NGOs), and tertiary services are mainly provided by NGOs (PHIC, 2019).

According to the most recent Palestinian annual health census report (2022), there are 89 hospitals distributed across Palestine, including East Jerusalem and the Gaza Strip; 54 are in the West Bank and East Jerusalem, and 35 are in the Gaza Strip. MOH runs 16 out of the 54 hospitals designated in the West Bank; 36 are non-governmental, one is run by UNRWA, and one is a military hospital. MOH runs 13 hospitals in the Gaza Strip, 17 of which are non-governmental, two of which are military, and three of those are private (MOH, 2022a; PCBS, 2022). The figure below (1-2) shows the distribution of hospitals by operating system.

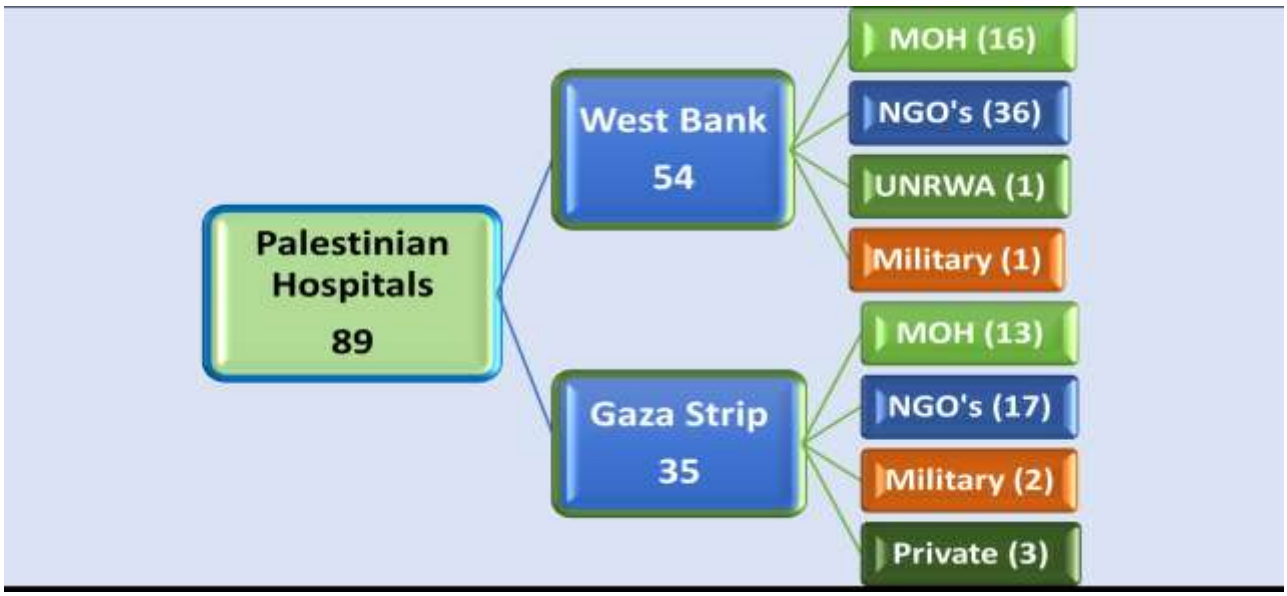


Figure 1-2: Distribution of Palestinian hospitals according to healthcare providers.

1.3.3 Distribution of Beds in Palestinian Hospitals Based on Healthcare Providers

According to the most recent annual report from the Palestinian Central Bureau of Statistics (2022), there are 7,769 beds distributed among all Palestinian hospitals, including those in the West Bank, East Jerusalem, and the Gaza Strip. The West Bank has 4,182 beds, with 1,869 designated for MOH hospitals and 2,313 dedicated to NGOs, UNRWA, and military hospitals (PCBS, 2022). The Gaza Strip has a total of 3,412 beds, 2,674 of which are in hospitals operated by the MOH, 527 by NGOs, 130 by the military, and 81 by the private sector (MOH, 2022a). There are 1.7 hospitals for every 100,000 people in the West Bank and 13.4 beds for every 10,000 residents. In contrast, there are 1.6 hospitals for every 100,000 people and 16.8 beds for every 10,000 people in the Gaza Strip (MOH, 2022a; PCBS, 2022). The following table (1-2) shows the distribution of hospital beds by region and healthcare provider.

Table 1-2: Distribution of hospital beds by region and by healthcare providers.

	Region	Number of Beds	MOH	NGO's and Others
Total Beds in Palestine 7,769	West Bank and East Jerusalem	4,182	1,869	2,313
	Gaza Strip	3,587	2,824	763
Total		7,769	4,693	3,076

**Palestinian Central Bureau of Statistics (PCBS, 2022)*

1.3.4 Allocation of Beds According to Specialty

Governmental and private hospitals in Palestine offer secondary medical care in a variety of specialties, such as internal medicine, general surgery, gynaecology and obstetrics, critical care, and other fields (MOH, 2022a; PCBS, 2022).

The following table (1-3) displays the distribution of MOH beds by the range of hospitals that serve the Palestinian region's healthcare needs; however, it makes no mention of the number of beds assigned in NGOs' hospitals concerning various specialties.

Table 1-3: Distribution of beds based on specialty in the Palestinian regions.

Region	Internal Medicine Beds	General Surgery Beds	Paediatric Beds	Gynaecology and Obstetrics Beds	Critical Care Beds	Total Beds
West Bank	519	476	313	270	291	1,869
Gaza Strip	711	543	362	212	280	2,108
Total	1,230	1,019	675	482	571	3,977

**Palestinian Central Bureau of Statistics (PCBS, 2022)*

1.3.5 Critical Care System in Palestine

Many Palestinian hospitals have critical care units (CCUs) that provide specialised care. Critical care units (CCUs) are intensive care units (ICUs) that provide care for patients suffering from a variety of conditions. Many hospitals have paediatric ICUs, neonatal ICUs, and cardiac-surgery ICUs in addition to general intensive care units. According to the most up-to-date annual Ministry of Health report (PCBS, 2022), there are a total of 571 beds for critical care allocated in MOH-run hospitals (Table 1–3, p.13); 291 beds are allocated in West Bank hospitals, while 280 are in Gaza Strip hospitals. However, there is no evidence reporting the number of critical care beds located in the NGOs, nor is there any evidence describing the allocation of critical care beds in the West Bank concerning specialty. Conversely, the MOH in the Gaza Strip reported the distribution of the critical care beds based on medical care specialty; the report showed that there are 47 beds for general ICU, 59 beds for cardiac and open heart surgery patients, 2 beds for burn cases, 24 beds for paediatric ICU, and 142 beds for neonatal ICU (MOH, 2022a).

Because occupied Palestine is a high-risk conflict area, the Ministry of Health is concerned about the availability of healthcare staff capable of providing high-quality care in a wide range of specialties to meet the demands of all Palestinian hospitals (MOH, 2022b; WHO, 2023). According to the Palestinian Central Bureau of Statistics (2022), the overall number of nurses working in Palestinian hospitals is 14,593, the total number of nurses working in West Bank hospitals is 10,557, and the total number of nurses working in Gaza is 4,036. In West Bank hospitals, the nurse-to-population ratio is 33.8/10,000, and the midwife-to-population ratio is 3.0/10,000; in Gaza, the nurse-to-population ratio is 19.2 for 10,000 persons, and the midwife-to-population ratio is 2.8 (MOH, 2022a, 2022b). There is no evidence of a nurse-patient ratio in Palestinian intensive care units. The distribution of nurses by region is shown in Table (1–4).

Table 1-4: Distribution of nurses by region and the healthcare providers.

Region	Total Nurses Number	Number of Nurses MOH	NGOs and Private Hospitals	Number of Midwives
West Bank	10,557	2,652	7,905	270
Gaza Strip	4,036	3,071	965	212
Total	14,593	5,723	8,870	482

**Palestinian Central Bureau of Statistics (PCBS, 2022).*

Adult critical care units provide a high level of care for patients with critical illnesses. These units are staffed with skilled healthcare professionals and advanced equipment to support patients with actual or potentially life-threatening illnesses (MOH, 2022a). Despite the primary goal of critical care units in Palestine, which is to care for patients requiring mechanical ventilation, continuous hemodynamic monitoring, and supportive medication, they provide care to patients needing health status monitoring (PHIC, 2019), and there is no evidence illustrating the nurse-patient ratio in Palestinian critical care units. According to one study, the nurse-patient ratio in intensive care units is influenced by workload and the patient's health status (Falk, 2023). Furthermore, there is no documentation available to show the distribution of nurses working in Palestinian critical care units based on specialised areas.

1.4 A Statement of Research Problem

The intensive care unit is a stressful environment for nurses, who are responsible for safely administering drugs (Wenham & Pittard, 2009). However, drug administration safety is currently considered a high priority on the worldwide and national agendas, and to enhance the safety of medication administration, educational strategy programmes were addressed to provide continuous professional education (CPE) for nurses (Soon et al., 2021). Although many

organisations are capable of providing CPE, there is still a need to assess the programme's effectiveness and efficiency to ensure pharmaceutical safety (Browne et al., 2021).

Nonetheless, pharmaceutical-related events are a serious and frequent problem in hospitals that emerged mostly during the order transcription and medication administration phases (Qin et al., 2017). As the nurses are the first line of defense, they are accountable for ensuring patients' rights in terms of safe medication administration, and enhancing safety during the medication process will positively influence the patient's outcome and length of stay in the hospital (Flynn et al., 2012). Furthermore, while the topic of drug administration has been extensively researched in the literature, the role of nurses in maintaining medication safety has not been fully explored (Rohde & Domm, 2018), although the use of polypharmacology has increased the number of medication-related events that cause patient harm (Soon et al., 2021).

However, no evidence showed that the factors that enhance and/or hinder medication administration safety in adult critical care units were explored in a full qualitative study conducted either in the Middle East or in Palestine. A study described that within the Palestinian system, a medication safety system is absent, as is the absence of a medication training programme (Al-Worafi, 2020).

From my previous clinical experience in the critical care unit, there were a variety of factors that influenced my practice as well as that of my colleagues when preparing medications, such as the high-risk ones. These factors included the workload, as there were three nurses on the shift who were assigned to five critically ill patients connected to mechanical ventilation, which made it a challenge to prepare the medications without having a risk of medication-related events. Additionally, there was no control over visitors during the process of administering medications. Then I moved to an academic position, which allowed me to follow up on the performance of both

the clinical instructor and the nursing students. During my monitoring of them, I noticed that there was malpractice from the instructors towards administering medication safely. One of the instructors made a mistake when he/she didn't notice that the student diluted the medications with potassium chloride instead of distilled water. One of the nurses who was available noticed the empty ampules of potassium chloride before the student started the phase of administering medication. Besides this, there was no statistical evidence that showed the rate of medication administration incidence in Palestinian critical care units.

Despite this, a qualitative study is needed to investigate and comprehend the factors that influence the safety of medication administration in Palestinian critical care settings from the perspective of critical care nurses. This study might help in determining how these factors impact the safety of patients in critical care units and how these factors could enhance or impede the patient's safety regarding medication administration. Furthermore, researching the factors influencing the safety of medication administration could help in the prevention of health-related problems as well as assisting managers in the implementation of policies to ensure the safety of medications as well as the safety of the patient.

In summary, the importance of this study is also due to the dearth of local studies in Palestine that are concerned with the factors that influence the safety of medication administration in an environment that could be harmful to patients. As well as no previously examined issues related to the environment in Palestinian critical care units.

1.5 Aim of the Study

The main aim of this study is to explore and investigate the set of factors that could enhance and/or impede the safety of medication administration in adult critical care units in Palestinian hospitals. Furthermore, it explores the nurses' perceptions of how to manage these factors to enhance the safety of administering medications as well as the safety of critically ill patients in the critical care units.

As a researcher, I have selected the adult critical care units for the following reasons (Di Muzio et al., 2016):

- No studies in Palestine could be found about critical care nurses' approach to medication administration safety in adult critical care units.
- The factors that influence the safety of medication administration are not well identified in the critical care units of Palestinian hospitals.
- Administering medications in a critical care environment is different from other hospital units as well for paediatric and neonatal critical care units, especially in that the medications used are high-alert medications and need a special process in either preparing or administering them.
- The care provided in paediatric or neonatal critical care units is quite different from that provided in adult critical care units, including preparing and administering medications that require a variety of factors for paediatrics and neonates.

1.6 Research Question

Based on the review of the literature, in addition to the aim of this study, the study will answer the following questions:

> "What are the factors that influence medication administration safety from the nurses' perception in Palestinian critical care units?"

Sub questions that were included to be answered:

- What are the factors that could enhance and/or impede the safety of medications used in Palestinian critical care units?
- What are the strategies and guidelines that nurses follow to ensure the safety of the medication administration process as well as patients' safety in Palestinian critical care units?
- What are the supportive measures that could enhance the safety of medication administration?

1.7 Chapter Summary

This chapter discusses the history of the Palestinian healthcare system, what critical care units are, medications given in critical care units, and medication-related events, as well as describes the risk factors influencing medication safety.

Additionally, this chapter introduces the research problem statement and the importance of this study in the Palestinian context. The factors influencing the safety of administering medication are not well identified in the Palestinian critical care units. However, this study aims to explore the factors that could enhance and/or impede safety in the Palestinian critical care units from the nurses' perspective who are working in critical care units.

Chapter 2 A FOCUSED NARRATIVE SYNTHESIS OF LITERATURE

2.1 Introduction

This chapter describes the process of assembling the analysed evidence identified from relevant studies (Jesson et al., 2011; Petticrew & Roberts, 2006). This narrative synthesis of the literature has been reviewed systematically to explore and critically analyse existing studies concerning factors influencing medication administration safety in adult critical care units. The focus of using research evidence is to inform decision-making and draw attention to the methodology limitations of evidence based on the knowledge that exists from academic research. Broadly, a narrative synthesis is a process of assembling pieces of evidence that are sufficiently similar; it is described as jigsaw evidence with common similarities that show the clear contribution of each study to the overall synthesis (Jesson et al., 2011; Petticrew & Roberts, 2006).

Narrative synthesis is a helpful method of synthesis and analysis across different research methods including quantitative and qualitative studies. Also, narrative synthesis is a process that is useful for conceptualisation terms within the content analysis, thematic synthesis, grounded theory, and framework synthesis, and these methods involve some form of structural synthesis of studies (Booth et al., 2016; Snilstveit et al., 2012). However, the narrative synthesis techniques used in this study aimed to develop a preliminary synthesis of the findings of the included studies (Jesson et al., 2011; Snilstveit et al., 2012). To conduct the narrative synthesis, a variety of tools are used in this study, including a textual description of the included studies, groupings, clustering, tabulating (Table 2-5), transforming data into a common rubric (Appendix 1), and thematic and content analysis for transcribing data, which are described in Section 2.7 of this chapter.

In this study, the purpose of this narrative synthesis is to describe the context of the included studies, that focus on factors that influence nurses' approaches to safe medication administration in a critical care setting. To answer the search question of what factors could influence administering medication safely in a critical care environment, inclusion and exclusion criteria were used to select the relevant studies with acceptable quality that meet the purpose of the present study and review abstracts to confirm the relevant studies. However, the narrative synthesis was used to identify and summarise what has been published previously, avoiding duplication and seeking new study areas that have not been addressed yet (Ferrari, 2015). As well as, narrative synthesis, content analysis of the selected studies helps to detect the research gap associated with the research question, and electronic online searching takes place through a series of databases and engines to generate new insight and recommendations.

2.2 Elements of the Narrative Synthesis Process

To carry out the narrative synthesis, a dynamic process of reviewing relevant studies took place focusing on the research question (Ferrari, 2015). Popay et al. (2006) defined four processes in a formalised narrative synthesis. They described that the four steps of formalised narrative synthesis should naturally occur through the included studies under review. The following framework shows the steps of the formalised narrative synthesis process including *developing the theory of change, developing a preliminary synthesis, exploring relationships in the data, and assessing the robustness of the synthesis products* (Booth et al., 2016 p. 184; Popay et al., 2006 p. 11).

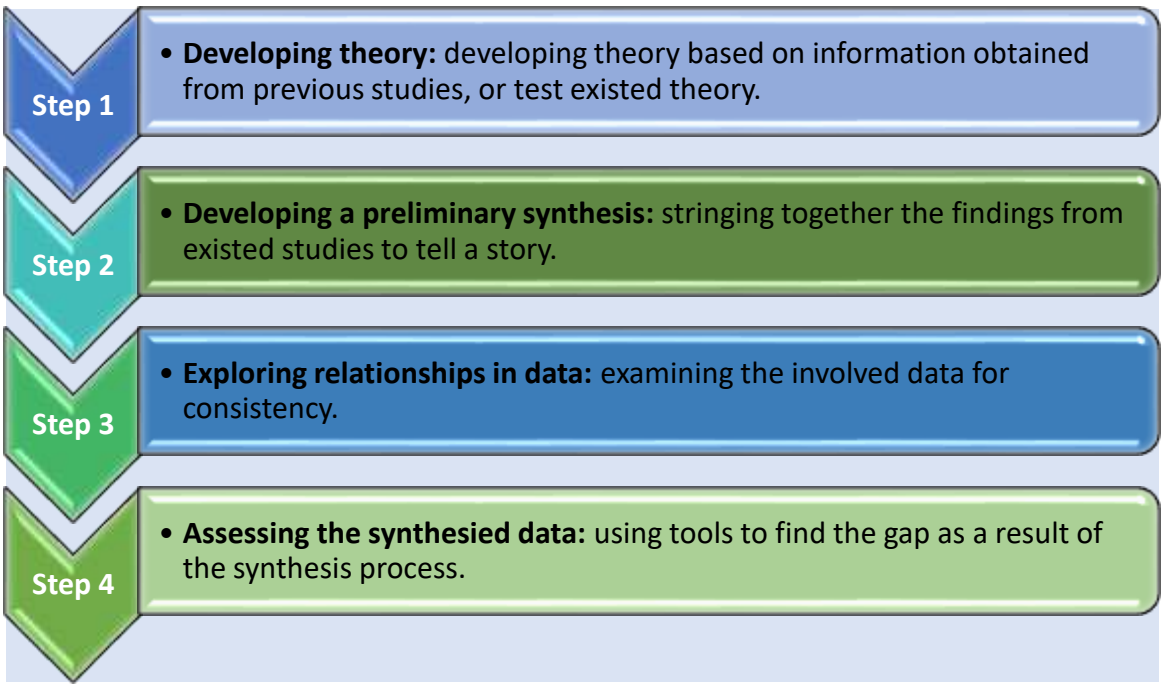


Figure 2-1: Framework of Narrative Review.

Figure (2-1) shows the steps of the narrative synthesis process, and the following explains the steps that are followed to conduct the narrative synthesis (Booth et al., 2016; Jesson et al., 2011; Petticrew & Roberts, 2006; Popay et al., 2006).

Step one begins with developing a theory of change based on information obtained from previous studies and then developing the inclusion and exclusion criteria in this study to organise the included studies into a logical list. Included and excluded studies are listed below (Table 2-3).

Step two is developing a preliminary synthesis of existing findings from the included studies based on reading and assessing each included study to link their findings together (Appendix 1). This step includes organising the findings in a particular layout to present the most meaningful categories. The results of reading and assessing the included studies are tabulated in chronological order, to make it easier to find the synthesised data (Table 2-5).

Step three is exploring the relationship between the findings of the included studies based on a critique of the studies by using different tools to evaluate the quality and strength of the included

studies. SALSA (Search, Appraisa*L*, Synthesis, and Analysis) is a framework that is used in the reviewing process of the included studies (Booth et al., 2016). Also in this step, findings are grouped to find out the similarities and differences between synthesised data and developing themes. The developed themes are discussed later in this chapter, Section 2.7.

Then, the last step is to highlight the knowledge gap based on assessing the robustness of the synthesis of the findings. The knowledge gap of the included studies is discussed within this chapter, Section 2.8.

2.3 Narrative Synthesis Objective

The purpose of a narrative synthesis depends on various factors, including the research question and purpose of the synthesis, narrative evidence (Jesson et al., 2011), and comprehensively identified relevant studies that could answer the research question (Petticrew & Roberts, 2006). However, narrative evidence-based practice is defined as systematically reviewing and appraising existing studies, while narrative synthesis goes beyond simply describing and summarising the main features of the included studies (Lisy & Porritt, 2016). The narrative synthesis also aims to identify and summarise what has been published previously to avoid duplicates and seek new study areas that have not yet been addressed (Popay et al., 2006), as well as generate new insights and recommendations beyond the findings' summary from different existing studies (Snilstveit et al., 2012). Additionally, Popay et al. (2016) described that formalised narrative synthesis provides deep and rich information about the included studies and moves the readers to identify the synthesised data with transparency and less bias.

However, in this study, the narrative synthesis aims to explore the factors influencing nurses' approaches to safe medication administration in a critical care environment.

2.4 Question for the Narrative Synthesis Review Question

The research question provides the structure and guidance for the whole set of included studies (Jesson et al., 2011). The authors described the research question as important in developing a review technique and starting a review search plan (Booth et al., 2012; Jesson et al., 2011) (Booth & Cleyle, 2006; Jesson et al., 2011). It was also described in the studies that good questions would help to focus on the research being studied, and the review question acts as a destination for the procedural guidelines that will be undertaken to develop the search plan (Booth & Cleyle, 2006; Guest et al., 2012). The review question was developed using the PICO framework; adopting this framework is more efficient in searching since it helps in developing a clear search question and utilising more detailed search methods for identifying particular answers (Booth et al., 2012; Petticrew & Roberts, 2006; Roever, 2018), where:

PICO framework represents, “P” describes the Population (nurses working in critical care units), “I” describes the Issues of interest (factors influencing the safety of administering medications in critical care units), “C” describes the Context (critical care units), and “O” describes the Outcome of the study (safe critical care environment).

The narrative review in this study will try to answer the question, “What are the factors influencing nurses’ approaches to safe medication administration in a critical care environment?

Table 2-1: PICo framework elements.

P: (Population)	Nurses who are working in adult critical care units. Adult patients (According to the WHO 2013; adults who is above 19 years old) who are receiving care in critical care units.
I: (Issue of interest)	Medications administered in adult critical care units. Factors influencing the safety of administering medications in critical care units
C: (Context)	Adult critical care units. Factors influence medication administered in critical care units.
O: (Outcome)	Safe administering medication in the adult critical care environment.

2.5 Narrative Synthesis Search Strategy

A variety of online databases were searched to track the information concerning this study (Jesson et al., 2011), the engine search used include EBSCO, the Cochrane database, the Web of Science, the Ethos Library, and PROSPERO, in addition to searching through Google Scholar to identify studies focusing on the proposed aim of this study.

The search included studies that focused on safely administering medication in adult critical care units and were published in academic journals between 2010 and 2020 and the search was updated to detect published studies between 2020 and 2023 concerning this research study; details could be found at the end of the chapter, page 70. Selecting studies published during this time is tied to the dramatic progress and changes in the critical care environment. In addition to the changes in protocols and strategies that were used to ensure the safety of medication administration in a critical care environment (Llapa-Rodriguez et al., 2017), the duration of the selected time covered all research studies that are linked to my research question. The search was restricted to studies published in English, though literature in Arabic was also examined to identify any published studies concerning the aim of this study, taking into consideration the appropriate justification for inclusion and exclusion criteria.

The following electronic databases were investigated throughout the search:

- EBSCO host (University of Hull Library), this data encompasses:
  - Academic Search Premier
  - CINHAL (Cumulative Index to Nursing and Allied Health Literature).
  - MEDLINE
  - APA PsychoINFO (American Psychological Association's)
- Cochrane database
- PROSPERO
- Web of Science
- Google Scholar
- Search for the grey studies through the University of Hull and Ethos Library for related books and thesis was viewed.

The search results were saved in an online record via the University of Hull library, which makes it easy to access a long-term record and saves time by not requiring repeating searches (Jesson et al., 2011). In addition, all the studies included in this study were saved using Endnote.

2.5.1 Narrative Review Search

A narrative review provides clarity to the key messages of the included studies and identifies the concepts within the context of the studies. There is no standard structure for the narrative review, but it is preferred to use the IMRAD format (Introduction, Methods, Results, and Discussion), and to organise the included studies in chronological order (Ferrari, 2015; Petticrew & Roberts, 2006). The narrative review of the included studies is tabulated according to the recommended format (Table 2-5). The narrative review's objective in this study is to identify and evaluate existing studies that discuss the factors that influence nurses' approaches to safe medication

administration in a critical care environment. To achieve this objective, significant keywords based on the review question were included in the search strategy. Boolean search operators were used to identifying synonyms that provide a comprehensive search (Jesson et al., 2011; Zawacki-Richter et al., 2020). Boolean search is based on connecting words to narrow search results in the term using the terms (AND, OR) to connect pieces of information to find what is searched for. "AND" was used to narrow the results in the search database, while "OR" was used to connect two or more synonyms, which broadened the results to search for all terms that could be present in the database results related to the topic. An asterisk (*) was used after the keywords to find out the truncation of the keywords; for example, nurs* would retrieve nurse, nurses, and nursing. The search strategy was developed, and an explanation of how to combine the keywords and phrases to refine the search was conducted (Guest et al., 2012; Jesson et al., 2011). The search strategy was supported by a librarian's specialties, who provided the necessary knowledge to search effectively. In contrast, I selected the keywords based on my study topic and the keywords from search topics; these keywords are known as natural keywords, which could be useful when searching the title, abstract, and full study text (Guest et al., 2012; Jesson et al., 2011). Additionally, I used the keywords attached to relevant studies to refine my search to include all relevant studies. The following section describes the tips that helped identify the keywords included in this study.

2.5.2 Constructing the Search

MESH was used to cover medical subject headings to not miss relevant studies (Higgins et al., 2019). A combination of the main keywords and phrases was used to find literature related to the study topic. The first search was by using the keywords and phrases which were nurs* OR “health care professional*” OR “healthcare professional*”, AND safe* OR secure OR right OR unharmed, AND “critical care” OR “intensive care” OR “ICU” OR “critical* ill*” OR “high dependency unit” OR

“HDU” OR “CCU” OR “coronary care” OR “intensive therapy” OR “ITU”, AND medic* OR drug* OR pharma*. This search strategy only yielded six studies, so I referred to the librarian as well as my supervisors to discuss and identify some keywords that could help improve search results. However, further searching was widened by modifying keywords and phrases to get all possible studies that focused on the study topic. The modified search showed an increase in the number of literatures found related to the proposed study question. The following shows the updated keywords and phrases used to retrieve all possible studies concerning the study topic:

- Keywords and phrases line one includes: nurs* or “health care professional*” or healthcare professional*”

  And

- Keywords two include: Safe* or secure or right or unharmed.

  And

- Phrases three were: “critical care” or “intensive care” or ICU or “high dependency unit” or “HDU” or “critical* ill*” or “CCU” or “coronary care unit” or “intensive therapy unit” or “ITU”.

  And

- Keywords and phrases four were: Medicat* or drug* or pharma*.

The search keywords and phrases are outlined in the following table (Table 2-2):

Table 2-2: Keyword Strategy

	Keywords	**OR**	**OR**	**OR**	**OR**	**OR**	**OR**	**OR**	**OR**	**OR**
AND	nurs*	"Healthcare professional*"	"Health care professional*"							
AND	Safe*	Secure	Right	Unharmed						
AND	"Critical care"	"Intensive care"	ICU	"Critical* ill*"	"High dependency unit"	HDU	CCU	Coronary care	Intensive therapy	ITU
AND	Medicat*	Drug*	Pharma*							

2.5.3 Inclusion and Exclusion Criteria

The inclusion criteria for selecting studies to be reviewed were based on selected studies that were published in English between the years 2010 and 2020 and focused on the nurses' approach who are working in adult critical care; studies that focused on safe medication administration in adult critical care units; and studies that focused on healthcare professionals (physicians and pharmacists) who are in direct relationship with nurses and involved specifically in medication administration in the adult critical care environment.

The first selection step was applied to the titles and screened based on the focus of the literature concerning adult critical care; studies that did not focus on the research question were excluded. Then all the abstracts of the remaining studies were retrieved to decide which studies could be included based on the inclusion criteria. The result of reviewing the literature's abstracts showed that some of these studies didn't meet the selection criteria, so they were excluded. At this point, I read the full text of the remaining studies to make sure that they met the inclusion criteria, so some of them were excluded because of not meet the inclusion criteria. Studies that focused on medication errors rather than safe medication administration, and literature focusing on neonatal, paediatric, and general wards were excluded.

Full texts were obtained for those studies that met the inclusion criteria to be evaluated; the inclusion and exclusion criteria are summarised in the table below (Table 2-3).

Table 2-3: Inclusion and exclusion criteria of selected published papers.

Included Studies	Excluded Studies
Studies written and published in English;	Studies not written in English;
Studies published between 2010-2020	Studies published before 2010
Published studies;	Studies that are not related to the search question and did not focus on safe medication administration in critical environments;
Studies that focus on nurses and healthcare professionals (Physicians, Pharmacists) who are in direct relationship with nurses in terms of the process of medication administration in adult critical care units;	Studies that focus only on other healthcare professionals (physicians or pharmacists) that do not include the nurses' approach in the process of administering medication in adult critical care units;
Studies that focused only on adult (who are above 18 years of age) intensive care units;	Studies focused on the neonate and paediatrics intensive care units;
Studies that focus on safe medication administration in adult critical care units;	Studies that did not focus on medication safety administration in adult critical care units;
Grey literature that includes a thesis concerned with medication safety in adult critical care and is included in Ethos Library;	Studies that are not related to the search question and did not focus on safe medication administration in adult critical care environments;

2.5.4 Narrative Review Search Results

Based on studies published in the English language (there were no studies written in Arabic found related to the topic of this study) and in academic journals between the years 2010 and 2020, the following results were retrieved via EBSCOhost (n = 1,394): MEDLINE = 542, Academic Search Premier = 354, CINAHL = 266, and APA PsycINFO = 232; after removing exact duplication, 501 articles remained.

However, the titles and abstracts of 501 studies were reviewed for eligibility. 472 studies were excluded as they did not focus on medication safety in adult critical care. At this point, 29 studies remained for full-text review, and the results revealed that 8 of the studies were concerned about medication errors without taking into consideration medication safety in adult critical care units or including nurses in these studies. According to this, the result revealed that 21 studies met the inclusion criteria. Further searching through Google Scholar, Web of Science, Ethos Library, and

PROSPERO, the result of searching these databases revealed two additional studies that focused on the search question after reviewing the full text, which were found via Google Scholar. According to the search, the total number of studies included in this review was 23.

The following table (Table 2-4) shows the database source of the studies that are included in this review.

Table 2-4: Search results overview.

Databases		**Article Retrieved**	**Included**	**Excluded**
EBSCOhost 1,394	MEDLINE	542	10	532
	Academic Research Premier	354	6	348
	CINHAL	266	4	262
	PsycINFO	232	1	231
Cochrane Database for systematic review		0	0	0
Web of Science		3	0	3
Ethos Library		1	0	1
PROSPERO		0	0	0
Google Scholar		4	2	2
Total		**1,402**	**23**	**1,379**

Search summary for inclusion and exclusion of selected studies through the database.

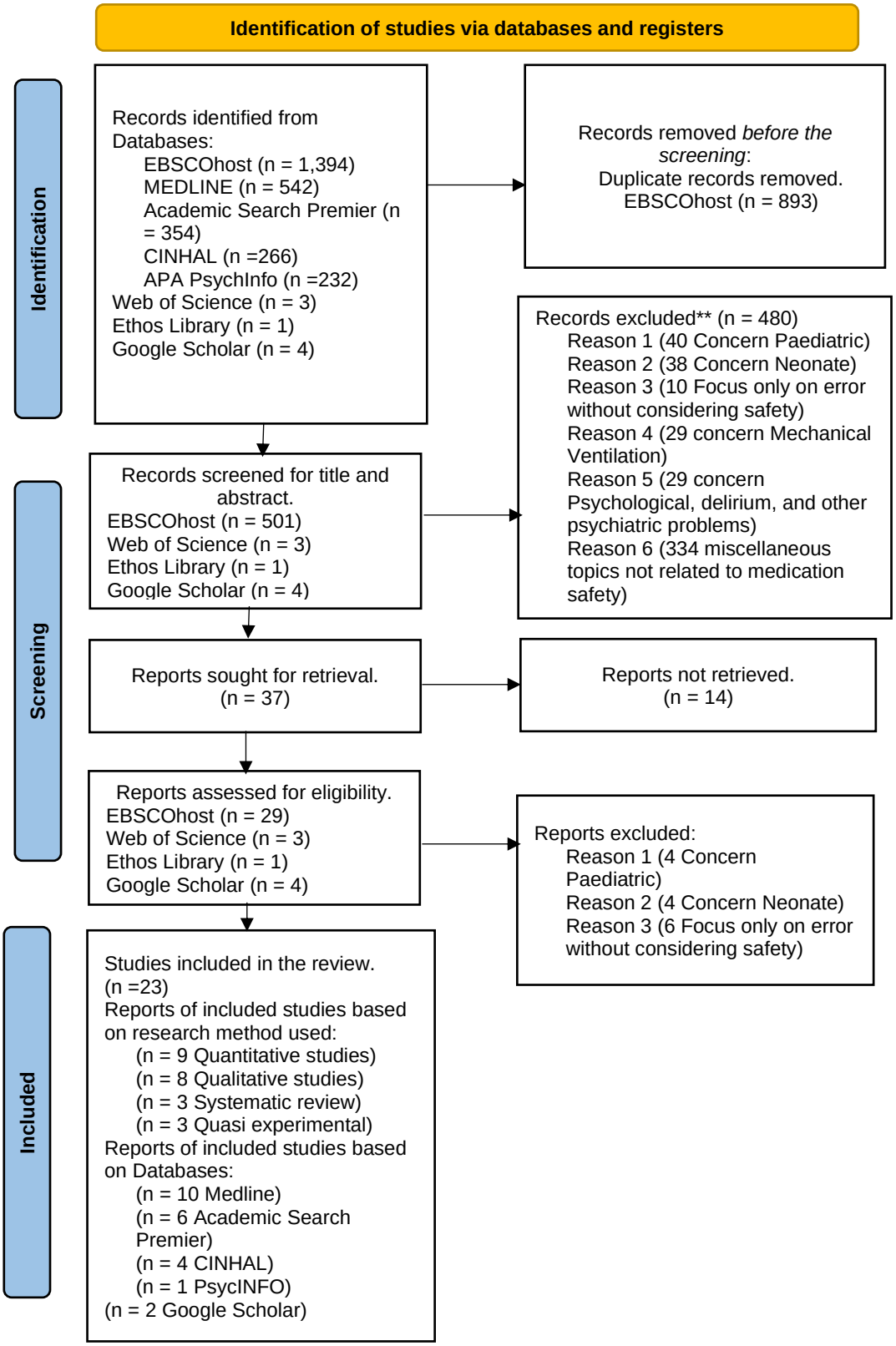


Figure 2-2: PRISMA 2020 flow Diagram (Page et al., 2021).

2.5.5 Narrative Overview of the Included Studies

The included studies were tabulated to describe the characteristics of the studies, including the referencing, aim of the study, population, methods, findings, and reflection on the reason for including the study (Booth et al., 2016; Jesson et al., 2011). The tabulated studies were chronologically listed and grouped according to the research methods used as shown in Table 2-5 a, and b.

Studies have been reviewed in depth as they are closely related to the topic of the study. It was found that nine studies used the quantitative/cross-sectional research method (Carayon et al., 2017; Carayon et al., 2014; Cavalaro et al., 2020; Johansen et al., 2016; Llapa-Rodriguez et al., 2017; Maydana et al., 2017; Muroi et al., 2017; Nguyen et al., 2014; Xu et al., 2017), eight studies used the qualitative method (Gimenes et al., 2015; Gimenes et al., 2016; Häggström et al., 2017; Halbesleben et al., 2010; Johnson et al., 2017; Mansour, 2011; Sessions et al., 2019; Stamp, 2010), three studies used the quasi-experiment method (Esfahani et al., 2016; Irajpour et al., 2019; Poon et al., 2010). These included studies were chronologically listed and grouped according to the method used; from 1-3 in Table 2-3 (a) were studies that used the quasi-experiment method, 4-11 studies that used the cross-sectional method, and from 12 to 20 the studies that used qualitative methods. Additionally, three studies were systematically reviewed and included in this study (Camerini et al., 2014; Kane-Gill et al., 2017; Mansour et al., 2012). The systematic review studies were checked to see if any of the twenty published studies included in this study were discussed within the systematic review studies. These studies are listed in Table 2-5 (b). So, only one of the systematic review studies by Kane-Gill et al. (2017) was reviewed here, which included four of the studies that were selected to be included in this current study (Carayon et al., 2014; Nguyen et al., 2014; Poon et al., 2010; Stamp, 2010). And the analysis of these four studies didn't impact my thematic analysis.

Nine of the studies focused on adopting protocols and guidelines for medication administration in adult critical care units that ensure the safety of administration (Camerini et al., 2014; Gimenes et al., 2015; Gimenes et al., 2016; Halbesleben et al., 2010; Irajpour et al., 2019; Johansen et al., 2016; Johnson et al., 2017; Kane-Gill et al., 2017; Llapa-Rodriguez et al., 2017); four of these studies used the qualitative method, two used the quantitative method, two used systematic review, and one used the quasi-experiment method. Additionally, seven of the studies focused on an inter-professional educational programme that enhances medication administration safety in adult intensive care units (Esfahani et al., 2016; Häggström et al., 2017; Irajpour et al., 2019; Johansen et al., 2016; Mansour, 2011; Muroi et al., 2017; Nguyen et al., 2014); two of the seven studies used qualitative methods, three used quantitative methods, and two used quasi-experiments. Six studies focused on critical care environment factors that may contribute to medication administration safety (Gimenes et al., 2016; Llapa-Rodriguez et al., 2017; Mansour et al., 2012; Sessions et al., 2019; Stamp, 2010; Xu et al., 2017); three of the studies utilised the qualitative method, while two used the quantitative method, and one of the studies was a systematic review. Also, eight studies highlighted the importance of implementing advanced technology that influences medication administration safely in adult critical care settings (Camerini et al., 2014; Carayon et al., 2017; Carayon et al., 2014; Cavalaro et al., 2020; Maydana et al., 2017; Poon et al., 2010; Sessions et al., 2019; Stamp, 2010); three of them used the quantitative method, three used the qualitative method, one used a systematic review, and one study used the quasi-experiment method.

Table 2-5 (a): Narrative Reviews Framework [included Quasi (3), Quantitative (9), and Qualitative studies (8)]

	Referencing	Title/country	Aim of the study	Methodology/ Design/Method	Results	Reflection
1.	Poon et al., 2010 New England Journal of Medicine. 362:18 DOI: 10.1056/NEJMsa0907115 2010/ Google Scholar https://www.nejm.org/doi/full/10.1056/NEJMsa0907115	Effect of Bar-Code Technology on the Safety of Medication Administration US	To assess rates of errors in order transcription and medication administration on units before and after implementation of the bar-code eMAR.	This study conducted a before-and-after, quasi-experimental study in an academic medical centre that was implementing the bar-code eMAR. Sample and settings: Observed 14,041 medication administrations and reviewed 3082 order transcriptions. Observers noted 776 non-timing errors in medication administration on units that did not use the bar-code eMAR.	Adopting a barcode influences the safety of the timing of administering medication, as well as enhances the safety of order transcription.	Focused on the use of the barcode to enhance the safety of medication and reduce the incidence of errors. Using a barcode doesn't enhance the safety of the administered medication if there is missing programmed information.
2.	Esfahani AK, Varzaneh FR, Changiz T. Iranian J Nursing Midwifery Research; 21:482-6. DOI: 10.4103/1735-9066.193394 2016/ MEDLINE	The effect of the clinical supervision model on high alert medication safety in intensive care units' nurses. Iran	To investigate the effect of the clinical supervision model on medication administration safety of high-risk drugs in intensive care units.	Quasi experiment Sample and settings: 32 nurses who are working in Al-Zahra ICU's hospitals.	Findings show that the score of medication safety of high-risk drugs increased after the administration of the clinical supervision model.	Increase safety medication administration after administering the clinical supervision model. The safety of proper medication processes can be promoted.
3.	Irajpour A., Farzi S., Saghaei M., Ravaghi H.	Effect of interprofessional education of medication safety programme on the medication error of	To investigate the effect of the interprofessional education of medication safety programmes on	Quasi-experimental study. Sample and settings: 50 members of a healthcare team (physicians, nurses, and a clinical pharmacist) with at	Inter-professional education in medication safety programmes can reduce medication errors and promote	Inter-professional education increases collaboration and improves work. Inter-professional education increases knowledge, and

	Journal of Education and Health Promotion. 8:196 DOI: 10.4103/jehp.jehp_200_19 2019 /MEDLINE	physicians and nurses in the intensive care units. Iran	medication errors of physicians and nurses in the ICUs.	least one year of work experience in the ICUs.	patient safety in the ICUs.	attitudes and improves holistic patient care. Educational programmes should not focus only on nurses.
4.	Carayon P., Wetterneck T., Cartmill R., Blosky M., Brown R., Kim R., Kukreja S., Johnson M., Paris B., Wood K., and Walker J. *BMJ Qual Saf*.; 23(1): 56–65. doi:10.1136/bmjqs-2013-001828. 2014/ MEDLINE	Characterizing the Complexity of Medication Safety using a Human Factors Approach: An Observational Study in Two Intensive Care Units. United States	To examine medication safety in two ICUs and to assess the complexity of medication errors and adverse drug events (ADEs) in ICUs across the stages of the medication management process.	Cross-sectional study. Sample and settings: Data from 630 consecutive ICU patient admissions, in two ICUs at a tertiary care, community teaching hospital in the Northeastern US.	Electronic health record technology with computerized physician order entry may be one step necessary to improve medication safety in ICUs, but not sufficient.	Using EHR is safe and may contribute to improving medication safety as orders are written clearly. Easy to access. Can be programmed to include full information about the medication that will be administered (route, dose, frequency, etc) Staff should be trained to use HER efficiently. EHR needs frequent maintenance.
5.	Nguyen, H. T. Pham, H. T. Vo, D. K. Nguyen, T. D. van den Heuvel, E. R. Haaijer-Ruskamp, F. M. Taxis, K. 2014	The Effect of a Clinical Pharmacist-led Training Programme on Intravenous Medication Errors: A Controlled Before and After Study	To assess the effect of a clinical pharmacist-led training programme on clinically relevant errors during intravenous medication preparation and	Prospective- Observational. Sample and settings: Nurses working in the intensive care unit. The sample size was 177 intravenous doses per ward.	The most frequent errors were wrong administration techniques and wrong preparation. The prevalence of clinically relevant errors decreased significantly	Adopting a pharmacist-led programme was effective in reducing intravenous errors. But still need to improve strategies and the working environment to ensure the safety of administering medication.

	BMJ Qual Saf DOI: 10.1136/bmjqs-2013-002357	Vietnam	administration in a Vietnamese hospital.		from 64% to 48.9% in the ICU after the pharmacist program was effective.	
6.	Carayon P., et al. *Journal of Patient Safety*. DOI: 10.1097/PTS.0000000000000358 https://www.researchgate.net/publication/314166739 2017/ MEDLINE	Medication Safety in Two Intensive Care Units of a Community Teaching Hospital After Electronic Health Record Implementation: Sociotechnical and Human Factors Engineering Considerations United States	To assess the impact of EHR implementation on medication safety in two ICUs.	Prospective pre-post design (Quantitative). Sample and settings: Assessing 1,254 consecutive admissions to two ICUs before and after an HER implementation.	EHR implementation in two ICUs of a teaching hospital reduced the level of harm associated with potential and preventable ADEs.	Implementing EHR may improve medication safety. HER needs to be maintained regularly by engineering. Provide sufficient information for using the technology system to ensure the prevention of patient harm and improve medication administration safety.
7.	Johansen ET, et al. *Eur J Hosp Pharm*; 23:197–202. doi:10.1136/ejhpharm-2015-000751 2016/ MEDLINE	Effects of implementing a clinical pharmacist service in a mixed Norwegian ICU. Norway	To study the contribution of clinical pharmacists to identifying and solving DRPs. To monitor and classify questions. from the staff and use them as indicators of the need for a clinical pharmacist support service in the ICU.	Prospective design (Quantitative) Sample and settings: One pharmacist attended the ICU from Monday to Friday between 09:00 and 12:00 h. All patients admitted to the ward between these hours were reviewed by the pharmacists' from15 October 2012 to 14 October 2013.	The implementation of a clinical pharmacist service improved the safety and quality of the entire medication process in a Norwegian mixed ICU.	Continuous monitoring for administering medication can improve safety. The presence of pharmacists in critical care units may reduce drug-related problems. Formal lectures can increase the awareness of nurses and doctors toward safe medication administration. Pharmacist as a team member may increase collaboration and

						communication between different disciples which improves the safety of administering medication.
8.	Llapa-Rodriguez EO, Silva LSL, Menezes MO, De Oliveira JKA, Currie LM. *Rev Gaúcha Enferm*. 38(4):e2017-0029. doi: http://dx.doi.org/10.1590/1983-1447. 2017.04.2017-0029. 2017/ MEDLINE	Safe patient care in the preparation and administration of medicines Brazil	To evaluate the compliance of nursing care and the adhesion of nursing professionals to the items of verification for the safe administration of drugs in an intensive care unit.	Cross-sectional with Quantitative approach. Sample and settings: Observe 557 doses of administered drugs in the Surgical ICU.	The use of patient safety protocols of drug guides increases the effectiveness of care as well as the safety of patient care. The care was classified as safe in the consequent adhesion of the professionals to the right form and right via items, as well as the right care for the right patient, right medication, right dose, right registry, right orientation, and the right time.	Inclusion criteria were used. To reduce bias, participants were informed that they would be observed. There is no specific protocol for administering medication, the protocol adopted is to administer medication half hour before or after prescribed. It is not clear the factors that may influence medication administration safety. The study focused on analysis, so it is not possible to establish inter-professional relationships or adopt education programmes.
9.	Jie Xu J., et.al *Nursing Research*; Vol 66, No 5, 337–349	Facilitated Nurse Medication-Related Event Reporting to Improve Medication	To explore the utility of facilitated MRE reporting in identifying system deficiencies and the relationship between	Observational study Quantitative measures process.	Task/process deficiencies were the most common contributory factor for MREs.	The study conducted in 7 months and in different times of the day and observe different nurses.

	DOI: 10.1097/NNR.0000000000000240 2017/ Academic Search Premier	Management Quality and Safety in Intensive Care Units California, US	MREs and nurses' work in the ICU.	Sample and settings: A total of 153 observations were collected from 109 nurses. This study was conducted in three ICUs in three different teaching hospitals.	MRE occurrence was correlated with increased total task volume. MREs correlated with increased workload, especially during night shifts. Facilitated MRE reporting provides a robust information source about potential breakdowns in medication management safety and opportunities for system improvement.	Nurse self-reported may lead to bias.
10.	Maydana, T. Giraldo, L. Gonzalez, Z. Schachner, B. Mayan, J. Luna, D. Benitez, S. 2017 Stud Health Technol Inform	Barcode Medication Administration in ICU: Learning from Our Nurses Argentina	Describe the implementation of a BCMA system and evaluation of its use in the ICU.	Descriptive, observational with quantitative. Sample and settings: 100 nurses working in different shifts and weekends in the ICU. ICU consists of 38 beds; rooms are individual for each patient with a computer. Each room in the ICU was equipped with a barcode reader.	95% of participants indicated that the system reduces the probability of medication errors.	Argument about the accessibility, and the effectiveness of the use of barcodes to increase safety.
11.	Muroi, M. Shen, J. J. Angosta, A. 2017	Association of Medication Errors with Drug Classifications,	Examine the association between MEs and their	Observational study. Sample and settings: Observing 2336 ME incident	Most frequent medication-related events were in medical-surgical wards followed	Nurses are responsible for patient safety.

	Appl Nurs Res	Clinical Units, and Consequence of Errors: Are They Related? US	consequences to patients.	reports, 1276 ME case group, 1060 control group.	by the intensive care unit.	Providing nurses with a supportive work environment, and resources for continuing education and training.
12.	Cavalaro, Jessika Oliveira Camillo, Nadia Raquel Suzini Oliveira, João Lucas Campos de Inoue, Kelly Cristina Ferreira, Andressa Martins Dias Matsuda, Laura Misue 2020	Use of the infusion pump in intensive care: perspectives of the nursing team Brazil	Analyse the perceptions of nursing professionals about the use of the infusion pump in their daily lives in intensive care.	Descriptive-exploratory. Qualitative approach. Sample and settings: 17 nurses and 20 technicians volumetric IP was the focus.	Highlight the positive and negative aspects of using infusion pumps.	The drop sensor cable is considered an obstacle. Suggest solving difficulties related to the drop sensor and alarm system.
13.	Halbesleben J., Savage G., Wakefield D., Wakefield B., *Health Care Manage Rev*; 35(2), 124-133 2010/ CINAHL	Rework and workarounds in the nurse medication administration process: Implications for work processes and patient safety United States	To examine rework and workarounds in hospital medication administration processes.	Qualitative Semi-structural interview. Sample and settings: 58 ICU staff and supervisory, nurses were selected from four different hospitals.	A total of 12 blocks were reported by the participants. Based on the analysis, blocks were categorized as related to information exchange, information entry, and internal supply chain issues.	A decentralized pharmacist on the unit may reduce workflow blocks (and, thus, workarounds and rework). Work process redesign may further address the problems of workarounds and rework.
14.	Stamp, Kelly D.; Willis, Danny G. 2010; 25 Issue 3 Journal of Nursing Care Quality	Nurse Interruptions Pre- and Postimplementation of a Point-of-Care Medication Administration System US	To identify and describe the types of interruptions and their nature pre- and post-POC implementation in participating RNs' accounts of the medication administration.	Qualitative method. Sample and settings: A purposive sample of 36 RNs who worked in intermediate medical-surgical intensive care and acute ante/postpartum care units.	Identified the types of interruptions including computer freezing and scanning unscannable.	This study described the types of interruptions that may influence medication safety pre-post POC implementation.

15.	Mansour M., *Nurse Researcher*. 18, 4, 28-32 2011/ Academic Search Premier	Methodological and ethical challenges in investigating the safety of medication administration. UK	To highlight methodological and ethical challenges that the researcher faced when conducting a study of the safety of medication administration in adult critical care.	Qualitative semi-structured interview. Sample and settings: 33 Adult critical care nurses.	Challenges that face authors in conducting research investigating safe medication administration. Approaching the participants for "expert" opinions, rather than "error-makers", helped to establish early rapport with participants.	The advantage is that all nurses were band 7 which means that all of them were adult critical care nurses. Focus on the methodology of recruiting participants in a study of medication administration safety, the results are not clear.
16.	Gimenes FRE, Marck PB, Atila EG, Cassiani SHB. *International Journal of Nursing Practice*; 21: 741–748 doi:10.1111/ijn.12304 2015/ Academic Search Premier	Engaging nurses to strengthen medication safety: Fostering and capturing change with restorative photographic research methods São Paulo, Brazil	To find out if researchers could use visual methods to engage practitioners and researchers in collaborative study and improvement of a complex work environment. The research question was: Could restorative photographic research methods help Brazilian ICU nurses to (re)think and improve their approach to medication safety issues in their work environment?	Restorative research methods. (Qualitative). Sample and settings: 5 registered nurses and 18 nursing technicians. Brazilian ICU of a medium-sized general hospital in São Paulo state, including 10 beds for ICU.	The results demonstrated that restorative photographic research methods enabled participants to (re)think and redesign their work environment in keeping with several recommended practices for improving medication management.	Photographs help in redesigning the work environment. This can't apply in all critical situations especially when there is an increase in task work. This method is visualized which can detect some tasks that didn't noticed during work, but it didn't represent nurses' attitudes and perceptions.

17.	Gimenes F., Torrieri M., Gabriel C., Rocha F., Silva A., Shasanmi R., Cassiani S., Journal of Clinical Nursing. Vol 25 (7-8), pp. 1073-1085. 2016/ APA PsycInfo	Applying an ecological restoration approach to study patient safety culture in an intensive care unit. Brazil	To gain an understanding of medication safety and other quality issues in a Brazilian ICU, using a restorative approach.	Qualitative Study. Sample and settings: 27 nurses and five physicians working in Brazilian ICUs.	The findings demonstrated the effectiveness of a restorative research approach for: • Supporting an ICU team to study the safety culture in place, the supports existing in the ICU that shape medication safety. • The barriers that impede safe medication management. The solutions to improve medication safety and the creation of a better medication safety culture.	Photographic methods can be reviewed at any time. Can evaluate the patient safety culture. Photos can't describe nurses' perceptions of the safe administration of medication.
18.	Häggström M, et al. Intensive Crit Care Nurs http://dx.doi.org/10.1016/j.iccn.2016.09.002 2016/ CINAHL	Learning to manage vasoactive drugs——A qualitative interview study with critical care nurses. Sweden	This study aimed to describe the experiences of critical care nurses learning to manage vasoactive drugs and to highlight the competence required to manage vasoactive drugs.	Qualitative design Semi-structural interview. Sample and settings: Twelve critical care nurses from three hospitals in Sweden were interviewed.	The findings revealed the theme ''becoming proficient requires accuracy, training, and pre-caution,'' which is further described in the categories: ''sources for knowledge,'' ''safety thinking'' and ''specific skills.'' Learning included developing cognitive, psychomotor, and effective skills.	Education is essential for safe medication administration specifically high-alert medications that are used in critical care units.

19.	Johnson M., et al. *Journal of Nursing Care Quality*; Vol. 00, No. 00, pp. 1–9 DOI: 10.1097/NCQ.0000000000000260 2017/ MEDLINE	Predictability of Interruptions During Medication Administration with Related Behavioural Management Strategies Australia	To examine whether interruptions were predictable or unpredictable and the strategies used by nurses to deal with the interruptions.	Qualitative study method. Sample and settings: Medical/surgical nurses, critical care nurses, nursing unit managers, clinical nurse specialists, and clinical nurse educators.	The most common sources of interruptions described by participants were initiated by nurses, often for checking medications or obtaining medication keys. This exploratory research has delivered a framework for understanding and providing education relating to predictable and unpredictable interruptions and their management using behavioural strategies.	The study represents the advantage of using strategies to decrease interruptions during medication administration. Educational programme about strategies to reduce interruption (predictable or unpredictable). The focus group in the critical care unit was small.
20.	Sessions, Laura C. Nemeth, Lynne S. Catchpole, Kenneth Kelechi, Teresa J. **2019. 57:12** Journal of Advanced Nursing (John Wiley & Sons, Inc.). DOI: 10.1111/jan.14173 Academic Search Premier	Nurses' perceptions of high-alert medication administration safety: A qualitative descriptive study US	This study aimed to determine nurses' perceptions of support and barriers to high-alert medication (HAM) administration safety.	Design: A qualitative descriptive design was used. Methods: Eighteen acute care nurses were interviewed about HAM administration practices. Sample and settings: Eighteen registered nurses (RNs) were recruited from two hospitals. Nurses worked in critical care, intensive care (ICU), telemetry, emergency department, oncology, and medical and surgical units.	Findings highlighted the importance of intra- and interprofessional collaboration, nurse engagement, and incorporating the patient in HAM safety.	HAM safety strategies are not consistently used. An organizational culture that supports collaboration, education on safe HAM practices, pragmatic HAM policies, and enhanced technology are recommended to prevent HAM errors.

Table 2-5 (b): Narrative Reviews Framework (Included Systematic Review Studies)

	Author/s Publication date	Title/country	Aim of the study	Methodology/ Design/Method	Results	Reflection
1.	Mansour M., James V., and Edgley A., Nursing in Critical Care. British Association of Critical Care Nurses. Vol 17 No 4 2012/ Academic Search Premier	Investigating the safety of medication administration in adult critical care settings. UK	To explore the development and use of the Organizational Safety Space Model in the industrial context and consider its application in investigating the safety of medication administration in adult critical care settings.	Systematic Review. Sample: 51 studies were considered relevant CINAHL, Medline, British Nursing Index (BNI), and PsychInfo databases were searched for peer-reviewed papers, published in English, published between the years 1970 to 2011.	This study paper provides a new perspective on the investigation of the safety of medication administration. Nurses were reported to have developed significant expertise in medication administration, and they are bound to offer a unique insight, perhaps among others, into those organizational aspects that influence the safety of medication administration in adult critical care settings.	This model has not fully investigated the perspective of nurses toward safe medication administration. It is useful to examine the application of the Organizational Safety Space Model in investigating the aspects that can influence the safety of medication administration in critical care settings.
2.	Camerini F., da Silva L., Muniz Mira A., *Journal of Research, Fundamental Care Online*. 6(4):1655-1665 DOI: 10.9789/2175-5361. 2014/ CINAHL	Nursing actions for a safe medications administration: an integrative review Brazil	To present the nursing actions published on error prevention during the administration of the medication in the ICU.	Systematic Review. Sample: Studies about the nursing actions that minimize the occurrence of errors during medication administration, published between the years 2005 and	It was clear that the most cited actions to prevent errors during the administration of the medication were: to adopt protocols and guidelines for the medication administration; to identify the drug to be	Building up protocols and guidelines for administering medication can improve the safety of administering medication. Using barcodes may be efficient in ensuring that the correct medication will be

				2011 and indexed in the LILACS, BDENF, and SciELO databases.	administered in the patient through barcodes; and to use incompatible connectors in different routes.	administered to the right patient. Other databases can be used to detect any further studies that discuss the importance of using barcodes in improving safe medication administration.
3.	Kane-Gill S., et al *Critical Care Medicine*. Vol. 45 Issue 9, pe877-e915. DOI: 10.1097/CCM.0000000000002533 www.ccmjournal.org 2017/ Academic Search Premier	Clinical Practice Guideline: Safe Medication Use in the ICU. United States	To provide ICU clinicians with evidence-based guidance on safe medication use practices for the critically ill.	Literature review. Sample: PubMed, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, CINAHL, Scopus, and ISI Web of Science Selected studies were between March 2013 to December 2015.	Initiate guidelines composed of three key components: 1) environment and patient, 2) the medication use process, and 3) the patient safety surveillance system.	Provide evidence-based guidelines for a safe environment. The selected studies were specified during a short period. Focus on adhering to education and using technology to improve the safe medication process. The importance of pharmacists' participation in the medication process to reduce MEs and ADEs.

2.6 Critical Appraisal of the Studies Included in the Narrative Review

The Critical Appraisal Skill Programme checklist (CASP) was used to assess the quality of the studies included in the final selection. Using the appraisal tool helps identify research problems in the literature and detect gaps in studies.

Critical appraisal is a systematic process of examining research studies before using the evidence to form a decision. This tool allows one to make sense of research evidence and close the gap between research and practice (Long et al., 2020). Furthermore, it provides a systematic method for evaluating the validity, findings, strength, and usefulness of published research (Booth et al., 2016). Long et al. (2020) report that the Critical Appraisal Skills Programme (CASP) instrument is the most used tool for quality appraisal in health-related qualitative evidence synthesis.
In general, the analysed studies are robust overall; the results were grouped, identified, and linked to the study topic; and the CASP analysis of the studies was tabulated as shown in Appendix 1.

The included studies were tabulated with a full description of each study, including the studied population, methods, and results. The description helps to show the extracted data from the study that contributes to the overall thematic data synthesis (Petticrew & Roberts, 2006). However, tabulating the study findings is important for data synthesis, which enables me to link the parts of the analysed data and assemble them in a new order (Jesson et al., 2011). In the synthesis phase, similar extracted data was gathered to make a link and synthesis a new story that contributes to knowledge and helps me to find the knowledge gap.

2.7 Narrative Review of the Included Studies

Themes were developed based on the study question. The benefit of thematic analysis is its flexibility, which provides rich details within the data. Additionally, thematic analysis is used to

produce comprehensive findings that make sense of complex data (Wiltshire & Ronkainen, 2021). From the collected data, the key points were highlighted with a set of themes that were derived from the included articles (Higgins et al., 2019; Leavy, 2017). The emerging themes were grouped into similar concepts to make them workable (Higgins et al., 2019).

The discussion and organising of the synthesised themes that were extracted from the included studies were based on the six phases of thematic analysis:

1. Be familiar with the data in depth.
2. Develop codes according to the content of the data set.
3. Sort codes by themes.
4. Review themes and consider the validity of themes to the data set.
5. Themes were defined and named.
6. Each theme is considered with the others (Braun & Clarke, 2006).

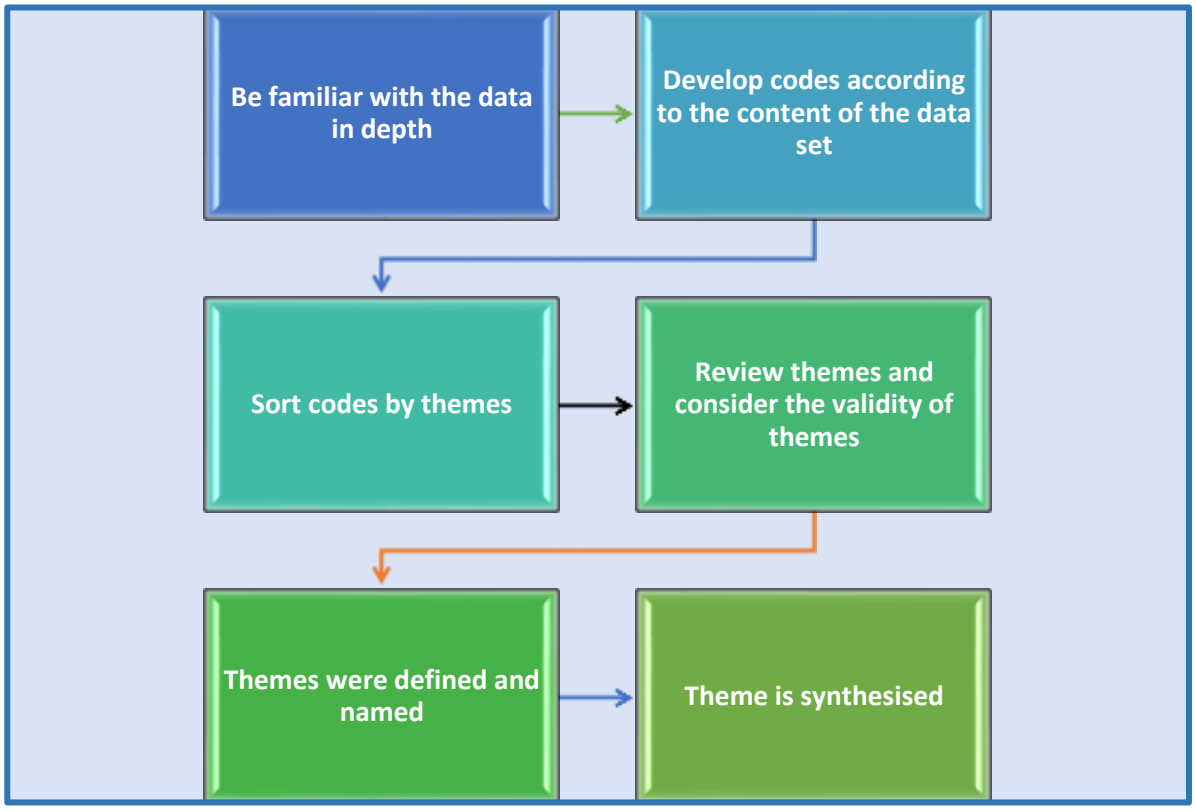


Figure 2-3: Mind map of the narrative analytic process.

The following table (2-6) shows the synthesised themes and the number of articles that cover each theme, taking into consideration that there were no duplications of the four studies that were included in the systematic review study by Kane-Gill et al. (2017) within each synthesised theme. Each theme is discussed thoroughly in the following sections.

Table 2-6: Number of studies included in each synthesised theme.

	Theme	Number of Studies
1.	Protocols and guidelines for medication administration safety in critical care environment (Camerini et al., 2014; Gimenes et al., 2015; Gimenes et al., 2016; Halbesleben et al., 2010; Irajpour et al., 2019; Johansen et al., 2016; Johnson et al., 2017; Kane-Gill et al., 2017; Llapa-Rodriguez et al., 2017).	9
2.	Educational programme for safe medication administration in critical care units (Esfahani et al., 2016; Häggström et al., 2017; Irajpour et al., 2019; Johansen et al., 2016; Mansour, 2011; Muroi et al., 2017; Nguyen et al., 2014).	7
3.	Critical care environment elements that impede safe medication administration (Gimenes et al., 2016; Llapa-Rodriguez et al., 2017; Mansour et al., 2012; Sessions et al., 2019; Stamp, 2010; Xu et al., 2017).	6
4.	The technology used influence medication administration safety in critical care units (Camerini et al., 2014; Carayon et al., 2017; Carayon et al., 2014; Cavalaro et al., 2020; Maydana et al., 2017; Poon et al., 2010; Sessions et al., 2019).	7

**Note: some papers fell within more than one theme, so the total is >23*

A discussion of the literature around the themes is followed by a discussion of the methods used in the identified studies and areas where further research is needed.

The following figure shows the synthesised themes extracted from the reviewed studies (Figure 2-4), which is followed by a description of the synthesised themes.

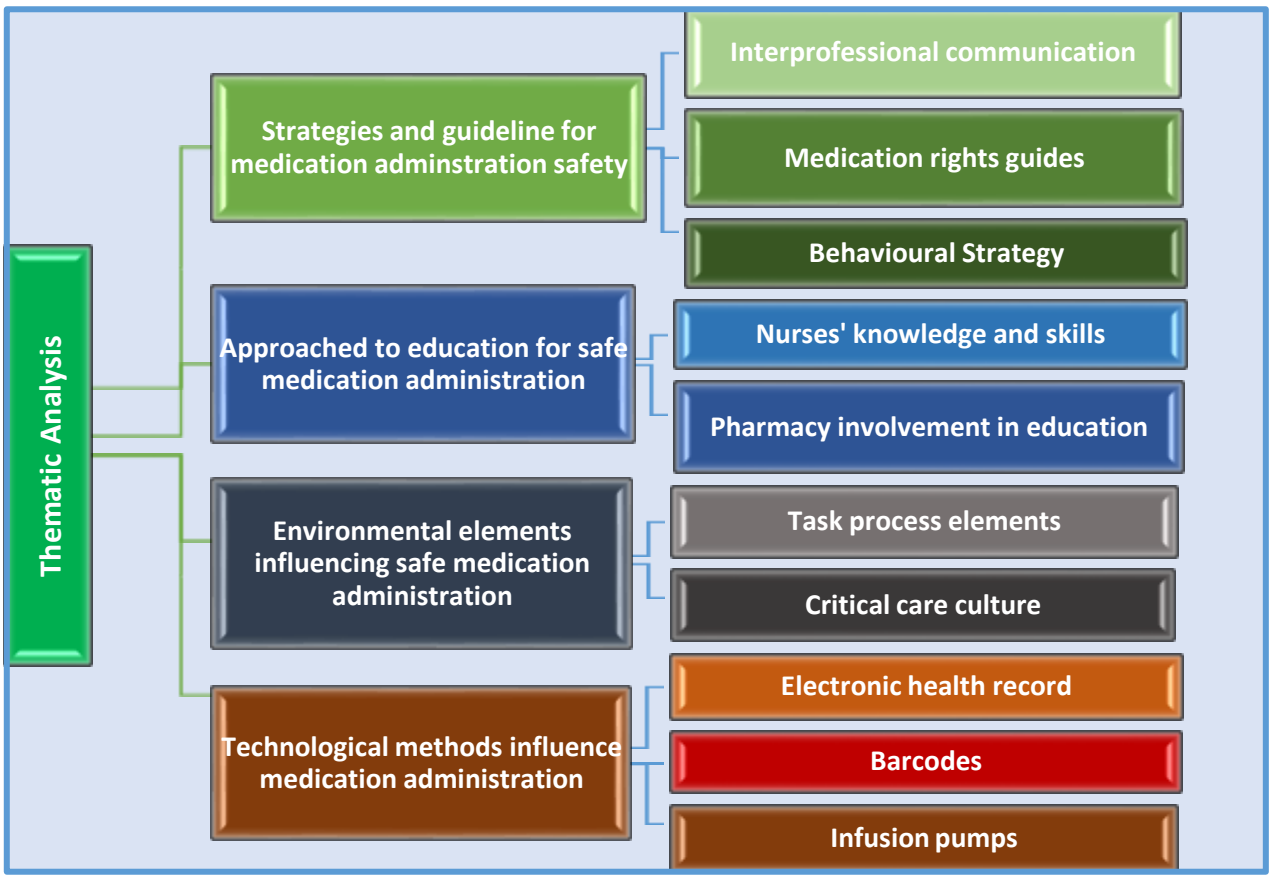


Figure 2-4: Synthesised themes.

2.7.1 Theme One: Strategies and guidelines for medication administration safety in a critical care environment.

This section discusses studies that focused on protocols, guidelines, and strategies used to enhance medication administration safety, including the elements that emerged from the synthesised theme. Nine studies focused on protocols and standards used in adult intensive care units to ensure safe medication administration. Four of these studies were qualitative (Gimenes et al., 2015; Gimenes et al., 2016; Halbesleben et al., 2010; Johnson et al., 2018), two were quantitative method (Johansen et al., 2016; Llapa-Rodriguez et al., 2017), two studies were systematic review (Camerini et al., 2014; Kane-Gill et al., 2017), and one was a quasi-experiment (Irajpour et al., 2019). Worldwide studies concerned with protocols, guidelines, and strategies for safe medication administration based on their origin: the quasi-experiment study was conducted

in Iran; the two quantitative studies were from Brazil, and one was in Norway; and each of the four qualitative studies was conducted in Brazil, Australia, and the United States; one of the systematic review studies was conducted in the US, while the other was in Brazil.

2.7.1.1 Inter-professional communication

Irajpour et al. (2019) highlighted the importance of an inter-professional education strategy that depends on the presence of the pharmacist in the critical care units to provide knowledge about preparing and administering medications. This quasi-experimental study investigated the effect of small-group discussions related to medication administration. They described that implementing an educational programme helps in medication calculation, dilution, and administration, and the findings showed that increased collaboration between healthcare providers enhances the safety of patients regarding administering medication. The authors explained that adopting the inter-professional programme in the orientation period for the staff reduces medication errors and enhances medication administration safety through continuous workshops focusing on a small group of healthcare providers.

The presence of a pharmacist in the critical care units is considered an important strategy to support staff, ensure medication safety, and reduce adverse drug events by providing continuous monitoring and answering questions related to medication administration. Also, the presence of the pharmacist enables them to classify the types of questions to be used as indicators to support the medication administration service system in critical care units (Johansen et al., 2016; Kane-Gill et al., 2017). The importance of pharmacists' presence aimed to redesign the work process by addressing the problem while administering medication. This strategy of redesigning work is based on workarounds and rework by using blocks that are classified into three categories: information exchange, which is associated with interprofessional communication; information entry, which

concerns using technological methods to ensure medication charting; and the internal supply chain, which focuses on the needed medication. The pharmacist will be able to provide essential information to critical care nurses, reducing workload and ensuring patient and medication safety (Halbesleben et al., 2010).

2.7.1.2 Medication rights guides

A study was conducted to observe the use of patient safety protocols for drug guidance in terms of using patients' rights, including the right form of medication, the right route, the right medication, the right dose, the right registry, the right orientation, and the right time, as well as the right care for the right patient. The results of this cross-sectional study showed that the majority of nurses reported a lack of access to institutional safety protocols (Llapa-Rodriguez et al., 2017).

2.7.1.3 Behavioural strategy

A behavioural strategy was used to examine whether intensive care nurses and medical-surgical nurses can manage interruptions while administering medication and whether these interruptions are predictable or unpredictable. The use of a behavioural strategy may block or stop the interruptions that influence medication administration in critical care units. Behavioural strategies that may be used include using signs such as "Do Not Disturb," wearing a vest while preparing and administering medications, or asking for help from another healthcare professional (Johnson et al., 2018). Using photographs as a research method helps in understanding the critical care environment and enables researchers and healthcare professionals to improve and control the complexity of this critical environment. The use of reviewed photos is considered evidence to redesign the work environment. In addition to studying the factors that contribute to medication safety, this strategy enables nurses to (re)think and improve their approach to safe medication administration. This visible strategy enables healthcare professionals to review their day-to-day

work, detect the barriers that contribute to safe medication management, and shape medication safety culture (Gimenes et al., 2015; Gimenes et al., 2016).

In conclusion, implementing strategies helps promote the safety of administering medication in critical care units and could be applicable, but some of these strategies need to be more thoroughly investigated to be adopted safely.

2.7.2 Theme Two: Approaches to education for safe medication administration in critical care units.

Seven studies were identified to focus on providing education to promote safe medication administration in critical care units. These studies consisted of two studies that used the qualitative research method (Häggström et al., 2017; Mansour, 2011), one of which originated in Sweden and one in the UK; three studies used the quantitative method; one was from Norway (Johansen et al., 2016); one was from Vietnam (Nguyen et al., 2014); and one was conducted in the US (Muroi et al., 2017); and two studies used the quasi-experiment method (Esfahani et al., 2016; Irajpour et al., 2019) both originated from Iran.

2.7.2.1 Nurses' knowledge and skills

The authors of a qualitative study reported that providing and supporting nurses with continuous education and training regarding the effective use of incident reports may help in delivering effective and safe high-risk medications administered in adult critical care units. According to the results of this study, 24.7% of medications administered in critical care units caused harm to patients, and 10% of these medications were cardiovascular medications that caused harm to patients when administered (Muroi et al., 2017).

A qualitative study conducted by Häggström et al., (2017) reported in their study that critical care nurses should require specific skills to be competent in safe medication administration, and they

described the experience of critical care nurses in managing vasoactive drugs as having knowledge, developing cognitive and being skilful, the authors revealed that becoming professional requires accuracy, training, and pre-caution, in their study they described the competencies as:

1. Sources of knowledge to be obtained from specialists, colleagues, and learning from experience,
2. Safety thinking which means being careful in preparing medications, knowing what to do if a failure occurs,
3. Gaining specific skills by knowing how to titrate doses, integrating technology, and being calm in different situations while administering medications.

The required knowledge is related to pharmacology, hemodynamics, and vasoactive medications; they proposed that the more patients that nurses care for, the more experienced they will be. A study by Mansour (2011) proposed that adopting a snowball sample method to investigate safe medication administration in a critical environment is a useful opportunity to explore how participants can explain their experiences and practices to recruit more participants in the study. The researcher selected experienced participants working in intensive care units to investigate safe medication administration and how they could transfer their knowledge to the snowball participants to approach the safety of medication administration. The findings of the study revealed that establishing early rapport by approaching "experts" is better than learning from "error-makers"(Mansour, 2011).

2.7.2.2 Pharmacy involvement in education

A study by Esfahani et al. (2016) was implemented to investigate the role of nurses before and after administering medications in critical care units to improve safety. A clinical supervision

model in critical care units was adopted to narrow the gap between theory and practice. A safety instruction programme was provided for the studied group regarding high-risk medication administration that included heparin, norepinephrine, dopamine, dobutamine, and warfarin. The results showed nurses' accountability for the improvement of high-risk medication safety practices and being more organised in their actions. In addition, the positive outcome of this model is patient safety (Esfahani et al., 2016). While another study described the importance of pharmacists' presence in adult critical care units to promote safe intravenous medication administration, by providing educational programmes regarding techniques used to administer medications and decreasing associated errors. Education provided by pharmacists was significantly effective in reducing medication errors, as reported (Nguyen et al., 2014). The errors decreased among intravenous doses administered in critical care units; the errors decreased 2.6 times after implementing a pharmacist-led educational programme.

However, small group discussions as a teaching method can be used by implementing scenarios related to medication safety to promote patient safety and reduce medication events. These sessions are managed by pharmacists who should be present in the intensive care unit as a part of the education programme to provide knowledge regarding medication calculation, methods used for dilution, oral administration of medication, the role of medication reconciliation, and adverse drug reactions (Irajpour et al., 2019). Johansen et al., (2016) reported in their study that providing lectures for nurses by clinical pharmacists may improve a safe environment for administering medication, and this can be achieved by providing information regarding the indication of medication, unnecessary drugs, dose route, adverse drug reactions, and interactions, and adjusting dose according to patient age and body mass index.

In summary, the studies revealed the importance of clinical pharmacist presence in the field of medication administration safety in critical care units to provide information related to calculating the dose, route of administration, process of dilution, and adverse events of medications.

2.7.3 Theme Three: Environmental elements influencing safe medication administration.

The studies that explored elements that influence safe medication administration in adult critical care environments were very limited. Six studies focused on medication-related events in critical care units: three used qualitative methods; one was conducted in Brazil (Gimenes et al., 2016), and two originated from the United States (Sessions et al., 2019; Stamp, 2010); two studies used quantitative methods, one from the United States (Xu et al., 2017), one from Brazil (Llapa-Rodriguez et al., 2017); and one systematic review that was conducted in the UK (Mansour et al., 2012).

2.7.3.1 Task process elements

Many factors influence the quality and safety of administering medication in critical care, including a messy medication sheet with sloppy handwriting, excessive information copied to MARs, and missing signatures of nurses after administering medication and before leaving shift. In addition, inadequate information access related to medication administration negatively influences the process of medication management (Stamp, 2010).

An observational study explored medication-related events by observing nurses working in intensive care units to identify the task-process factors that contribute to medication-related events. It was reported that medication-related events had a relationship with the tasks performed by nurses and those who provide direct care to patients. The study explained that most medication-related events increased during night shifts and occurred during medication administration, in addition to the number of tasks performed per hour. However, reporting can

improve medication administration management, but not all events can be captured by the traditional report method, as concluded by the authors (Xu et al., 2017).

Llapa-Rodriguez et al. (2017) explained that unlabelled, prepared medication is another factor contributing to the safety of medications in critical care units, and the study relied on medication safety due to work overload and an inadequate number of employees. In Session et al (2019) study, nurses explained that organizational factors included the workload and distractions influencing the safety of administering medications, as well as the nurses' competencies and peer collaboration influencing safety by providing appropriate information regarding administering intravenous medication in the critical care environment, for example, administering heparin, insulin, and hydralazine.

2.7.3.2 Critical care culture

The study by Gimenes et al. (2016) explained that by establishing a safe environment for managing medications, visualized methods could be used to identify factors influencing safety. The contributing factors that were described included a lack of efficient communication between pharmacy staff and nurses; incorrect packaging of medication within intensive care units; look-alike medication; and fear of reporting medication errors or adverse events. The visualization method allows nurses to visualize the critical care environment and reflect on the day's work to improve medication safety (Gimenes et al., 2016; Mansour et al., 2012).

The overall factors that were explored in the study concluded that working hours, the number of tasks performed at a time, the type of interruptions, and the environment of the critical care unit influence medication administration.

2.7.4 Theme Four: Technological methods that influence medication administration safety in critical care units.

Adopting technological methods in critical care units can contribute to medication administration safety; these methods include computerized physician order entry and smart pump machines, which are considered important methods for enhancing the safety of administering medications. Furthermore, the studies described how adopting technological methods reduced medication events in critical care units. The studies that focused on these methods were seven worldwide: three used qualitative methods; two were carried out in the United States (Sessions et al., 2019; Stamp et al., 2010); one was from Brazil (Cavalaro et al., 2020); three used quantitative methods (Carayon et al., 2017; Carayon et al., 2014); one was carried out in Argentina (Maydana et al., 2017); one used a quasi-experiment method that was conducted in the United States (Poon et al., 2010); and the study used systematic review was from Brazil (Camerini et al., 2014).

2.7.4.1 Electronic health record

Nurses emphasised the importance of using technology to promote medication administration safety in critical care units; they reported that the presence of a computerised system allows nurses to easily access the patient's data., As well as the computerised setting alarm reminds nurses of the diagnostic results and assessment before administering medication, such as getting the result of the glucose level before administering insulin or during the administration of intravenous insulin (Sessions et al., 2019).

A study by Carayon et al. (2017) assessed the impact of using electronic health records on medication safety in critical care units. Medication safety was classified into three categories:

1. No harm event in which medication does not cause harm to the patient.

2. Potentially preventable harm in which an error can be interrupted, and the patient does not experience harm.
3. Actual preventable harm in which medication errors harmed patients. The severity of harm ranged from fatal to life-threatening, serious, and significant.

The result of the study showed a decrease in potential preventable adverse drug events after implementing electronic health records, an improvement in medication safety, and a reduction in the level of harm (Carayon et al., 2017).

Carayon et al (2014) described implementing computerized physician order entry as ~~is~~ necessary to improve medication administration safety, as most errors occur at the level of prescribing and administration. Furthermore, the study concluded that using CPOE helps reduce errors, adverse events, duplication of orders, inappropriate abbreviations, and omission of orders (Carayon et al., 2014).

2.7.4.2 Barcodes

The use of barcode technology influences the safety of medication administration by reducing the amount of information included in MARs and preventing messy medication sheets and unclear handwriting. This technology system promotes medication administration safety and, in return, enhances the patient's safety (Stamp, 2010). However, using bar-code eMAR technology to ensure the safety of administering the right medication to the right patient at the right time is recommended. Once the pharmacist approves the computerized physician order, nurses will be able to scan the barcode on the patient's wrist and the medication to be administered, and the scanned dose will be automatically documented. The result of this study showed the significant effectiveness of using barcodes in reducing medication administration errors, dose errors, and medication documentation errors (Poon et al., 2010). Other studies showed that nurses were

satisfied with using the barcode technology method, reporting that using a barcode minimised the medication's incidence of errors during the administering process and that they should be trained to adopt this effective method to enhance patients' safety (Camerini et al., 2014; Maydana et al., 2017).

2.7.4.3 Infusion pumps

From the point of view of nurses, they control almost all medications administered in critical care units, and they consider infusion pumps part of their daily lives in intensive care units. Furthermore, infusion pumps can save patients' lives; conversely, nurses reported that infusion pumps' alarms annoyed them, and this problem should be solved (Cavalaro et al., 2020).

In conclusion, the use of technological methods can reduce medication adverse events and improve the safety of patients. Technological methods include using electronic records, smart infusion pumps, and the barcode of medication to ensure administering the right medication to the right patient with the right dose and the right calculation according to the patient's age and body weight.

2.8 Discussion of the Research Methods Used and the Gap Identification.

Based on exploring previous studies that focused on my study, there were a limited number of factors that influence nurses' approaches to safe medication administration in a critical care environment.

The reviewed studies in this chapter that used quantitative methods have explored the influence of adopting strategies and protocols, inter-professional educational programmes, and advanced technology to improve the safety of administering medications in critical care units, and in turn, the factors that may influence drug-related events and how to promote the safety of administering medications (Carayon et al., 2017; Carayon et al., 2014; Cavalaro et al., 2020; Johansen et al., 2016; Llapa-Rodriguez et al., 2017; Maydana et al., 2017; Muroi et al., 2017; Nguyen et al., 2014; Xu et al., 2017).

The studies that used the cross-sectional method explored the influence of effective communication between healthcare professionals and the use of educational programmes on the safety of medication administration (Llapa-Rodriguez et al., 2017). Researchers in their studies revealed that the presence of pharmacists improved the safety of the medication process; conversely, pharmacists cannot be available on all shifts to provide the necessary information regarding medication (Johansen et al., 2016; Nguyen et al., 2014).

In the study of Jie Xu et al. (2017), the authors considered their study to be the first to describe the correlation between medication-related events and the number of tasks worked by intensive care nurses. Nurses' total task work was a barrier to attending lectures and workshops and failed to capture medication adverse events. While studies reported that using technology (HER, CPOE) helps in improving the safety of medication administration, these methods are still not sufficient

to prevent physician order mistakes, duplication of orders, omission of orders, and wrong information (Carayon et al., 2017; Carayon et al., 2014; Gimenes et al., 2015).

The use of quantitative studies does not answer the question of "why" nurses' education or how using technology may influence nurses' approach to administering medication in critical care units. Self-reported questionnaires gather information directly (Wisker, 2008), and cannot tell us exactly why administering medication safely can be influenced by the critical care environment. In addition, this method cannot tell us why adverse events occurred during the administration of medication or how safety was influenced.

Eight studies used the qualitative method (Gimenes et al., 2015; Gimenes et al., 2016; Häggström et al., 2017; Halbesleben et al., 2010; Johnson et al., 2017; Mansour, 2011; Sessions et al., 2019; Stamp, 2010). The qualitative research method is used to get detailed and sensitive information in depth based on experience and feelings (Dawson, 2019; Wisker, 2008). The use of behaviour strategies was supposed to manage the predictable and unpredictable interruptions during medication administration in critical care units. In the study by Johnson et al., (2017), they concluded in their findings that the behaviour strategy did not find interventional support to reduce interruptions, and this strategy had to be more applicable in medical-surgical wards than in critical care units. Mansour (2011) found in his study that early rapport can promote safe medication administration in critical care units. In addition, he concluded that learning from experts is more effective than making errors; in addition, the findings of Halbesleben et al (2010) study, emphasized the importance of the presence of pharmacists as one healthcare professional in critical care units who can improve medication administration safety by providing pharmacological knowledge to ensure the safety of medication administration (Häggström et al., 2017).

Gimenes et al., 2015; Gimenes et al., 2016; in their studies based on reevaluating the environment in which medication administration took place, suggested that using a visualized strategy enables healthcare providers to evaluate the work environment for medication administration safety by reviewing photos; on the contrary, they found that photos cannot capture all the details of the surrounding work place, and moreover, these studies focused only on nurses without taking into consideration other healthcare providers who were involved in medication administration.

Three studies used the Quasi-experimental method to evaluate educational intervention in critical care units (Esfahani et al., 2016; Irajpour et al., 2019; Poon et al., 2010), the studies were conducted to examine the effectiveness of inter-professional education in critical care units in addition to the clinical supervision model during administering medications, as well as the effectiveness of using a barcode medication administration system to ensure the safety of medication administration, it was concluded that clinical supervision can narrow the gap between practice and theory, authors suggested further researches to promote the safety of patients, and they recommended that educational programme should be included in the orientation period for nurses and physician who will work in critical care units. Further research may be developed to evaluate the effectiveness of these strategies.

According to Irajpour et al. (2019) and Johansen et al. (2016), they described in their studies the importance of inter-professional education, particularly the presence of pharmacists in critical care units to provide lectures and group discussions related to the medication administration process. They described how this strategy helps enhance the safety of medication administration. Although Halbesleben et al. (2010) praised the presence of pharmacists in critical care units, they explained that the impact of their presence on nurses' rework and workarounds for administering medication safely cannot be detected.

However, the disadvantages of these studies are that they focused on implementing inter-professional education that is provided by pharmacists during a specific period, which was during day shifts only, with no availability of educational support during evening and night shifts. Otherwise, the studied sample were nurses, without taking into consideration that the safety of medication starts at the level of prescribing the drug by the physician.

In relation to protocols used to enhance medication administration, Llapa-Rodriguez et al. (2017) emphasized the importance of adhering to medication administration protocols to ensure the safety of the process in the critical care environment. Also, the study described that the safety of medication administration is influenced by the number of nurses available as well as the effectiveness of communication between healthcare providers in critical care units.

Other studies explained that adopting behavioural strategies enables healthcare providers to manage the rate of interruptions (Johnson et al., 2018), additionally, to review the environment, and re(think) about the process of medication administration in critical care units (Gimenes et al., 2015; Gimenes et al., 2016). The disadvantage of these strategies is that they need to be re-evaluated, as they are more useful in medical-surgical wards than critical care units (Johnson et al., 2018). In addition, the visualized strategy cannot describe the perception of nurses toward safe medication administration and their perception of the critical environment (Gimenes et al., 2015; Gimenes et al., 2016).

Häggström et al. (2016) and Mansour (2011) discussed in their studies that learning from experience and positive discussion would enhance competence in knowledge and practice and enhance the safety of medication administration rather than learning from mistakes. The disadvantages of these studies were that they focused on a small sample (Mansour, 2011), and most of the sample were females (Häggström et al., 2017).

Education has a positive influence on the quality of the medication process in critical care units. Implementing pharmacists to supervise nurses and physicians concerning the medication administration process (Esfahani et al., 2016; Irajpour et al., 2019; Johansen et al., 2016), one of the studies emphasized that education and training should be provided during the orientation period (Irajpour et al., 2019). From the point of view of Johansen et al. (2016), pharmacists cannot be available during night shifts and weekends, so they will not be able to answer any questions regarding the medication process when needed. So, it was recommended further research concerning high-risk medication and factors influencing their administration (Esfahani et al., 2016).

In relation to the factors that may contribute to the safety of medication administration in critical care units that nurses adhere to as consequences of tasks during administering medication (Llapa-Rodriguez et al., 2017; Xu et al., 2017), nurses might need to review their existing medication administration by taking photos (Gimenes et al., 2016). The authors described how taking photos enables nurses to evaluate the strengths and weaknesses of the surrounding environment while preparing and administering medications. The negative point of this type of research is the insufficient relationship between participants and researchers to describe the impact of participants on medication administration safety.

It was clear the impact of implementing technology methods on the enhancement of medication administration in critical care units, including the use of smart infusion pumps (Cavalaro et al., 2020), electronic health records, computerized physician order entry (Carayon et al., 2014; Maydana et al., 2017; Poon et al., 2010), and using a barcode to identify the type of medication to be administered (Maydana et al., 2017; Poon et al., 2010; Stamp, 2010). It was recommended by researchers to conduct further research to investigate the safety of medication administration within a critical care environment (Cavalaro et al., 2020); in addition, it was recommended to

improve the EHR system to promote the safety of medication administration in critical care units (Carayon et al., 2017; Carayon et al., 2014).

An additional search was conducted to detect recent studies published between 2020 and 2023 via all databases that were searched earlier that focused on the factors influencing medication administration safely. Four additional studies were found; three of them used the descriptive quantitative method (Arboit et al., 2020; Carayon et al., 2021; Santiago et al., 2020), and one study used a quasi-experimental method (Camerini et al., 2022).

Two of the studies explored the influence of technology on medication administration safety (Carayon et al., 2021; Santiago et al., 2020), and one of the studies explored how training and monitoring nurses enhance the safety of medication (Camerini et al., 2022); in addition, while one of the studies focused on nurses' knowledge related to checking medication to be administered safely (Arboit et al., 2020).

Two of the studies took place in Brazil (Arboit et al., 2020; Camerini et al., 2022); one was in Toronto (Santiago et al., 2020), and the other was in the US (Carayon et al., 2021). However, this recent search supports the earlier search results that showed no evidence of studies conducted either in Palestine or the Middle East focusing on the factors influencing medication administration safety in critical care settings.

2.9 Chapter Summary

This chapter discusses the narrative synthesis of the literature, which includes the process of assembling and analysing existing studies that are relevant to this current study. The chapter also includes the elements of the narrative synthesis process that followed to analyse the included studies to find out the gap. Additionally, it identifies the objectives of narrative synthesis and how the research question was developed based on the synthesis review.

This current work explains how the narrative synthesis search strategy took place to find relevant studies that could answer the research question of this study. This strategy includes the electronic databases that were searched, how the search was constructed, the inclusion and exclusion criteria that were followed, and the results and number of studies that were presented by using the PRISMA flow diagram. The included studies were critically analysed and tabulated according to the narrative review framework. Then these studies were grouped according to the shared area that was studied, and themes were synthesized from these studies.

The findings show four synthesised themes focused on strategies and protocols used in critical care units that impact the medication administration in critical care units, the educational approach and who is involved in this programme, environmental factors that could contribute to the process of medication administration, and the technological methods that are used to facilitate the process of administering medications.

Based on the findings, the included studies highlighted the importance of an educational approach to enhance the safety of administering medications in the critical care environment. In addition, the influence of interprofessional communication and the pharmacist's involvement in the process of administering medication and providing essential information to enhance safety was also

highlighted. However, there was no evidence to show that the highlighted issues were investigated from a Middle Eastern perspective.

In general, the advantages of these studies are that all of them emphasized the importance of adopting guidelines and strategies for administering medication safely in the critical care environment, providing workshops, continuously monitoring nurses' practice while administering medications, and the presence of pharmacists to improve nurses' and physicians' knowledge, which helps in the safety of administering the high-risk medications given in critical care units.

Conversely, using the visualized strategy may help review the workplace and detect the factors that contribute to medication administration safety, but some areas of administering medication may be missed because of the workload.

These worldwide study search results showed no evidence that there were any studies conducted either in the Middle East or in Palestine focusing on factors that influence nurses' approaches to medication administration safety in critical care units.

As occupied Palestine is considered a high-risk area of violence, the Ministry of Health is concerned about the availability of healthcare providers who provide high-quality care in various specialties to cover the demands of all hospitals all over Palestine (PHIC, 2019). In addition, there is no evidence showing the ratio of nurses per patient in critical care units that may influence the process of medication management.

Therefore, it is appropriate to explore the critical care environment and the factors that influence nurses' approach toward medication administration safety in the Palestinian critical care units, whether these factors are positive or negative. This will help in explaining how the critical care environment can be managed to ensure the safety of medication administration from the perspective of critical care nurses. In addition, this study can play a role in transferring the

experience of European and American nurses regarding safe medication administration to improve the knowledge and skills of Palestinian nurses.

Furthermore, qualitative research is needed to explore medication administration safety in critical care units, which is an appropriate method to undertake using in-depth interviews as a data collection method. The qualitative study design may achieve a better understanding of the factors that influence nurses' approaches to medication administration safety in the Palestinian critical care environment. This study will address the question, "What are the factors that influence medication administration safety from the nurses' perception in Palestinian critical care units?"

Chapter 3 METHODOLOGY AND RESEARCH METHODS

3.1 Introduction

This chapter discusses the research and research methodology used to explore the factors influencing nurses' approaches toward medication administration safety in Palestinian critical care units. This chapter also discusses the research design and philosophical approach underpinning the research. The ontology, epistemology, and theoretical perspective are also included in this chapter. This study examines the rationale for adopting the constructive grounded theory and the data collection method, ethical considerations, participant recruitment, settings, and data analysis. The research study question guides the researcher in selecting the research design that suits the study objective. Furthermore, it helps to carefully design, sample, and recruit to ensure the maximum discovery of knowledge about the studied area (Given, 2008). Furthermore, the research question provides an opportunity to encode and foreshadow an approach to inquiry (Creswell, 2013).

3.2 Research Methodology

The term "methodology" refers to the choice of study the methods of gathering data and forms of data analysis (Silverman, 2013), and it is a systematic technique that guides researchers on how the research could be conducted (Igwenagu, 2016). As well, (Kothari, 2004) defined the research methodology as systematically solving research problems and how the researchers design the study systematically to ensure validity and reliability that addresses the research aims and questions. Additionally, research methodology is defined as an approach in which research arguments are solved thoroughly and systematically. In this study, a qualitative research approach

with grounded theory was adopted in alignment with the aims and objectives (Mishra & Alok, 2017).

3.3 Qualitative Research Approach

A qualitative research method has been selected based on studying and reviewing the research question. Creswell (2018) defined qualitative research as an approach to exploring and understanding a social or human problem from the point of view of individuals or groups (Creswell & Creswell, 2018). Qualitative research is the appropriate approach to understand and characterize people's experiences (Fischer, 2006). Varieties of approaches are included in qualitative research, such as narrative research, phenomenology, grounded theory, ethnography, and case studies (Creswell, 2013); these approaches are popular across the health and social sciences (Creswell & Creswell, 2018); moreover, qualitative research approaches have different analysis and interpreting procedures and techniques (Strauss & Corbin, 1998).

A variety of qualitative research approaches are available to answer the research question. Wisker (2008) described qualitative research as being conducted "*to understand meanings and interpretations, observe, describe, and understand experiences, ideas, beliefs, and values*" (Wisker, 2008 p 74). Other authors described the qualitative research method as being used to understand the meaning of how people experience specific issues (Cohen et al., 2007). Otherwise, qualitative research examines the personal meanings of individuals' experiences and actions in the context of their social environments. Therefore, they expressed the qualitative research method as the systematic evidence for providing and gaining insights into how people view the world (Polgar & Thomas, 2020). Likewise, nurses are responsible for preparing and administering medications, so adopting the qualitative research method was appropriate for several reasons. First, this allowed the nurses who are included in this study to talk about their experiences regarding their

approaches toward the safety of administering medications in a critical care environment from their point of view, further exploring nurses' knowledge and skills regarding the process of administering medication and how they promote its safety. Furthermore, the qualitative research method enables the researcher to identify the strategies that nurses adopted in administering medications in Palestinian critical care units and to identify how they behave in the context of the safety of the medication administration process. As well, adopting qualitative research helps nurses understand the consequences of their practices in administering medications safely in the critical care environment and will enable them to explore the factors that could influence their practice during the process of administering medication in their workplace. For that, using the qualitative method enables the nurses to express themselves and reflect on their experiences rather than using the quantitative method. The quantitative research method identifies specific variables that will be observed and precise, and it finds the relationship between these variables. The theory in the quantitative method is tested by falsification hypotheses, while in the qualitative method, the researcher is close to participants and provides insight into the nature of the context, and the researcher matches interpretation with what was said by participants and gives meaning to what was observed and said (Polgar & Thomas, 2020). Using a questionnaire would be contrary to this study's aim of exploring and obtaining a better understanding of nurses' experiences. It is important to give nurses the chance to talk about their own experiences through an interview (Cohen et al., 2007). A questionnaire with specific questions could limit nurses’ responses and potentially miss some points.

The second reason for adopting a qualitative approach is to gain a deep, intense, and holistic overview of the context under study (Corbin & Strauss, 2015; Gray, 2014), and the interview can press responses regarding complex and deep issues (Cohen et al., 2007). Authors argued that the power of the qualitative approach comes from its richness and holism with a strong potential for

revealing complexity (Miles et al., 2014, 2020); this will give the participants the chance to express their experience openly and in depth from their point of view and explore certain areas thoroughly (Corbin & Strauss, 2015).

3.4 Philosophical Approach

The reason why I was interested in carrying out this study is to enable nurses to express themselves in their own words regarding their experience in administering medications in the critical environment that they are working in; moreover, they have the chance to distinguish the factors that might alter the safety of the medication process. My interest in this study is consistent with Gray's (2014) point of view on the importance of understanding the participants' perceptions and how they act. My approach is to treat the participants as active subjects by allowing them to talk about their experiences and express their beliefs and behaviours in selecting the appropriate approach for administering the medications safely in critical care units. However, Charmaz (2006) described human beings as active agents in their world, so they could create structures during their engagement in the research study process. This allows me to understand the process nurses adhere to when administering medication and how they act in a critical care environment.

It also allows the participants to identify and recognize the factors that could influence medication administration in the critical care environment. Moreover, nurses will be able to describe the environment from their point of view and specify their role in managing the environment, which might ensure the safety of administering medications in adult care units. Thus, this research focused on understanding how participants act and account for their actions (Gray, 2014). It is important to listen to nurses' experiences in their own words to achieve a holistic description of their knowledge, skills, and practice towards administering and managing the safety of medication administration. In this context, researchers could gather information by talking to participants,

observing them, and acting within their context (Creswell & Poth, 2018). Interactions between researchers and participants constructed knowledge through the development of a clear understanding of the collected data, which is based on careful observation and interpretation; also, evidence and data could shape the knowledge to find out the truth in the constructed knowledge (Creswell & Creswell, 2018). Participants developed meaning from their experience with a certain subject; here, nurses described the real world that they are living in and gave meaning to what they practiced in administering medication safely. For this reason, I had a curiosity to know how Palestinian critical care nurses constructed their knowledge, how they behaved in their everyday experiences, and what it meant for them to administer medication safely in critical care units. Besides, exploring the factors that influence nurses' practice in administering medications used in critical care units from their point of view as well as how they managed these factors, each participant viewed and described the factors that influence the safety of administering medication differently from each other, even if they are working in the same environment and following the same guidelines of practice.

In epistemological terms, my position is linked to the whole research process (the philosophical study of nature, origin, and limits of human knowledge). I cannot be separated from the research process. Thus, I should consider this when engaging in direct interaction with nurses and responding to their questions to clarify essential details. Additionally, I was aware of when to contribute to keep control over the interview (Cohen et al., 2007).

3.4.1 The Researcher Positionality

Throughout the journey of my work experience, I had been working as a qualified critical care nurse and then moved to be a nursing director in two private hospitals before starting to be a nursing lecturer at a Palestinian university. This variety of experiences enabled me to address

several problems that may face nurses in their workplace. One of my interests is the critical care environment and how this environment could influence the practice of nurses. For that reason, I noticed that medication administration in critical care units is influenced by the surrounding environment and could be life-threatening for the patients.

However, to be specific, the first reason that urged me to explore the factors influencing medication administration safety in the critical care unit was related to my clinical experience in the critical care unit. One of the most important practices that nurses are responsible for is administering a variety of medications, including high-alert medications such as dopamine and dobutamine. For these medications and others, nurses should be qualified and know how to prepare, calculate, and administer medications safely. So, I noticed that not all my colleagues were confident in how to practice the medication procedure, and they always needed to consult nurses on duty for more information, which could delay administering the medication on time and affect the patient. Also, this increases the workload on the nurses, which would also distract them from completing their assigned procedure and even influence administering medication to their assigned patient on time. Also, I noticed that not all of my colleagues were able to calculate the high-alert medications accurately, which could result in administering the wrong medication dose. In all situations, the medication administration process could be negatively impacted, as could the patient's health status.

The second reason was that during my academic position, one of the most critical situations that I was informed that one of the nursing students' groups prepared the medications with the wrong diluent without waiting for their instructor to attend. One of the nurses noticed that, stopped the procedure immediately, and informed the student's instructor (mostly, it was noted that there were look-alike medications).

When I thought about the medication events and the above reasons, I thought about their impact positively, although they had a negative impact, as these reasons urged me to find the factors that could influence the process of medication administration as well as the safety of performing the procedure without influencing the patient's health status. In addition, these reasons encouraged me not only to find the reasons but also to find out how the causes of these errors could be controlled to enhance the safety of the medication and minimise the morbidity and mortality of the patients.

Additionally, at the beginning of the research study, the aim was to evaluate the level of knowledge, practice, and attitudes of critical care nurses toward medications used in critical care units by using the qualitative research method. However, after reviewing the literature, it was clear that nurses know the procedure of administering medication, but there was an argument about issues that could influence the procedure. There was a discussion with the supervisors about the search results, and they recommended reviewing the literature to identify the gap in the knowledge base; thus, I contributed to this. After reviewing the literature thoroughly, I found that there were limited studies, especially in the Middle East, that focused on the safety of administering medications in adult critical care units. So, after a discussion with my supervisors, I modified the research study and decided to explore the factors that influence the nurse's approach toward administering medication safely in the critical care environment.

The literature review showed that most of the studies in this area were focused on medication errors rather than medication administration safety. Most of these studies used the quantitative method by using a survey tool to collect the data. Based on the aim of this study, I was interested in exploring the factors that influence the safety of administering medications from the nurses' point of view who are working in the Palestinian adult critical care units.

3.4.2 Philosophy: Ontology and Epistemology Perspective

Philosophy is the first idea that reflects the process of research, and it is usually the use of abstract concepts that informs the research (Creswell & Creswell, 2013). Philosophy helps the researcher design the work well (Gray, 2014). Actions, situations, and consequences are raised out of philosophy (Creswell & Creswell, 2018). Additionally, the philosophy of the research is classified as ontology and epistemology, which enables the researcher to adopt the research approach that answers the research question (Saunders et al., 2007).

3.4.2.1 Ontology

Ontology refers to the study of reality and is usually concerned with what will exist (Bryant, 2017). Ontology addresses the nature of reality and its characteristics (Creswell & Creswell, 2013). In this study, relativist ontology was adopted to view the reality of the participants' experiences with administering medication safely as well as the different perceptions between them (Wisker, 2008). Relativism is individually constructed and mediated by individuals to give meaning to a phenomenon (Guba & Lincoln, 1989). Bryant (2017) demonstrated that the ontological position could be shaped by interaction with individuals to make sense of their experiences.

In this study, my ontological position was developed while reviewing the literature and began with a certain assumption about the phenomenon of interest; however, my position was flexible enough to receive new ideas.

3.4.2.2 Epistemology

The study of how we know and understand knowledge and how belief is justified. Epistemology aims to answer the question of how we understand the concept of justification, whether the justification is internal or external to one’s mind (Bryant, 2017; Creswell & Poth, 2018). In this context, it is important to know people's perceptions of truth, how they could access it, and what

the relationship is between the researcher and the participants in the study. However, in qualitative research, the researcher needs to spend sufficient time with participants to gain an understanding of their subjective and multi-dimensional views of reality. However, understanding and sharing meanings are constructed through the relationship between the researchers and the participants to provide a constructed reality. This reflects that the meaning of a situation is constructed based on a specific situation, and there is no absolute truth or absolute reality as every participant has his/her own understanding of the situation (Gray, 2014).

This study adopted a constructive epistemology, with the belief that the researcher cannot separate herself from her background and what she knows about the phenomena. It also acknowledges that the researcher needs to be reflexive about his or her position as a main research tool (Gray, 2014; Holloway, 2005). In this context, the constructive position is the belief that critical care nurses construct meaning about the safety of medication administration and enhance safety through interactive experiences with other colleagues.

I conducted face-to-face semi-structured interviews with eligible critical care nurses. This enabled me to interact with the participants and explore their meaning of safe medication administration in critical care units and their experiences with controlling factors influencing medication administration to enhance safety. This study investigated critical care nurses in their own context, as the reality of the situation under study could not be isolated from their context (Guba & Lincoln, 1989). This study adopted a relativist ontological and constructivist epistemological position.

3.5 Research Theoretical Perspective

There are several approaches to developing qualitative research that influences how research is designed and analysed. These approaches include phenomenology, ethnography, and grounded theory, which emphasizes the direction of the study (Marshall & Rossman, 2016). Although the three approaches are superficially similar, each one has its strengths and weaknesses. It is important to select a methodology that is appropriate to the aim of this study. Each method is discussed briefly, with justification for rejection and acceptance of the chosen one.

The participants in the phenomenology method explain their life experiences to understand the nature of human consciousness, putting their perceptions, feelings, and thoughts aside. Personal experience is seen as the basis for personal experience without reflection. However, transferability is more difficult to achieve than in grounded theory (Pringle et al., 2011). Otherwise, the phenomenology research method focuses on participants who share the same experience that they have in common, which limits external validation (Creswell, 2007; Polgar & Thomas, 2020; Pringle et al., 2011).

Conversely, ethnography is another type of qualitative method that focuses on an entire group sharing the same culture and is associated with the way people perceive, describe, and explain the world. People select and apply specific rules and principles to define and mean the situation (Brookes, 2007). Ethnography requires extended observation of a group and immersion in its culture (Creswell & Creswell, 2007). Additionally, the ethnography method is based on multiple forms of data collection, which are impacted by the observed participants included in the study (Bowling, 2023; Creswell, 2019). This study adopted constructive grounded theory, the following section focuses on the design, theory version, and the decision to adopt the theory.

3.6 Grounded Theory Design

Research design is the plan to conduct a study (Creswell, 2013). Grounded theory is a qualitative research design that enables the researcher to develop a general explanation of the research process, actions taken through the process, and interactions shared with the participants (Creswell, 2013; Creswell & Creswell, 2018). Grounded theory is an inductive study method (Charmaz, 2006), and data is collected systematically during the research process, which supports the construction of the theory (Corbin & Strauss, 2015). The strategies of grounded theory were articulated by the collaboration of Barny Glasser and Anselm Strauss (1967), who came from different research backgrounds (Glaser & Strauss, 1967). It was argued that the different experiences of the two researchers influenced the strength of the qualitative and quantitative methods (Walker & Myrick, 2006). Grounded theory methods provide researchers with relevant predictions, explanations, interpretations, and applications (Glaser & Strauss, 1967). However, authors explored analytic ideas in conversations and exchanged preliminary notes analysing observations in the field (Charmaz, 2006; Corbin & Strauss, 2015). So, Glaser and Strauss (1967) argued that grounded theory aims to move qualitative inquiry beyond descriptive studies into an explanatory theoretical framework.

Glaser and Strauss argued that there is too much structuring in the grounded theory approach, which was advocated by Charmaz (2006) who adopted the constructive interpretations of grounded theory. This approach became more popular in many disciplines, such as sociology, nursing, education, and psychology (Creswell, 2013).

The grounded theory method uses a systematic and flexible approach to collect and analyse qualitative data to construct a grounded theory. Systematic qualitative analysis, as described by Glaser and Strauss, is an inductive and deductive analysis process that is illustrated by working

back and forth to develop a theory (Charmaz, 2006; Creswell & Creswell, 2018). Corbin and Strauss (2015) emphasised that grounded theory has unique features:

Firstly, they described that concepts are derived from collected data during the research process.

Secondly, there is an interrelation between the collected data and research analysis; they conclude that constant comparative analysis and data collection are part of a cycle process during the research process.

However, grounded theory can shape and reshape the collected data, and the method of grounded theory gives a flexible guideline that directs the study (Charmaz, 2006).

In this study, the researcher aimed to explore and understand how nurses' experiences influence the safety of medication administration in the adult critical care environment through a form of constructive grounded theory, which is characterized by *"discovery, development, and provision verified by systematic data collection and analysis"* (Charmaz, 2014 p 15-16). Creswell (2013) defined the features of grounded theory as follows:

1. Grounded theory is a process or an action that means the researcher has an explanation for a movement or attempt.
2. Developing theory for the process, that is, understanding and explaining what the researcher developed.
3. In developing theory, memos are a part of the process; in other words, the researcher writes down the collected data, the analysis, and the ideas.
4. Interviewing as the primary form of collecting data is based on comparing the collected data from participants with the researcher's ideas about the emerging theory. This process enables the gathering of new data and returns to fill in the gaps.

5. Structure the analysed data to develop a theory by selecting each category and analysing it.

The above features consist of systematic guidelines for collecting and analysing data to construct a theory based on the collected data (Charmaz, 2006). Moreover, knowledge gained through grounded theory enables the researcher to explain and take action to alter or change a situation (Corbin & Strauss, 2015).

3.6.1 Grounded Theory Versions

The different backgrounds of grounded theory's developers, Glaser and Strauss, contribute to the ultimate differences in grounded theory research applications (Charmaz, 2006). This led to the split of grounded theory into two models: Glasarian and Straussian (Strauss & Corbin, 1998; Strauss & Corbin, 1990; Walker & Myrick, 2006). Glaser grounded theory is called classical or traditional and is based on the analysis of the collected data to generate the theory (Glaser, 1992), while the Strauss strategy is based on the emergence of theory from the collected data (Rupsiene & Pranskuniene, 2010; Strauss & Corbin, 1990). However, another approach was developed by Charmaz (2006) which was developed from the Straussian approach and called Constructivist Grounded Theory. The literature discussed three main issues about ground theory: ontology and epistemology perspectives; the Straussian coding paradigm and the data analysis approach; and the time of the research process when the literature should be used.

About ontology and epistemology perspectives, the debate was on adopting the Glaserian approach, which states that the researcher is a natural observer of an object and external reality, which reflects the researcher's classical positivism (Annells, 1997). Strauss assumed that while collecting data, the researcher needed to keep an unbiased position to enable participants to express their points of view (Strauss & Corbin, 1998). However, Charmaz assumes that both

approaches adopt realism and positivism, but there are still some differences. Charmaz focused on constructivism rather than discovering, and this is approached by interactions between people, culture, and objects and the interpretation and meaning raised from these interactions (Crotty, 1998). Otherwise, the constructivism approach strengthens researchers' reflexivity about their interpretations on an objective level. This approach identified that theories, concepts, and categories are the outcomes of the discovered data through questioning. (Charmaz, 2006).

Another difference between the three grounded theory approaches was the use of coding, which helps researchers explore data in different dimensions for a better understanding of a social phenomenon. Strauss and Corbin (1998) emphasized that induction and deduction are equally important in grounded theory. Glaser argued that the induction-coding paradigm is the only way to conduct grounded theory (Cooney, 2010). Conversely, Charmaz (2006) argued that both approaches are not flexible enough to enhance the emergence of theory (Charmaz, 2006).

Additional debate about grounded theory approaches was the use of literature before and after collecting the data. Glaser focused on the fact that the researcher should look for literature during the phase of analysing the collected data that will enable the researcher to be mind-free and open to discovering concepts, categories, and interpreting the data (Glaser, 1978). Charmaz and Strauss emphasized the use of literature before starting the study (Charmaz, 2006; Strauss & Corbin, 1990).

In this study, as a Ph.D. student, it is required to understand literature related to the studied area and to design a formal proposal to convince others of the study's importance. The approach to literature helped the researcher justify the aim and clarify the importance of conducting this study. Moreover, looking for literature while collecting data and during analysis enables the researcher to focus on the data that needs to be discovered or strengthened.

3.6.2 Adopting Constructive Grounded Theory

The study adopted the constructivist grounded theory described by Strauss and Corbin that explains events (Strauss & Corbin, 1998; Strauss & Corbin, 1990). The knowledge gained through this theory enables the researchers to explain and understand practice and belief in certain situations. The use of constructive grounded theory is a logical approach in a qualitative study that is characterized by discovering, developing, and providing systematic data collection and analysis. This method enables an understanding of how nurses' experiences influence the safety of medication administration in a critical care environment (Charmaz, 2014; Creswell, 2013; Polgar & Thomas, 2020). This use of constructive grounded theory is considered useful as it enables researchers to develop their own theories or modify existing theories that can explain behaviour and events and give control over a situation (Glaser & Strauss, 1967). Also, adopting constructive grounded theory methods will keep directing, managing, and streamlining the collection of data and constructing the primary analysis of the data (Charmaz, 2006). However, adopting constructive grounded theory in this study for several reasons:

First, to uncover what is behind the phenomenon that is little known about and not sufficiently researched (Strauss & Corbin, 1998). Based on reviewing the literature, the experiences of nurses working in critical care units regarding the safety of administering medication are poorly understood and not well-searched; this study could be the first to explore this area. Adopting constructive grounded theory as a research method could help the researcher explore the factors that influence the safety of medication administration in the Palestinian critical care units, and there is an opportunity to highlight the knowledge gap and what I'm trying to achieve.

Second, to explore and understand in depth the participants' experiences by allowing them to talk about their own experiences from their point of view (Cohen et al., 2007), as well as make sense of

their experiences (Charmaz, 2006, 2014). In addition, exploring the inner experiences of the participants (Corbin & Strauss, 2015) as this approach matches the aim and objectives of this study. In this study, the researcher examined the meaning of safety from the nurses' point of view concerning the medication administration process in the critical care environment. As well as to understand the nurses' behaviour to enhance the safety of medications given in critical care units.

Third, grounded theory increases flexibility, this will allow the researcher to acquire the associated skills while collecting data for better achievement and with the mentoring of the researcher's supervisors (Chun Tie et al., 2019). However, flexibility allows for following details and gives more focus to what is happening with the collected data (Charmaz, 2006). As well as to understand the nurses' behaviour to enhance the safety of medications given in critical care units. The systematic approach to collecting the data encourages the researcher to interact consistently with the participants and the data via theoretical sampling and constant comparison through the phases of collecting and analysing the data. This systematic approach to collecting the data gives the researcher flexibility in working with the collected data and analysing it. Constant interaction is achieved through the constant comparative method, which leads to the identification of the categories (Strauss & Corbin, 1997). Comparing the collected data occurred during the process of analysis; each collected piece of data was compared with the previous one. All interviews were coded in the same way to be able to identify the concepts. Each emerging concept was compared with each other in the same interview and with another interview to detect the connections between them and build up the initial category. Each identified category or sub-category was compared within its properties and between different interviews at the same hospital to detect similarities, and then grouped and compared with interviews in another hospital to gain any similarities, differences, or connections (Strauss & Corbin, 1990).

Adopting constructive grounded theory allowed the researcher to explore the factors influencing medication administration safely from the perspective of the critical care nurses, as well as how nurses identified these factors and what measures they followed to manage the critical care environment to enhance safety. By memo, the notes that the researcher write while collecting data enable the researcher to explore ideas and thoughts (Creswell, 2019). As well, the researcher was also able to identify and contextualise the participants' interviews. Furthermore, the use of grounded theory is dependent on how the researcher applies research principles to achieve rigour.

The fourth reason that encouraged me to adopt constructive grounded theory was the ability to modify the models and perceptions about the phenomena and models under study and to adapt alternatives based on participants' perceptions. Charmaz (2006) argued that the adoption of grounded theory enables the researcher to control the process of research and enhances the power of the researcher's work.

However, grounded theorists provide researchers with various guidelines on the data collection process, analysis, and application (Corbin & Strauss, 2015; Strauss & Corbin, 1990), these guidelines enable the researcher to select the appropriate grounded theory style to enhance the research study. Overall, grounded theory provides researchers with "*relevant predictions, explanations, and applications,*" as described by the founders of grounded theory, to select the appropriate theory style for application in this study (Glaser & Strauss, 1967; Strauss & Corbin, 1998 p. 5).

In this study, and based on the discussion with the supervisors, the researcher adopted the constructivist grounded theory version (Charmaz, 2006), which reflected the aim of the study and the researcher's philosophical approach. Otherwise, adopting a constructive grounded theory style

was based on its compatibility with the researcher's position. The constructivist position employed is that the interviewees construct meaning about the safety of administering medications in Palestinian critical care environments. The following sections discuss and describe the constructive grounded theory elements and how they were used in this research.

3.6.3 Elements of Constructive Grounded Theory

Regardless of the version of grounded theory used, there are common elements adhered to by researchers when approaching the theory. The following discusses the elements and clarifies how the researcher used them in this research (Glaser & Strauss, 1967; Strauss & Corbin, 1997).

3.6.3.1 Literature as a data source

There was a debate among the grounded theory founders about when and how literature should be used. The researcher adopted the view that reading literature before undertaking the research study was essential to enhancing theoretical sensitivity (Charmaz, 2006; Strauss & Corbin, 1998). Reading literature assisted in preparing questions to obtain data during the interviews as well as guiding the prompting questions. Additionally, reviewing literature helps the researcher clarify thoughts and identify existing studies that help where further studies are needed. Accessing literature is a continuous process throughout the study. This allowed me to stimulate theoretical sensitivity and explore all the literature related to the study.

3.6.3.2 Theoretical sensitivity

Theoretical sensitivity is gaining insight, and being sensitive to the data, which enables the researcher to find the meaning in the data, understand the collected data, and identify the important and related data from those that are not related (Strauss & Corbin, 1998). The theoretical sensitivity comes from reading literature to gain familiarity with published studies that enable the researcher to gain insight into the studied phenomenon. Personal and professional

experience as a source for theoretical sensitivity was rejected by Glaser (Strauss & Corbin, 1997). The researcher had previous experience in both academic and clinical settings, particularly in critical care. This experience enabled the researcher to understand the critical care environment and what could influence the safety of administering medications.

To avoid forcing analysis while reading the literature, Charmaz (2006) suggested that early constant comparative analysis, following leads, and building on ideas could correct direction through theorisation activities. These acts include *seeing possibilities, establishing connections, and asking questions* (Charmaz, 2006, p.135). I was conscious that complete neutrality and objectivity were not possible to achieve because I was familiar with some of the care settings and my role was the main research tool; preconceptions about the safety of medication existed. However, it was important to maintain a balance between subjectivity and objectivity and identify preconceptions and participants' understanding. This self-awareness enabled me to constantly reflect on the need to be as open as possible to influence the participants' perceptions and discover their perspectives and beliefs.

3.6.3.3 Theoretical sampling

In grounded theory, theoretical sampling is the process of collecting data, together with analysis, refining, coding, and deciding what to collect next to emerge the theory (Charmaz, 2006; Corbin & Strauss, 2015). Sampling in qualitative research is referred to as "purposive"; the researchers select the best place to provide the information for understanding the personal meanings of health-related events (Polgar & Thomas, 2020). Therefore, a specific sampling strategy is required to identify the participants who could share their experiences with the researcher.

A purposive sample is usually used in qualitative research, which is based on having rich information from experienced participants concerning the research topic (Leavy, 2017). Choosing

the sample for a specific purpose enables a full scope of information to be explored (Cohen et al., 2007). Purposive and theoretical sampling are used in many qualitative studies (Mason, 2002). The purpose of using theoretical sampling is to direct the researcher on where to go and to obtain the data that will help to explicate the categories (Barrett, 2023; Charmaz, 2006). As well, theoretical sampling is the major strength of grounded theory and helps in forming the theory (Charmaz, 2006; Creswell, 2013).

Theoretical saturation means that when gathering fresh data, no additional data is found that "*no longer sparks,*" and the researcher is confident about the saturation of the categories (Charmaz, 2006; Corbin & Strauss, 2015). To achieve saturation, comparative analysis requires interchangeability between the emerging categories until the theory is dense and there is no gap in the explanation (Charmaz, 2006; Glaser & Strauss, 1967). Moreover, the researcher can say saturation is achieved when the categories and themes are explored in depth in different dimensions and under different conditions, the categories become well understood, and the collected data makes sense (Corbin & Strauss, 2015).

3.6.3.4 Coding and categorizing

Coding is an essential element in analysing data in grounded theory (Strauss & Corbin, 1998). It starts by forming the initial codes and concepts from the deconstructive information. Then, the emergent codes were arranged to form categories that form the theoretical concepts that reflect the content. Charmaz (2006) emphasized that the coding process in grounded theory is the base of the data analysis, and linking the data enhances the emerging grounded theory. To approach this, the large set of data is divided into smaller pieces to be more manageable. According to Charmaz, coding is important to build a grounded theory rather than testing a theory, so researchers ask

analytical questions to understand what is happening. The existing issues from the analysed data direct the researcher to subsequent data collection (Corbin et al., 2008).

As the researcher started coding, concepts and categories emerged, and then the researcher compared the incidence within the same category and other categories (Charmaz, 2006; Strauss & Corbin, 1998). However, the researcher integrated the emerging categories through constant comparison of new data. Finally, the discovery of the relationship between the categories and concepts provided a theoretical understanding of the collected data (Strauss & Corbin, 1998). Further details related to coding processing and the system of coding are described in the data analysis section (3.11).

3.6.3.5 Constant comparison

The constant comparative analysis method is a key feature of grounded theory. The success of grounded theory is linked to finding the consistency and differences, where data collection and analysis occur synchronously (Chun Tie et al., 2019). This method stimulates the researcher's thoughts about concepts and categories to enhance the theoretical sensitivity for developing grounded theory (Corbin et al., 2008). The constant comparative method continues through data analysis, and it is an endless method even after the completion of the analysed data (Glaser, 1992). The concepts and incidents are grouped to form the category. Then, categories and concepts are compared and examined against emerging categories to attain theoretical saturation (Charmaz, 2006). Next, the concepts and categories are integrated to help in writing the theory. Otherwise, the continuous, constant comparison between categories and incidents within the same interview and comparing them with different interviews helps to find the relationship between the emerging categories. The initial concepts that emerged from the first four pilot interviews guided the subsequent data collection. The researcher followed this method

throughout the whole process of collecting and analysing data to the point that the researcher is confident about the saturation of the categories (Charmaz, 2006; Corbin & Strauss, 2015). To achieve saturation, comparative analysis requires interchangeability between the emerging categories until the theory is dense, and there is no gap in the explanation (Charmaz, 2006; Glaser & Strauss, 1967). Moreover, the researcher can say saturation is achieved when the categories and themes are explored in depth in different dimensions and under different conditions, the categories become well understood, and the collected data make sense (Corbin & Strauss, 2015). However, this procedure enables researchers to examine the studied topic, identify barriers from different angles, and develop comprehensive explanations (Corbin & Strauss, 2015).

3.6.3.6 Memo writing

A memo is an instrument to capture the outflow of ideas, insight, and observation. When the researcher writes thoughts down, they become concrete, and they are recorded; there is no wrong or poorly written memo (Given, 2008). Also, it is a process that begins when coding data and leads to abstraction or ideation (Strauss & Corbin, 1997). Memo involves total freedom and creativity; it helps the researcher reflect on the ideas, feelings, and experiences of the interviewees during and after conducting the interview. There are no rules regarding writing, grammar, or style.

Despite the usefulness of using memos in formulating a grounded theory, memos could be used in a variety of ways. First, memos give insight into the work process and shape the association between concepts and categories; it is not necessary to be grammatically correct and without monitoring and judging what is written.

Second, memos are used to unblock; they are used when the researcher feels that he or she cannot describe the interview in words. The researcher could use a letter as if she were writing to someone and ask questions by using dialogue.

Third, memos could be used for tracking, they start at the beginning of the conceptualization of the emerging data (Strauss & Corbin, 1997).

In this study, the researcher used memos in several ways, starting by writing the thoughts about the interview and writing unconnected sentences, then reading what was written and reconnecting the sentences to track the raw data. Additionally, the researcher described the environment in which the interview took place and the interviewee's body language, which reflected the interviewee's responses. By reading the memo several times, the researcher reflected on it, and sometimes the researcher used drawing diagrams to either follow the direction of the data or to conclude the key points used during the interview. An example of the memo is shown in Appendix 2.

3.7 Research Setting

Data collection took place in several critical care units at seven hospitals located in three Palestinian cities. The critical care units include the general intensive care unit, the coronary care unit, the surgical intensive care unit, and the cardiosurgical intensive care unit. The researcher selected these hospitals for several reasons.

First, the use of a variety of hospitals and different critical care departments facilitated the requirement process. Second, about 30.5% of the Palestinian population lives in these three cities. Third, Palestinians come from different regions to seek good medical services, especially in Nablus hospitals. Fourth, choosing hospitals from different regions enriches the recruitment process.

The Palestinian healthcare system includes five sectors: governmental, private, military, NGOs, and the educational sector. Details of the Palestinian healthcare system are described in Chapter (1). However, all these sectors follow the regulations and policies of the Ministry of Health, except the private hospitals, which have their regulations and policies regarding hospital management. The study was conducted in seven hospitals in Palestine's three main cities. Three of the hospitals are governmental hospitals with a capacity of 462 beds. These hospitals provide health care for the populations that have governmental health insurance. One of these large hospitals included a surgical critical care unit and a coronary critical care unit; the second one had just a surgical critical care unit; the third one had a coronary critical care unit; and the fourth one had a capacity of 135 beds and was in one of the largest cities in Palestine. The last hospital mentioned is the largest, and many cases from many Palestinian regions are transferred to this hospital, as well as from other hospitals, to gain health care services that are not available in those hospitals. In addition, the three private hospitals had a capacity of around 178 beds, and all of them had general surgical intensive care units. The following table (Table 3-1) shows the distribution of the hospitals with the bed numbers in each, as well as the code that is used in the findings and analysis for these hospitals.

Table 3-1: Demographics and coding for hospitals included in the study.

Hospital Type	Abbreviation	Number of beds	Hospital Code
Governmental	G	207	D
Governmental	G	200	F
Governmental	G	55	B
Educational	E	120	G
Private	P	64	A
Private	P	60	C
Private	P	54	E

3.8 Ethical Consideration

Before starting the data collection formal approval was gained from the research ethics committees at the University of Hull (Appendix 3), the Palestinian Ministry of Health (Appendix 4), and the ethical committee in each private hospital participating in the study (Appendix 5). All ethical application documents are attached in the appendices. Additionally, the documents include an invitation poster (Appendix 6), a formal letter from the researcher that is sent to private hospitals (Appendix 7), an invitation letter to participants (Appendix 8), a consent form (Appendix 9), interview guide questions (Appendix 10), the demographic questionnaire (Appendix 11), and the participants' information sheet (Appendix 12).

Ethical issues should be considered in the whole research process, including avoiding harming participants, autonomy and voluntary participation, anonymity and confidentiality, and justice.

The following procedures were undertaken to protect participants:

3.8.1 Voluntary Participation

The participants were informed about their rights and responsibilities, and they made their decision to participate in the study without any influence from other colleagues or the researcher. To recruit the participants who met the criteria, information was provided to them before deciding on their participation. The researcher distributed envelopes including the participant information sheet, a brief demographic questionnaire for recruitment, and the invitation letter. The participants were asked to complete the demographic questionnaire in their free time and return it to the envelope and keep it with the in-charge nurse, and the envelopes were collected by the researcher later.

The information sheet contained an explanation of the purpose of the study, risks and benefits, rights of the participants, an informed consent process, and the researcher's email address and phone number for any inquiries from participants. Nurses were welcome to ask questions about the study and contact the researcher for any clarifications.

Written consent was obtained from the participant before conducting the interviews to clarify that their participation was voluntary and that they had the right to refuse to participate or withdraw at any time without any excuse. Further, the participants were told that they had the right not to answer any questions and could terminate the interview at any time (all the interviews were completed). The consent process was important to make sure that the participants understood the information sheet and were fully informed about the study.

During the interview, the participants had the right to stop voice recording (some participants asked to stop recording for a few minutes).

3.8.2 Beneficence and Non-Maleficence

The benefits and risks were clarified in the participants' information sheet. The participants were informed about the possible benefits and risks of taking part in this study, and this was clear in the information sheet. The participants were told that the findings could improve the standards of patient safety and nursing practice.

The participant's information sheet and consent form process helped the participants understand their rights and responsibilities during their involvement in this study. The researcher was aware that the participants might be afraid that what they said could reach their colleagues, as this was reported by some of the participants. Therefore, the researcher clarified that the records and the transcribed data will not be invaded and will be in a secured and protected file with a password on

the iCloud Box of the University of Hull system. Moreover, it was clarified that the names of the participants will not be mentioned either in the study or in any reports or publications.

3.8.3 Confidentiality and Data Storage

To maintain the privacy and confidentiality of the participants, the interviews were conducted in a private room in each hospital. This room could be the nurses' office room, nursing director's office, conference room, or in-charge nurses' office. As well as to prevent interruptions during the interview. It is stated that the participants' information and their responses would be treated with full confidentiality and anonymity, and anyone who took part in the research would be identified only by code numbers. Furthermore, the researcher's demographic information and the transcribed interviews were stored separately. The participants' names were not mentioned in the audio recording, and each recording was assigned a code number.

All interviews were recorded by a digital recorder and then transcribed. The records and the transcribed data were stored in a secured file that could be accessed by a password on the iCloud Box of the University of Hull system. The records will be destroyed at the end of the study. Access to the records is only available to the researcher and the study supervisors. After the completion of the study, the electronic storage data will be treated according to University of Hull regulations.

3.8.4 Justice

In this study registered nurses who are working in the different critical care units were recruited from seven Palestinian hospitals. All participants were given the same information about the study and were asked the same questions by the interview guide.

3.9 Recruitment in Grounded Theory

This study recruited twenty registered nurses in three types of adult critical care units (general ICU, CCU, and surgical ICU) at seven Palestinian hospitals over four months. The registered nurses are staff members and in-charge nurses who are willing to participate in the study. The sample inclusion criteria are shown in the following table:

Table 3-2: Participants' inclusion criteria.

All nurses who are working in one of the adult critical care units
Nurses who are registered by the Ministry of Health
Nurses who are scheduled to work in critical care units
Nurses are responsible for preparing and administering medications.
Nurses who have one or more years of experience in critical care units.

In addition, the participants needed to be:

- able to participate outside their working hours.
- willing to participate.
- willing to discuss and share information regarding their experience in administering medication in critical care units.

The exclusion criteria are shown in the following table (Table 3-3):

Table 3-3: Participants' exclusion criteria.

Nurses who are not working in adult critical care units.
Nurses who are not registered by the Ministry of Health.
Nurses who have no experience in preparing or administering medications in critical care units.
Nurses who are not responsible for preparing and administering medications.
Newly graduated nurses or having experience less than one year in critical care units.

In this study, the recruiting method was based on theoretical sampling to identify the participants and explore their experiences that addressed the research question. According to Polgar and Thomas (2020), sample size is important to enhance credibility and reach saturation. Charmaz (2006) suggested that the sample for the grounded theory study needs to be representative, there will be a huge amount of data even if the sample is small. In grounded theory, the appropriate number of participants in the study area ranged from 20 to 30 (Creswell & Creswell, 2018). The size of the studied sample depends on sample saturation, which means no additional codes or themes could be added (Bryant & Charmaz, 2007; Corbin & Strauss, 2015).

The following table shows the participants' demographic characteristics (Table 3-4):

Table 3-4: Demographic characteristics of the participants.

Interviewee Number	Hospital	Department	Code Number	Sex	Age	Total Experience	Critical Care Experience
1	Private	General ICU	AP01	M	40-44	More than 10	More than 10
2	Governmental	CCU	BG02	M	30-34	6-10	1-5
3	Private	General ICU	AP03	M	Less than 25	1-5	1-5
4	Private	General ICU	AP04	M	25-29	1-5	1-5
5	Private	General ICU	CP05	F	25-29	1-5	1-5
6	Private	General ICU	CP06	M	34-39	More than 10	More than 10
7	Governmental	General ICU	DG07	M	More than 45	More than 10	More than 10
8	Governmental	General ICU	DG08	M	34-39	More than 10	More than 10
9	Private	General ICU	EP09	F	Less than 25	1	1
10	Private	CCU	EP10	M	25-29	6-10	6-10
11	Private	CCU	EP11	M	Less than 25	1-5	1-5
12	Private	General ICU	EP12	M	Less than 25	1-5	1-5
13	Private	General ICU	BG13	M	25-29	1-5	1-5
14	Governmental	Surgical ICU	FG14	F	40-44	More than 10	More than 10
15	Governmental	Surgical ICU	FG15	F	34-39	More than 10	More than 10
16	Governmental	Surgical ICU	FG16	M	34-39	More than 10	More than 10
17	Governmental	General ICU	FG17	M	30-34	More than 10	6-10
18	Educational	General ICU	GE18	M	34-39	More than 10	6-10
19	Educational	Surgical ICU	GE19	M	30-34	6-10	6-10
20	Educational	CCU	GE20	M	34-39	More than 10	More than 10

3.9.1 Sampling

The sample is defined as a subset of the population to ensure that our sample is representative (Polgar & Thomas, 2020). The purposive sampling technique was used in the initial phases of this research to recruit four pilot interviews at different times based on the recruitment criteria. The initial interview guide was used in this phase, and a subsequent analysis was undertaken for the interviews. Based on the findings of the initial interviews, participants' comments, and the researcher's supervisor's feedback, minor modifications were made to the prompts. The advantage of a semi-structured interview is the ability to add or remove questions during the period of data collection in response to the collected data (Strauss & Corbin, 1998). The analysis of the initial interviews and the modified interview prompts directed the future data collection. There was the flexibility to change the interview guide during the process of collecting data, as the directors of the participant's hospitals gave the researcher the freedom to ask and modify prompts based on the interviews. Despite this, the modified interview prompts guided the researcher to find the key participants to saturate the categories and sub-categories to build up the theory.

It was necessary to conduct a few interviews in private hospitals and compare the factors influencing the safety of medication administration in critical care units with those of governmental hospitals. Additionally, more participants were recruited from educational hospitals to compare the resources and confirm the results. Furthermore, the researcher took into consideration the experience and role of the registered nurses in recruiting additional participants. The researcher recruited more in-charge nurses to gain data saturation. Additionally, in critical care units, only a few females were found, so the researcher recruited four who met the inclusion criteria.

3.9.2 Recruitment Procedure

At first, the researcher gained ethical approval from the faculty of health sciences research ethics committee at the University of Hull (Appendix 3). Second, the researcher gained approval from the following institutions:

- Palestinian Ministry of Health (Appendix 4)
- The ethics committee of each participating hospital (Appendix 5)

Emails were sent to the private hospital administrators explaining the purpose of the study, as well as to the head of the ethical committee in the Palestinian Ministry of Health, to gain access to these hospitals (Appendix 7). The Palestinian Ministry of Health's ethical committee sent their approval letter to each governmental hospital participating in the study, and an approval response was sent to the researcher by email (Appendix 4). As well, the researcher sent separate emails to the private hospitals' managers to gain ethical approval, and the response was received by email (Appendix 5).

In the process of gaining access to the Palestinian government hospitals, the approval letter of the FHS ethical committee at the University of Hull was sent to the Ministry of Health (Appendix 3). This included sending the abstract of the study, the participant invitation letter (Appendix 8), the participant information sheet (Appendix 12), and the interview questions (Appendix 10). The response from the ethics committee did not take a long time; the researcher received an approval email within two weeks of the application request. Later, the researcher visited the nursing managers of the hospitals and explained to them the research study's aims, methods, and recruitment process, and asked them to display a poster (Appendix 6) in the critical care units to invite nurses to participate in the study.

The ethical application for the private hospitals was a little bit different, as emails were sent to the directors of the hospitals, as not all private hospitals have an ethical committee, and the approval was gained directly from the hospital's manager. The researcher gained ethical approval from all the private hospitals that were requested to participate in the study (Appendix 5).

To gain access to a clinical area, the researcher visited the hospitals included in the study and talked with the directors of nursing, and critical care units to ensure cooperation and obtain permission to display the poster (Appendix 6). The discussion included the researcher's identity, the purpose of the study, the recruitment strategy, the data collection method, and ethical issues.

Although the researcher is familiar with many of the nursing managers, she introduced herself as a Ph.D. student to conduct a research study, and the participant information sheet was provided for further details (appendix 12).

The researcher arranged meetings with the critical care unit's in-charge nurses after obtaining ethical permission and access. A brief information session was provided in each critical care unit and in the different shifts (about 10–15 minutes) to explain the purpose of the study, the consent form, the ethical issues for taking part in the study, the participant information sheet, the interview process, and how to contact the researcher if the participant is willing to be included in the study. However, the researcher visited the critical care units several times to provide any additional information, and this helped in building trusting relationships and encouraged the participants to give their approval to participate.

In each critical care unit, envelopes were provided to the nurses, including a short demographic questionnaire (Appendix 11), an invitation letter (Appendix 8), and participant information sheets for recruitment purposes (Appendix 12). Nurses were asked to complete the demographic data on their own time and to leave it in the department with the manager in a sealed envelope, and they

were notified that their participation was voluntary. In addition, two weeks were given to read the participant information sheet, which includes the aim of the study, risks and benefits, rights of the participants, and the researcher's details for any queries.

For the nurses who were willing to participate, who completed the questionnaire, and who met the inclusion criteria, an appointment was arranged for the interview at a convenient time for the participant, as they are working in the critical care unit, so the interview took place outside of their working hours. For example, some of them asked to have the interview before starting their shift, and others asked to have the interview at the end of their shift.

The interviews were conducted in a private room in each hospital, for example, in the nurses' restroom, the nursing manager's office, the conference room, or the in-charge office room. However, informed consent was obtained before starting the interview (Appendix 9). The importance of conducting the interviews in a comfortable place that is suitable for interviewees is recognized for the following reasons:

- to enable the participant to speak freely.
- to minimize interruptions during the interview.

The following figure describes the recruitment process that the researcher follows (Figure 3-1).

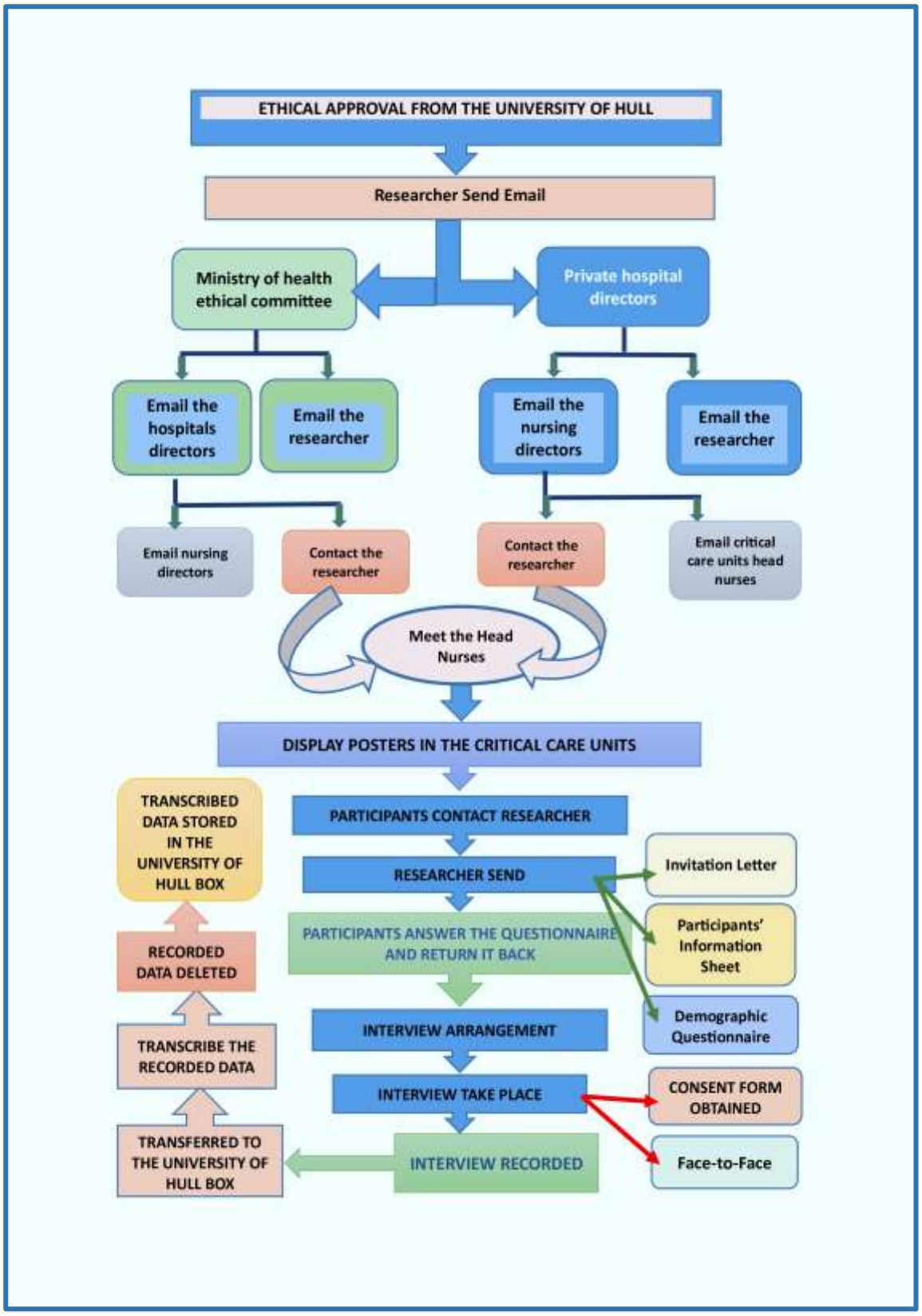


Figure 3-1: Steps of the recruitment process.

3.10 Data Collection in Grounded Theory

To meet the purpose of the study, the researcher used a semi-structured face-to-face interview. Semi-structured interviews are used to achieve the purpose of grounded theory rather than other interview methods (Corbin & Strauss, 2015). This method includes collecting, analysing, and interpreting the collected data to answer the research question (Creswell & Creswell, 2018); the data collection process and analysis continued simultaneously until concepts and themes were saturated (Fischer, 2006; Strauss & Corbin, 1998). However, the following discusses the qualitative interview method that was used in this study.

3.10.1 Qualitative Interview

Data collection is an important method. The importance of the interview comes from enabling the researcher to explore and understand the participants' behaviours and actions. Thus, it is the best way to give the participants the chance to express their experiences through the interview. In this study, the interview is a two-way process that enables the researcher to collect in-depth data about the nurses' experiences and how they interact with the critical environment to administer medication safely, as well as allow the participants to talk freely about their experiences and perceptions. For that, building a trusting relationship with the participants enables them to express their feelings freely during the interview (Silverman, 2001).

To achieve the aim of the study, the researcher needs to select participants who are willing to participate in the study to ensure the truth about the phenomena under study (Cohen et al., 2007). To enhance the effectiveness of the interview, the researcher used appropriate probing, promoted interaction with the participant, and acted comfortably.

In this study, the researcher used face-to-face interviews as the main data collection tool, which is consistent with the philosophical assumptions. So, it was easy to involve the nurses in the study

and ask them about their experiences directly. The researchers used diverse kinds of data that include field notes, interviews, and information in reports and records; the selected method will be based on the topic and the availability of access.

3.10.2 Semi-structured Interviews

The researcher conducted semi-structured interviews with eligible adult critical care nurses; this enabled the researcher to explore the factors that influence the nurses' approach to administering medication safely. The nurses were investigated in their real context, which was the critical care units.

Interview-guided research questions were used to identify the phenomenon under examination. To achieve the phenomenon description, Charmaz (2006) recommended that the research questions for grounded theory be open-ended and broad. However, the ladder question technique was used to lead the interview; this technique enables the researcher to select the most appropriate questions based on the respondent's dialogue (Price, 2002). Price (2002) suggested starting the interview with clear and simple questions related to participants' knowledge and actions rather than asking about feelings, as this will provide more comfort and assurance for the participant.

The following figure shows the levels of ladder questions, and in each level, the participants were asked questions that encouraged them to provide a wide range of information related to their experience.

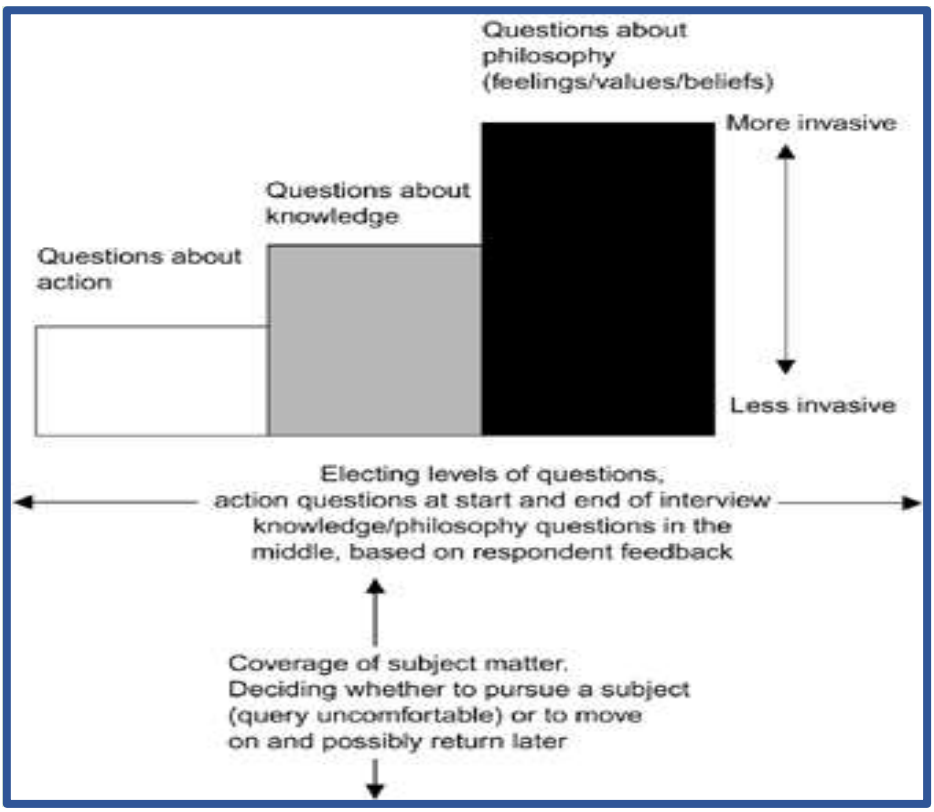


Figure 3-2: Adapted Ladder Questions model (Price, 2002)

Using the technique of asking questions builds trust with the participants, so questions should be planned and prepared carefully (Cohen et al., 2007). To enhance the richness of information that relies on in-depth understanding, prompt questions were used, as well as to give the interview some structure and provide it with the necessary focus (Miles et al., 2014). This process enabled the participants to discuss their own experience of medication administration in critical care units and to describe their practice toward the safety of medication administration procedures. Semi-structured interviews allowed the participants to expand their focus on the discussed topics that they considered important in practice. The length of the interviews ranged from 25 to 52 minutes.

3.10.3 Interview Guide

The researcher conducted four pilot interviews as an initial interview guide. Based on these interviews, minor modifications were made to the prompts according to discussion and feedback from the study. One of the advantages of semi-structured interviews is the flexibility of adding or

removing questions during the interview session in response to the collected data (Corbin & Strauss, 2015). The following table shows an example of the general questions that were asked, including the prompts that were used during the interview.

Table 3-5: Examples of the initial interview guide questions.

General questions were asked to build relationship trust with the participant, for example, "Could you tell me about yourself, your experience, your job?	
General question	Prompts
Can you please start to tell me about the medication administration procedure in the adult critical care unit?	Well, I need to know how you practice the procedure of administering medication in the adult critical care unit.
What are the skills that you should have to administer medication safely in critical care units?	It means you are following steps to administer medication, so what helps you to organize your procedure?
What do you think your role is in administering medication in the adult critical care unit?	I need to know what tasks you perform regarding medication administration.
What do you know about the factors that influence safe medication administration in the adult critical care environment?	OK, do you think that these factors can be maintained or prevented?
How do you feel about the methods that are used in the adult critical care unit regarding the safety of administering medication?	Do you think the methods used are useful enough for administering medication safely?

3.10.4 Conducting the Interviews

Interviews were conducted according to scheduling appointments at a convenient time for the participant. The interviews were conducted in a suitable and quiet place within the hospital; this interview took place either in the nursing director's office, the nurse's office, or the hospital conference room. Before each interview, the researcher reminded participants about the purpose of the study, confidentiality, and that their participation was voluntary. The steps for conducting the interview are discussed as follows:

3.10.4.1 Preparing for the interview

The interviewer used these steps to prepare for the interviews:

- Be familiar with the setting where the interviews took place.

- The researcher met with the nursing directors of the settings to obtain information about the settings and to obtain permission to display the invitation poster.
- The researcher met the head nurses of the critical care units where the study took place.
- The researcher visited the hospitals several times to distribute the participants' documents related to the study, which include the participants' information sheet, demographic questionnaire, and invitation letter.
- The digital recorder that was used for recording the interviews was checked before each interview to exclude any unexpected problems.
- The interviews took place in private to avoid interruptions, allow participants to speak freely, and protect confidentiality.
- The interviewer had the necessary interview skills, which were gained through reading and supervisors' feedback. In addition, the researcher joined the qualitative research module and gained the essential skills provided by the University of Hull librarian specialists.
- Pilot interviews were conducted for interview guidance; the pilot study consisted of four interviews, which were transcribed and analysed before conducting the following interviews.

3.10.4.2 Interview stage

The researcher conducted one to two separate interviews each day (Polit & Beck, 2018), as Palestine has a special situation regarding transporting from one city to another. These interviews were conducted either once or twice a week to facilitate concentration in the interviews and to have enough time for listening to the interviews and for transcribing. The interviews were arranged to be started before the evening shift between 1:30 pm and 2:30 pm, and some interviews were at the end of the morning shift between 2:30 pm and 3:30 pm. One of the private

hospitals arranged for all the interviews to occur on the morning shift between 11:00 am and 3:00 pm. Otherwise, no one was excluded from the study.

In the beginning, the researcher, who is the interviewer, introduced herself to establish a familiarity and trust relationship with the participant, and then the interviewer asked for permission to record the interview. The use of the digital voice recorder was discussed on the information sheet, during the information session, and at the beginning of the interview. The interviewer explained again that the records would be accessed only by the researcher and the supervisors and would be stored in a safe place using the cloud box at the University of Hull for confidentiality purposes. Moreover, the interviewer explained another time the purpose of the study, saying that the interview is not an exam with right or wrong answers and to feel free with the given answers regarding the medication administration in the critical care units. Participants were told that they could withdraw from the study at any time during the interview without giving any explanation. Only one of the nurses was hesitant about his participation before starting the interview, and after the clarification, the interviewee was willing to continue the interview. Otherwise, all nurses who conducted the interview were included in the study. All the participants reported that they were unfamiliar with the interview as a research method, and this was the first time they had a recorded interview.

The interview started with a broad, open-ended question to start the conversation, and then prompt questions were used to guide the rest of the conversation. The researcher listened attentively and allowed the participant to ask questions during the interview if they wanted that or if they wanted clarification on the question. The researcher gave positive feedback to the participant, such as moving the head down and up and using supportive words like "aha," "okay," and "I see." Sometimes, the researcher used silence to give the participants time to recall what

they wanted to talk about and express their thoughts clearly regarding their experience administering medication in the critical care units. Most of the participants were male, so some of them asked to keep the door open (a religious and cultural issue), and others didn't have a problem closing the door.

The interview's estimated time was between 30 and 60 minutes. Some interviews took less than 30 minutes, as the participants did not have any additional information. On the other hand, some interviews took more than 45 minutes, and the researcher used several techniques to guide the interviews. The researcher prompted the interviewee's responses to explore and discover unclear issues; she also summarized what was discussed, and at the end of the interview, the participants were asked if they had anything else to add.

At the end of the interview, the researcher thanked the participants for their participation and obtained permission from the participants for future contact if further information was needed. On the contrary, the researcher's contact details were left with the participants if they needed further information or had any questions (email and telephone numbers). The researcher mentioned that the results of the study will be shared with the hospitals and the MOH.

3.10.4.3 Transcription

All interviews were digitally recorded and transcribed word-for-word. The process of verbatim transcription started with four pilot interviews. The first interview was translated into English as the participant mixed his speech in English and Arabic; all medical terms were spoken in English while the main speech was in Arabic. After the transcribed interview was sent to the supervisors for feedback, all interviews were transcribed and stored in the University of Hull Box for backup (protected by username and password) when needed to be revisited and for confidentiality issues. In addition, memos and field reflective notes were used to allow reflexivity.

I listened to the recordings again to compare them with the transcribed interview and check for transcription accuracy. For transparency and to confirm the accuracy of what was said compared with what was transcribed and translated, participants were asked if they wanted to check what they had discussed during the interview; no one asked to see their transcribed record. After the first four transcribed interviews, the researcher started to manually code each interview as part of the transcription process. The overall transcribed interviews were around 575 A4 pages. An example of transcribing data is shown in Appendix 13.

3.10.4.4 Translation

Palestinians speak Arabic as their native language and use English as a second language. The English language is taught in Palestinian schools, and the use of the English language in higher education depends on the type of specialty that will be taught. So, the English language used for studying the bachelor's, master's, and doctoral degrees in nursing is English; for that, all nurses use the medical language in their careers.

Even though the participants were asked to use the language that they preferred, some started to speak in English and then shifted to Arabic or mixed Arabic and English; others preferred to speak in English, although there were many grammar mistakes during their speech. while some of the participants' speeches were completely in Arabic. Therefore, all the interviews were conducted in English, with the occasional translation of the questions to Arabic. However, the participants used English for medical terms because it is difficult to translate them into Arabic. The researcher translated all the interviews that were in Arabic and those that were mixed between English and Arabic into English; some of the interviews were in English, and the researcher saved them in the English language.

To ensure the accuracy of the translation, a translation back from English to Arabic was conducted, the text consistency was examined, and the translation was shown to be accurate concerning the meaning being communicated. Translation from one language to another is not simple, and back-translation is essential to ensuring consistency between words and their true meaning (Bowling, 2023). The translation facilitated the understanding of the content, the process of data analysis, and coding. The researcher was aware of using the participants' expressions during the interview, such as pausing to laugh or to observe silence, and interpreting their meaning during the analysis process. The researcher kept in contact with the study supervisors during the transcription and translation process to discuss raised issues and their feedback.

3.10.5 Piloting

Piloting is a small-scale version of the study, which is carried out in preparation for the whole study. It is used to assess the study's feasibility, provide an initial evaluation of the item's consistency, and refine the methodology (Creswell & Creswell, 2018).

To test the appropriateness of the methods of collecting data, the first four interviews were conducted as a pilot test to determine that the research questions were compatible with the obtained data. The interviews took place in the same settings that were used in the study for collecting data. The participants in the pilot were asked to give their feedback on the prompts from their point of view. The first transcribed interview, the English transcript, was sent to the supervisors for their feedback. Based on the discussion with the supervisors and according to the participants' feedback, minor modifications were carried out in the interview guide, and the modification was included as part of the methodology.

Piloting helps the researcher determine the suitability of the environment during the interview by testing the audio recording and the suitability of the interview guide. In addition, it helps to

examine the suitability of the length of the interview as well as determine the possibility of having problems during the interview and refine them in the next interviews. Pilot interviews were included in the entire study.

In this study, the sample started with four pilot interviewees and continued until theoretical saturation was achieved, theoretical sampling is discussed on page 89. Theoretical saturation was used as a marker to indicate when to cease collecting data, and it is not related to developing new ideas. It refers to the identification of the relationship between categories (Strauss & Corbin, 1998).

In this study, theoretical saturation occurred after eighteen interviews, as neither categories nor subcategories emerged from the collected data. The researcher conducted another two interviews to be confident about the results and to ensure that there were no new emerging categories from the last two interviews. However, 20 interviews were at the point of saturation with no additional new data or codes (Polgar & Thomas, 2020).

3.11 Data Analysis

According to Given (2008), the researcher should use his personal and professional skills, knowledge, and training to produce a clear picture concerning the collected data (Given, 2008). The researcher completed two modules concerning the research methodology: the Introduction to Qualitative and Quantitative Methods module and the Research Methods module. Occasionally, the qualitative analysis and the analysed interviews for training purposes were discussed with Ph.D. student colleagues. Besides, the supervisors were the main source for getting advice and feedback. Therefore, these equipped the researcher with the required training and skills to be competent to conduct a credible analysis.

Analysing data in grounded theory focuses on four main steps called the "4 Cs": coding the existing data, customising the codes, categorising the codes, and constructing the theory (Glaser & Strauss, 1967). Based on grounded theory in this study, ongoing comparative analysis and writing were adopted in each step along with the collection of the data. Coding each piece of the data enabled the researcher to examine what was going on with the data (Wertz, 2011). So, the gathering of data and analysis proceed concurrently and actively (Fischer, 2006). The researcher transcribed word-for-word all the interviews during and after the data collection phase. The researcher listened to the voice recordings several times to get all the participants' words, as well as read the transcribed data to become familiar in depth with the data and any relevant thoughts or ideas (Charmaz, 2014). The twenty interviews were analysed through a constant comparative analysis method.

The use of the semi-structured interview in this study is based on adopting the grounded theory design, which employed a comparative method for analysing the collected data (Bryant & Charmaz, 2007). This method consisted of a process of comparing data with data, data with

category, a category with category, and category to the concept during the analysis procedure, as described by many authors (Bryant & Charmaz, 2007; Charmaz, 2006; Corbin & Strauss, 2015). Through theoretical sampling, this strategy is a consistent method for collecting, coding, and analysing data.

However, the researcher utilizes a flexible approach here, as during the coding and analysis, the researcher returned several times to the open coded stage for modifying the codes, and the rationale for that is to allow the development of the theory (Charmaz, 2006). Otherwise, the data analysis and coding focused on the interview transcripts, memos, and field notes, which were used to support the coding process.

Concerning the use of grounded theory, the researcher has been restricted to the elements of grounded theory, which include theoretical sensitivity, theoretical sampling, the coding process (open, selective, and axial coding), constant comparative analysis, and memos. These elements are vital to ensuring the flexibility of the research strategy.

3.11.1 Open Coding

The researcher adopted manual coding to be immersed in the data provided by the critical care nurses without being influenced by previous experience (Saldaña, 2021). As there had been a gap between the academic and clinical settings for more than five years, this didn't influence the process of manual coding. Manual coding is a cyclic process that helps researchers; this process includes code mapping, which enhances credibility and trustworthiness, and code landscaping, which is a manual systematic method that enables the researcher to organise and assemble codes and subcodes as needed. The researcher follows five steps: retrieve, filter, link, compare, and identify the relationship between keywords and phrases (Saldaña, 2013). During this process, the researcher was conscious of being as objective and neutral as possible.

However, the researcher is involved in exploring the data and identifying the units of analysis to code for the meaning of what is being said by the participant (Cohen et al., 2007). The researcher listened attentively to the recorded interviews and read the transcribed data to be sensitive to ideas and new thoughts. This was important to develop theoretical sensitivity and awareness of the data (Bryant, 2017). The researcher began first by analysing the pilot interviews, followed by all the interviews. The following table is an example of the initial codes.

Table 3-6: Example of the initial codes.

Initial codes
Types of medications administered in critical care units
Three checks, medication rights
The intended effect, side effect
Sources of Knowledge
Role of the nurse who is in charge.
Role of the nurse who is assigned to the patient
Role of the pharmacist or pharma doctor
Role of the physician
The procedure of administering medication
Steps of administering medication
Interpreting the physicians' order
Skills to administer medication
Advantages of using technological methods
Disadvantages of using technological methods
Preceptorship
Protocol of competencies
Physician order
Administering the medication
High-alert medications policy
Monitoring and observing nurses' performance
Managing problems
Continuous education
Interruptions
Nurse-patient ratio
Patient factors
System factors
Nurse experience
Medications may cause harm
Training courses
Achieving the goal, of avoiding malpractice
Administer medications with caution

In the open coding stage, the researcher explored the transcribed data word-for-word, line by line, to code up the data, creating new codes, categories, and sub-categories where necessary (Bryant & Charmaz, 2007; Cohen et al., 2007). In other words, open data is a process of breaking down the data, examining it, comparing it with relevant data, and developing categories and sub-categories (Corbin & Strauss, 2015; Wertz, 2011). The codes emerged from the actual words of the participants, and using the actual words of the participants provides evidence that the data is grounded (Glaser & Strauss, 1967).

3.11.2 Axial Coding

Axial coding is an advanced phase of open coding that produces concepts that fit the collected data. Axial coding consists of intense analysis around a category that could form an axis for further coding and could be the core category of the emerging theory (Bryant & Charmaz, 2007). According to Charmaz (2006), axial coding is considered the most helpful method for describing the relationship between categories and their relationship with the subcategories. Axial coding is also defined as the interconnectedness between categories and making connections between categories (Cohen et al., 2007; Corbin & Strauss, 2015).

In this study, axial coding was performed alternatively with the open coding that began after the first four interviews, in which the discussion ends with categories. The emerging categories from the open coding were important to start axial coding and to relate the categories with their subcategories through their dimensions and properties, which explained the phenomena under study (Strauss & Corbin, 1998). From the axial coding, subcategories were developed that answered questions such as why the phenomenon occurred, where, and when; who took the actions; how the response of the phenomenon was; and the sequences of the actions that were taken. In this context, I asked prompted questions based on my analysis of the interviewee's

answer. For example, interviewees mentioned that they follow steps in administering medication, and this positively influences the safety of medication administration. So, I asked prompted questions, such as why these steps are particularly used and whether these steps are related to hospital policies or related to their knowledge. Then, in the subsequent interviews, the nurses were asked what the factors were that could influence the safety of the steps they used to administer medication and how they responded to control these factors to enhance safety. As revealed in the data, interviewees could not control all factors to enhance safety. This was explained in the way that nurses have limited resources to enhance safety, such as the availability of equipment and supplies, and they mentioned that this is out of their responsibility. Finally, I thought about the consequences of the nurses' and stakeholders' actions that they could take to enhance the safety of medication administration in critical care units.

Also, a constant comparative analysis was used in axial coding, and each category was compared with other categories; this facilitated the refining process and confirmed that a category was exclusively mutual. The use of constant comparative analysis helped me to check and recheck the consistency of the main categories that emerged from the data.

Finally, this study aimed to explore the factors that influence the safety of administering medications in critical care units. So, in the next stage, I needed to make a link between categories and their subcategories and integrate them to form a core category or theoretical framework that could explain the phenomena. The final stage of data analysis in grounded theory is selective coding, which builds upon the structure of the previous work in open and axial coding.

3.11.3 Selective Coding

For grounded theory, selective coding starts only when the analysis finds the core variable. The emerging core variable became a guide for further data collection and theoretical sampling

(Glaser, 1992). As the core variable emerged, open coding ceased, and the coding became limited to those related to the core variable. So, selective coding identifies a potential core category that is the main concern of the interviewees (Bryant & Charmaz, 2007). Selective coding includes identifying a core code and finding the relationship between the core code and the other codes to explain the whole phenomenon (Cohen et al., 2007).

The core category was conceptualised, which fit the data and appeared in all the interviews to some extent (Charmaz, 2006). This allowed for a logical and consistent interpretation of the factors that could influence the safety of medication administration in critical care units. Also, it explains nurses' understanding of the phenomena and how they act to enhance the safety of medication administration.

After identifying the grounded theoretical structure, I continued with the theoretical sampling and data analysis through constant comparative analysis to reach theoretical saturation (Strauss & Corbin, 1998). This was achieved when all categories became saturated, no new theoretical insights appeared in the data, and the theory became well-developed (Charmaz, 2006).
By using selective coding, I was able to identify variations in the data both within and between the categories. This stage was continued until the completion of writing the thesis.

3.12 Quality and Trustworthiness

Trustworthiness means a judgment of a piece of research by another researcher, reader, or participant (Creswell, 2013). Trustworthiness replaces the traditional positivist criteria of internal and external validity (Denzin & Lincoln, 2017); it arises from emphasizing the natural setting, which reflects the actual participants' actions in the context of naturality (Given, 2008).

However, the trustworthiness criteria developed by Lincoln and Guba (1985) are the most widely used criteria for evaluating qualitative content analysis. The aim of using this criterion is to support the argument that inquiry findings are worth paying attention to (Guba & Lincoln, 1989). Additionally, this is important when using inductive content analysis, as categories are created from raw data without a theory-based categorization matrix (Elo et al., 2014).

Trustworthiness in qualitative studies is achieved by four criteria, which are equivalent to reliability and validity in quantitative studies (Lincoln & Guba, 1985). The four criteria articulated by Lincoln and Guba (1985) within trustworthiness were credibility (parallel to internal validity), transferability (parallel to external validity), dependability (parallel to the conventional criterion of reliability), and confirmability (parallel to the conventional criterion of objectivity). The four trustworthiness criteria are described as the gold standard for qualitative research (Guba & Lincoln, 1989).

3.12.1 Credibility

Credibility is the 'truth' of the study results (Denzin & Lincoln, 2017). According to Polgar and Thomas (2020), credibility is defined as whether the interpretation of the data makes sense and has an accurate interpretation of what the participants mean. Credibility allows the researcher to feel confident about observation, interpretation, and conclusion (Creswell, 2013). Credibility is enhanced by several strategies in this study (Saldaña, 2021).

First, engagement and spending time in the field helped the researcher build trust with the interviewees and understand the setting. This was achieved by visiting the field several times and conducting several sessions to provide essential information related to the research study. The researcher is originally from Palestine and has previous experience in the adult critical care unit, which provides the researcher with a good understanding of the Palestinian critical care environment. This enabled the researcher to understand the nurses' behaviour and performance in critical care settings.

Second, the employment of purposeful and theoretical sampling in this study contributed to credibility; the selected sample was made up of registered nurses who had at least one year of experience in the critical care units and were willing to participate. Therefore, they knew about medications used in critical care units and were willing to share their experience related to administering medications within the critical care environment. Additionally, the use of constant comparison of the emerged data from the participants is another technique to ensure credibility, and it also helps the researcher throughout the analysis to check and recheck the emerged categories and sub-categories (Corbin & Strauss, 2015).

Third, in the qualitative research method, the researcher is the instrument for collecting data, so credibility is influenced by the researcher's previous experience. The researcher had experience in critical care units and teaching, which enabled her to be in direct contact with hospital managers and in-charge nurses, which facilitated the recruitment process. The interviews took place in the second year of the Ph.D.; within this time, the researcher completed two research methods modules, including the qualitative method, in addition to training skills for collecting data provided by the librarians. In addition, the researcher was in contact with the supervisors to get feedback,

advice, and help in solving any existing problems. This equipped the researcher with the appropriate skills and training to achieve credibility in the interview.

Fourth, the supervisors reviewed the work at each level of the research process and provided critical feedback on this study to verify its accuracy. They guided the researcher through the process of collecting data, analysing, interpreting, and validating the study results. Additionally, feedback about the methodology and the analyses of emerging concepts and categories was provided by an examiner during the annual review. The overall feedback helps the researcher enhance the research process.

3.12.2 Transferability

Qualitative research aims to describe the phenomenon under study and generate knowledge rather than generalize results that could be transferred to other situations and settings (Creswell & Creswell, 2007; Marshall & Rossman, 2016). This is similar to external validity, which is bound to the interpretation of phenomena that could be applied to a comparable setting, such as critical care units in different hospitals.

This study was conducted in Palestine because the researcher intended the findings to be transferable there. Furthermore, it should be of global interest and valuable to a variety of critical care specialists. The study recruited seven hospitals throughout three Palestinian cities, representing around 30% of the Palestinian population. The interviewees for this study worked in adult critical care units with various specialties, and they represented the nurses who work in these settings. The emerging categories are based on interviewee perceptions of medication administration in Palestinian critical care units.

The researcher provided a thorough description of the research setting, methodology, and findings that could help future researchers and readers judge the applicability of the research

question in various critical care settings. Furthermore, the researcher employed purposeful recruitment to enable future investigators to approach key healthcare practitioners to gain responses from various critical care units.

3.12.3 Dependability

Dependability involves the use of multiple independent methods for collecting the data, and the study will develop similar results (Polgar & Thomas, 2020), which concerns the stability of the collected data over time regardless of the methodological decisions, because of maturing reconfigurations (Guba & Lincoln, 1989). The researcher conducted all the interviews independently, using the same interview guide. Then, the researcher manually transcribed all twenty interviews and analysed them. The researcher had the required knowledge and skills to collect and analyse the data, which increased its reliability.

To compose the discussion chapter, the study findings were compared to the existing literature. In addition, one of my colleagues examined a part of one of the transcripts for reliability, and the supervisors checked the progress of the study and provided reasonable comments.

During the Ph.D. journey, the researcher presented the literature review and the study findings in a local workshop and received feedback on the content of the presentations. Furthermore, the supervisors provided comprehensive feedback at each stage of the research study process.

3.12.4 Confirmability

Confirmability refers to the steps of the research process being described clearly (Polgar & Thomas, 2020), and ensuring that the study findings represent the experiences, ideas, and ways in which participants understand their world rather than the preferences of the researcher (Guba &

Lincoln, 1989; Marshall & Rossman, 2016). Confirmability shows the connections between the collected data and the researcher's interpretation (Gray, 2014).

Confirmability could be achieved through an audit trail, which provides a transparent way to show how data were collected and managed and enables someone to see the data as evidence to follow the research process step-by-step to represent and interpret the findings (Marshall & Rossman, 2016). An audit trail is a record of the researcher’s decisions regarding gaining access to the field, interviewee recruitment, ethical considerations, and analysis methods (Holloway, 2005). To facilitate the auditing, the researcher in this study used audiotape and transcription of interviews. In addition, the use of quotes in the findings chapter refers to the participant code and interviewing number. Furthermore, the researcher analyses and interprets the data manually.

The second technique for enhancing confirmability is reflexivity. Creswell (2007) defines reflexivity as the researcher's awareness of the biases, values, and experiences that he or she brings to the qualitative research study, as the researcher is the main instrument for collecting data (Creswell, 2007). As a result, the researcher needs to maintain a balance between field engagement and the objectivity and sensitivity of the study. While collecting and analysing data, the researcher utilized reflective memos to record and reflect on ideas, feelings, and preconceptions regarding safe medication administration. Moreover, the supervisor's constant feedback, input from Ph.D. colleagues, and input from seminars assisted the researcher in identifying her contribution to the interpretation.

Generally, confirmability was enhanced by a thorough description of the study context, the researcher’s reflexivity, the extent of credibility, and dependability.

3.13 Chapter Summary

This qualitative study, using and adopting constructivist grounded theory, is designed to investigate adult critical care nurses' perceptions toward their experiences of administering medication safely. Also, this method enables an understanding of the factors that contribute to the safety of administering medications in a critical care environment. Ethical approval was obtained from the ethical committee in the Faculty of Health Sciences at the University of Hull, the Palestinian Ministry of Health, as well as the hospital directors in the private and educational hospitals. The study took place in seven Palestinian hospitals (three governmental, three private, and one educational hospital).

The sample consisted of twenty critical care nurses from different critical care areas (general ICU, surgical ICU, and coronary critical care). Data were collected using face-to-face, semi-structured interviews to enrich the data from the experienced nurses working in the Palestinian hospitals. All the interviews were audio recorded and transcribed thoroughly. The data were kept confidential, and ethical standards were addressed to protect the participants.

Twenty interviews were manually analysed to extract the emerging themes, which were analysed through comparative analysis. Straussian stages of coding (open, axial, and selective) were followed to analyse the collected data, while Charmaz's constructive ideas maintained the development of the theory. The study's quality and trustworthiness were achieved by the academic supervisors' input, peer debriefing, prolonged engagement, and reflexivity.

Chapter 4 RESEARCH FINDINGS

4.1 Introduction

The previous chapter underpins the method for developing grounded theory. The comparative analysis and the evidence in the literature supported the emergence of the theory. This chapter tried to identify the factors influencing the safety of administering medication in Palestinian critical care units from the critical care nurses' perception and how these factors could be managed to enhance safety. This chapter explores the research question and sets out to answer it.

The research question in this study was:

> "What are the factors that influence medication administration safety from the nurses' perception in Palestinian critical care units?"

4.2 Participants in the Study

This chapter presents the data generated from twenty face-to-face semi-structured interviews, which ranged from twenty-five to fifty-two minutes in length and took place between October 2021 and January 2022. All the recorded interviews were transcribed verbatim, and details related to grounded theory data collection were discussed in the previous chapter (Chapter 3).

The data were derived from twenty participants who were formally interviewed in-depth, and those participants typically reflected the population of Palestinian critical care nurses. The participants willing to participate in this study were sixteen male nurses, representing 80%, and four female nurses, representing 20% of the studied sample. The reason for recruiting male nurses more than females was related to their willingness to participate rather than female nurses; the female nurses were unable to be interviewed outside of working hours as some of them wished to

get back to their children or they were living outside the city, and for political reasons, they needed to leave early.

Twelve participants, representing 60%, were working in private hospitals, while eight of them were working in governmental hospitals. The participants' ages ranged from 25 to 45 years old, with the largest group of six (30%) aged between 34 and 39 years old. Details of the demographic characteristics of the participants are found in Chapter 3 (Table 3-2, p. 98).

4.3 Findings of Categories from the Initial Interviews

The initial four participants had experience in different working areas, including general intensive care units, surgical intensive care units, and coronary care units located in governmental and private hospitals. Their working experiences in critical care units varied between one and ten years. One of these four participants was an in-charge nurse, and the three others were lower-grade nurses with no management experience.

Initial coding was conducted to explore the data from the initial interviewees. The initial coding in grounded theory prompted the areas that needed to be discovered (Charmaz, 2006). However, the initial coding helped to separate the data into categories. Line-by-line coding took place to analyse the data thoroughly and engage actively with the data to view the generated data from different perspectives (Charmaz, 2006).

All the initial participants talked about their thoughts on medication administration safety in the critical care units, and they highlighted its primacy. As well, they described that the priority of safety helps the nurses prevent harm to the patient, and this will be achieved by having the knowledge and appropriate practice:

> *"Safety means, in simple words, no problems; it means no harm, and the outcome is good if I follow step by step the medication administration procedure." (AP01)*

"[Safety]: means nurse should have evidence of knowledge about the medication that will be given, organising the procedure, and respect the medication rights." (AP04)

"It is so important to follow the safe preparation of the medications, as this will help me. And when preparing the medication accurately, this will influence the patient's response to the medication." (AP03)

"[Safety]: do not harm the patient or cause morbidity or mortality; safety is a priority for me. Also, it means safe procedure, and administering the right medication to the right person." (BG02)

The analysis of the first four interviews identified factors that impact safety; these factors could enhance safety and/or impede safety (Figure 4-1). These factors are discussed thoroughly in this chapter.

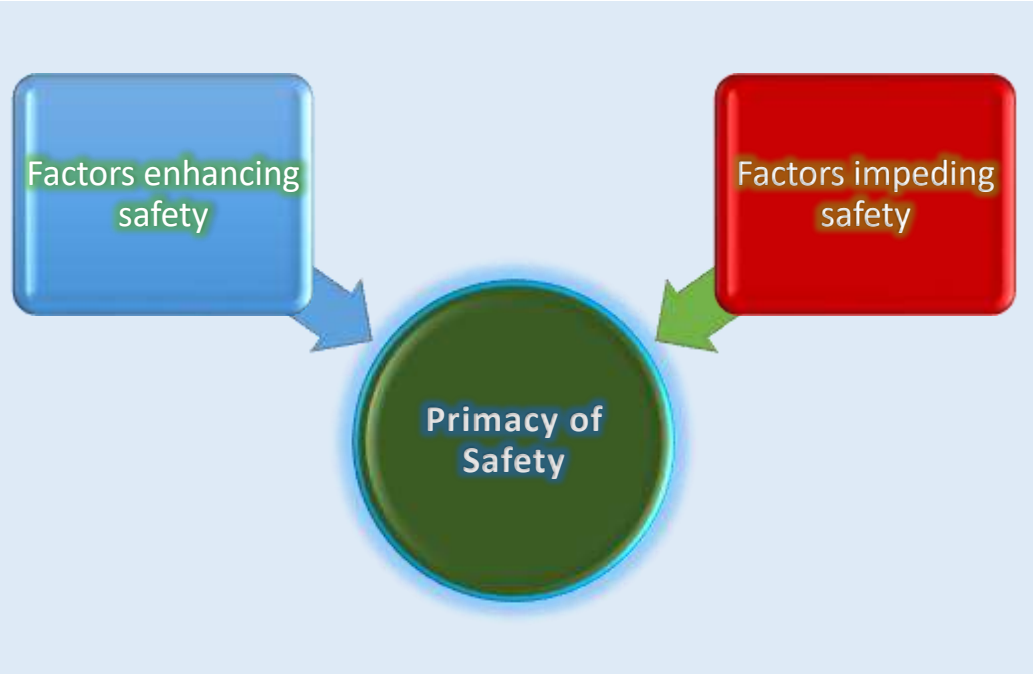


Figure 4-1: The primacy of safety includes factors that enhance and/or impede safety.

Figure 4-1 describes the focus of all the participants on the primacy of safety, which is classified into factors enhancing safety, and factors impeding safety. Some of the participants talked about factors enhancing safety, while others talked about factors impeding safety in Palestinian critical care units.

The initial four participants talked broadly about the factors that could influence the safety of administering medications in critical care units. The participants described the importance of knowledge and skills that could influence medication administration safety; additionally, they explained that the nurses need to know about the types of medications and their uses, as well as how their knowledge could help in discovering and managing problems raised during administering medications:

> *"I have to know about each available medication and all of the medications needed for the patient. I have to know how to prepare, administer medication to the patient, and how to monitor this process." (AP01)*

> *"I should have a good background about the types and sub-types of medications and medication groups, and patient's health history." (BG02)*

> *"The nurses in the ICU have and should have good knowledge about medications, contraindications, uses, allergies, and the antidote for the medication." (AP04)*

> *"Based on our knowledge we could discover the problem if the patient developed side effects, and [knowledge] could help in solving the problem according to patient's assessment." (AP03)*

They also mentioned a variety of resources that nurses could rely on to get the knowledge that they need to administer medications safely; these resources include updated textbooks, trusted websites, and consulting pharmacists and physicians:

> *"Ask for help from our experienced nurses around me, the doctors and atlases, textbooks, the internet, and trusted internet websites." (BG02)*

> *"I could consult the clinical pharmacist to ask about how the medication could be diluted and administered." (AP03)*

Additionally, the participants described the process that nurses follow to administer medications, starting by interpreting the physician's order, ensuring medication rights, and checking medication before administering it for safety purposes. They added that the process of administering medications includes a variety of issues that nurses need to consider during the procedure; these

issues include assessing the patient before, during, and after administering medication. As well as how to prepare, dilute, calculate, and administer the medications:

> *"[process]: I have to concentrate and follow the five or six rights that we learned in the universities and be aware to prevent harm during administering medication." (AP01)*

> *"We prepare the medication, then we check if this medication is to be administered at this time; we do double-check, then we administer the medication and sign it." (AP03)*

> *"The patient's information and health status, vital signs, and lab results will guide me on when and how I should administer medication." (BG02)*

> *"We cannot administer amiodarone to the patient if the patient has hypotension because the patient will be at risk for hypotension." (AP04)*

Moreover, the participants talked about different skills that could help the nurses practice the process of administering medications safely. These included communication skills, calculating, and being an advocate for the patient's rights:

> *"I must have critical thinking and good calculation techniques, assess the patient systemically, and the patient's medication history." (BG02)*

> *"Communication skills help me to explain the drug to the patient, and I will possibly pursue the patient to have the medications." (AP04)*

From the open coding, the initial participants described the role of the healthcare providers, including the nurses, physicians, and pharmacists, in administering the medications in the critical care units. The participants highlighted the responsibility of administering medication by the experienced nurse or the in-charge nurse in the critical care units; they added that the responsibility of the nurses included consulting either the pharmacist or physician to get information or clarification regarding the prescribed medications:

> *"The nurse who is in charge responsibility is to give IV and oral medication, including reconstitute, administer, monitor, and ensure the availability of all medications." (AP01)*

> *"My responsibility is to perform double-check, and I should check medication information with the pharmacy department to ensure safety." (BG02)*

"I refer to the doctor for clarification if there is a medication that I don't know how to dilute or how it will be given." "Maybe I will ask the nurse who is with me on the shift, the pharmacist, to ask about how the medication can be administered." (AP03)

Additionally, the initial four participants highlighted the importance of using technology in critical care units; they described how the use of computerized systems and infusion pumps could impact the safety of medication administration. In addition, they described how these technological methods could help in calculating, monitoring, and administering medications:

"The computerized prescriptions could make things easier to follow among the doctor, pharmacist, and the nurse." (BG02)

"This technology will help me give the patient an accurate dose; it will also help me control the dose that I will administer per hour or minute." (AP03)

"We have some instruments or devices that help us control medication, like syringe pumps or dropper machines." (AP01)

"For example, it is very difficult to calculate the dose, the specific dose of norepinephrine, but if I use the syringe pump, this is a minimal amount of about 50 cc in a syringe." (AP04)

Also, they described that the technology is a good method for saving time and solving some problems relating to medication administration:

"Technological methods can be used to save time, so malpractice will be minimal that could save the patient." (AP03)

"Sometimes we fill in a problem when we write medication by handwriting, so you know sound-alikes and same-like medications. A computerised system could solve this problem as the entered medication's name will be clear." (AP01)

The environmental factor was another factor that emerged from the open code. Patients in critical care units are critically ill, and they receive multiple medications at the same time. So, the initial participants described that there are a variety of environmental factors that could impact the safety of administering medications; these included the tidiness of medication boxes and medication trolleys, the boxes where medications are saved and labelled by the medication's

name as well as the patient's name. In addition to workload and interruptions that could be caused by several causes:

> *"The environment in the ward, the ICU ward, if we have tidy boxes for the patient, the bed number, etc., this means about the air conditioning, the tidying of items in the ICU, about the emergency trolley, emergency drugs, beds, and lockers of the patient." (AP04)*

> *"... interruption we have during administering medications including the doorbell, the telephone bell, and the patient recall." (BG02)*

> *"Sometimes the nurse on the shift is responsible for about two or three patients in the ICU; it is a load on the nurse, so sometimes during this time the nurse is giving medication on a high load." (AP01)*

Policies are an additional factor identified during the open coding that impacts the nurses' practice of administering medication safely. Participants described how the presence of policies or guidelines could influence the nurses' practice of preparing and administering medications safely in critical care units. For example, the job description policy describes the responsibilities of each healthcare provider who is involved in the process of administering medications. As well, the participants highlighted the importance of having medication training courses as a policy to update the nurses' knowledge and train the newly graduated nurses:

> *"Job description: the doctor should do his work, the pharmacist should do his work, and the nurse should do his/her work." (AP03)*

> *"If you have the knowledge, you have the power, the knowledge about the medication, and to have refreshment courses, we need refresher courses for IV medication and oral medication." (AP01)*

> *"Knowledge can always be maintained by doing educational sessions for new nurses and for nurses who don't work in ICU." (BG02)*

> *"ICU nurses have a long time of graduation years; these nurses have not had any universal training for a long time, so we need to refresh his mind and refresh his knowledge." (AP04)*

Open coding of the first four initial participants' interviews consequently emerged a provisional set of seven categories; the emerged categories initially were unconnected, as each of these categories enhanced or impeded the safety of medication administration (Figure 4-2).

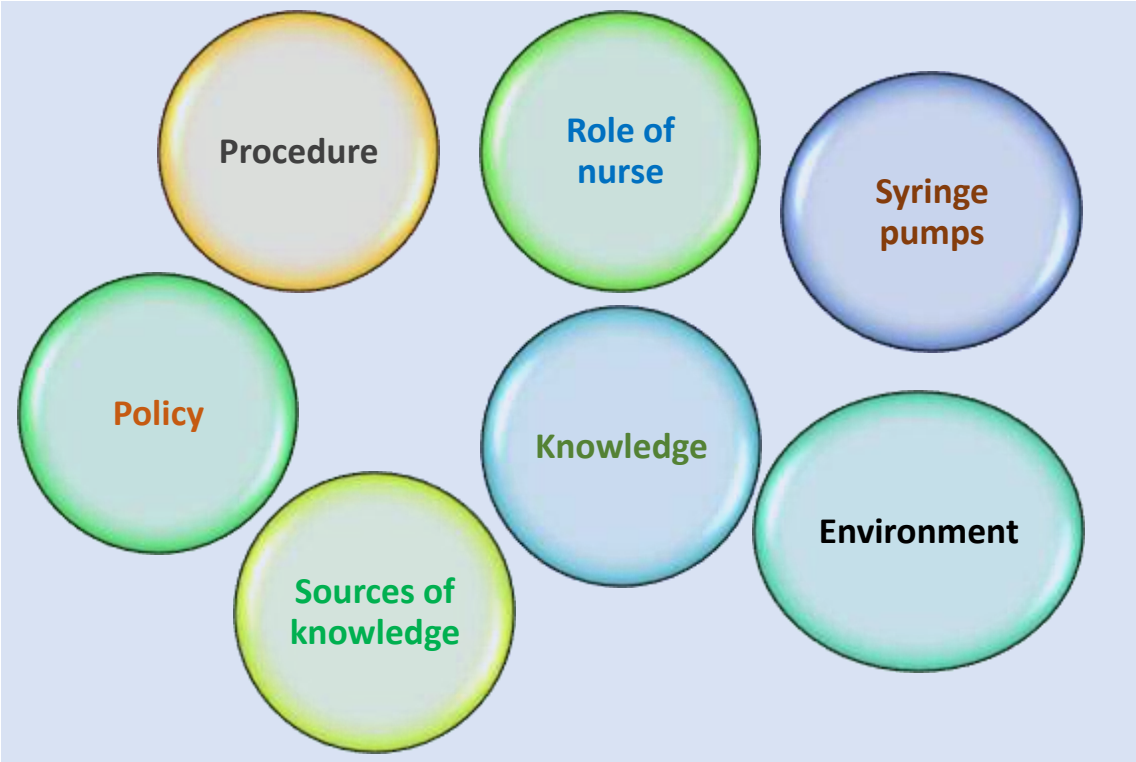


Figure 4-2: The first illustration of the grounded theory includes the seven broad categories.

The emerging categories directed the data collection and development for the remainder of the study. As well, the provisional categories directed the theoretical sampling process (Charmaz, 2006). For example, figure 4-3 demonstrates how the theme of "knowledge and skills" emerged and guided the theoretical sampling of participants working in the critical care units. As the other categories emerged, the theoretical sampling gradually grew and was refined. Therefore, participants who were in-charge nurses were approached because mostly they were responsible for the safety of medication administration procedures as well as observing and evaluating the newly graduated nurses for their competencies. In addition, female participants were approached, as it was noticed that the number of male nurses was dominant in the critical care units.

Furthermore, the emerged categories informed the following sampling of participants, new areas to discover, and targeting sampling distribution until no relevant data emerged; in addition, the conducting of the theoretical sampling guided the researcher to the considerable areas of the grounded theory (Charmaz, 2006).

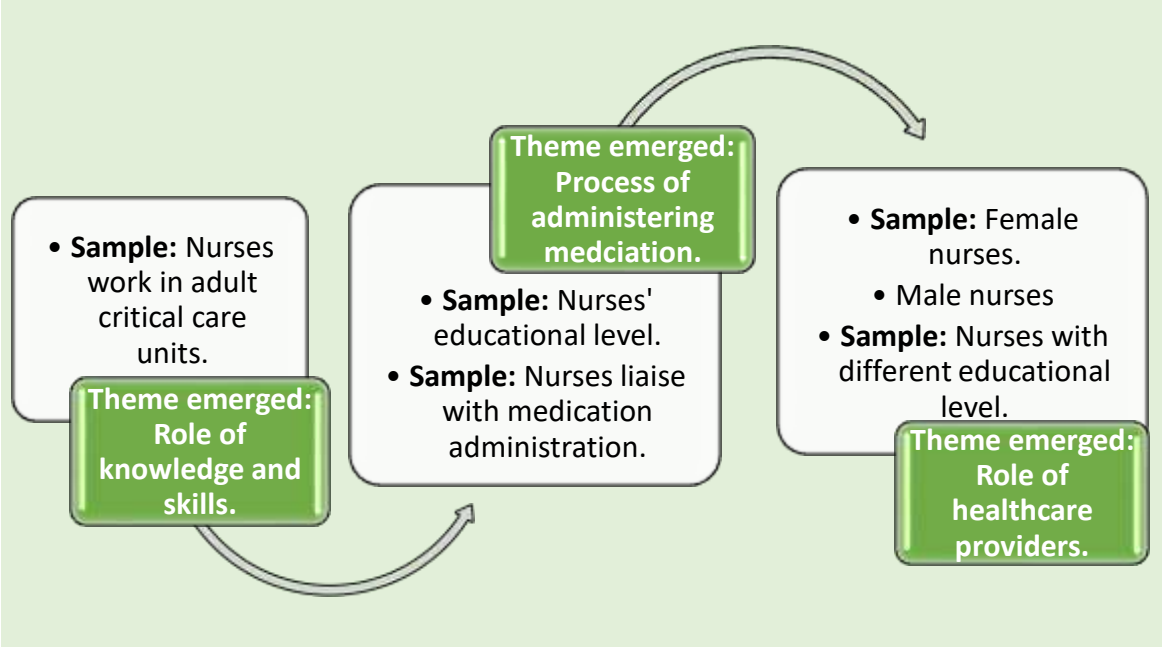


Figure 4-3: Example of the theoretical sampling process. The early emerging theme is the green boxes that influenced the sample decisions in the white boxes.

Based on the theoretical sampling in the grounded theory, the recruited participants were selected to refine and fill the emerging categories as well as enrich the gathered data. The data gathered from the insights of the participants caused the emergence of grounded theory. Then, the development of the interview schedule was based on the collected data and findings of the initial participants. The initial interviews focused on validating and exploring the existing provisional categories as well as ensuring the sensitivity of new ideas that could expand the grounded theory (Charmaz, 2006, 2014).

Based on theoretical sampling, another 16 interviewees were recruited who were working across the range of critical care specialties, bringing the total number to 20 interviewees. These interviews took place between October 2021 and January 2022. Open coding of the data validated

the initially emerging categories. Further, the selective and axial coding helped in refining the emerging categories and identifying the relationship between the categories and the developed core category. An analysis of the 20 interviews proposed that there were no new findings or new categories or sub-categories emerging from the collected data. Comparison between categories and sub-categories showed no spark and no fresh data yield (Charmaz, 2006). So, the decision was made that the theoretical saturation had been achieved and to cease gathering the data, as there were no more new categories that emerged during data collection.

4.4 Core Category and Associated Categories Development

4.4.1 Developing the Core Category “Primacy of Safety”

The open code identified the core category that focused on the "Primacy of safety" in administering medications, which was the main concern of the participants (Bryant, 2017; Charmaz, 2016). The core category "Primacy of Safety" was verified through theoretical saturation, relevance, and feasibility, as well as by moving back and forth between data and emerging categories (Charmaz, 2006).

There were different definitions of safety from the perspective of the interviewees; about half of the participants’ definitions were consistent with the mentioned definition (p.124-125). They defined the concept of safety as causing no harm to the patient. They described that certain medications could cause problems for the patients if they were administered inappropriately:

> *"[Safety] means to administer medication without any problem, without causing problems for the patient or complications. (EP11)*
>
> *"It means to prevent harm to the patient; it means to give the correct medication to the correct patient, in the correct dose, in the correct route." (GP20)*
>
> *"The safety is that you didn’t cause any harm or danger, didn’t cause morbidity, and you didn’t cause anything by the medication." (DG08)*

"Give medication without complications for the patient; this is safety, also, safety means safe prepare medication, accurate dose, accurate drug, mean the medication right, the accurate dose, accurate route." (FG14)

Additionally, participants emphasized the importance of safety to ensure the patient's safety:

"Patient safety is the major thing we have to be sure is done in our unit, and drug administration is a very critical procedure." (FG17)

"Safety medication survives exactly; when you safely administer medication, you save the patient's life." (EP09)

Participants described how the nurse could prevent the patient's harm by practicing the procedure safely and using the appropriate method for administering medications:

"Make sure about the patient's safety by ensuring safe practices; not performing safe practice will cause harm to the patient." (EP12)

"I ensure that the procedure does not do harm to the patient and does not interfere with his well-being and vital signs." (BG02)

"To administer medication safely means that you are not administering medication in the wrong way to the patient, and there are no complications for the patient." (CP06)

4.4.2 Associated Categories of the "Primacy of Safety"

As a result of analysing the interview data, it was identified that there was a link between the various factors that could impact the nurses' approach to administering medication and the primacy of safety in critical care units. The focus was on the "Primacy of Safety" concept and what factors could enhance or impede safety in administering medications in a critical care environment. According to the continuity of data analysis, the boundaries of the factors that impact the safety of medication administration became clearer, and the connection between the primacy of safety and the emerging categories was established (Charmaz, 2006). Six associated categories were identified in the context of safety, including nurses' knowledge and skills, the

process for administering medications, the technology, the policies, the environment, and the role of the healthcare providers in administering medication in critical care units (Figure 4-4).

The first illustration of the development of grounded theory showed seven broad categories; two of these categories were merged as they related to knowledge. However, syringe pumps are related to technological methods; for this reason, the category was identified by the technology factor. So, the final illustration of the emerging categories consisted of six associated categories.

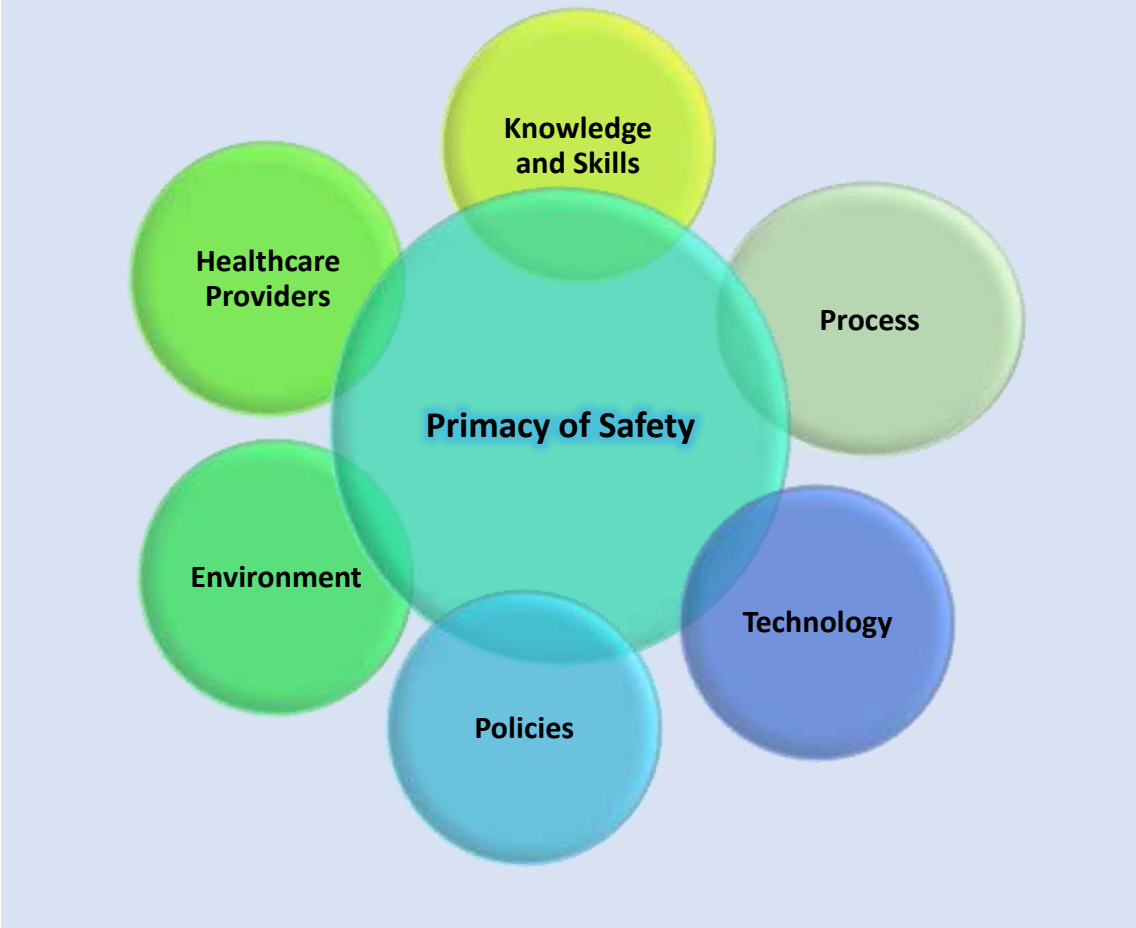


Figure 4-4: The second illustration of the grounded theory is composed of the core category and the associated categories that emerged from the open coding.

4.4.2.1 Knowledge and skills

This category describes the importance of knowledge and skills that nurses need to be equipped with to administer medications safely to patients. This included pharmacological knowledge, as nurses need to know about the intended effect and the side effects, as well as all types of

medications that are used in critical care units. Some of the participants described how having this knowledge could enhance the safety of administered medications:

> *"Knowledge about the medication itself is very important if I don't know, for example, what is the antibiotic, which generation, what is the side effect of it, what is the action of it, these are so important because this will influence the planning for administering other medication." (DG07)*

> *"I have to know about each available medication and all of the medications needed for the patient." (AP01)*

> *"Should have enough knowledge about the use of medication; some medications are diluted in a special type of IV fluid, not all types of fluids, as some medications need the type of solution to do the desired effect." (FG14)*

Participants described that they should have skills in addition to their knowledge; they mentioned that they should know how medications are prepared, diluted, and administered. In addition, nurses should know the route of administration based on how this medication should be administered and the appropriate monitoring based on what they know about the effect and side effects of the medication:

> *"For example, when we administer KCl, we don't administer it IV push usually. We dilute the KCl with normal saline." (EP09)*

> *"Insert the CV line because the KCl in the peripheral IV cannula will hurt the patient, hurt the vein, and will be painful for the patient." (AP04)*

> *"The monitors tell us about the effect of the medication, by monitoring the vital signs and ECG, for example, if administering medication for the treatment of the AF; there should be continuous monitoring for the patient." (FG14)*

Conversely, participants added that the lack of knowledge impeded medication administration safety:

> *"If I don't have enough medication information, this will influence safety; if the medication is the first time to be given or I don't know about it, safety will be impeded." (CP05)*

> *"If one has little information about the medication or doesn't know the symptoms of an allergic reaction, it may influence my practice." (FG15)*

However, they described how knowledge could be enhanced by adopting a continuous education programme and medication administration training courses:

> *"Knowledge is always maintained by doing educational sessions for newly graduated nurses and for nurses who didn't work in ICUs or critical care units." (BG02)*

> *"Courses will provide nurses with the essential training to administer medication: simulation training and training on the manikin on how to prepare and administer medications safely." (EP09).*

4.4.2.2 Process

The process includes the steps that the nurses follow to ensure the safety of the medication administration procedure. Participants explained that nurses should be aware of the five medication rights before administering medications. They also focused on how ensuring the five rights helps prevent complications:

> *"The most important are the five rights: right medication, right patient, right route, right time, and right dose, which are the most important for the patient's safety." (CP05)*

> *"Safely prepare medication: an accurate dose, an accurate drug, the medication rights, the accurate dose, and an accurate route." (FG14)*

> *"Considering the five rights of the patient, I will be so satisfied that I administered the medication without any complication" (EP11)*

Additionally, participants described that one of the most important steps in the process of administering medications was to critically assess the patient and evaluate the patient's laboratory tests, which have a direct impact on the process. For example, nurses need to check the serum level of potassium if the patient is given diuretics to prevent fluid imbalance and unstable hemodynamics:

> *"I think so it is important [assessing the patient], and it is the first thing, and this shows the effectiveness of the drugs. Some patients were admitted here with a WBC of 29.000; antibiotics were administered without response, and the WBCs were still high and still feverish. From the lab results, we can determine if the patient took the drugs effectively or not." (FG16)*

"If I have administered diuretics, I will observe the patient's urine output; if I have administered potassium, I should check the serum potassium." (BG13)

The participants talked about how nurses could determine the effectiveness of the process of medication administration. They explained that this could be done by monitoring the patient's hemodynamics and again by monitoring the level of drugs in the blood serum, as this would guide the nurse to the appropriate intervention to maintain the safety of either the medication administration procedure or the patient:

"From the reading of labs, we can determine if the patient took the drugs effectively or not." (FG16)

"For example, if I administer medication for hypertension and I notice that the blood pressure is maintained and the patient has no complications, I feel that we are in the right direction." (CP05)

4.4.2.3 Technology

Technology includes a variety of methods that are used in critical care units to enhance the safety of medication. Participants mentioned that the use of computerized systems, mobile applications, infusion pumps, and other sources could be helpful to enhance safety:

"The computerized technology makes issues more comfortable in critical care units, for example, you cannot sign a medication in advance, the medication should be signed on time." (DG08)

"The medications administered by these [infusion pump] methods are administered correctly, which is the most important." (GE18)

"I will use the Medscape application to learn about contraindications, if there is no contraindication I will administer the medication safely, if it is a contraindication, I will inform the doctor and discuss this with him to prescribe an alternative." (AP04)

In addition, these technological methods, as described by the participants, could assist in calculating, administering, and monitoring the administered medications:

"Technological methods include the infusion pump, which is found in the ICU; it calculates drops per minute." (EP09)

"Technology for giving medications—one infusion pump or two infusion pumps for each patient—because of the intensive care unit, many medications are administered for one patient." (FG16)

"We have the syringe pump, dropper machine, regulator, kangaroo-feeding pump, and sometimes administer medications by nasogastric tube, temp-catheter, or perm-catheter." (GE18)

Conversely, participants explained that these technological methods could also impede safety if there were problems with the settings of the machines. They added that nurses need to check frequently on the functioning of the infusion pump as well as follow up regularly on the maintenance of these devices to ensure the safety of the administered medications:

"I always check the infusion pump; even if it didn't give an alarm, I check it frequently, make sure about the rate and that there is no occlusion, and note that the syringe is blocked without giving the alarm." (FG14)

"There is maintenance for the infusion pumps yearly; even if they are working, the medical engineer will check them, update the software, and make sure it is functioning 100%." (GE19)

4.4.2.4 Policies

Participants described that there were a variety of policies that could impact the nurse's practice of administering medications safely in the critical care units. They focused on the importance of having a written policy that provides nurses with instructions that enable them to administer medications safely. The instructions included medication protocols that described how to calculate and administer each medication given in critical care units:

"We have here a manual book of the medications that need an infusion pump administered according to the protocol." (DG08)

"The most important thing for me in the unit is to be strict with the instructions; check for the order, the dose, and the quality of the sterility." (EP10)

They added that the presence of policies such as the preceptorship programme, contributes to the progress of the newly graduated nurses' performance to practice administering medications safely, and improve their practice from novice to expert regarding administering medications:

> *"The newly graduated nurses should have a preceptor to guide them for the medication administration procedure; and as they grow up in the career, they will be experts in this." (EP11)*

> *"[Newly graduated nurses] should be supervised by a senior nurse, and when the nurse is well trained, the nurse will be competent to administer the medication safely." (GE20)*

The participants explained that a clear policy reduces the occurrence of problems related to administering medications, and adopting the policy of a continuous education programme will update the nurse's knowledge and enhance safety:

> *"There should be a staff that provides a high quality of care, as there should be continuous education and training courses to prevent the occurrence of the problem." (AP03)*

> *"Preventing problems completely is impossible but reducing them could be done by following protocols and having continuous education." (EP12)*

4.4.2.5 Environment

Participants explained the role of environmental factors that influence the safety of medication administration. They focused on the interruptions that could be caused by the health status of the patients, the interruption of the family, and the surrounding environment:

> *"I think so; critical care cases and emergency cases admitted to the ICU can interrupt the administration of medication." (FG16)*

> *"In emergency cases, for example, I may have two code-blue patients at the same time in the unit; or I could have a patient with cardiac arrest, and at the same time, there is an admission to the critical care unit. This will increase the workload on the nurse, especially when there is a shortage of nurses." (GE19)*

> *"The interruption, we are as you know in critical settings, sometimes a patient who is critically ill or nearly dying, sometimes family factors, sometimes troubling in an ICU critical setting." (AP01)*

Additionally, they focused on the nurse-patient ratio that impacted the workload and could, on the contrary, impact the safety of medication administration procedures in critical situations:

> *"The workload determines the nurse-patient ratio; sometimes, one nurse cannot manage the medication of one patient as there is much medication for one patient and the nurse needs help to ensure medication safety." (GE19)*

> *"The barrier for us to practice the procedure safely is the availability of staff who are responsible for administering medications; in this situation, nurses' shortages influence safety." (FG17)*

> *"I have been assigned to three critical cases, which I think is overload; this will influence the practice, and I will lose my concentration between the patients, so maybe I will administer medication for another patient." (EP11)*

Some of the participants explained that nurses could help in controlling and managing the arising problems through collaboration and delegation of tasks to achieve safety. In addition, nurses need a comfortable environment and the availability of supplies and equipment for the safety of the medication administration procedure:

> *"I must solve the problem or manage the critical condition that occurred; maybe I could delegate my procedure to another nurse; if I could delegate medication administration procedure to another nurse, my colleague, etc., I could solve the problem by myself." (AP01)*

> *"Safe environment that the department provides for me: as everything is available and every medication is labelled, monthly the medications in stock are checked, there is a double check, the environment would be comfortable and safe to administer the medication." (GE19*)

4.4.2.6 Role of healthcare providers

Participants talked about the different roles of healthcare providers in administering medications in critical care units. They focused on the basic role of the nurses in administering medication; most of the participants relied on the in-charge nurses to administer medications:

> *"A registered nurse who administers medication (not an assistant nurse, not a student) should be a registered nurse who has a bachelor's degree." (GE19)*

> *"The role of nurses is basic in administering medication; the doctor prescribes the order, and nurses will carry it out." (EP12)*

They added that in certain cases, the nurses need to consult and collaborate with other healthcare providers to get information regarding medications that will be administered to the patient. Participants explained that pharmacists are the most trusted healthcare providers that nurses could consult for information related to medications:

> *"In case you don't know about administering medications, you will return to the pharmacist or someone who has more knowledge than you." (EP12)*

> *"I will consult the most qualified personnel who can help me in this; sure, the pharmacist; they should have this information." (FG15)*

> *"The pharmacist can also help sometimes with knowing more about medications in general or for some types of medications, even a new medication that is available on the market." (AP01)*

Additionally, participants described that they could consult a physician to clarify the prescribed order if it is not clear or if there is a special consideration in the order. In addition, nurses could consult colleagues to get specific information related to preparing and administering medications:

> *"I refer to the doctor for clarification if there is a medication that I don't know how to dilute or how it will be given." (AP03)*

> *"If I need help with specific information, we are always learning; maybe my colleague would help me with specific information." (DG07)*

4.4.3 Identify the Relationship Between Categories.

The analysis of the interview data within the grounded theory methodology identified the interrelationship between the core category and the emerging categories by comparing the similarities and differences within the same interview and comparing the data with another interview to find the relationship between existing categories and subcategories (Charmaz, 2006). However, the constant coding identified the relationship between the emerging categories, which include knowledge and skills, process, technology, policies, environment, and healthcare

providers, that influence medication administration in the context of the primacy of safety in the Palestinian critical care environment (Figure 4-5, p. 148).

Concerning this, the six categories were conceptualized as a chain linked to each other, and each one contributes to and influences the other categories, although each of the categories has its own characteristics. As the grounded theory developed, it became clear that there was an interrelationship between the emerging categories as well as a link between these categories and the core category.

Additionally, the open analysis showed that the core category "Primacy of safety" could be enhanced and/or impeded by the associated categories, and vice versa, the associated categories could be enhanced and/or impeded by the safety of the nurses' practice. For example, if the nurse had the knowledge and skills to perform the process of administering medication by using the appropriate technological method, following the appropriate policies and protocols used in critical care units in a safe environment, and being confined to his or her role, in this situation, safety could be approached.

The axial and selective coding, conversely, identified the relationship between the categories and between the associated categories, as well as verified the features that described each category and controlled the safety, either by enhancing or hindering the safety, as will be explained later in this chapter.

Figure 4-5: The third illustration of the grounded theory demonstrates the primacy of safety with the associated categories that could enhance or impede safety or both.

The above figure (figure 4-5) showed the third and final illustration of the grounded theory that answered the research question. It was proposed that there were factors that could enhance and/or impede the associated categories to enhance the safety of medication administration. The grounded theory in this study found that the interrelationships and unity between the associated categories in the context of safety help to enhance safety, while the breakdown of the chain between categories could impede safety.

4.4.4 Conclusion

It described how the grounded theory emerged from the constant analysis of the early four initial interviews, which directed the theoretical sampling. Through the analysis, a set of connected categories emerged, and a conceptualized framework was nuanced.

Throughout this section, it is explained how the core category was developed as well as how the six associated categories were identified. Each one of these categories has an influence, either by enhancing or impeding the safety of administering medications.

The following explores the details of the emerging categories in the context of the primacy of safety.

4.5 Category 1: Knowledge and Skills

This category reflected the influence of nurses' knowledge and skills on medication administration to ensure safety in the critical care environment. This category describes that nurses need to be equipped with knowledge and skills regarding the medications administered in critical care units, as these medications are distinguished from those that used to be administered in general wards. As described by most of the interviewees, nurses need to know the medications to be given in critical care units to ensure the safety of the patients. Four main elements emerged from this category, including (figure 4-6):

- Pharmacological knowledge,
- sources of knowledge,
- supported skills, and
- patients' characteristics.

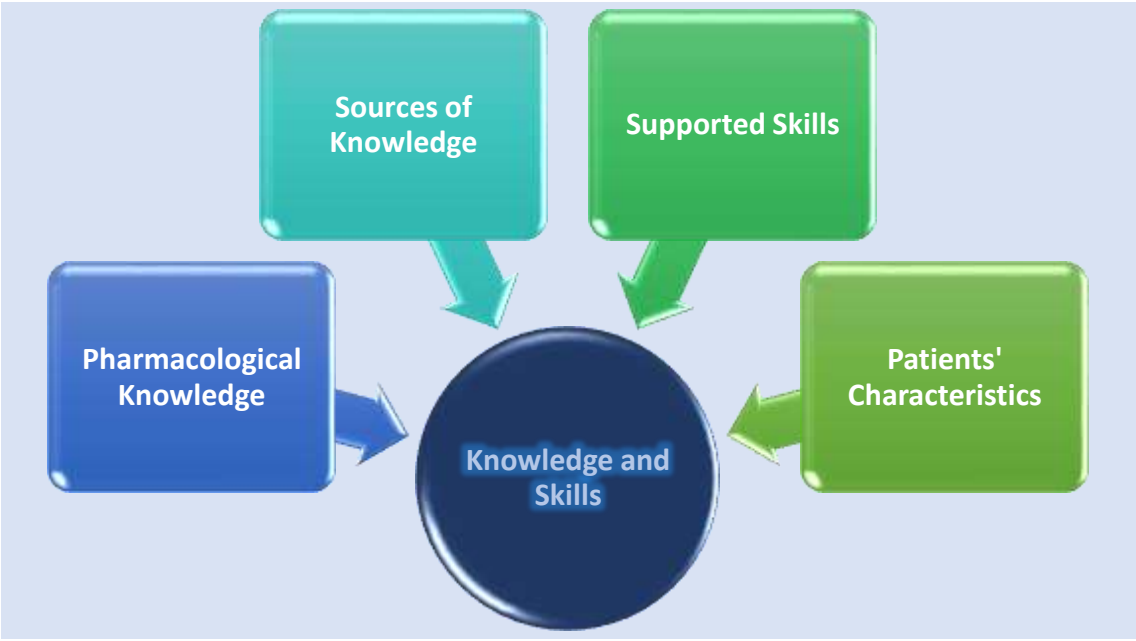


Figure 4-6: Elements included within the category "Knowledge and Skills".

However, the participants explained that the nurses should be competent to be able to administer medications in the critical care units. Three of the participants classified the competencies into three categories:

- knowledge, which concerns what information the nurses knew about the medications,
- skills that included the practices that the nurses performed to administer the medications,
- The attitude concerns how nurses perceive medication administration in the critical care units:

> *"The competencies of medications, in general, are divided into more than one category." (GE18)*
>
> *"The competencies are divided into three parts: knowledge, skills, and attitude; the knowledge of the nurse about the medications; the skills on how the medications are administered; and the attitude of how he administers and how to act with certain methods of administration." (GE19)*
>
> *"The competency is concluded from theoretical information about the medication and side effects and the items of policy that are merged and generalized in the hospital on how to give the medication." (GE20)*

Additionally, the same participants described that the competencies should be examined before the newly graduated nurses are allowed to administer medications in the critical care units. Examining competencies allows nurses to be qualified to ensure the safety of administering medications:

> *"The competencies are performed not only for the newly graduated nurses but also for the old employees; the competencies of medication administration should be achieved in the first month of employment, and the competencies should be evaluated annually." (GE19)*
>
> *"If the new employee is competent and passes the evaluation, which is marked at least 87%, he/she could safely give the medication to the patient." (GE20)*
>
> *"The competency test should be passed by the nurse before being allowed to administer medication." (GE18)*

The evaluation of the competencies is based on scoring the performance of the nurses; the evaluation checklist consists of three components, including knowledge, skills, and attitude. The result of the evaluation determines if the nurse is competent to administer the medication or if further training is needed to ensure the safety of medication administration:

> *"The competency looks like an exam, and it is also based on the in-charge nurse's observation, including assessing nurses' theoretical and practical skills and observing how the nurse administers the medications, as at the end I will report if he is competent or not." (GE18)*

> *"According to the competencies, for example, the nurse should know that this medication is only given by infusion and administered by using a pump machine and only administered by certain fluids and should display a high-alert label on the syringe and the extension tube." (GE19)*

The following describes the elements that emerged from the knowledge and skills associated category.

4.5.1 Element 1: Pharmacological Knowledge

As shown in Figure 4-6, this element reflected the nurses' knowledge and skills related to pharmacodynamics and pharmacokinetics, which enabled the nurses to know about the different medication groups that are used in critical care units. As well as being familiar with the intended effect and the side effects of the medications. However, participants described that having pharmacological knowledge could help the nurses administer the medications safely as well as influence the safety of the nursing plan:

> *"I must have a good background about all the types and subtypes of medications administered in the critical care units as well the medication families." (BG02)*

> *"Knowledge about the medication itself is very important if I don't know what the antibiotic is, which generation it is, what the side effects are, what the action of it is, and what causes acute or long-term side effects. These are so important because they will influence the planning for administering other medications." (DG07)*

Additionally, the participants explained that having pharmacological knowledge helps nurses administer medication safely. Also, they described that nurses should know about the appropriate type of diluent, the diluent amount, and the appropriate method to be used to administer the medication:

> *"Should have adequate knowledge about the use of medication; some medications are diluted in a special type of IV fluid, not all types of fluids could be used, as some medications need a specific type of solution to achieve the desired effect." (FG14)*

> *"Sometimes diluent is not suitable for diluting this drug, as amiodarone must be diluted in dextrose water if you are diluting it in normal saline, which is useless for amiodarone." (FG16)*

> *"You should know about pharmacology; you should know the name of the drug, the dose of the drug, and the route; the route is so important here." (DG08)*

Moreover, about half of the participants mentioned different types and groups of medications that are used in critical care units. For example, *(GE18) and (BG13)* classified the medications into those supporting cardiac and circulatory function, antibiotics, sedatives, and minerals:

> *"Medications include all vasopressors, cardiac support, and also sedation such as fentanyl and all kinds of sedation; chemotherapy sometimes; I'm telling you about medication groups; and also, we administer diuretics and insulin." (GE18)*

> *"... consists of narcotics, sedatives, antiarrhythmics, inotrope medications, adrenergic medications, anti-seizure medications, and electrolytes that are compensatory potassium, magnesium, calcium, and sodium chloride." (BG13)*

Additionally, participants mentioned some examples of medications that support the cardiovascular system and medications that maintain the function of the body's systems. For example, adrenaline, aggrastat [Tirofiban], and nitroglycerin:

> *"Vasopressor drugs and inotropic drugs such as adrenaline, atropine, noradrenaline, and nitroglycerin are all drugs in intensive care that are critical drugs." (FG16)*

> *"We give the inotropes, vasodilators, and vasotherapy; in addition, we can give sedation medication for patients who are ventilated and mechanically supported." (GE20)*

> *"Some medications like Aggrastat [Tirofiban], which is a thrombolytic drug that is administered for most patients after cardiac catheterization if stents were inserted." (EP11)*

4.5.1.1 Knowing the intended effect of medication (Pharmacodynamics)

Three of the participants described that nurses should be aware of the dynamic effects of the medications that are used in the critical care units, as these effects could influence the health status of the patient and some medications might cause adverse effects:

> *"You have to know first the drugs, the action, the duration of the effect, and the side effects." (CP06)*

> *"Nurses need to know what the intended effect is, what reactions will develop, and what adverse effects could arise for the patient." (BG02)*

Three participants described how being aware of the intended effects could help nurses determine the appropriate assessment measures that could be carried out for the patient. Additionally, evaluate the effectiveness of the medication by monitoring the patient, as some medications have a direct effect on the patient's health status:

> *"With IV medications, we give the support medications that affect the hemodynamic, which means that we give the inotropes, vasodilators, and vasotherapy." (GE20)*

> *"For example, if we have noradrenaline, adrenaline, phenylephrine, calcium, potassium, and magnesium, the effect will be directly on the patient because most of the patients have a central line or jugular line, so the medication goes directly to the heart and is then distributed to the body." (FG14)*

> *"For example, if you don't know the action of noradrenaline, as it is vasoconstriction, not vasodilation, and you use it to increase the patient's blood pressure, not decrease it, you should know that it is antiarrhythmic or the drug of choice for AF." (DG08)*

4.5.1.2 Knowing the side effects (Pharmacokinetics)

Conversely, the participants explained that nurses need to know the kinetic effects of the medications and should highlight these side effects during medication administration. Three participants classified these medications as critical because they have serious side effects that might cause complications for the patient:

"Some medications have side effects, so we apply for its high alert label, as some medications such as KCl, and Vancomycin we apply for these alert labels." (EP12)

"You have to know the side effects that may affect the arrhythmias, medications like vancomycin or antibiotics that have serious side effects." (CP06)

"The patient will develop a change in the vital signs; maybe he will have hypovolemic shock; some patients may develop seizures, desaturation, and many other reactions, and you will link this with the medication that was administered to the patient." (FG15)

Three participants added that nurses should be aware of the risks of the administered medications and observe the patients closely for any possible side effects, for example, during administering potassium chloride, high-alert medications, and sedatives, nurses should interpret the patient's ECG for arrhythmias, GCS to assess patient's level of consciousness:

"High-alert medications that have a major side effect, such as severe hypotension or hypertension, cause the patient to become drowsy, have a decrease in the level of consciousness, have arrhythmias in the ECG, and have a decrease in the Glasgow-coma scale on the patient." (FG14)

"For example, about KCL, all high-alert medications have side effects; it is not easy to give them to the patient, so we should be careful when dealing with these medications." (CP05)

"We have to be oriented about the pain killer and sedation; sometimes we are giving diclofenac, pethidine, or morphine; we use all kinds of narcotics; and we have to be able to distinguish between the apnea that may be as a result of sedatives, or the patient relaxed, and life ended." (FG17)

4.5.2 Element 2: Sources of Knowledge

The participants considered a variety of sources of knowledge that nurses could rely on to enhance the safety of medication administration in critical care units. These resources include the university, physicians, pharmacists, books, websites, and mobile applications. They assumed that these resources could help with knowledge regarding the medications given in the critical care units. In addition, the mentioned resources could guide and support the nurses in the process of administering, diluting, and titrating the medications. The following describes how each of these sources could enhance safety.

4.5.2.1 knowledge from initial training

Three of the participants relied on their pharmacological expertise from what they learned at the university, which was between one and ten years ago. However, they considered that this initial knowledge was a basic source for the process of administering medications to the patient. Participants described that the pharmacological knowledge gained from university is limited, but the basic skills of administering medications remain the same:

> *"How we learned in the university, we carried out in the clinical, how do we administer it [medication] in general." (EP12)*

> *"Some medications, as we have learned at the university, but the pharmacology course was not enough." (BG13)*

> *"The theory that they come from the university remains the same about the indication, the side effect, and the contraindication for the medication." (GE20)*

4.5.2.2 Books and References

However, participants mentioned that updated resources such as textbooks, pharmacopeia, and manual books are useful resources for nurses. They added that the availability of these resources in the critical care units enables them to access these resources immediately when they need specific information regarding the medication. The manual book that was prepared by critical care nurses includes medications used in critical care units and how each medication is calculated and administered, which is adopted as a policy in critical care units:

> *"I always prepare medication as it is mentioned or recommended by the pharmacopeia textbook, and according to the guidance, I rely on the books and textbooks adopted by our hospital." (BG02)*

> *"There is a book for medication protocols, how to administer them, and how we can dilute the medications for most of the medications that we are using in the ICU." (DG07)*

> *"We have here a manual book about the medications in the ICU, especially the medications in the emergency trolley." (DG08)*

Additionally, participants talked about a variety of software resources that nurses could access whenever and wherever they needed to get the information they needed. Many of the participants downloaded pharmacological applications on their mobiles, and they also could access pharmacological sites for certain knowledge regarding the medications, for example, Medscape, and online pharmacopeia that could be accessed by the smartphone:

> *"Medscape is the most popular website we use, and even I have downloaded its application on my mobile." (FG14)*

> *"If I don't have the knowledge, I will use the Medscape application to know about the contraindication; if there is no contraindication, I will give the medication safely." (AP04)*

Also, they described using mobile applications and/or websites as an easy and fast methods to get updated knowledge on how to prepare and administer medications. They described these resources as an official and trustworthy, such as Medscape:

> *"We return to Medscape, which belongs to Medline or medicine or drugs.com, where many sites explain how we can administer the medication, the dilution process, the concentration of the medication in the solvent, and the time that the medication will be administered." (BG13)*

> *"The knowledge will be obtained from books or the internet; the internet is faster to learn about medication. Some sites are registered, such as Medscape, which is considered an official site." (EP12)*

4.5.2.3 Training courses

An additional source of knowledge that participants talked about was training courses, especially for newly graduated nurses. They added that all nurses need to attend these educational sessions to update their knowledge. As always there is something new regarding medications that nurses need to know:

> *"Knowledge is maintained by doing educational sessions for newly graduated nurses, for nurses who didn't work previously in ICUs or critical care units." (BG02)*

"An ICU nurse has had a long time since graduation; they are experienced; these nurses have not had any universal training for a long time, so they need to update their knowledge because there is always updating research and knowledge related to medication." (AP04)

In addition, participants added that the training sessions provide nurses with knowledge about all types of medications used in critical care units, and these sessions could also enhance the safety of medication administration:

"[Training courses] This is so important, especially with the newly graduated nurses, because a lot of mistakes can occur, especially in the ICU." (AP03)

"A scientific committee consists of three nurses that provide literature for all types of antibiotics and all types of medications about the action, the side effects, the method of administration, and the time of administration." (FG16)

4.5.3 Element 3: Supporting Skills.

This element described a variety of skills that participants mentioned that could help nurses enhance the safety of administered medications in critical care units. However, these skills include critical thinking and calculation, infection control, communication, and managerial skills.

4.5.3.1 Calculation skills

The calculation is one of the most important skills in the critical care unit, as certain medications need to be calculated accurately before being administered to enhance the safety of the patient such as those medications that influence cardiovascular function. Participants described that calculation is one of the skills that require critical thinking, and the nurse should be confident about:

"I must have critical thinking and good calculation techniques." (BG02)

"Then we start to administer a dopamine renal dose of 2–3 micrograms, then we need to change it to cc per hour, 3 or 4 cc according to the patient's body weight, and as ordered." (CP06)

Additionally, two of the participants explained that to administer, for example, inotropic medications, the nurses need to use an equation to calculate the dose that will be administered based on the patient's body weight:

> *"If, for example, dopamine dose is micrograms per kilogram per minute, then we start calculation as we know the rule of dopamine: prescribed dose multiplied by volume, multiplied by the patient's body weight, and multiplied by 60, then divided by the available dose with the converted milligram to microgram (1000)." (CP06)*

> *"For example, for noradrenaline that we administer for patients with hypotension generally, the prescribed dose is multiplied by 60 minutes, multiplied by the weight of the patient, and multiplied by volume divided by total dose and multiplied by 1000 (to convert from milligram to microgram)." (DG07)*

4.5.3.2 Infection control skills

To administer medication safely, aseptic precautions should be taken to reduce cross-infection during the procedure of administering medications. Participants explained the importance of being constrained with the use of PPEs to enhance the safety of the administered medications and ensure medication sterility:

> *"The PPEs, should I handle or wear when I'm preparing, and when I'm administering harmful medication, just like chemotherapy or antineoplastic." (BG02)*

> *"I will use the gloves, latex gloves, and hand hygiene before the alcohol swap, and I will use gauze for IV or IM." (AP04)*

Conversely, two of the participants explained that nurses should be aware of the sterility of the medication as well as the central line lumens. They described that certain medications need to be tested for culture to detect microorganisms' growth, specifically if this medication bottle is used multiple times. For example, the amino acid bottle should be sterilized before aspirating the next dose, and frequent culture and sensitivity testing should be done to prevent cross-infection:

> *"We have a case with a central line; for example, we have three lumens in which we will administer the medication, we should use the aseptic technique before administering the medication." (EP09)*

"There are the amino acids; we need to do culture after using it; if we don't care about the sterility, the bottle will be discarded as we just use a little amount of it. Always after using the bottle, we should test the growth of microorganisms by doing specimen culture for the solution to be sure about the safety of the medication, whether it is positive or not." (EP10)

4.5.3.3 Administrative functions

Based on the nurse's knowledge regarding the intended effect and the side effect, the participants explained that this could help the nurses to solve arisen problems immediately and reduce the risk that could develop, for example, arrhythmias or hypotension. Three of the participants described how solving the problem immediately could help prevent advanced interventions such as intubation if the patient develops life-threatening side effects:

"I stop the medication immediately when I face a problem or a mistake during medication administration." (BG02)

"I should observe the patient during the administration of the medication; some toxicity, for example, may cause ECG changes or changes in the vital signs." (FG14)

Additionally, the nurse should know how to administer different types of medications without causing harm to the patient, and this is achieved by administering each medication separately to prevent drug-drug interaction, as described by the participants. Also, they explained that patients should be evaluated for the effectiveness of the administered medications:

"Some medications should not be mixed with another medication; for example, if I'm administering noradrenaline, it is a contraindication to administer fluid with it in the same lumen as fluids will increase the flow of the medication." (GE19)

"If a patient is admitted with a WBC of 29.000, antibiotics were given and there was no response; the WBC is still high; and the fever is still high; according to the lab results, we can determine the effectiveness of the medication." (FG16)

4.5.4 Element 4: Patients' Characteristics

Participants described the patients' characteristics in critical care units. The patients' characteristics enable the nurses to implement the appropriate intervention for medication

administration. The participants explained that patients in critical care units are either critically ill, nearly dying, or need cardiac resuscitation. Moreover, patients who need intake and output monitoring with fluid intake restrictions, as well as patients who were intubated, described how these situations could impede the safety of medication administration:

> *"Sometimes a patient who is critically ill or nearly dying needs the medication to be administered rapidly, as well as in a critical situation, as in CPR, or life-threatening conditions." (AP01)*

> *"[Patients] with restrictions of the fluid, like renal, and have a patient with pulmonary oedema, and you should not administer a large volume of fluid." (DG08)*

> *"Sometimes we receive patients from other wards who need intubation as a result of a medication reaction." (FG15)*

Two participants described how knowing the patient's characteristics helps the in-charge nurse manage the nurse-patient ratio as well as manage problems that could arise:

> *"Sometimes, one nurse cannot manage the medication of one patient as there is so much medication for one patient." (GE19)*

> *"If I have an intubated and sedated patient, one nurse can manage with one patient, but if the patient is not intubated and hemodynamically stable, the nurse can manage with two patients." (GE20)*

4.6 Category 2: Process

This category emerged from the elements that described the process of medication administration in critical care units in the context of safety. This category reflects how the nurses interpret the physician's order and the steps that they follow to administer medication safely in the critical care units. The four elements include (figure 4-7):

- Interpreting physician orders
- Steps of the procedure
- Patient's assessment
- Administering medication

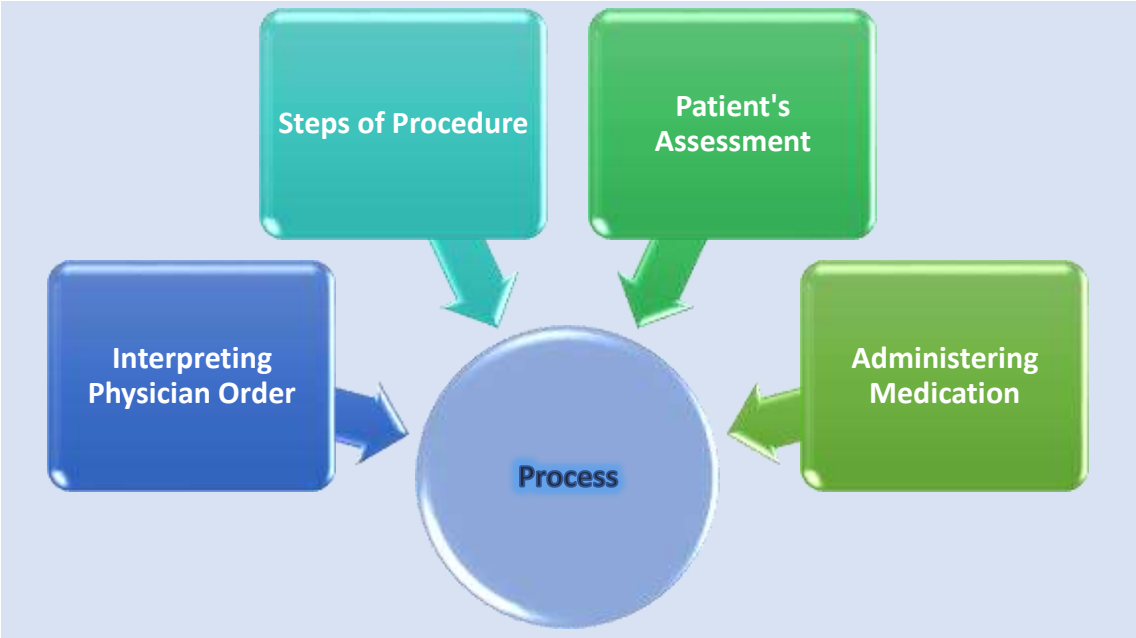


Figure 4-7: Elements included within the category "Process".

Figure 4-7 shows the elements of the "process" category in the context of safety. The process of medication administration started by interpreting the physician's order and identifying each component of the order, for example, the name, dose, and frequency of the prescribed medication. Then, the nurses follow the consequence steps to administer medication, which

include being aware of medication checks and rights. In addition, assessing patients before, during, and after administering medications and then using the necessary skills to administer medication safely, for example, calculating the prescribed dose:

> *"I'm searching for the safe procedure, the safe person who will administer the medication, who will do the procedure; the right patient, the right dose, the right dosage, the right constitution, and the right time." (BG02)*

> *"There is a special procedure to be administered by, how to dilute, and the time to be administered by the compatibility if it has incompatibility with other medications." (BG13)*

4.6.1 Element 1: Interpreting Physician Orders

The process of interpreting the physician's order starts by reading the physician's order. Participants described that interpreting the physician's order should be checked line-by-line for the details:

> *"I have to interpret the order of medication line by line, then I write it on the drug sheet, it is a nurse's responsibility here in (A) hospital, then tick each medication that it is transferred to the drug sheet, that's second. Third, request the medication from a pharmacy, and follow the bringing of medication to ICU until the medication is given." (AP01)*

> *"I will read the order; if I can know the type of medication, I will start the process. If I couldn't interpret the order I would ask the doctor for clarification, or another nurse, or my head nurse to clarify this medication order." (AP04)*

Then the nurses check the components of the physician's order, including the generic name, frequency, dose, and route:

> *"First, I will make sure about the date, the time, the name of the medication, the route for administration, the dose that will be administered, and the policy on how we will administer the medication." (EP10)*

> *"I compare the generic name with what is written in the visit, in the order, or in the prescription with the available medication, then the type, the dosage, the frequency over the day, and the amount of the medication required." (BG02)*

4.6.2 Element 2: Steps of the Procedure

Many of the participants described how the nurses followed steps and organized these steps to administer medication safely. The first step was transferring the prescribed order from the order sheet or computer to the patient's drug sheet. Then request the prescribed medications from the pharmacy and make sure of their availability. When transferring medication from either the computerized system or order sheet to the drug sheet, there is a risk of transferring an incomplete prescription order, which influences medication safety:

> *"When the doctor writes the order, he describes administering two doses of the medication or three doses; you should transfer this to the drug sheet, and we make sure that the medications are available." (AP03)*

> *"We start at the visit [computerized physician order] of the doctor, talking about the medication rights of the patient—dose, name, frequency—then we request it from the pharmacy and start to administer it for the patient." (CP06)*

In the second step, the participant explained that nurses have the autonomy to schedule the prescribed doses over twenty-four hours and make sure that each medication on the drug sheet is matched with the box of the scheduled time:

> *"I will check the drug sheet for the time of medication, and for the route, I will check the patient box for the medication to see if it is available or not." (AP04)*

> *"As an ICU nurse, I will decide when to administer the medication according to the health status of the patient and the needs; maybe I will distribute the medication to be administered at midday and midnight." (CP05)*

The third step that most of the participants, for example *(CP05) and (EP11)*, talked about was checking the medication rights before administering them to ensure the safety of the patient. Some of the participants mentioned that there are five rights, while others mentioned ten rights. Although some of the participants mentioned that there are ten rights, most of them emphasized the importance of five rights:

"The most important are the five rights: right medication, right patient, right route, right time, and right dose." (CP05)

"The ten rights, whether the medication is simple or complicated, are the right patient, right time, right dose, right medication, right administration, and the others such as right evaluation, right assessment, and..., but the most important are the five rights." (EP11)

Additionally, participants emphasized the importance of medication checks with another nurse when preparing certain types of medications, for example, high-alert medications and sedatives. They mentioned that there are two checks, while others mentioned there are three checks, which include the check of medication before preparing, the second check when starting to prepare, and the third one before administering the medication. They added that these checks could prevent mistakes from developing:

"The most important thing is to double-check for medication, check the medication itself, and check with the patient that this medication is for this patient; this is generally to prevent any mistake." (AP03)

"Generally, there are three checks: generally, we do check, and I check the medication by myself when I bring it out of the cupboard before I dilute it and before I administer it." (EP11)

"The checks should be before administering medication, during administration, and after administering medication." (EP12)

The next step that participants focused on was diluting the medications appropriately to enhance the safety of the procedure as well as the safety of the patient. They described that medications should be diluted appropriately with the appropriate fluid volume and according to the recommended time:

"The best practices for administration and reconstitution, constitution, dilution, and concentration of medications to provide them safely for the patient." (BG02)

"Some medications need dilution, such as calcium gluconate; I have diluted it in 100 ccs of KCl; we should be aware of it." (EP09)

Then, the prepared medications should be labelled with the medication details, including the name of the medication, dose, frequency, starting time, and ending time:

"It is important to prepare the medications and label them with the name and the dose. Sometimes I want to give half of the dose, and for the remaining dose, I will label it with the date, dose, time, and the patient's name to be sure that this is for the patient and the accurate dose." (AP03)

"I have labels, empty labels, and sometimes transparent labels; when I dilute the medication, I write on it, and each medication has a label on it; sometimes I recognize them by labels." (EP09)

Also, participants talked about calculating the prescribed dose as part of the process of preparing medications:

"For example, for noradrenaline that we administer for patients with hypotension generally, the required dose is multiplied by 60 minutes, multiplied by the weight of the patient, multiplied by volume, divided by the total dose multiplied by 1000 (to convert from milligram to microgram)." (DG07)

"For example, if we prescribe dopamine per microgram per kilogram per minute, then we start as we know the rule of dopamine: the prescribed dose multiplied by volume multiplied by weight multiplied by 60, then divided by the available dose converted from milligram to microgram (1000)." (CP06)

The fifth step emphasized by the participants was following the infection control protocol. They described that nurses should be aware of using personal protective equipment when appropriate and using the sterile technique during administering medications to ensure the safety of the patient and prevent cross-infection:

"I will use gloves, latex gloves, and hand hygiene before; I will describe the procedure; I will give the medication; and then I'm finishing the procedure with hand washing." (AP04)

"Washing hands and wearing gloves, you are sure that your patient has a peripheral cannula that is functioning, and the central line is functioning." (CP06)

4.6.3 Element 3: Patient's Assessment

Participants focused on the risk assessment of the patient before the process of giving the drug to ensure the patient's safety and reduce risks that could occur during or after the administration of the medication. So, the nurse should take into consideration the indication of the medication

when assessing the patient and the priority of which medication should be administered first according to the patient's health status:

> *"The patient information and health status, the vital signs, the lab tests, the lab results, the recommendation, and what is planned for the patient will guide me on when and how I should administer the medication." (BG02)*

> *"The priorities, the patient himself according to the need of the patient, according to the patient priority I organize my procedure." (CP05)*

Additionally, the participants focused on the importance of assessing the patient's hemodynamics, laboratory results, and health history to enhance the safety of the medication administration:

> *"Medication Amiodarone, we cannot give it to the patient if the patient has hypotension." (AP04)*

> *"I check for the hemodynamic of the patient and other things, just like his sensations and feelings." (BG02)*

4.6.4 Element 4: Administering Medication.

The fourth element that emerged from the process category was administering medication procedures. Participants described that nurses should have basic skills on how to administer medications and be able to distinguish between medications administered by using the central line and those administered by using a peripheral cannula:

> *"We have more than one route for administering medication; the most that is used in the critical care unit is the central line, as here there are critical cases, so mostly there is a central line through which we administer medication according to the case." (EP09)*

> *"Most of the patients in the ICU have a central line; this is a basic in the ICU; the central line is the access to administer medications for the ICU patients, so the medication is administered according to its type." (DG07)*

Two of the participants described how the procedure of administering medication could impede the patient's safety. So, the nurses need to follow instructions to enhance the safety of the

patient; for example, potassium chloride should be diluted and shouldn't be administered through a peripheral cannula:

> *"Administering KCL via central line is safer because the KCl in the peripheral IV cannula will hurt the patient, hurt the vein, and be painful for the patient." (AP04)*

> *"For example, when we administer KCl, we don't administer IV push directly; when someone administers IV push, safety and the policy are broken, and the patient will be harmed. We should dilute the KCl with normal saline." (EP09)*

4.7 Category 3: Technology

This category reflected the role of the technological methods that are used in the critical care units in supporting the safety of administering medications as well as the safety of the patient. Participants focused on four main benefits of using technological methods to support the medication administration's safety; these elements that emerged are shown in the following figure (Figure 4-8):

- Prescribing support,
- Calculation support,
- Administration support,
- Monitoring support.

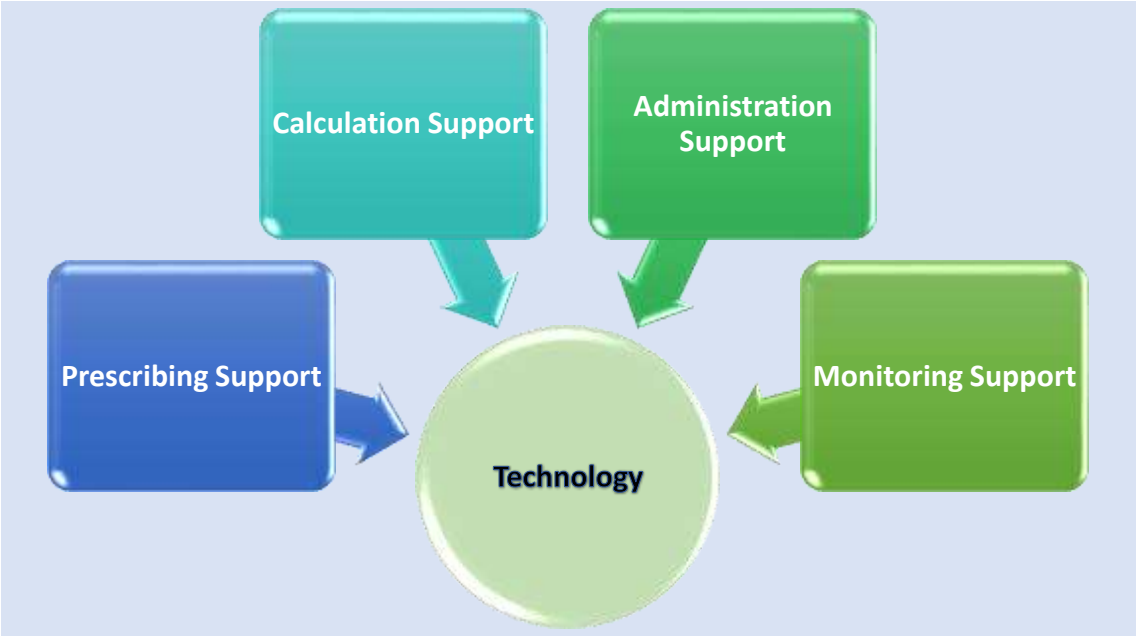


Figure 4-8: Elements included within the category "Technology".

There are a variety of helpful technological methods used in critical care units that could enhance the safety of medication administration. For example, infusion pumps, computerized systems, and, in certain cases, mechanical ventilators could be used to administer bronchodilators. These

methods, as described by the participants, are programmed to make medication administration easier and more accurate:

> *"We have just, I think, a pump machine and a dropper machine." (AP04)*

> *"There are other machines, such as infusion pumps. It will help a lot if they are available." (AP03)*

> *"Ventilator: sometimes you can use it to administer medication; there is a nebulizer in the ventilator; we can use it to administer Atrovent or Ventolin." (EP09)*

4.7.1 Element 1: Prescribing Support

Computerized systems could support medication administration. Two of the participants described the usefulness of the computerized system in prescribing medications; they described the entry of the order by using the computerized system as entering the gate. A computerized system helps connect the critical care units with the pharmacy to make it easier to request medications as soon as the physician prescribes them. This could help the nurse administer the prescribed medication on time:

> *"The doctor prescribed it [medication] at the gate, and I check what is written on the computer." (BG02)*

> *"[Computerized system] Connected with the pharmacy, to request our medications from the pharmacy, by a computerized system." (AP01)*

Moreover, the participants described how the use of a computerized system in the critical care units could help minimize the problems related to handwriting as well as the problems related to soundalikes. Participants explained that this will enable the nurse to read the prescribed medications clearly:

> *"The computer is the official one. You check the medication on the computer, and then you administer it to the patient." (DG08)*

> *"We fill in this problem sometimes with sound-alike and same-like medications. So, a computerized system will solve these problems; generic names are used in a computerized*

system, not trading names; sometimes we fill in a problem when we write a medication by handwriting." (AP01)

4.7.2 Element 2: Calculation Support

The first element that emerged from the category of technology is the calculation that could support the administered medications. The participants described that the infusion pumps could help in calculating the prescribed medication doses that will be administered, as some types of syringe pumps are programmed to calculate the dose according to the chosen medication:

"This technology helps in administering an accurate dose to the patient." (AP03)

"Technologically, we have dropper machines and syringe pump machines, sometimes we can use it during the administration of antibiotics, or any other drugs." (FG16)

Further, two of the participants described that the purpose of using the technological methods is to calculate the dose of the medications more easily and more accurately. Additionally, they described that an equation could be programmed within the setting of the infusion pump to make the calculation easier:

"The syringe pump is more accurate, calculating the dose by using an equation. Using the syringe pump is faster and easier, as we can immediately calculate the dose." (CP05)

"We want to use the infusion pump; it has a programme for calculation; we have the pump include software for propofol, so I will set the weight of the patient and it will calculate the dose." (GE19)

Additionally, participants described that infusion pumps are useful for administering small doses of medications that are difficult to titrate manually:

"We can administer the decimals of the medication, and we can also calculate with it according to the patient's weight; just set the weight with the dilution volume of the medication, and it [infusion pump] will calculate the dose." (FG14)

"When we want to administer doses like 10 mics per kilogram per minute in the syringe pump or machine pump generally, the infusion pump will calculate and administer the exact dose." (DG07)

4.7.3 Element 3: Administering Medication Support.

The third element is medication administration support, the participants described infusion pumps as a safe method to administer minimal doses of medications. In addition, these technological devices help ensure that the medications are administered by giving an alarm if there is occlusion within the intravenous access:

> *"Some medications are administered over 24 hours with a minimal dose and cannot be administered by regular infusion, this need, a syringe pump, or dropper machine." (EP12)*

> *"It is safer to administer medication by using the syringe pump or dropper as occlusion or blockage will give an alarm, so you will follow up on what's going on." (FG15)*

However, the participants mentioned a variety of medications that are administered by using infusion pumps based on the dose that will be administered and the fluid volume that will be used in diluting the medication:

> *"High-alert or sedation or vasopressors, ……., but when I want to administer noradrenaline 5 mics per minute it should be run 5 mics per minute, so the technology that I will use is the syringe pump." (GE19)*

> *"……., the Nexium, dopamine, dobutamine, Norepinephrine, and medications for regulating blood pressure we use syringe pumps." (EP10)*

Otherwise, two of the participants explained that using syringe pumps minimized the volume of fluid that will be administered to the patient, as well as prevented fluid overload, especially for those patients with fluid volume restrictions. For example, patients with renal problems, or cardio-pulmonary problems:

> *"Have the syringe pump here, instead of diluting in 500cc and causing a problem to the patient, I can give a microgram per minute, this will help a lot." (AP03)*

> *"……., with restrictions of the fluid like in patients with renal problems and you don't want to administer a large volume of fluids, the right thing is administered this by pump machine, and also if you have a patient with pulmonary oedema and you don't want to administer a large volume of fluid." (DG08)*

4.7.4 Element 4: Monitoring Support

This element described different technological methods that could support monitoring and ensuring the safety of administered medications. Participants mentioned that these methods include monitors that are used to assess and monitor the patient's hemodynamics, which reflect the effectiveness of the administered medications. Besides, monitoring the changes in the mechanical ventilator settings indicates the effectiveness of the sedatives administered to the patient:

> *"The monitors tell us about the effect of the medication that impacts the patient's vital signs and ECG, for example, the AF; I will recognize changes in the ECG as there is continuous monitoring for the patient." (FG14)*

> *"The ventilator, if I'm administering sedation, will detect if the patient is asleep or not and will determine the lung expansion based on ventilator parameter changes." (GE20)*

In addition, participants focused on the importance of infusion pumps in monitoring the administered medications. They described how the alarm system warns the nurse that there is a blockage, but the medication is not administered. So, nurses need to check the infusion pumps regularly to ensure the accuracy of the administered medication's programmed dose:

> *"I always check the infusion pump; even if it didn't give an alarm, I check it frequently, make sure about the rate and that there is no occlusion, and note that the syringe is moving up, and it is noticed that it is working or blocked without giving the alarm." (FG14)*

> *"I should be sure about the infusion pump, as sometimes it is blocked; be sure that the syringe pump alarm is working; and not waste time either for me or for the patient." (CP05)*

4.8 Category 4: Policies

From the opening code, participants focused on many policies used in critical care units that helped them administer medications safely. Some of them emphasized the importance of having certain policies to enhance safety, and some of them talked about the absence of policies that could impede safety. The elements that emerged from this category include (Figure 4-9):

- Continuous education,
- Job description,
- Incident report, and
- Manual handbook.

Figure 4-9: Elements included within the category "Policies".

Figure 4-9 shows the elements of the policies that are used in critical care units. As described by many of the participants, these elements could help ensure the safety of medication administration. Taking into consideration that these elements could enhance the safety of medication administration, their absence could impede it.

The participant described the importance of having protocols to follow in the critical care units to ensure the safety of the administered medications as well as the patient's safety. They emphasised having written protocols prepared by the educational committee in collaboration with the critical care nurses to act as a guide for nurses in preparing and administering medication. Some of the participants described that this guidance includes medications given in critical care units and how these medications are prepared to enable critical care nurses to administer medications safely:

> *"Following the protocols set by the hospital administration to handle it, then I will ensure that medication does not harm the patient, and doses do not interfere with his well-being and vital signs." (BG02)*

> *"I think there should be a clear written protocol available, consisting of written clarifications, drawings, or arrows for how to check the medication, dilute it, and administer it." (EP11)*

> *"Some medications have a written protocol in a file in the ICU, such as adrenaline, epinephrine, amiodarone, heparin, dopamine, and dobutamine." (FG14)*

4.8.1 Element 1: Continuous Education Policy

Participants described having a continuous educational programme as a policy in the organization as essential to update nurses' pharmacological knowledge and skills frequently. Adopting this policy will enable healthcare providers to be updated by evidence to enhance their skills and performance in administering medications safely:

> *"The training courses will be very useful; this is the most important reason to have periodic training on medication generally and new drugs specifically." (DG07)*

> *"To have training courses for both the healthcare providers who know and those who don't, these courses should consist of updating knowledge and be provided by specialized personnel." (FG14)*

Additionally, the participants focused on the importance of the preceptorship programme as part of the continuous education to train and evaluate newly graduated nurses. They described that

the newly graduated nurses should be competent before being able to administer medications, and preceptorship will help the newly graduated nurses follow the policies and guide them to administer medication safely:

> *"We have preceptorship for the newly employed; it is known as teaching the newly employed; you teach the employee everything; the policy includes everything." (DG08)*

> *"The competency is linked with the policy; we have medication administration policy and at the same time we have medication administration competency." (GE19)*

> *"[A newly graduated nurse] should be supervised by a senior nurse whom we call a preceptor nurse; after that, when the nurse is trained and well trained, the nurse is competent to give the medication safely." (GE20)*

4.8.2 Element 2: Job Description Policy

Two of the participants talked about the importance of having job descriptions as a policy in the hospital that describes the responsibilities of each healthcare provider as well as their responsibilities in relation to administering medications:

> *"Job description: the doctor should do his work; the pharmacist does his work; and the nurse does her work. In this way, we can reduce the risks that could occur." (AP03)*

> *"The person who administers medication should be a registered nurse, and the job description allows him or her to administer medication." (GE19)*

Additionally, two other participants described that the pharmacists' job description includes reviewing the patients' medications every morning and preparing the protocols for the prescribed medications. Mostly, the protocols are written to be available and approachable for healthcare providers when needed, while some of the participants reported that the protocols are verbal. However, verbal protocols will hinder safety if some information is missed:

> *"The protocol should be prepared by the pharmacist. Some medications have a written protocol in a file in the ICU, such as adrenaline, epinephrine, amiodarone, heparin, dopamine, and dobutamine, but for other medications, the protocol is verbal, not written." (FG14)*

"If we have any new medication, [the pharmacist] will send us the protocol to follow the steps to administer it; they will provide us with the protocol for how we can administer it; these issues are available." (DG07)

4.8.3 Element 3: Incident Report Policy

Only three participants emphasized the importance of an incident report policy that could enhance the safety of medication administration. They described how, based on the incident report, the nurses could detect the problems and the cause of the problems. They added that knowing the problem and its causes could help the stakeholders know how they could solve these problems. Adopting the policy of incident reporting will help detect weaknesses in nursing performance related to medication administration and will help in planning and restructuring policies:

"We have here a policy of an incidence report during administration; during anything in the hospital, the nurse can write an incidence report, and we can use any action to solve these problems." (FG16)

"If the nurse does not sign the medication and there is no medication in the drawer so we can write an incident report, the benefit is a corrective benefit, which means that we may correct the attitudes." (GE20)

"The quality department analyses the incidence into categories according to the percentage of harm. We have something called "red cause analysis," in which we follow the cause that leads to the incident, and based on it, we modify the strategies." (GE18)

4.8.4 Element 4: Manual Handbook Policy

Having a manual handbook in the critical care units was another policy that the participants talked about. They explained that nurses could rely on it to get the information they need concerning diluting, calculating, and administering medications in critical care units. The manual handbook was prepared by critical care nurses with the collaboration of the continuous educational committee and includes instructions on how to prepare and administer medications given in critical care units:

"There is a book for medication protocols, how to administer them, and how we can dilute the medications for most of the medications that we are using in the ICU." (DG07)

"For example, for vasopressors, we have protocols for them; it is written in the manual handbook: the drug, the dilutant, the volume... instead of calculating it, it is available, for example, how much the cc equals by mic or milligram, so this is supposed to be faster." (FG15)

Additionally, the participants mentioned that a variety of medication protocols are included in the manual handbook, which describes the instructions that nurses follow in preparing and administering medications:

"We have here a manual book, and especially for the medications in the emergency trolley, all the team follows the protocol; for example, dopamine needs the protocol, noradrenaline needs the protocol, and heparin needs the protocol." (DG08)

"A protocol and at the same time there is JCI, the JCI proposed to have special medication concentration and high-alert medication, the high-alert such as adrenaline, norepinephrine, epinephrine, and propofol." (GE19)

4.9 Category 5: Environment

The open coding showed that environmental factors as one of the important factors that influence the safety of medication administration. This category describes the environmental factors that could enhance or impede the safety of medication administration in critical care units and how nurses could manage the environment to achieve safety. The interviewees focused on the following environmental elements, as shown in Figure 4-10:

- Interruptions,
- Nurse-patient ratio,
- Availability of supplies,
- Tidiness of the environment.

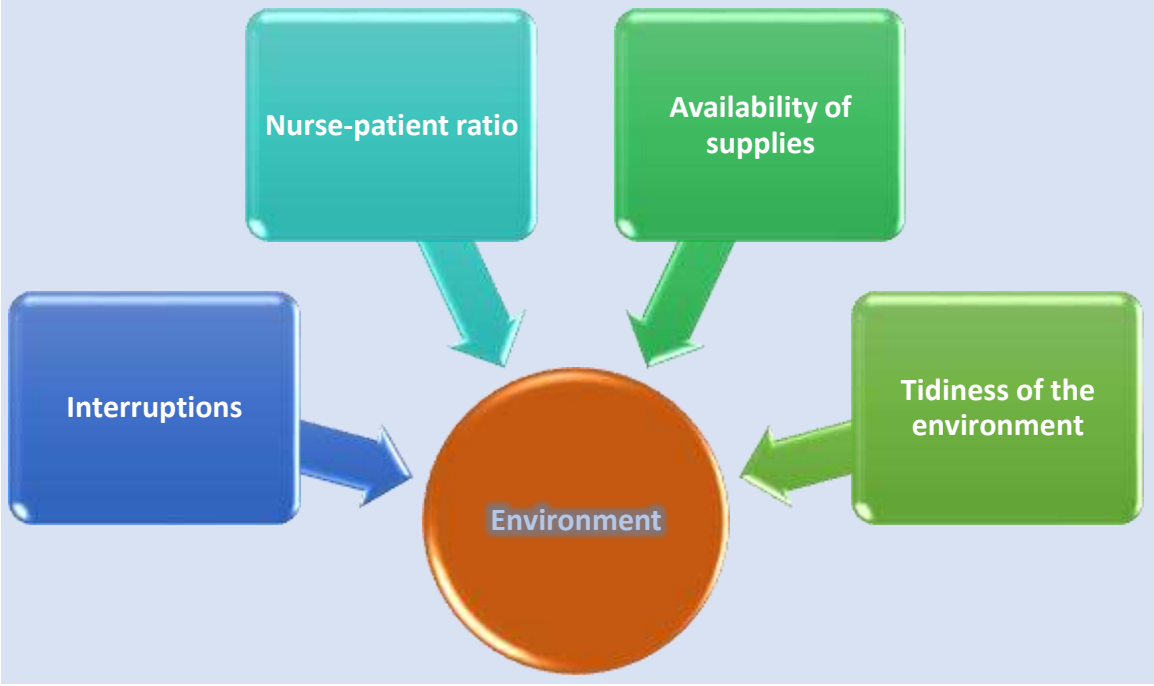


Figure 4-10: Elements included within the category "Environment".

Figure 4-10 describes the elements that emerged from the analysis of the environmental category; these elements reflect the factors that could enhance or impede the safety of medication administration in critical care units.

Two of the participants mentioned some of the factors that could enhance or impede safety. They described that the critical care units are a stressful environment that could distract the nurse during medication administration, while the nurses need to work in a comfortable environment to enhance the safety of medication administration:

> *"Environment! "This is about the air-conditioning, the tidying of items in the ICU unit, the emergency trolley, emergency drugs, beds and lockers of patients, and machines like mechanical ventilators and monitors; everything will be tidy." (AP04)*

> *"Maybe if there is stress or distraction, which are common here in the unit, they will do something wrong." (FG15)*

4.9.1 Element 1: Interruptions

Four types of interruptions were identified by the participants, including interruptions caused by the patient himself or herself, the patient's family, phone calls, and interruptions that could be caused by the medical team.

4.9.1.1 Patients' interruptions

Participants described that the patients' critical situation could interrupt the process of medication administration. They explained that the patient's critical situation will impede safety if the nurse administers the medication in a hurry or is unable to administer the medication on time. And in both cases, safety will be influenced and cause risk to the patient:

> *"The interruption: we are, as you know, in critical settings; sometimes a patient is critically ill or nearly dying, and sometimes we need to give the medication fast." (AP01)*

"Emergencies could interfere with safe practice and safe medication administration because the nurse could either administer the medication in a hurry or could miss the time scheduled to administer medication." (BG02)

Another three participants described that sometimes the patients became aggressive or uncooperative because of their health status, they explained that patients could pull out the intravenous cannula or disconnect the intravenous line. Because of this, administering medication could be delayed or administered inappropriately:

"Interruption, sometimes from the patient himself; by disconnecting the infusion line that consists of the medication. Nervousness, an ICU patient suffering from depression, delirium, they could cut the IV fluid line, or pull out the IV cannula." (FG16)

"If the patient is aggressive or not cooperative, this is a difficult job, as sometimes the IV line could be disconnected." (AP04)

4.9.1.2 Family interruptions

Sometimes the interruptions are caused by the patient's family, as described by participants. Sometimes family members insisted on staying with their patient outside the visiting hours and during the time of administering medications, which could impede the nurses' concentration and performance to administer the medications safely:

"Something else is visitor interruptions; visitors may come at any time to visit the patient, and sometimes we face many visitors that may interrupt the guidelines or the visiting hours." (GE20)

"There should not be visits at this time; moreover, scheduling the visiting hours is important, as cooperating with the family members could reduce the risk of delaying the time of administering medications." (CP05)

4.9.1.3 Calls and Bell Interruptions

Participants explained that phone calls and bells were factors that could cause interruptions during the administration of medications. They described how such interruptions could impede the nurses' concentration as well as medication safety:

"The most thing that will distract you during administering medication is the mobile; if your mind is with the mobile and at the same time with the medication, this will not be working, as your concentration should be focused on the medication." (DG08)

"The factors that strongly influence the procedure are when I'm preparing medication and someone calls me, I will leave the medication and then return; this will influence the procedure's safety." (CP05)

4.9.1.4 Medical staff interruptions

One more thing that could interrupt nurses during the process of administering medications was the medical round. Participants described that the environment should be calm during the procedure of preparing and administering medications, and it is recommended to have a special area for preparing the medications to prevent being distracted:

"The main interruption that we may face is medical rounds during medication preparation." (GE20)

"The environment should be calm; you should not start medication administration during the doctors' round; it is difficult to administer medication or prepare medication in this environment with the sounds of people around and doctors around." (DG08)

"We should have a special area for preparing medication as the nurse will not be distracted and will be able to concentrate while preparing the medication." (CP05)

4.9.2 Element 2: Nurse-Patient Ratio

According to the nurse-patient ratio, the participants described that it is preferable to have one nurse to one patient, which means that the nurse-patient ratio is one-to-one. However, as they described, the nurse-patient ratio is influenced by the health condition of the patient, the quality of care provided for patients, and the number of medications prescribed for one patient:

"All the nurses are responsible for all patients, so for me to have one patient for one nurse is a good thing as you will focus better and you will follow the steps better, and this is the right thing." (EP09)

"If I have an intubated and sedated patient, I have one nurse for one patient, but if the patient is not intubated and hemodynamically stable, the nurse can manage with two patients, so, in general, the ratio is one to one and a half." (GE20)

"We have to assign according to the quality of patients; some patients need one nurse, sometimes one and a half nurses are needed, and sometimes more than twenty medications are given to one patient." (AP01)

Another two participants described how the nurse-patient ratio could increase the nurse's workload and expose them to a stressful environment. They added that the increase in workload could impede the safety of medication administration:

"Here in the ICU, one nurse for four patients, one nurse for three patients, this could cause for an improper way for administering medication here." (FG16)

"If I assign one nurse to three cases, this will put the nurse under pressure, and he will administer medication in a hurry to finish the work before the shift ends." (GE18)

Conversely, the participants talked about the influence of workload on the nurses' concentration, which could impede the safety of medication administration. They added that the extra working hours reduced the sleeping and rest hours, which influenced the nurses' concentration as well as impeded safety:

"Workload is number one of the factors, when we have a workload, the opportunity for drug administration mistakes goes up." (GE20)

"The work overload influences the nurses' sleeping hours, and not having enough rest decreases concentration; if the nurse worked 17 hours, his concentration will definitely not be the same as that of a nurse who just works 7 hours." (EP12)

Additionally, the participants mentioned that emergencies increase the nurses' workload, which in turn could impede the safety of medication administration. They described that in such situations, the nurses could administer medication rapidly or could postpone it, so medications would not be administered on time:

"Sometimes, if we have work overload, we will be assigned to three or four patients. In this situation, maybe I will forget to write the name of the medication on the prepared syringe, and a mistake will happen." (FG15)

"Maybe I have two code-blue patients at the same time in the unit; I have a patient with cardiac arrest and there is a shortage of nurses' numbers, and at the same time I have

admission to the ICU, so in this situation maybe I will administer the medication fast and maybe I will not notice the expired date." (GE19)

4.9.3 Element 3: Availability of Supplies and Equipment

Participants talked about the poverty of syringe pumps and dropper machines. They added that having one or two syringe pumps for the patient in the critical care unit is not enough, as there are usually multiple types of medications that need to be administered to only one patient by using either syringe pumps or dropper machines. Participants explained that the availability of infusion pumps could ensure the safety of medication administration; conversely, the decreased number of infusion pumps could be an obstacle to administering polypharmacy to one patient, so safety will be impeded:

"The syringe pump is so safe, but I think the number that is available in the ICU is not enough; there is no adequate number of syringe pumps available." (DG08)

"One infusion pump or two for each patient; because of intensive care unit patients, we have many drugs to be administered." (FG16)

Additionally, some of the participants complained about the shortage of supplies that are used in preparing and administering the medications, for example, the syringes and the infusion set. They described that they used to flush the intravenous sets before using them for the second time for the same patient with different types of medications, and this could impede the safety of the medication administered. Using the same syringe to prepare two different medications will impact the development of the risk of drug-drug interaction:

"The most critical factor is the shortage of medical supplies here, which are important things for administering medication." (FG16)

"I will use the same IV set and do an IV flush for it each time; sometimes we don't have enough syringes and needles, so I cannot dispose of them, and sometimes I use the same syringe and needle to dilute many medications with them." (BG13)

" According to the lumen, some medications should not be mixed with another medication, for example, if I'm administering noradrenaline, it is a contraindication to administer another medication with the same lumen." (GE19)

4.9.4 Element 4: Tidiness

Another element that the participants talked about was the tidiness of the critical care environment, including the space between the patients' beds and the numbering of the beds. The participants described that the space between the patients' beds is not enough, so they must be aware of the patients' bed number. In addition, they focused on the importance of checking the patient's name before administering medication, as sometimes two patients could have the same surname as well as the same first name:

"The space between patient and patient is less than the other wards in the hospital, so I should be organized to perform a good task and should organize the patient and medication for all of the patients." (AP04)

"Patient name for sure; sometimes two patients or more have the same names, so the nurse should be aware of the number of the beds, patient dose, route, and right time." (EP09)

Additionally, two of the participants emphasized the importance of medication box tidiness and separating them, as well as labelling boxes, either for the critical care units' medication stock or the medications that belonged to the patient. They described how using the labelled boxes could help the nurse recognise the medications by their labels:

"Generally, the high-alert medications have a special box that consists of narcotics, sedatives, antiarrhythmics, inotropes, adrenergic medications, anti-seizure medications, and the electrolytes that are compensatory potassium, magnesium, calcium, and sodium chloride." (BG13)

"All the high-alert medications are kept in a separate cupboard that is for the unit, and this cupboard is divided either by a bag or box that consists of a sticker label containing the information about the patient, his name, and the registration number." (GE19)

4.10 Category 6: Healthcare Providers

In the analysis of the interview data, the associated category of the role of healthcare providers emerged. A variety of roles emerged that healthcare providers practiced enhancing the safety of medication administration in critical care units. Some of the participants described that there were practices that could impede the safety of medication administration, while the collaboration of the healthcare providers could enhance the safety. The elements that emerged from this category include Figure 4-11:

- Prescribing,
- Administering, and
- Administrative roles.

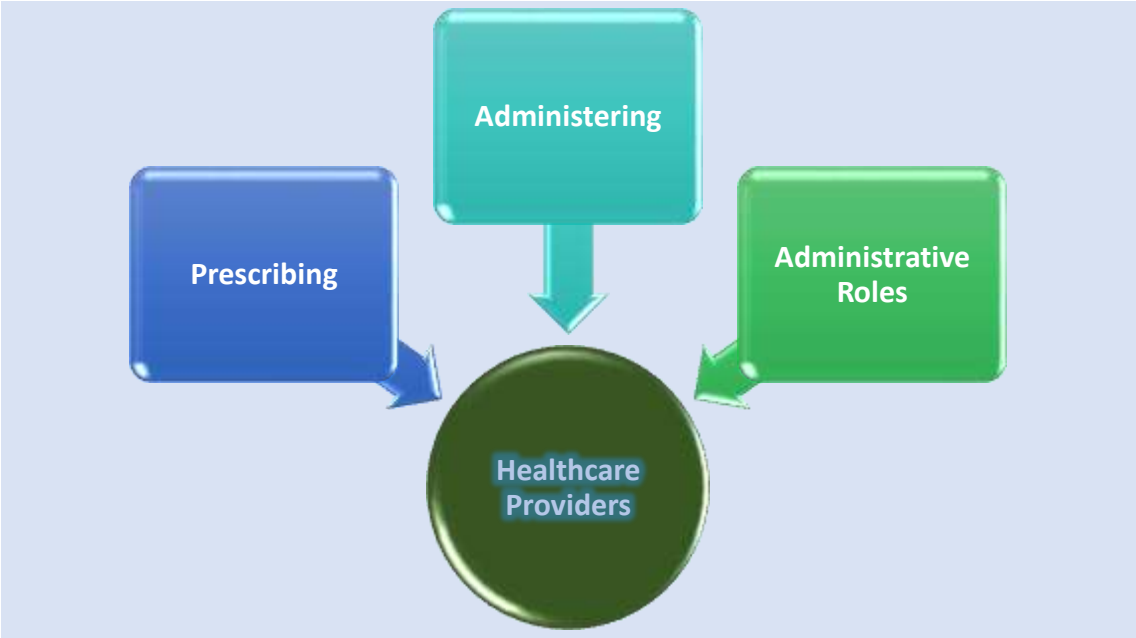


Figure 4-11: Elements included within the category "Healthcare providers".

The elements in the above figure (figure 4-11) reflect the category of healthcare providers' roles and their responsibilities toward administering medication safely in critical care units. The participants described the roles of the nurses, pharmacists, and physicians in the context of safe

medication administration, as well as the collaboration between them to ensure the safety of the medication as well as the safety of the patients.

4.10.1 Element 1: Prescribing

This element describes healthcare providers' roles in prescribing medications in critical care units. Participants described how collaboration between healthcare providers (nurses, physicians, and pharmacists) helps enhance the prescribed medications.

4.10.1.1 Role of the physician

It was described by the participants that the main role of the physician is to prescribe medications. Also, participants explained that the role of physicians is to write their orders clearly and understandable to prevent filling mistakes. A physician's order should include all components to ensure that medications will be administered safely, for example, the unit of the dose, frequency, and route:

> "The doctor prescribes the medication for the patient, either tablet or IV medication, *the order should be complete which means the dose is remarked, the route, when to start at what time, and the signature of the doctor with the stamp*." (GE20)
>
> *"The doctor writes the order; he describes administering two doses of the medication or three doses, this should be clear." (AP03)*
>
> *"The doctor just writes the order, the dose, name of medication, and frequency, for example, dopamine 2 micrograms per kilogram per minute." (CP06)*

Some of the participants focused on the importance of signing the prescribed order by the physician for legality issues, as in specific situations the nurses received the physician's order verbally or by phone. For example, one of the participants mentioned that the physician's order should be stamped and not just signed by the physician's name:

> *"The doctor should sign the drug sheet to ensure that all medications transferred from the physician's order sheet to the drug sheet were accurate." (EP11)*

"... the signature of the doctor with the stamp; if the stamp is not available, he has to write his registered number in the hospital." (GE20)

4.10.1.2 Role of nurse

The role of the nurse concerning prescribing the medication is limited; their responsibility at this level is to check the physician's order and to ensure the prescribed order is complete and understood:

"The order should be clear, especially for medications that are similar in mic and unit and should specify the weight; and the physician should approximate the patient's weight if it is not available." (FG14)

"The nurse checks that the order is complete, which means the dose is noted, the route, when to start at what time, and the signature of the doctor with the stamp." (GE20)

In addition, participants mentioned that nurses could administer medications in emergency cases without waiting to be prescribed based on their knowledge of how to treat these emergency cases; for example, they know what to administer if a patient develops atrial fibrillation or cardiac arrest. In addition, nurses can discuss the prescribed medications with physicians based on the results of certain laboratory tests:

"Even with the arrhythmia, you should treat it yourself. If the patient develops AF, PVCs, or anything else, you should treat it by yourself and inform the doctor." (EP11)

"The nurse should know that the patient needs a trough level lab test before administering the next dose of antibiotics, [trough level] level of medication concentration in blood. Mostly we do this test for patients who have renal impairments, as most antibiotic excretion is through the renal system." (GE19)

4.10.1.3 Role of pharmacists

Two of the participants described that the pharmacists' main role is restricted to dispensing and checking the prescribed medications:

> *"The role of the pharmacy here is just to provide us with the medications, and sometimes when someone from other wards needs information from the pharmacist for certain medications, he/she is referred to the ICU, and told to ask the ICU team." (FG14)*

> *"The pharmacist just requested the medications; they checked the medications in the unit only and did not participate in providing information regarding medications." (GE18)*

Conversely, other participants explained that pharmacists' roles are not only restricted to dispensing medications, but they also contribute by providing essential knowledge related to prescribed medications. Participants emphasized the importance of the presence of a pharmacist to share in prescribing medications; they recommended when to start medication and when to terminate it, as well as the prescribed dose:

> *"The pharmacist reviewed the medications; for example, if it was noticed that the patient had been on Levox for more than eight days, the pharmacist reported that this medication should be administered just for seven days." (DG08)*

> *"Have a pharmacist attend the morning round with the physicians and help in the treatment plan towards the medications; for example, if the patient's culture and sensitivities test results are positive, the pharmacist will recommend what type of antibiotic is the best." (FG15)*

4.10.2 Element 2: Administering Medications.

This element reflected the role of healthcare providers concerning the responsibility for administering medications in critical care units. All participants focused on the nurses' role in administering medications. A couple of participants relied on pharmacists for the role of administering medications, while one mentioned that physicians could be involved in administering medication in critical care units.

4.10.2.1 Role of nurse

Two of the participants described that administering medication in critical care units is the responsibility of the in-charge nurse. They described that the in-charge nurse is responsible for administering all types of medications, whether it is intravenous or oral medications:

> *"Procedures of medication administration are the responsibility of a nurse who is in charge of administering IV and oral medications." (AP01)*

> *"Mostly a head nurse or senior nurse who is responsible for medication administration, otherwise, every nurse practices the assigned tasks." (AP03)*

While most participants explained that the nurse who is assigned to the patient is responsible for administering medications to his or her patient, they added that the nurse who prepared the medication is responsible for administering it and should not allow another nurse to do so:

> *"My role as a nurse is to administer the medication on time with an accurate dose, and I should calculate the dose of medication accurately." (EP11)*

> *"The assigned nurse is responsible for administering the medication; whoever prepares the medication should administer it; it is not allowed to let someone else administer it." (GE19)*

4.10.2.2 Role of pharmacists

Participants talked about the role of the pharmacist in relation to administering medications. They described that the pharmacist's role is to ensure that the medications are administered appropriately, in addition to checking every morning's medication doses. They explained that if there are any remaining doses from the previous day, this means that the patient missed one of his or her medication doses. Two of the participants mentioned that pharmacists had a role in administering certain types of medications, for example, chemotherapy:

> *"The clinical pharmacist has a very important position here in administering antibiotics, sometimes, they help in diluting the medications with the recommended amount of solvent." (FG16)*

"There are some medications that should be given by pharmacists, and there should be a witness when giving them, like chemotherapy." (AP01)

4.10.3 Element 3: Administrative Roles

A variety of administrative roles are practiced by healthcare providers to administer medications, as described by many of the participants. These roles include monitoring, teaching, delegating, advocating, consulting, and communicating. There was variation in practicing these roles among the healthcare providers; each of the healthcare providers could practice one or more of these roles. However, all the participants described that nurses practice all the administrative skills concerning administering medications.

4.10.3.1 Monitoring

Many of the participants described that the main role of the in-charge nurse is to observe and monitor the process of administering medications performed by the nurses. In-charge nurses observe how nurses prepare and administer medications, which enables them to detect weaknesses and strengthen their practice:

"My role is to supervise how they [nurses] administer, with one of the senior nurses supervising the drug administration." (FG16)

"We try to follow the team more closely and make sure about the dose that will be administered to the patient, the route, and the frequency." (EP10)

"The head nurse or senior shift observes other nurses, how to prepare medication, and how to administer medication." (CP06)

In addition, other participants described that the in-charge nurses' role includes monitoring the newly graduated nurses until they are competent to administer medications safely:

"When there are newly graduated nurses with me and they want to administer medication, I'll be with them in every step, with calculation, and when they administer medication." (EP11)

"My main role is observing and supervising, and then observe the performance of the final competency for the nurses to ensure they can administer the medication safely." (GE20)

4.10.3.2 Teaching

Another role that the in-charge nurse is involved in is teaching and providing knowledge to the team members, as described by the participants. Sometimes, nurses need help with calculations or need to know how new medications will be administered:

"I provide teaching for the nurses in general; in your role as a manager, you should teach your team members." (DG08)

"I will help in teaching them calculation and make sure about this if the nurse does not know, but I don't interfere with the expert nurses who are on duty with me." (FG14)

"Teach the team how it will be administered, just when it is a new drug, and observe their performance." (DG07)

Other participants focused on the pharmacists' role in teaching. They described how nurses could collaborate with the pharmacists by providing lectures about new medications and special considerations in administering certain types of medications:

"The pharmacist can provide lectures to the nurses about medication administration in collaboration with CNE." (GE20)

"There are certain medications the pharmacist recommended how to administer in a certain method or to pay attention that this medication is photosensitive and should be wrapped in aluminium foil." (EP10)

Moreover, the participants described how pharmacists could teach nurses how to prepare and dilute medications, as well as provide them with special instructions concerning medication storage:

"Some medication should be kept in the refrigerator, others not; the role of the pharmacist should always remind us about the storage requirements." (EP12)

"The role is when there is special concern about certain drugs and how they should be stored; some medications are light-sensitive; and some medications are contraindicated to be administered together." (FG17)

"And about the time that I can keep the medication after opening the medication vial, it depends on its stability; this is determined by the pharmacist department." (GE19)

4.10.3.3 Delegating

Delegation is another role that the in-charge nurses are responsible for, as mentioned by participants. However, the in-charge nurse delegated the tasks by assigning the patients to nurses. Participants added that each nurse who is assigned to a patient is responsible for administering medications to his or her patient, and this will enable the in-charge nurse to have time for solving other issues:

"I must solve the problem or solve the critical condition that happened. I could delegate my procedure to another nurse to manage other raised issues." (AP01)

"The assigned nurse is responsible for administering the medication; whoever prepares the medication will administer it, even if the nurse prepares the medication at the end of the shift." (GE19)

4.10.3.4 Advocating

Nurses play a role in advocating for patients' rights. Participants described that nurses are responsible for preventing harm and ensuring patients' safety. This includes medication administration safety and stopping the procedure if there is doubt that the patient would be harmed:

"I'm the only advocate for the patient and the only one who advocates for his health and safety. Do not harm the patient or cause morbidity or mortality, and always be safe; safety comes first for me." (BG02)

"The most important thing is to prevent harm to the patient. If medication is administered wrongly, it should be stopped immediately." (EP10)

4.10.3.5 Consulting

Participants described that nurses need to consult healthcare providers to administer medication safely. They identified that in the first place they could consult their colleagues who are on duty with them:

> *"If I don't know about this medication, I can ask another nurse with me on duty to ensure the safety of my performance." (CP06)*

> *"... and the other nurses, if they want to consult me, I will help them in calculation and make sure they are confident to practice it." (FG14)*

Other participants added that nurses consult physicians for clarification about the prescribed medications. The participants emphasized the importance of the physician's presence in the critical care units for further clarification about the prescribed order or providing clarification on how to administer certain types of medications:

> *"I will consult the doctor by telephone about how I can administer specific medication; the doctors may mostly provide us with information." (DG07)*

> *"It is important to have the resident physician available in the critical care unit all the time for any query or clarification, so if any problem occurs, the physician will treat it immediately." (EP10)*

Moreover, other participants focused on the importance of consulting pharmacists, as they are considered the most helpful and knowledgeable about medications given in critical care units, on how to dilute, administer, and discuss the most effective medication for the patient based on their knowledge and evidence:

> *"We return to the pharmacy and ask them how to dilute the medication, even if they didn't have to deal with such medication regularly so they will read and make sure about the information and return to us for how we should dilute it." (FG15)*

> *" We have a pharmacist with a master's degree, [pharmacist] help us a lot; recently, the pharmacist has been a good reference for us." (CP05)*

4.10.3.6 Communicating

Communication skills help nurses in critical care units administer medication effectively. For the safety of the patient, participants described that nurses should prepare the patient and explain the procedure of administering medication; they added that this is one of the patients' rights to know about the procedure and either to accept it or refuse:

> *"If the patient is conscious, talk with him to explain the procedure itself, and we are going to administer medication." (EP09)*

> *"If the patient refuses to take his or her medications, communication skills help me explain the drug to the patient, and I will possibly persuade the patient to have the medication." (AP04)*

Communication with physicians and pharmacists enhances the safety of medications; collaboration with both physicians and pharmacists helps in clarifying information and providing knowledge to administer medication safely:

> *"The pharmacist can provide lectures to the nurses about medication administration in collaboration with CNE." (GE20)*

> *"I check that information with the pharmacy department to ensure safety." (BG02)*

> *"If the physician could provide evidence on how medications could be administered that were ordered and discussed with nurses' colleagues." (EP12)*

4.11 Chapter Summary

This chapter demonstrated the development of the grounded theory conceptual framework. The primacy of safety was the focus of all the interviewees in the Palestinian critical units. The findings revealed six interrelated categories influencing the safety of medication administration as shown in the following figure (Figure 4-12). However, the emerging categories were described thoroughly in terms of how they could enhance or impede the safety of medication administration in the critical care environment.

Figure 4-12: The developed grounded theory conceptual model.

Nurses' knowledge and skills were considered evidence to practice the process of administering medication safely by using the appropriate resources and skills. In addition, knowledge enables nurses to detect problems or complications that could arise during the procedure and solve them effectively. Moreover, nurses need to be aware of different technological methods that could be

used to support medication administration, and nurses need to know how these devices work to ensure safety.

Additionally, collaboration between healthcare providers helps to ensure safety, and each one of them should be restricted to the job description and the institutional policies to enhance the safety of medication administration. However, ensuring the safety of the critical care environment is considered a primacy for nurses to enhance the safety of medication administration.

Chapter 5 DISCUSSION CHAPTER

5.1 Introduction

This chapter discusses the findings of the research question: “What are the factors that influence medication administration safety from the nurse's perception in Palestinian critical care units?” The study particularly uncovered six factors that enhance and/or impede safety in Palestinian critical care units:

1. The nurses’ pharmacological knowledge and skills could enhance or/and impede the safety of medication administration in the critical care units.
2. The process of administering medications and the steps that critical care nurses follow to ensure that medications are administered safely.
3. The types of technological methods used in critical care units that support medication administration safety.
4. The institutional policies and guidelines that the critical care nurses adhere to regarding the process of administering medications from the prescribing level to the administering level.
5. The physical control of the critical care environment could enhance or/and impede patient safety.
6. The role of healthcare providers in enhancing medication administration safety in critical care units.

This study focuses on exploring fully the complex nature of medication safety within the Palestinian critical care units, rather than previous studies that focused on one or a few areas regarding factors influencing the safety of medication administration (Anselmi et al., 2007; Harkanen et al., 2015; Kim et al., 2011; Tang et al., 2007).

In this study, the concept of safety was a characteristic of all the interviews based on an in-depth review of the nurses' perceptions toward administering medications in the Palestinian critical care units. The core category that was highlighted by all the interviewees in this study and talked about was the primacy of the safety of administering medication. Previous studies revealed that understanding factors influencing the safety of medication administration is still limited (Harkanen et al., 2015; Kim et al., 2011). This study described the factors that enhance or/and impede the safety of administering medications based on the critical care nurses' perceptions. The interviewees considered the medications used in critical care units to be high-risk and would influence the patient's safety if the revealed factors contributed to the medication's safety. However, all the factors described in this study should be integrated to optimize the primacy of safety as well as manage the factors that could impede medication administration safety as well as patient safety.

5.2 Conceptualized Model

In the previous chapter, six categories emerged, and their interrelationship with the primacy of safety was highlighted. The model below (5-1) illustrates the grounded theory derived from the key findings of this study. In addition, the model demonstrates the interrelationship between the primacy of safety and the associated categories that could enhance and/or impede safety. The uninterrupted circle that passes through all the factors reflects that the unity of these factors is essential to ensuring safety; conversely, to ensure the primacy of medication administration safety, the six emerging factors should be considered in the critical care units.

Figure 5-1: Conceptual grounded theoretical model of the "Primacy of Safety".

The findings considered that the integration of all the emerging factors enhances the safety of the medication administered in the critical care units. Additionally, in this study, the interviewees believed that ignorance of one of these factors could impede the safety of medication

administration. The findings revealed that nurses should be knowledgeable about the pharmacological kinetics and dynamics, follow the institutional policy to practice the process of medication administration, use the appropriate technological methods, collaborate with healthcare providers, and be aware of the critical care environment to ensure that the medications will be administered safely.

5.3 Primacy of Safety – *"Preventing harm and patient safety".*

This study demonstrated that patient safety is a priority in health institutions, and one of the most important issues that healthcare providers are concerned about is enhancing the safety of medication administration to ensure patient safety. This is supported by what was described by the World Health Organisation (WHO), which described medication administration safety as one of the global patient safety challenges (Donaldson et al., 2017). Consistent with previous studies (ISMP, 2007; Jafaru & Abubakar, 2022; Millar, 2002), safety was defined as the prevention of harm and the avoidance of unexpected events. However, by moving beyond the thematic description of the interviewees' reports to the development of the grounded theory model, this study provides important insight into how interviewees conceptualised the primacy of safety, including how the safety of medication administration could be enhanced, and how it could be impeded, as well how the factors that influence safety could be controlled.

The primacy of safety arose from a range of factors influencing medication administration in the Palestinian critical care units: nurses' knowledge and skills, the process of administering medication, technology contributing to medication administration, policies and procedures followed to administer medication, the critical care environment, and the role of healthcare providers in administering medication in critical care units.

The concept of medication safety was described in other studies as a central and complex problem that needs to be assessed across the stages of the medication process, and during these stages, the nurses have a significant role in improving patient safety as well as medication safety (Carayon et al., 2014; Kim et al., 2011). A study that was conducted in the United States explored medication safety in critical care settings and identified that medication safety is a priority for healthcare organisations, and the authors of the study explained that medication events should be

prevented at all stages of the medication process, which could influence the patient's safety (Kane-Gill et al., 2017).

This current study, along with the Tang et al. (2007) study, explained that the safety of medication administration starts from the phase of prescribing the medication, interpreting it, and requesting medication from the pharmacy to the phase of administering the medication. In addition, the primacy of medication safety is an important issue in health settings that have a role in the improvement of patient safety (Gunningberg et al., 2014; Hughes, 2008). This study emphasised the importance of nurses' role in ensuring the primacy of safety in each phase of administering medication alongside the safety of patients to prevent morbidity or mortality.

The current study develops a grounded theory model that describes the 'primacy of safety' arising from the six emergent factors (Figure 5-1). To prioritise medication administration safety, nurses should ensure that neither of the six emergent factors impedes safety during the medication administration process in critical care units. In addition, nurses should ensure that these factors are managed to enhance medication administration safety as well as the patient's safety.

The Swiss Cheese Model is widely accepted to draw attention to the failure of the health system and identify the weaknesses that cause harm (Perneger, 2005). So, in this study, I used the Swiss Cheese Model (Reason, 2000) to examine how the alignment of cheese layers could enhance and/or impede medication administration safety by analysing factors influencing medication in critical care units. Figure (5-2) shows the Swiss Cheese Model and how the error occurs. However, James Reason explained in his model that the alignment of the holes in the Swiss Cheese Model slices allows errors to pass through and cause harm.

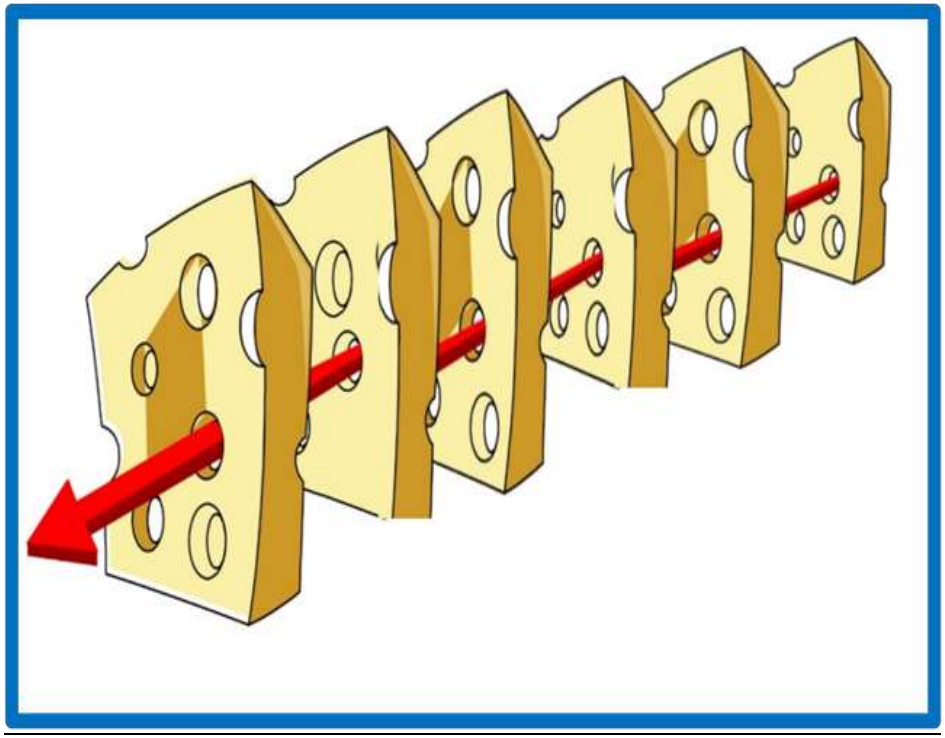


Figure 5-2: The original Swiss Cheeses Model, free copyright (Reason, 2000).

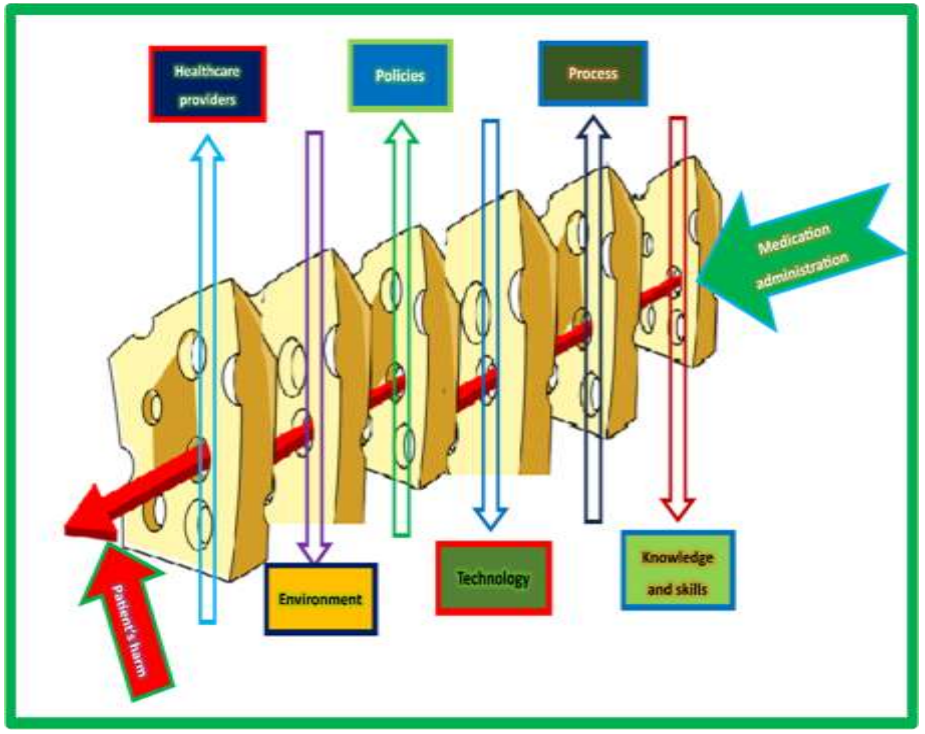


Figure 5-3: Restructured Swiss Cheese Model representing grounded factors influencing medication safety. (2024)

As shown in the above figure (Figure 5-2), if the slice openings are in front of each other, this enables the cause of harm to pass through and cause harm to the patient (Reason, 2000). However, detecting the holes in the cheese slices that could allow the harm to pass through helps healthcare professionals to analyse the root of the harmful cause and manage it before causing harm, whether the cause is at the personal level or the organisational system level, which would help to enhance safety by blocking these holes and preventing harm from occurring (Reason, 2000; Wiegmann et al., 2022).

Figure 5–3 shows the restructuring of the Swiss Cheese Model by overlaying the six grounded factors that emerged in this current study; the six emerging factors were discussed in Chapter 4. In this section, I revised Reason's original Swiss Cheese Model and overlaid the grounded theory found in the current study based in Palestine. As shown in Figure 5-3, each slice of cheese is a factor derived from the grounded theory, and thus each factor has an impact on medication safety.

For example, as shown in Figure 5-3, the nurses' knowledge and skills in the first cheese slice: if nurses have adequate pharmacological knowledge and skills about the intended effect or the side effects of the high-alert medications and could identify the weakness in their knowledge, this will block the hole in the cheese slice layer, the harm will be prevented, and the patient will potentially be safer. This could be applied to all the conceptualised grounded factors that emerged in this study. The reverse is true: lack of knowledge could mean the hole is not avoided; thus, harm is created, or the next slice must prevent harm.

In conclusion, the Swiss Cheese Model is an effective model that helps to understand the strengths and weaknesses of the emerging grounded factors in this study by identifying the cause of harm within each emergent factor. As well, the model helps nurses learn how to block the holes

to prevent the occurrence of harm and enables them to think about how to manage these factors to enhance safety and prevent the occurrence of harm, which could minimise morbidity and mortality. The explanation for applying the Swiss Cheese Model in this study is consistent with previous evidence that described the threat factors that could be controlled if detected earlier.

The studies concluded that the factors that could be controlled include inadequate pharmacological knowledge, poor skills, miscommunication among healthcare providers, inappropriate patient assessment, unclear evidence-based policies, a lack of medical supplies, the absence of certain medications, and the unavailability of pharmacist coverage over twenty-four hours (Hughes, 2008; Li & Thimbleby, 2014).

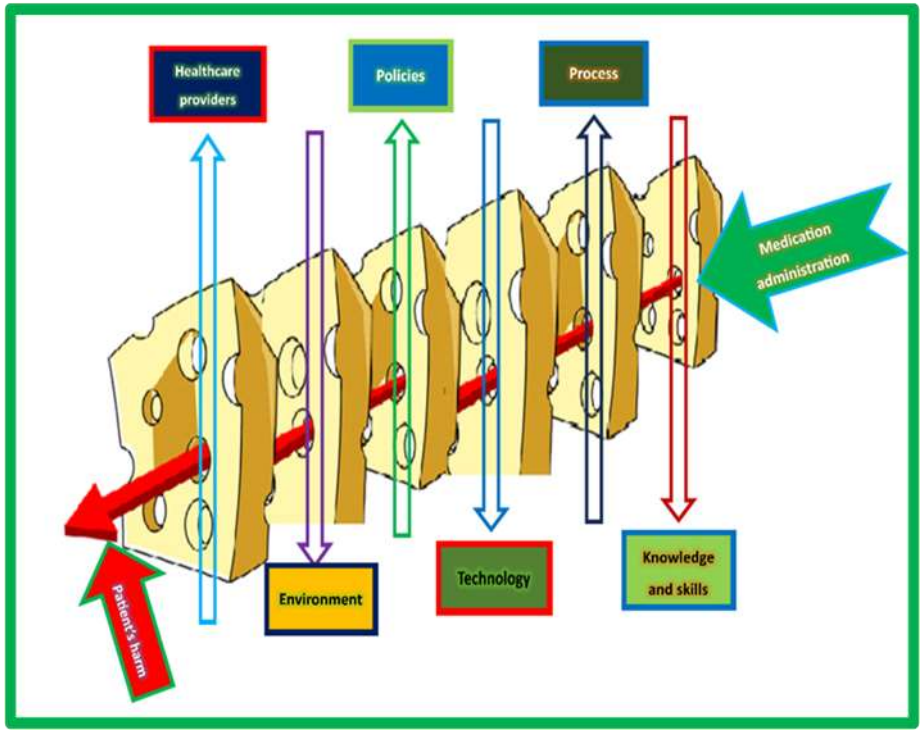


Figure 5-3: Restructured Swiss Cheese Model representing grounded factors influencing medication safety. (2024)

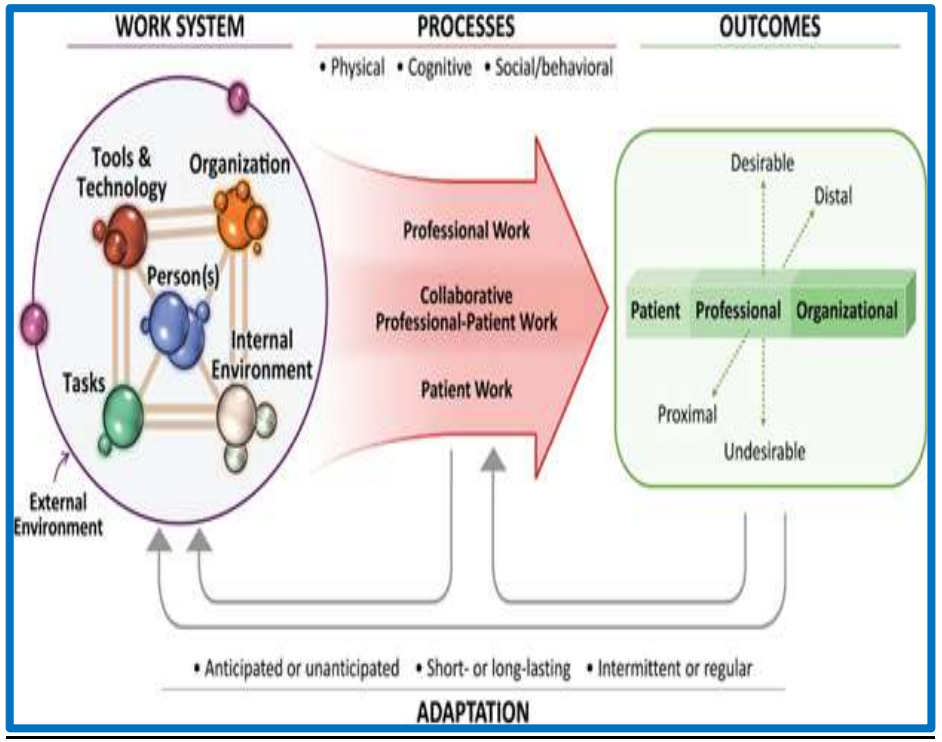


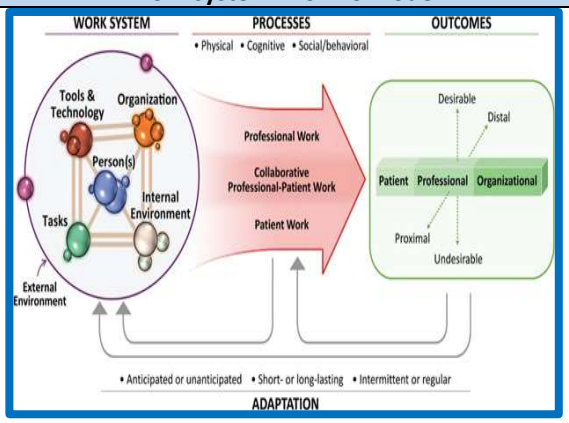
Figure 5-4: SEIPS 2.0 model, free copy (Holden et al., 2013).

Additionally, the restructured James Reason's "Swiss Cheese Model" (Figure 5-3) was compared with the SEIPS 2.0 model, which is the greatest human factors framework that contributes to healthcare domains (Holden et al., 2013). The SEIPS conceptual model (Figure 5-4) is an analytical tool for professionals who are studying the improvement of work done by healthcare providers, patients, and mixed professional-patient teams. And it offers a conceptual framework that captures the complexity of the healthcare environment (Holden et al., 2013).

The core domains of the SEIPS model are the work system, processes, and outcomes (Figure 5-4). The general structure of the model is that the sociotechnical work system produces a work process that shapes the outcomes. Using this framework for analysing safety events leads to a decrease in the gap between the actual and ideal healthcare performance to improve the workplace or to redesign and adapt the performance.

These domains overlaid the conceptually grounded factors that emerged from the collected data in this current study based in Palestine, as described in the following table (5-1).

Table 5-1: Illustration of the SEIPS work system concepts and the grounded theory factors of this current study.

Work system in SEIPS model	Grounded theory factors in Palestinian critical care units
	
Person in the centre of the sociotechnical system: • Healthcare providers. • Patient. • Healthcare-patient team.	**Healthcare providers:** • Critical care nurses. • Physicians. • Pharmacists.
Tasks are specific actions within the work process, characteristics of tasks include: • Difficult. • Complex. • Variety. • Ambiguity. • Sequence.	**The process is a sequence process carried out in collaboration with collaboration of healthcare providers (nurse, physician, and pharmacist):** • Interpreting physician order. • Steps of the medication administration procedure. • Patient's assessment. • Administering medication.
Technology which is classified according to usability, accessibility, familiarity, and functionality: • Technological information. • Medical devices. • Physical tools and equipment.	**Technology includes devices that support:** • Prescribing medications. • Calculating medication doses. • Administering medications. • Monitoring support which includes monitoring administered medication and monitoring the patient's health status for effectiveness of administered medication.
Organisation within the institution: • Work schedule and assignments. • Management and incentives. • Organisational structure. • Training. • Policies. • Availability of resources.	**Policies include:** • Continuous education programme. • Clear job description regarding medication administration responsibilities. • Incident report for modifying behaviour to carry out the process of administering medication safely. • Availability of knowledge resources as a policy.
Internal environment refers to the physical environment including: • Lighting, noise, vibration, temperature, physical layout and available space, and air quality. **External environment which incorporates the macro-level of society includes:** • Economic, ecological, and policy factors outside an organization.	**Environment factors refer to:** • Interruptions that disrupt the process of administering medication. • Nurse-patient ratio that influences the workload. • Availability and access to supplies and equipment. • Tidiness of surrounded environment in critical care units.
**The primacy of safety is nuanced in both models. The grounded theory model of this current study discussed the grounded factor 'knowledge and skills' separately, while it is included with the organisation factor in the SEIPS model.* **The outcomes in the SEIPS model could be desirable or undesirable, while the grounded theory of this study focuses on the primacy of safety and managing the grounded factors to enhance safety.*	

Briefly, the person in the centre of the tetragon could represent the patient who is the centre of care; the other four domains that take place on the four angles of the tetragon represent the technological methods that are used to administer medications (tasks) within the critical care environment (internal environment) in the hospitals (organisation) that are covered by using policies and guidelines to enhance the safety of the tasks.

Also, the SEIPS model highlighted that healthcare is a complex, dynamic, and multilevel system that needs healthcare providers' collaboration to adapt to the environment to achieve the desired outcome (Figure 5-5). In this research study, critical care nurses are active agents who are working in a complex environment and use technology and resources in collaboration with physicians and pharmacists to administer medication safely to critically ill patients. Additionally, to achieve the desired outcome, nurses should be competent in their knowledge and skills and be able to manage and control the internal and external environmental factors that could impede safety.

5.4 Knowledge and Skills – *"Knowledge is power"*

Nurses in this study described themselves as knowledgeable and highly competent to administer medication safely. They indicated that they should know about all types of medications that are used in critical care units, which helps them provide the appropriate nursing care plan to enhance safety. The result of this study is consistent with other studies that described that the majority of unsafe medication administration is related to a lack of knowledge and information about the patient (Esfahani et al., 2016; Kane-Gill et al., 2017; Millichamp & Johnston, 2020; Sessions et al., 2019). Additionally, this study with other studies described that inadequate nurses' knowledge is a concern for patient safety (McLeod et al., 2015; Romero et al., 2013), and the NMC determines that nurses are accountable for their practice to demonstrate their competence and knowledge to administer medication safely (El-Ata et al., 2019; NHS, 2019). The interviewees in this study highlighted the importance of knowing each group of medication, and they described that they should know how each medication group could be administered. This study also added that the nurse's knowledge about medications enables them to discuss the prescribed medication and its dose with the physician based on their evidence of the patient's assessment. Additionally, interviewees reported that nurses have the knowledge that enables them to interpret the lab test results and how these results could influence the prescribed medication doses, and they could discuss the medication dose with the physician to prescribe the appropriate dose.

This current study, along with other existing studies demonstrated that nurses should not only have knowledge related to all groups of medications given in critical care units but also have confidence in their knowledge of administering high-alert medications (HAMs) safely according to the defined institution's procedures (Lu et al., 2013; Sullivan et al., 2021). This study and others showed that if nurses have inadequate knowledge about high-alert medications (HAMs),

vasopressors, and sedatives, it will impede the patient's safety as well as the medication administration process (Escrivá Gracia et al., 2019; Farag, 2017; Zyoud et al., 2019). However, this current study adds that to enhance the safety of administering HAMs, nurses should know how to differentiate between the types of HAMs based on the indications of each of these medications. In addition, they should know when it is necessary to administer renal doses and cardiac doses in the case of administering medication such as dopamine.

However, the interviewees explained that nurses should have essential knowledge regarding pharmacodynamics, and pharmacokinetics of all types of medications that are used in critical care units. Pharmacokinetics is defined as the response of the body to the medication, while pharmacodynamics is the effect of medications (Bakker et al., 2019; Roulston & Davies, 2021). The finding in this study is consistent with a study that described the nurses' pharmacological knowledge as a concern; nurses are expected to be competent in related medication administration, and their knowledge includes mathematical professionalism, calculating doses, and other pharmacological skills (Grandell-Niemi et al., 2006); conversely, this is against a result of a study that reported the focus should be on the medication administration activities rather than on the knowledge (Keohane et al., 2008). However, knowing the type of medications helps nurses administer medication safely, and the deficit of the nurses' pharmacological knowledge impedes safety (Kane-Gill et al., 2017; Lu et al., 2013; Sessions et al., 2019). Otherwise, some interviewees reported that besides the nurses' knowledge about medication classifications, including high-alert medications and their potential effects, nurses also need to know the effect of medications on the health status of the patients, including how each type of medication should be prepared and administered. They described that the high-alert medications have more side effects than medications given in general wards; this finding is in line with a result of a study that highlighted that the high-alert medications, including epinephrine and norepinephrine, have twice as many

side effects as those given in general wards (Bakker et al., 2019). Additionally, interviewees described that administering high-alert medications could cause harm to patients in the critical care units; this result is consistent with a study that revealed that high-alert medications could cause significant harm to patients if they were administered unsafely (Lu et al., 2013).

Additionally, the interviewees described that nurses should be aware of how to monitor and observe the changes that the patient may develop because of administering the high-alert medications. Nurses should monitor the patient's hemodynamics while administering the inotropes and vasopressors.

In this study, one-fifth of the sample reported that nurses need to be competent to administer medication safely in a critical care unit. This result is in line with previous studies that described that nurses should be competent and have the knowledge and skills to make appropriate decisions to administer high-alert medications (Rohde & Domm, 2018; Sessions et al., 2019).

However, the interviewees in this study classified the nurses' competencies into three parts: knowledge, skills, and attitude. This is consistent with previous studies that categorized the competencies into knowledge, skills, performance, values, and attitudes (Kono et al., 2017; Sulosaari et al., 2011). Four of the interviewees described how competencies should be developed and tested specifically for newly graduated nurses. They described how newly graduated nurses should be trained, observed, and tested for their competencies before being allowed to administer medications. This comes consistently with studies that focused on the development of the nurses' competencies; the authors described that to achieve competencies, the nurses should have the necessary skills and personal traits to perform effectively nursing duties, including knowledge, skills, and attitudes (Fukada, 2018; Kono et al., 2017; NHS, 2019; Sulosaari et al., 2011). This study revealed that in-charge nurses are accountable for administering high-alert

medications, observing, monitoring, and evaluating the performance of the newly graduated nurses related to their competency in administering medication safely, as well as ensuring the safety of the patient in the critical care units. This result is against previous evidence that described the role of the in-charge nurse as limited to administering high-alert medications, although they are responsible for high-alert medication safety by managing, improving, and participating in developing policies to ensure safety (El-Fattah et al., 2016). Observing and monitoring the nurses' performance while preparing and administering high-alert medications has a positive impact on the safety of administering medication (Fathy et al., 2020). Although four of the participants emphasized the importance of examining the newly graduated nurses' competencies to administer medications in critical care units, sixteen of the participants said that there is a preceptorship programme for the newly graduated nurses to train nurses for all skills performed in critical care units, but it is not specified for medications given in critical care units. However, there is still a risk in this situation of unsafe medication administration.

The interviewees mentioned a variety of resources of knowledge that nurses could rely on to have the pharmacological knowledge they need to administer medications safely. More than half of the interviewees included in this study emphasized the importance of medication training courses to keep their knowledge up to date, although they have experience, as there is always evolution in knowledge as well as new medications manufactured. The findings of this current study are consistent with the findings of two of the studies that described the importance of providing educational programmes as a main resource for knowledge to healthcare providers in their orientation programme to ensure the safety of medication (Farag, 2017; Irajpour et al., 2019). While the result of this study is contradictory to the result of one of the previous studies that reported, despite the presence of well-trained staff in ICUs and their empowerment with knowledge and training courses, the prevalence of unsafe medication events is still high, especially

for high-risk medications (Esfahani et al., 2016). The Esphahani et al. (2016) study used the quasi-experiment method to assess the effectiveness of implementing medication training courses on medication event prevalence without considering other critical care environmental factors that could influence safety. Importantly, this current study highlighted the importance of providing medication educational courses to newly graduated nurses as well as to all staff members who are involved in medication administration in critical care environments, with collaboration between critical care in-charge nurses and pharmacists.

In addition, the grounded theory in this research study demonstrated that nurses should be competent to administer medication safely, and they should be trained before being able to practice administering medications. The interviewees added that newly graduated nurses had insufficient pharmacology knowledge that could enhance the safety of administering medications in a critical care environment. This result was supported by existing studies, which explained that nursing schools struggled to train students for safe medication administration in critical environments because some schools integrated the pharmacology content into other nursing courses and others taught pharmacology in a separate course (Ndosi & Newell, 2010; Preston et al., 2019). Additionally, interviewees in this study described that they gained basic pharmacological knowledge during their initial studies at university, but they were not trained appropriately in critical care units. The result of this study is consistent with a study by El-Ata et al. (2019) that reported the nurses' perceptions regarding their pharmacological knowledge. The authors described in the study that nurses are unsatisfied with their pharmacological knowledge and skills, and they explained that this relies on unclear pharmacological university curricula (El-Ata et al., 2019). This current study added that there should be more focus on medication administration training during the nursing student's internship practice specifically for those who plan to be employed in the critical care units. Moreover, to update the curriculum to meet the

needs of being competent in administering medication which includes preparing and calculating the medication doses.

However, many of the interviewees described that the newly graduated nurses have a knowledge deficit regarding calculation skills. They explained that to administer medication safely, nurses should have knowledge and skills about how to calculate the dose of the prescribed medications and should be confident about the high-alert medication equation. The result of this study alongside other studies described emphasized the importance of implementing educational programmes focusing on medication calculation skills to enhance the safety of medication administration, especially among nurses, as well the educational programmes could strengthen the nurses' knowledge bout high-alert medications, and enhance the safety of preparing and administering these types of medications (Irajpour et al., 2019; Lu et al., 2013; Nguyen et al., 2014).

Interviewees added that nurses are not competent in terms of calculation skills in critical care units, especially in calculating the high-alert medications which influences the safety of administering these types of medications. They described that the most common causes for the calculation skills deficit are related to workload, frequent changes in medication doses, and failure to adhere to the procedure policy (Al-Worafi, 2020; Awajeh et al., 2019). However, the earlier studies didn't address the importance of knowing medication calculation skills (Ndosi & Newell, 2010). Others emphasized the importance of being competent in the calculation, as poor calculation and nurses' incompetence in calculation impede medication administration safety (Edwards & Axe, 2015; Roulston & Davies, 2021). My study showed that all nurses either the newly graduated nurses or those who are working in critical care units regardless of their years of experience, should be engaged in the medication administration training courses periodically to

ensure that they are confident about calculating the medication doses accurately to enhance the safety of the medication process.

This current study and other studies highlighted the importance of the educational programme in providing critical care nurses with information related to the intended effects and side effects of high-alert medications, including hypotension, hypertension, bradycardia, tachycardia, and changes in the urine output (Camerini et al., 2022), as nurses were unsatisfied with their knowledge regarding medication administration related to inadequate training courses (Fathy et al., 2020). Although most of the participants reported the lack of medication training courses related to medications given in critical care units, they emphasized that they are confident about their skills in calculating medication doses accurately.

Despite this, there is a risk of not calculating the dose accurately. This was explained by interviewees, as the workload influences their concentration, and this will influence their practice in preparing, calculating, and administering medication.

Other resources that some of the interviewees mentioned were pharmacological books, pharmacopeia, and manual books. They explained that these resources provide nurses with the essential information and protocols to administer medication appropriately and safely. This result is contradicted by the findings of a study that reported that the majority of nurses relied on their clinical experience and/or their colleagues' information rather than reading and searching in books to update their knowledge regarding medication administration (Shahzeydi et al., 2022). However, the interviewees added that the manual handbook, which is prepared by the critical care unit's in-charge nurses in collaboration with the continuous education committee, helps them administer the medications given in critical care units safely. They described that this manual handbook includes a list of all medications used in critical care units with details about the medication doses

based on the patient's weight, and using this handbook allows for the efficient administration of medication as soon as it is prescribed.

Additionally, the interviewees in this study reported that they relied on official pharmacological websites and mobile applications to access the information they needed related to the intended effect, side effects, drug-drug interaction, dosing, and diluting process, as these technological methods will provide the needed information easily and quickly. The result in this study is in line with the evidence that showed the importance of using mobile applications to access the pharmacological information needed, for example, the medication plan, trade name of the medication, ingredients, dose, route, and if there are special requirements for storage instructions (Anglada-Martinez et al., 2017; Bach & Wenz, 2020; Navas, 2015).

The findings of this study are consistent with other studies emphasising the importance of the internet availability to easily access medication information, additionally, it was reported that there are many recommended websites that nurses could rely on to get the information they need related to pharmacodynamics, pharmacokinetics, and drug-drug interaction (Alsaad et al., 2022; Roulston & Davies, 2021). However, the accessibility of pharmacological websites in the Palestinian healthcare setting is available, as is the use of mobile applications during working hours, which allows the nurses to get the information they need from the reconstitution phase to the administering medication phase. The use of mobile applications or websites as a source of medication knowledge is personal and not adopted by the institution system. So, it is not clear how and when the nurses use these resources as most of the participants reported that the workload keeps them busy during their working hours.

5.5 Process – *"Safe procedures equals safe patient".*

In this study, the interviewees described the process that nurses follow to enhance safety when preparing and administering medications in critical care units. The findings of this study and the study by Benoit et al. (2012) classified the medication administration process into transcribing the physician's order, following consequence steps, assessing the patient's health status, and then administering medications. Another study by Wulff et al. (2011) classified the process of administering medications into three main phases: ordering or prescribing, dispensing medications by a pharmacist, and administering medication, which includes monitoring for therapeutic and adverse effects. Additionally, the findings of this current study are consistent with previous evidence that described streamlining the process of medication administration, enhancing safety, and reducing the risk of medication-related events (McLeod et al., 2015; Nguyen et al., 2014). However, this current study added that the process of medication administration should include interpreting the physician's order accurately, including medication rights, and double-checking with the physician the prescribed order to ensure the accuracy of either the handwriting or the computerised order. In addition, nurses should organize the steps of the process of administering the medication according to their assessment of the patient, and the monitoring of the patient's health status, it is described that this could help the nurses to prioritise which medication should be administered first.

- In the interpretation of the physician's order, the interviewees demonstrated in this study that nurses should consider the medication's rights, which include the five medication rights, while others mentioned that medication rights range between five and ten medication rights, but all the interviewees emphasised the five medication rights. This result is in line with a variety of studies that highly considered the five medication rights,

including the right drug, dose, and route to the right patient at the right time, to ensure the safety of administering medications (Edwards & Axe, 2015; Kee et al., 2021; Martyn et al., 2019; Roulston & Davies, 2021; Wulff et al., 2011).

- The second step of the medication process is preparing the medications that all the interviewees described. The interviewees explained that nurses should know how each medication is diluted and the type of fluids that should be used to make sure about the medication's stability and effectiveness, and they gave many examples mentioned within the findings chapter (Chapter 4). The findings of this study are consistent with studies that revealed medications should be diluted with the appropriate diluent and the correct volume for each intravenous medication preparation (Benoit et al., 2012; Escrivá Gracia et al., 2019). This study added that nurses should know how each medication should be diluted. Several interviewees mentioned that not all the nurses in critical care units are confident about the type of diluent that should be used, and the volume of fluids considered for each medication. They added that nurses should consult pharmacists for further information to enhance medication safety. Additionally, the interviewees mentioned that they should perform medication double-checks before and during the preparation of the medications as a step included in the medication process. These findings are aligned with previous studies that indicated that nurses should perform double-checks for the programmed dose and concentration of the high-alert medications (Goulding & Bedard, 2015; Kingman & Chin, 2013; Sullivan et al., 2021). Importantly, this study added that there should be three medication checks, which include matching the selected concentration programmed medication dose within the infusion pumps with the information included in the displayed label on the intravenous bag or the syringe. The interviewees explained that the label’s information should include the medication name to

be administered, the patient's name, the medication dose, the dose rate that will be administered, and the time started and the time end of the administered medication. A study by Souza et al. (2019) conducted in Europe described the importance of using coloured-coded labels, especially for high-alert medications, to enhance the safety of medications given in critical care units. The study reported that coloured-coded labelling is a standard used in intensive care units in Europe. In this study, the interviewees reported that using the red label for the high-alert medications is recommended for differentiation from other types of medications, as the coloured label will inform the nurse about the high-risk medications that are in the process of administration.

- The next step includes patient assessment and monitoring, which are two skills that nurses should perform during the process of medication administration. The interviewees explained that patients in critical care units are receiving complex medications and should be assessed continuously to prevent patient harm. Importantly, the interviewees highlighted the importance of the patient's assessment for enhancing safety; they described that nurses should assess the patient's hemodynamics, assess lab test results, and review their health status history. The interviewees explained that most medications used in critical care units influence the patient's hemodynamics. However, the findings of this study are aligned with the result of Pinsky et al. (2022), who explained that the body system assessment helps in determining the fluid balance infusion to prevent complications, for example, the risk of pulmonary oedema, and the authors of the study explained that the cardiovascular assessment is a therapeutic challenge that could enhance the patient's safety (Pinsky et al., 2022). The current study emphasised that it is important for nurses to know how to assess the patient's lab results, which could help them evaluate the effectiveness of the administered medications. The lab test results could also indicate

the modification of the administered medication dose in collaboration with the physician. Otherwise, interviewees revealed that nurses monitor critically ill patients during and after administering medications, and a lack of patient monitoring is a barrier to administering medication safely. This result is consistent with a study that described critically ill patients receiving complex pharmacotherapy that impedes the patients' safety, specifically during the phase of administering intravenous medications (Escrivá Gracia et al., 2019; Fanikos et al., 2017; Polidori, 2012; Romero et al., 2013), and WHO asserted that patient monitoring is one of the factors that may influence medication safety (Jafaru & Abubakar, 2022). Other studies demonstrated the importance of monitoring the patient's hemodynamics continuously while administering vasoactive medications (Camerini et al., 2022; Kee et al., 2021) because the vasopressors are indicated to increase arterial blood pressure and to restore and maintain adequate tissue perfusion (Goulding & Bedard, 2015; Hunter et al., 2020). Most of the interviewees explained the importance of continuous hemodynamic monitoring, which indicates the progress of the patient's health status as well as the achievement of the intended effect of the prescribed medication.

- The last step that interviewees described was administering medications. Most of the interviewees highlighted the importance of the availability of central line access to administer high-alert medications for critically ill patients. This finding of this study, along with other studies, reported the importance of administering high-alert medications by using a central line. Conversely, some of the interviewees revealed that nurses should differentiate between medications that should be administered through the central line and those that could be administered by using peripheral venous access. However, this result is contradicted by the Doseburg et al. (2020) study, which emphasised the importance of inserting a central line for all critically ill patients in the critical care units to

ensure the safety of the administered medication as well the patient's safety. The study described that each of the high-alert medications should be administered in a separate lumen (Doesburg et al., 2020). Additionally, this study confirms with other studies that to ensure safety, nurses should assess the patency of the central line lumens or the intravenous access before starting medication administration, as well as ensure that medications are infused (Camerini et al., 2022; Doesburg et al., 2020).

However, the current study comprehensively explained the process of medication administration in the Palestinian adult critical care units and discussed the steps that nurses perform to enhance the safety of medication administration as well as the patient's safety.

5.6 Technology – *"Medical technology and medications' safety"*

This study describes the role of technology in enhancing the safety of medication administration in critical care units. Almost all the interviewees mentioned a variety of technological methods that they are using in the Palestinian critical care units to support medication administration. According to what the participants described, some of the technological methods are used to support prescribing medications, and other methods help in administering, calculating, and monitoring the process of administering medications. The findings of this current study, along with those of other studies, reported that the technological methods used in critical care units could improve the quality and safety of medicine (Colpaert et al., 2010; Jung et al., 2014). Also, the findings of this study are consistent with a study by Mattox (2012), which found that the use of technological devices could impede the safety of administering medications if nurses experience fatigue and stress in the critical care environment, which could influence their concentration and cause them to fail to operate the technological devices appropriately.

Although this study showed two contradictory roles of technological methods used in critical care units, which include enhancing and impeding safety, the findings of this current study added that the periodic maintenance of the technological devices used in critical care units will improve their efficiency, which will enhance their safety.

The first role of the technological methods described by most of the interviewees was prescribing medications, and they emphasised the importance of using a computerised system in connecting the critical care units with the pharmacy to request the prescribed medications, which were ordered through the computerised system. They also described that using the computerised system helps enhance medication safety by correcting the spelling of the entered medications as well as providing suggestions to choose the prescribed medication when two or more of the

medications share similar letters. The result of this study is contradicted by the studies that demonstrated the use of the computerised physician order entry (CPOE) system could impede safety at any of the three phases of medication entry, including prescribing, administering, and documenting, despite the healthcare providers' experience of using the computerised system. Also, authors in the same studies explained that information omission is a major cause of impeding medication safety, and this could cause potential harm to critically ill patients in critical care units (Cho et al., 2014; Romero et al., 2013; Shelton et al., 2019). In addition, the findings of this study are consistent with the findings of Gold et al. (2015) study, which explained if the prescribed medication was not interpreted correctly by the pharmacist because of information omission or using the medication brand name, which is not commonly used, it would result in dispensing another medication that was not prescribed by the physician, for example, administering an antibiotic instead of a vasopressor for a patient with hypotension that shares the same first letters.

Additionally, in this study, the interviewees explained that using a computerised system could prevent mistakes that arise from handwriting, as sometimes there is unclear information, omission of letters or information, and conflicting descriptions of medication that influence the safety of medication administered. This finding is consistent with studies that revealed that replacing handwriting by implementing an electronic medication administration record enhances safety (Cho et al., 2014; Shelton et al., 2019; Wulff et al., 2011), while another study contradicted this finding and described that if the prescribed order is not correct and complex, it will impede the safety of transcribing the order (Escrivá Gracia et al., 2019). The interviewees in this current study added that some medications look alike in writing, so the computerised system could solve this problem. Conversely, other interviewees reported that the computerised system could be unsafe; they explained that while typing the medication's name, another medication could be entered

instead that shares almost the same letters (look-alike or sound-alike). So, according to what the interviewees described, the use of electronic health records (EHR) could enhance safety if used properly, and if the nurse carefully monitors the entered medication, as well as if the HER is not used properly, this will impede the safety of medication administration in critical care units. Additionally, the findings of this current study are concurrent with a study that emphasised the importance of implementing computerised prescriber order entry to increase access to medication information, which enables the pharmacist to be involved in medication administration, monitor the phases of medication administration, and help educate healthcare providers about the safe use of medications (Jung et al., 2014). Also, a study by Polidori (2012) revealed that the use of a computerised technological system could identify drug-drug interactions by producing an alarm during the entry of the prescribed medications to enhance the safety of medication administration. This study added that Palestinian nurses should be trained on how to use the computerised system and how to get access to the medication information they need, which could influence their practice and enhance the safety of the medication.

Moreover, this current study, along with a study by Joseph et al. (2020), confirmed the importance of documenting through the health electronic record, including the signature, which provides evidence that the medication was administered. In addition, documentation through HER provides the number of changes in the infused medication doses; it was described that this enables the intensive care unit pharmacist to enhance the accuracy and safety of medication doses (Joseph et al., 2020). My study added that a computerised system enables nurses to be in direct contact with the pharmacists to gain the information they need as soon as possible, which also enables them to administer medication on time.

Another technological method that two of the interviewees described was the barcode. According to their description, a barcode could support prescribing and administering medications safely in critical care units. The interviewees explained that the use of barcodes enhances the safety of medication administration by verifying the prescribed medication dose to be administered to the right patients at the right time. They added that their knowledge is based on what they learned from literature, although they didn't use this technological method in the Palestinian hospitals. Previous evidence highlighted the importance of using the barcode technological method in enhancing the safety of administered medications. The authors of the studies explained that using barcode checks could help nurses and pharmacists check that the right medication is administered to the right patient at the right time (Kavanagh et al., 2017; Seibert et al., 2014). Additionally, much previous evidence supports the use of barcode checks in reducing medication adverse events by using bedside barcode scanning in critical care units, as all medication information is included within the barcode (Kee et al., 2021; Kingman & Chin, 2013; Poon et al., 2010; Raman et al., 2011; Seibert et al., 2014). Contradictory to the Palestinian interviewees' perception of the importance of using barcode checks to enhance safety, according to studies by Seibert et al. (2014) and Shelton et al. (2019), implementing the barcode medication administration system in the critical care units could help to enhance the safety of medications by "tech-check-tech," but could not be an alternative to the pharmacist's visual scanning to verify the prescribed doses and could impede safety if there is missed information. This current study didn't add additional information regarding the use of barcodes in critical care units, but it provides insight into the contribution of knowledge in the future, as explained in Section 6.2.1.

Interviewees in this current study highlighted that the use of infusion pumps is the most technologically advanced method used in critical care units to support medication administration and control fluid volume. Importantly, the findings of this study, along with those of other studies,

described that using smart pump systems in critical care units impacts the patient's safety and enhances safety associated with intravenous medications if implemented and used appropriately (Jung et al., 2014; Kavanagh et al., 2017). The interviewees described the benefits of using the infusion pumps to support administering medications; they described that the infusion pumps help by titrating the prescribed dose based on their calculation of the prescribed dose, while other interviewees described that the infusion pumps are programmed to support calculating the prescribed medication doses. They explained that the programmed infusion pumps are supported within the settings with an equation for some medications; this setting enables the nurse to select the medication and concentration that will be administered to the patient, and then the infusion pump will calculate the dose. The interviewees gave the inotropic medications as an example that are programmed within the infusion pump setting; the nurse just selects the medication name and dose, and the infusion pump will calculate the amount that will be infused into the patient. Additionally, the findings of this study added that the use of infusion pumps enables nurses to administer restricted fluid volumes for those patients who are at risk of fluid overload, for example, patients who have renal failure or cardiac failure, so medications will be diluted in a small fluid volume to maintain the patient's safety.

The findings of my study, along with those of other studies, showed the differences between using conventional infusion pumps and smart syringe pumps. Despite this, it was confirmed that both types are used to ensure the safety of the administered dose of medications used in critical care units. However, by using the smart infusion pump, the nurses could select the programmed medication and the standard concentration from the library setting, then enter the prescribed dose and the patient's weight, and the smart pump would calculate the dose. Conversely, the use of a conventional infusion pump is based on calculating and setting up the prescribed dose that will be administered by the nurse. The authors in these studies explained that there was minimal

effect on increasing safety by using smart syringe pumps, as only a few duplicates or overdoses were detected by using smart syringe pumps compared to conventional infusion pumps (Ibarra-Pérez et al., 2021; Kingman & Chin, 2013; Nuckols et al., 2008).

Moreover, the results of this study are consistent with the results of other studies that reported that the usability of the smart pumps is safer and easier than the conventional infusion pumps, as well as enhancing medication and patient safety (Camerini et al., 2022; Goulding & Bedard, 2015; Kavanagh et al., 2017; Mansfield & Jarrett, 2015; Skledar et al., 2013).

Thus, in previous evidence, Doesburg et al. (2017), Doesburg et al. (2020), Goulding and Bedard (2015), and Kavanagh et al. (2017) explained that there is an important benefit of using smart pump machines, which was not highlighted in the findings of this study as most interviewees reported that they use conventional infusion pumps. The authors of the studies explained that the use of smart pumps enables the administration of more than six medications at a time by using three lumens of the central line, and this is based on algorithmic calculation. These smart pumps are connected to a touchable screen by USB to select the prescribed dose and give the command to administer the selected medication. The authors also added that the medications included in the medication library should be compatible to prevent drug-drug interaction and that the nurses should be trained to use the system effectively (Doesburg et al., 2017; Doesburg et al., 2020; Goulding & Bedard, 2015; Kavanagh et al., 2017). Further information about the contribution to knowledge and recommendations is explained later in the following chapter.

Conversely, the interviewees in this current study described that infusion pumps are human-made, and the settings are programmed by humans, so there is an opportunity for error and to influence the safety of the administered medication dose. This result is consistent with a study showing that sometimes there are manufacturer errors in the device that could influence the safety of the

medication, and sometimes there is a running battery in the device with a silent alarm (Mattox, 2012), and there is a need for periodic programmed library revision (Ibarra-Pérez et al., 2021). The findings of this study revealed that the safety of medication could be impeded at the level of administering medication. These findings are contradicted by the Wulff et al. (2011) study findings, which revealed that smart infusion pumps could impede safety at the prescribing level of the CPOE, thus, other studies described that the integration between the computerised system and the software of the smart pumps could enhance safety (Manrique-Rodriguez et al., 2012; Mansfield & Jarrett, 2015).

Otherwise, the interviewees in this study reported that the safety of administering medication in the institutions that they are working in is related to an inadequate number of infusion pumps, especially when they want to administer the high-alert medication to the patient, and this will cause a delay in administering these types of medication, thus influencing the stability of the patient's health status. This finding is aligned with the result of a study that revealed nursing practice is influenced by the ICU environment and access to resources (Hunter et al., 2020).

My study adds that the availability of a variety of technological methods enhances the safety of medication administration and influences the safety of patients as they would receive their medication accurately and on time, which will influence the patient's health status positively.

This study identifies the weaknesses of the technological methods that support medication administration in critical care units. The technological methods mentioned by the interviewees are not safe enough to enhance the safety of medication administration, as not all hospitals adopted the computerised system, all hospitals had a deficiency in smart pump machine numbers, and none of the hospitals used a barcode either to scan the prescribed medication or the dose administered.

5.7 Policies – *"Policies impact safety".*

In this current study, some of the interviewees described policies and strategies that are used to enhance the safety of medication administration in Palestinian critical care units. Studies have described that having and adhering to professional protocols improves the nurse's practice and the safety of administering high-alert medications because these types of medications are the most commonly used in critical care units (Camerini et al., 2022; Camerini et al., 2014; Cuesta Lopez et al., 2016).

The interviewees explained that adopting a policy of medication administration training for newly graduated nurses is important to ensure that they will be competent to administer medications safely in critical care units and that they can administer medications independently. Importantly, all the interviewees emphasised the importance of having educational training courses focusing on medications given in critical care units as a policy, specifically for newly graduated nurses as well as for healthcare providers who are involved in medication administration to critically ill patients in critical care units.

The findings of this current study are consistent with the findings of many previous studies indicating that nurses should increase their pharmacological knowledge and abilities in critical care units (Di Muzio et al., 2017; Di Simone et al., 2018; Fathy et al., 2020; Muroi et al., 2017), and it was demonstrated that the increase in nurses' pharmacological knowledge could be achieved by implementing medication training courses as a strategy in hospitals for enhancing safety and decreasing the incidence of medication events (Browne et al., 2021; Camerini et al., 2022; Kim & Bates, 2013; Lu et al., 2013).

However, interviewees in this study highlighted the importance of implementing a continuous professional education programme as a policy that will empower nurses with the needed

knowledge and skills to enhance the safety of medications, as it is not possible for nurses to know everything about all medications as well as high-alert medications used in critical care units.

Additionally, the interviewees mentioned a variety of interruptions that could influence their practice while administering medications in the Palestinian critical care units. They described that having a strategy or policy to reduce the influence of interruptions could help enhance safety while preparing and administering medications. This finding is aligned with the findings of other studies that recommend using the "Do Not Interrupt" sign strategy, which helps in the reduction of medication-related events and enhances safety during the preparation of medications and administration. This strategy is based on designating a quiet zone with yellow tape or displaying a sign that says "Do Not Interrupt," or the nurse could wear a fluorescent sash while preparing and administering medications to reduce distraction and interruptions (Berdot et al., 2021; Huckels-Baumgart et al., 2017; Panduwal & Bilaut, 2019). Moreover, the interviewees explained that not all strategies could be implemented or adopted; they described that interruptions could be caused by the health status of the patient, such as developing deterioration in health status or cardiac arrest, which could interrupt the process of medication administration. As well, they also reported that sometimes there is no control over visiting hours, which is related to the Palestinian culture, and visitors could be present at the time of administering medication, which influences the time of administering the medications for their patient. The interviewees added that administering medications in the presence of family members could influence their concentration and focus on the process of medication administration. However, this study added that there should be more restrictions on visiting hours, as well as an increase in the number of nurse staff on duty to help with unexpected critical situations that could arise at any time.

Otherwise, some of the interviewees in this study described the importance of incident reports as a policy in the institution to enhance the safety of the medication administration process; they explained that incident reports are used to correct the nurse's performance rather than to punish. An incident report policy enhances safety by analysing the incident and modifying the practice. The result of this study is consistent with the Kane-Gill et al. (2017) study, which described that increasing reporting allows for comprehensive analysis of events and systematic changes to prevent future occurrences. However, another study revealed that consistent reports of medication events and solving problems related to medication safety are challenges to healthcare providers and the system (Jafaru & Abubakar, 2022). This current study adds that the incidence should be micro-analysed to find out the cause. Three of the interviewees explained this process of analysis as "*red cause analysis*." This will guide nurses to find the cause of the incidence, and then the stakeholders will work on modifying the policy to ensure that the process of medication administration is safe.

Additionally, the interviewees described that the incidence of medication-related events occurs at the level of administering medications rather than at other levels of the medication process. This finding is against the findings of other studies that described that most incidents of medication events occur at the level of transcription, followed by prescribing, and then administering (Yoon et al., 2022; Zirpe et al., 2020). However, unsafe medication administration could be a consequence of unsafe processes at the level of transcription or prescribing. So, the presence of clinical pharmacists as a policy could help in the continuous monitoring of the steps to enhance the safety of the medication process. The presence of pharmacists in critical care units is recommended by interviewees and is described in the following chapter.

Another policy that many of the interviewees described is the job description, which provides healthcare providers with instructions and guidelines. Some of the interviewees reported that the guidance and responsibilities for administering medications in critical care units are not clear in the job description protocol. They explained that in emergencies in critical care units, nurses used to administer medications, for example, adrenaline, without waiting for the physician's attendance, and they considered this implication to be against the standards that didn't allow nurses to administer medications without a prescription. This result is consistent with previous studies that explained how the absence of written guidelines impedes the safety of administering high-alert medications (Farag, 2017; Romero et al., 2013).

This study highlighted the importance of implementing medication administration training courses as a policy, specifically for nurses who want to work in critical care units as well as for newly graduated nurses. Otherwise, this study added that the responsibility of administering medication should be added to the job description to enhance the medication administration process and to clarify the responsibility of each healthcare provider regarding who should be involved in the process of medication administration.

5.8 Environment – *"Environment challenges influencing safety".*

The ICU is a complex, high-acuity environment requiring specialised care and complex decision-making (Alsohime et al., 2019; Kane-Gill et al., 2017; Perrin & MacLeod, 2018). This study describes a variety of environmental factors that could enhance and/or impede medication administration safety. In a 2010 study, the authors described the critical care units as an unsafe environment (Colpaert et al., 2010). Many of the interviewees revealed that interruption is one of the major environmental factors that influence safety. However, interruptions could be caused by the patient if there is a critical situation that forces the nurse to either administer the medications quickly or delay the prescribed medication. The result of this study is in line with previous evidence that demonstrated that the interruptions could be caused by life-threatening events, for example, developing cardiac arrest, which will influence the safety of the medication process (Benoit et al., 2012; Huckels-Baumgart et al., 2017; Panduwal & Bilaut, 2019; Rafferty & Franklin, 2017).

This study, along with other studies, demonstrated a variety of physical environmental factors that cause interruptions as well as distractions during preparing and administering medications in critical care units, including inadequate lighting, increased patient acuity, noise, temperature, doorbells, and phone calls (Kane-Gill et al., 2017; Mattox, 2012; Schutijser et al., 2019). Additionally, the findings of this study are aligned with those of another study by Schutijser et al. (2019) that revealed interruptions highly influence the preparation and administration of medications in critical care units compared to other wards, as the environment of the ICUs is continuously busy with preparing and administering medications.

My study finding is consistent with those of other studies that explained that interruptions during preparation and administering high-risk medications disrupt the nurses' concentration, and this

will impede the safety of medication as well as the safety of the patient (Browne et al., 2021; Farag, 2017; Kee et al., 2021; Kingman & Chin, 2013; Rafferty & Franklin, 2017). Conversely, one of the studies contradicted the findings of this study and explained that although the alarms have a negative outcome on the care provided, they could inform the nurse about the health of the patient, such as the alarms of infusion pumps that inform the nurse about the medication flow (Schutijser et al., 2019).

This study described that one of the causes of interruptions is the continuous presence of family members; most of the interviewees reported that in the context of Palestinian culture, family members insist on staying beside their patients, and sometimes they interfere with the process of medication administration. They added that the presence of family during preparation and administering medication will cause distraction and influence the nurse's concentration, which was discussed in the previous section. The interviewees added that during administering medication, family members ask about details of the process of administering medication, and this influences their concentration and could cause an unsafe medication process. The result in this current study is consistent with the results of studies that reported that interruptions caused by the family are related to their anxiety. Also, the family phone calls cause interruptions to the treatment plan, and the nurse will take a break while preparing and administering medication to answer the calls (Rafferty & Franklin, 2017; Schutijser et al., 2019).

Broadly, this study classified the interruptions into two groups: individual and technical. The interviewees explained that the individual interruptions are caused by their colleagues; additionally, they described that asking questions while preparing or administering medications or if the physicians make the medical round at the time of administering medications will disrupt the process of medication administration, which will also impede safety. However, they described the

technical interruptions as caused by machine alarms, doorbells, phone calls, or missing equipment or medications. This result is in line with the evidence that classified the interruptions into human and technical, with the human factor including healthcare professionals, family members, and patients, while the technical factor includes missing equipment and alarms (Bower et al., 2015; Schutijser et al., 2019; Suclupe et al., 2020). This study adds that this interruption could be managed by identifying the cause of the interruption and the sequence of this interruption for causing an unsafe medication administration process. Moreover, there was an argument about who should administer the medication. Many interviewees reported that one nurse should be assigned to administer the medication for all the patients in the critical care units, while others explained that sometimes there are a lot of medications for just one patient, which makes it difficult to administer medicines for all patients at the same time, and this will influence the safety of the medication process.

This study, along with other studies by Farag (2017) and Romero et al. (2013), found that the shortage of nurses increases the workload, which could impede the safety of administering HAMs. In this study, most of the interviewees explained the influence of the nurse-patient ratio and workload on the safety of medication administration. They described that most of the time, one nurse is responsible for two or three patients in the critical care units, regardless of the severity of the patient's illness, which could influence their performance in administering medication safely.

However, the findings of this study are consistent with the result of a study that showed that the highest percentage of nurses experienced anxiety and depression because of the workload and complexity of the patient's care, which impeded their safety (Mohammed, 2019). In this study, the interviewees explained that the increase in workload is related to the number of patients admitted to the critical care units, and they gave an example of the situation during the COVID-19

pandemic; they reported that there was a shortage of healthcare providers, which impeded patient safety. This result is aligned with a study showing that medication events are associated with medication events during the COVID-19 pandemic and that nurses' and patients' safety is related to the increased workload, shortage of healthcare providers, and increased patient numbers admitted to critical care units (Mahamid et al., 2022; Stayt et al., 2022).

Moreover, as described by the interviewees, the workload in critical care units is high compared to the number of nurses; they reported that there is a shortage of nurses, especially during the evening and night shifts, when there are mostly two nurses caring for four or five patients, and the worst thing is if a patient develops an emergency condition or if there is a new admission. They described that the workload negatively influences the process of administering medication. This result is consistent with what was described in previous studies: the complexity of the critical environment determines the ratio of nurse to patient, which influences the care provided and medication events, and the inadequate nursing staff hinders the safety of patients (Almenyan et al., 2021; McLeod et al., 2015). This study didn't add any additional techniques that could be used to manage the complexity of the critical care environment. Despite this, the interviewees reported that increasing the number of nurses could help solve the problem of the increase in workload, and they explained that the recruitment process is not their role and that the stakeholders should take responsibility for recruiting nurses to meet the work demand.

Importantly, interviewees talked about the environmental tidiness in critical care units to enhance medication administration safety; this finding is consistent with the result of a study by Escrivá Gracia et al. (2019), which showed the organisation of the intensive care unit influences the safety of the medication process. In this study, the interviewees described that the high-alert medications should be organised in a separate box and labelled with a high-alert label that informs

nurses about the special considerations during preparing and administering these types of medications. As well, nurses should prepare the medications at the patient's bedside. They added that preparing medications at the patient's bedside helps nurses organise the procedure of medication preparation. This result is contradicted by a study that reported that preparing medications at the patient's bedside could influence the nurse's concentration, fall outside pharmaceutical standards, and misinterpret the effective dose (Tan et al., 2017).

However, this study explored all the environmental factors influencing medication administration from the interviewees' point of view; otherwise, these factors were explored separately in previous studies. In this study, it is not clear the nurse-patient ratio in critical care units, but it is nuanced the importance of the nurse-patient ratio in managing the safety of the medication process. Additionally, all environmental factors that were described within this section should be managed to enhance the safety of medication administration in the critical care units.

5.9 Healthcare Providers – *"Collaboration enhances safety".*

The interviewees in this study mentioned a variety of roles that healthcare providers perform to ensure the safety of medication administration in Palestinian critical care units. They described that there is a collaboration between nurses, physicians, and pharmacists concerning the process of medication administration, although each one of them has his/her own role based on his/her specialisation.

Concerning prescribing medications as a role for the physician, the interviewees described that the prescribed order should be clear and consist of details including the name of the medication, dose, frequency, route, date of the order, and time, and should be signed clearly. Some of the interviewees reported that sometimes they received the order verbally or by phone, especially in critical situations or if the physician was busy in another ward. They added that the physician is responsible for documenting the order as soon as possible for legal issues, which is consistent with one of the studies that reported about two-thirds of unsafe medication administration related to verbal orders (Cho et al., 2014). They described that if the handwritten order is clear and all the order details are clear, this will enhance the safety of the medication administration as well as the patient's safety. Conversely, if there is a missing component or the handwriting is not clear, this will impede safety as nurses could interpret the physician's order incorrectly.

Some of the interviewees talked about the unsafe role of resident physicians as they periodically rotate between hospital wards as part of their residency programme. The interviewees described how the rotation programme impedes the safety of the prescribed medication; sometimes there is missing information in the physician order because of inadequate experience in critical care units. A study explained that the incident of unsafe medication administration related to insufficient physician knowledge of using the system for the medication protocols, and the junior physicians

were mostly responsible for the omission of prescribed medication information, which was corrected by the intensive care nurses (Cho et al., 2014).

Additionally, in this study, some of the interviewees described that pharmacists do not have a role in prescribing medications and that their role is confined to dispensing medications and providing the critical care units with the requested supplies. This finding is against the findings of a study by Goulding and Bedard (2015), who emphasised the importance of collaboration between critical care nurses and pharmacists to decide whether to increase the dose or change the percentage of vasopressors in the critical care area. Conversely, other interviewees explained the importance of the pharmacist's role in discussing the prescribed medications based on the patient's health status and results of laboratory tests; for example, prescribing antibiotics for critically ill patients was discussed with the pharmacists based on the results of specimen cultures. Additionally, pharmacists provided knowledge concerning the dose, dilution, amount of dilutant, titrating the medications, and storage of the medications; this result is in line with studies that described the importance of the clinical pharmacist in providing knowledge on preparing and administering techniques and on how to select the appropriate diluents (Nguyen et al., 2014; Zirpe et al., 2020). Some of the interviewees emphasised the importance of the pharmacist's presence in the morning physician round to discuss the prescribed medications, as pharmacists are the most knowledgeable healthcare providers who know about the dynamic and kinetic effects of medications, as well as reviewing the prescribed medications to prevent overdue administration of medications. This is consistent with studies that focused on the importance of the presence of pharmacists in the critical care units to improve the safety of medication administration, as they could be consulted immediately for high-risk intravenous medications (Kingman & Chin, 2013; Plutínská & Plevová, 2019). However, some of the participants reported that pharmacists are not available during the evening and night shifts, and they will not be able to get the information they

want, especially if a new medication was prescribed and they need instructions regarding diluting, dosing, and administering.

Most of the interviewees mentioned a variety of roles that nurses are accountable for to administer medication safely. They described that the main role of the critical care nurses is to administer the medications, which is consistent with much evidence that reports that registered nurses are the main administrators of prescribed medication (Esfahani et al., 2016; Jafaru & Abubakar, 2022; Martyn & Paliadelis, 2019). Despite this, other interviewees relied on the responsibility of administering medications to the in-charge nurses as well as to the most senior nurses in the critical units, specifically the inotropic medications. This result is in line with studies that describe the role of senior intensive care nurses in preparing, titrating, administering, and weaning the prescribed vasoactive medications for critically ill patients (El-Ata et al., 2019; Hunter et al., 2020; Kavanagh et al., 2017).

This study indicates a variety of administrative and managerial roles that the in-charge nurses or senior nurses are practicing concerning the safety of medications in critical care units. These roles include monitoring the newly graduated nurses, teaching, advocating for the patient's rights by administering the medications safely, delegating the task of administering medication to competent nurses, and being a consultant for any question related to pharmacological knowledge. This result is concurrent with previous studies that described how insufficient monitoring impedes the safety of medication administration in critical care units, as nurses are the most accountable for preventing medication events and enhancing the safety of medication as well as for the patient (Esfahani et al., 2016; Romero et al., 2013). Another study described the in-charge nurses' roles, including managing and improving the safety of high-alert medications within the critical care unit as well as managing factors that influence medication safety (El-Fattah et al., 2016). In addition,

nursing managers are responsible for managing the critical care environment to prevent distractions such as answering phone calls and responding to patients' requests (Kim et al., 2011).

Most of the interviewees determined the importance of collaboration between physicians, pharmacists, and nurses to achieve the safety of medication administration. As well, critical care nurses are accountable for leading the interdisciplinary team toward the goal of enhancing patient safety (Kavanagh et al., 2017; Roulston & Davies, 2021). They described how the triangle of the three healthcare providers needs to discuss the prescribed medications based on each provider's responsibilities. This study raised the high quality of nurses' performance described in Chapter 4. Conversely, it highlights the limited involvement of the pharmacist in transcribing, prescribing, and administering medications, and their role is restricted to prescribing medication and providing information related to medication when it is needed only.

5.10 Chapter Summary

This chapter discusses medication administration safety in Palestinian critical care hospitals from the perspective of critical care nurses. Although the interviewees had a positive view of medication administration safety in the critical care environment, they described the challenges that they face to enhance safety during their practice administering the medications used in critical care units. They related the safety of medication administration to a variety of factors, as well as how these factors could impede safety.

According to the interviewees, if the negative factors influencing medication safety were managed appropriately, their influence would be minimized, they would not cause harm to the patient, and medications would be administered safely. Conversely, if even one of the factors influences safety negatively, the impeded factors will weigh more, and safety will be impeded. So, enhancing and or impeding safety depends on how each factor influences safety and the severity of harm that could be caused by this factor. For example, if the nurse knew to practice the procedure of administering medication by using the appropriate technological method, following the institution's policy within a satisfactory environment, and collaborating with other healthcare providers, safety would be secured. Conversely, if one of these factors is not achieved, safety will be impeded.

Chapter 6 REFLECTIONS, IMPLICATIONS, AND FUTURE PLAN

6.1 Introduction

This research study has outlined a considerable grounded theory, generated from the interviewed data, that explains the nurses' perceptions of the factors influencing the safety of medication administration in critical care units. The grounded theory outlines six integrated factors influencing medication administration within the core category of the primacy of safety: knowledge and skills, process, technology, environment, the role of healthcare providers, and policies. The evidence from the searched literature demonstrated that previous studies didn't fully address the perception of adult critical care nurses towards factors influencing administering medication safely.

By highlighting the primacy of safety in the critical care environment, this study has implications for the future development of safety enhancement. By exploring insight into the nurses' perception of medication safety in critical care units, the study raises questions about the roles and responsibilities of healthcare providers and stakeholders in enhancing medication administration safety. Furthermore, the study highlights several areas where further research is required. As well, it offers a reflection on the research process, discusses limitations, and offers implications for further research and practice.

6.2 Contribution to Knowledge and Summary

6.2.1 Contribution of knowledge within chapter one

Chapter One outlines the background and significance of this study and describes the Palestinian health system. Also, the chapter includes the purpose, the problem statement, and the research question. Additionally, this chapter highlights the characteristics of the Palestinian healthcare system (WHO, 2019, 2022, 2023) and the levels of healthcare provided (MOH, 2022a; PHIC, 2019). Within this chapter, the contribution of knowledge indicates that there is a dearth of studies that focus on medication safety and an absence of studies that explore factors influencing the safety of medication administration in the Palestinian context (Al-Worafi, 2020). However, this chapter highlights the need to address the factors that could enhance medication safety in the Palestinian critical care units.

6.2.2 Contribution of knowledge within chapter two

In Chapter 2, a comprehensive review of the literature was undertaken to identify the factors influencing the safety of medication administration in critical care settings. A range of databases were used to retrieve all studies that were registered within the electronic search, which were discussed in the chapter.

The outcome themes were presented with a focus on understanding the factors influencing administering medications safely from the perspective of critical care nurses. The narrative analysis of the literature demonstrated a variety of factors that could enhance or impede safety in critical care environments. Existing studies have explored factors influencing the safety of administering medications given in critical care units, such as strategies and guidelines followed to enhance safety, the availability of educational programmes and technological methods to support

nurses' practice to ensure safety, and environmental factors within the critical care settings. However, these studies did not fully investigate critical care nurses' perspectives concerning the safety of administering medications in critical care units. The aim of this recent study and research question was derived from the reviewed studies, and gaps were identified in the existing studies. So, the grounded theory method was used to identify the gaps in the literature.

The contribution to knowledge within this chapter was by identifying that there were very few studies regarding medication safety that used qualitative methods, and these studies identified only some factors that could influence the safety of different groups of medications that are given in critical care environments (Gimenes et al., 2015; Gimenes et al., 2016; Häggström et al., 2017; Halbesleben et al., 2010; Johnson et al., 2017; Mansour, 2011; Sessions et al., 2019; Stamp, 2010). So, this current research will address this gap. Furthermore, these existing studies did not analyse all the factors; some explained one or two factors influencing the safety of medication administration. None of the literature provided a full explanation of how all these factors were integrated to enhance and how they could impede safety from the critical care nurses' perspective. In the narrative analysis of literature in this chapter, four main themes emerged, which concluded the factors that could influence the safety of medication administration in critical care units. The themes include the strategies and guidelines for medication administration safely, approaches to educational programmes for safe medication administration, environmental elements of the critical care units influencing safe medication administration, and technological methods used to influence medication administration safely. These themes were discussed thoroughly earlier in Section 2.7. However, none of the research explored the factors influencing medications by using grounded theory as a research method.

6.2.3 Contribution of knowledge within chapter three

Chapter three described the philosophical assumptions underlying the constructivist grounded theory adaptation in this study and outlined the methodology, design, and method. Justification for using the adapted form of grounded theory was employed.

Furthermore, using face-to-face, semi-structured interviews as the main method of data collection was consistent with the study's philosophical assumptions to explore both nurses' views and perceptions about administering medication safely in critical care units. Moreover, reflections on the analysis process using the constant comparative method were outlined. Other methodological considerations, such as interviews being recorded, transcribed, and translated, were addressed. Additionally, the ethical considerations and the measurements used to enhance the quality and trustworthiness of the study were described in Section 3.12.

Within this chapter, the contribution to knowledge was methodological by adding constructive grounded theory to explore the factors influencing the safety of medication administration in Palestinian critical care units. Based on exploring the literature that was analysed in Chapter 2, the results show that there is an absence of qualitative studies that explore these factors and their influence on the safety of medication as well as the safety of patients. The results also showed that there were no studies that used the constructive grounded theory, either in the Middle East or in Palestine, that explored factors influencing safety and how to control these factors to enhance the safety of medication administration in critical care units.

6.2.4 Contribution of knowledge within chapter four

The data that emerged from the interviews revealed factors that could enhance or impede the safety of medication administration in Palestinian critical care units. The grounded theory conceptualised six themes discussed in Chapter 4, which include knowledge and skills, processes,

technology, policies, the environment, and healthcare providers in the context of safety. The contribution to knowledge within Chapter 4 is that nurses are aware of the factors that could impede safety, but despite this, they are experiencing a variety of challenges in administering medications safely within the Palestinian critical care environment. Chapter 4 discussed the grounded factors that influence medication administration as well as the interventions that the nurses carry out to manage these factors in the Palestinian critical care environment. The findings raised doubt about how nurses could behave to enhance safety in the presence of the factors that impede safety, in addition to the managerial responsibilities that help them to enhance safety and manage the critical care environment to ensure the patients' safety in collaboration with healthcare providers. However, the findings highlighted the challenges within the critical care environment and how these challenges could encourage nurses to use all available resources to enhance safety, including being knowledgeable and experts in following the appropriate process to administer medications and using technological methods and policies that support the safety of medication administration in collaboration with healthcare providers. Despite this, nurses still have inadequate knowledge and insufficient resources to support the process of administering medications safely in adult critical care settings.

6.2.5 Contribution of knowledge within chapter five

In Chapter Five, key findings and their elements were discussed and compared to those in the existing literature. It provided an understanding of how factors could enhance or impede the safety of administering medications in critical care units. It is clear from the findings that these factors could be managed by modifying the nurses' behaviour to achieve safety.

The contribution to knowledge within this chapter was that, although a few studies have been conducted in the critical care area about the medication administration process, these studies did

not address the views and perceptions of nurses who are working in adult critical care about safely administering medications, nor did they provide a full explanation of how they manage the factors contributing to the process of medication administration to enhance safety. Furthermore, studies that were conducted in the Palestinian context did not use a grounded theory approach based on nurses' knowledge concerning administering high-alert medications in critical care units and patients' safety within the hospital culture. However, using grounded theory has the benefit of allowing the nurse's voice to be heard.

Based on the narrative analysis in Chapter 2, four themes emerged, as described in Chapter 2, while in the grounded theory of this study, two additional factors emerged in the context of safety, which were knowledge and skills and the process of medication administration. The details of the developed grounded theory conceptualised framework are discussed in Chapter 4.

The key contribution of this study is to highlight that medication administration in critical care units is not going to be enhanced until all the emerging factors are integrated to ensure safety. As well, the enhancement of integrated factors is based on managing the critical care environment and modifying healthcare providers' behaviour.

The integration of factors existing in this research study in the context of the primacy of safety is a new approach for Palestinian critical care nurses who are working in critical care settings that enhances the safety of patients. Palestinian critical care nurses are aware of the variety of factors that influence the safety of medication administration, but this study is the first to comprehend all the emerging factors. My research study has examined and analysed Palestinian critical care nurses' perspectives on administering medications safely in critical care units.

Therefore, this study is useful to provide insight into the factors enhancing medication administration in adult critical care units. additionally, it provides insight into the perspective of

Palestinian nurses concerning administering medication safely. However, this is the first research study to explore the factors influencing the safety of administering medications in Palestinian adult critical care units. also, it is the first that focuses on the nurses' perspective on administering medications given in adult critical care units and how they use their knowledge and experience to enhance safety.

6.2.6 Contribution to knowledge within chapter six

However, Chapter Six provides a summary and contribution to the knowledge of the thesis chapters, which is discussed in Section 6.2. It also provides insights on plans to be undertaken in the future, limitations that arose while conducting this study, recommendations, and the main implications of this study, which are discussed in the following sections.

6.3 Plans for Future Research

The grounded theory outlined within this thesis has several implications for further research and the implementation of safety. For the researchers, grounded theory helps to refresh thinking and to be reconsidered to reaffirm the theoretical tasks (Charmaz, 2006). This leads to getting back for a further look and deeper reflection, which could encourage me to expand the research on my theory in the future. The following are several recommended plans for future research that could help with exploring the adult critical care environment in depth and from different dimensions.

- The study provides suggestions for best practices and recommendations focusing on the safety of medication administration in a critical care environment. In addition, future research will explore the adult critical care environment in depth and from different dimensions.
- Previous literature was examined to find the factors that could influence the safety of administering medications in critical care units. Most of these studies focused on one or

more factors that influence medication administration in critical care environments. An ethnographic research method could be added to a future study; however, this research method could be open to the settings, actions, and people. Also, the ethnographic method enables researchers to work from the ground up, as in constructive grounded theory, and to pursue findings that are of great interest (Charmaz, 2006). So, a combination of the two methods (constructive grounded theory and ethnography) could be useful to gain a better understanding of the nurses' actions in adopting strategies to administer medication and how they could control the critical environment to enhance the safety of medications used in critical care units.

- Moreover, interventional studies may be useful to investigate the influence of changing the nurses' behaviour during interruptions to enhance safe practice when preparing and administering medications. The evidence describes that selecting the method to control interruptions is based on the type of interruption, as well as the evidence showing that the use of the vest and sign "Do Not Disturb" is not effective when the cause of interruptions is the alarms (Rafferty & Franklin, 2017). However, further studies are needed to address the method that could positively impact interruptions (Drews et al., 2019).
- Previous literature recommended medication training courses (Irajpour et al., 2019; Preston et al., 2019), a qualitative study could be useful to examine the effectiveness of medication training courses, specifically medications used in critical care units. This could be done by assessing the nurses' knowledge before and after conducting a medication training programme.
- One of the steps of the medication process is to assess the patient before and after administering medication. It is recommended to conduct a study that could determine the

effectiveness of patient assessment from the nurses' point of view on achieving the safety of administering high-alert medications by using qualitative methods.

- In this study, most of the interviewees focused on the role of the pharmacist in providing the pharmacological knowledge that nurses need to administer medication safely, and they reported that the role of pharmacists in critical care units is limited. So, it will be recommended to investigate the importance of pharmacist presence in critical care units from the perspective of nurses as well as pharmacists.
- Additionally, in this study, the interviewees highlighted the absence of medication administration responsibility within the job description. In addition, previous literature didn't explore the influence of healthcare providers' job descriptions on the safety of medications given in critical care units; so, it is recommended to explore the impact of the job description regarding the responsibilities of administering the medication on enhancing safety and minimising medication-related events.

6.4 Limitations of the Study

The study provides a valuable contribution to existing knowledge related to the safety of medication administration in critical care units. Despite semi-structured interviews that provide an enriching description of the actual nurses' practice in critical care units to achieve the safety of medication administration, there are specific areas that need to be explored in different research aims, questions, and findings.

The use of grounded theory has inherent limitations. The development of the theory depends on interview data from a relatively small, defined group (Chapter 3, p.109). So, the finding is too questionable to be generalized (Falk & Guenther, 2021). In this study, previous chapters outlined the steps that were taken to enhance the feasibility and generalization of the resulting theory.

These include a transparent approach to the theoretical sample, the inclusion of the earliest interview data to support the findings, and the evolution of grounded theory (Chapter 4). Nonetheless, once the grounded theory developed from the first interviews' data, the analysed data guided many prompted questions related to safety to ensure that deeper understanding and responses were secured. However, patient harm is associated with unsafe medication administration by healthcare providers (Afaya et al., 2021). As a result, the grounded theory will be utilized as the starting point for a series of research projects to explore the different areas of safety raised in this study.

Another limitation in this study related to the theoretical sampling was the involvement of male nurses rather than females in the study; only four female nurses (Chapter 3) participated in the study because of their limited number in the critical care units and the rejection of some of them to take part in the study because of their commitment to personal issues outside their working hours. Although all the interviewees were willing to talk and share their experiences on how their practice enhances the safety of medication administration, the study cannot compare the perceptions of female nurses and male nurses. Therefore, future studies could be conducted to explore the perceptions of female nurses and compare them with those of male nurses to investigate in depth the different methods that both use to enhance safety in critical care environments.

The critical limitation that the researcher had while collecting the interview data was traveling between the Palestinian cities, as the data was collected from three main cities in Palestine: Nablus, Jenin, and Tulkarim. As Palestine is an occupied country, most of the time there are struggles and many checkpoints between cities, which made it a challenge for the researcher to conduct the interviews regularly. For safety reasons, the researcher had to conduct two or three

interviews on the same day when traveling to another city to collect interview data. Otherwise, the interviewees from Tulkarim and Jenin were not willing to interview via Zoom or other audiovisual platforms for confidentiality.

The native language in Palestine is Arabic, which was another limitation for the researcher; a limited number of the interviewees talked in full English while others mixed between Arabic and English. So, the researcher transcribed and translated from Arabic to English, as well as performed translation back to Arabic, to ensure that the content of the interviews' data reflected the Arabic language used (Chapter 3; p108). However, this influenced the increase in study workload and time expended on transcribing and translating.

Although the use of NVivo software is valuable for organising the interview data, I preferred to organise and analyse the data manually because the software doesn't support the Arabic language and it is difficult to import the Arabic data. It will also take additional time to import the translated data. As well, manual organising and coding provide me with the skills and experience to understand the process. More details about the method of organising, analysing, and coding data are described in Chapter 3.

6.5 Recommendations

This study focused on factors influencing medication administration in critical care units from the perspective of critical care nurses only. Nurses are accountable for administering medications, and they are also advocates for patient safety. As well as the healthcare system is also responsible for providing the appropriate environment to practice healthcare and medication administration safely. This study provides a variety of recommendations for best practices focusing on the safety of medication administration in adult critical care environments.

6.5.1 Recommendations for nurses' practice

There are various implications for this study. The findings highlighted several practical considerations concerning the planning, development, and implementation of safety measures to administer medication in critical care environments. The primacy of safety associated with factors influencing medication administration was fully explored from the perspective of nurses working in Palestinian critical care environments. This is not the first entire study to understand the influence of safety on emerging factors; there was a study that focused only on a few factors and provided a limited understanding of these factors (Harkanen et al., 2015).

- Adopting the primacy of safety in critical care units highlights the nurses' roles in enhancing medication administration safely in critical care units, as well as enhancing the safety of the patient and preventing harm. Medication administration safety and the nurses' role were not fully explored in maintaining medication safety (Rohde & Domm, 2018). It is recommended to work on improving various technical practices, such as medication rights and double-checking, in addition to the three phases that support the medication safety process: prescribing, dispensing, and administering, to improve the quality of the healthcare system (Alves et al., 2017).

- The grounded theory suggested implementing medication administration training courses with specific concerns about the medications used in critical care units, for example, high-alert medications. Implementing medication training courses as part of the health system's strategies and policies improves the quality of care as well as nurses' pharmacological knowledge and skills, reducing the incidence of medication-related events. Additionally, nurses will be able to assess patients effectively and manage unexpected events appropriately. For example, if the patient is receiving medications that support the cardiac system and increase blood pressure and the patient develops hypotension, the nurse will be aware that she or he should either manage the dose or pause administering the medication until a further assessment is performed to ensure the patient's safety. Adopting these courses regularly will update the nurses' knowledge and skills and increase their confidence to practice medication administration safely.
- The interviewees in the study described the importance of the integrated role between nurses, physicians, and pharmacists to enhance the safety of medication by practicing various roles: teaching, monitoring, evaluating, and administrative roles. The impact of an effective interprofessional communication system influences the effectiveness of teaching, monitoring, and decision-making related to the prescribed medication. Sharing decision-making based on a patient's physical assessment and reviewing laboratory data results helps in prescribing the appropriate medication, dose, constitution, and administration to enhance safety and optimize the healthcare system. Thus, the importance of interprofessional communication skills was highlighted; effective communication encourages teamwork and collaboration (in this study, interprofessional communication among nurses, physicians, and pharmacists), and the use of communication techniques

enables the expression of ideas and discussing issues related to prescribed medications (Skarbalienė et al., 2019).

- The discussion of the critical care environment identified various factors influencing safety; interruptions were the most important environmental challenge that nurses face. Although the interviewees described that there are no rules or regulations to control the interruptions during administering medications, they urged having a policy or strategy that could control the interruptions to enhance safety during preparing and administering medications. From the nurses' perspective, there are different types of interruptions, and the most common one is the alarm, which is the most common method that could be used to control and reduce interruptions. The evidence describes that selecting the method to control interruptions is based on the type of interruption.
- Additionally, newly graduated nurses should be competent in administering medications and be tested for their competencies in preparing, calculating, and administering medication. Educational programmes focusing on knowledge regarding high-risk medications are needed to enhance the safety of medication administration and bridge the gap between theory and clinical practice (Cho et al., 2014; Esfahani et al., 2016; Farag, 2017; Irajpour et al., 2019; Zyoud et al., 2019). Moreover, it is recommended to practice the training courses on administering medication in a simulation laboratory and during the preceptorship, as a simulation lab will provide a similar environment to that in hospitals. It is argued that training in the simulation before starting the job in the real environment will help to ensure that the nurse is competent in preparing and administering all types of medications used in critical care units, as well as enhancing the patient's safety and preventing harm.

- The findings of this study suggest adopting advanced technological methods to support medication at the different phases: prescribing, dispensing, calculating, and administering. The interviewees' perspective towards technological methods is that these methods are useful methods to save time and effort in dispensing, calculating, and administering medication, as well as effective methods to enhance the safety of medication administration. They suggested having a connected network between the critical care units and the pharmacists and having regular maintenance of the technological devices and the network to ensure that they are functioning well with no errors. Though recent studies are focusing not only on connecting critical care computerized systems with pharmacies or having smart infusion pumps, but they are also working on connecting the computerized system with smart pumps directly, as the physician order will be going directly to the smart pump and setting the dose and rate of the prescribed medication based on the programmed equation. Planning and implementing advanced technology will enable healthcare providers to be updated about patients' health status as well as enhance safety in a critical care environment (Doesburg et al., 2017; Doesburg et al., 2020). There were no previous studies in Palestine that explored the nurses' knowledge and behaviour toward using these technological methods to enhance the safety of administering medications in critical care units.
- Regarding the use of smart pump machines, it is recommended to use standardized IV dosing units as well as standardized concentrations, which can provide safety when administering medications such as inotropic, nitroglycerin, midazolam, and phenylephrine (Jung et al., 2014; Ruhl, 2013).

6.5.2 Recommendations for the healthcare system

The results of this study highlighted a variety of recommendations that the healthcare system could adopt to ensure the primacy of safety while administering medications in critical care units.

- The findings suggested that the presence of pharmacists in critical care units is important to enhance safety; their presence provides nurses with the pharmacological knowledge related to the intended effect, side effects, constitution, diluent, and administering medication that nurses need when preparing and administering medications. The interviewees argued that the presence of pharmacists over twenty-four hours will be helpful, as they sometimes need to know about prescribed medications during the evening or night shift. The barrier to this is the possibility of developing a policy to have pharmacists either in the hospital or in the critical care units for twenty-four hours. Previous evidence supported the need for clinical pharmacists in the care units; clinical pharmacists demonstrated an essential role in improving medicine safety both at an individual and a broader critical care organizational level (Qato et al., 2021; Rudall et al., 2017). The absence of a medication safety system is a major challenge contributing to medication safety in Palestine, as is the absence of educational medication safety courses in all healthcare settings (Al-Worafi, 2020).
- The grounded theory identified a range of compensatory pharmacological resources that nurses could rely on during the absence of the pharmacist. Developing protocols and guidelines related to medications used in critical care units with the pharmacists' collaboration helps nurses administer medications safely by following approved protocols in the institution.

- Many of the interviewees were unsatisfied with the knowledge they took during their initial studies at the university. They described that the skills and knowledge they had were basic, and they were not allowed to administer medication during their training in the hospitals. So, it is recommended to update the nursing school curriculum to focus on the knowledge and skills needed to be competent at administering medication safely. Otherwise, studies emphasized the importance of simulation practice to improve the students' skills to prepare and administer medication, specifically their medication dose calculation skills.

The findings of this thesis have been discussed in the context of previous literature concerning the safety of medication in critical care units. In conclusion, it is recommended for further research is required to validate the reconceptualization of the primacy of safety and provide details on the interrelationship of the identified subcategories.

6.6 Dissemination of Findings

This study examined and analysed the Palestinian critical care nurse's perspective on the factors that could influence administering medication safely within a critical environment. Few studies in Palestine examined the errors that contribute to medication-related events, and no evidence examined the factors influencing medication safety in Palestinian critical care units.

At the level of the stakeholders, the findings could contribute to setting policies and guidelines that could be implemented to modify the factors that impede safety. And at the level of the nurses, this study could contribute to changing the nurse's behaviour toward optimizing the quality of care in administering medications.

Sharing the findings of the research with colleagues and peers allows critique and the sharing of a vision for future research. Before the completion of the research in June 2021, the literature review was presented in a seminar at the Doctoral College/ University of Hull with positive professional feedback. In May 2023, the findings of the research were shared with colleagues and professionals within the series of workshops of the ICAHR. The feedback was positive, but there was concern about the methodological method.

The dissemination plan for this project is to develop a written paper and present it at appropriate conferences. The literature review described in Chapter 2 will be expanded, reviewed with current evidence, and submitted to a journal with an impact factor. Another piece of the work concerns the findings of the study planned to be submitted. Additionally, plan to share at conferences focusing on the findings and the study's implications.

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Appendix 1: CASP Systematic Review Checklist

Systematic Review Checklist **Author/ date**	1 Did the review address a clearly focused question?	2 Did the authors look for the right type of papers?	3 Do you think all the important, relevant studies were included?	4 Did the review's authors do enough to assess the quality of included studies?	5 If the results of the review have been combined, was it reasonable to do so?	6 Are the overall results of the reviews clear?	7 How precise are the results?	8 Can the results be applied to the local population? ?	9 Were all important outcomes considered? ?	10 Are the benefits worth the harms and costs?
Kane-Gill S., et al (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Precise	Yes	Yes	Can't tell
Camerini F. (2014)	Yes	Yes	No	Yes	Yes	Yes	Precise	Yes	Yes	Can't tell
Mansour M., et al (2012)	Yes	Yes	Yes	Can't tell	Yes	Yes	Precise	Yes	Yes	Can't tell

The table shows the critical appraisal of the systematic review studies that were used in this study, the results were satisfied for being included.

CASP qualitative study checklist

Qualitative Study Checklist **Author/date**	1 Was there a clear statement of the aims of the research?	2 Is a qualitative methodology appropriate?	3 Was the research design appropriate to address the aims of the research?	4 Was the recruitment strategy appropriate to the aims of the research?	5 Was the data collected in a way that addressed the research issue?	6 Has the relationship between researcher and participant s been adequately considered?	7 Have ethical issues been taken into consideration?	8 Was the data analysis sufficiently rigorous?	9 Is there a clear statement of finding?	10 Is the research valuable?
Johnson M., et al. (2017)	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes
Gimenes FRE, et al (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gimenes FRE, et al (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mansour M. (2011)	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Can't tell
Halbesleben J. (2010)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Häggström M, et al (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Session L., et al. (2019)	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes
Stamp K., Willis D., (2010)	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes

The table shows the score of the critical appraisal of the qualitative studies that were used in this study, the results were satisfied for being included.

CASP cross-sectional study checklist

Cross Sectional Study Checklist **Author/ date**	1 Did the study address a clearly focused issue?	2 Did the authors use an appropriate method to answer their question ?	3 Were the subjects recruited in an acceptable way?	4 Were the measures accurately measured to reduce bias?	5 Were the data collected in a way that addressed the research issue?	6 Did the study have enough participants to minimize the play of chance?	7 Are the results presented clearly?	8 Was the data analysis sufficiently rigorous? ?	9 Is there a clear statement of findings? ?	10 Can the results be applied to the local population?	11 Is the research valuable ?
Llapa-Rodriguez EO et al (2017)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Jie Xu J., et.al (2017)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Johansen ET, et al (2016)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Carayon P., et al (2016)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Carayon P., et al (2014)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Nguyen HT., et al (2014)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Valuable
Cavalaro J., et al., (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Maydana T., et al (2017)	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Yes	Yes	Can't tell	Valuable
Muroi M., et al. (2017)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Can't tell	Valuable

The table shows the score of the critical appraisal of the cross-sectional/observational studies that were used in this study, the results were satisfied for being included.

CASP quasi-experimental study checklist

Quasi Experimental Study Checklist **Author/ date**	1 Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	2 Were the participants included in any comparisons similar?	3 Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	4 Was there a control group?	5 Were there multiple measurements of the outcome both pre and post-intervention/exposure?	6 Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analysed?	7 Were the outcomes of participants included in any comparisons measured in the same way?	8 Were outcomes measured in a reliable way?	9 Was appropriate statistical analysis used?	10 Overall appraisal. Included Excluded Seek further information
Irajpour A., Farzi S., Saghaei M., Ravaghi H. (2019)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Included
Esfahani AK, Varzaneh FR, Changiz T. (2016)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Included
Poon E.G., et al., (2010)	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Included

The table shows the score of the critical appraisal of the quasi-experiment studies that were used in this study, the results were satisfied for being included.

Appendix 2: Memo and Field Note Sample

Memoing and Field Notes (AP01)

17th of October 2021 at 12:10

Private Hospital (Hospital A)

Participant 1: In-charge nurse male 40-44 years old with more than 10 years of experience in a private hospital. Had a master's degree.

The intensive care unit is in a separate area of the hospital which is composed of two parts, including patients who need mechanical ventilation and close observation, and part for isolated patients.

The isolation section is divided by a visible class door. There were four beds in the isolation and eight beds in the general intensive care part.

There are fourteen beds that were separated by using a curtain between every two beds. Each bed had a mechanical ventilator beside it and a monitor hanging above the bed. The number of infusion pumps used for the patient depends on the number of medications that were administered to the patient. So, it varies between one patient and another.

The door of the ICU has an inter-come, visitors can't get in the unit without permission or be opened by one of the staff members on duty.

There are codes for nurses used to enable them to get into the critical care units.

The two parts are equipped with mechanical ventilation machines, infusion pumps, and monitors that are connected to the central monitor in the nursing station.

The area of preparing medications is in the middle of the unit as well the nursing station. There is a separate area for storing the different supplies and the different types of equipment.

Note: During the interview, we heard shouting and loud voices outside the room where we had the meeting, and when we explored the cause, we were informed that members of a patient family were shouting that they wanted to get into the ICU and stay beside their patient. Then they blamed the medical staff that they do nothing for their patient although their patient was on mechanical ventilation. When asked about the patient's health status, he was admitted unconscious with an intracranial hemorrhage and his Glasco-coma scale was very bad.

The interview started by introducing myself, as well as an introduction about the study, and the aim of the study. The participant gave permission to take part in the study.

Memos	Reflexivity	Analysis
The participant described the **procedure** of administering medications as the **role of the in-charge nurse**. Administering medication is the **responsibility of the nurse** who is assigned to the patient. The **responsibility** starts from the constitution to the step of administering medications.	The participant described that the procedure of administering medications is the in-charge nurse's responsibility, and then the participant mentioned that the responsibility is to the nurse who is assigned to the patient. As there is doubt about who is responsible for the procedure, the interviewer will ask for clarification about the nurse's role in administering medication. The participant explained that there is no clear policy about who is responsible for the medication procedure.	The procedure of administering medications. Role of the in-charge nurse. Role of the nurse.
To administer medications safely, nurses need to have **skills, knowledge**, and experience. The medications that are used in critical care units are **a red line**, which means that the nurses need to be skillful and have knowledge. The participant was asked what he meant by the red line or medication as a critical issue. It was described that the medications are critical and **super interventional** because they are invading the patient's body. So, this could cause harm to the patient. **The experience** of nurses could influence the safety of medication administration.	The participant was asked about the skills, but he said you mean to ask about skills and knowledge. That could mean there is a combination between knowledge and skills, this could be explained as, the nurse who had skills should have knowledge and vis versa. The participant described the medications by different concepts to emphasize the importance of medications used in critical care units. It is important to assess the patient to administer medication safely. Even the nurses could have experience, but there is a need always to update knowledge regarding medications used in critical care	Knowledge and skills are a priority to administer medication safely. The experience of nurses could help in the safety of administering medication.

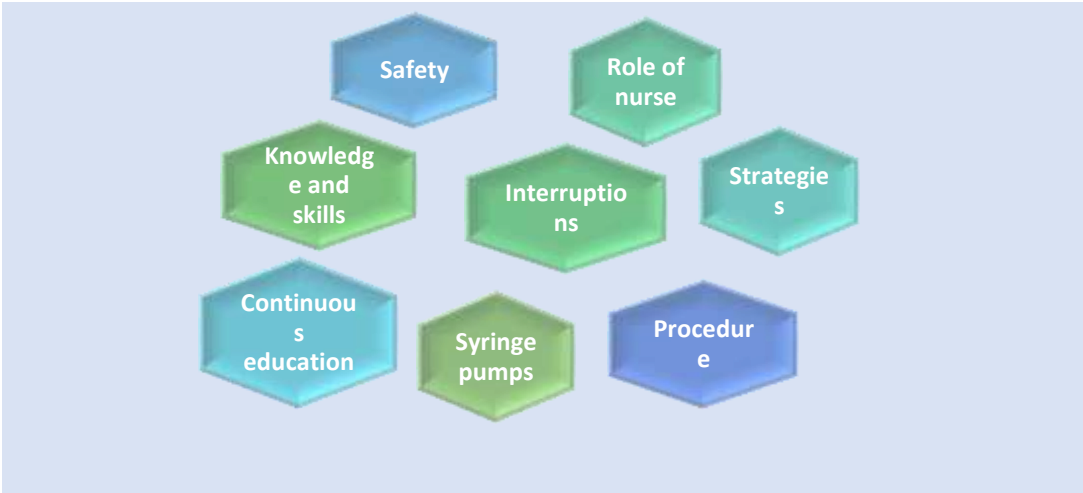
	units as there is always new knowledge or methods to administering medications. The participant saw himself as a hero in administering medications in critical care units, but I think even an in-charge nurse needs always to update his/her knowledge as he/she is a role model and reference for the staff.	
Regarding how the nurses **organize** the procedure, it starts by scheduling the time that medications will be administered to the patient. The participant described the **steps** that the nurses follow to organize and administer the medications. The participant explained that as an in-charge nurse, he **monitors** the procedure of administering medications.	The nurses need to know the medications that they will administer to enable them to organize the steps of preparing and administering the medications. Sometimes, there are some medications not available, and the patient's family should buy the medications from outside the hospital.	Steps that the nurses follow to administer medication safely. Availability of the medications. The role of the in-charge nurse includes monitoring the procedure of administering medications.
The participant didn't attend medication **training courses**, the participant put his hand on hand showing that didn't attend medication administration. The participant nodded his head and agreed on the **importance** of having medication training courses.	It was noticed that there is no continuous educational department in the hospital. Training is based on what the in-charge nurse explained to the newly graduated nurses, and even if the nurses need information, they rely on the in-charge nurse. The researcher will ask about this in the next interviews to explore which hospital had medication training courses and how these courses could influence safety.	Training courses could improve the practice of nurses in administering medications safely. Having a continuous education committee could be useful to enhance the knowledge and skills of the nurses regarding medication administration safety.
The nurses need to **concentrate** when starting to prepare and administer medications as medications are a critical issue in the critical care units.	It was doubtful how many medications nurses had to check. It was mentioned that we have five or six, so the participant can't confirm how many rights we have.	Medication rights.

The participant added that nurses should consider the five or six rights when administering medications.		
Safety means not harming the patient, having no problems, and having no troubles. **Safety means** following the **steps** to administer medications. To ensure safety, the participant described the importance of assigning **qualified nurses** to the most critical patients.	The definition of safety is based on doing no harm to the patient. The nurses who work in critical care units need to be qualified, so, it is expected to assign the nurse to the patient without choosing from the staff on duty, If the in-charge nurse relies on only the most qualified nurses, this will make the load on a specific number of nurses.	Definition of safety. Workload. Nurse-patient ratio.
When it comes to **the interpretation of** the physician's order, the participant described that all components of the order should be clear and simple which enables the nurse to read and interpret. One of the **nurses' roles is** to transfer the medications to the drug sheet. The participant mentioned the **steps** that are followed to interpret the physician's order.	The physician's order needs to be interpreted accurately to ensure the safety of the medications. That means checking the physician's order and checking the details of the order. The participant mutes two times while explaining the interpretation of the physician's order.	Procedure: Interpret the order clearly to enhance the safety of medication administration. Role of the nurse.
The participant was thinking about the factors, so, he muted for a couple of minutes before starting to talk. Then started to describe a variety of **factors** that could influence safety, these factors include: Interruptions could be caused by the patient's health status if the patient is in a critical situation or if the patient is about to die and needs CPR. Sometimes, the **interruptions** are caused by the family who could be troublemakers and want to stay beside their patient or want to get in the critical care unit at the time of administering medications. The participant explained that this would impede the concentration of the nurse and	At the time that the researcher started the interview with the participant, a loud voice came from outside the in-charge nurse which is part of the intensive care unit. When asked about the cause, it was from patients' relatives who wanted to get into the critical care unit and wanted to stay beside the patient. The nurses on duty and the in-charge physician tried to calm them down and tried to explain to them, but they insisted on getting in and one of the relatives tried to push the nurse. All the	There are factors related to the patient's health status, and critical situations that could be developed (**environmental factors).** Factors related to the family. Managing problems could be done by delegation. Control the interruptions could enhance the safety.

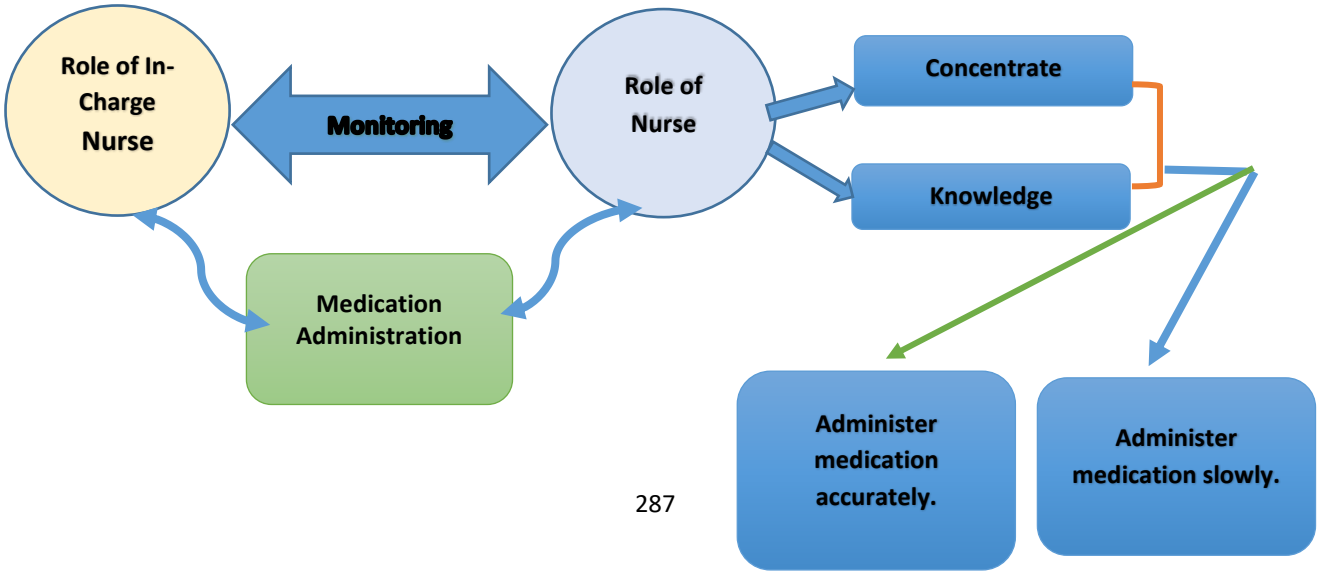
could influence safety by influencing the nurse to administer the medications rapidly. Participant added, that **controlling** the interruptions could help in enhancing safety. The participant added that the nurse is a human and could cause a problem during administering medications, and to manage the problems the nurse could **stop the procedure** or postpone it until ensuring a safe environment.	people who were there tried to control the situation and hardly the upset of the family was controlled. The in-charge nurse explained to me that this was not the first time that they had had this trouble and it happened constantly with the time of administering medication as our meeting start at 12:10 and this is the around hour of administering medication. So, some medications were delayed being administration. Stopping the procedure or postponing the medication administration could influence the safety of the patient, especially if the health status of the patient is influenced by the administered medications. As well, administering medications rapidly by the nurse could impede the safety of the patient. The nurse could solve the problem by **delegation** as prescribed by the in-charge nurse.	
The **technological methods** that are used include the **computerized system** that connects the critical care unit with the pharmacy, it is used to request the prescribed medications from the pharmacy. Using the **computerized system** could minimize the problems related to **handwriting**.	Some medications are look-alike in writing, the computerized system could minimize this problem. In addition, the medications are programmed by using the generic name, and this also could minimize the problem, especially if the handwriting is not clear. Using infusion pumps could help in the procedure of administering medications, for example, titrating the prescribed dose,	The role of a computerized system is to facilitate communication between physicians, nurses, and pharmacists. The role of the infusion pumps could help in calculation and titration.

The participant thought about what other technological methods could be helpful in administering medications safely. **Syringe pumps** could be used to **calculate** medications in addition to **regulating** the prescribed doses. **Infusion pumps** could help in administering medications that need special consideration, such as **covering** the administered medication.	and calculating the dose, and it could help in administering the accurate dose especially when medications are photosensitive and need to be covered. The argument is if the infusion pumps could be trusted as it is programmed by human, could the infusion pumps detect if the calculation is not, correct?	
The participant was asked about his thoughts regarding the methods that are used in critical care units that could **enhance the safety of medication administration**, and he generalized that all strategies that are used are enough to ensure safety. He added that **medication training courses** could help in ensuring safety. The participant added, that the **presence of a pharmacist** could also help, as pharmacists could provide essential information regarding the procedure of medication administration immediately and when it is needed. The participant suggested that pharmacists could have a role in preparing and administering medications.	Based on my previous experience working in hospitals, pharmacists could be present during the morning shift only, but it will be difficult to have pharmacists during the evening and night shifts. The presence of pharmacists in critical care units needs to employ more pharmacists in the hospitals. This needs to be reviewed this strategy with the stakeholders in the Ministry of Health.	Having pharmacists in the critical care unit as a strategy could enhance the safety of medication administration.
The interview ended by thanking the participant and the participant had no questions to ask.		

The following diagram concludes the main key points that the participant focused on during the interview.



Administering medication in the proper method, as well as making sure that the nurses are correctly practicing the procedure.



Appendix 3: Approval letter of the FHS ethical committee at the University of Hull

UNIVERSITY OF HULL

University of Hull
Hull, HU6 7RX
United Kingdom
T: +44 (0)1482 462095 | E:
matthew.hardman@hyms.ac.uk

PRIVATE AND CONFIDENTIAL
Rasmia Anabtawi
Faculty of Health Sciences
University of Hull
Via email

8th September 2021

Dear Rasmia

REF FHS364 - "Factors that Influencing Nurses' Approach to Safe Medication Administration in the Adult Critical Care Environment in Palestinian Hospitals"

Thank you for submitting your ethics application to the Faculty of Health Sciences Research Ethics Committee.

Given the information you have provided I confirm approval by Chair's action.

Please refer to the Research Ethics Committee web page for reporting requirements in the event of any amendments to your study.

Should an Adverse Event need to be reported, please complete the Adverse Event Form and send it to the Research Ethics Committee FHS-ethicssubmissions@hull.ac.uk within 15 days of the Chief Investigator becoming aware of the event.

I wish you every success with your study.

Yours sincerely

Professor Matthew Hardman
Acting Chair, FHS Research Ethics Committee

UNIVERSITY OF HULL

Matthew Hardman | Chair in Wound Healing | Director of Research - Hull York Medical School
University of Hull
Hull, HU6 7RX, UK
www.hull.ac.uk
matthew.hardman@hyms.ac.uk | 01482 462095
@UniOfHull /UniversityOfHull universityofhull

Appendix 4: Palestinian MOH Ethical Approval Letter

State of Palestine
Ministry of Health
General Directorate of Education in
Health and Scientific Research

دولة فلسطين
وزارة الصحة
الإدارة العامة للتعليم الصحي
والبحث العلمي

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

الرقم: عد/١٦٥٣/٢٠٢١م
التاريخ: ٢٠٢١/٩/١٥م

الأخ مدير عام الادارة العامة للمستشفيات المحترم ،،،

تحية واحترام،،،

الموضوع: تسهيل مهمة بحث دكتوراه

يرجى التكرم بتسهيل مهمة **الطالبة : رسمية عنبتاوي– طالبة دكتوراه تمريض – جامعة هال–**

المملكة المتحدة، وباشراف د. اندريا هلتون ود. ديفيد باريت، في عمل بحث بعنوان:

"Factors that Influencing Nurses' Approach to Safe Medication Administration in Adult Critical Care Environment in Palestinian Hospitals"

من خلال السماح للطالبة بجمع معلومات عن طريق تعبئة استبانة من قبل ممرضي العناية المكثفة (بعد اخذ موافقتهم)، وذلك في:

– مستشفى رفيديا – مستشفى الوطني – مستشفى جنين

– مستشفى طوباس – مستشفى طولكرم

على ان يتم الالتزام بجميع تعليمات واجراءات الوقاية والسلامة الصادرة عن وزارة الصحة بخصوص جائحة كورونا، وتحت طائلة المسؤولية.

على ان يتم تزويد الوزارة بنسخة PDF من نتائج البحث، التعهد بعدم النشر.

مع الاحترام،،،

د. عبد الله القواسمي
مدير التعليم الصحي والبحث العلمي

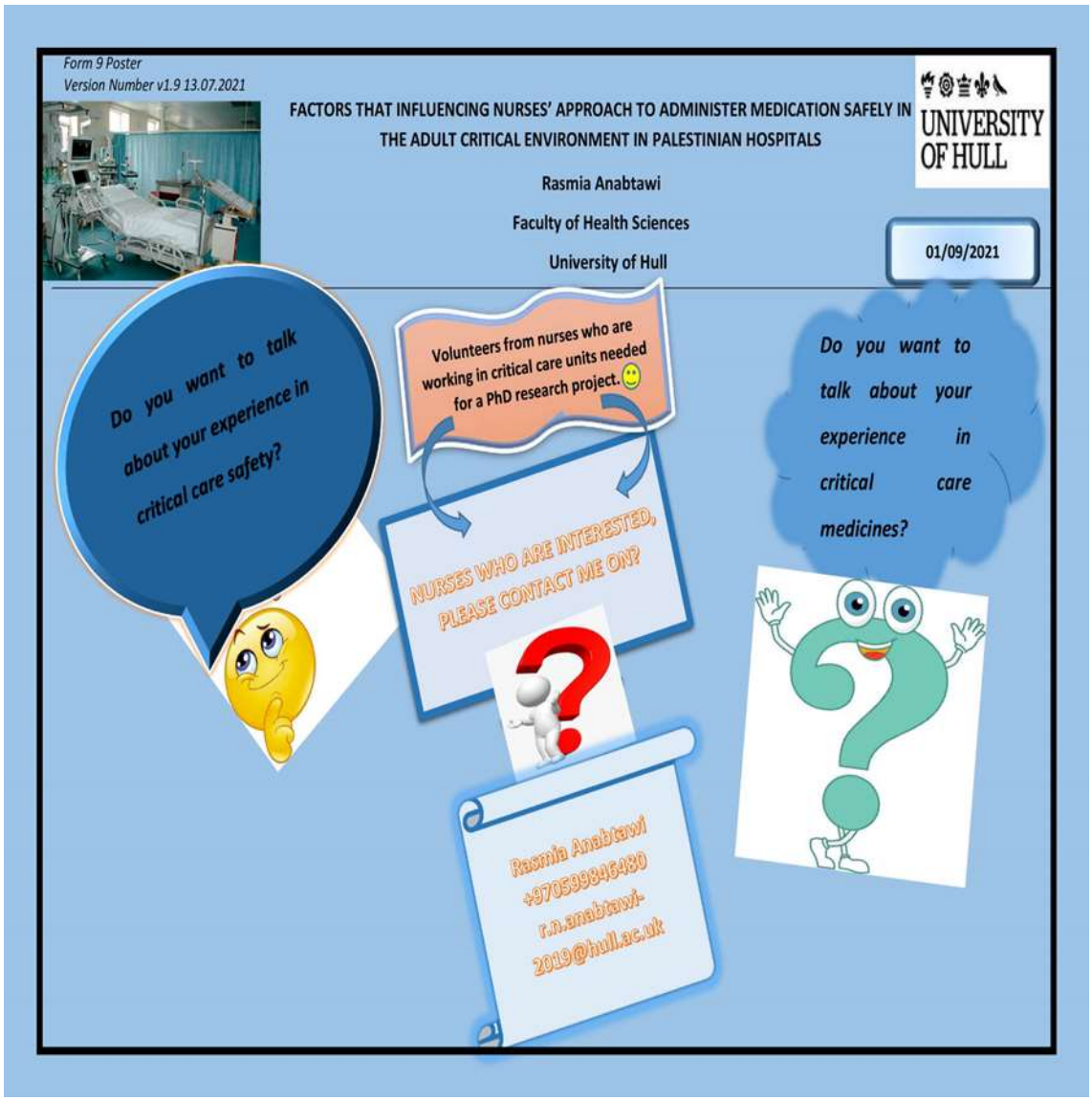
نسخة: مشرفة الدراسة المحترمة

P.O .Box: 14
Telfax.:09-2333901
scientificresearch.dep@gmail.com
ص.ب. 14
تلفاكس: 09-2333901

Appendix 5: Private hospital's ethical approval letters

Will be available upon request for confidentiality purposes.

Appendix 6: Invitation poster



Appendix 7: **Formal letter to private hospitals**

Form 6 Email for Palestinian Hospital
Version Number v1.6 10.07.2021

UNIVERSITY OF HULL

University of Hull

To Whom It May Concern

My name is Rasmia Anabtawi. I am a PhD student in the Faculty of Health Sciences (Nursing Department) at the University of Hull, UK. I am conducting a doctoral study, on the factors that influence nurses' approach to safe medication administration in the adult critical care environment in Palestinian hospitals.

I'm sending this email to have permission to gather data from nurses who are working in adult critical care units, all gathered data will be confidential and for research purposes only. Moreover, I'm requesting permission to do the interviews on-site to ensure confidentiality in gathering the data, it is preferable to do the interviews either in the conference room at the hospital or a private room that you may assign to gather the data such as the nursing director office.

This research study has been granted ethical approval through the University of Hull as part of my Doctorate Degree in nursing studies and is supervised by Dr Andrea Hilton (a.hilton@hull.ac.uk), and Dr David Barrett (d.i.barrett@hull.ac.uk) at the University.

Kind regards,

If you have any queries, please do not hesitate to contact me for further clarification. My contact details are:

Name: Rasmia Anabtawi
City/Country: Nablus-Palestine
Mobile: XXXXXX
Email: r.n.anabtawi-2019@hull.ac.uk

Appendix 8: Participants' invitation letter

Form 3 Invitation Letter
Version Number v1.3 08.06.2021

UNIVERSITY OF HULL

University of Hull

Invitation Letter

Dear Nurse,

My name is Rasmia Anabtawi. I am a PhD student in the Faculty of Health Sciences (Nursing Department) at the University of Hull, UK. I am conducting a doctoral study, on the factors that influence nurses' approach to safe medication administration in the adult critical care environment in Palestinian hospitals.

You are being invited to take part in this study. If you are a registered nurse working in an adult intensive care unit, responsible for administering medication regardless of your years of experience. Participation will entail 45-60 minutes outside of your working hours.

Please take your time to read the participant information sheet enclosed. If you are happy to take part, please give your consent to participate in the short questionnaire form enclosed. Your participation in this study is highly valued.

This research study has been granted ethical approval through the University of Hull as part of my Doctorate Degree in nursing studies and is supervised by Dr Andrea Hilton (a.hilton@hull.ac.uk), and Dr David Barrett (d.i.barrett@hull.ac.uk) at the University. Moreover, ethical approval was granted from MOH as well as from private hospitals.

Kind regards,

If you have any queries, please do not hesitate to contact me for further clarification. My contact details are:

Name: Rasmia Anabtawi
City/Country: Nablus-Palestine
Mobile: XXXXXX
Email: r.n.anabtawi-2019@hull.ac.uk

Appendix 9: Informed consent

Form 7 Participant Consent Form
Version Number v1.7 08.06.2021

UNIVERSITY OF HULL

University of Hull

Participant Consent Form

Title of study: *"Factors that Influencing Nurses' Approach to Safe Medication Administration in Adult Critical Care Environment in Palestinian Hospitals"*

Name of Researcher: Rasmia Anabtawi

Please initial box

1. I confirm that I have read the information sheet dated..... version..... for the above study. I have had the opportunity to consider the information, ask questions, and have any questions answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason up to the point of data analysis, I understand that once I have completed the interview, I cannot withdraw my anonymised data. I understand that the data I have provided up to the point of withdrawal will not be retained. ☐
3. I understand that the research interview will be audio-recorded and that my anonymised verbatim quotes may be used in research reports and conference presentations. ☐
4. I understand that my nursing manager will be contacted if I disclose unsafe clinical practice. ☐
5. I understand that the research data, which will be anonymised (not linked to me), will be retained by the researchers and may be shared with others and publicly disseminated to support other research in the future. ☐
6. I understand that the information held and maintained by the researcher may be used to help contact me or provide more information if I need it. ☐
7. I understand that my data will be kept securely by data protection guidelines and will only be available to the immediate research team. ☐
8. I give permission for the collection and use of my data to answer the research question in this study. ☐
9. I understand that interview may be on Zoom, I specifically give consent for this platform to be used. I understand the security and privacy of this platform. ☐
10. I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Name of Person Taking consent	Date	Signature

Name: Rasmia Anabtawi
City/Country: Nablus-Palestine
Mobile: XXXX
Email: r.n.anabtawi-2019@hull.ac.uk

Appendix 10: Interview guide questions

Form 8 Interview Questions
Version Number v1.8 08.06.2021

UNIVERSITY OF HULL

Interview Questions

Aims and Objectives

Findings and gaps arise from the literature review:

Based on the findings of the literature review, the following gaps were identified and needed to be explored which will enable to answer the research question

Further studies are required to determine what type of strategies or protocols nurses should use to ensure the safety of medication administration in the adult critical care environment.

The existing studies didn't describe how the educational programme influences the perception of nurses to maintain the safety of administering medication in the adult critical care environment.

The presence of inter-professional personnel who provide knowledge and education towards safe medication administration is restricted during the daytime.

Insufficient studies described what elements that impede the safety of administering medication in the adult critical care environment.

Studies did not answer the question of how using the technology may influence nurses' approach in administering medication safely in the adult critical care environment.

The worldwide studies search results showed no evidence that there was any study conducted either in the Middle East or in Palestine focusing on factors that influence nurses' approach towards medication administration safety in critical care units.

Therefore, it is appropriate to explore the critical care environment and the factors that influence nurses' approach towards medication administration safety in critical care units in Palestinian hospitals, this, in turn, will help in explaining how the critical care environment can be maintained to ensure the safe medication administration in the perspective of the adult critical care nurses.

According to the literature review findings and the arising gaps, this study will try to answer the question "What are the factors that influence nurses' approach to safe medication administration in a critical care environment?"

Research question

What are the factors that influence nurses' approach to safe medication administration in the adult critical care environment?

Aims of the study based on the literature review:

Explore factors that influence nurses' approach toward safe medication administration in the adult critical care environment.

Identify if there are any strategies and guidelines used to ensure safe medication administration in the adult critical care units.

Explore how the factors that influence the adult critical care environment can be maintained to ensure the safety of medication administration in the adult critical environment.

Interviewing:

I will focus on the data collection process to collect details that will answer my research question; the questions that will be used in the semi-structured interview are open-ended questions that will give a focused understanding regarding the main question of my study. Using an in-depth semi-structured interview is a useful method that will be used rather than other methods as it will provide a better understanding of the nurses' approach towards administering medication safely and will allow the researcher for probing during the interview, besides, the semi-structured interview will enable participants to talk about their experiences openly and share their ideas freely.

The interview will be face-to-face with the participants who are working in adult critical care units located in the governmental and private hospitals which are distributed in the north of Palestine. Otherwise, for Covid 19 restrictions interviews may take place by using the Zoom platform taking into consideration

privacy policy during recording the interviews. Based on grounded theory all nurses who are working in adult critical care units will be invited to take part in the study, the ultimate criterion for the final sample size is theoretical saturation, and the general role is to gather data until each category or theme is saturated. In other words, the number of participants who will be included is determined by no additional data will be added from participants, so approximately 15-20 participants will be recruited.

Interview protocol or guide:

The interview protocol will be a guide for the interviewer consisting of five to seven open-ended questions.

The interview protocol enables the interviewer to take notes during the interview about the responses of the interviewee, in addition, to reading the more obvious body language indicators of tension or relaxation of the interviewee. It also helps the interviewer organize thoughts on items such as headings, information about starting the interview, concluding ideas, information on ending the interview, and thanking the respondent.

Title of the study: factors that influence nurses' approach to safe medication administration in the adult critical care environment. Time of interview: Date: Place: Interviewer: Interviewee: Position of interviewee: Brief description of the study: Questions: Complete the interview within the time specified:

Interview Questions:

In grounded theory, the questions may be directed toward generating a theory of some process, such as the exploration of a process as to how nurses interact in administering medication safely in the adult critical care environment.

A few interviews will take place first as a pilot study to determine the feasibility of the questions that will be asked during the interview, and if essential questions are to be added.

The ladder questions technique will be used in asking the interview questions, the aim of using this technique is to understand how respondents' thoughts, beliefs and actions correspond with each other.

The purpose of using the Laddered question technique of research interviewing as this technique has a contribution to make in grounded theory research. Using this technique helps participants to evaluate their place of the research and their part in it, on the contrary, it gives the power for researcher over participant by shaping and opening agenda for the interview.

The level of questions will include questions about actions, questions about knowledge, and questions about philosophy which concern about feelings, values and beliefs of participants.

Ladder question levels purpose is to set the scene, collect contextual information, and help the respondent feel assured that the researcher is interested in what they have been doing.

Ladder Questions Level	Interview questions	PROMPTS
Questions about actions	Can you please start to tell me about the medication administration procedure in the adult critical care unit?	Well, I need to know how you practice the procedure of administering medication in the adult critical care unit.
	What are the skills that you should have to administer medication safely in critical care units?	Yes, I see.
	How have you been organizing the medication administration procedure?'	Ok, it means you are following steps to administer medication, so what helps you to organize your procedure?
	Have you attended any training courses regarding medication administration?	Can you tell me why did you attend the training courses? Was it useful? I see. What are changes have occurred in your practice?
	What do you think your role is in administering medication in the adult critical care unit?	I need to know what tasks you perform regarding medication administration.
Questions about knowledge	Can you tell me please what it means for you the safe administering medication in the adult critical care unit?	Well, I need to know what it is mean to you to administer medication safely in the adult critical care unit.
	Will you tell me the sequence that you follow when you receive the order of medication?	Well, can you tell me how you use the information in the physician order? I see, so can you clarify for me how you interpret the order?

	So, how can you ensure the safety of medication administration?	I know that you are doing your best to ensure the safety of administering medication, so, can you please tell me more about your practice to ensure the safety of administering medication?
	What do you know about the factors that influence safe medication administration in the adult critical care environment?	So, do you think that there are factors that may influence you during administering medication? Well, can you tell me how can you manage the arise problem? So how did you discover the problems? Ok, do you think that these factors can be maintained or prevented?
	Can you tell me about the technological methods that are used in the adult critical care unit?	So, you see that technology influence medication administration in critical care units, what type of technology is used in the critical care unit. Well, can you tell me how this technology can influence the safety of administering medication?
Questions about philosophy	Tell me about your thoughts regarding your experience towards the safety of medication administration.	Ok, I know that it is a complex procedure when administering medication for critically ill patients, can you please tell me how you view your experience in administering medication. Well, you reach a point that you need help from another healthcare provider, how do you feel about that?
	How do you feel about the methods that are used in the adult critical care unit regarding the safety of administering medication?	Do you think the methods used are useful enough for administering medication safely? What do you think is the most important strategy that is used to maintain the safety of medication administration in critical care units?
	What do you think can be added to understand medication administration safety?	So, do you feel that there is anything to be added to ensure the safety of medication administration in critical care units from your point of view?
		What motivated you to administer medication safely?

The interview questions will also include a general question at the beginning of the interview by asking the participant to introduce him/herself, which make sense of comfort between researcher and participant. And at the end, the researcher will ask the participant if there is anything would like to add, if want to ask any question, and then thank the participant for taking part in the study and for his time.

Appendix 11: Demographic questionnaire

Form 4 Demographic Questionnaire
Version Number v1.4 08.06.2021

UNIVERSITY OF HULL

University of Hull
Demographic Questionnaire

Factors that Influence Nurses' Approach to Safe Medication Administration in Adult Critical Care Environment in Palestinian Hospitals: A Qualitative Study

Dear participant,

Thank you for your willingness to take part in this study. I would be grateful if you would complete the following short questionnaire and return it within one week from the date that the invitation was delivered to you.

I will contact you to arrange an interview side of your work hours, and at a time that is convenient for you. Let me remind you that this study aims to investigate the factors that influence nurses' approach to safe medication administration in adult critical care units from the point of view of nurses. It is entirely up to you to decide to take part in the study. You can withdraw your data from the study up to the end of the interview, after which withdrawal of your data will no longer be possible as the provided data will be in the process of analysis. All the information you give will be anonymous and your name will not be identified in the research report.

Please answer the following questions:

1. **What is your age group? (Mark with X that applies)**
   A. Less than 25 years ☐ B. 25-29 ☐ C. 30-34 ☐
   D. 34-39 ☐ E. 40-44 ☐ F. 45+ ☐
2. **Which of the following describes you? (Mark with X that applies)**
   A. Male ☐ B. Female ☐
3. **How many years of experience do you have as a registered nurse? (Mark with X that applies)**
   A. Less than 1 Year ☐ B. 1-5 ☐
   D. 6-10 ☐ E. 10+ ☐
4. **How many years of experience do you have as a registered nurse in the adult critical care unit? (Mark with X that applies)**
   A. Less than 1 Year ☐ B. 1-5 ☐
   D. 6-10 ☐ E. 10+ ☐
5. **Please state the hospital you are working in. (Mark with X all that applies)**
   A. Governmental ☐ B. Private ☐
6. **Please state the critical care unit you are working in. (Mark with X that apply)**
   A. General ICU ☐ B. Surgical ICU ☐
   D. CCU ☐ E. Cardio surgical ICU ☐
7. **Please state how you would like the interview to take place. (Mark with X that applies)**
   A. Face-to-face interview. ☐
   B. Using Zoom platform. ☐

Please provide your contact details (these will be kept confidential):

Name: ……..

Tel:……...Email: ……..

Thank you very much for agreeing to participate. If you have any queries, please contact me and I will clarify these for you. My contact details are:

Name: Rasmia Anabtawi

City/Country: Nablus-Palestine

Mobile: XXXXX

Email: r.n.anabtawi-2019@hull.ac.uk

Appendix 12: Participant information sheet.

Form 2 Participant Information Sheet
Version Number v1.2 08.06.2021

UNIVERSITY OF HULL

University of Hull
PARTICIPANTS INFORMATION SHEET
معلومات للمشاركين في الدراسة

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

Title of study *"Factors that Influencing Nurses' Approach to Safe Medication Administration in Adult Critical Care Environment in Palestinian Hospitals"*

I would like to invite you to take part in a research project which forms part of **my PhD nursing** research. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

عنوان الدراسة " العوامل المؤثرة على المنهجية المتبعة من قبل العاملين في مجال التمريض في إعطاء الأدوية بشكل آمن في بيئة العناية المكثفة للكبار في المستشفيات الفلسطينية"

أود دعوتكم للمشاركة في موضوع الدراسة والتي هي جزء من دراستي للحصول على درجة الدكتوراه في التمريض. من الأهمية معرفة الأسباب لإجراء هذه الدراسة ودورك في المشاركة قبل إتخاذك القرار للمشاركة. الرجاء أخذ الوقت الكافي لقراءة المعلومات المدرجة بدقة قبل أخذك القرار واستشارة من تراه مناسبا. وكذلك بإمكانك التوجه لي لتوضيح أو الإستفسار عن أي معلومات إضافية.

What is the purpose of the study?

The purpose of the study is to explore the factors that influence nurses' approach to safe medication administration in the adult critical care environment in Palestinian hospitals.

In addition, the study will focus on the following aims:

1. Determine if strategies and guidelines are used to administer medication safely in adult critical care units.
2. Explore what are the elements in the adult critical care units influencing the safety of administering medication in adult critical care units.
3. Explore how a critical care environment could influence the safety of medication administration in critical units from the nurses' point of view.
4. Identify how the technology influencing the medication administration safety in adult critical care units.

ما هو هدف الدراسة؟

الهدف من هذه الدراسة هو البحث في العوامل التي تؤثر على المنهجية المتبعة من قبل العاملين في مجال التمريض في إعطاء الأدوية بشكل آمن في بيئة العناية المكثفة للكبار في المستشفيات الفلسطينية.

بالإضافة إلى أن الدراسة تهدف إلى البحث في:

1. تحديد ماهية وجود إستراتيجيات وقواعد متبعة في إعطاء الأدوية بشكل آمن في أقسام العناية المكثفة للكبار.
2. إستكشاف ما هي العوامل المؤثرة على إعطاء الأدوية بشكل آمن في أقسام العناية المكثفة للكبار.
3. البحث في كيفية تأثير بيئة العناية المكثفة للكبار على إعطاء الأدوية بشكل آمن من وجهة نظر الممرضين/الممرضات العاملين في أقسام العناية المكثفة للكبار.
4. تحديد كيفية تأثير استخدام التكنولوجيا على إعطاء الأدوية بشكل آمن في العناية المكثفة للكبار.

Why have I been invited to take part?

You are being invited to participate in this study because you are eligible to be one of the participants in this study according to the following criteria:

1. A nurse who is working in the adult critical care units.
2. A nurse who is registered by the Ministry of Health.
3. A nurse who has experience in working in adult critical care units.
4. A nurse who is responsible for preparing and administering medications in adult critical care units.

Please note that you are not eligible to participate in this study if you are:

1. A Nurse who is not working in the adult critical care units.
2. A Nurse who is not registered by the Ministry of Health.
3. A Nurse whose experience is not in the adult critical care units.
4. A Nurse who is not responsible for preparing and administering medications in adult critical care units.

لماذا يتم دعوتي للمشاركة؟

أنت/ي مدعو للمشاركة في هذه الدراسة كونك مؤهل للمشاركة بناءا على المعايير التالية:

1. ممرض/ة يعمل في أحد أقسام العناية المكثفة للكبار.
2. ممرض/ة حاصل على مزاولة مهنة التمريض من قبل وزارة الصحة الفلسطينية.
3. ممرض/ة لديك الخبرة في العمل في أحد أقسام العناية المكثفة للكبار.
4. ممرض/ة مسؤول عن تحضير وإعطاء الأدوية في أقسام العناية المكثفة.

الرجاء الأخذ بعين الإعتبار بأنك غير مؤهل للمشاركة في هذه الدراسة اذا كنت/ي:

1. ممرض/ة لا يعمل في أحد أقسام العناية المكثفة للكبار.
2. ممرض/ة غير حاصل على مزاولة مهنة التمريض من قبل وزارة الصحة الفلسطينية.
3. ممرض/ة ليس لديه/ا الخبرة في العمل في أقسام العناية المكثفة للكبار.
4. ممرض/ة غيرمسؤول/ة عن تحضير وإعطاء الأدوية في أقسام العناية المكثفة.

What will happen if I take part?

If you choose to take part in the study, you will be asked for:

1. Read the Participant's information sheet, which includes details related to the research study.
2. Go through the invitation letter that includes my details which will enable you to contact me for further information.
3. Answer the short questionnaire that is included demographic data related to the participant.
4. Return the signed short questionnaire with your signature, which permits me to contact you for arranging the interview.
5. Arrangement for the face-to-face interview will take place in a safe well-ventilated area such as the nursing director's office, or the hospital conference room after having permission for this, taking into consideration Covid 19 restrictions by using PPE and keeping personal distance.
6. You should attend the interview if you are only fit for work.
7. You will be asked to sign the consent form before starting the interview.
8. If there are restrictions for a face-to-face interview, the online interview will take place, and you will be asked to send an email with your approval to take part in the study.
9. Once you sent an email about your willingness to take part in the study, the

arrangement for the interview will take place at a time that is convenient to you.

10. You will be informed that the interview will be recorded and will be saved confidentially for research purposes only.
11. You will be informed that the gathered data will be secured and confidential until the end of the study, then it will not keep any more, however, the gathered data will be used for research purposes only.
12. The interview will be out of your working hours, and it will take approximately forty-five minutes to one hour.
13. You will be asked about your experiences related to medication administration procedures in the adult intensive care unit, as well as to describe the environment in which the procedure is carried out.

ماذا سيحدث اذا شاركت في الدراسة؟

اذا اخترت/ي المشاركة في هذه الدراسة سيتم الطلب منك التالي:

1. قراءة هذا النموذج والذي يتضمن تفاصيل متعلقة بالدراسة.
2. قراءة الدعوة المرفقة للمشاركة بالدراسة والتي تحتوي على الوسائل التي تتيح لك الإتصال بي في حال لديك/ي إستفسار أو للحصول على معلومات إضافية متعلقة بالدراسة.
3. الإجابة على الإستبيان القصير المرفق والمتعلق بمعلومات شخصية للمشارك/ة.
4. التوقيع على الإستبيان ومن ثم إعادته، والذي سيسمح لي بالتواصل معك/ي لتحديد موعد للمقابلة.
5. ستتم المقابلة بمكان آمن وذو تهوية جيدة مع مراعاة إستخدام وسائل الوقاية الشخصية المتعلقة بفايروس كورونا، سيتم اللقاء بمكتب مدير/ة التمريض أو بقاعة المؤتمرات في المستشفى إن و’جدت وذلك بعد أخذ الموافقة لذلك.
6. عليك التواجد للمقابلة إذا كنت مؤهل للعمل.
7. سيتم الطلب منك التوقيع على نموذج الموافقة للمشاركة في الدراسة قبل البدء في المقابلة.
8. في حال وجود عوائق لإجراء المقابلة وجاهيا، سيتم إجراء المقابلة من خلال الإنترنت وسيتوجب عليك/ي إرسال بريد إلكتروني بموافقتك للمشاركة في الدراسة.
9. عند إرسالك للبريد الاكتروني بموافقتك للمشاركة في الدراسة، سيتم التواصل معك للإتفاق على الموعد المناسب لك /ي لإجراء المقابلة.
10. سيتم إعلامك بأنه سوف يتم تسجيل المقابلة وسيتم المحافظة عليها بسرية تامة وسيتم إستخدامها لأغراض البحث العلمي فقط.
11. سيتم إعلامك بأن المعلومات التي سوف يتم تزويدها سيتم التعامل معها بشكل آمن وبسرية تامة لحين الانتهاء من الدراسة وبعد ذلك سيتم مسحها، علما بأن معلوماتك سيتم إستخدامها لغرض البحث العلمي فقط.
12. ستتم المقابلة خارج أوقات العمل، وستستغرق تقريبا ما بين 45 - 60 دقيقة.
13. سيتم سؤالك خلال المقابلة عن خبرتك في الإجراءات المتبعة في إعطائك للأدوية في أقسام العناية المكثفة للكبار، وكذلك وصف البيئة المحيطة أثناء إنجزاء الإجراء التمريضي في إعطاء الأدوية.

Do I have to take part?

Participation is completely voluntary. You should only take part if you want to, and if you choosing are choosing not to take part will not disadvantage you in any way. Once you have read the information sheet, please contact me if you have any questions that will help you decide to take part. If you decide to take part we will ask you to sign a consent form and you will be given a copy of this consent form to keep.

Please note that you will not be included in the study if the gathered data reach the saturation in each category or theme. In other words, the number of the participants who will be included is determined by no additional data will be added from participants.

هل يجب علي المشاركة في الدراسة؟

مشاركتك هي طوعية تماما. يمكنك المشاركة فقط إذا رغبت بذلك، ولا يوجد أي إجراء يمكن أخذه ضدك في حال عدم مشاركتك. في حال موافقتك على المشاركة في الدراسة سيتم الطلب منك التوقيع على إقرار الموافقة وسيتم تزويدك بنسخة للاحتفاظ بها.

مع التنويه بأن يمكن عدم إختيارك كمشارك في الدراسة وذلك عندما يصل جمع المعلومات لحالة الإشباع، أي أنه لا يوجد إضافات جديدة من المعلومات التي تم جمعها من المشاركين في الدراسة.

What are the possible risks of taking part?

The risk that may arise during data collection includes revealing unsafe medication administration practices toward patients in the adult critical care unit.

Unsafe practice during the procedure of administering a medication that may cause harm for the patient or cause life-threatening of the patient, the provided data will be disclosed to your manager in order to prevent further patient harm or complications.

ما هي المخاطر المحتملة من مشاركتي في الدراسة؟

المخاطر التي يمكن أن تظهر خلال المقابلة وجمع المعلومات هي الكشف عن إعطاء الأدوية بطريقة غير آمنة للمرضى المتواجدين في أقسام العناية المكثفة للكبار.

إعطاء الأدوية بطريقة غير آمنة قد تؤدي إلى التسبب بأذى للمريض أو إحداث خطورة على حياته في قسم العناية المكثفة، سيتم الإفصاح عن المعلومات التي تم تزويدنا بها لمسؤولك المباشر وذلك لتجنب مضاعفات صحية قد تحدث للمريض.

What are the possible benefits of taking part?

Being part of the study and discussing approaches to enhancing medication safety, participants will be able to reflect on their practice and that of their colleagues. In turn, this may enable them to identify areas where they can enhance practice and develop strategies that underpin safer medication management within their organizations.

ما هي الفائدة من مشاركتي في الدراسة؟

مشاركتك في الدراسة ومناقشة الأمور التي تؤثر على إعطاء الأدوية بطريقة آمنة سوف تؤثر على أدائك وأداء زملائك. وبالمقابل سيكون لديك القدرة على معرفة المواطن المؤثرة التي ترتكز على تحسين الأداء وتطوير إسترتيجية لإعطاء الأدوية بطريقة آمنة في المؤسسة التي تعمل بها.

Data handling and confidentiality

Your data will be processed by the General Data Protection Regulation 2016 (GDPR).

1. All collected data will be confidential and will be used for research purposes only.
2. The recorded data will be stored in the University of Hull Box which will be accessed by the researcher's university ID and password.
3. All data collected will be treated according to the University of Hull's data protection policy and regulations.
4. There will be disclosing for confidentiality if the patient will be exposed to any harm regarding unsafe medication administration.
5. Only the researcher and supervisors at the University of Hull have the right to access the recorded data.
6. The recommended storage for data is 10 years, unless if participant recommends destroying his/her data after completion of the research.
7. Acknowledgement for participants will be included in the final report without identifying names.
8. Personal data will not be shared outside the university, if data will be used for any reason rather than this study a consent form will be obtained. The agreement of using data will continue to be held in compliance with UK data protection standards (GDPR).

9. The research data will be used to support future research and may be shared anonymously with other researchers.

كيفية التعامل مع المعلومات التي تقدمها وسريتها

سيتم التعامل مع المعلومات المقدمة من قبلكم حسب أنظمة حماية المعلومات العام (2016)

1. سيتم التعامل مع المعلومات المقدمة بسرية تامة وسيتم إستخدامها لأغراض البحث العلمي فقط.
2. سيتم تخزين المعلومات المسجلة في الصندوق الإلكتروني الخاص بجامعة هال البريطانية، ويتم الدخول من خلال هوية التعريف الجامعية للباحثة ومن خلال كلمة السر.
3. سيتم التعامل مع المعلومات المقدمة حسب أنظمة وقوانين حماية المعلومات المعمول به في جامعة هال البريطانية.
4. سيتم الكشف عن المعلومات المقدمة للمسؤولين في حال وجود خطورة على حياة المريض نتيجة إجراء غير آمن في إعطاء الأدوية.
5. سيتم الإضطلاع على المعلومات المقدمة فقط من قبل الباحثة والمشرفين على البحث.
6. يتم تخزين المعلومات لمدة عشرة سنوات لغرض المقارنة في أبحاث مستقبلية، إلا إذا رغب المشارك في إتلاف معلوماته بعد إنتهاء الدراسة.
7. سيتم التوجه بالشكر للمشاركين في الدراسة في التقرير النهائي وذلك دون ذكر أسماء.
8. لن يتم مشاركة المعلومات المقدمة خارج جامعة هال البريطانية، وفي حال إستخدام المعلومات خارج نطاق هذه الدراسة سيتم أخذ موافقة مسبقة من المشارك قبل القيام بمشاركة المعلومات. وهذا حسب أنظمة حماية المعلومات العام (2016).
9. سيتم مشاركة المعلومات لدعم أبحاث مستقبلية وسيتم مشاركتها دون مشاركة أسماء المشاركين في هذه الدراسة.

Data Protection Statement

The data controller for this project will be the University of Hull. The University will process your data for the research purposes outlined above. The legal basis for processing your data for research purposes under GDPR is a 'task in the public interest' You can provide your consent for the use of your data in this study by completing the consent form that has been provided to you. Information about how the University of Hull processes your data can be found at **https://www.hull.ac.uk/choose-hull/university-and-region/key-documents/data-protection.aspx**

You have the right to access and change the information held about you during the interview, once your information is analyzed, you will not have the right to correction, erasure, objection, and data portability. Questions, comments, and requests about your data can also be sent to the University of Hull Data Protection Officer [**dataprotection@hull.ac.uk**]. If you wish to complain to the Information Commissioner's Office, please visit **www.ico.org.uk.**

قانون حماية المعلومات

جامعة هال البريطانية هي المراقب لهذه الدراسة. ستقوم الجامعة بالتعامل مع معلوماتك فقط لأغراض البحث كما هو موضح سابقا. قانونية التعامل مع معلوماتك الشخصية يندرج تحت قانون حماية المعلومات العام (2016)، بتوقيعك على نموذج الموافقة للمشاركة بالدراسة فإنك تعطي الحق بإمعلوماتك، وسيتم تزويدك بنسخة من النموذج الموقع. بإمكانك الاضطلاع على كيفية إستخدام جامعة هال لمعلوماتك من خلال استخدام الرابط " https://www.hull.ac.uk/choose-hull/university-and-region/key-documents/data-protection.aspx"

لديك الحق في مراجعة وتغيير البيانات التي تقوم بإعطائها خلال فترة إجراء المقابلة، وفي حال تم تحليل البيانات التي قمت بإعطائها فلن يكون لديك الحق في التعديل، أو الإلغاء، أو الإعتراض عليها. في حال لديك سؤال أو ملاحظات بخصوص معلوماتك الشخصية بإمكانك إرسال بريد إلكتروني لمسؤول حماية البيانات في جامعة هال على العنوان [dataprotection@hull.ac.uk]. وإذا كان لديك شكوى عن مسؤول حماية البيانات يمكنك زيارة الوقع www.ico.org.uk لتسجيل الشكوى.

What if I change my mind about taking part?

You are free to withdraw up to the end of the interview, without having to give a reason. Withdrawing from the study will not affect you in any way. You can withdraw your data from the study up to the end of the interview, after which withdrawal of your data will no longer be possible as the provided data will be in the process of analysis. If you choose to withdraw from the study, we will not retain the information you have given thus far, and the personal data that you have provided will not be kept. To safeguard your rights, there will be minimizing in using your personality-identifiable information.

ماذا فيما إذا ما غيرت رأيي في المشاركة في الدراسة؟

لديك الحق في الإنسحاب من الدراسة حتى نهاية المقابلة بدون إبداء أسباب لذلك. إنسحابك من الدراسة لا يؤثر عليك بشيء. بإمكانك سحب بياناتك التي قمت بإعطائها حتى نهاية وقت المقابلة، بعد هذا الوقت لن يكون بإمكانك الإنسحاب حيث أنه سيتم البدء بتحليل البيانات فور الإنتهاء من المقابلة. وفي حال إختيارك الإنسحاب لن يتم الإحتفاظ ببياناتك الشخصية وكذلك المعلومات التي قمت بإعطائها المتعلقة بالدراسة. ولحفظ حقوقك في الإنسحاب سيتم التعامل مع بياناتك في أضيق الحدود.

What will happen to the results of the study?

The results of the study will be summarized after analyzing the collected data and will be used in my PhD thesis. After completion of the thesis, it will be published, and you can access it through the website. Taking into consideration your name will not be published.

ماذا سيحدث لنتائج هذه الدراسة؟

سيتم تلخيص نتائج هذه الدراسة بعد تحليلها وسيتم إستخدامها في أطروحة الدكتوراه الخاصة بي. وبعد الإنتهاء من الأطروحة سيتم نشرها وبإمكانك الاضطلاع عليها من خلال الموقع الإلكتروني. مع الأخذ بعين الإعتبار بأنه لن يتم نشر إسمك.

Who has reviewed this study?

Research studies are reviewed by an independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and been given a favorable opinion by the Faculty of Health Sciences Ethics Committee, University of Hull.

من الذي قام بمراجعة هذه الدراسة؟

يتم مراجعة هذه الدراسة من قبل مجموعة مستقلة تسمى "لجنة أخلاقيات البحث العلمي" والتي تعمل على حماية إهتمامك بالمشاركة في الدراسة. تم مراجعة الدراسة وإبداء الرأي فيها من قبل لجنة أخلاقيات البحث العلمي في كلية العلوم الصحية /جامعة هال.

Whom should I contact for further information?

If you have any questions or require more information about this study, please contact me using the following contact details:

Rasmia Anabtawi
City/Country: Nablus-Palestine
Mobile: XXXX
Email: r.n.anabtawi-2019@hull.ac.uk
University of Hull

من يمكنني التواصل معه للحصول على معلومات إضافية؟

إذا كان لديك أي سؤال أو تود في الحصول على معلومات إضافية تخص هذه الدراسة، فضلا بإمكانك التواصل معي من خلال إستخدام معلوماتي الشخصية:

رسمية عنبتاوي

نابلس/فلسطين
جوال: XXXXXX
بريد إلكتروني: r.n.anabtawi-2019@hull.ac.uk

What if I have further questions, or if something goes wrong?

If you wish to make a complaint about the conduct of the study, you can contact the University of Hull using the details below for further advice and information:

Dr Andrea Hilton
University of Hull
Hull, HU6 7RX, UK
www.hull.ac.uk
a.hilton@hull.ac.uk
OR/AND
Dr David Barrett
University of Hull
d.i.barrett@hull.ac.uk
https://www.hull.ac.uk/staff-directory/david-barrett

Alternatively please contact coo@hull.ac.uk

ماذا إذا كان لدي أسئلة أخرى، أو إذا حدثت أمور سيئة؟

إذا أردت أن تقدم شكوى بخصوص القائمة في الدراسة، بإمكانك التواصل مع جامعة هال البريطانية من خلال إستخدام التفاصيل التالية لأخذ النصائح والإرشاد لذلك:

د. أندريا هيلتون
www.hull.ac.uk
a.hilton@hull.ac.uk
أو
د. ديفيد باريت
d.i.barrett@hull.ac.uk
https://www.hull.ac.uk/staff-directory/david-barrett
أو
coo@hull.ac.uk

Thank you for reading this information sheet and for considering taking part in this research.

أشكرك لقراءة المعلومات المرفقة وإهتمامك للمشاركة في هذه الدراسة

Appendix 13: Interview transcript sample

Interview Transcribing (GE20)

Research question.

Title of the study: Factors That Influence Nurses' Approach to Safe Medication Administration in The Adult Critical Care Environment.
Time of interview: 2:00 PM
Date: 15th February 2022
Place: Hospital (G)
Interviewer: Rasmia Anabtawi
Interviewee: 20 (ICU In-Charge NURSE)
Position of interviewee: In-Charge Nurses Office
Brief description of the study:

Any Questions: No.
Consent Give: Obtained
Complete the interview within the time specified: 32.47 minutes

Fully transcribed word-for-word

Time	Speaker	Content	Code
0.39	Interviewer:	**Question 1:** Can you please start to tell me about the medication administration procedure in the adult critical care unit?	
0.46	Participant:	1.First of all, the doctor prescribes the medication for the patient 2.either its tablet or IV medication, the nurse check that the order is 3.complete which means the dose is remarked, the route, when to 4.start at what time, and the signature of the doctor with the stamp, 5.if the stamp is not available he has to write his registered number in 6.the hospital. While the nurse is checking this medication he can 7.prepare it from the pharmacy, so he calls the pharmacy to prepare 8.the medication and when it's ready, normally the pharmacy brings 9.the medication to the ward, and if there is no available enough team	The procedure that is used for administering medications in critical care units. Role of the physician. Role of the nurse in the procedure of medication administration. Role of the pharmacist.

		10.the nurse will go to the pharmacy and prepare the medication and 11.bring it to the ward, then the nurse will check that the medication 12.is written in the patient drug sheet which means the drug sheet 13.with the start date which is the most important that the start date 14.and time of administration, ok, then the nurse who is responsible 15.for the patient prepare the medication according to its 16.instructions, if it should be prepared in normal saline, for example, 17.or dextrose water and extra. And he administers medication to the 18.patient, after giving the medication he signs in the box which is 19.remarked to be signed. Then he will check the order again and sign 20.the order that the medication is given to the patient. normally this 21.is the process briefly.	Policy.
2.39	**Interviewer: PROMPT**	Is there a protocol or a strategy that you follow here to administer medication safely?	
2.47	Participant:	1.Actually according to the medication, for example, we have a 2.written **protocol** for Heparin which is the anticoagulation for cardiac 3.diseases, this medication we have a protocol which is marked in the 4.patient file and it's marked in the port of the unit, but for other 5.medications, we are now developing a protocol for potassium, 6.calcium, sodium which means minerals to give to the patient. So 7.actually, we don't have a general protocol for all medication, but we 8.have a policy on how to give a medication.	**Written Protocol for administering medication.** **Policy on how to administer medication.**
3.30	**Interviewer: PROMPT**	What kind of medications do you administer here in your unit?	
3.36	**Participant:**	1.Ok. It depends on the medication actually for tablet medication 2.normally we give anti-failure therapies for cardiac diseases, for IV 3.medications we give the support medications which affect the 4.hemodynamics, which means that we give the inotropes, 5.vasodilators and vaso-therapy, in addition, we can give sedation 6.medication, the sedation medication for patients who are ventilated 7.and mechanically supported.	**Effect of medications used in critical care units.** Medications that are administered in critical care units.
4.11	**Interviewer:**	**Question 2:**	

		What are the skills that should the nurse have to administer medication safely?	
4.24	Participant:	1.As soon as the nurse is hired in the department, we give him at least 2.three months of orientation, so during this period the nurse is not 3.to give medication alone, he should be supervised by a senior nurse 4.whom we call a preceptor nurse, after that when the nurse is trained 5.and well trained the head nurse and other two members of the 6.seniors from the department evaluate the new employee in a 7.competency form, and three signatures assigned on the 8.competency that this nurse is competent to give the medication 9.safely. The competency is concluded of theoretical information 10.about the medication and side effect, and the items of policy that 11.is merged and generalized in the hospital on how to give the 12.medication if the new employee is competent and pass these 13.medications which are marked at least 87% he can safely give the 14.medication for the patient. so, the follow of competency, is 15.repeated annually actually.	Preceptorship. Role of senior nurse: Supervise the newly graduated nurse. Role of head nurse regarding evaluating newly employed nurse. PERCEPTION: The nurse should be competent before administering medication to ensure safety. The policy of preceptorship.
5.42	Interviewer: PROMPT	So how do you assign the nurse according to patients?	
5.48	Participant:	This means, sorry?	
5.50	Interviewer: PROMPT	When you want to assign the nurses for working with the patients, how do you choose this nurse for this patient, and how do you assign them?	
6.02	Participant:	1.It is according to the nurse and the severity of the illness of the 2.patient, for example, in this unit is responsible for open-heart 3.surgeries, so when I have fresh open heart surgery, normally I 4.assigned the patient to the most senior in the ward either in the 5.morning, evening and night shift, but in the first day and second-day 6.patient become more stable so I can assign this patient for other 7.nurses who are juniors or 2-3 years of experience in the ward.	Assigning a nurse to the patient depends on the severity of the patient's illness. As well as nurse experience. Junior is assigned to the patient on his second and third-day post-surgery.
6.42	Interviewer: PROMPT	What is the ratio for assigning a nurse to the patient?	
6.46	Participant:	1.Here in CCU is one to one and a half, which means if I have an 2.intubated and sedated patient, one nurse for one patient, but if the	Nurse-patient ratio. One nurse to one and a half patients.

		3.patient is not intubated and hemodynamically is stable the nurse 4.can manage with two patients, so in general the ratio is one to one 5.and a half.	Nurse-patient ratio according to the health status of the patient.
7.09	Interviewer: PROMPT	You said that the nurse should pass something like competencies, and they are received by preceptor when they are employed, is there training courses for medication here?	
7.28	Participant:	1.Yes, there is medication it is assigned by **CNE** which means 2.continuous education department, it means that a new employee 3.has a booklet which contains the competency he should pass during 4.three months, medication administration safety is one of part of this 5.competencies and then they give them lectures about the **policy** and 6.how to manage the medication and during this, the new employee 7.is supervised by his preceptor and other seniors, of course, the head 8.nurses are included with this supervision but mainly it depends on 9.the preceptor, and at the end of three months, the preceptor will 10.sign that the competency is passed and the head nurse will sign 11.after him.	Preceptorship CNE Protocol strategies used in critical care units to ensure the safety of administering medication.
8.23	Interviewer: PROMPT	Do you feel that there are changes in the attitude and the practice of the nurses after completing such courses?	
8.31	Participant:	It means the…., I don't understand the question.	
8.37	Interviewer: PROMPT	Do you think that these courses are beneficial for the nurses and that their attitudes and their practices changed after completing such courses?	
8.49	Participant:	1.Yes, of course, actually the theory is the same, the theory that they 2.come from the university remains the same about the indication, 3.the side effect, and the contraindication for the medication, but 4.normally we have some differences in the method of application of 5.the theory, for example, if they learn in the university to give the 6.medication in 100 ml of saline, for example, if they practice this 7.medication in another hospital they come with some differences so 8.they may use 50cc of normal saline and so on. Here, we actually, 9.rechange the general guidelines, to universal guidelines to return to 10.the correct way to administer the medication.	The benefit of medication training course. Knowledge. Availability of medication administration training courses for newly graduated nurses.

9.50	Interviewer: PROMPT	Who provides these courses?	
9.52	Participant:	1.CNE is responsible for arranging these courses, normally part of the 2.medication administration depends on the pharmacy or senior 3.nurses in the different units. It is not necessarily to be from my unit 4.to give the nurses from my unit about these policies but normally 5.we hold some lectures in general for the nurses in the hospital.	healthcare providers that could participate in providing training courses regarding medication administration.
10.26	Interviewer: PROMPT	So the pharmacist can provide lectures to the nurses about medication administration?	
10.30	Participant:	Yes, with collaboration with CNE.	
10.34	Interviewer: PROMPT	Ok.	
10.38	**Interviewer:**	**Question 3:** What is your role as a head nurse in the process of medication administration?	
10.45	Participant:	1.My main role is observing and supervising, and then doing the final 2.competency for the nurse to make sure that he can give the 3.medication safely. It means that observing when I come to the ward 4.and see that the nurse is giving the medication, I just observe the 5.nurse and observe the preceptor whether he is supervising this new 6.employee nurse or not, and then I direct the both of them either the 7.nurse or the preceptor what to do, for example, **the infection 8.control protocol** how to strict with the infection control guidelines, 9.some missing information about this, so I direct the preceptor and 10.the nurse.	role of the in-charge ICU nurse regarding administering medication safely. To be strict with the infection control guidelines.
11.42	Interviewer: PROMPT	So there is a role for the infection control committee regarding medication administration?	
11.49	Participant:	Mainly in hand hygiene and scrubbing the hub for the IV access or something like that.	Infection control.
11.58	Interviewer: PROMPT	Ok.	
13.15	Interviewer:	**Question 4:** Can you tell me please what it means for you to administer medication safely?	

13.24	Participant:	1.It means to **prevent harm to the patient**, in simple words it means 2.to give the correct medication to the correct patient, in the correct 3.dose in the correct route.	Perception toward administering medication safely. Prevent harm to the patient. Advocacy, attorney.
13.40	Interviewer:	**Question 5:** Do you think that there are factors that may influence the process of medication administration safely?	
13.49	Participant:	Yes.	
13.50	Interviewer: PROMPT	What are these factors from your point of view?	
13.53	Participant:	1.The workload is number one of the factors, so when we have a 2.workload the opportunity for drug administration mistakes goes up, 3.training is another factor, other than training it means the absence 4.of preceptor for many reasons may affect the training process for 5.the new employee which may increase the risk for medication 6.administration error. The compliance for the new employee to be 7.stick to the policy it's a contributing factor which we see normally, 8.the most important factor that I see in the hospital is the handover, 9.some medications need to be specific handover, from one nurse to 10.one nurse, missing information will lead to medication 11.administration errors.	Factors influencing the safety of medication administration. Workload. Training. Absence of preceptorship. Handover. Perception: risk of Missing information.
14.58	Interviewer: PROMPT	Can you please tell me more about what you mean by compliance?	
15.05	Participant:	1.Compliance means how much the new employee will stick to the 2.policy, the theory, and the skills he has learned. So, I learned some 3.skills about how to give antibiotics as a new employee, and after 4.three months I'm out of supervision theoretically so I return to my 5.old habits in giving my skills, this is the non-compliance with the new 6.employee nurse.	Compliance. Skills. Maintain compliance to ensure safety skills.
15.36	Interviewer: PROMPT	As I understand from you that you allow the newly graduated nurse to administer medication after three months of their employment?	
15.46	Participant:	After they passed the full competency of drug administration safety.	Perception.
15.54	Interviewer: PROMPT	What do you think about interruptions during the administering of medication?	

15.59	Participant:	Which means stopping the medication?	
16.02	Interviewer: PROMPT	Any interruption that you may face during administering medication? Something like that maybe.	
16.08	Participant:	1.Interruptions, the main interruption that we may face is medical 2.rounds during giving medication this may lead to, actually, we rarely 3.see such interruptions but still something to take into consideration. 4.So two interruptions are important, the medical rounds during 5.giving medications, which means that the medical rounds are not 6.well organized in our unit, some medical rounds come at 10 am, but 7.other rounds come at 2 pm or 12 midday. Something else is visitor 8.interruptions, visitors may come at any time to visit the patient, ok 9.we have some roles to control the visitors but sometimes we face 10.many visitors that may interrupt the guidelines or the control 11.timing for visiting in the ward.	factors influencing the safety of medication administration. Interruptions: Medical round. Visitors. Medical rounds cause interruption. Visiting hours can be controlled.
17.13	Interviewer: PROMPT	As a head nurse, how do you manage this problem?	
17.16	Participant:	1.This problem actually as a head nurse I can stop giving medication 2.while I'm in my window, my window is one hour before the time and 3.one hour after the time, so I have two hours, but if I feel the medical 4.round will lead to passing this window I can stop the medical round 5.or take the medical round to another patient and encourage my 6.nurse to administer his medication for his patient, for visitors we can 7.call the security, we can lock the doors, they are automatically 8.locked so we can control the visit at this time.	Procedure: problems that may arise during medication administration. strategies used to manage a problem during administering medication.
18.02	Interviewer:	**Question 6:** How can you make sure that the nurses at your unit administer the medication safely?	
18.12	Participant:	1.Mainly by observing, by observing. First of all, the signature of the 2.nurse, means that the nurse has given this medication and the 3.signature on the medical record or the doctor's order and the drug 4.sheet or drug sheet for the patient, means that this nurse has given 5.this medication, the other thing that there is no medication in the	PROCEDURE. Policy: The signature of the nurse means the medication has been given.

		6.drawer of the patient which means all medications in the drawer 7.administered for the patient.	
18.50	Interviewer: PROMPT	Even if it is not signed?	
18.52	Participant:	1.Even if it is not signed, I call the nurse and make sure, we can write 2.an **incident report** in this case, if the nurse does not sign the 3.medication and there is no medication in the drawer so we can write 4.an incidence report and ask the patient and ask the nurse. But to 5.make sure that the medication is administered in the correct way it 6.mainly depends on observation, just observation either by me or the 7.senior nurse.	**Incident report.** **Role of in-charge nurse.**
19.31	Interviewer: PROMPT	What is the benefit of the incident report?	
19.34	Participant:	1.The benefit is a **corrective benefit** which means that we may correct 2.the attitudes, and the habits of the nurse to make sure that 3.everything is given correctly. So it is not a punishment way, it is 4.corrective action.	Perception. Corrective attitude.
19.53	Interviewer: PROMPT	How do you interpret the physician's order?	
20.00	Participant:	1.If it is clear to me, so it is clear but it is not clearly written is not clear 2.I can call the doctor to explain the order and write his explanation 3.on the doctor's order which means that the doctor may repeat his 4.order in other words or other handwriting which means he may 5.print his order, sometimes we fight doctors with their handwriting 6.it is very bad so we call the doctor and ask him an explanation as 7.soon as I understand the order I can sign it.	Factors influencing safety: Unclear order. Unclear handwriting.
20.38	Interviewer: PROMPT	So, the order here is written mainly by hand?	
20.41	Participant:	By hand. Yes.	
20.42	Interviewer: PROMPT	and sometimes they use a computer….?	
20.47	Participant:	1.Basic orders mean when the patient comes to the unit, he is 2.admitted to the unit normally the basic order which includes the 3.summary for the case is printed on the computer.	Printed order.
21.01	Interviewer: PROMPT	Do you think that handwriting may influence the safety of medication administration?	

21.07	Participant:	yes, it is one of the factors which can increase the risk of drug administration errors.	Handwriting increases the risk of errors.
21.15	Interviewer: PROMPT	So, it may influence your practice and implementation of the order.	
21.20	Participant:	Yes.	
21.21	Interviewer: PROMPT	Ok.	
21.22	Participant:	1.So, it depends on the responsibility of the nurse, did he understand 2.the order, or he can imagine that he understand the order but 3.actually in the real situation he didn't understand so this will lead to 4.risk.	Factors impeded the safety of medication administration. Understanding the order.
21.42	Interviewer:	**Question 7:** You said before you administer here some medications like supportive medications, do you use any technological methods here to administer medication safely?	
21.55	Participant:	yes, with a syringe pump.	
21.58	Interviewer: PROMPT	How do you use it, and what is its benefit of it?	
22.02	Participant:	1.We have the syringe pump which calculates the medication, the 2.dose for the medication, so it's automatically we put the syringe of 3.normally 50cc of saline or dextrose water and we programme the 4.syringe pump, the machine, with the name of the medication and 5.the dose that is wanted or written in the order, so we have a 6.titration order which means we start at this dose, we can titrate the 7.medication with this dose per hour, for example, and we can stop it 8.when the hemodynamic is reaching to this target. So if my target is 9.the mean blood pressure to reach 65 I can stop my medication with 10.titration when I reach the target.	the technological methods that are used in critical care units to ensure the safety of medication administration. Stop medication to prevent the risk of harm.
22.58	Interviewer: PROMPT	So, you observe the patient during administering medication?	
23.03	Participant:	Yes, of course, with the hourly signing of the hemodynamics.	
23.09	Interviewer: PROMPT	Ok. How do you administer the medication when you want to administer it IV, is it by peripheral lines or central lines?	

23.18	Participant:	1.According to the medication, for support medication, we prefer to 2.be in the **central line**, if I don't have a central line temporarily we 3.can administer in peripheral lines, but as soon as we can apply a 4.central line we ask to apply a central line, this is according to 5.medication, according to the number of medications so if I have 6.many IV medications I can apply more than one peripheral and here 7.we ask the doctor or the anesthetic to insert a central line as soon 8.as possible.	the policy of administering medications. medications used in critical care units that have a special protocol.
23.57	Interviewer: PROMPT	You said before that the medication should be diluted, what kind of medications do you dilute, what solution do you use, and what frequency, is it a policy here?	
24.09	Participant:	1.It is not a policy but it is a training course on our **learning modules 2.system** for each medication which fluid should be diluted in and how 3.much should I dilute, for example, **the antibiotics should not be 4.diluted with less than 100cc of normal saline**, for support 5.medications, it is diluted with this dose which means, for example, 6.norepinephrine I can dilute 4 milligrams in 50cc, this is marked in 7.our learning module system which is generalized for all nurses, so 8.normally nurses know this information.	Training course. Diluting medications: skills. Knowledge.
25.00	Interviewer: PROMPT	I will return to the syringe pump, is there any other technological methods that you use here to administer medications?	
25.13	Participant:	1.Infusion pumps for medication that is diluted in bags of fluids which 2.means high rate cc, larger than 100 ccs, we have infusion pumps, for 3.example, we have some anticoagulation medication like Aggrastat, 4.Aggrastat will not be administered in syringe pump so we use an 5.infusion pump.	**Availability of infusion pump to administer large volume of fluids.** Medication used in critical care units.
25.37	Interviewer: PROMPT	Do you feel that there are disadvantages to using technological methods?	
25.45	Participant:	1.Failure disadvantages sometimes, battery, of course, the benefits 2.much more than the disadvantages but still, there are some 3.disadvantages like the battery, the electricity resources, some 4.failure in the operations and it needs some training.	Disadvantages include: Battery charge. Electricity resources. Failure to operate with the technological methods.

26.17	Interviewer: PROMPT	Do you feel that sometimes the patient may be a barrier to administering medication safely?	
26.24	Participant:	1.In ICU, no, it is very rare. No. We don't face it regularly. Normally the 2.patient is sedated, and we can control the patient, in open wards I 3.can't promise you but sometimes visitor is a barrier, not the patient 4.but as we are in intensive, we don't have visitors during 5.administering medications.	Patients are not barriers to administering medication safely. As well, as visitors.
26.51	Interviewer: PROMPT	Ok.	
26.53		**Question 8:** How do you see your experience with medication administration safety?	
26.58	Participant:	1.I'm good. Personally, as a head nurse yes I'm good. I practice actually 2.for ten years as a staff nurse then I became a head nurse, so I have 3.some experience.	The experience of nurses is important for the safety of medication administration.
27.15	Interviewer: PROMPT	You are considered a reference for the nurses here to administer medication and to guide them in the process of medication administration.	
27.26	Participant:	1.If some information that I don't know, I tell my nurses that I don't 2.know this information, I can search for it, I can ask someone like a 3.pharmacy or a specialist and I will return with my answer.	Sources for knowledge.
27.42	Interviewer: PROMPT	So, when you need help regarding medication administration so you will ask?	
27.48	Participant:	Yes, of course.	
27.49	Interviewer: PROMT	From whom you will ask?	
27.51	Participant:	1.It depends on the question, so if I want to ask about the indication 2.for medication, for example, I can ask the specialist, sometimes the 3.resident if I trust this person I can ask him, but it is according actually 4.to the personality, so I freely can ask any specialist in the hospital, if 5.I'm asking about the dosing I can ask the head of the pharmacy so I 6.contact the pharmacy, CNE in some examples I can ask them.	healthcare providers can ask for help in the administering medication process. The pharmacist is a source for gaining information. Role of the pharmacist.

28.34	Interviewer: PROMT	From your point of view, what do you think is the most important strategy that is used here to administer medication safely?	
28.46	Participant:	1.Training, the training I can assume is a long period of training of 2.three months if the new employee is not competent we can extend 3.this period to six months, but this is the **most important strategy** to 4.administer medication, continuous education, and continuous 5.training for the new employee if the new employee feels that there 6.is someone who watches him all the time, this is the most important 7.so he is under observation all the time.	The most important strategy that can be followed that ensure the safety of medication administration in the critical care unit.
26.27		**Question 9:** Do you think that the protocols and the procedures that you are following here in ICU are fair enough to maintain the safety of medication administration?	
26.40	Participant:	1.I think so, 90% is enough, but we need more, more nurses 2.sometimes, more instruments sometimes, just only. The load of 3.work I think so is so much one nurse for three patients in ICU or four 4.patients, but sometimes we have four patients in all wards or five 5.patients in all wards, and we can properly give medication.	Methods that are used regarding the safety of medication administration. Having more nurses. More instruments. Workload.
29.25	Interviewer:	**Question 10:** Do you think that there is something to be added to understand medication administration safety?	
29.35	Participant:	1.Yes, something like, actually the lectures that we have in the 2.learning module system can generalize them with writing, I can't 3.guarantee that all nurses can enter to the module system and read 4.about medication administration but if I put these papers or lectures 5.in front of them, for example, on the board in the unit, in the station, 6.they are forced to read more, this is something we can improve in 7.collaboration with the administration and with the CNE. Infection 8.control guidelines this is something we can improve.	Strategies to be added to ensure the safety of administering medication. Ensure the availability of lectures for all nurses. Infection control guidelines can be improved.
30.30	Interviewer: PROMPT	What motivated you or your staff in CCU to administer medication safely?	
30.42	Participant:	1.The feel freely, they don't feel that they are not threatened, this is 2.one thing they depend on, so they can ask freely about the	Motivations to administer medications safely.

		3.medication, of knowing something went wrong they will not be 4.punished but they will be educated more, so they are not afraid of 5.the head nurse, of the administration and the preceptor, for 6.example, so feeling safe in the unit will motivate him to do his best 7.to be the best in the ward.	
31.23	Interviewer: PROMPT	And what about you as a head nurse? What motivated you to administer medication safely?	
31.30	Participant:	1.It is seldom or rare I give medication, but if I want to seek some 2.motivation, something like, ok, I will be a role model for my team. 3.So if give medication in the best way I know that my team will do 4.their best to be like their head nurse.	**Role model for nurses.** Nurses consider the in-charge nurse for having feedback.
32.01	Interviewer: PROMPT	Ok. Do you want to add anything more regarding medication administration safety?	
32.07	Participant:	1.Yes, I hope that these instructions that we discussed here be applied 2.in all intensive care units, furthermore, in the open units it is very 3.important that is published in the out units, so I hope that we can 4.see this publication, can apply these in our hospital.	
32.33	Interviewer: PROMPT	Do you want to ask any questions?	
32.38	Participant:	No, thank you very much.	
32.38	Interviewer: PROMPT	Thank you very much for your participation, and cooperation. It was so a wonderful interview.	