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Acute and critical care nurses' knowledge of non-invasive ventilation

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Abstract

Background: Non-invasive ventilation (NIV) use has significantly increased over the past three decades, adapted from critical care settings into ward settings, becoming an integral tool in the management of respiratory failure. Evidence suggests that proper use of NIV has several advantages, but a lack of team expertise increases the risk of NIV failure. To provide good standard of care it is crucial that all staff providing NIV are trained in both knowledge as well as practical skills within their area of competence.

Objectives: The main objectives of this study were to assess the knowledge of local nurses who provide NIV patient care on non-invasive ventilation, and to associate the study findings related to knowledge with selected demographic variables of nurse participants.

Design and methods: The study was conducted among 78 nurses who work either in specialized units providing NIV therapy or NIV patient care at the acute general teaching hospital in Malta, excluding nurses in a managerial post. A self-administered online questionnaire, consisting of 35 close-ended questions, was prepared by the researcher and used to collect the data. For analysis of the results, frequencies and percentages were obtained using Mann-Whitney U, Kruskal-Wallis and Spearman's tests, where appropriate.

Results: Participants predominantly had between 6-10 years of general nursing experience and 3-10 years of NIV experience, with most having undergraduate degrees and more than half currently working in an emergency setting. Most of the participants attended NIV training and were more aware of local guidelines than international guidelines. Overall participants' knowledge was moderate, with participants having more knowledge in pathophysiology than in other domains. There was no statistical significance between knowledge and the independent variables.

Conclusions: The overall participants' knowledge level on NIV was generally moderate. Knowledge was better in variables such as units, nursing experience, NIV experience, and training, although no statistical significance was found. On the other hand, no difference in NIV knowledge levels existed between participants in different categories related to guideline awareness and formal education. A positive association was identified between the four knowledge domains with a statistically significant association between the monitoring, technical, and nursing domains.

Keywords: KNOWLEDGE, NON-INVASIVE VENTILATION, NURSING, RESPIRATORY FAILURE.

Dedication

I would like to dedicate this dissertation to my wife Daniela, to my six-year-old daughter Tiffany and my three-year-old daughter Emily, for their endless love and support.

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Abbreviations

ABG's	Arterial Blood Gases
ARF	Acute Respiratory Failure
BiPAP	Bi-level Positive Airway Pressure
CCCU	Cardiac Critical Care Unit
CI	Confidence Interval
CICU	Cardiac Intensive Care Unit
CINHAL	Cumulative Index to Nursing and Allied Health Literature
CL	Confidence Level
CO_2	Carbon Dioxide
COPD	Chronic Obstructive Pulmonary Disease
CPAP	Continous Positive Airway Pressure
CVI	Content Validity Index
DCU	Day Care Unit
EBSCO	Elton B. Stephens Company
ECG	Electrocardiogram
ED	Emergency Department
EPAP	Expiratory Positive Airway Pressure
ERS	European Resipratory Society
GCS	Glasgow Coma Scale
HDU	High Dependency Unit
HyDi	Hybrid Discovery
ICCMU	Intensive Care Coordination & Monitoring Unit
ICU	Intensive Care Unit
IMV	Invasive Mechanical Ventilation
IPAP	Inspiratory Postive Airway Pressure
ITU	Intensive Therapy Unit

JBI	Joanna Briggs Institute
MEDLINE	Medical Literature Analysis and Retrieval System Online
MeSH	Medical Subject Headings
NCEPOD	National Confidential Enquiry into Patient Outcome and Death
BTS	British Thoracic Society
NIC	Nursing Intervention Classification
NIH	National Institute of Health
NIV	Non-Invasive Ventilation
O_2	Oxygen
P&BU	Plastics and Burns Unit
PEEP	Positive End Expiratory Pressure
pH	Potential of Hydrogen
PRISMA	Preferred Reporting Items for Systematic Review
PS	Pressure Support
PSV	Pressure Support Ventilation
PubMed	Public/Publisher MEDLINE
RCT's	Randomized Controlled Trials

Chapter 1

INTRODUCTION

1.1 Introduction

Non-invasive ventilation (NIV) is defined by Hyzy & McSparrone (2021) as the delivery of positive pressure ventilation through a non-invasive interface, such as a nasal mask, a facemask, or nasal plugs. Thus, in NIV, air with specific fractionated oxygen is administered on inspiration to a patient, under positive pressure via a ventilator, while the patient is awake. This is opposed to invasive ventilation, which occurs through an invasive interface, such as an endotracheal tube or a tracheostomy, commonly used on an unconscious patient (Hyzy & McSparrone, 2021).

The use of non-invasive ventilation has significantly increased over the past three decades and has become an integral tool in the management of both acute and chronic respiratory failure (Kim et al., 2021; Jang & Hwang, 2017; Sanchez et al., 2014; Hoo, 2018). Initially NIV therapy was confined to critical care settings, however, as demand increased, with the appropriate resources and expertise, NIV has been adapted to be used in alternative ward settings (Sanchez et al., 2014). The United States National Inpatient Sample Database showed almost twofold increase in the number of hospitalizations for acute respiratory failure (ARF) between 2001 and 2009, becoming the most common reason for hospitalization. This report documented that the use of NIV has increased from 3.8 to 10.1%, whereas the use of Invasive Mechanical Ventilation (IMV) dropped from 48.5 to 42.1% (Stefan et al., 2013).

1.2 Background of the study

Evidence suggests that the proper use of NIV in acute respiratory failure has several advantages. In comparison with IMV, NIV reduces patient discomfort and procedural complications, improves quality of care, and reduces the strain on intensive care units as well as financial costs (Carron et al., 2013). NIV is sought when standard therapeutic measures such as antibiotics, diuretics, oxygen, and bronchodilators are not sufficient to maintain adequate ventilation and oxygenation. (Van der Sluijs, 2013). Numerous literature feature NIV as favourable in reducing the length of patients' hospital stays, improved outcome, and

reduction in mortality and morbidity (Hoo, 2018, Cherian et al., 2019, Tarah & Dalar, 2015, Raurell-Torreda et al., 2019). This is reflected in a recent British Thoracic Society (BTS) National Audit Report: Adult NIV Audit (2019), conducted on 3502 patients' records with in-hospital initiation of NIV (Davies 2019). It was reported that mortality was reduced from 34% in 2013 to 26% in 2019. The BTS mainly attributed this improvement to time reduction from diagnosis by blood gases to initiation of NIV and better patient selection for NIV. Therefore, it underlines the importance of immediate accessibility to blood gases results to recognise and treat respiratory failure. Equally important is the adequate selection of patients according to evidence-based indications. In both cases, it will result in a better chance of NIV success and positive patient outcomes.

Despite the benefits of NIV, there are several factors influencing the efficacy of NIV and failure may occur in as widely as 5 – 60% of cared patients. The failure of NIV can be attributed to several factors, including the severity of the disease, poor patient interface tolerance, the expertise of the team and the intensity of care provided by the environment (Scala & Latham, 2010).

Acute NIV patient care is only successful if the treatment is adequately provided through a multidisciplinary team approach (Davies et al., 2018). To provide a good standard of care it is essential that all staff are trained in both knowledge and practical skills corresponding to their role (Davies et al., 2018). The 2017 report by the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) highlighted a deficiency in associated competencies among healthcare professionals caring for patients with NIV. The report identified that 45% of the hospitals permitted staff without competencies to care for patients with NIV.

However, literature that defines nursing competencies in NIV is very limited and mostly grounded on expert opinion. According to Ali (2018). competencies include all related knowledge, skills, abilities, and attributes that form a person's job. This limited literature might be attributed to the fact that nursing competencies vary according to area of work, and roles overlap with other personnel. The British Thoracic Society recommends that a nurse

working with patients on NIV should at least be competent in these four areas: initial NIV machine set-up; monitoring of patient on NIV including observing compliance, synchrony and adequate ventilation; support patient mobility and rehabilitation; as well as initiate process of palliation on NIV (Davidson et al., 2016).

As nurses continuously provide close patient care, they play a vital role in the identification of deteriorating patients, requiring either optimization of NIV related factors or direct for escalation of care through endotracheal intubation and invasive mechanical ventilation (Annarani et al., 2017; Tarhan et al., 2015). Nursing care can improve patient compliance and monitor improvements, but success of NIV is drastically reduced if insufficient associated knowledge and experience exist (Mohammed et al., 2019). This failure is further exacerbated if a low nurse to patient ratio also exists (Mohammed et al., 2019).

1.3 Rationales and justification for the study

International studies have highlighted an inadequacy and inconsistency in nurses' knowledge on NIV due to lack of adequate training and protocols, resulting in poor patient outcome (Raurell-Torreda, et al., 2019). To the researcher's knowledge, no studies or standard nursing training on NIV exist in the local healthcare setting. Thus, this research is required because through the identification of knowledge gaps, the findings of this study would in turn aid, guide, and support the formulation of training initiatives aimed to improve the practices related to NIV in the local hospital setting. Hence, the research is pertinent to local nurses providing NIV patient care as well as practice nurses and practice development nurses responsible for formulating NIV nurse training. Furthermore, it is crucial to improve the limited amount of research on nurses' knowledge on NIV that is currently internationally available.

1.4 Research question, aims and objectives

Research questions act as enquiries that the study aims to answer, and along with hypotheses serves as a framework for the study (Creswell, 2014). The research question for this study was:

What is the level of NIV knowledge among local nurses who provide NIV care?

Therefore, the research aim is:

To assess the knowledge of local nurses with regard to non-invasive ventilation.

The research objectives are:

1. To determine the level of clinical expertise, experience, and academic background as well as other possible variables pertaining to the nurses applying NIV and NIV care in their respective specialised units.
2. To identify overall knowledge levels of nurses working with patients requiring NIV and NIV patient care.
3. To explore participant knowledge on the following knowledge domains: respiratory pathophysiology, technical knowledge, monitoring knowledge and nursing knowledge, related to NIV and NIV patient care.
4. To explore any correlation or association between clinical or academic training, and years of clinical experience with nurses' knowledge in NIV and NIV patient care.
5. To identify any association among the four knowledge domains mentioned above.
6. To explore participant knowledge for individual knowledge questions.

1.5 Study design and methods

The study was conducted using a descriptive quantitative approach with a non-experimental design, with 78 nurses working in units that provided care for patients on NIV at an acute general teaching hospital in Malta. A self-administered online questionnaire,

consisting of 35 close-ended questions, was prepared by the researcher and used to collect the data. For analysis of the results, frequencies and percentages were obtained and statistical analysis was performed using Mann-Whitney U, Kruskal-Wallis and Spearman's tests, where applicable.

1.6 Dissertation overview

This research study will consist of 6 chapters. Chapter 1 sought to introduce the topic of NIV and NIV patient care, as well as the motivation for the research, and logic behind the research aim and objectives. The following chapter, chapter 2, will present an analysis of the literature currently available pertaining to NIV and NIV patient care. Chapter 3 will subsequently present the methodological framework for this research study and data collection. The fourth chapter will set out the findings of the study, based on the data collected, and the fifth chapter will undertake an extensive analysis and discussion of this data, highlighting the findings and results. The final chapter of this dissertation, chapter 6, will present a conclusion of the study, highlighting the study's strengths and limitation, as well as recommendations generated for clinical education, training, and research on NIV and NIV patient care.

1.7 Conclusion

NIV knowledge is vital to successfully care for patients on NIV, since its use has significantly increased. Considering that nursing knowledge on NIV therapy has not been explored in the local population, this study was essential to fulfil this gap.

Chapter 2

LITREATURE REVIEW

2.1 Introduction to the review

This chapter aims to give an overview of the literature search strategy applied, the relevant literature identified, as well as a critical appraisal of all relevant literature. This is followed by an analysis and interpretation of the findings. This literature review provided a framework for the rest of the study both for the research tool construct as well as to compare the results with available findings. This systematized literature search and critical appraisal intended to answer two questions:

(1) what *knowledge should the nurse have*, when taking care of a patient with non-invasive ventilation?

(2) what *knowledge does the nurse have* while taking care of a patient with non-invasive ventilation?

2.2 Systematised review methodology

The systematic review methodology consisted of the processes adopted to determine the current applicability of literature on nurses' knowledge related to NIV patient care. Since there was a difference in characteristics in each individual question required to conduct this literature review, the researcher deemed best to use 2 different research strategies. A narrative review approach was used for the first question (*section 2.3*) and a systematized review approach for the second question (*section 2.4*).

2.3 Narrative review for question 1

2.3.1 Strategy applied to investigate question 1

In light of the necessity to identify the knowledge required to provide essential care to patients using NIV, the first search focused on literature surrounding such. Currently, research literature around this topic is dispersed across different guidelines, journals, papers, reviews, and books. Thus, for the first question, a narrative review was conducted. The aim of a narrative review is to answer the question by summarising previous literature and seeking

novel literature related to a topic (Campbell Collaboration, 2001). The advantage of a narrative review is that it uses a wider approach to collect information (Baethge et al., 2019). While tools such as the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) exist for systematized review, none exist for a narrative review (Ferrari, 2015). Ferrari (2015) states that a narrative review is essential to follow trends in clinical practices and scientific principles which otherwise would be lost with the restrictive rules of a systematized review. Conversely, the main weakness of a narrative review is subjectivity that would lead to bias (Ferrari, 2015; Baethge et al., 2019). In this case, since no hypothesis existed and a more general exploration on the topic was required, a narrative review was conducted. A narrative review proved essential in the context of this study as it helped in the creation of the questionnaire tool.

2.3.2 Search strategy for question 1 (*what knowledge?*)

To limit the bias generated by a narrative review, a framework as suggested by Ferrari (2015) was followed. The framework as described by the latter is presented in Table 2.1 below.

Table 2.1 *General Framework for a narrative review* (*Ferrari, 2015)*

Introduction	Content	To identify what knowledge a nurse should have while taking care of a patient on NIV (section 2.3)
	Structure	Knowledge on NIV • Respiratory pathophysiology • NIV setup • NIV patient monitoring • NIV nursing care, weaning and palliation
	Limits	Define the objectives and scope: • To identify the knowledge required by a nurse using NIV • To create a baseline for comparison to what knowledge the nurse needs while using NIV knows
Literature search	Search strategy	**Databases:** Medline, HyDi, CINAHL, EBSCO, and PubMed. **Keywords:** Related to nurse, non-invasive ventilation & knowledge (Table 2.2)
	Inclusion/exclusion criteria	Inclusion: • Research related to; NIV care, adult patients, nursing care, nursing knowledge and education, in English language and published between January 2000 and January 2022. Exclusion:

		• Research not related to NIV care, in languages other than English language, older than January 2000, and research related to paediatric and neonatal patients.
	Search Outcome	To verify the available studies
	Data Extraction	Citing and listing the study references
Central Body Discussion	Section 1 First Key Concept: Discuss & Evaluate Summarize	**Nurses' knowledge on respiratory physiology** • Respiratory physiology • Indication for NIV • Contraindications
	Section 2 First Key Concept: Discuss & Evaluate Summarize	**Non-Invasive ventilation setup** • Ventilator • Circuit • Oxygen • Interface • Modes of NIV • Settings • Alarms & Troubleshooting
	Section 3 First Key Concept: Discuss & Evaluate Summarize	**Non-Invasive ventilation patient monitoring** • Clinical monitoring • Physiological monitoring • NIV related monitoring • Complications
	Section 4 First Key Concept: Discuss & Evaluate Summarize	**Nursing care and rehabilitation in non-invasive ventilation** o Theory of needs • Breathing support • Nutritional care • Mobility & pressure injury prevention • Eye care, oral & total body hygiene • Elimination support • Communication aid • Psychological care, education, patient accomplishment & participation • Spirituality • Safety • Maintaining normothermia • Sleep • Weaning • Palliative Care
Conclusions	For each Summarized section: Main Points Connect with research needs Repeat the meaning for research design	Main Points: • Respiratory physiology • Non-Invasive ventilation setup • Non-Invasive ventilation monitoring • Non-Invasive ventilation nursing care & rehabilitation Research needs (*To avoid repetition the conclusion of the narrative review is located in section 2.9*)

2.3.3 Electronic search

An electronic search was conducted across 5 databases: HyDi, Medline, Cinahl, EBSCO, and Pubmed. Keywords and Mesh Subject Heading (MeSH) were selected according to the first research questions mentioned above, and their relationship and significance. The identified keywords were combined with the Boolean Operator "AND" and "OR". The truncation '*' was used to broaden the searches as it was deemed necessary to find all available literature that matched the inclusion criteria. Moreover, in accordance with the inclusion criteria, the following filters were applied: full text online, nurses, English language, and published between 2000 and 2022. These are presented in Table 2.2 below.

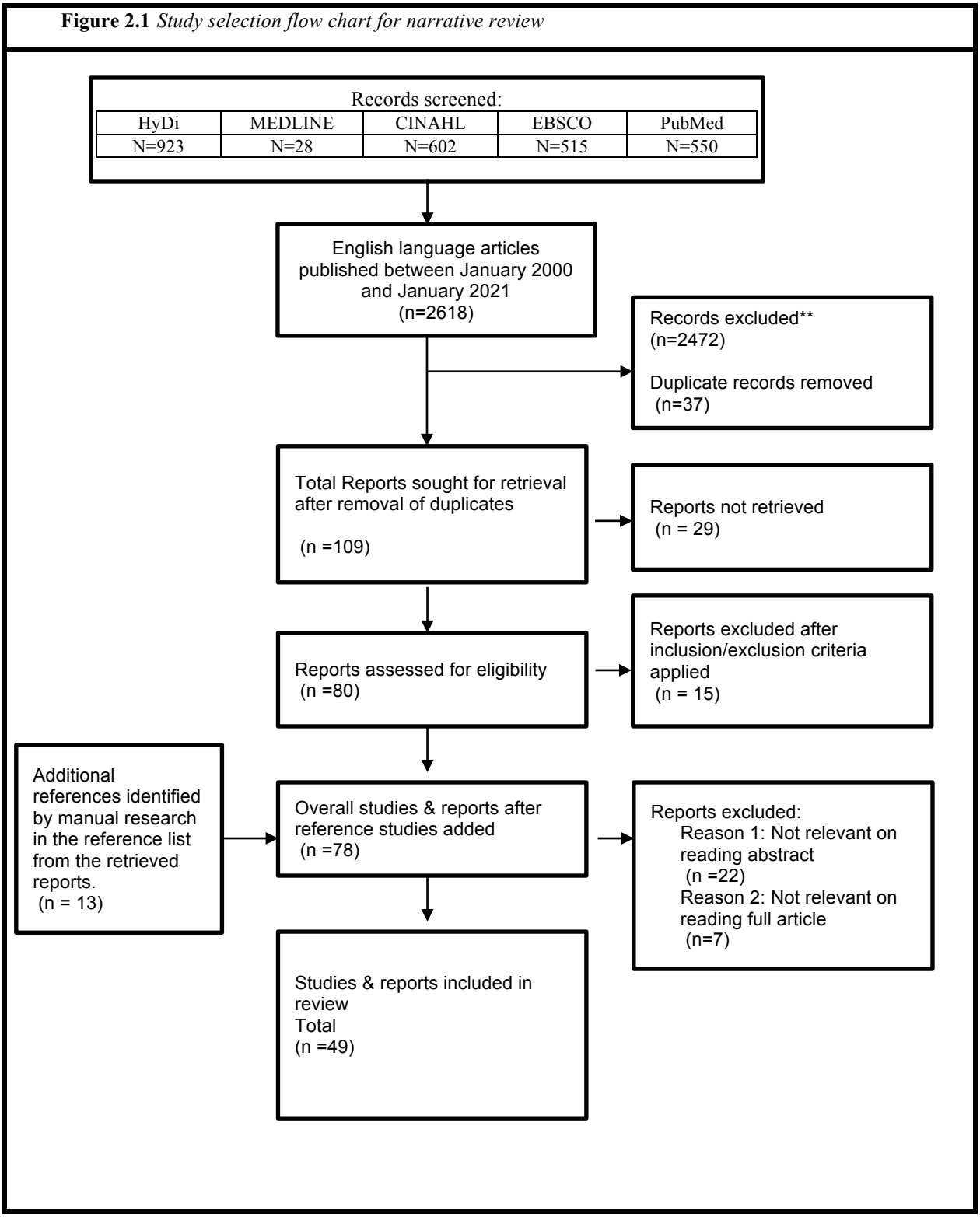
Table 2.2 *Search terms and synonyms.*

Concept			
Key words	Nurse	Non invasive ventilation	Knowledge
MeSH term	Nurses Nursing Nurs* Healthcarer Health-carer Carer Care-giver Caregiver	Non-invasive ventilation Noninvasive ventilation NIV NPPV NIPPV Bi-leveled ventilation Continuous Positive Airway Pressure CPAP Positive-Pressure Respirations Intermittent Positive-Pressure Ventilation Non Invasive Mechanical Ventilation Non invasive positive pressure Positive end expiratory pressure PEEP Pressure support ventilation Bipap Bilevel positive airway pressure Bi-level positive airway pressure Continuous positive airway pressure ventilation	Education Understanding Apprehension Awareness Comprehension Skill Skills Learning Cognition Information Acquaintance Insight Wisdom Intelligence

2.3.4 Search outcome

Figure 2.1 illustrates a flow chart of the study selection process that includes records identified, screened, excluded, and included as per criteria highlighted.

Figure 2.1 *Study selection flow chart for narrative review*



2.3.5 Data extraction

Table 2.3 below presents an overview of the studies included for the data extraction phase.

Table 2.3 *Studies included for data extraction phase for narrative review*

Study Design	Authors	First author & date
RCT's	Storre, J.H., Huttmann, S.E., Ekkernkamp, E., et al. (2014)	Storre (2014)
	Kwok, H., McCormack, J., Cece, R., et al. (2003)	Kwok (2003)
	Girault, C., Beloncle, F., Dangers, L., et al. (2009)	Girault (2009)
	Navalesi, P., Fanfulla, F., Frigerio, P., et al. (2000)	Navalesi (2000)
	Riachy, M., Tayeh, G.A., Dabar, G., et al. (2017)	Riachy(2017)
Non-RCT's	Ballard, E., McDonnell, L., Keilty, S., et al. (2010)	Ballard (2010)
	Berning, J.N., Poor, A., Buckley, S.M., et al. (2016)	Berning (2016)
Descriptive Quantitative	Raurell-Torreda, M., Argilaga-Molero, E., Colomer-Plana, M., et al. (2019)	Raurell-Torreda (2019)
	Terzi, N., Darmon, M., Reignier, J., et al. (2017)	Terzi (2017)
	Schallom, M., Cracchiolo, L., Falker, A., et al. (2015)	Schallom (2015)
	Tarhan, M., Hancer, O., Polat, F., et al. (2015)	Tarhan (2015)
	Nava, S., Pacilli, A.M.G., Valentini, I. et al. (2014)	Nava (2014)
	Kogo, M., Nagata, K., Ito, J., et al. (2015)	Kogo (2015)
	Walkey, A.J., & Wiener, R.S. (2013)	Walkey (2013)
	Annarani, M.A., Chacko, S.T., Lucas, A., et al. (2017)	Annarani (2017)
	George, D.L., Falk, P.S., Umberto, M.G. et al. (1998)	George (1998)
	Launey, Y., Painvin, B., Roquilly, A., et al. (2020)	Launey (2020)
	Bendavid, I., Singer, P., Theilla, M., et al. (2017).	Bendavid (2017)
Systematic reviews & Meta-analysis	Mohammed, H., Karim, R., Burns, K.E.A., et al. (2019)	Mohammmed (2019)
	Davidson, C., Banham, S., Elliot, M., et al. 2016)	Davidson (2016)
	Sanchez, D., Smith, G., Piper, A., et al. (2014)	Sanchez (2014)
	Ngandu, H., Gale, N., Hopkinson J.B. (2016)	Ngandu (2016)
	Carron, M., Freo, U., Bahammam, A.S., et al. (2013)	Carron (2013)
	Algahtani, J.S., & Alahmari, M.O. (2018)	Algahtani (2018)
Book Chapters	Dougherty, L., & Lister, S. (2011)	Dougherty (2011)
	Elliot, M.W. (2018)	Elliot (2018)
	Elliot, M.W. (2002)	Elliot (2002)
	Scala & Latham, R. (2010)	Scala (2010)
	Hare, A., & Chatwin, M. (2015)	Hare (2015)
	Simonds, A.K. (2015)	Simonds (2015)
	Brill, A. K. (2014)	Brill (2014)
	Kaul, S., et al (2006)	Kaul (2006)
	Cuomo, A.M. (2015	Cuomo (2015)
	McKenna, H.P., Pajnkihar, M. & Murphy, F.A. (2014)	McKenna (2014)
	Kinnear, W.J.M. (2014)	Kinnear (2014)
	Henderson, V. (1961)	Henderson (1961)
	Kaul, S., & Simonds, A.K. (2015)	Kaul (2015)
Reviews	Wheatley, I. (2021)	Wheatley (2021)
	Antonelli, M., Pennisi, M.A., Montini, L., (2005)	Antonelli (2005)
	De Azevedo, R., & Machado, F.R. (2013)	De Azevedo (2013)
	Papathanassoglou, E.D. (2010)	Papathanassoglou (2010)
	Singer, P., & Rattanachaiwong, S. (2018)	Singer (2018)
	Gonzales, M.M., Parreira, V.F. Rodenstein, D.O. (2002)	Gonzales (2002)
	Johnny, J.D., Drury, Z. Ly, T., et al. (2021)	Johnny (2021)
	Wong A.I., Cheung, P.C., Happ, M.B., et al. (2020)	Wong (2020)
	Metheny, N.A., Clouse, R.E., Chang, Y.H. et al.	Metheny (2006)

	(2006)	
	Ergan, B., Nasilowski, J., & Winck, J.C. (2018)	Ergan (2018)
	Schwartz, A. R., Kacmarek, R. M., & Hess, D. R. . (2004)	Schwartz (2004)
Online source	National Institute of Health (2022)	NIH (2022)

2.3.6 Discussion of the findings

2.3.6.1 Defining nursing knowledge in NIV

In nursing, knowledge can be gained through various means of learning. Oxford Dictionary (2021) defines knowledge as *the information, understanding and skills gained through education and experience*. Nurses gain scientific knowledge through formal and informal training or education, and experience. Nurses are expected to apply the gained knowledge into practice, and this is vital to deliver optimal NIV care, minimise complications, and improve patient outcomes (Elliot et al., 2002; Antonelli et al., 2005; Ensquinas et al., 2006). With rapidly emerging evidence-based information and improvements in ventilator technology, it is imperative for the nurses to keep updating their clinical knowledge. This may prove challenging for nurses and studies such as those conducted by the Ballard et al. (2010), Tarhan et al. (2015), Annarani et al. (2017), and Raurell-Torreda et al. (2019) have highlighted a lack of knowledge pertaining to the care of patients with NIV, leading to inferior quality of care.

Mohammed (2019) attempted to conduct a systematic review with meta-analysis on education and training in NIV, however high-quality studies in the area proved to be limited. Consequently, they conducted a narrative analysis by 64 international experts on education and training of NIV. They recommended that all key players, including nurses, should have a comprehensive understanding of respiratory physiology and pathophysiology. Additionally, they need to be familiar with the utility, limitations, and technicalities of NIV. Furthermore, they must have experience and knowledge in intensive care medicine, including management of agitation and hemodynamic monitoring.

In upcoming sections, this research explores the four topics highlighted by both Mohammed et al. (2019) and BTS (Davidson et al., 2016). The available associated literature

is explored, beginning with respiratory pathophysiology, followed by NIV setup, NIV monitoring, and nursing care with rehabilitation.

2.3.6.2 Respiratory pathophysiology

A basic understanding of how the breathing physiological system, including the mechanisms of the respiratory systems' load, drive, and capacity, is required for a practitioner to provide proper NIV care (Elliot, 2018). This is further supported by recommendations offered by Mohammed et al. (2019) and Davidson et al. (2016). Elliot (2018) elaborates that a detailed understanding of how various illnesses affect the respiratory system, as well as their implications for both routine medical therapy and how the ventilator should be used in the management of respiratory failure, is necessary.

- *Non-invasive ventilation indications*

Indication for NIV use varies according to the underlying patient condition, illness severity, and associated risk factors (Davidson et al., 2016). Data registries on NIV remarked poorer patient outcome when NIV was applied on diseases unsupported by evidence (Walkey & Wiener, 2013). Additionally, mortality was higher in patients that required intubation after NIV failure, than in those without a prior NIV trial (Walkey & Wiener, 2013). Therefore, this highlights the importance of appropriate patient selection when considering NIV. Having nurses knowledgeable about the indications for NIV will aid in timely selection of eligible patients, resulting in better patient outcomes (Mohammed et al., 2019).

There exists heterogeneity on the indications for NIV therapy. Nonetheless, both the British Thoracic Society and the European Respiratory Society recommend that NIV be used in the following conditions: severe acute exacerbation of COPD (pH<7.35 and relative hypercarbia), acute cardiogenic pulmonary oedema and acute respiratory failure (ARF), risk of respiratory failure post-extubation, weaning from IMV, ARF in selected 'not for intubation' patients, and ARF post lung resection or abdominal surgery. Furthermore, it is also indicated in acute deterioration of disorders associated with sleep hypoventilation and

palliation for symptom relief. Importantly, due to lack of evidence, both guidelines refute the use NIV in asthma.

- *Non-invasive ventilation contraindications*

The National Institute of Health (NIH) defines contraindication as "Anything (including a symptom or medical condition) that is a reason for a person to not receive a particular treatment or procedure because it may be harmful." (NIH, 2022). Davidson et al. (2016) divided contraindications into two groups: absolute contraindications, which are conditions that make it impossible to perform NIV and therefore should not be attempted, and relative contraindications, where NIV can be performed but needs caution and additional measures. Absolute contraindications include severe facial deformity, facial burns, and fixed upper-airway obstruction, (Davidson et al., 2016).

Relative contraindications require higher level of care such as high-dependency units (HDU) or intensive care units (ICU) setting and rapid and recurrent assessments whether if IMV is required. These include patients with:

- pH of <7.15 (pH <7.25 with additional adverse features);
- Glasgow Coma Scale score of <8, confusion or agitation;
- Cognitive impairment;
- Impending respiratory arres;
- NIV failing to augment chest-wall movement or reduce the level of CO_2;
- An inability to maintain an arterial blood oxygen level of 85-88%;
- A need for intravenous sedation;
- Adverse features requiring closer monitoring;
- The patient is difficult to intubate in the event of NIV failure;
- Vomiting;
- Recent upper gastrointestinal surgery;
- Hemodynamic instability;
- Untreated pneumothorax;
- Severe comorbidity;
- Bowel obstruction;
- Copious secretions requiring frequent expectoration or clearance using suction;

(Davidson et al., 2016; Wheatley, 2021).

Wheatley (2021) further highlights that the patient requires a higher level of supervision if one or more relative contraindications are present, whereas according to Davidson et al. (2016) these should not, on their own, lead to withholding NIV.

2.3.6.3 Non-invasive ventilation setup

NIV setup consists of the physical setup (ventilator, oxygen, circuit tubing, and interface) as well as adjustment of the ventilator settings (mode, settings, and alarms) (Simonds, 2015). Since several non-invasive ventilator arrangements exist, it is necessary for caring professionals (including nurses) to be familiar with both the equipment and software, as well as other alternatives. Moreover, it is important that variance in NIV equipment in the ward/unit is limited, as variation can cause confusion in NIV setup, leading to adverse events (Simonds, 2015).

- *Non-invasive ventilators & circuits*

Some non-invasive ventilators are complex intended for intensive care, while others are simple and are intended for households (Hare & Chatwin, 2015). Similarly to ventilators, various circuits exist which can be categorized into two: single limb circuits, and double limb circuits. Single limb circuits alternately deliver inspiratory and expiratory pressure, commonly used in general wards and households, and require an exhalation port (Hare & Chatwin, 2015). Double limb circuits sometime incorporate one in another (coaxial) and have separation inspiration and expiration limbs, with incorporated valves and commonly used in critical care setup (Hare & Chatwin, 2015).

- *Oxygen delivery*

Oxygen delivery in certain ventilators is administered through oxygen blenders. Oxygen blenders have the advantage of accurate titration and monitoring while delivering high oxygen concentration (Kaul et al., 2006). On the other hand, oxygen administration entrained

in the tubing or interface is required if a ventilator is without an oxygen blending system. Awareness that oxygen concentration varies depending on tubing placement, settings, type of exhalation port, breathing patterns and leaks, is essential for professionals using these set-ups (Schwartz et al., 2004). Moreover, certain higher levels of oxygen concentrations cannot be obtained without using an oxygen blender (Kaul & Simmonds 2015).

- *Non-invasive ventilation interface*

The interface (mask) is what connects the tubing to the patient's airway and delivers pressurised air through the airway to the lungs (Brill, 2014). Interface selection responsibility varies internationally between nurses, doctors, and respiratory physicians (Raurell-Torreda et al., 2019). Locally, nurses select the patient's interface, the main goal of which is to minimise leak without compromising comfort, while ensuring an adequate interface for the NIV setup (Brill, 2014). The most common interfaces are oro-nasal mask, nasal mask, full-face mask, nasal pillow, and helmet. Interfaces also vary in size and therefore manufactures' sizing gauges are recommended (Brill, 2014). The latter stresses that choosing the appropriate interface and sizing improves NIV success rates.

Interfaces can also be vented (have one or multiple little hole) or non-vented. Vents cause intentional leaks, preventing the rebreathing of own CO2 which causes or worsens hypercapnia (Hare & Chatwin, 2015). Most literature recommend vented interfaces to be used only with a single tubing circuit without an exhalation port as unwarranted intentional leaks can hinder NIV therapy (Davidson et al., 2016; Wheatley et al., 2021; Elliot, 2018; Hare & Chatwin, 2015).

Moreover, interface strategies differ between acute and chronic setting. While during acute respiratory failure (ARF) the priority is to achieve effective ventilation, in chronic respiratory failure the priority is placed on comfort (Brill, 2014). A small number of studies compared different interfaces in ARF. Overall, masks covering mouth and nose were associated with more positive outcome, with regard to faster improvement in ABG's, less NIV failure, while

nasal masks were often better tolerated in the longer term (Kwok et al., 2003; Girault et al., 2009; Navalesi et al., 2000). Both oro-nasal masks and full-face masks are recommended in the acute phase by the BTS and European Respiratory Society (ERS) guidelines (Davidson et al., 2016; Simonds, 2015).

- *Ventilator modes*

Ventilator modes are pre-defined settings that dictate how much support is offered by the ventilator (Storre et al., 2014). The most common types of ventilator modes used in NIV are presented below.

- *Continuous positive airway pressure* (CPAP) consists of a single pressure throughout the respiratory cycle. In absence of spontaneous breathing, it will still deliver a constant pressure, therefore inefficient in patients with episodes of apnoea, and not considered as NIV.
- *Pressure Support Ventilation* (PSV) *Mode* can be spontaneous or timed. In this case, the ventilator is triggered by inspiration or after a period of time if the patient's breathing spontaneously falls below the backup rate. Inspiratory time is also present in this mode, with the ventilator cycling into expiration after a set period of time rather in response to patient flow. This is particularly useful in situations with large leak or lung mechanical issues.
- *Timed Ventilation Mode* is when the ventilator has a timed mode and is not triggered or cycled in response to patient effort. Instead, it is the clinician who determines the respiratory rate, and the ventilator initiates inspiration at a set time.
- *Volume Present Mode* contrastingly requires a selection of the tidal volume or minute volume rather than pressure to be delivered.

- *Non-invasive ventilator settings*

NIV settings are the micro-components that the NIV modes highlighted above are constructed upon. They are crucial in NIV therapy as they ensures individualised care for every patient. The most important NIV settings are detailed below.

Inspiratory positive airway pressure (IPAP) is the pressure provided by ventilation on patient inspiration, while *expiratory positive airway pressure* (EPAP) is the pressure delivered by the ventilator on patient exhalation (Hare & Chatwin, 2015). *Pressure Support* (PS) is the difference between the IPAP and the EPAP, while the *back-up rate* is set up by a clinician and delivers timed breaths to ensure that minimum-breathing rate is reached, therefore ensuring the minimum minute ventilation. The *inspiratory time* ensures that the ventilator delivers an inspiratory pressure for a set time only, regardless of spontaneous patient breathing. Additionally, *trigger sensitivity* detects inhalation by monitoring changes in flow and pressure. Leaks can affect ventilator triggers as they can cause a drop in pressure and flow, therefore preventing the detection of patient inspiratory effort.

- *Alarms & troubleshooting*

Alarms aid the user identify problems caused by patients or technical faults. Alarms vary between machines however pressure alarms and flow alarms are commonly found in most. *Low pressure alarms* reflect a disconnection or excessive leaks while *high pressure alarms* are useful in volume-present modes due to excessive high pressure caused by occlusion, commonly in patients with physiological changes (Nava et al., 2014). Moreover, *flow alarms* also detect leak and airflow obstruction (Nava et al., 2014).

There are several indications for non-invasive respiratory support, therefore it is important to set the ventilator alarms according to the patient's condition. Hare & Chatwin (2015) stress that although NIV can be set without understanding the setting and function of the equipment, it can result in higher chance of failure.

2.3.6.4 Non-invasive ventilator patient monitoring

Patients on NIV, especially during the acute phase, require closer monitoring. Monitoring assesses NIV effectiveness in the acute phase and identifies potential failure immediately. It

comprises of clinical, physiological, and NIV-related monitoring. Nurses care for NIV patients constantly, and therefore perform most of the monitoring (Ergan et al., 2018).

- *Clinical monitoring*

Clinical evaluation upon initiation of NIV is fundamental and includes observing for patient comfort, respiratory distress, cough efficiency, and neurological status (Scala & Latham 2010; Ergan et al., 2018). Strong predicators of NIV failure consist of poor tolerance, severe encephalopathy, marked dyspnoea, and inefficiency of removing secretions (Scala & Latham 2010; Ergan et al., 2018). Observation of patients for the clinical features listed above is essential to raise the alarm when signs of failure are noticed.

- *Physiological monitoring*

Assessment of gases exchanged (oxygen and carbon dioxide levels) at the initial stage and during the early hours of starting NIV is essential to recognise failure. All of Davidson et al. (2016), Dougherty & Lister (2015), and Ergan et al. (2018) agree that the monitoring of pulse oximetry is essential in all patients on NIV therapy. Similarly, respiratory rate measurements both at baseline and after 1 and 4 hours of NIV is a strong predictor of NIV outcome, and therefore mandatory.

Unfortunately, unlike pulse oximetry, non-invasive carbon dioxide monitoring cannot be obtained accurately in most situations. Therefore, arterial blood gases (ABGs) are required. Davidson et al. (2016) on the BTS guidelines recommend that ABGs should be taken at baseline, after 1 and 4 hours, and at regular intervals thereafter. Additionally, ABGs should also be obtained with every change of the NIV setting and upon reverting to spontaneous breathing in order to decide on the timing for weaning from NIV (Davidson et al., 2016; Ergan et al., 2018).

Basic non-invasive cardiovascular monitoring such as ECG, pulse rate, and non-invasive blood pressure are recommended by Davidson et al. (2016) in patients undergoing NIV due to

cardiovascular complications. Scala & Latham (2010) argue that cardiovascular monitoring is essential in all patients on NIV as the occurrence of cardiovascular complications is correlated with NIV failure. Additionally fluid balance should be assessed daily in all patients as complications due to renal failure and fluid overload may be correlated with NIV failure (Scala & Latham, 2010). Likewise, Dougherty & Lister (2015) highlight that full monitoring of heart rate & rhythm, respiratory rate, blood pressure, and oxygen saturation are required. Monitoring of interface and ventilator-related issues are crucial to evaluate the effectiveness (patient-ventilator interaction) and complications of NIV (tolerance, leaks, and skin damage) (Brill, 2014; Ergan et al., 2018).

- *Non-invasive ventilation complications*

Although NIV has benefits over IMV, it is not without risks. Greater awareness of factors that cause complications, as well as recognising and treating complications, can enhance safety and improve NIV outcomes (Carron et al., 2013). A meta-analysis conducted by Carron et al. (2013) consisting of 154 articles, which included 62 Random Control Trials (RCT's), identified and classified complications into two; major and minor complications. Major complications have a high risk of morbidity and mortality, whereas minor complications only lead to mild or temporary medical issues and are related to NIV specific features like the gas flow or the interface (Wong et al., 2020).

2.3.6.5 Nursing care and rehabilitation

Providing basic nursing care for a patient on NIV requires a holistic approach. Patients that are usually independent in their daily activities generally need assistance when receiving NIV therapy. Research commonly highlights challenges related to caring for NIV patients, however the literature on this area of care is limited. Consequently, existing local guidelines, including the Intensive Care Coordination & Monitoring Unit (ICCMU) guidelines (Sanchez et al., 2014) and clinical nursing care books were used to construct this section. Additionally,

to ensure that all aspects of nursing care were covered, a framework built on the Theory of Needs by Virginia Henderson was used for guidance.

Virginia Henderson, The Theory of Needs

The Need theory is based on this definition of nursing, acknowledged by the International Council of Nursing in 1946. It was built as a concept rather than a theory, in a period where the patient's needs were the primary concern. It focuses on nursing care to fulfil needs whenever the patient is incapable to perform one or more of these needs independently (Marriner-Tomey & Alligood, 2009).

The highlighted needs consist of

1. Breathing normally;
2. Eat and drink adequately;
3. Eliminate body wastes;
4. Move and maintain desirable position;
5. Sleep and rest;
6. Select suitable clothes-dress and undress;
7. Maintain body temperature within normal range by adjusting clothing and modifying the environment;
8. Keep the body clean and well-groomed and protect the integument;
9. Avoid dangers in the environment and avoid injuring others;
10. Communicate with others by expressing emotions, needs, fears, or opinions;
11. Worship according to one's faith;
12. Work in such a way that there is sense of accomplishment;
13. Play or participate in various forms of recreation; and
14. Learn, discover, or satisfy the curiosity that leads to normal development and health and use the available health facilities.

    (Virginia Henderson, 1966)

The first nine components were categorized as physiological needs, ten and twelve as needs related to the psychological aspect of communication and learning, eleven as a spiritual need, and thirteen and fourteen as social needs (Meleis, 2012; George, 2011).

- *Breathing*

Breathing necessities are central to NIV patient care. Ensuring that the patient is in a sitting position, at a minimum 45-degree angle, improves ventilation and increases comfort (Dougherty & Lister, 2015). The later emphasizes on coordinating patient tasks such as washing and eating to limit exertion and prevent the patient from becoming distressed. Moreover, a thorough breathing assessment, as previously underlined, is fundamental to monitor and identify risk of deterioration (Dougherty & Lister, 2015).

- *Nutrition & hydration*

Nutritional approach in NIV varies based on patient acuity and existing NIV breaks (Terzi et al., 2017). Singer & Rattanachaiwong (2018), argue that other nutrition measures such as enteral or parenteral feeding should be considered in distressed patients. An observational study highlighted that 60% of NIV patients were starved up to 48 hours post-admission, and only 2.6% received enteral feeding (Terzi, et al., 2017). In addition, Terzi, et al. (2017) found an association between lack of or underfeeding and intubation rate, ventilation-free days, and mortality. Similar trends were found in a worldwide Nutrition Day ICU audit: 40% were starved 24 hours post-admission (Bendavid, et al., 2017).

Meanwhile several reasons for keeping NIV patients starved exist. Patients classified in critical conditions were kept starved in view of potential rapid sequence intubation. This does not explain why parenteral nutrition shouldn't be initiated. Additionally, nasogastric tubes cause unintentional leaks when used with an improper interface, create discomfort, pressure sores, nosocomial sinusitis, and aspiration of gastric content (George et al., 1998; Metheny et

al., 2006). Nowadays, interfaces have specific ports for nasogastric tubes which aid in preventing related complications.

Another study conducted by Kogo et al. (2015) compared 70 patients with ARF on NIV therapy for more than 48 hours that were incapable of independent feeding. Patients receiving enteral feeding were compared with those without feeding, with the results concluding that there was no relationship between enteral nutrition and mortality, although airway complications increased and the duration of NIV was prolonged.

In view of the abovementioned complications, it is therefore appropriate to consider early feeding and nasogastric tube insertion for feeding, however close monitoring is required as complications might arise due to the feeding itself (Wheatley, 2021).

Hydration is essential for mouth moisture, as patients are restricted from drinking due to lengthy interface application. It is therefore crucial for the caring nurse to encourage fluid intake when breaks of more than five minutes are tolerated, and if not, intravenous fluids should be administered, adequately monitoring patient fluid intake and output (Dougherty & Lister, 2015).

- *Elimination*

Constipation or delayed elimination affects 5 – 83% of critically ill patients, (De Azevedo & Machado, 2013). Factors such as shock, increased intra-abdominal pressure, use of sedatives and opioid agents, electrolyte disturbance, and change in nutritional intake increase the frequency of constipation (De Azevedo & Machado, 2013). Launey et al. (2020), in a multi-centred prospective observational study on 396 (44 patients on NIV) critical adults, found that non-invasive ventilation is associated with longer times to defecate. Constipation restricts proper ventilation, and is additionally associated with increased morbidity and mortality (Launey et al., 2020).

- *Mobility & pressure injury prevention*

The association between NIV therapy and pressure related injuries in literature ranges between 10 to 31% (Schallom et al., 2015). Patients are encouraged to sit out of bed if tolerated. When in bed, an upright position to facilitate chest wall expansion is recommended (Sanchez et al., 2014).

Additionally, a growing amount of evidence highlights pressure ulcers related to interface application (Brill, 2014). Facial ulcers create a considerable impact on the patient's outcome due to treatment adherence and quality of life (Alqahtani & Alahmari, 2018). Therefore, pressure injury prevention measurements are essential prior to initiation of NIV. According to the Sanchez et al. (2014) guidelines, measures include; utilising of interface with tubing ports, use of hydrocolloid dressings and skin moisturizer to protect skin in contact with the interface, and change or reposition interface when skin deterioration noticed. Additionally, the "2-fingers strap technique" (able to place two adjacent fingers underneath head-straps) prevents excessive skin pressure (Sanchez et al., 2014).

- *Sleep*

NIV is essential for patients with breathing problems to sleep. However, it is also a sensitive time for NIV patients as they may fear accidentally dislodging the interface from their face, which will cause leaks and therefore ineffective ventilation (Brill, 2014). Thus, the nurse needs to adjust and monitor the interface for leaks during the night more frequently. The sounds generated from the ventilator and the alarms also causes sleep interruption (Gonzalez et al., 2002). During sleep patients tend to hyperventilate due to a general reduction in brain responsiveness and decreased muscle tone, increasing upper airway resistance and decreasing chest expansion. It is therefore crucial that patients on NIV are more frequently monitored during their sleep, especially for hypoxia.

- *Maintain body temperature (clothing)*

No studies on thermoregulation related to NIV or IMV were found and therefore the researcher was unable examine this area.

- *Eye care, oral & total hygiene*

Besides improving comfort, Johnny et al. (2021) claim that oral hygiene might also reduce the chance of hospital-acquired pneumonia. Inward and outward airflow dries out the upper airway, including the mouth. Oral hygiene is required every two hours as long as the patient tolerates cessation of NIV for longer than five minutes (Sanchez et al., 2014). The ICCMU (2014) guidelines recommend at least a full body wash daily, and more often if the patient is diaphoretic and tolerates washing (Sanchez et al., 2014).

Dryness of the eyes occurs when using full-face masks or the interface leaks over the nasal area. This causes discomfort and leads to conjunctivitis, which in turn reduces effectiveness of NIV. The ICCMU (2014) guidelines also recommend that nurses provide eye care every two hours, apply artificial teardrops, look for signs of conjunctivitis, and alert the appropriate professional when noticed (Sanchez et al., 2014).

- *Safety*

Safety is present in all aspects of nursing care, from setup to monitoring and other procedures. This central characteristic means that it has already been overtly highlighted in sections 2.3.5.4 and 2.3.5.3 above.

- *Communication*

Patient tolerance to NIV is crucial to its success, with patient comfort and communication being major contributing factors (Riachy et al., 2017). Most patients on NIV with either a full face or an oro-nasal mask have impaired communication (Wong et al., 2020; Hoo, 2011). Such is commonly accepted, and limited effort exists in attempting to improve

communication with these patients. Additionally, when medical staff need to communicate with a patient, they often remove the interface, increasing the risk of patient breathing deterioration and limits communication to short periods (Wong et al., 2020). Such increases anxiety and frustration, reducing compliance, and potentially leading to NIV failure (Wong et al., 2020). Dougherty & Lister (2015) encourage nurses to reassure patients, use communication templates, and involve relatives to improve communication. Wong et al. (2020) also recommend innovative solutions such as interface embedded communication devices (microphones and speakers) to improve two-way communication.

- *Spirituality*

Virginia Henderson (1966) highlights spirituality as one of the needs required to provide holistic care. It has been shown that in patients on mechanical ventilation, spiritual care has the possibility of reducing anxiety and stress (Berning et al., 2016). No evidence on the impact of spirituality on NIV was identified. Nonetheless both anxiety and stress have a negative impact on NIV care. Therefore, Sanchez et al. (2014) suggest that spiritually is addressed as part of the psychosocial support needs.

- *Psychological care, education, accomplishment, participation*

Although there is evidence that providing psychosocial support to intubated and ventilated patients and their relatives is essential, no studies related to patients receiving NIV were conducted. A systematic review performed by Ngandu et al. (2016) focused on patients' perception on NIV. Themes such as fear (interface, death, suffering), lack of involvement, and information offered were cited.

Additionally, a narrative review conducted by Papathanassoglou (2010) suggested that vital signs, sleep, satisfaction and decrease in pain are linked to psychosocial support. Papathanassoglou (2010) further found that this further reduces length of stay and compilation rates.

- *Weaning from NIV*

Most patients will autonomously choose when NIV therapy is no longer needed. Kinnear (2014) maintains that is acceptable if adequate monitoring during the first night is performed. The objective of weaning is to reach spontaneous breathing the entire day prior to stopping nocturnal NIV. Weaning is performed by lengthening their periods of spontaneous ventilation and not by reducing NIV pressure (Kinnear, 2014).

The weaning plan must be explained to and agreed upon by the patient. A daily plan is needed with the goals. The nurse needs to stay with the patient during weaning to provide supplementary oxygen if the patient desaturates, monitor the breathing, and provide reassurance (Kinnear, 2014).

- *Palliation*

Henderson in her Need theory described a patient as a person who is incapable to function effectively and independently in one or more of the needs, and therefore requires a level of support (care) to maintain independence, or peaceful death (McKenna et al., 2014; Master, 2005). NIV is used for symptom relief when standard medical treatment fails and no escalation to invasive mechanical ventilation is decided and documented (Davidson et al., 2016; Cuomo, 2015). This approach is nowadays acceptable although studies still highlight resistance from the medical profession to comply with such procedure, (Sanchez et al., 2014).

2.4 Systematised review for question 2

2.4.1 Strategy applied to investigate question 2

The following sections collectively form the second part of the review. The aim of this part of the systematized review is to methodically attempt to obtain all the suitable research studies available to answer the second question **"what knowledge does the nurse taking care of non-invasive ventilation patient have?"**. In order to answer this question, this

section will aim to explore studies investigating nurses' knowledge on NIV and its association with other variables, mainly, education and experience. The following PEO question was formulated, since the topic under exploration contained exposure:

"What is the knowledge that the nurse taking care of non-invasive ventilation patient have and what is the association of education and training on knowledge?"

Consequently, Table 2.4 below, reveals the application of the PEO framework to the question highlighted above.

Table 2.4 *Completing the PEO framework for Systematised Review*

PEO	**Elements of the PEO Framework**
Population	Nurses
Exposure	Education and Experience in NIV
Outcome	NIV Knowledge

2.4.2 Eligibility criteria

The inclusion/exclusion criteria were compiled before beginning the search to specify the demographic characteristics (Polit & Beck, 2014) and to decrease the possibility of bias when picking studies. The criteria were based on the PEO question, thus they looked at the nurses' knowledge of NIV and how it relates to education and knowledge. Table 2.5 below presents the inclusion and exclusion criteria determined.

Table 2.5 *Inclusion and Exclusion Criteria for Systematised Review*	
Inclusion Criteria	**Exclusion Criteria**
Type of Intervention	
• Research studies which analysed nurses knowledge in relationship to training and/or experience on NIV	• Research studies which analysed NIV knowledge of other professional only • Research studies which analysed NIV training and experience of other professionals only. • Research studies which analysed experience, training and knowledge of a topic other than NIV
Type of Studies	
• Systematic reviews, meta-analyses, cohort studies, case control studies, cross sectional studies, and observational studies. • Studies with full text availability.	• Case reports, editorials, opinions, and narrative reviews. • Abstracts, letters to the editor and qualitative studies. • Studies unavailable in full text.
Type of Participants	
• Studies which included nurses, of any gender and ethnic group, residing in any geographic location.	• Studies that did not include nurses.
Language	
• Studies in English	• Studies published in a foreign language other than English and without available translation.
Conflict of Interest	
• All studies including those with declared conflict of interest were included.	• No studies were excluded on the bases of conflict of interest

2.4.3 Information sources

Following the development of the inclusion/exclusion criteria, the researcher went on to identify the important concepts, as well as synonyms and alternative phrases. (Table 2.6). The author then proceeded to use these key terms in the HyDi search engine, and the following databases: PubMed, MEDLINE Complete, EBSCO, and CINAHL Complete with Full Text. The search was carried out between August 2021 and January 2022.

Table 2.6 *Synonyms and Alternative Terms for Systematised Review*

PEO	Elements of the PEO Framework	Key Concepts	Synonyms and Alternative Terms
Population	Nurses	Nurses	Health Carer Carer Caregiver
Exposure	Exposure to NIV training & experience	NIV Training, Nursing Experience	Education Simulation Learning
Outcome	Increase in knowledge of nurses on NIV	NIV Knowledge	Understanding Wisdom Intelligence Awareness

2.4.4 Search outcome

After the inclusion and exclusion criteria were determined, the same databases, keywords and MeSH words characteristics implemented for the first question, were also applied for the second question. In addition, the following filters were applied in compliance with the inclusion criteria: Nurses, systematic reviews, meta-analyses, cohort studies, case control studies, cross-sectional studies, and observational research are all available in full text online and in English.

In addition, the reference lists of the retrieved studies were examined for studies that might be relevant (Table 2.7).

Table 2.7 *Keywords and Boolean Operators used with Number of Hits for Systematised Review*

	Keywords and Boolean Operator	**Total Hits**	**Relevant Hits**
HyDi Advanced Search	**Nurse**; Nurs* OR Health* OR Care* **Knowledge:** Knowledge OR Education OR Understanding OR Awareness OR Comprehension OR Skill* OR Learning OR Information OR Insight OR Intelligence **Non-Invasive Ventilation:** Non invasive ventilation" OR "Non-invasive ventilation" OR "Noninvasive ventilation" OR "Non Invasive Mechanical Ventilation" OR "Non-Invasive Mechanical Ventilation" OR "Noninvasive Mechanical Ventilation" OR NIV OR NPPV OR NIPPV OR "Bi-levelled ventilation" OR "Continuous Positive Airway Pressure" OR "CPAP" OR "Intermittent Positive-Pressure Ventilation" OR "Non invasive positive pressure" OR 'Pressure support ventilation" OR Bipap OR "Bilevel positive airway pressure" OR "Bi-level positive airway pressure" OR "Continuous positive airway pressure ventilation	323	34
PubMed		550	5
EBSCO Host Academic Search Ultimate		6	3
MEDLINE Complete Academic Search Ultimate		20	8
CINAHL		86	5
Reference List		13	8

2.4.5 Study selection and data collection process

An audit trail in research is imperative for highlighting the methodical process adopted by a researcher during data collection, and therefore facilitating understanding of the process for literature extraction (Gerrish & Lacey, 2010). Hence, a tabular form was constructed by the researcher and reviewed by the research supervisor. This enabled the researcher to record the full electronic search strategy, as well as the study results, in an objective way. The search engine/database used, and the keywords and Boolean operator(s) inserted, were recorded in the respective tabular forms. The overall number of hits, the number of possible relevant hits, as well as the title, author, and date of any feasible relevant study were all noted, in the tabular formats.

2.4.6 Data items

The researcher generated a data extraction form before attempting to extract any information from the trials. The information extraction from for the research studies retrieved is highlighted in the Table 2.8 below.

Table 2.8 *Type of Data Extracted from Studies for Systematised Review*
Demographics including age, gender, location & other population characteristics
Study Design
Period study was carried out
Sample size
How experience, training & education and knowledge were defined.
Setting
Keywords
Inclusion & Exclusion Criteria
Recruitment Methods
Method of Data Recording
Outcome Measures
Ethical Considerations
Statistical Analysis Methods Used
Funding & Conflict of Interest

2.4.7 Risk of bias in individual studies

Bias is outlined as the influence that prevents objective consideration of a question, which in turn can affect the quality of evidence (Polit & Beck, 2014). Good clinical practice might be in jeopardy when guided by findings that are biased, inaccurate, or misinterpreted (Polit & Beck, 2014). To minimize this risk, numerous approaches were created to rigorously examine the reliability, relevance, and outcomes of published studies, as well as to effectively decrease bias (Burns & Grove, 2011). Because these tools are designed to work with a variety of research designs, Gerrish and Lacey (2010) emphasise the importance of identifying appropriate checklists for each study design that fits the inclusion requirements. Thus, as the studies found consisted of quantitative cross sectional, the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies (JBI, 2017) was used for all relevant studies. The tool was used to evaluate the validity, reliability, and applicability of the studies retrieved in a systematic, explicit, and consistent manner (Gerrish & Lacey, 2010). The tool was also utilised to gauge for the presence of bias common in every research study (Gray et al., 2017).

2.4.8 Risk of bias across studies

Risk of publication and related biases, even in rigorously conducted systematic reviews, cannot completely be eliminated, Gerrish and Lacey (2010). To identify the bias possibilities on a study a formal assessment by statistical model techniques such as the funnel plots are required. In this systematic review, however, no funnel plots or other statistical tests were utilised due to time constraints. Although around 86% of the journals are published in the English language and there is a higher chance of citation in the English language, by no means does this mean that non-English language studies are inferior, Jackson and Kuriyama (2019). Nonetheless, owing to time restrictions, as well as a lack of resources and funding, the systematic review's inclusion/exclusion criteria specifically stated that only articles written in English were considered.

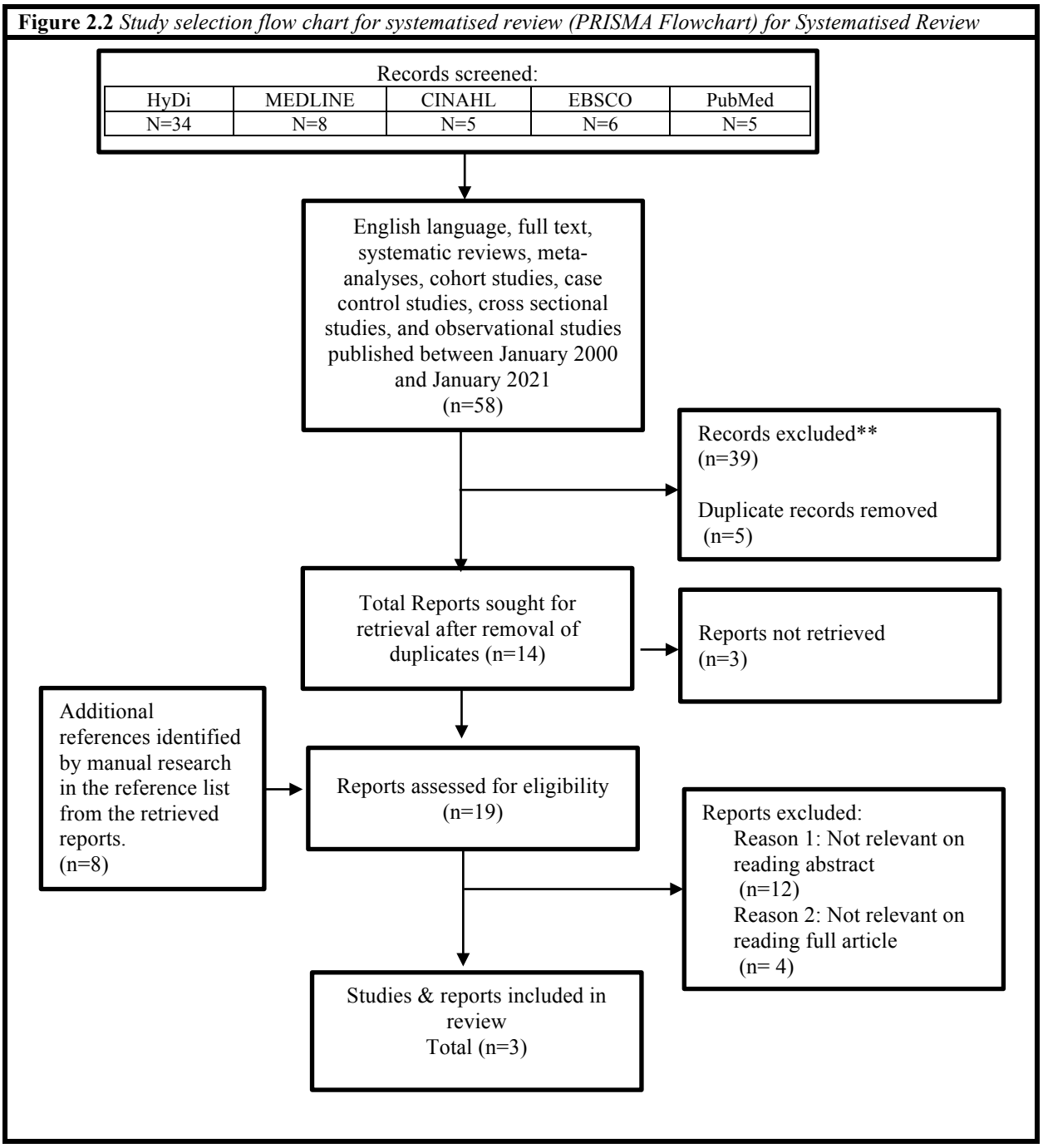
2.4.9 Results

The sections that follow intend to detail the results of the critically selected studies, starting with the studies' characteristic description, appraisal for bias, presentation of the results and discussion for each study.

2.4.9.1 Study selection

Figure 2.2 depicts the PRISMA flowchart of the study selection process for this section that includes records identified, screened, excluded, and included as per criteria highlighted.

Figure 2.2 *Study selection flow chart for systematised review (PRISMA Flowchart) for Systematised Review*



The reasons for excluding those articles upon reading the full articles are presented in Appendix 20.

Following an extensive search, the following studies listed in Table 2.9, were chosen to be included in the systematic review.

Table 2.9 *Studies retrieved and included for Systematised Review*

Name of Study	Author	Date	Type of Study
Nurses' and physicians' knowledge and skills in non-invasive ventilation: Equipment and contextual influence	Raurell-Torreda et al.	2019	Cross-sectional Descriptive Study
Knowledge of Nurses Regarding Non Invasive Ventilation (NIV) Therapy	Annarani et al.	2017	Cross-sectional Descriptive Study
Noninvasive Mechanical Ventilation Knowledge Level of the Nurses: A Questionnaire Survey in a Tertiary Care Training and Research Hospital	Tarhan et al.	2015	Cross-sectional Descriptive Study

2.4.9.2 Study characteristics

Table 2.10 summarises and contrasts the study characteristics of the three research studies retrieved.

Table 2.10 *Characteristics of the studies retrieved.*

Authors & Date	Raurell Torreda et al. (2019)	Annarani et al. (2017)	Tarhan et al. (2015
Type of Study	Cross-sectional Descriptive Study	Cross-sectional Descriptive Study	Cross-sectional Descriptive Study
Location of Study	Spain	India	Turkey
Aim of the study	To assess NIV knowledge and skills among nurses and physicians in different context.	To assess knowledge of nurses regarding NIV therapy and associate findings of knowledge with selected demographic variables.	To determining the level of knowledge about NIV of nurses working in a training and research hospital.
Number of participants	N=229: (Nurses n=181), (Doctors n=48)	N=100 nurses	N=147 nurses
Sampling	Total population of nurses & physicians (n=407)	Computer assisted simple random sampling	Total population of nurses (n=210)

Participant's selection units/hospitals	4 ICUs, 3 ED, 3 recovery units and 3 general wards in 4 university hospitals	Selected multispecialty wards in a tertiary care training and research hospital	All ward/units in a tertiary pulmonary hospital
Inclusion & Exclusion criteria	Inclusion criteria: Nurses & doctors. Working in the selected wards & hospitals. All nurses & doctors hired regularly included. Exclusion criteria: Doctors that were never on call	Inclusion criteria: Nurses with more than one year of experience. Available at the time of data collection.	Inclusion criteria: All nurses working in the hospital (tertiary pulmonary hospital).
Method of data collection	Self-designed, self-administered, close-ended, structured questionnaire; (13 knowledge questions).	Self-designed, self-administered, close-ended, structured questionnaire; (15 knowledge questions).	Self-designed self –administered, close-ended, structured questionnaire; (35 knowledge questions).
Tool Validation	Face and content validity by a Delphi procedure; 28 health professionals from 4 hospitals, 20 nurses & 8 physicians. Kappa Index of 0.97 (95% CI [0.965-0.975]	Validated for content validity; 4 nurses 1 medical expert. CVI score of 0.97 (4.93/5=0.97)	There is no mention on how or if the tool was validated.
Questionnaire tool scoring	1 point for correct answer, 3 points for "do not response" answer 5 points for incorrect answer. Therefore the higher the score the less the level of knowledge	1 point for correct answer, 0 points for incorrect answer.	1 point for correct answer, 0 points for incorrect answer.
Outcome measurements	Demographics and knowledge levels of participants on aspects of NIV	Demographics and knowledge levels of participants on aspects of NIV	Demographics and knowledge levels of participants on aspects of NIV
Statistical Method used	Frequency and percentages for correct and incorrect answers. Mean+/- SD for each item, by unit and professional	Categorical Variables were reported by frequency & percentages. Mean +/-SD was reported for continuous variables.	Average, Mean +/- SD, percentage.
Method for association of variables	Inferential analysis Fisher / Chi square test for qualitative variable and Student T test for	Chi-square/ Fisher's exact test P value <0.05 adopted.	Mann-Whitney U, Kruskal-Wallis one-way analysis of variance tests. Result 95% CI

	quantitative. P value of <0.05 adopted.		p<0.05 adopted.
Participant stratification	Experience (professional, unit, NIV), training, unit/hospital & profession.	Age, gender, professional qualifications, NIV session attendance, care provision to NIV patients.	Gender, marital status, education status, unit, years of experience, institution experience, state & source of training.
Subgroup analysis	Doctors and nurses	Not applicable	Not applicable
Knowledge definition	Interface knowledge, predictors of NIV success & failure, NIV strategies, and nursing care in NIV.	Interface knowledge, nursing care in NIV, NIV parts and alarms, indication & contraindication of NIV, hypercapnea definition, and the aim of PEEP 3 levels of knowledge were defined according to score; <50% - Inadequate Knowledge 51%-74% - Moderate Knowledge >75% Adequate Knowledge	Interface advantage, NIV setup knowledge, NIV advantages, complications, improvements and contra-indications, considerations prior to NIV applications, and criteria for NIV success.
Definition of education/ training	The authors did not define training.	Class attendance on NIV	Previous training received but not defined. A selection list of training sources was provided consisting of; seminars, and literature.
Definition of experience	Professional experience, unit experience & NIV experience in years	Providing care for patients on NIV	Professional experience & institution experience in years
Ethical consideration	Permission provided by the Clinical research ethics committee of; Hospital Universitari de Belvitge Hospital Dr. Josep Trueta de Girona Hospital Clinic de Barcelona Consorci Hospitalari de Vic	College of Nursing Research Committee.	Secretariat General of Istanbul Faith Public Hospitals Association.

Any research Grant	Authors did not report whether the study was funded or not	Authors did not report whether the study was funded or not	The authors declared that no finical grant was provided for the study
Conflict of interest	The authors have no conflict of interest declared	The authors did not explicitly state that they had no conflict of interest	The authors declared that there was no conflict of interest
Keywords	Non-invasive ventilation; Emergency; Critical care; Skin lesions; Masks	Knowledge, Non – Invasive Ventilation Therapy, Nurses.	Knowledge, noninvasive ventilation, nursing, respiratory failure.
Study period	First semester 2016	The authors did not explicitly state the period that the study was conducted.	July 2013

2.4.9.3 Risk of bias within studies

The following section will appraise and scrutinise the aforementioned studies in light of credibility and bias.

- *Appraisal of Raurell-Torreda et al. (2019)*

Raurell-Torreda et al. (2019) held a cross-sectional descriptive study assessing knowledge and skills among nurses and physicians in four hospitals in Spain between January to March 2016.

Data was collected using a questionnaire devised by the authors, and consisted of close-ended demographic questions and thirteen knowledge questions. Tool validation consisted of face validity and content validity, performed by 28 'experts' in NIV. A Delphi approach was used for validation although the amount of rounds performed was not specified. The final questionnaire had a Kappa Index of 0.97 (95% CI [0.965-0.975].

The authors opted for a whole population (407 nurses and doctors) to avoid sampling and selection bias, of which 229 participants (56.3%) were successfully recruited (181 nurses and 48 doctors). The reduced response rate might have led to non-response bias. Non-response bias alters characteristics of responders and non-responders, whom are not properly accounted for and may alter the results (Bowling, 2014). This is further observed as doctors had poorer participation rate (39%) compared to nurses (63.7%). This raised an issue in scores as

responses of both nurses and doctors were combined when knowledge on NIV was compared to unit. Participation was voluntary, and the invited participants worked in the following settings; ICU, recovery unit, emergency department, and general wards. This may also have led to voluntary response bias as participants self-select themselves and cause an overrepresentation of certain individual characteristics.

Participants included nurses and doctors working in selected wards and hospitals. Moreover, participants from the relieving pool, regularly placed in selected wards, were also included. This is understandable since they provided NIV therapy in the studied units. Doctors who were never on call were excluded, even though they possibly prescribed NIV treatment. The authors decided to exclude the former since they did not offer NIV maintenance supervision. The rationale behind this is somewhat unclear to the researcher.

Demographics collected consisted of profession, experience, training, unit, and working hospital. Experience was divided into professional experience, unit experience, and NIV experience (in years). The definition of training provided in each unit according to the author was presented in the paper's annex. Unfortunately, the researcher could not obtain access to the information.

Knowledge was defined through the questionnaire based on these areas; interface knowledge, predictors of NIV success and failure, NIV strategies, and nursing care in NIV. Knowledge scored a value of 1 if correct answer, 3 if "no response" and 5 if incorrect answer, therefore the lesser the score meant the more knowledgeable the response. The results were presented in both numerical values and percentages and the mean +/- for each item was also detailed. The authors used the Fisher Test, Chi Square Test, and the Student T test with a 95% confidence interval and a p-value of <0.05. There is no clarity on which of the tests were used for which variables, and therefore the researcher cannot comment on their applicability.

The participating hospitals' clinical research ethics committee approved the study. The authors did not say whether the study was paid for, but they did indicate that they had no

conflicts of interest. The study design appears to be robust, with a moderate risk of bias, based on the arguments raised.

- *Appraisal of Annarani et al. (2017)*

Annarani et al. (2017) conducted a cross-sectional descriptive study in India. The study aimed to assess knowledge of nurses on NIV therapy and associate knowledge findings with selected demographic variables.

For data collection, the authors constructed a questionnaire consisting of close-ended questions, including demographics, and 15 knowledge questions. The tool content validity was performed by 4 nurse experts and 1 medical expert, and resulted in a content validity index (CVI) score of 0.97. According to Polit & Beck (2007), S-CVI of 0.9 or higher is a prime score for CVI.

Participants were selected using computer-assisted random sampling from multispecialty ward nurses in a Tertiary Care Training and Research Hospital. No further details were provided on the sample significance to the whole population. While random sampling will eliminate selection bias, it might not be a true representation of the real population. Inclusion criteria consisted of nurses with more than one year of nursing experience.

Demographics collected included age, gender, professional qualifications, and years of experience in the current hospital. The authors did not give further explanation on why only the experience in the current hospital was considered, creating a potential for bias. Participants were asked however if they had any previous NIV class attendance and NIV caring experience.

Knowledge questions covered the following topics; nutrition, priority nursing, pressure prevention, positioning, interface application and selection, nursing assessment, phobia, alarms, hypercapnia definition, ABGs interpretation, PEEP purpose, NIV parts, indications & contraindications, and purpose of NIV therapy. Scores were converted in percentages and categorized into three classes; a score lower than 50% defined inadequate knowledge, a score

from 50% to 75% defined moderate knowledge, and a score above 75% adequate knowledge. No justification on the classification of these percentages was provided by the authors.

Categorical variables were reported by frequency and percentages while the Mean +/- SD was reported for continuous variables. The Chi Square Test and the Fisher's Test were used for evaluation of any association between the variables and a p value of <0.05 was adopted. The College of Nursing Research Committee provided ethical approval. The authors did not say if the study was funded or not, but they denied any conflicts of interest. The study design appears to be robust, with a moderate risk of bias, based on the arguments raised.

- *Appraisal of Tarhan et al. (2015)*

The Tarhan et al. (2015) study is similar to the above studies, aimed at determining the level of knowledge nurses have in NIV, working in Yedikule Chest Diseases and Chest Surgery Training and Research Hospital. The study consisted of a cross-sectional descriptive approach. A close-ended questionnaire was used for the study and consisted of 36 demographics and knowledge questions. Although this was a self-constructed questionnaire the authors failed to comment on the methodology of the tool validity, creating doubts if the tool is genuinely valid (Bowling, 2014).

The study's inclusion criteria consisted of nursing staff working at the previously mentioned hospital. No other inclusion or exclusion criteria existed. The total population of nurses (n=210), working in the hospital were invited to participate. The authors argue that since the nurses regularly rotated between wards, they all had the potentiality of caring for patients on NIV. This eliminated any probability for selection and sampling bias to occur. From the total population around 70% participated (n=147), a high percentage and a true representation of the whole population.

Demographics collected included; gender, marital status, educational qualifications, place of work, experience, and NIV training. Experience was divided as years of nursing experience and years of institutional experience. Training was defined as previous session in NIV and

source (seminar, courses, etc.; literature; by oneself; physician; or other nurses). The demographics were collected in frequency, percentages and Mean +/- SD.

NIV knowledge was outlined by means of questions on advantages, contraindications, complications & symptoms reduction in NIV, advantages of interface, considerations prior to NIV applications, criteria for NIV success, and difference in NIV setup. Score consisted of 1 point for a correct answer and 0 points for an incorrect one. Knowledge data was collected in frequency and percentages.

Participants were stratified by gender, marital status, educational qualifications, and state of training. Variables were compared with knowledge using the Mann-Whitney U test, while the place of work, occupational experience, institutional experience and source of training were analysed using the Kruskal-Wallis one-way analysis. The results had a 95% confidence interval and an adopted p-value with a significant level of <0.05.

The Secretariat General of Istanbul Faith Public Hospital Association provided ethical approval. The authors declared that no funding was provided for the study and denied any conflict of interest. Given tool validity methodology was not provided, the study by Tarhan et al. (2015) appears to have a higher risk of bias when compared to the other studies.

2.4.9.4 Results of individual studies

The results will be presented in separate tables, as variation in the samples, methodology and analysis exists between the different studies. It is important to highlight that only results related to nurses' knowledge were presented here both for clear representation of results and ease of reference. Results related to other professionals were not included in this section. As a result, the reader is invited to consult the original papers for a more thorough examination of the tables as presented by the respective authors. Table 2.12 presents the results of the study by Raurell-Torreda et al. (2019).

- *Raurell et al. (2019) results*

Raurell-Torreda et al. (2019) involved 181 nurses (63.7%) from a targeted population of 284 nurses. ED professional had the least in-unit experience (years of clinical experience in the unit and with NIV therapy) with a mean difference of 5.4 years, 95% CI [3.1-7.8], p<0.001 and also with NIV with a mean difference of 4.9 years, 95% CI [3.5-6.5] compared to ICU. Results related to NIV training, due to lack of clarity in presentation, were excluded from this review. Nurses replied only 25.1 % of the answers correctly on interface selection and application.

Knowledge of nurse participants was lower than doctors' (3.27+/- 0.5 vs. 2.37+/- 0.5) with a 95% CI and p value of <0.001. Furthermore, only half of the nurses knew how to adequately measure a mask and to apply a smaller size when in doubt. Additionally, 11.7 % of nurses correctly indicated that masks should allow enough space to allow 2 fingers to pass beneath the headgear.

Nurse (n=181) and doctors (n=48) obtained 52.8% correct answers related to patient-ventilator strategies, ventilator settings (65.3%), NIV success (91.7%), and failure (86.9%). Of concern, a majority of general wards participants, (10 nurses and 3 doctors), incorrectly chose to improve patient-ventilator synchronization. Only 7% of the global participants identified agitation as a complication of NIV. Lastly, both ICU and ED professional (41.3% and 45.2 % respectively) correctly consider physiotherapy as part nursing care when compared to the general wards (15.4% p=0.05). The authors noted this as concerning in the latter since "Thoracic Physiotherapy" (NIC3230) is part of the Nursing Intervention Classification (Bulechek et al., 2013).

Table 2.11 presents the results of the study by Raurell-Torreda et al. (2019).

Table 2.11 *Raurell-Torreda et al. 2019*

Unit	Targeted population	Response rate (N)	Response percentage (%)	Experience (included both nurses and doctors)			Correct responses number / N (%)	
				Profession	Unit	NIV	Nurses targeted questions (10,11,13)	Nurses & Doctors targeted questions (3,7,8,9,12)
ICU	198	130	65.6%	14.9 +/- 10.5	11.4 +/- 9.3	9.4 +/- 7.1	98/390 (25.1%)	396/750 (52.8%)
ED	42	28	66.7%	12.1 +/- 9.9	6.1 +/- 6.1	4.4 +/- 2.8	21/84 (25%)	112/210 (53.3%)
Post surgical	29	13	44.8%	17.8 +/- 9.2	11.3 +/- 8.7	6.5 +/- 5.1	9/39 (23.1%)	66/120 (55%)
Wards	15	10	66.7%	16.3 +/- 7.4	10.6 +/- 6.5	4.3 +/- 3.8	8/30 (26.7%)	30/65 (46.2%)
Global	**284**	**181**	**63.7%**	**14.8 +/- 10.2**	**10.4 +/- 8.7**	**7.9 +/- 6.5**	**136/543 (25.1%)**	**604/1145 (52.8%)**

- *Annarani et al. (2017) results*

In Annarani et al. (2017) study, most participants were females (97%), and had general nursing and midwifery as their professional qualifications. The majority of participants (62%) had between 5 to 20 years' experience, while only 12% of total participants were between 41-50 years. Only 26 % of participants attended a class on NIV therapy, but the majority (66%) have taken care of patients on NIV therapy.

Only 31% had moderate adequate knowledge (50%-75%) and only 1% had adequate knowledge (>75%). The questions most participants answered correctly were on; parts of NIV machine (75%), the meaning of hypercapnia (81%), patient-positioning (70%), purpose of NIV therapy (65%), and priority nursing (63%). The answers with the lowest answer rate were related to nutrition, indications, mask selection, and application and contraindications, (20%, 19%, 18%, 17%) respectively.

There was no statistical significance between the level of knowledge on NIV and age (p 0.341), gender (p 0.451), years of experience (p 0.106), or educational qualification (p 0.095).

There was however, a statistical significance between attendance of NIV class (p 0.022) and exposure to NIV care (0.027) and NIV knowledge.

Table 2.12 presents the results of the study by Annarani et al. (2017).

Table 2.12 *Annarani et al. 2017*

Demographic Variables	>51% correct answers	>50% correct answers	p value
	%	%	
Age (Years)			
20-30	38.6	61.4	0.341
31-40	29.5	70.5	
41-50	19.7	83.3	
Gender			
Female	32	68	0.451
Male	33.3	66.7	
Years of Experience			
1-5	32.4	67.6	0.106
5-10	45.9	54.1	
10-15	14.3	85.7	
15-20	18.2	81.8	
>20	0	100	
Educational Qualifications			
GNM	35.2	64.8	0.095
BSc (N)	0	100	
Post BSc (N)	0	100	
Attended NIV class			
Not attended	25.7	74.3	*0.022
Attended	50	50	
Taken Care of NIV patients			
Not cared for NIV patients	17.6	82.4	*0.027
Cared for `NIV patient	39.4	60.6	

- *Tarhan et al. (2015) results*

In the study by Tarhan et al. (2015) the mean age of the participants was that of 32.45+/-7.59. Of the participant nurses 85.7% were females, 60.5% were married and 46.3% had a bachelor's degree. The majority, 38.8% worked in an internal medicine unit. While 27.9% of the participants had 1-5 years' experience, almost half (45.6%), had the same term in the same institution. Furthermore 40.8% had received previous training in NIV and 24.5% had learned how to administer NIV by themselves.

When taking into consideration individual questions, only 18.4% knew all the advantages of NIV and 24.5% incorrectly chose cardiogenic pulmonary oedema. Only 4.8% knew all the advantages and disadvantages of the oro-nasal mask even though it is commonly used in their setting. On the other hand, 78.9% of the participants responded correctly on interface application, and 68.7% correctly recognized gastric distension as an NIV therapy complication. Similarly, knowledge on NIV success rate was present in 89.9% of the participants and 61.2% correctly chose answers related to administration of inhaled drugs. Nurse knowledge on the asphyxia valve and exhalation port was present in 61.2% and 56.5% of the participants. 75.5% of the participants had proper knowledge on filter application and use in terms of reducing infections. Also, nurse participants had sufficient knowledge related to NIV breaks but had low knowledge related to NIV maintenance. Lastly, only 2.7 % knew the difference between conventional ventilators and NIV-specific ventilators.

There was statistically significance found between gender (p 0.037) and educational level (p 0.011) but no statistically difference related to marital status (p 0.183). Female participants and those with a post-graduate degree had higher scores. The Kruskal-Wallis one-way analysis was used to obtain an associate value on knowledge between; units (p 0.087), profession experience (p 0.536), institutional experience (p 0.555) and training state (p 0.292) and training source (p 0.156) value. There was no statistically significance i.e. ($p < 0.05$) between these variables on NIV knowledge.

Table 2.13 presents the results of the study by Tarhan et al. (2015).

Table 2.13 *Tarhan et al., 2015*

Demographic variable	Number	Percentage	Questionnaire mean score	P value
Gender*				
Female	126	87.5	76.98	**0.037**
Male	21	14.3	56.14	
Marital Status				
Married	89	60.5	70.24	**0.183**
Single	58	39.5	79.78	
Qualifications*				
Medical vocational course	24	16.3	57.12	**0.011**
Associate degree	45	30.6	68.81	
Undergraduate degree	68	46.3	78.59	
Postgraduate degree	10	6.8	106.65	
Unit**				
Internal medicine	57	38.8	67.42	**0.087**
Surgical clinic	23	15.6	73.30	
Emergency Unit	16	10.9	63.12	
Others	12	10.9	89.62	
Intensive care	11	8.2	102.64	
Outpatient clinic	12	8.2	63.46	
Operating room	16	7.5	85.81	
Profession experience in years**				
<1	8	5.4	49.12	**0.0536**
1-5	41	27.9	71.67	
6-10	26	17.7	83.08	
11-15	27	18.4	74.57	
16-20	23	15.6	75.00	
>20	22	15.0	74.91	
Institution experience**				
<1	15	10.2	60.67	**0.555**
1-5	67	45.6	74.78	
6-10	21	14.3	86.19	
11-15	14	9.5	65.43	
16-20	18	12.2	71.94	
>20	12	8.2	78.08	
NIV Training**				
Yes	60	40.8	78.44	**0.292**
No	87	59.2	70.94	
Training source**				
Seminar, courses etc.	34	23.1	80.00	**0.156**
Brochure, book, etc.	14	9.5	79.94	
By oneself	36	24.5	71.49	
From physician	19	12.9	75.50	
From nurse	11	7.5	41.14	
I don't know	33	22.4	78.29	

*. Mann-Whitney U Test, **. Kruskal-Wallis one-way analysis of variance

2.4.9.5 Discussion of results

The following section will present a summary and discussion of the main relevant findings of each study.

- *Discussion on Raurell-Torreda et al. (2019) study*

In the study by Raurell-Torreda et al. (2019) ICU professionals had more experience, but this did not reflect in better knowledge. The authors state that as NIV-specific ventilators are frequently used outside ICU settings, which are simpler and more familiar for participants outside ICU. In this study, nurses also demonstrated less knowledge than doctors. Raurell-Torreda et al. (2019) claim that as doctors frequently organise nurses' training, it tends to focus more on the theoretical aspect of NIV rather than on the nurses' competencies. The authors might have reached this conclusion after consulting training data that the researcher does not have access.

The majority of nurses (69.6%) recognized the appropriate mask to be used and half knew how to measure the masks appropriately. Nurse and doctors' knowledge on patient-ventilator strategies, ventilator settings, NIV success, and failure, was adequate.

Contrastingly, a considerable percentage of respondents incorrectly identified strategies related to patient-ventilator synchronization that included "covering the expiratory port" and "pressing mask against patient face" as unintentional leak. More than two-thirds of participants from general ward responded incorrectly. There was no difference in responses between doctors and nurses. ICU professional use conventional ventilators that have tubing dedicated for expiration and usually require non-vented mask, which the authors argue, might be the reason leading to incorrectly answer in 28.2% of ICU participants. Still of concern 22.5% of participants in ED and 61.5% of participants in general wards selected to cover vents even though they presumably were familiar with intentional leaks. The authors claim that this is due to lack of training provision.

Only half of nurse participants responded correctly to questions on mask size and just 11.7% correctly chose to "2-finger fit" adjustment. Improper application of interface can be detrimental to the patient.

Only 7% of the general respondents selected agitation as a NIV complication with no difference between units or professionals. Moreover, more than half of the nurses did not consider physiotherapy as part of their nursing care even though "thoracic physiotherapy" was included in the Nursing Intervention Classification (NIC), (NIC3230).

- *Discussion on Annarani et al. (2017) study*

Annarani et al. (2017) study underlined that 68% of the nurse participants had inadequate knowledge, i.e. less than 50% correct answers, regarding NIV therapy. Their study further highlights the lack of training attended by participants (26% attendance), considering that 66% of the participants cared for patients on NIV. Additionally, the study clearly demonstrates that experience alone does not increase knowledge. Two-thirds of the participants that cared for patients on NIV and more than 85% of participants with more than 10 years of nursing experience had inadequate knowledge on NIV.

Knowledge related to the application of NIV mask, and proper fitness with the 2-finger rule was found correct in only 18% of the participants. Only a few participants had knowledge related to indication, contraindications and nutrition. In contrary participants had knowledge on NIV setup, hypercapnia, patient posture, and priority nursing. Similarities, to the formerly Raurell-Torreda et al. (2019) study exist. Likewise, Annarani et al. (2017) conclude that lack of knowledge is associated to how training is provided. The study found that there is a statistical significance of nurses' knowledge, NIV training ($p=0.022$) and NIV patient care ($p=0.027$). Moreover, there was no statistical significance in knowledge and other demographic variables such as age, gender, years of experience and general educational qualifications.

- *Discussion on Tarhan et al. (2015) study*

In the study by Tarhan & Dalar (2015), similarly to the previous studies, nurses' knowledge on NIV appeared to be low (19.32+/- 4.51 in points ranging from 7-33). The authors found that female nurses and those who had a post-graduation degree had more knowledge although male participants consisted of 14.3% from the total sample. Hence caution should be exerted on the interpretation and conclusions of these results.

More than half (59.2%) of the nurse participants in this study didn't receive training, and in contrary to previous study no correlation was found between training and NIV knowledge (p=0.292). Likewise, no statistical significance was found between knowledge and occupational or institutional experience as well as the unit the participants worked in.

Few participants (18.4%) knew all the advantages of NIV, and when asked about contraindications 24.5% of nurse participants mistakenly identified cardiogenic pulmonary oedema as one of the contra-indications. Oddly, cardiogenic pulmonary oedema is one of the most common conditions in which NIV therapy is initiated. Additionally, only 4.8% of the participants knew all the advantage and disadvantages of the oro-nasal mask even though according to Tarhan & Dalar (2015) it is frequently used in the participants' settings. Knowing the advantages as well the limitations of the interface improve precautions and decrease interface-related complications.

The most correctly answered question was related to the application of interface (78.9%). These results are distinctive from Raurell-Torred et al. (2019) and Annarani et al. (2017) studies. Also, most nurses knew that gastric distension might be caused by NIV therapy and that patient ideally need to be sitting up during NIV therapy. Additionally, nurses' participants demonstrated knowledge in recognition NIV success (89.9%). The authors concluded that it might be the case as these practices were routinely performed and therefore easily assimilated.

Nurse participants had moderate knowledge on the asphyxia valve and exhalation port, which is directly related to patient safety. Nurses had adequate knowledge (75.5%) on proper

filter application, reducing infections, and NIV breaks however their knowledge related to NIV maintenance was low. Lastly only 2.7 % knew the difference between conventional ventilators and NIV-specific ventilators. The authors attributed this to the fact that as only 8.2% of the participants were ICU nurses most participants lacked exposure to conventional ventilators used in NIV.

2.5 Conclusion

2.5.1 Summary of evidence question 1

From the conducted narrative review, the following points were drawn. Nurses require knowledge in four major areas: respiratory pathophysiology, setup of NIV, monitoring and patient nursing care.

Nurses' understanding of the respiratory concepts, as well as indications and contraindications of NIV therapy are fundamental to the comprehension and delivery of suitable NIV nursing care. As nurses are the principal NIV machine operators, they must understand the various parts and functions. In addition, most NIV monitoring (clinical, physiological, & NIV monitoring) depends on nursing competence. Monitoring is essential for nurses to take the appropriate steps, to recognize NIV success or failure and to prevent complication as well as address these complications immediately.

Lastly, patients on NIV therapy, including otherwise independent patients, commonly need assistance in their activities of daily living. It is therefore imperative that nurses have knowledge of specific needs that NIV therapy generates. Nurses must plan the care holistically, individually with each patient, and cautiously consider the entire patient needs. Especially as sometimes NIV therapy might not aim necessarily at healing or gaining independence but rather at palliating symptoms and dying a comfortable death.

2.5.2 Summary of evidence question 2

From the systematized part of the review focusing on the knowledge that nurses caring for patients on NIV have, the following findings were highlighted. The overall knowledge of nurses providing NIV appears to be low throughout the studies. Shortage in NIV training attended was also acknowledged in every study. Statistical significance of training on NIV knowledge was identified in Annarani et al. (2017) study but not in Tarhan et al. (2015) study where no statistical significance was found.

Correspondingly, NIV experience was found to increase NIV knowledge in the Annarani et al. (2017) study, however this was not replicated in Tarhan et al. (2015). The latter, on the other hand, found a statistical significance in both gender and educational status on NIV knowledge outcome.

Lastly these studies identified areas which the participant nurses lack knowledge in most. No consistency exists between the three studies and therefore found it impossible to summarize these results collectively in this section. Consequently, a summary of participants' knowledge on individual topics for each study is presented in Table 2.14 below.

Table 2.14 *Participants' knowledge on various NIV topics arranged by research study and adequacy of knowledge.*

Study by Author	Inappropriate knowledge	Appropriate knowledge
Raurell-Torreda et al., (2019)	Synchronization strategies	Interface selection
	Interface application	NIV strategies
	Complications	NIV settings
	Physiotherapy (nursing care)	NIV success
	Indication for NIV	NIV failure
Annarani et al., (2017)	Interface application	NIV settings
	Indication for NIV	Hypercapnia definition
	Contraindication for NIV	Nursing care (positioning)
	Nursing care (Nutrition)	Nursing care (priority)
Tarhan et al., (2015)	Advantages of NIV	Interface application
	Contraindications	Complications
	Interface benefits	NIV success
	Maintenance	Safety in NIV

2.5.3 Recommendations for further research

It is undisputed that knowledge on NIV improves patient care. Nonetheless research studies that guide nurses' knowledge on NIV therapy, particularly on nursing care is scarce. Consequently, there is a dire need for good quality research on this topic. Additionally, there is no consensus between the studies analysed on the relationship between the variables (experience, training, unit) and local studies on the nurses' knowledge on NIV are non-existing.

In the light of all this, it is clear that local nurses' knowledge on NIV among those that provide NIV care needs to be explored. This is required to provide a clearer image on what knowledge the nurses in the local nursing population have and what gaps exists. Additionally, the research will highlight any associated variables and if there are any, similarities to the existing studies. Lastly it will add up to the limited international studies that are currently available.

2.5.4 Conclusion

This chapter critically appraised the literature on the nurses' knowledge of NIV, associated variables and influence on knowledge. A systematic literature review consisting of both a narrative and a systematized review were presented in a step-by-step manner. The recommendations for this study were based on the emerging knowledge's conclusions. These recommendations will be explored in detail in the following methodology chapter.

Chapter 3:

METHODOLOGY

3.1 Introduction

The need for more research on the knowledge of nurses on non-invasive ventilation (NIV) was clearly highlighted in the literature review. The overall aim of this study was to explore the NIV knowledge of nurses providing NIV.

"The research design guides the researcher in planning and implementing the study in a way that it is most likely to achieve the intended goal"

(Burns & Grove, 2005, p211)

Therefore this section involves a comprehensive account of the methodological process applied to this study. The rationale for choosing a quantitative study is also provided. Moreover, this chapter elaborates on the methodological foundations including the purpose of the study, the quantitative approach, methodology and design, the data collection method, data analysis, ethical considerations, and the timeframe.

3.2 Philosophical Worldview

Philosophical perspectives affect our research even though they are largely unseen (Slife & Williams, 1995). The importance of contextualising the research study within a philosophical framework helps define the assumptions made about the nature of ontology and epistemology (Creswell & Plano-Clark, 2011). This research supported a post-positivist worldview, an extension of the positivist worldview. Positivism claims that knowledge resides in the object, is measurable and non-manipulating, doesn't change when collected, and cannot be altered (Creswell & Creswell, 2018). On the other hand, post-positivism claims that reality, in this case nurses' knowledge of NIV, is 'out there', but the ability to capture it and represent it accurately through research without affecting it is somewhat limited, with the possible effect of biases (Miller, 2007; Taylor & Lindolf, 2011). For instance, by conducting this study, participants may have become more aware of NIV-related knowledge and sought more information or training. Leading to a change in the overall knowledge of NIV after the research was carried out, eventually changing the nature of this 'reality'. From an

epistemological perspective, post-positivists still maintain that objective knowledge can be collected. However, this is seen as an approximation, in this case an inference on the level of nursing knowledge on NIV at the point of data collection. Within a post-positivist paradigm, there is always the possibility to eventually confirm or falsify any inferences made (Creswell & Creswell, 2018).

3.3 Research design

Choosing the appropriate research design is crucial as it is the basic strategy required either to test a hypothesis or answer the study questions (Polit & Beck, 2014). Bowling (2009) defines a research design as the overall research structure or plan. Therefore, it is essential for the research methodology and data collection to be planned (Bowling, 2009). As the design is founded on a research question, itself based on a research problem, it is imperative to introduce the research problem and question.

3.3.1 Research problem

Polit & Beck (2014) define a research problem as *"an enigmatic or troubling condition"* that the research aims to "solve" or contribute to the solution by collecting related data. Various international studies and audits highlighted the inadequacy and inconsistency in nurses' knowledge on NIV owing to a lack of adequate training and protocol, resulting in poor patient outcome (Raurell-Torreda, et al., 2019), although limited international research on the subject exists (Bambi, et al., 2017). Furthermore, no local research on nurses' knowledge on NIV was conducted. Polit & Beck (2014) highlight that the source from where the research problem was raised is rarely identified. In this case, the researcher determined the research problem based on everyday experience in the clinical area, combined with evidence in nursing literature.

3.3.2 Research question

The research question is the defining query that the researcher has and that guides the entire methodological strategy of data collection, analysis and interpretation (Polit & Beck, 2014). Upon extensive analysis of the literature, the research question formulated for this study is "What knowledge do local nurses caring for patients on non-invasive ventilation have on non-invasive ventilation care?

Therefore, the research aim is:

To assess the knowledge of local nurses with regard to non-invasive ventilation.

The research objectives are:

1. To determine, the level of clinical expertise, experience, and academic background as well as other possible variables pertaining to nurses applying NIV and NIV care in their respective specialised units.
2. To identify the overall knowledge level of nurses working with patients requiring NIV and NIV patient care.
3. To explore participant knowledge on the following knowledge domains: respiratory pathophysiology, technical knowledge, monitoring knowledge, and nursing knowledge, related to NIV and NIV patient care.
4. To explore any correlation or association between clinical or academic training, and years of clinical experience with nurses' knowledge in NIV and NIV patient care.
5. To identify any association among the four knowledge domains mentioned overhead.
6. To explore participant knowledge on individual knowledge questions.

3.3.3 Quantitative approach

A quantitative strategy was determined to be the most appropriate after considering the study's aim, objectives, and resources available, as the study will focus on the systematic gathering and analysis of numerical data (Polit & Beck, 2014). The philosophical worldview

proposed in the study was the postpositivist worldview as it focused on precision, generalizability, and reliability. Creswell & Creswell (2018) defined this worldview as a deterministic philosophy since causes determine effects or outcomes.

This research data was collected using a *prospective* approach through a questionnaire, as no data was readily available. Dehejia (2015) states that a non-experimental design should be chosen when control of variables is not possible, either because it is ethically or technically difficult, or because experimentation is impracticable owing to time limits or inconvenience. Therefore, the researcher opted for non-experimental approach, due to time constraints and limited resources.

The descriptive research method was chosen because it details and documents things as they naturally occur (Polit & Beck, 2014). The drawback of such an approach is that it fails to direct the cause-and-effect relationship (Polit & Beck, 2014). However, advances in statistical approaches have addressed this constraint (Polit & Beck, 2014).

3.3.4 Population and sampling

The targeted population selected for this research study consisted of nurses delivering care in NIV designated units/wards at a local hospital. It included 293 nurses working in any of these areas: Intensive Therapy Unit, Day Care Unit, Burn & Plastics Unit, Cardiac Critical Care Unit, Cardiac Intensive Care Unit, and the Emergency Department. Due to the COVID-19 pandemic, as NIV is classified as aerosol generating procedure, Day Care Unit and Burn & Plastic Unit had areas transformed to NIV units mainly due to their layout. Therefore, most of the staff was relatively new to NIV care. The abovementioned wards/units cater for all the patients that are admitted and require NIV therapy during their stay. No other unit in the researched hospital, at the time of the research study, offered care for NIV patients.

All the targeted population was invited to participate in the study, as it was still practicable. This prevented selection and sampling biases commonly related to sampling techniques (Bowling, 2014). Therefore, by decreasing the risk of bias, the researcher sought a higher

chance of generalisability of the findings.

Eligibility criteria are necessary to ensure that population samples are consistent and that any factors that may induce bias within populations are excluded (Burns & Groove, 2005). It includes both inclusion and exclusion criteria.

The inclusion criteria for this study consist of:

- Nurses, who at the commencing date of data collection, are working at a state general hospital.
- Nurses working in at least one of these units: Intensive Therapy Unit, Day Care Unit, Burn & Plastics Unit, Cardiac Critical Care Unit, Cardiac Intensive Care Unit, and the Emergency Department during the data collection periods.

The selected exclusion criteria aimed to leave out nurses with limited or no exposure to NIV. As Charge nurses and Practice nurses' roles are managerial and educational respectively, they generally lack the daily exposure to NIV patient care. The study's aim was to assess the knowledge of those nurses that are in daily contact with these patients and therefore, including the former would not have provided a true picture of the local situation. The exclusion criteria for this study include:

- Charge nurses and Practice nurses
- Nurses working in other wards/units other than those selected for the study
- Nurses that do not work in the local state hospital being studied
- All other non-nursing members
- Nurses from the relieving pool working in these areas

3.4 Method of data collection

Creswell & Creswell (2018) emphasise that the purpose of using a methodological approach is to collect data in the most appropriate way in the given circumstances, to answer the phenomena under investigation. The researcher developed a close-ended questionnaire

that was then disseminated and self-administered online through the Google Forms platform. This methodology was chosen as it allowed the researcher to collect data from the total population while keeping participants anonymous, therefore a higher chance for honest answers. Additionally, as highlighted by Nayak & Narayan (2019), data collection could be rapidly gathered, and at a low cost, considering the limitations in conducting the study.

3.4.1 Systematic literature review

Knowing what is known and, by extension, what is unknown about a topic area is a vital skill as it allows one to comprehend the present state of a subject field, relate it to ongoing research, and discover knowledge gaps (Arshed & Danson, 2015). A literature review can help settle an argument, indicate the need for more study, and define a research topic, (Arshed & Danson, 2015). The information gathered through previous studies and guidelines, also taking in consideration the main objectives of the study, were then used to generate the individual questions for the questionnaire.

3.4.2 Knowledge domains and items generation

The researcher decided to develop a knowledge-based questionnaire as none of the available literature covered all nursing aspects of NIV. Therefore, following the literature review, the researcher identified 4 domains in NIV nursing care that required exploration. These domains amounted to a 50-item questionnaire, divided in the following subgroups: demographic questions (14 items), NIV respiratory physiology (5 items), NIV setup (9 items), NIV monitoring (5 items), and on other NIV nursing care (16 items). Each question varied in the number of answers and score: 1 mark if the all the answers in a question were correct, half a mark if answers selected in a question were partially correct, and no score if none of the correct answers in a question were selected. The maximum number of points is 27 and the minimum is 0. The higher the score, the more knowledgeable a nurse is in NIV nursing care.

3.4.3 Validity of data gathering

Initially the questionnaire consisted of 50 questions that included 14 demographic questions and 36 NIV knowledge questions. Experts in the field can determine the validity of an instrument both qualitatively and quantitatively (Ayre & Scally, 2014; Sangoseni et al., 2013). The validation of the questionnaire tool was done through face and content validity.

Face validity

Face validity is a qualitative component that can be thought of as an extension of comprehensive variable selections and item generation/presentation (Saint-Maurice et al., 2014). It entailed, among other things, ensuring that the created statements were appropriate for each of the components relating to wordings, structures, orderliness, and scoring forms (Creswell, 2014; Sangoseni et al., 2013). The researcher's study supervisor conducted face validity and although rewording was done in ten questions no questions were excluded.

Content Validity

This quantitative technique entailed quantifying expert opinions on the draft instrument's content validity (Devon et al., 2007). The content validity index (CVI) method is one of the most extensively used empirical approaches for measuring the content validity of study instruments (Devon et al., 2007; Rodrigues et al., 2017). This phase was important to ensure that the instruments contained all the necessary items, that the items were relevant to the study's aim, and that an adequate balance of elements existed, with none of the items being over-or under-represented (Hu et al., 2012).

- *Sampling and sample size for content validity*

To select the healthcare professionals who were experts in the field, a purposeful sample was used. This approach was preferred to get the appropriate respondents with right knowledge and experience in the researched area. Lynn's criteria suggest an I-CVI=1.00 with

3 to 5 experts and a minimum I-CVI of .78 for 6 to 10 experts. Ayre & Scally (2014) recommend between three to ten experts for the running of an appropriate content validity study. Lynn's criteria was used to identify items with acceptable I-CVI in relationship to the number of experts. To conduct content validity, ten experts in the field were purposely selected, of which nine replied successfully. The experts consisted of one respiratory consultant, one emergency consultant, two anesthesiologists, two practice nurses (directly involved in the hospital NIV nursing training), resuscitation practice nurse, an academic with background in intensive care, and an emergency nurse.

- *Data collection for the content validity study*

The selected experts received a participation and information email together with a link to the questionnaire on the Google Forms platform. The questionnaire tool was modified and after each question a four-score liker-scale for relevance (not relevant to very relevant) and clarity (not clear to very clear), and a comments section were added.

- *Statistical analysis for the content validity*

Validity results (*individual items and overall questionnaire*).

The results were computed on an excel sheet and an I-CVI for each question and a total S-CVI/AU and S-CVI/AVE were calculated. The content validity indices, such as the items content validity index (I-CVI) and the scale content validity index (S-CVI) were calculated using the experts' perspectives provided in the content validity forms (Devon et al., 2007). The content validity results are presented in Appendix 12 and 13.

Validity results (*individual items*)

I-CVI was calculated for each item to determine whether it should be accepted or rejected as part of the instrument (Devon et al., 2007). It was calculated as the percentage of experts who evaluated the item 3 or 4 out of a total of experts (Ayre & Scally, 2014; Zamanzadeh et

al., 2015). I-CVI values range from 0 to 1, and an item was regarded relevant if it had an I-CVI of > 0.79, needing modification if it had an I-CVI of 0.70 to 0.79, and being rejected if it had an I-CVI of >0.70. Overall, 15 questions were excluded, resulting in a final S-CVI/AVE of 0.95 and S-CVI/AU of 0.54. A table with the excluded questions and the reason for exclusion is presented in Appendix 16.

Validity results (*overall questionnaire*)

The S-CVI is defined as the average value of the I-CVI for the instrument, and the values were estimated using both the universal agreement (UA) among experts (S-CVI/UA) and the average CVI (S-CVI/Ave) approaches (Devon et al., 2007). S-CVI/UA only considers items that the reviewers are in total agreement with and therefore chance of agreement declines as the number of reviewers increases (Polit et al., 2007). S-CVI/UA was calculated by adding all the items with an I-CVI of 1, then dividing by the total number of items (Zamanzadeh et al., 2015). Whereas S-CVI/Ave was calculated by adding the I-CVI values, then dividing by the entire number of items (Zamanzadeh et al., 2015). S-CVI/Ave values of 0.95 were regarded excellent content validity (Ayre & Scally, 2014; Zamanzadeh et al., 2015) and S-CVI/UA value of 0.54, which although lower than 0.80 recommended by Polit et al. (2007), is quite reasonable considering that the maximum number of reviewers involved. A table with the corrected score post questions' exclusion is found in Appendix 14.

Clarity Results (*individual item and overall questionnaire*)

Clarity was also calculated using also nine raters on a four-point Likert Scale (1= not clear, 2= needs revision, 3= clear but needs minor revision, 4= very clear). The average clarity score for individual item ranged from 3.22 to 4.0 with 10 items (20%) considered very clear with a score of 4. 29 items had a score ranging from 3.89 to 3.56 and 11 items had a score ranging from 3.44 to 3.22. Therefore none of the questions needed revision or were unclear and minor

changes were done to 4 of the questions; question 14, question 17, question 25, question 28. The final questionnaire post amendments had an overall clarity score of 3.78.

3.4.4 Reliability of data gathering

Reliability is defined as how consistent the tool can measure repeatedly (Middleton, 2019; Creswell & Creswell, 2018). To test the reliability of the tool, the researcher opted for a test re-test, testing consistency of the questionnaire over time. Stability of the measure (NIV knowledge) had to be assumed by the researcher for test-retest to occur (Bowling, 2014). Participant population for the test-retest included nurses with previous exposure to NIV care, in the same hospital. Charge Nurses and Practice Nurses, similarly to the actual study, were excluded from the test-retest study. The selected test-retest participants, different from the actual study participants, had previously provided care for NIV patients, but stopped receiving NIV patients 18 months prior to the study. This was due hospital amendments in view of the COVID-19 pandemic. McMillan et al. (2014) recommend a sample size of between 40 to 480 participants, depending on the minimum acceptable error rates of the clinical protocol. The researcher decided on that particular sample for the test-retest as a large sample was required (52 participants), and therefore not to deplete the studied population. Additionally, since tool consistency rather than NIV knowledge was being tested, even though the participants lacked current exposure to NIV, it was deemed an appropriate population for the study. Therefore, all 52 nurses from 3 different acute medical wards were included in the study. Unfortunately, only 6 participants filled out stage 1 of the test-retest reliability testing. Assuming that all six participants filled the second test, the statistical significance of the correlation would have been trivial.

Additionally, none of the 4 critically evaluated studies conducted by Torreda-Raurell et al., 2019; Goktas et al. (2017), Tarhan et al. (2015), and Annarani et al. (2017) included a reliability testing when evaluating the actual knowledge of participants in NIV. Bolarinwa (2015) argues that when performing test-retest reliability, the researcher has to consider two assumptions. Firstly, that the measured characteristics (NIV nurses' knowledge) do not

change over time. Secondly, that the time period is long yet short enough that the participants' memory does not affect the results.

Therefore, considering all arguments above and low response rate, the researcher regretfully decided to terminate the reliability testing prematurely and resume with the research study.

3.4.5 Data gathering tool

The finalised version of the data collection tool consisted of thirty-five questions, seven of which were demographic questions and twenty-seven are NIV knowledge questions; four questions on respiratory pathophysiology, eight questions on technical knowledge of NIV, three questions on NIV monitoring and twelve questions on patient's nursing needs. The questionnaire also has a comment section at the end.

3.5 Study protocol

When a detailed description of the study process is provided, it permits the reader's critique and adds value to the study, (Thomas, 2011). It also permits reproduction of the study for comparison of results. Therefore, in this section the research study methodology will be presented.

1. The researcher was assisted by the Bed Management Unit at the Local General Hospital to identify the units where NIV care is provided.

2. Following the identification of the participating units and wards, the respective ward Charge Nurses and departmental Chairpersons were contacted by email that included the information letter (Appendix 10) draft questionnaire (Appendix 11). Consent was provided either via email or in certain instances through a hard copy (Appendix 2 & 3).

3. Potential intermediaries were then identified, approached, and a brief explanation of the study and their role was provided. The intermediaries consented via email (Appendix 1).

4. The CEO, Nursing Director, Medical Director and DPO were than briefed and consent was obtained (Appendix 4-7).

5. The researcher applied for Ethical Approval and obtained approval from the University of Malta Research Ethics Committee (Appendix 8).

6. An information letter for the study was sent, through the respective intermediaries, to all participants one week prior to the questionnaire (Appendix 9). This aimed to improve responses (Sammut et al., 2021).

7. The questionnaire was then distributed to the participants via their respective intermediaries.

8. No time limit or access limitation was applied to the questionnaire.

9. A total of three reminders were sent via the intermediaries and the study was conducted over a period of 45 days.

3.6 Data collection

Polit and Beck (2014) emphasise on pre-planning of data collection as a vital step in the study research. Considering the poor response during the reliability phase of the validation and the fact that the study was conducted during the winter holidays, the researcher extended the allocated period for the data collection process from 30 to 45 days. Therefore, the study was initiated on the 15th of December 2021 and ended on the 31st of January 2022.

After data collection, such was statistically analysed. Statistical tests to interpret data were selected after consultation with the statistician.

3.7 Data analysis

Data was examined using the Statistical Package for Social Science software (version 28) and Microsoft Excel 2011. Demographic data was categorized as years of nursing experience, years of NIV experience, level of education, NIV training, NIV guidelines awareness, and working unit. Descriptive statistics were collected using frequency

and percentages, to aid the reader understand the population's characteristics (Connelly, 2013). Following, the demographic data was used as independent variables and relationship to participants' knowledge explored, (Connelly, 2013). Knowledge was scored using 1-point score for each correct answer, 0.5-point score for partially correct answers, and then percentages were calculated.

Prior to examining the association between variables, the overall knowledge and the knowledge domains were tested for normality. The most popular methods used are the Shapiro-Wilk test and the Kolmogorov-Smirnov test. The Shapiro-Wilk test is more appropriate for small sample sizes (n=<50) although it can also be used for larger samples, while the Kolmogrov-Smirnov can be in samples of ≥50, (Mishra et al., 2019). The Kolmogrov-Smirnov test was used as a sample greater than 50 was used, as well as to see if the overall knowledge and knowledge domains followed normal or abnormal distributions. Thus, the researcher could determine whether a parametric or non-parametric test could be used (Ghasemi & Zahedaisl, 2012).

Subsequently, as no normal distribution was present, inferential statistics were analysed using non-parametric methods; the Kurskall-Wallis test that included three or more categorical variables, and the Mann-Whitney U test for variables that consisted of two categories. These tests were applied to examine for an association between knowledge and independent variables. Additionally, as no normal distribution was present across the knowledge domains, the Spearman's Correlation test was used to check for any association between them. The results were within the 95% confidence interval and had a margin of error around 10%. A significance level of $p<0.05$ was adopted for the results. Table 3.1 below illustrates the objectives in relationship to the tests performed on SPSS.

Table 3.1 *Objectives of the study in relation to the statistical tests applied*

Objective	Test
To determine the level of clinical expertise, experience, and academic background as well as other possible variables pertaining to the nurses applying NIV and NIV care in their respective specialised units.	Mean, median, standard deviation, frequencies, and percentages.
To identify the overall knowledge level of nurses working with patients requiring NIV and NIV patient care.	Mean, median, standard deviation, frequencies and percentages. ***Kolmogorov-Smirnov normality test***
To explore the participant knowledge on the following knowledge domains: respiratory pathophysiology, technical knowledge, monitoring knowledge and nursing knowledge, related to NIV and NIV patient care.	Mean, median, standard deviation, frequencies, and percentages. ***Kolmogorov-Smirnov normality test***
To explore any correlation or association between clinical or academic training, and years of clinical experience with nurses' knowledge in NIV and NIV patient care.	**Kurskall-Wallis test** and ***Mann-Whitney U test***
To identify, any association amongst the four knowledge domains.	***Spearman's Correlation test***
To explore participant knowledge for individual knowledge questions.	Mean, median, standard deviation, frequencies, and percentages.

3.8 Ethical considerations

All necessary authorities gave their consent for this study to be conducted (Appendix 2-7). Furthermore, the University of Malta Research Ethics Committee also gave its approval (Appendix 8).

A written information letter with all the necessary information and contact details of both the researcher and the research supervisor were provided to the participants (Appendix 9). The information letter highlighted the aim of the research study, the participants' right to refuse without any repercussions, and their right to confidentiality. In the participation letter it was also remarked that participation was voluntary and the ability to withdraw at any time, although their data could not be erased after submission as no identifiers were collected. Consequently, ward clerks, and in one circumstance a hospital practice nurse, (as no ward clerk available), were approached and agreed to be the intermediaries. The intermediaries were responsible for the dissemination of the invitation letter with a hyperlink to the online questionnaires via participants' work email. The intermediaries had already a pre-defined list of participants' emails prior to the study. The researcher had no access to the email lists. Data was collected anonymously through Google Forms and therefore no personal or digital

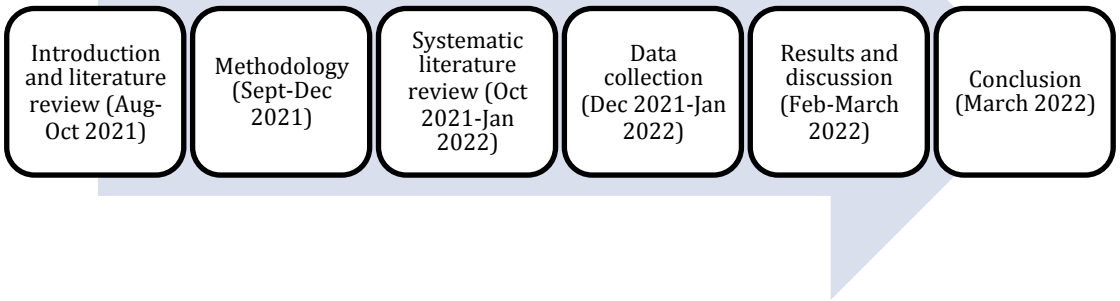
identifiers were collected. It was ensured that all the collected data would be used for research purposes (Resnik, 2015).

Only the researcher and clinical supervisor had access to the data. Data was stored on a password protected excel document on the researcher laptop. All data will be destroyed upon termination of the research study as a protective measure.

3.9 Timeframe

Figure 3.1 illustrates the entire timeframe undertaken for the research study.

Figure 3.1 Study timeframe



3.10 Conclusion

This chapter demonstrated the research methodology adopted in this research. Through the research problem highlighted and the associated philosophical worldview, it was deemed fitting for the researcher to choose the highlighted research approach (Dehejia, 2015; Polit & Beck, 2014). The research's ethics and the time frame of the study were presented. Chapter four will present the results obtained from data collected using the methodological process described in this chapter.

Chapter 4

RESULTS

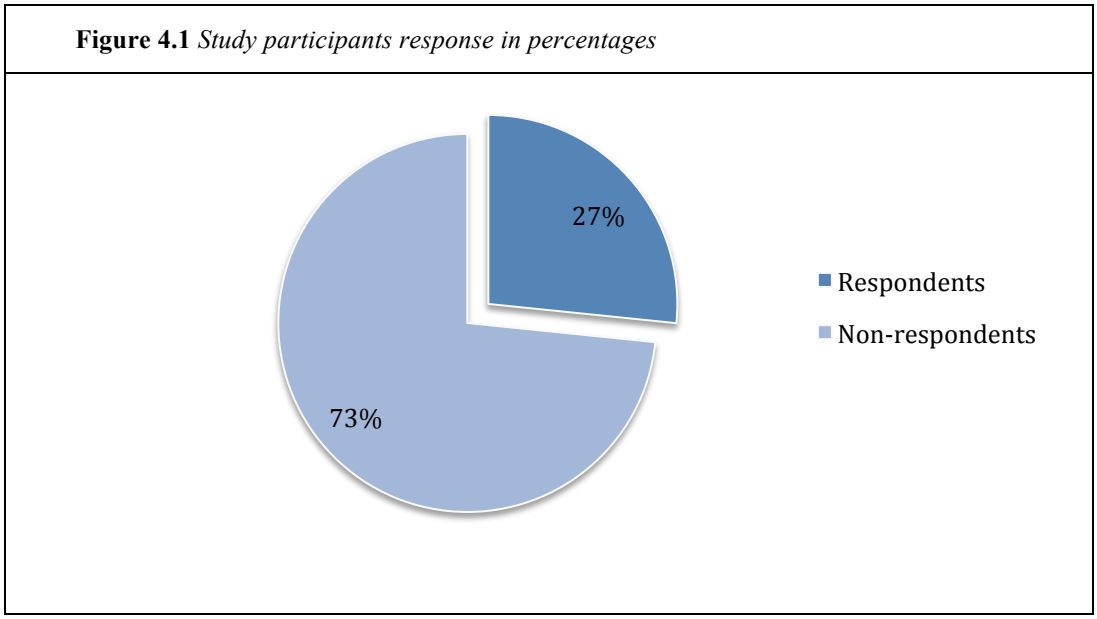
4.1 Introduction

This chapter describes and details the primary data gathered from the participants' questionnaire. It intends to explore nurses' knowledge of NIV and NIV care in the local setting, as well as to undertake a statistical analysis to investigate the influencing variables on the participants' knowledge associated with NIV. This chapter will initially present data with respect to response rates, followed by demographic data, and finally the overall knowledge scores. Knowledge was then divided into four domains: pathophysiology, technical, monitoring and nursing care. Subsequently the knowledge domains were compared together, followed by an exploration of each individual question.

4.2 Study participants' response

The total number of nurses that provide NIV care at the local hospital during the study period i.e. from the 15th December 2021 to the 15th of January 2022 consisted of 293 nurses. From the total amount of nurses, 78 participants (26.6%) participated in the study as demonstrated in figure 4.1. With this response rate, the analysis carries a 10% margin of error at a confidence level of 95%.

Figure 4.1 *Study participants response in percentages*



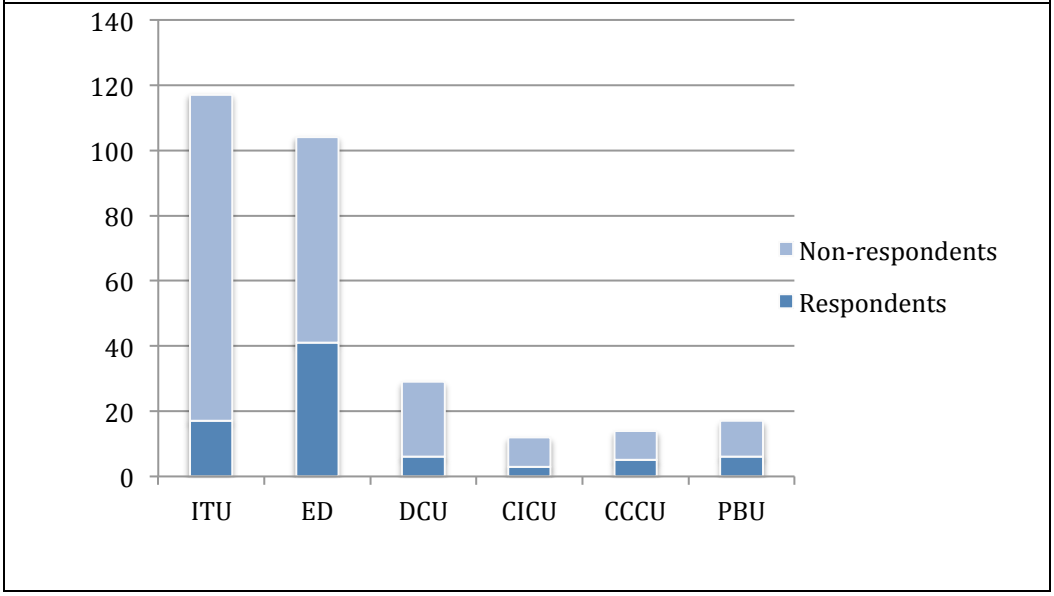
4.3 Demographic results

Demographic data gives the researcher a better understanding of the background characteristics of the participants as well as the contribution of individual variables (Bowling, 2014). The demographics collected in this study included the participants' working unit, experience, education, guideline awareness, and training characteristics. The data was presented in term of frequency, and percentages.

4.3.1 Unit demographics

The study was conducted in all the six units that collectively provided NIV care at the local hospital during the time of the study. Nurses' population distribution was provided for each unit in both frequency and percentage, as per exclusion and inclusion criteria. ITU had the most nurses (n=117) providing NIV care, 39.9% of the global population, while CICU had the least nurses (n=12) and therefore only representing 4.1% of the global nursing population.

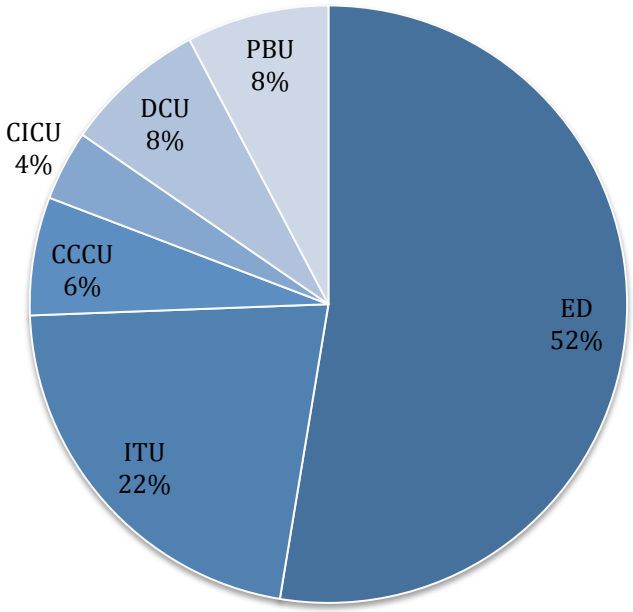
Figure 4.2 *Unit total population, respondents and non-respondents*



Responses were collected and calculated per unit, then compared to the current total population (Figure 4.2). The highest in-unit response rate in percentages was ED (39.4%, n=41), followed by CCCU (35.7%, n=5), PBU (35.3%), CICU (25%), DCU (20.6%) and ITU with the least responses (14.5%).

Furthermore, Figure 4.3 illustrates how 52% of the survey responders work at the ED; 22% at the ITU; 8% at the PBU or DCU; 6% at CCCU; and finally, 4% at the CICU.

Figure 4.3 *Percentage of participant response for each of the units*



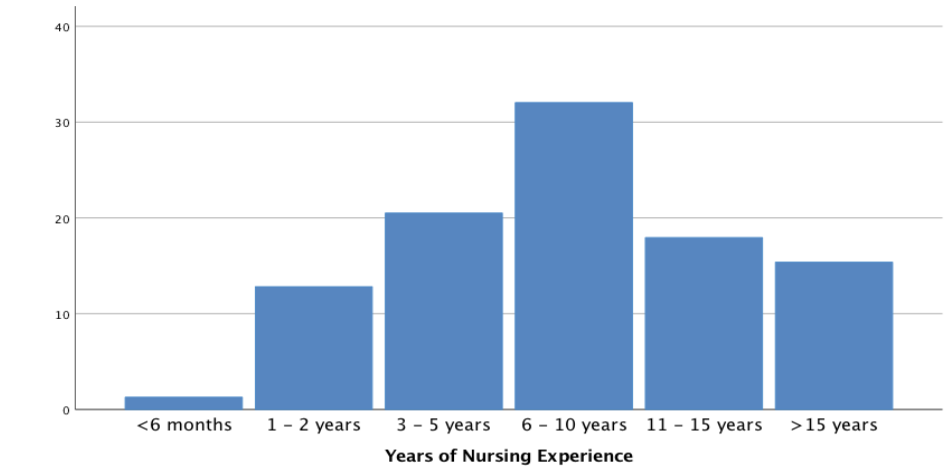
4.3.2 Participants' experience

Experience was gathered as overall nursing experience and NIV nursing experience. Overall nursing experience consisted of the participants' collective number of years working as a nursing profession, while NIV nursing experience consisted of the number of years providing NIV care independently.

- *Overall general nursing experience*

Most participants had 6-10 years of nursing experience (32.1%), followed by the 3-5 years bracket (20.5%), as demonstrated in Figure 4.4 below.

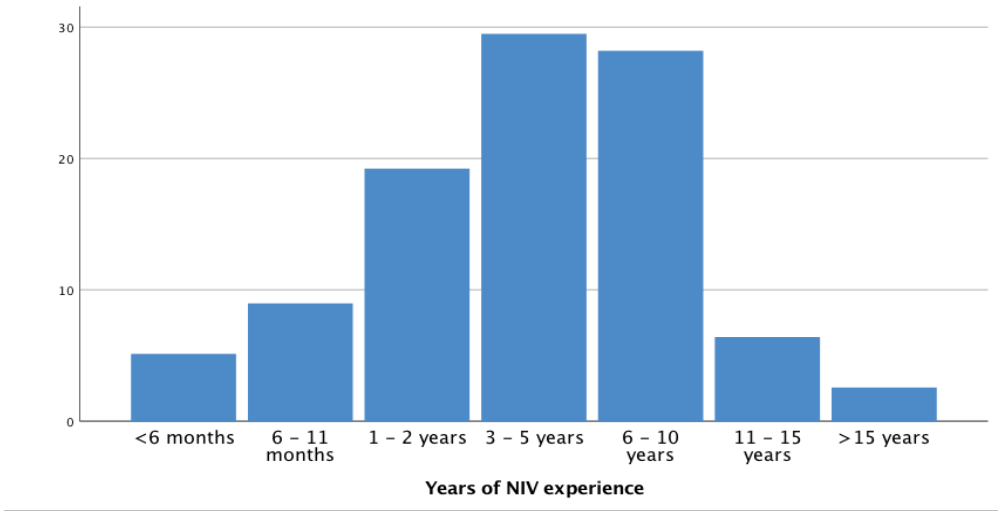
Figure 4.4 *Nursing years of experience distribution*



- *Overall NIV nursing experience*

NIV nursing experience entailed the overall number of years of providing care for patients on NIV. Most participants had between 3-5 years (29.5%) and 6-10 years (28.2%) of NIV caring experience, with only one participant more in the former group. This is depicted in Figure 4.5 below.

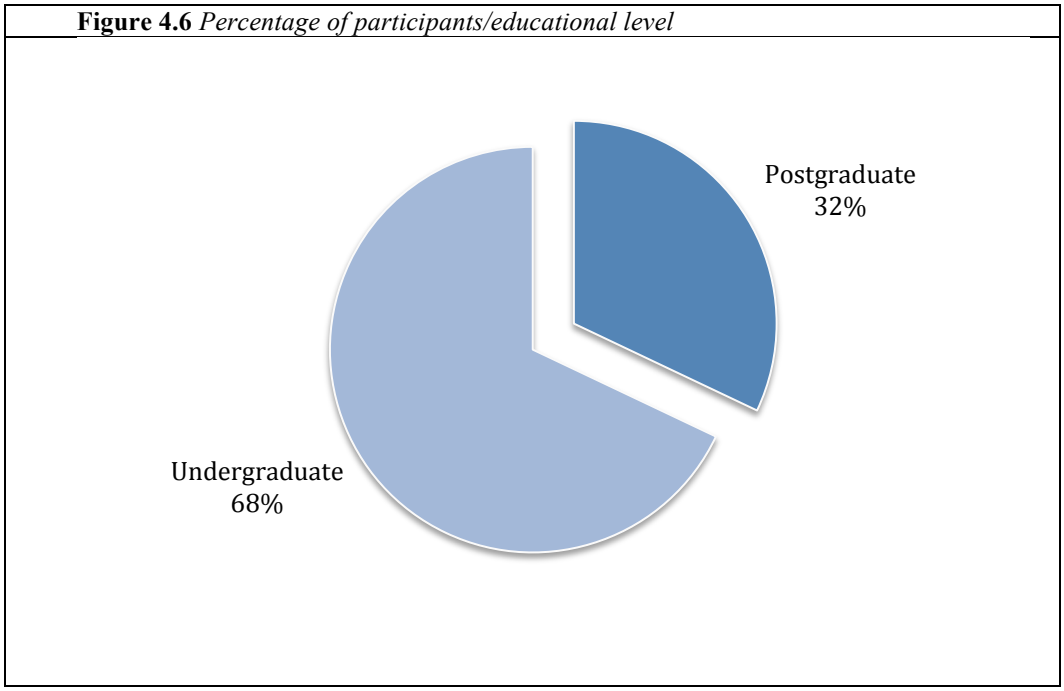
Figure 4.5 *Years of NIV experience distribution*



4.3.3 Participants formal education

Formal education qualifications incorporated the formal nursing course, as well as postgraduate courses correlating to healthcare, that were obtained by the participants. Qualifications were grouped either as undergraduate (Traditional enrolled nurse (EN), traditional, state registered nurse (SRN), EN to SRN conversion, Diploma/ Higher Diploma and Bachelor of Science (B.Sc.) in Nursing) or postgraduate (Postgraduate certificate and Masters' Degree in relation to a healthcare).

Figure 4.6 *Percentage of participants/educational level*



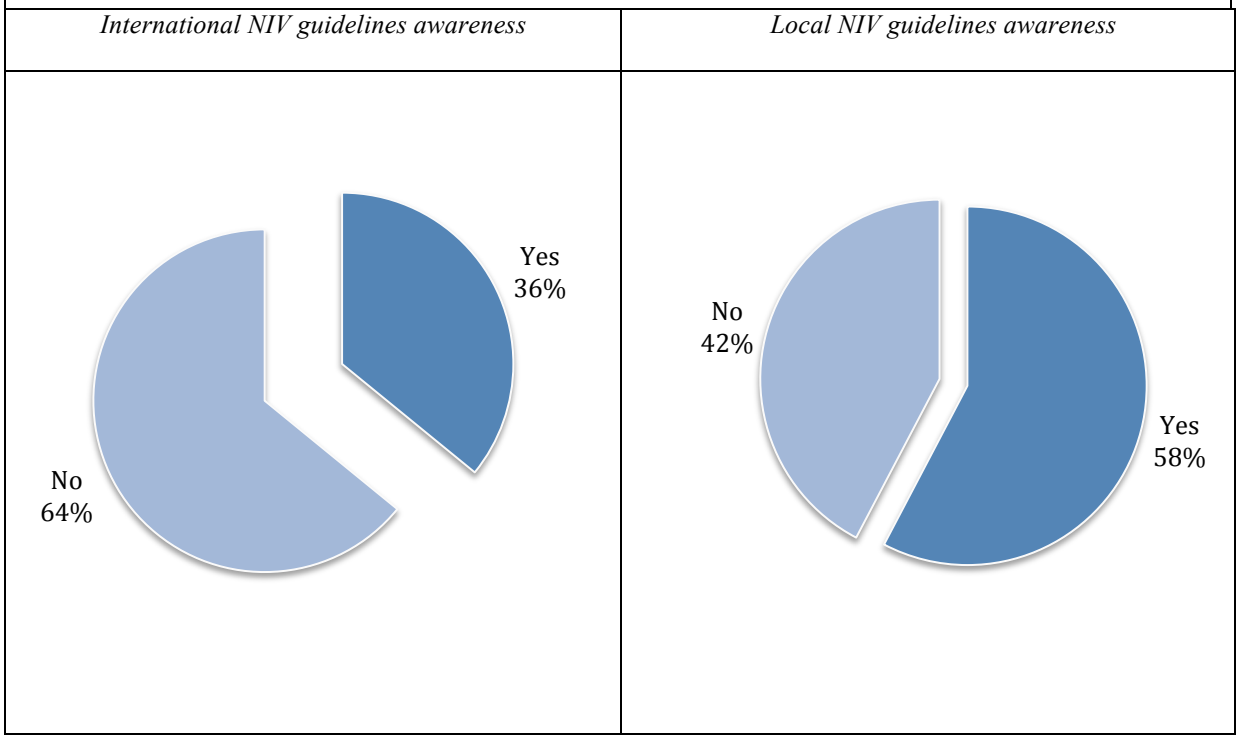
Several participants (32.1%, n=25), as highlighted in Figure 4.6, had achieved a postgraduate qualification (Masters' Degree or Postgraduate Certificate). However, most of the participants (67.9%, n=53) had not obtained postgraduate qualifications.

4.3.4 Participants' guidelines awareness

The participants were asked if they were aware of any NIV guidelines. One question was devoted to the local hospital NIV guidelines and the other for any international NIV guidelines. Figure 4.7 demonstrates that most participants (64%, n=50) were not aware of

international guidelines in relation to NIV. In contrast, it shows that most participants (57.7%, n=45) were aware of local hospital NIV guidelines.

Figure 4.7 *Percentage of participants aware on NIV guidelines*



Awareness was additionally grouped based upon participants' awareness either of both, one, or none of the local and international NIV guidelines. Most participants (38.46%, n=30) were aware of both guidelines, followed by none of the guidelines (32.05%, n=25). The associated results are presented in Table 4.1 below.

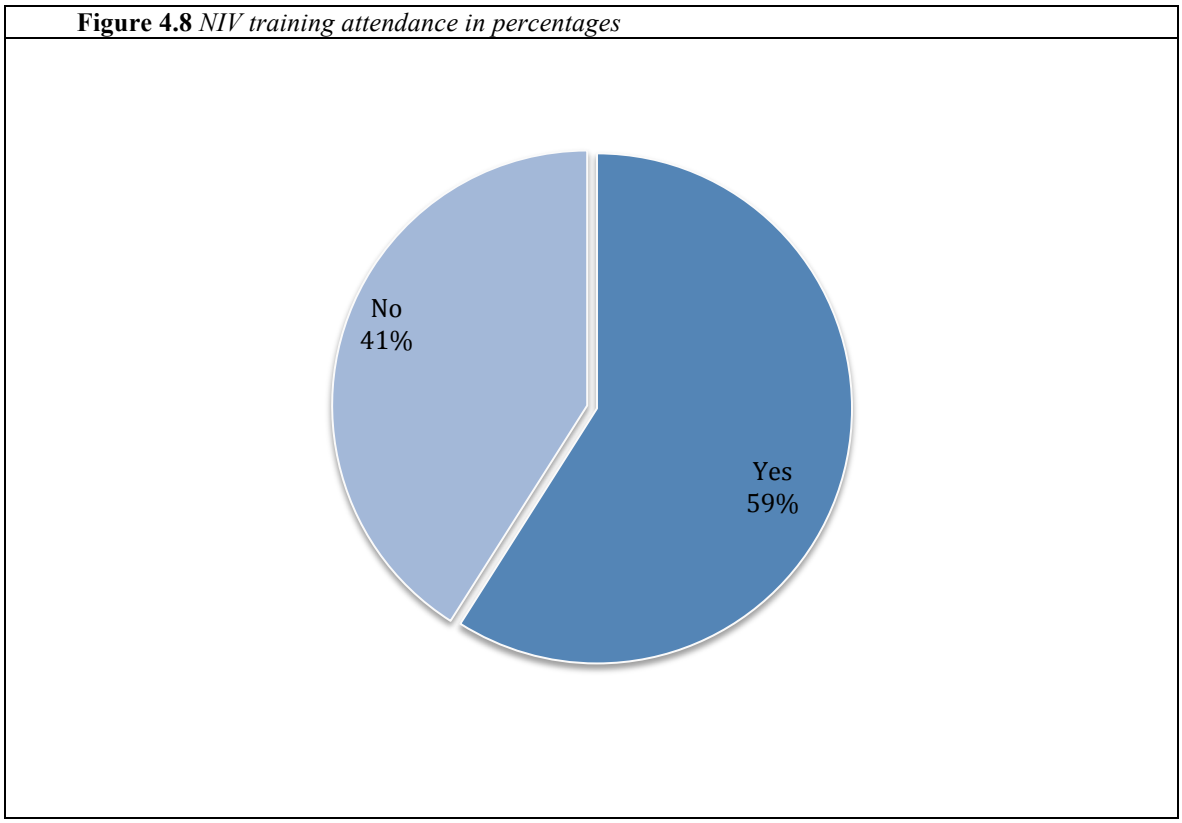
Table 4.1 *Participants' guideline awareness in terms of frequency and percentages.*

NIV guidelines awareness	None	One	Both
Participants (n)	25	23	30
Participants (%)	32.05%	29.49%	38.46%

4.3.5 Participants' training in non-invasive ventilation

Training attendance was considered as any training session and format offered to the participants. More than half of the participants were provided training on NIV, as shown in Figure 4.8 below.

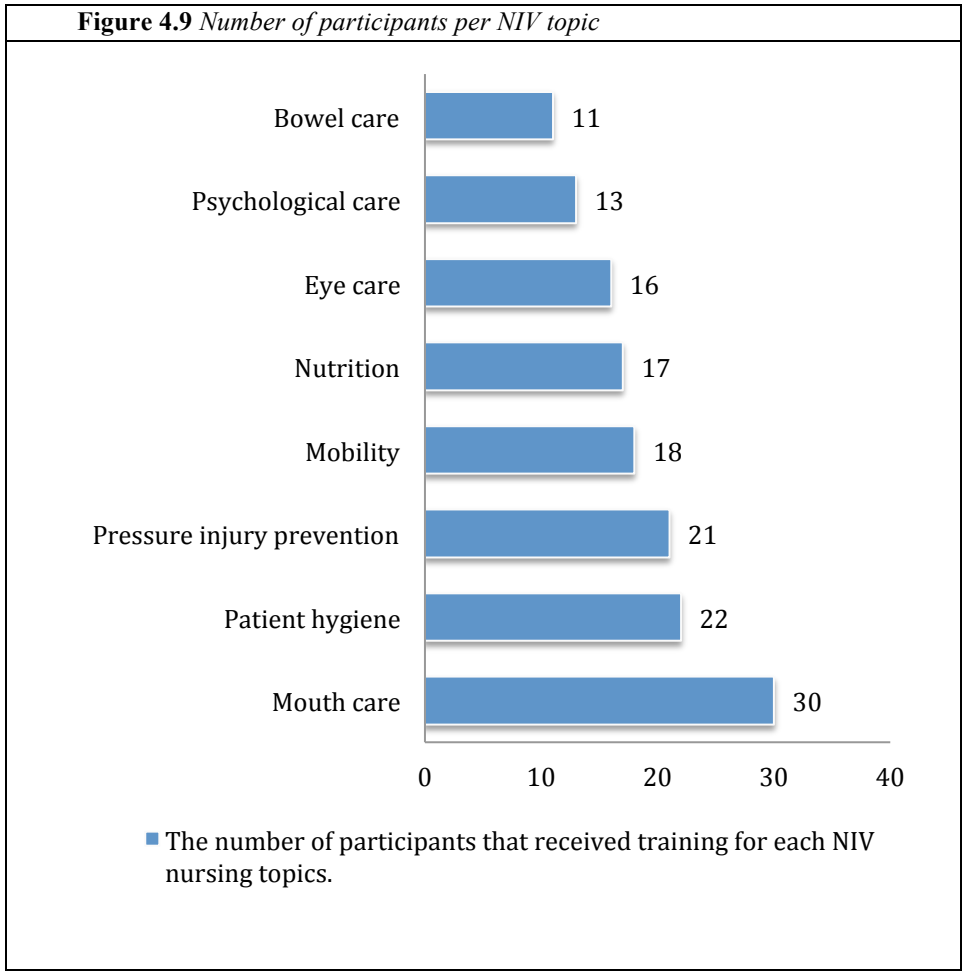
Figure 4.8 *NIV training attendance in percentages*



NIV training topics

Additionally, participants that attended training (59%, n=46) were asked to select topics, related to NIV nursing care, covered in the training sessions (Figure 4.9). Out of forty-six participants that attended NIV training, thirty-two answered the question related to the NIV topics covered. The most common training topic covered is mouth care (88%, n=30), followed by the pressure injury prevention (65%), patient hygiene and eye care (62%, n=22). Bowel Care (32%, n=11) seems to be the least common training topic to be covered. Participants were not asked about training topics covering the other domains.

Figure 4.9 *Number of participants per NIV topic*



4.4 Overall knowledge

An overall knowledge score was obtained by adding the total scores of each participant. Participants scored 1 point when choosing all the correct answers for each question, half-a-point when partially selecting a correct answer, and no points if questions were left unanswered or no correct answer selected. The maximum score was 27 out of 27 questions. Nineteen questions had 2 or more correct answers while 8 questions had 1 correct answer.

4.4.1 Overall knowledge scores distribution

Participants' overall knowledge scores ranged between 9.5-20 points as exhibited in Table 4.2.

Table 4.2 *Overall knowledge score description*

			Statistic	Std. Error
Overall knowledge	Mean		14.455	.2836
	95% Confidence Interval for Mean	Lower Bound	13.890	
		Upper Bound	15.020	
	5% Trimmed Mean		14.457	
	Median		14.500	
	Variance		6.274	
	Std. Deviation		2.5048	
	Minimum		9.5	
	Maximum		20.0	
	Range		10.5	
	Interquartile Range		4.1	
	Skewness		-.058	.272
	Kurtosis		-.857	.538

The mean overall knowledge score was 14.46 with a standard deviation of +/- 2.505, and a median score of 14.5 at a 95% confidence level (CL), as demonstrated in Figure 4.12. The overall knowledge was tested for normality, as demonstrated in Table 4.3. The normality test was used to identify if data carries a normal distribution. If data carries a normal distribution, a parametric test is indicated, whereas if data is not normally distributed, a non-parametric alternative is required (Mishra et al., 2019). The most common methods used to test normality are the Shapiro-Wilk and the Kolmogorov-Smirnov tests. While the Shapiro-Wilk test is more appropriately used for small sample sizes ($n<50$), the Kolmogrov-Smirnov can be used in samples of ≥ 50 (Mishra et al., 2019). As the sample was greater than 50 participants, the Kolmogrov-Smirnov test was used. The *p*-value was 0.040, less than the 0.05 criteria, and therefore it can be concluded that the data is not normally distributed. This is exhibited in Table 4.3 below.

Table 4.3 *Normality test for Overall Knowledge (Kolmogorov-Smirnov)*						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Overall knowledge	.103	78	.040	.975	78	.128
a. Lilliefors Significance Correction						

Furthermore, looking at the Q-Q plot charts (Figure 4.10) and histogram (Figure 4.11), it can be noted that the observations are distributed closely around the straight line, reflecting the slight statistical significance (p=0.040) mentioned overhead. Moreover, the histogram in Figure 4.11 demonstrates that the overall knowledge score seems to be unevenly distributed among participants, further reinforcing that overall knowledge is not normally distributed among participants.

Figure 4.10 *Q-Q Plot of the overall knowledge scores*

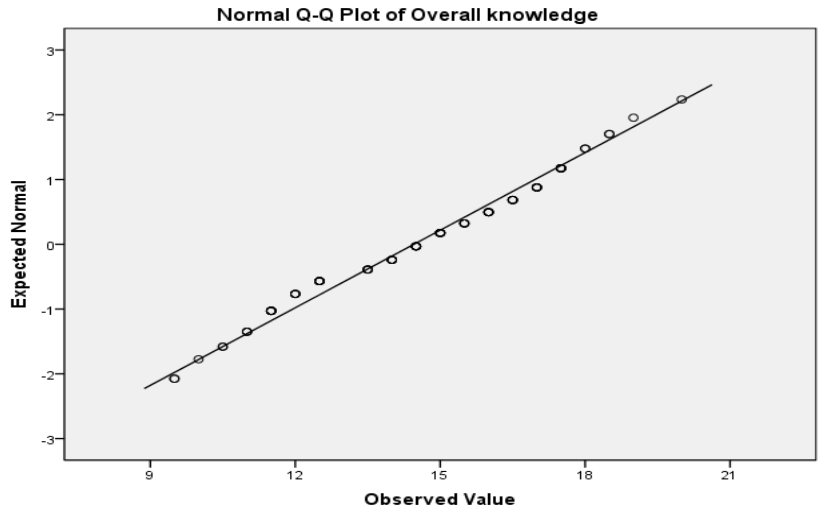
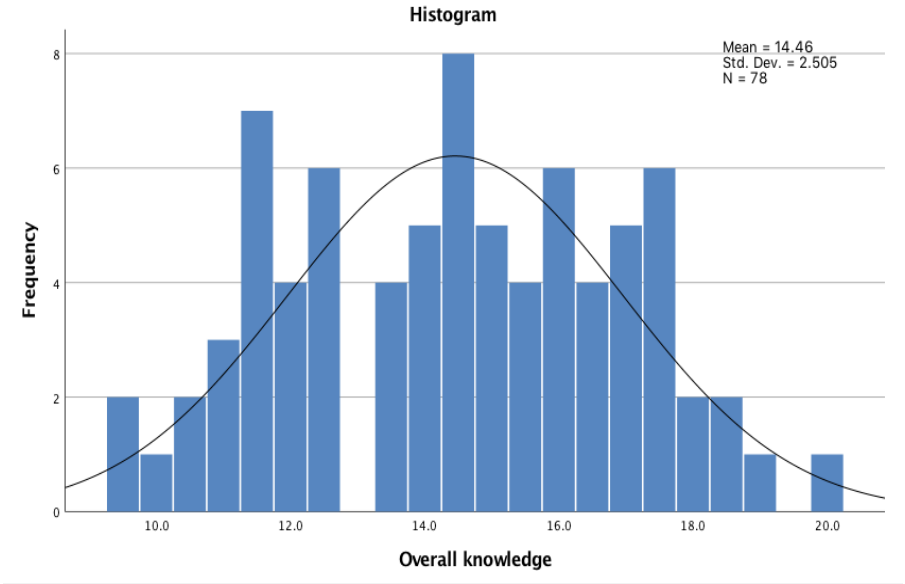


Figure 4.11 *Distribution of the overall knowledge scores*



4.4.2 Knowledge & unit

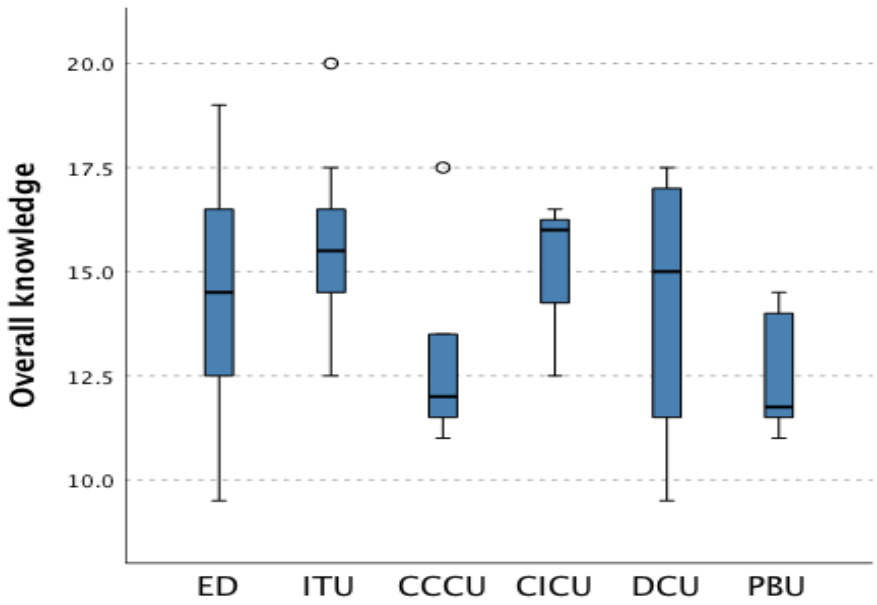
Participants were categorized per unit. The Kruskal-Wallis test was used to identify if there was a statistically significance difference in overall knowledge between units. The Kruskal-Wallis test is a non-parametric method used to compare two or more groups when there is no normal distribution in any of the variables (Stevens, 2013). The mean score per unit, standard deviation and mean percentages of the overall knowledge were calculated, as demonstrated in Table 4.4. Statistical significance was estimated using the above-mentioned test. There was no statistically significant difference (p=0.132, between units, although percentage mean score was highest in the ITU (56.45%) and lowest at the PBU (45.98%)). This is demonstrated in Table 4.4 below.

Table 4.4 *Knowledge scores / Unit*

Unit	Mean +/- SD Score	Standard deviation	Mean Score (%)	Significance (p value)
ITU	15.35	1.05	56.45	
ED	14.54	0.78	53.30	
CCCU	13.10	2.31	49.0	
CICU	15.03	2.51	54.33	0.132
PBU	12.42	1.17	45.98	
DCU	14.25	2.57	52.80	

Furthermore, as can be seen from the box plot graph (Figure 4.12), the ITU department has the highest overall score, followed by ED. Note that ITU and CCCU have one outlier in each case. The median knowledge score is highest in the CICU group followed by ITU, and least in PBU.

Figure 4.12 *Unit knowledge scores (Mean score +/- SD) Kruskal-Wallis Test*



4.4.3 Knowledge & general nursing experience

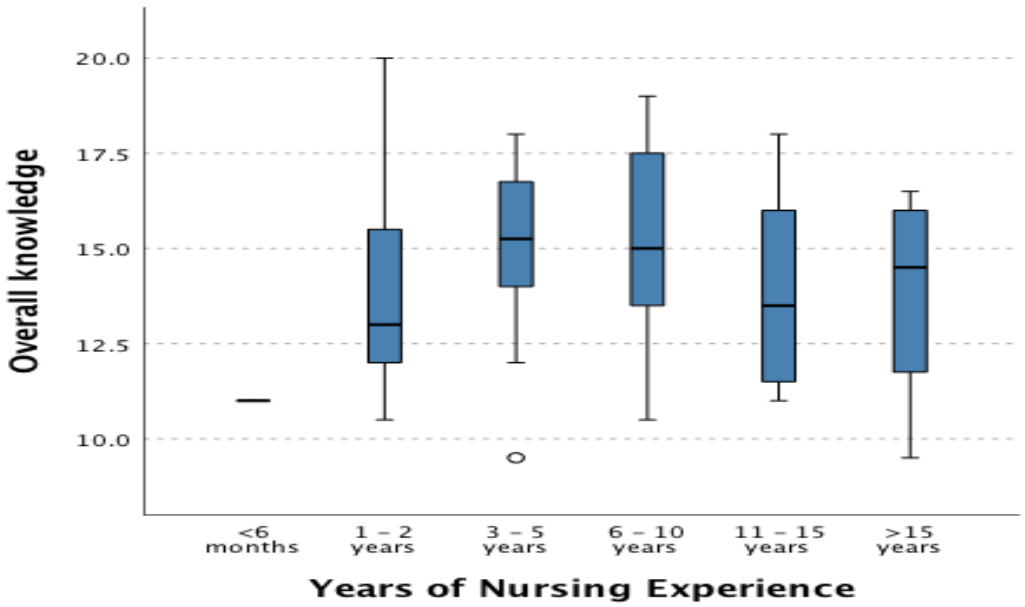
Participants were then grouped by nursing experience in months or years. Mean scores with standard deviation and mean percentages of the overall knowledge were calculated for each year category (Table 4.5). Statistical significance was estimated using the Kruskal-Wallis Test. The *p*-value was equal to 0.367, meaning that the distribution of the overall knowledge was the same across categories of years of nursing experience. The mean knowledge score was highest in the 3-5 year group (55.58%), followed by the 6-10 year group (54.97%). The least knowledge score obtained was in the <6-month group (40.70%), followed by >15 years group. Importantly, the <6-month group only consisted of one participant and therefore caution should be practiced when interpreting this result.

Table 4.5 *Nursing years of experience knowledge score*

	Mean Score	Standard deviation	Mean Score (%)	Significance (p value)
<6 months	11	-	40.70	0.367
1-2 years	14.05	1.81	51.11	
3-5 years	15.03	1.08	55.58	
6-10 years	14.96	0.96	54.97	
11-15 years	13.93	1.34	51.33	
>15 years	13.88	1.43	50.78	

Figure 4.13 demonstrates that the median score was highest in the 3-5 year group followed by the 6-10 year group. An outlier is present in the 3-5 year group while only one participant was in the <6-month group, also occupying the lowest median score, but instead followed by the 11-15 year group. Additionally, the 1-2 years group had the broadest range in knowledge scores and demonstrated by the whiskers box plot underneath.

Figure 4.13 *Years of nursing experience and knowledge score (Mean +/- SD) Kruskal-Wallis Test*



4.4.4 Knowledge & non-invasive ventilation experience

The overall knowledge and its association to NIV nursing experience will be analysed in this section. Participants were grouped by NIV nursing experience in months or years. Mean scores, standard deviation, and mean percentages of the overall knowledge were calculated for each category, presented in Table 4.6. Similarly, statistical significance was estimated

using the Kruskal-Wallis test and resulted in a *p*-value of 0.447. Therefore, no statistically significant difference was demonstrated between the groups. Additionally, Table 4.6 demonstrated that the 3-5 year group had the highest mean score (56.03%), followed by >15 year group (54.65%) with the lowest being the group with less than 6 months of NIV experience (47.23%).

Additionally, the box plot graph hereunder (Figure 4.14) shows the overall knowledge with nursing experience. The 3-5 years, 11-15 years, and >15 years groups had equivalently highest median scores, while participants with less than 6 months experiences had the least median score. Furthermore, the 1-2 year group had the widest range in knowledge scores as demonstrated by the long whiskers in the box plot below.

Figure 4.14 *NIV nursing experience and knowledge score (Mean +/- SD) Kruskal-Wallis Test*

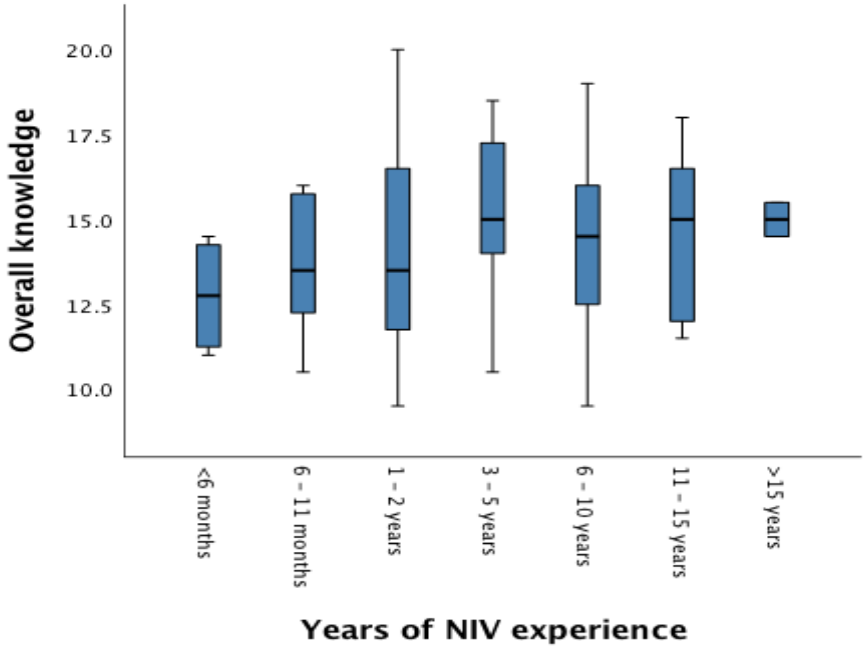


Table 4.6 *NIV nursing experience knowledge scores*

	Mean +/- SD Score	Standard deviation	Mean % Score	Significance (p value)
<6 months	12.75	1.72	47.23	
6-11 months	13.71	1.61	50.00	
1-2 years	14.23	1.50	52.35	
3-5 years	15.30	0.94	56.30	0.447
6-10 years	14.18	1.07	52.11	
11-15 years	14.60	2.47	53.72	
>15 years	15.00	0.98	54.65	

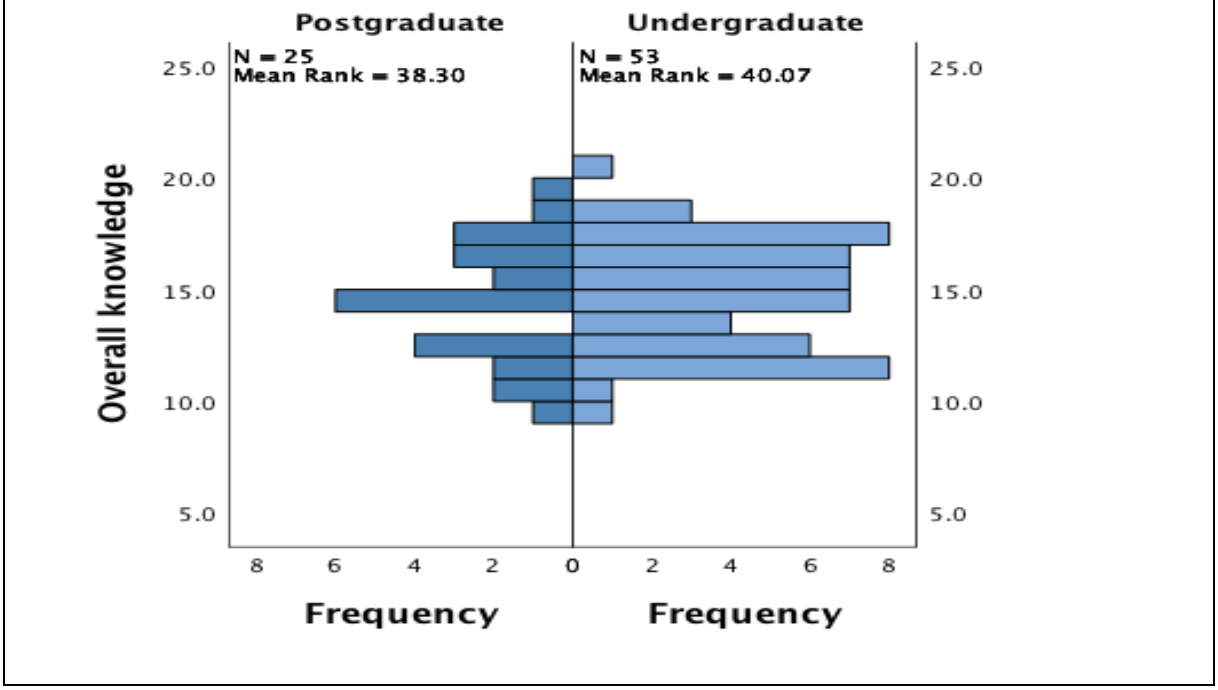
4.4.5 Knowledge & formal education

Participants were classified according to their highest nursing academic achievement as explained in section 4.3.3. Mean scores with standard deviation and mean percentages of the overall knowledge were calculated for each group, demonstrated in Figure 4.15 and Table 4.7 below. As the analysis included only two groups, to assess for statistical significance the Mann-Whitney U test was used as recommended by Shier (2004). Both undergraduate and postgraduate groups had similar average score, 53.54% and 52.54% respectively. The *p*-value was 0.748, thus it can be concluded that there is no association between formal qualifications and overall NIV knowledge.

Table 4.7 *Highest formal nursing education knowledge scores (Mean +/-SD)*

	Mean Score	Standard deviation	Mean % Score	Significance (p value)
Undergraduate education	14.53	0.66	53.54	0.748
Postgraduate education	14.30	1.03	52.54	

Figure 4.15 *Overall knowledge score distribution in undergraduates & postgraduates (Mann-Whitney U Test)*



4.4.6 Knowledge & guidelines

The aim of this section is to investigate whether there is an association between awareness of both local and international guidelines, and the overall score. Participants were sorted according to their awareness of guidelines, first to international guidelines and then to local guidelines. Mean scores with standard deviation and mean percentages of the overall knowledge were calculated for each group. The mean and the standard deviation were similar both in the international and the local guidelines awareness groups (Table 4.8 & Table 4.9). Statistical significance was estimated using the Mann-Whitney U Test. The *p*-value of 0.324, being greater than the 0.05 criterion, suggests that there is no association between the international guideline awareness and overall score (Table 4.8). The comparison of the distribution of knowledge on the international NIV guidelines awareness is shown in Figure 4.16 below.

Figure 4.16 *Overall knowledge score distribution in International NIV guidelines awareness groups. (Mann-Whitney U Test).*

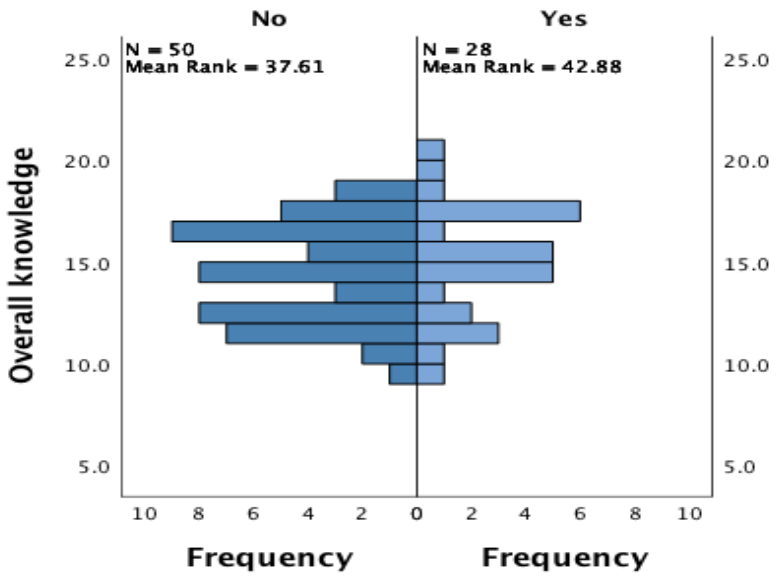


Table 4.8 *International NIV guidelines awareness knowledge scores*

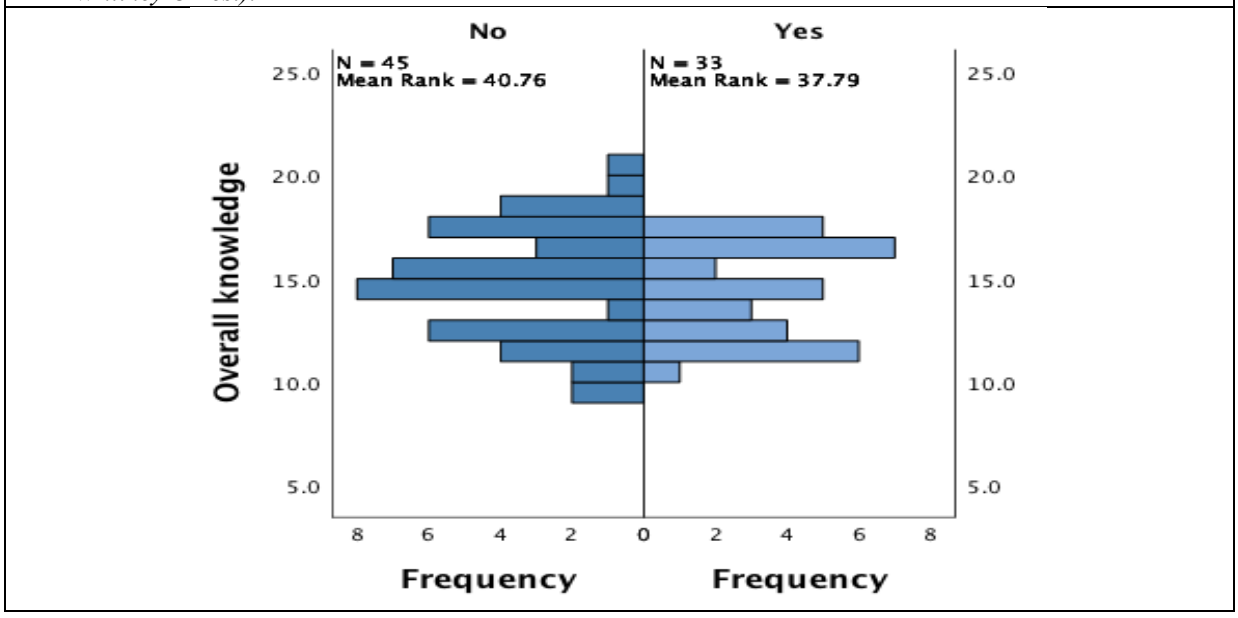
	Mean +/- SD Score	Standard deviation	Mean % Score	Significance (p value)
Yes	14.23	0.663	52.19%	0.324
No	14.86	0.998	54.78%	

Similarly for the local guidelines and overall knowledge score, since the *p*-value 0.567 is greater than the 0.05 criteria, it can be concluded that there is no association (Table 4.9). The comparison of the overall knowledge on the local hospital guidelines awareness is also illustrated in the bar graph (Figure 4.17).

Table 4.9 *Local hospital NIV guidelines awareness knowledge scores*

	Mean +/- SD Score	Standard deviation	Mean % Score	Significance (p value)
Yes	14.27	0.756	52.42%	0.567
No	14.59	0.793	53.63%	

Figure 4.17 *Overall knowledge score distribution in local NIV guidelines awareness groups, (Mann-Whitney U Test).*



Additionally, knowledge score was highest in participants with no guideline awareness (55.03%), and lowest in those that had awareness to both guidelines (52.67%). These results are demonstrated in Table 4.10 below.

Table 4.10 *Guidelines awareness knowledge scores by awareness category*

Guidelines awareness	None	One	Both
Knowledge score	14.86	14.33	14.22
Knowledge score (%)	55.03	53.07	52.67

4.4.7 Knowledge & training attendance

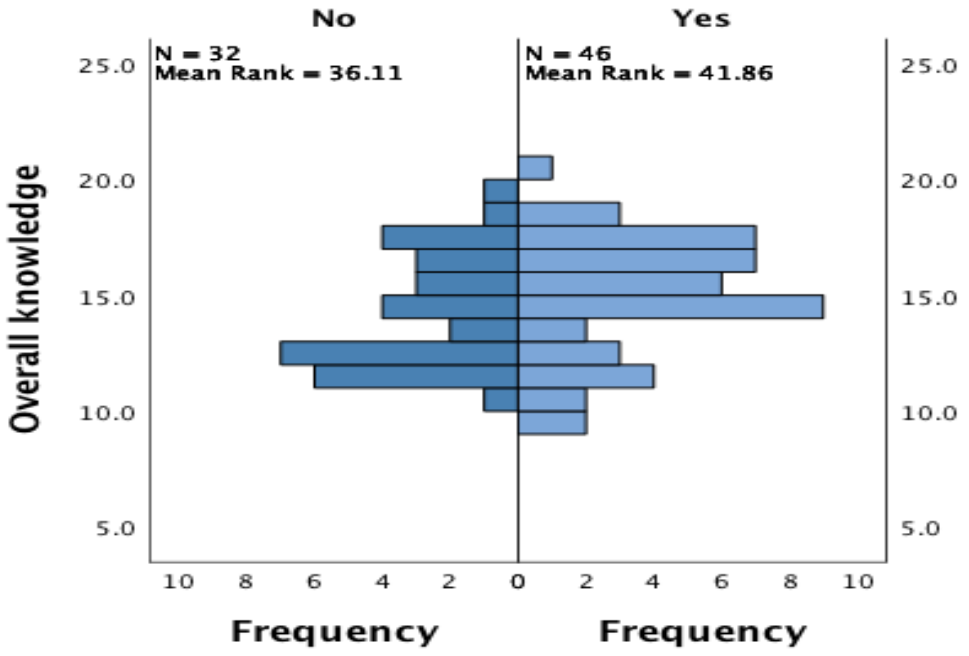
This part investigates the association of overall knowledge to previous training exposure. Participants were categorised into two groups: those having previous training exposure and those with no training exposure. Mean scores with standard deviation and mean percentages of the overall knowledge were calculated for each group. The mean percentage scores between the group that attended NIV session and that did not are 54.12% and 51.68% respectively. These results are provided in Table 4.11 below. As the independent variable only consisted of two groups, statistical significance was estimated using the Mann-Whitney U Test. There was no statistical difference as the *p*-value was 0.269, also highlighted in Table 4.11.

Table 4.11 *NIV training past attendance knowledge scores*

	Mean Score	Standard deviation	Mean % Score	Significance (p value)
Yes	14.71	0.736	54.12%	0.269
No	14.09	0.845	51.68%	

Additionally, a comparative histogram that compared training attendance categories was also presented in Figure 4.18 below.

Figure 4.18 *NIV training attendance and overall knowledge score distribution, (Mann-Whitney U Test).*



4.5 Knowledge domains

Following the overall knowledge analysis, NIV knowledge was examined by domain. Hence this section focuses on participants' knowledge scores in the four knowledge domains, i.e. pathophysiology knowledge, technical knowledge, monitoring knowledge, and nursing knowledge. Table 4.12 provides detailed scores in terms of mean, median, and standard deviation for each domain.

Table 4.12 Knowledge scores by domains (*Mean +/-SD, median, range, skewness & kurtosis*)

			Statistic	Std. Error
Knowledge of pathophysiology	Mean		2.385	.0784
	95% Confidence Interval for Mean	Lower Bound	2.228	
		Upper Bound	2.541	
	5% Trimmed Mean		2.400	
	Median		2.500	
	Variance		.480	
	Std. Deviation		.6928	
	Minimum		.5	
	Maximum		4.0	
Technical knowledge	Mean		2.558	.1214
	95% Confidence Interval for Mean	Lower Bound	2.316	
		Upper Bound	2.799	
	5% Trimmed Mean		2.563	
	Median		2.500	
	Variance		1.149	
	Std. Deviation		1.0720	
	Minimum		.5	
	Maximum		5.0	
Knowledge of patient monitoring	Mean		3.000	.1076
	95% Confidence Interval for Mean	Lower Bound	2.786	
		Upper Bound	3.214	
	5% Trimmed Mean		2.979	
	Median		3.000	
	Variance		.903	
	Std. Deviation		.9501	
	Minimum		1.0	
	Maximum		5.0	
Nursing knowledge	Mean		6.513	.1248
	95% Confidence Interval for Mean	Lower Bound	6.264	
		Upper Bound	6.761	
	5% Trimmed Mean		6.514	
	Median		6.500	
	Variance		1.214	
	Std. Deviation		1.1019	
	Minimum		4.0	
	Maximum		9.0	

Additionally, mean percentage scores were calculated from the mean scores above. Pathophysiology knowledge domain had the highest mean percentage score (59.63%), while Monitoring knowledge domain had the lowest percentage score (50%). These results are demonstrated in Table 4.13 below

Table 4.13 *Knowledge domains' mean percentage scores*

	Pathophysiology Knowledge	Technical knowledge	Monitoring knowledge	Nursing knowledge
Mean Percentage Score	59.63%	51.16%	50%	54.28%

4.5.1 Knowledge domains' normality tests

The domains were assessed for normal distribution using the Kolmogorov-Smirnov (KS) Test with a statistical significance value of p <0.05. All the domains had a statically significant p value (<0.001) less than the alpha value of 0.05 and therefore do not follow normal distribution. The normality test results for the abovementioned domains are provided in Table 4.14 below.

Table 4.14 *Knowledge domains' score (Mean =/- SD) & normality P value (Kolmogrov-Smirnov Test)*

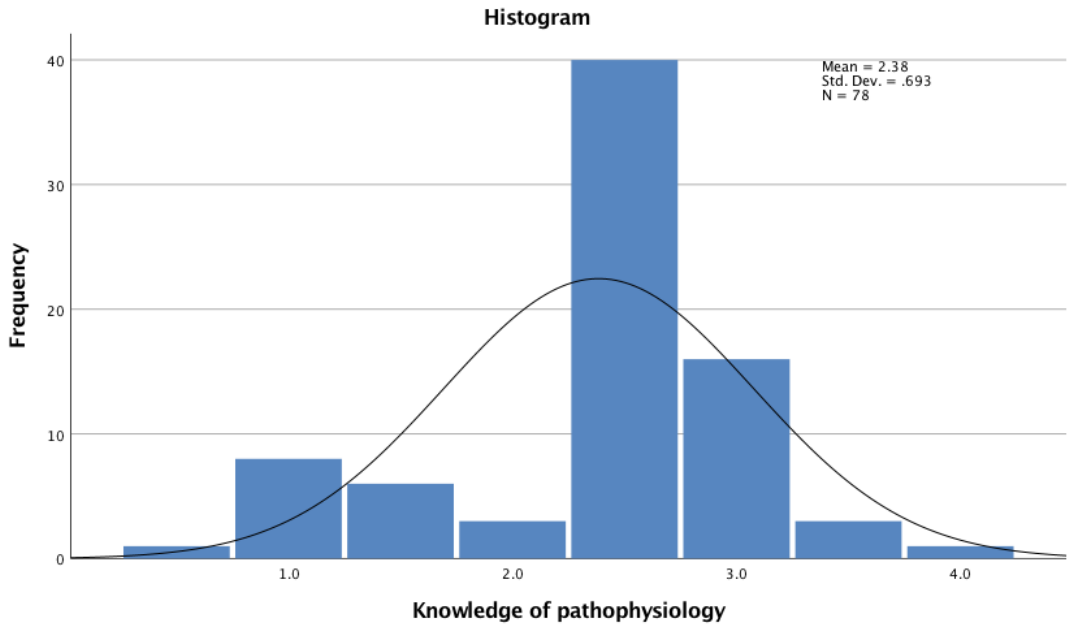
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Knowledge of pathophysiology	.335	78	<.001	.848	78	<.001
Technical knowledge	.147	78	<.001	.959	78	.013
Knowledge of patient monitoring	.149	78	<.001	.956	78	.009
Nursing knowledge	.154	78	<.001	.965	78	.029

[a]Lilliefors Significance Correction

Moreover, results are also illustrated via histograms in Figure 4.19 to Figure 4.22 presented underneath. The graphs demonstrated the number of participant knowledge scores per

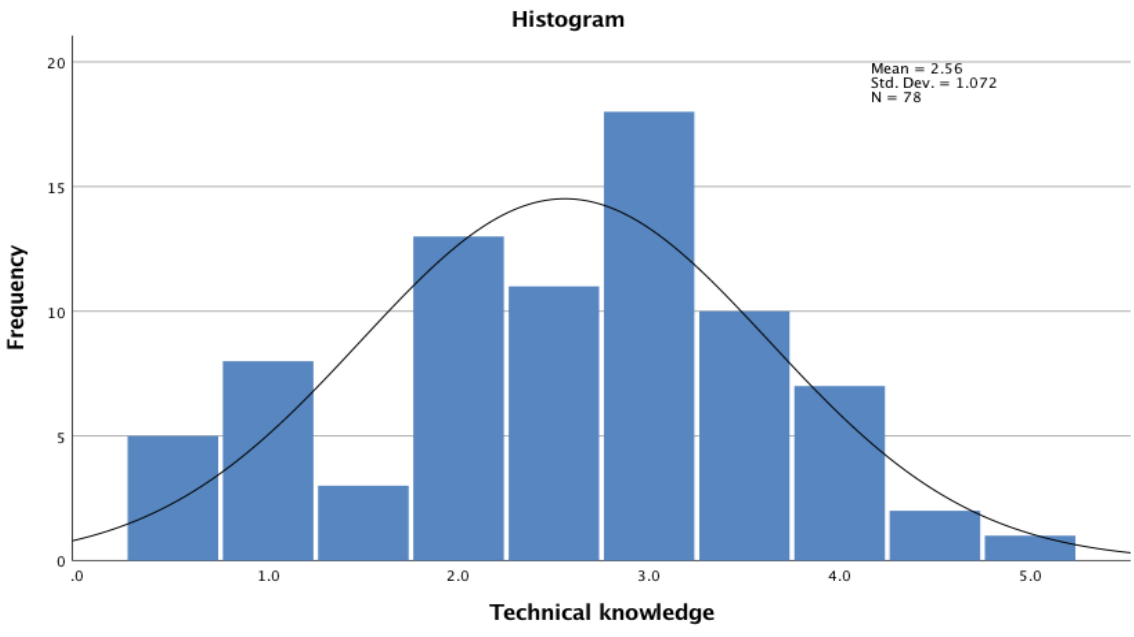
domain, accompanied by the means and standard deviation. Additionally, Q-Q plots for each domain are presented in Appendix 18.

Figure 4.19 *Pathophysiology knowledge domain distribution of knowledge score & normality waveform*



Pathophysiology knowledge domain had a mean score of 2.38 from a maximum score of 4, with a standard deviation of 0.693. The technical knowledge domain had a mean score of 2.56 of a maximum score of 5, with a standard deviation of 1.072

Figure 4.20 *Technical knowledge domain distribution of knowledge score & normality waveform*



Furthermore, monitoring knowledge domain had a mean score of 3 from a maximum score of 6 points, with a standard deviation of 0.95 (Figure 4.22). Finally, nursing knowledge domain had a mean score of 6.51 from a total of 12 points, with a standard deviation of 1.102 (Figure 4.23.

Figure 4.21 *Monitoring knowledge domain distribution of knowledge score & normality waveform*

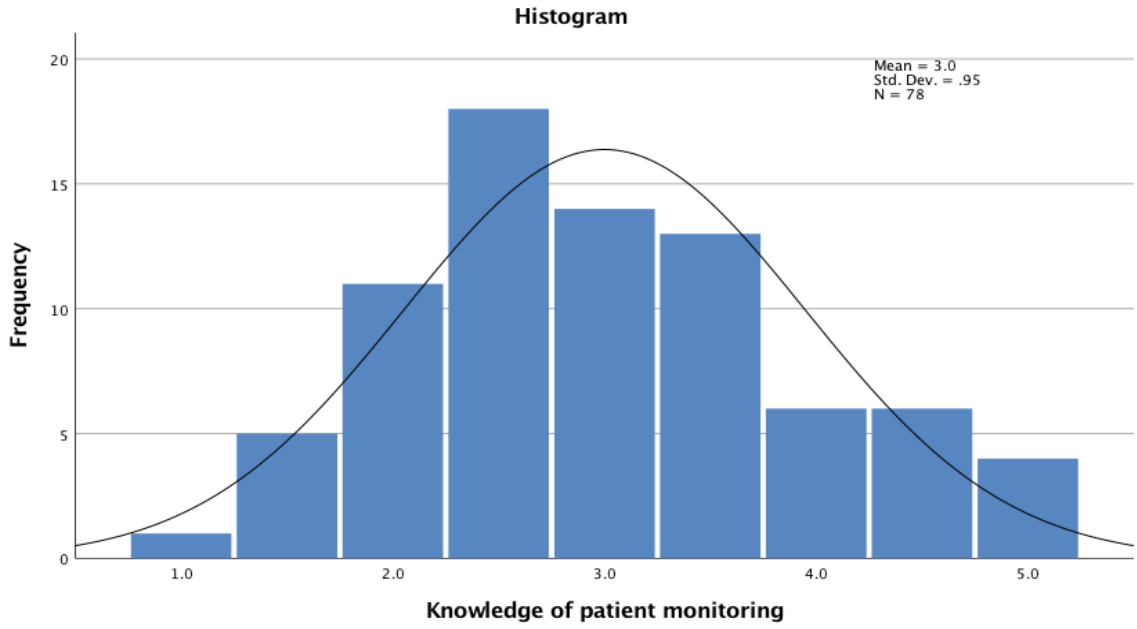
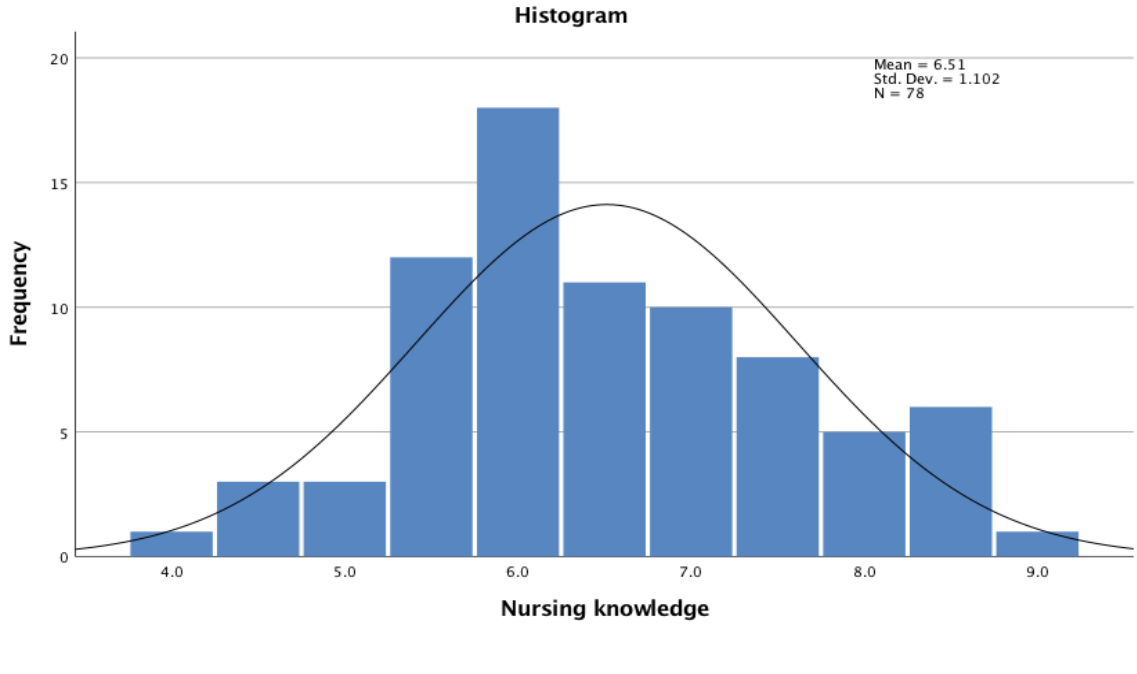


Figure 4.22 *Nursing knowledge domain distribution of knowledge score & normality waveform*



4.5.2 Correlation between domains

A Spearman correlation analysis was used to test whether there is a significant correlation between the four main domains: Knowledge of pathophysiology, technical knowledge, monitoring knowledge, and nursing knowledge. Cohen's suggestions were used to determine the strength of the relationships between variables, if the coefficient is between 0.10-0.29, there is a small effect, coefficients between 0.30 and 0.49 represent a moderate effect size, and greater than 0.5 indicates a high correlation between variables (Cohen et al., 2003). As all knowledge domains follow an abnormal distribution, a non-parametric test such as the Spearman correlation test was required (Pallant 2016).

The results related to the correlation between knowledge domains are presented in Table 4.15 below:

Table 4.15
Correlation between the NIV knowledge domains (Spearman's Correlation Test)

Correlations

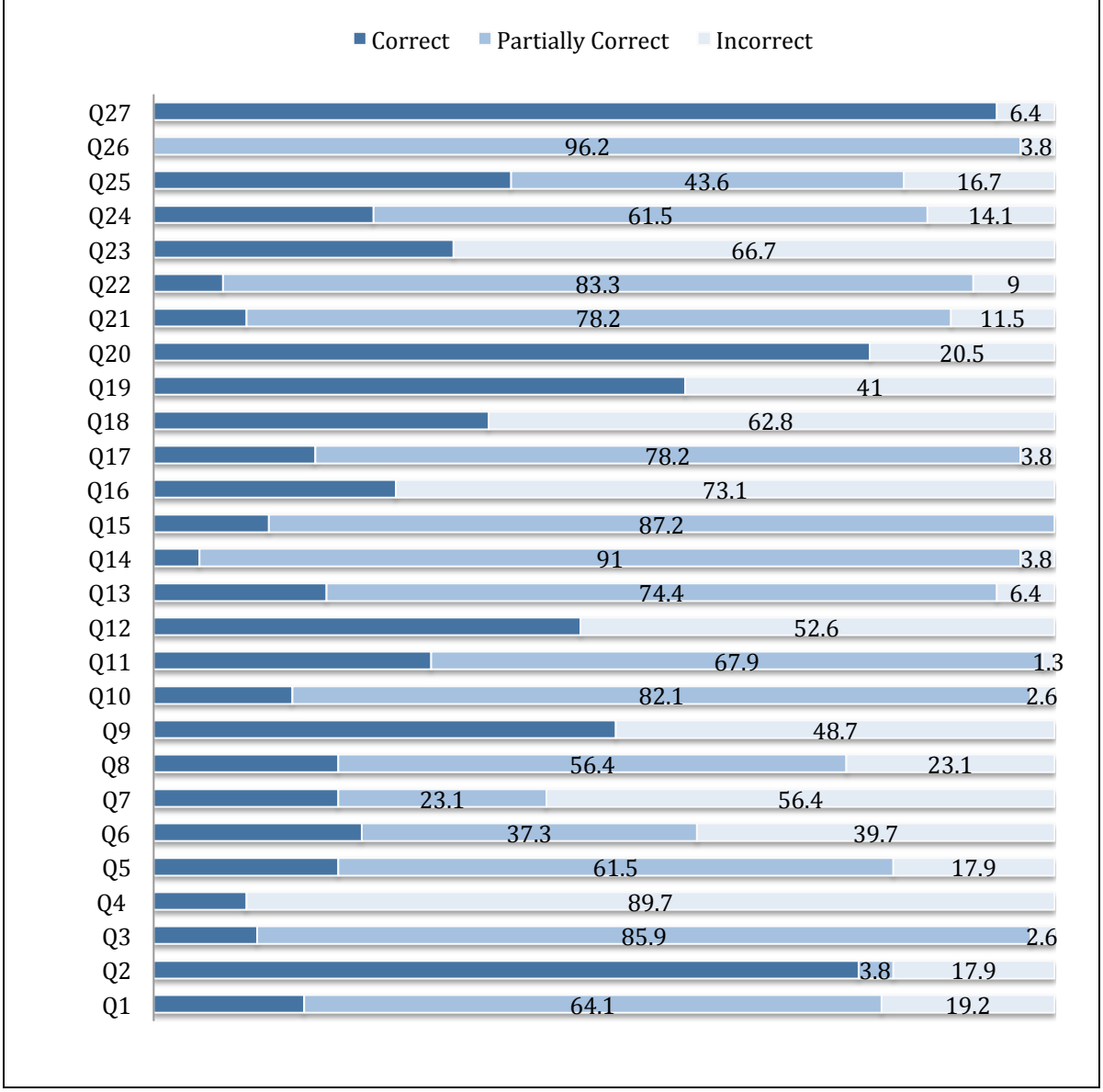
		Knowledge of pathophysiology	Technical knowledge	Monitoring knowledge	Nursing knowledge
Knowledge of pathophysiology	Correlation Coefficient	1.000	.149	.111	.214
	Sig. (2-tailed)	.	.192	.331	.060
	N	78	78	78	78
Technical knowledge	Correlation Coefficient	.149	1.000	.321	.411
	Sig. (2-tailed)	.192	.	.004	.000
	N	78	78	78	78
Knowledge of patient monitoring	Correlation Coefficient	.111	.321**	1.000	.164
	Sig. (2-tailed)	.331	.004	.	.152
	N	78	78	78	78
Nursing knowledge	Correlation Coefficient	.214	.411**	.164	1.000
	Sig. (2-tailed)	.060	.000	.152	.
	N	78	78	78	78

From the above table it can be concluded that all knowledge domains had a positive correlation. A weak correlation existed between pathophysiology domains with other domains, with no statistical significance. A moderate correlation existed between the technical knowledge and monitoring knowledge (p=0.004), and between technical knowledge and nursing knowledge (p=0.000), with statistical significance.

4.6 Individual question responses

This section provides a description of the participant responses for each of the twenty-seven questions, grouped into the four knowledge domains. Figure 4.23 and (Appendix 19) presented data in both frequency and percentages for each question.

Figure 4.23 *Distribution of correct, incorrect & partially correct answers for each knowledge question.*



Question 14, asking about methods to preserve facial skin integrity, was the least correctly responded question (n=4, 5.1%), although most participants (n=71, 91%) partially selected correct methods. Similarly, question 22, which examined participants' knowledge on eye care, was correctly answered by only 6 participants (n=6, 7.7%). Nonetheless, most participants (n=65, 83.3%) partially selected the correct answer. Participants had a low correct response rate for question four related to absolute contraindications of NIV, and although most (n=67, 89.7%) selected some of the absolute contraindications, only few (n=8, 10.3%) selected just the correct answers. Likewise, the same number of participants indicated the correct conditions that benefit from NIV (n=8, 10.3%), although only (n=2, 2.6%), did not choose any of the correct answers in question 3.

The most correctly responded to question was question 27 on the use of physiotherapy during NIV (n=73, 93.6%). Question 21, when to provide oral nutrition for patients on NIV, was also answered correctly by most participants (n=62, 79.5%). Equally, participants correctly responded question 2, examining knowledge on Type 2 respiratory failure (n=61, 78.2%). With less correct responses, question 19 enquiring on the right sequence of application of NIV was selected by 59% (n=46) of the participants.

4.7 Conclusion

This chapter set forth the descriptive and inferential statistics associated with this study according to the objectives highlighted in the introduction. Primary data was collected through a self-administered questionnaire that assessed the overall knowledge and the knowledge by domain of participants on NIV and NIV nursing care. A total of 26.6% from the total population participated and resulted in a confidence level of 95% and a 10% margin of error.

The findings were subjected to normality testing to assess whether a normal or abnormal distribution had been established and tests to assess statistical significance were applied accordingly.

Moreover, a summary of the main objectives and the associated results obtained is presented below.

Summary of main objectives and key findings

- *Objective:* To determine, the level of clinical expertise, experience, and academic background as well as other possible variables pertaining to the nurses applying NIV and NIV care in their respective specialised units.

  - *Findings:* The participants were predominantly from ED, between 3-10 years of NIV experience and 6-10 years of nursing experience, and mostly undergraduate. Additionally, participants had less awareness to international NIV guidelines than local guidelines, with most attended training in NIV.

- *Objective:* To identify, the overall knowledge level of nurses working with patients requiring NIV and NIV patient care.

  - *Findings:* The overall knowledge of nurse participants on NIV patient demonstrated moderate knowledge level in NIV and NIV patient care.

- *Objective:* To explore, the participant knowledge on the following knowledge domains: respiratory pathophysiology, technical knowledge, monitoring knowledge, and nursing knowledge, related to NIV and NIV patient care.

  - *Findings:* Participants had moderate knowledge in all 4 domains, with more

knowledge in the respiratory pathophysiology and least knowledge on monitoring required for patients on NIV.

- *Objective:* To explore any correlation or association between clinical or academic training, and years of clinical experience with nurses' knowledge in NIV and NIV patient care.

  - *Findings:* There was no statistical significance in correlation between either clinical training, or academic training, or clinical nursing experience, when compared to participants' knowledge in NIV and NIV patient care.

- *Objective:* To identify any association among the 4 knowledge domains mentioned above.

  - *Findings:* A weak correlation was identified between the pathophysiology domain domains and all the other domains. Moderate correlation was found between the technical domain and the nursing domain, and the technical domain and the monitoring domain, with statistical significance.

- *Objective:* To explore participant knowledge for individual knowledge questions.

  - *Findings:* The most correctly responded questions were related to; physiotherapy, nutrition, the sequence of NIV application, and the definition of type two respiratory failure. Most incorrectly responded questions were related to; eye care, facial skin integrity, absolute contraindications and conditions that would benefit from NIV.

The following section will look at the components under investigation, analysing means and statistical differences between independent variables and overall knowledge. Furthermore, an analysis of the 4 domains and the individual questions is also presented.

Although no statistically significant results were identified, several remarks were highlighted, which will be expanded upon in the next chapter.

Chapter 5

DISCUSSION

5.1 Introduction of the study

This purpose of this chapter is to answer the research question by examining the data generated by the participants that are directly involved in providing NIV and NIV care locally. This was conducted through an appraisal and evaluation of, as well as implications stemmed from, the findings. The outcomes were then compared with results obtained from other studies highlighted in the systematic review. Moreover, an appraisal of the study was additionally conducted, including strengths and limitations, and presented at the end in this chapter.

5.2 Appraisal of findings

This section involves a discussion of the quantitative findings obtained from the questionnaires. An examination of the findings related to the overall knowledge and the knowledge domains was initially conducted, together with an evaluation of independent variables, and a critical analysis of the variables with the overall knowledge. Additionally, each individual knowledge question was explored.

5.2.1 Overall knowledge

The overall knowledge was defined as the total score that each participant obtained when answering the NIV knowledge questionnaire. The outcome of this section helped identify the level of knowledge of nurses working with patients requiring NIV care. For the purposes of the study knowledge criteria were developed as a questionnaire, and based upon established recommendations by Mohammed et al. (2019) and British Thoracic Society BTS (Davidson et al., 2016). Additionally in this chapter, the study conducted by the researcher will be referred to as “the local study”.

The findings of the local study revealed that nurses have a moderate level of knowledge on NIV patient care, with a mean score 54%. Similar moderate scores were reported by Tarhan et al. (2015), who reported a mean knowledge score of 47%. Using a different approach to

report scores, Annarni et al. (2017) also reported moderate to low knowledge scores, with 68% of the participants scoring less than 50%. This is partly in contrast with findings of this study, in which 31% of the participants scored less than 50%.

Although variances exist between the studies, participants' NIV knowledge seemed to be marginally higher in this study. Nonetheless, the overall knowledge was still inferior to that currently recommended in literature.

5.2.2 Demographic independent variables

Through the demographic variables: level of clinical expertise, experience, academic background, as well as other possible variables pertaining to nurses applying NIV were established. The study was conducted among 293 nurses that provided care for NIV patients at a local hospital in Malta. Only 27% of the potential participant population replied to the questionnaire. The low response resulted in a margin of error of 10% at a confidence level of 95%. This limits generalisability of results. Although a low response rate can result in non-response bias, Visser et al. (1996) and Keeter et al. (2006) both yielded more accurate results in surveys with lower response rates (20%) and (25%) than in studies with a response rate of around (60%) and (50%), respectively. Therefore, while bias must be assumed, having a lower response rate might not always mean less accurate results.

A third of the nurses offering NIV care at the local hospital work at the ITU while another third work at the ED. Surprisingly ITU had the least response rate at 14.5% of the ITU nurse population. The reasons for such response rates could not be elicited, however the effects of research fatigue and COVID fatigue can be felt in high-acuity and critical care areas and possibly these are affecting response to research projects. In any case, results cannot be generalized to the whole population of ITU nurses response rate of 14.5% and similarly to DCU nurses, which as also a low response of 20.6%.

Additionally a third of participants (31.2%) had 6 to 10 years of experience, and more than half (57.7%) had NIV experience that ranged from three years and ten years. This means that participants had reasonable amount of both general nursing and NIV experience.

Most of the participants (68%) had awareness to at least one NIV guideline and 59% had attended NIV training, although only a third of participants obtained postgraduate qualifications (32.1%). Participants in the local study therefore had higher training attendance than Tarhan et al. (2015) study (40.8%), and Annarani et al. (2017) study (26%). Moreover, almost seventy percent of participants that were provided NIV training covered some of the nursing topics highlighted in the questionnaire. Only 19% covered all the nursing topics presented in the questionnaire. Raurell-Torreda et al. (2019) argued that NIV training is commonly coordinated by doctors, and therefore lacks focus on specific nursing topics. This seemed to be reflected also in this study as only nine participants covered all nursing related topics.

5.2.3 Demographics and overall knowledge association

The association of the demographics and the overall knowledge in NIV was explored in this section, and aimed at identifying any statistical significance between variables.

- *Comparing Knowledge amongst Units*

The mean overall knowledge was highest in ITU (56.45%) and lowest in PBU (45.98%), although no statistically significant difference $p = 0.132$ (<0.05) was present between the various units. Correspondingly a study conducted by Tarhan et al. (2015) yield similar results as it yielded higher knowledge in ICU however statistical significance between units was not found. This result suggests that units that care for patients with higher acuity (ITU & CICU), although not statistically significant, had slightly higher NIV knowledge than those caring for patients with lower acuity (PBU & CCCU). Although one can only speculate the reason for this variation in knowledge per unit, it might be due to training modification for unit needs,

and exposure to patients with higher acuity. Higher acuity might result in better exposure and performance in skills commonly performed on both NIV patients and other patients. It is important to note that ITU had a low response rate, and results may have differed if response rates increased.

- *Comparing Knowledge with Experience*

NIV knowledge in association with general nursing experience seemed to increase for participants with less than six months experience and a score of 40.7% to around 55% for participants with three to ten years' experience. Oddly, the mean knowledge score drops again in participants with eleven years of nursing experience and over (51%). No statistical significance exists between knowledge and general experience $p = 0.367$ (0.05). Likewise, in Raurell-Torreda et al. (2019), general experience was not reflected in better knowledge outcomes.

NIV knowledge when compared to NIV nursing experience also increased from 47.23% at less than 6 months to 56.3% at 3-5 years, but then dropped again at 6-10 years (52.11%). Though no statistically significant difference was identified between years of NIV experience, it seemed to be best at 3-5 years.

Following Benner's theory, 'From Novice to Expert', (Benner, 1982), the participants' knowledge increased with years of experience for the first 10 years of practice, as they maturedfrom novices to expert. However, participants with more than 11 years nursing and NIV experience did not reflect this pattern, and their level of knowledge started declining. Similar patterns were found in studies by Annarani et al. (2017) and Tarhan et al. (2015). This cannot be interpreted with the existing results and further studies are required to explore this oddity. The researcher suggests that participants with more than 11 years of experience might have not followed recent educational advancements available on NIV. In fact this is reported in literature where experienced nurses seem to engage less in CPD opportunities (Pool, Poell

& Cate, 2013; Mlambo, Silen, Mc Grath 2021). Price and Reichert (2017), claims that individual education is given less priority at mid-late stages of the carrier.

- *Comparing Knowledge with formal qualifications*

Knowledge on NIV was similar in both the undergraduate group and the postgraduate group, at 53.54% and 52.54% respectively. The researcher argues that since NIV care is a clinical skill, it is independent from educational formal qualifications and therefore no difference in knowledge should be present between groups. Similarly, Annarini et al. (2017) found no difference between groups. This conflicts with the results generated by Tarhan et al. (2015), who found a statistically significant difference (p=0.01) and that those with a postgraduate degree had higher knowledge on NIV. The researcher argue that since NIV care is a clinical skill, is independent from educational formal qualifications and therefore no difference in knowledge should present between groups.

- *Comparing Knowledge with NIV Guidelines Awareness*

When examining the overall knowledge scores association to NIV guidelines awareness, participants with no awareness obtained slightly higher knowledge scores (55.03%) than those with awareness with either one or both local and international guidelines (53.07%, 52.67%). Although not statistically significant, this is surprising considering that the tool was constructed upon international NIV guidelines (Davidson et al, 2016; Rochwerg et al 2017). Additionally, local guidelines are in line with internaitonal guidelines and related NIV literature. The researcher argues that this outcome is a result of a gap between participants' awareness and actual understanding of the guidelines. None of the studies evaluated the impact of NIV guidelines awareness on NIV knowledge, therefore further studies related to this aspect are recommended.

- *Comparing Knowledge with training attendance,*

The Overall knowledge scores of those that attended NIV training was marginally greater than of those participants that did not attend any NIV training. While it was not statistically significant (p=0.269), this demonstrated that NIV training does improve NIV knowledge. Similarly, Tarhan et al. (2015) demonstrated a higher knowledge in participants who attended NIV training when compared to those who didn't, although no statistical significance was found (p=0.292). Conversely, Annarani et al. (2017) reported statistically significant results (p=0.022) between those who attended than those that did not, favoring the attendees. While training seems to have a beneficial effect, naturally, this is not clearly identified in this literature.

5.2.4 Knowledge domains

Further to the overall knowledge the four domains were also examined. Participants obtained the highest scores in the pathophysiology domain (59.63%), while scoring lowest in the monitoring domain (50%). This might be the result of an imbalance in the training content provided. Raurell-Torreda et al. (2019) highlights that most of the time training is coordinated by doctors, unintentionally neglecting important nursing aspects. This may be the case in this study, nonetheless limited data regarding the training content was collected and therefore further studies are recommended to analyse the training content provided during NIV nursing training in the local setting.

5.2.5 Association amongst the 4 domains of knowledge

Following the analysis of knowledge for each domain, the association between the 4 domains was investigated, and aimed at examining the relationship between them. All the domains had positive correlation between each other and therefore as knowledge of one domain increase so does the knowledge of the other domain.

Correlations between the pathophysiology domain and other domains were weak and with no statistical significance (>0.05). These results suggested that a weak association exists because while the other three domains are used in daily nursing practice, pathophysiology knowledge has a cognitive use. Contrastingly, correlation findings related to technical, monitoring and nursing domains demonstrated a moderate association, with statistical significance. As previously mentioned, knowledge related to these domains is commonly used when setting up NIV, monitoring, and nursing patients, and mainly provided by nurses. Therefore, greater associations between these domains exist as they more likely overlaps in practice than pathophysiology.

5.2.6 Individual questions overall scores

To have a better apprehension of the participants' knowledge on NIV related to independent NIV nursing aspects, questions were also individually analysed and, where applicable, compared to other pre-existing relevant studies. Additionally, to obtain a better narrative flow, the questions were grouped according to their respective domains.

Questions on pathophysiology

Questions on pathophysiology enquired about the definitions of type one and type two respiratory failures, the contraindications and conditions that benefit from NIV. Differentiation between the two types of respiratory failure is crucial in the context of the load, capacity, and drive of the respiratory system, the disease, and NIV (Elliot 2018). Recognition additionally aids in prompt alertness and initiation of NIV that in turn improves the rate of NIV success, and therefore improves patient outcomes (Davidson et al., 2016).
Participants, similarly to Annarani et al. (2017), adequately recognised type two respiratory failures, answering the related question correctly. The question associated to type one respiratory failure had two correct answers. Interestingly, one of correct answers (low PaO2 and normal PaCo2) was selected by most participants (73.08%), but some (26.92%) failed to

select the other correct answer (low PaO2 and PaCo2). This demonstrated that although participants were able to successfully differentiate between the types of respiratory failure, most of them lacked true understanding of patient physiology alteration (hyperventilation), reflected in ABG's results. This was also demonstrated in Annarani et al. (2017) where only 36% identified normal ABG values.

Similarly, very few participants (11.54%) identified all the conditions that benefit from NIV, the least selected condition being post-operative respiratory failure. Tarhan et al. (2015) participants yielded similar results when it comes to NIV benefits. This is possibly due to the limited exposure of non-intensive nurse participants to this condition usually requires intensive care. In this study, only 26% of participants came from intensive care (ITU & CICU). Additionally, although pneumonia alone is not a criterion for NIV initiation provided by the BTS (Davidson et al., 2016; Evans 2001; Keenan et al., 2011), it was incorrectly selected by around 30% of the participants. This possibly reflects practices where certain patients presenting pneumonia-related respiratory failure require NIV. Though not all patients with pneumonia end up on or require NIV therapy (Valley et al., 2017).

Awareness of the definite contraindications is essential as attempting NIV therapy in these conditions can cause harm (Davidson et al., 2016). Participants' knowledge on the absolute contraindication of NIV was limited. Similar patterns were highlighted in both Annarani et al. (2017) and Tarhan et al. (2015). Most participants knew some, and partially chose some, of the absolute contraindications but additionally selected other conditions like claustrophobia and gastric distension. The latter are more relative contraindications requiring closer monitoring and additional nursing support to improve success rather than suspension of NIV treatment (Davidson et al., 2016; Wheatley, 2021).

Questions on technical knowledge

Technical knowledge was evaluated through questions related to the setup of NIV equipment, including the interface and understanding of the basic functions.

Vents generate intentional leaks avoiding CO2 retention and worsening hypercapnia and are recommended only with single tubing without exhalation port (Davidson et al., 2016; Wheatley, 2021; Elliot, 2018; Hare & Chatwinn, 2015). Only 20.5% of participants chose the correct answer, with 61.5% choosing the application in all circuits irrelevant of their setup characteristics. Similarly, most participants in Raurell-Torreda et al. (2019) chose to incorrectly cover the exhalation port to prevent leaks. Similar to Raurell-Torreda et al. (2019), the researcher concluded that these findings demonstrate a lack of understanding of the exhalation port's function, its relation to the tubing, and the interface.

On the other hand, 51.3% of the participants defined pressure support. Likewise, 52.1 % of participants in Torreda et al. (2019) selected this answer correctly, with the author commenting that correct responses were higher in the ED (71.4%) and the general wards (66.7%). The latter analysis was not performed in this study.

Locally, nurses are responsible for interface selection and application. Although most participants correctly selected a total facemask as the appropriate interface for patients in acute respiratory failure, ARF, few selected the oro-nasal mask. In Raurell-Torreda et al. (2019), 69.9% correctly identified the 'a mask that covers both the nose and the mouth' as the appropriate interface. Both types of interfaces are recommended for ARF by the BTS (Davidson et al., 2016) and European Respiratory Society (ERS) (Simonds, 2015). Nonetheless it is important to note that locally, in the studied hospital, nurses have limited if any experience with oro-nasal mask, therefore they are more familiar with total facemasks than the former. Consequently, these results highlight the lack of exposure to different modalities of NIV application, equipment and more importantly reflect the mode of training, which is often founded on specific equipment available rather than nursing needs.

Interestingly, in another question pertaining to interface, strap tightness was correctly answer by only a third of the participants, most of them choosing to strap it tight with concerns over leaks. This is similar to results obtained by Annarani et al. (2017) and Raurell-Torreda et al. (2019). None of the participants incorrectly selected to apply the mask loosely.

Therefore, although participants are aware of unintentional leaks cause by loosely fit interface, they lack awareness of the complications and discomfort an interface might cause. Raurell-Torreda et al. (2019) argue that adverse events related to strap over-tightening might lead to NIV cessation. In contrast, participant knowledge on the correct application sequence of NIV was predominantly correct.

Questions on knowledge about NIV monitoring

Questions exploring participants NIV monitoring knowledge enquired about machine alarms, back-up rate, and patient monitoring.

Nurses have complete responsibility for the monitoring of patients on NIV machine, (Ergan et al., 2018). As mentioned in the systematic review monitoring consists of clinical, physiological and NIV-related monitoring, (Scala & Latham, 2010). Having an understanding of the common alarms and how to solve them is crucial part when monitoring NIV therapy. Participants' knowledge on alarms significance was unsatisfactory, as only 23.1% and 20.5% of participants answered questions related to NIV flow alarms correctly. Therefore these results created certain concerns on the participants' current monitoring practices.

Conversely, most participants (73.1%) distinguished the aim of back-up rate functions in patients not triggering breathes. Surprisingly very few participants (32.1%) identified patients that become apnoeic, the NIV machine would still ventilate patient according to the backup rate. This knowledge is an essential part of NIV monitoring, as it reflects the patient's respiratory effort (Simonds 2015). It therefore showed that although participants had knowledge about back-up rate, a deeper understanding about certain functions and presentation was absent.

Most participants correctly indicated failure to reduce CO_2 or increase O_2 arterial blood levels as signs of NIV failure but failed to recognize a GCS <12 after one hour as one of the signs. Only few participants (14.4%) answered this question correctly. Increased awareness of factors that cause problems, as well as the diagnosis and treatment of issues, can improve

NIV outcomes and safety (Carron et al., 2013). Participants were additionally asked about the essential vital signs required to monitor patients on. While very few indicated only the correct parameters, most participants included these parameters as part of the selected list. This demonstrates that participants recognized parameters that are a prerequisite NIV patient monitoring. Similarly Carron et al. (2013) highlighted that this is an important factor to improve patient outcomes.

Questions on nursing knowledge

Knowledge related to nursing domain was explored by using questions correlated patient's needs and NIV, and included twelve questions.

Adequate positioning is essential for NIV care provision as it improves ventilation and comfort (Dougherty & Lister, 2015). The recommended patient positions during ARF are Fowler's and Semi-Fowler's positions (Davidson et al., 2016; Dougherty & Lister, 2015). According to the results, most participants were aware of the Fowler's position (78.2%) but only few (37.2%) knew about the viability of semi-Fowler. Considering that NIV requires a balance between effectiveness and comfort, this knowledge can make a significant difference in patient NIV success and compliance.

Suction clears a patient's airway and indirectly improves effectiveness of NIV therapy. On the other hand, suction can also cause patient distress and interrupts NIV care. Therefore, it is crucial that it is only used when needed. Wheatley (2021) and Dougherty and Lister (2015) recommend the use of suction in patients with upper airway secretion and a weak cough. This answer was only correctly selected by (39.7%) of the participants, showing lack of knowledge in this regard.

Additionally, physiotherapy is fundamental and its benefits when applied in conjunction with NIV therapy cannot be contested (Kinnear, 2014; Chatwin, 2015). Piper & Moran (2006) highlighted that physiotherapy improves airway clearance and breathing function, consequently reducing NIV periods and length of hospital stay. Locally, nurses are neither

taught nor expected to provide physiotherapy. Nonetheless, it is crucial that nursing providers recognise when physiotherapy is required and liaise with a physiotherapist for the provision of such. Knowing that physiotherapy can be performed without stopping NIV is therefore essential, as it can also be offered in respiratory distressed patients (Kinnear, 2014). Most participants (93.6%) had knowledge on performing physiotherapy without NIV interrupting NIV.

Nutritional needs of patients on NIV are also essential, but most of the time practitioners are unwilling due to concerns of certain potential risks or neglect (Terzi et al., 2017). Nurse participants correctly (79.5%) indicated when to provide oral nutrition, also preventing risks of complications such as respiratory distress and hypoxia in patients where oral nutrition is not indicated. Additionally, a nasogastric tube is indicated for enteral feeding in distressed patients (Singer & Rattanachaiwong, 2018). Only few participants (26%) selected this answer correctly, corresponding with the available international literature (Terzi et al., 2017).

Moreover, NIV therapy may result in gastric distension due to gastric inflation and abdominal distension (Dougherty & Lister, 2015). Wheatley (2021) remarks that as this complication hinders effective ventilation, which is vital for successful NIV therapy, a nasogastric tube is essential to decompress the stomach. This indication was correctly chosen by 44.9% of the participants, and therefore more training is required on this topic.

Oral hygiene will not only improve patient comfort but also prevent oral infections and complications (Johnny et al., 2021). One third of the participants (33.3%) knew that oral hygiene could be provided to patients every two hours if they can tolerate breaks, as recommended by the Sanchez et al. (2014) guidelines.

Monitoring and preventing facial ulceration is also important as it leads to serious patient discomfort and reduces compliance to NIV therapy (Alqahtani & Alahmari, 2018). Unfortunately, it is one of commonest complications, most of the time due to a lack of preventive measures being applied by healthcare professionals, including nurses (Schallom et al., 2015). Similarly, conjunctivitis is also preventable and commonly occurs due to lack of

attention and prevention (Sanchez et al., 2014). Just 5.1% and 7.7% of participants correctly responded questions related to skin integrity care and eye care, respectively. Additionally, only a small portion of participants had attended topics related to skin integrity and eye care (26.9% and 20.5%, respectively). However, most of the participants partially selected correct answers and therefore partial knowledge associated with these topics exists.

Participants (62.8%) were aware that ambulation can be encouraged with NIV if patient tolerates it. Still, a considerable number of participants (33.3%) chose to ambulate patient at weaning phase, which comes much later during the patient stay. The nurse is at the forefront in encouraging patients to mobilize and therefore, prevent associated complications such as risks of pulmonary embolism and pressure ulcers, (ICCMU 2014). This is a critical mistake and might reflect what occurs in existing local nursing practices.

One of the issues associated with NIV therapy is how the patient communicates without becoming distressed (Riachy et al., 2017). Ineffective communication leads to patient frustration and contributes to NIV therapy intolerance (Wong et al., 2000; Hoo 2011). Most of the participants selected good communication approaches; reassuring the patient and ensuring comfort (76.9%), and encouraging the patient to use other means of communication (73.1%). However certain participants (31.6%) opted for stopping the machine to communicate with patient. NIV therapy interruption hinders NIV care and potentially can be detrimental of the patient, (Wong et al., 2000). Therefore, participant awareness on such poor practices is required.

Prior to the weaning process, adequate preplanning and preparedness, especially with the patient, are required (Kinnear, 2014). Nurses are required to identify this stage and initiate patient preparation as it increases the chance of a successful weaning process (Kinnear, 2014). Almost half the participants (47.4%) knew when weaning should be initiated. When considering that more than half the participants work in the ED, where weaning does not occur, the participants seem to be adequately knowledgeable on this topic.

Lastly, the importance of NIV therapy as part of the palliative care, when escalation is deemed futile, is emphasised by respiratory societies such as BTS (Davidson et al., 2016) and ERS (Cuomo, 2015). Nonetheless, some studies still highlight resistance from the medical profession to comply with such procedures (Sanchez et al., 2014). Most participants (n= 55, 70.5%) were not aware that NIV therapy can be used in palliative care patients and therefore lacked the knowledge of the role of NIV in end-of-life care.

5.3 Study implications

This research highlighted several aspects that can be used to improve the educational, clinical and research settings.

5.3.1 Implication for education

The main scope of this research was to explore the level of knowledge that local nurses caring for patients on NIV have. Even though participants' NIV knowledge was marginally better than the existing international studies, several notable deficits were highlighted. Therefore, this study aims to create awareness on the deficit in NIV knowledge that the local nursing population may have, generating necessity for additional and improved NIV nursing and related training.

Findings in the local study revealed that NIV training and NIV guidelines awareness were ineffective in improving nursing NIV knowledge. This suggests that NIV nursing trainers failed to address several assumptions related to education of professionals highlighted by Knowles (1984). Therefore amendment in the NIV training approach is required to alter these results. Additionally, several specific remarks and recommendations were elicited, that can be used as a blueprint for the training transformation required to meet the training needs of the local nursing population. These recommendations are presented in the following chapter (chapter 6).

The study results will be distributed to all the potential participants and stakeholders, aiming to provide feedback and raise the need for more evidence-based knowledge on NIV nursing care to the participants.

5.3.2 Implication for practice

If evidence-based knowledge is transmitted into practice, patient care will undisputedly improves (Stevens, 2013). Following the application of the educational recommendations in the next chapter, improving NIV knowledge of nursing working in an NIV care setting will indirectly advance patient outcomes. Better practices would in turn decrease hospital demands in terms of length of stay and financial burden related to certain complications that are caused by a lack of practitioner knowledge (Lindenauer, et al., 2014).

5.3.3 Implication for research

This research underlined the gap that exists between the literature and current nurses' knowledge. Throughout this research, the limited amount of literature on this topic was highlighted, and therefore the data generated by this study supplements the limited amount of literature that currently exists. Despite this study, more research is required, ideally multi-centred and pre-post trials, especially since nursing knowledge in NIV seems to be chronically low both locally and internationally. Furthermore, qualitative studies are required to achieve a deeper understanding into knowledge deficits. Although this research has provided an answer to the research question, it in turn generated more questions requiring investigation.

5.4 Appraisal of the study

An appraisal of this research study was conducted in this section. The appraisal included the research design, research instrument, the method of data collection and data analysis, as well as the ethical considerations taken.

5.4.1 Research Design

This research explored nurses' knowledge pertaining to NIV and NIV patient care at a local hospital. Although direct observation would have been the ideal, considering the available resources, and limitations associated with observational studies, a self-administered questionnaire was deemed as the appropriate alternative to answer the research question. Additionally, the research only included participants who were willing to participate in the study. This resulted in a lower response rate and therefore result generalisability is reduced. Moreover, since participants were not monitored while filling the questionnaire, answers might have been skewed by consulting with other individuals or resources. The researcher attempted to counteract this limitation by explaining in detail the importance of the research and offering reassurance that the study would by anonymous. Additionally, the researcher is assuming that all the participants had the same opportunity to answer the questionnaire and without any limitations. The researcher did not have any additional information on the potential participants that were unable to participate. Various reasons for non-participation existed, including long sick leave or leave, which in turn would have partially altered the final questionnaire results. Nonetheless, the low response rate does limit generalizability of results. The study was conducted in only 1 of the 3 local centres that offer NIV patient care. Although by far most patients on NIV are cared for in the included hospital, it by no means can be applied to other institutions. The total population was selected to compensate for the limited available population and low response rates were also predicted. To ameliorate the response rate, methods as suggested by Harrison et al. (2019) and Sammut et al. (2021), a pre-notification as well as multiple reminders, were sent.

The researcher only limited a variable by excluding nurses in a managerial role. The reason for this approach was that most of the time these nurses lacked direct patient contact and exposure, which could taint the overall population knowledge. Although comparison of NIV knowledge of nurses in different role positions might have been interesting to compare, it was beyond the scope of research. The low response rate resulted in a limitation of

generalisability of the results, especially in units with low response rate such as ITU (14.5%) and DCU (20.6%).

5.4.2 Research instrument

The research questionnaire was constructed for the purpose of this study and therefore, appropriate validity and reliability were needed prior to dissemination. The validity of both items and overall questionnaire were conducted. The final questionnaire had an S-CVI/AVE of 0.94, regarded excellent content validity (Ayre & Scally, 2014; Zamanzadeh et al., 2015) and S-CVI/UA value of 0.53, lower than 0.80 recommended by Polit et al. (2007), though considering that the maximum number of reviewers included in the validity testing, it was still considered as adequate. Furthermore, the questionnaire was also assessed for clarity, with the final overall clarity of 3.78.

A reliability test was also attempted even though measuring knowledge consistency is questionable, as knowledge responses may change after initial exposure to the questionnaire (Bolarinwa 2015). The reliability test was terminated prematurely because of lack of response and therefore no reliability test was conducted. Therefore it is one of the major limitations of this questionnaire tool.

5.4.3 Data Collection and Analysis

Data was disseminated via unit intermediaries; therefore, the researcher is assuming that all the possible participants were included with equal opportunities to answer the questionnaire. Data collection was collected through the Google Forms platform to protect participant anonymity and ensure feasibility. The researcher experience in data analysis is fairly novel. The researcher attended a course provided by the University of Malta covering SPSS® (v.28) and testing. Additionally, a professional statistician aided and supervised all the statistical work conducted, recommended the appropriate tests to conduct, and ensured that suitable data analysis and interpretation was conducted.

5.4.4 Ethical Consideration

The University of Malta Research and Ethics Committee (UREC), the concerning institution, and departments approved this research. Throughout the research study, appropriate measures were taken to ensure ethical aspects. Through the distribution of an online questionnaire link, by intermediaries via a generic email, and additionally collecting the questionnaire online through the Google Forms platform, absolute anonymity was respected. Moreover, as the researcher did not collect personal identifiers, total anonymity was ensured. Furthermore, data was stored in a password secured computer with access limited to the researcher and dissertation supervisor.

Lastly the participants had the right to decline without any repercussions and were able to withdraw from the study at any time.

5.5 Conclusion

This chapter presented a logical discussion of the study results. An evaluation of the overall knowledge levels confirmed that participant knowledge is overall poor. Knowledge was higher in variables such as units, nursing experience, NIV experience and training, although no statistical significance were found. On the other hand, no difference existed in guidelines awareness and formal education. Pathophysiology knowledge was higher than the other domains due to possible trainer bias in content administration. This research suggests moderate correlation exists between technical, monitoring, and nursing knowledge with the possibility of influence as they are jointly used in daily nursing practices and thus highly likely that knowledge overlap exists. The study also examined the knowledge on single topics that made up the overall NIV knowledge. From the analysis, participants had adequate knowledge only in relation to a handful of topics related to NIV.

This study offers various propositions for different areas. It underlined the NIV knowledge areas which require attention and therefore focus when providing training, potentially

improving NIV knowledge which will then advance clinical practice, improving patient outcomes and reducing hospital costs.

This study is the first research conducted on NIV nursing knowledge locally and one of the few available international studies related to this topic. The research study tool was successfully validated and objectively analysed through a statistical analysis approach. The local ethics committee also approved the study. The research study limitations consisted of a low participant response rate, the study being single-centred, and that no reliability test was conducted. Additionally, the lack of researcher experience and the limited timeframe were also limiting factors in the research study. Recommendations that emerged from this study will be explored in the following chapter.

Chapter 6

CONCLUSION

6.1 Introduction

The following conclusions and recommendations were constructed based upon on the obtained findings and are presented in the sections below.

6.2 Emergent findings of the research study

The systematised review presented in chapter 2 stressed on the significance of NIV nursing knowledge on improving patient care outcomes (Ballard et al., 2010; Tarhan et al., 2015; Annarani et al., 2017; and Raurell-Torreda et al., 2019). Nurses need knowledge in four main domains; respiratory pathophysiology, technical, monitoring, and nursing, to obtain holistic care toward patients on NIV therapy, (Davidson et al., 2016; Mohammed et al., 2019). Research additionally emphasised on the importance of individualised patient care, not necessary aiming at healing of symptoms, but also at palliation of symptoms and peaceful death (Davidson et al., 2016; Simonds, 2015).

Furthermore, the systemised findings acknowledged that overall nursing knowledge levels from the available studies was suboptimal, and more NIV nursing training was needed (Tarhan et al., 2015; Annarani et al., 2017; Raurell-Torreda et al., 2019). The latter studies suggested that NIV training improved knowledge, however statistical significance was only found in Annarani et al. (2017). Similarly, NIV experience was found to positively influence NIV knowledge, but statistical significance was only identified in Annarani et al. (2017). Different from other studies, Tarhan and Dalar (2015) found a statistically significant difference in NIV knowledge among different genders and formal educational level.

Moreover, in this study, NIV nursing knowledge was found to be moderate overall. NIV knowledge was better in units with higher acuity and in those participants that attended NIV training, although no statistical significance was observed. There was minimal difference in NIV knowledge when guideline awareness was compared between groups. Similarly, marginal difference existed in groups grouped by formal education. Knowledge levels were highest in the participant group of between 3-10 years of general nursing experience, but

knowledge dropped again after 11 years. Correspondingly, knowledge related to NIV experience also increases up to 5 years but dropped in the 6-10 year group. Participants had more knowledge related to pathophysiology than in other domains. This implied that participants were more exposed to this domain during NIV training than any of the other domains. Additionally, a weak correlation exists between the pathophysiology knowledge domain and other domains, possibly as pathophysiology knowledge has more theoretical characteristics when compared to the practical features of other domains. A moderate association also exists between the nursing, technical, and monitoring domain, which implies a more practical use of knowledge related to these domains. The analysis of the individual questions concluded that participants had certain NIV knowledge but lacked a complete understanding of the subjects under examination.

6.3 Recommendations

Recommendation extends the research possibility for further studies. In this phase, particular approaches are proposed and intend to offer a solution to any challenges and limitations identified in the conducted research, and then proposed for future studies (Evan et al., 2014). The research offers the following recommendations to the clinical practice, education, and research.

6.3.1 Recommendation for clinical practice

- As practices are heavily dependent on guidelines, better composed NIV nursing guidelines are required, as NIV nursing caring aspect is barely cited in any of the leading international guidelines.
- Revision of the local guideline is also advocated as no recent reviews were performed.
- When possible, consistency in availability of NIV equipment (interfaces, tubing, and ventilators) is required, as alterations in equipment can cause confusion both in knowledge and practices that adversely affect patient care.

- Evidence-based reflective-practice is individually required by NIV nurse provider to improve and maintain patient care at a desirable level.

6.3.2 Recommendations for research

- Further research including studies on framework related NIV nursing knowledge is required, as currently limited research is available.
- Additional studies on the current state of NIV nursing knowledge in the international arena are required, as few good quality studies presently exist.
- As this research study was single-centred, the researcher proposes multi-centred studies, as farther generalizability of finding in the local and international population is needed.
- Research exploring the training programs including approaches, topics, and other characteristics related to NIV training sessions is also needed.
- Further research on the association between the knowledge domains is required, since a deeper understanding is necessary to improve nurses' knowledge and practices.
- The relation of nursing experience patterns with knowledge that were highlighted in this research, also need to be examined further to identify if any causations exist.
- Further tool testing of this study knowledge questionnaire is needed, both for validity and most importantly for reliability, as the latter was not performed.
- The researcher also advocates that a universal knowledge tool to assess NIV nursing knowledge needs to be composed, offering homogeneity of results among studies, as none currently exits.

6.3.3 Recommendations for education

- Revision of local NIV nursing training is required, as better adaption to nursing needs is recommended. This should include the following;
  - An explanation of the physiological changes associated to certain clinical findings and results such as arterial blood gases and other parameters including level of response.

- An explanation of the indications and contraindications of NIV therapy, in line with recognized international guidelines such as BTS and ERS guidelines.
- A demonstration of the different features existing in NIV setup, even those that not commonly used in the local hospital, as well as an understand of their affect the NIV therapy process.
- A demonstration and supervised practice on the proper application of straps and highlighting straps related complication.
- An explanation of common NIV alarms, indicators of NIV failure and troubleshooting solutions for certain issues and failures.
- A discussion of nursing aspects related to suctioning in NIV, and conditions that require NGT insertion.
- A discussion on nursing aspects such as patient ambulation, patients' positioning, oral care and skin care
- A discussion on appropriate methods to facilitate communication with the patent during receiving NIV.
- A discussion on palliative care in NIV.

• Unit rotation for nursing staff offering NIV care is recommended, since certain knowledge is gained from daily practices. This generates opportunities for exposure of practices uncommon in their unit, but which are commonly present in other units.

• Research highlights the importance of adequate knowledge to provide optimal NIV care. Therefore, efforts should be increased to educate nursing providing NIV care on NIV.

6.4 Strengths and Limitations of the Study

6.4.1 Strengths

The study encouraged 'honest' responses as much as possible as questionnaires were collected anonymously, confidentially, and voluntarily. Additionally, both a face validity and content validity were conducted for the tool questionnaire. Content validity was performed

using nine experts, obtaining an excellent S-CVI/AVE of 0.94 and a reasonable S-CVI/UA 0.53. Moreover, as the whole population was used, it increased the possibility of generalizability of the results, as bias related to populations sampling was eliminated. Lastly data was collected in an objective way and therefore as near to the 'true reality' as much as possible.

6.4.2 Limitations

One of the main limitations of this study was the poor participant response rate both overall (26.6%) and also in certain units that were as low as 14.5%. Several factors might have influenced such response rate including task burden, negative expectations, perceived flaw, and seeing the investigation as an obstacle (Duan & Tan 2020). Additionally, as the study was single-centred, it limited generalisability of results to the studied institution. Therefore, the study results need to be interpreted with caution when applying it to certain units or other institutions.

Training topics related to technical, monitoring, and pathophysiology domains were not covered during a question that analysed the topics provided during NIV training sessions. This led to an incomplete illustration of the NIV training content provided. Furthermore, due to anonymity, participants were not supervised while answering the questionnaire, and therefore consultancy with other literature and individuals cannot be ruled out. Although consultancy might lead to knowledge maturity, there is a possibility that the data is not a true representation of the results. Lastly, as reliability testing was not conducted, no conclusion can be reached in terms of tool reproducibility, even though testing knowledge reliability is debatable.

6.5 Reflection on learning

NIV therapy was always a topic of interest as it offers a balance between fundamental nursing care and technical qualities. Both aspects of NIV need an optimal level of knowledge

to obtain a good level of care. My willingness to study this topic and give evidence in this respect was driven by the lack of a defined nursing framework tied to NIV knowledge needs. This study, along with all its phases, such as choosing the appropriate strategy, methodology, data analysis, and data assessment, was the first of its type for the researcher, allowing for a learning curve. Additionally, knowledge was developed further through attended related sessions, discussing with experts, and the use of new software that aided in reaching conclusions that filled certain gaps in the literature. The study also highlighted the distinctions between writing research in theory and putting it into practice, considering the realities of social sciences. It was tremendously exciting to be able to develop fresh conclusions and highlight key discoveries on the issue, some of which the researcher had entirely disregarded at the outset. Knowing that fresh discoveries from this study have been discovered and may be utilised as a foundation for additional research to expand the literature on the issue was incredibly fulfilling. This research can be completed further by presenting this research finding through nursing journals and disseminating said research findings and suggestions to academics and educational institutions.

6.6 Conclusion

This research highlighted that there is moderate NIV nursing knowledge among nurses providing NIV care in the local setting. Although none of independent variables was found to be statistically significant, NIV training and unit (specialty) seem to positively influence NIV nursing knowledge. Changes in training approach and exposure to other NIV units' practices are required to improve such knowledge and therefore patient care. Further in-depth research regarding these variables and the other variables underlined in this study is needed, to obtain more concrete results.

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Appendix 1: Permission approval for intermediaries

Permission e-mail from CICU intermediary

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

intermediary invitation letter
2 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 10 August 2021 at 22:15
To: duncan.briffa@gov.mt
Cc: Trevor Abela Fiorentino <trevor.abela-fiorentino@um.edu.mt>

Dear Mr Duncan Briffa,

My name is Peter Spiteri and I am a student at the University of Malta, presently reading for a Master of Science degree in Nursing. I am conducting a research study for my dissertation titled " Acute and critical nurses' knowledge of non-invasive ventilation".

I would like to ask for your aid and act as an intermediary in my study. This will involve sending an email with a participant information letter, a link to a questionnaire to the nurses working in CICU a week later. Then resend the link on the third week.

If you accept my invitation kindly forward your reply, stating that you accept to act as an intermediary, to my email below. Should you have any queries do not hesitate to contact me on 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt. Thank you for your time and kind consideration.

Looking forward to hear from you,
Best regards,
Peter Spiteri

Briffa Duncan at Health-MDH <duncan.briffa@gov.mt> 11 August 2021 at 06:44
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: Trevor Abela Fiorentino <trevor.abela-fiorentino@um.edu.mt>

Dear Peter,

It will be a pleasure for me to help you out with this endeavour.

Regards,

Duncan

From: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Sent: 10 August 2021 22:15:06
To: Briffa Duncan at Health-MDH
Cc: Trevor Abela Fiorentino
Subject: intermediary invitation letter

CAUTION: This email originated from OUTSIDE the Government Email Infrastructure. DO NOT CLICK LINKS or OPEN attachments unless you recognise the sender and know the content is safe.

[Quoted text hidden]

Permission e-mail from DCU intermediary

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

intermediary invitation letter

3 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 10 August 2021 at 22:11
To: wayne.busuttil@gov.mt
Cc: Trevor Abela Fiorentino <trevor.abela-fiorentino@um.edu.mt>, Zammit Emanuel B at Health-MDH <emanuel.b.zammit@gov.mt>

Dear Mr Wayne Busuttil,

My name is Peter Spiteri and I am a student at the University of Malta, presently reading for a Master of Science degree in Nursing. I am conducting a research study for my dissertation titled " Acute and critical nurses' knowledge of non-invasive ventilation".

I would like to ask for your aid and act as an intermediary in my study. This will involve sending an email with a participant information letter, a link to a questionnaire to the nurses in your unit (DCU) a week later. Then resend the link on the third week.

If you accept my invitation kindly forward your reply, stating that you accept to act as an intermediary, to my email below. Should you have any queries do not hesitate to contact me on 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt. Thank you for your time and kind consideration.

Looking forward to hear from you,
Best regards,
Peter Spiteri

Zammit Emanuel B at Health-MDH <emanuel.b.zammit@gov.mt> 11 August 2021 at 07:35
To: "peter.spiteri.03@um.edu.mt" <peter.spiteri.03@um.edu.mt>

Your message

To: Zammit Emanuel B at Health-MDH
Subject: intermediary invitation letter
Sent: Tuesday, August 10, 2021 10:11:07 PM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna

was read on Wednesday, August 11, 2021 7:34:47 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna.

Busuttil Wayne at Health-MDH <wayne.busuttil@gov.mt> 11 August 2021 at 08:39
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: Trevor Abela Fiorentino <trevor.abela-fiorentino@um.edu.mt>, Zammit Emanuel B at Health-MDH <emanuel.b.zammit@gov.mt>

Dear Peter,

I kindly accept to act as your intermediary.

Regards

Wayne

Permission e-mail from ITU intermediary

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

intermediary invitation letter
4 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 9 August 2021 at 08:13
To: raymond.a.gatt@gov.mt, trevor.abela-fiorentino@um.edu.mt

Dear Mr Raymond Gatt,

My name is Peter Spiteri and I am a student at the University of Malta, presently reading for a Master of Science degree in Nursing. I am conducting a research study for my dissertation titled " Acute and critical nurses' knowledge of non-invasive ventilation".

I would like to ask for your aid and act as an intermediary in my study. This will involve sending an email with a participant information letter, a link to a questionnaire to the nurses in your unit a week later. Then resend the link on the third week.

If you accept my invitation kindly forward your reply, stating that you accept to act as an intermediary, to my email below. Should you have any queries do not hesitate to contact me on 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt. Thank you for your time and kind consideration.

Looking forward to hear from you,
Best regards,
Peter Spiteri

Gatt Raymond at Health-MDH <raymond.a.gatt@gov.mt> 9 August 2021 at 08:38
To: "peter.spiteri.03@um.edu.mt" <peter.spiteri.03@um.edu.mt>

Your message

To: Gatt Raymond at Health-MDH
Subject: intermediary invitation letter
Sent: Monday, August 9, 2021 8:13:40 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna

was read on Monday, August 9, 2021 8:37:49 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna.

Gatt Raymond at Health-MDH <raymond.a.gatt@gov.mt> 9 August 2021 at 08:45
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>

Good morning Peter,

I accept to act as an intermediary, to your email below.

Kind regards

Raymond Gatt
G4S Clerk
Intensive Therapy Unit
Health-Mater Dei Hospital

Permission e-mail from CCCU intermediary

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

intermediary invitation letter
2 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 10 August 2021 at 22:09
To: nigel.ferriggi@gov.mt
Cc: Trevor Abela Fiorentino <trevor.abela-fiorentino@um.edu.mt>, Deguara Alida at Health-MDH <alida.deguara@gov.mt>

Dear Mr Nigel Ferriggi,

My name is Peter Spiteri and I am a student at the University of Malta, presently reading for a Master of Science degree in Nursing. I am conducting a research study for my dissertation titled " Acute and critical nurses' knowledge of non-invasive ventilation".

I would like to ask for your aid and act as an intermediary in my study. This will involve sending an email with a participant information letter, a link to a questionnaire to the nurses in your unit (CCCU) a week later. Then resend the link on the third week.

If you accept my invitation kindly forward your reply, stating that you accept to act as an intermediary, to my email below. Should you have any queries do not hesitate to contact me on 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt. Thank you for your time and kind consideration.

Looking forward to hear from you,
Best regards,
Peter Spiteri

Ferriggi Nigel at Health-MDH <nigel.ferriggi@gov.mt> 11 August 2021 at 07:53
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>, Deguara Alida at Health-MDH <alida.deguara@gov.mt>

Dear Peter Spiteri,

I am glad to accept to be your intermediary, I will forward the questionnaire to the nurses in my unit as soon as i recieve it.

By any chance do you have an idea when you will send me the questionnare,because i will be on leave from tomorrow till next Monday.

And to how many nurses should i send the it to.

Best wishes on your journey at the UOM.

Regards,

Nigel Ferriggi.

Sent from Mail for Windows

From: Peter Spiteri
Sent: 10 August 2021 22:09
To: Ferriggi Nigel at Health-MDH

Permission e-mail from ED intermediary

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

Intermediary invitation letter

2 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 9 August 2021 at 16:15
To: mary-grace.c.farrugia@gov.mt, Schembri Maria C at Health-MDH <maria.c.schembri@gov.mt>, trevor.abela-fiorentino@um.edu.mt

Dear Ms Mary-Grace Farrugia,

My name is Peter Spiteri and I am a student at the University of Malta, presently reading for a Master of Science degree in Nursing. I am conducting a research study for my dissertation titled " Acute and critical nurses' knowledge of non-invasive ventilation".

I would like to ask for your aid and act as an intermediary in my study. This will involve sending an email with a participant information letter, a link to a questionnaire to the nurses in your unit a week later. Then resend the link on the third week.

If you accept my invitation kindly forward your reply, stating that you accept to act as an intermediary, to my email below. Should you have any queries do not hesitate to contact me on 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt. Thank you for your time and kind consideration.

Looking forward to hear from you,
Best regards,
Peter Spiteri

Farrugia Mary Grace at Health-MDH <mary-grace.c.farrugia@gov.mt> 11 August 2021 at 11:09
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: Schembri Maria C at Health-MDH <maria.c.schembri@gov.mt>

Good morning

Yes sure I accept to be your intermediary.

Thanks and regards

MaryGrace Farrugia
G4S Clerk Emergency dep.

SPTAR MATER DEI

T +356 +356 25454032

E mary-grace.c.farrugia@gov.mt

Mater Dei Hospital, Triq id-Donaturi tad-Demm, l-Imsida, Malta MSD 2090 | Tel +356 2545 0000 | https://deputyprimeminister.gov.mt/en/MDH/Pages/Home.aspx | https://www.facebook.com/materdeihospital/

Think before you print.

This email and any files transmitted with it are confidential, may be legally privileged and intended solely

Permission e-mail from B&PU intermediary

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

Intermediary invitation letter

Peter Spiteri 11 August 2021 at

<peter.spiteri.03@um.edu.mt> To: brenda.a.schembri@gov.mt Cc: Farrugia Charmaine B at Health-MDH <charmaine.b.farrugia@gov.mt>, Trevor Abela Fiorentino <trevor.abela-fiorentino@um.edu.mt>

Dear Ms. Brenda Schembri,

My name is Peter Spiteri and I am a student at the University of Malta, presently reading for a Master of Science degree in Nursing. I am conducting a research study for my dissertation titled ˝ Acute and critical nurses' knowledge of non-invasive ventilation''.

I would like to ask for your aid and act as an intermediary in my study. This will involve sending an email with a participant information letter, and a questionnaire link to the nurses in Burns & Plastics unit a week later. Then resend the link on the third week.

If you accept my invitation kindly forward your reply, stating that you accept to act as an intermediary, to my email below. Should you have any queries do not hesitate to contact me on 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr. Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt.

Thank you for your time and kind consideration. Best regards Peter Spiteri

Schembri Brenda at Health-MDH

<brenda.a.schembri@gov.mt> To: "peter.spiteri.03@um.edu.mt" <peter.spiteri.03@um.edu.mt>

16 August 2021 at 09:14

Dear Mr Spiteri,

I will accept to act as an intermediary to your study.

Regards,

Brenda Schembri

Permission e-mail from MAU 1/2/3 intermediary

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

intermediary invitation letter

2 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 15 August 2021 at 11:01
To: duncan.briffa@gov.mt
Cc: Trevor Abela Fiorentino <trevor.abela-fiorentino@um.edu.mt>

Dear Mr Duncan Briffa,

My name is Peter Spiteri and I am a student at the University of Malta, presently reading for a Master of Science degree in Nursing. I am conducting a research study for my dissertation titled " Acute and critical nurses' knowledge of non-invasive ventilation".

I would like to ask for your aid and act as an intermediary in my study. This will involve sending an email with a participant information letter, a link to a questionnaire to the nurses working in MAU 1/2/3 a week later. Then resend the link on the third week.

If you accept my invitation kindly forward your reply, stating that you accept to act as an intermediary, to my email below. Should you have any queries do not hesitate to contact me on 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt. Thank you for your time and kind consideration.

Looking forward to hear from you,
Best regards,
Peter Spiteri

Briffa Duncan at Health-MDH <duncan.briffa@gov.mt> 17 August 2021 at 06:50
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: Trevor Abela Fiorentino <trevor.abela-fiorentino@um.edu.mt>

Appendix 2: Permission approval from unit Charge Nurses

Permission e-mail from B&BU Charge Nurse

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

dissertation permission letter
4 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 09:42
To: charmaine.b.farrugia@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Ms Charmaine Farrugia Camilleri,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the Burns and Plastics Unit.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter Burns and Plastics unit.docx
16K

Farrugia Charmaine B at Health-MDH <charmaine.b.farrugia@gov.mt> 27 July 2021 at 09:52
To: "peter.spiteri.03@um.edu.mt" <peter.spiteri.03@um.edu.mt>

Your message

To: Farrugia Charmaine B at Health-MDH
Subject: dissertation permission letter
Sent: Tuesday, July 27, 2021 9:42:39 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna

was read on Tuesday, July 27, 2021 9:51:39 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna.

Farrugia Charmaine B at Health-MDH <charmaine.b.farrugia@gov.mt> 28 July 2021 at 11:10
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Good morning Peter,

You have my permission to carry out your study in PSBU/NIV.

Good luck

Charmaine Farrugia
Charge Nurse
Burns & Plastics Unit
Health-Mater Dei Hospital

Permission e-mail from CCCU Charge Nurse

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

dissertation permission letter

3 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 09:36
To: alida.deguara@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Ms Alida Deguara,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the CCCU.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter CCCU.docx
16K

Deguara Alida at Health-MDH <alida.deguara@gov.mt> 27 July 2021 at 11:29
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Hello Peter,

Yes Peter, by all means!! Go ahead.

Good luck.

Permission e-mail from CICU Charge Nurse

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

dissertation permission letter

3 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 09:47
To: tonio.attard@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Mr Tonio Attard,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the Cardiac Intensive Care Unit.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter CICU.docx
16K

Attard Tonio at Health-MDH <tonio.attard@gov.mt> 30 July 2021 at 21:31
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Hi

Permission granted from my end,

Thanks,

Tonio Attard,

C.N.

Permission e-mail from CICU Charge Nurse

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

dissertation permission letter

3 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 09:47
To: tonio.attard@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Mr Tonio Attard,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the Cardiac Intensive Care Unit.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter CICU.docx
16K

Attard Tonio at Health-MDH <tonio.attard@gov.mt> 30 July 2021 at 21:31
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Hi

Permission granted from my end,

Thanks,

Tonio Attard,

C.N.

Permission e-mail from DCU Charge Nurse

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

dissertation permission letter
4 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 09:22
To: emanuel.b.zammit@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Mr Emanuel Zammit,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the DCU.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter DCU.docx
16K

Zammit Emanuel B at Health-MDH <emanuel.b.zammit@gov.mt> 27 July 2021 at 09:25
To: "peter.spiteri.03@um.edu.mt" <peter.spiteri.03@um.edu.mt>

Your message

To: Zammit Emanuel B at Health-MDH
Subject: dissertation permission letter
Sent: Tuesday, July 27, 2021 9:22:19 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna

was read on Tuesday, July 27, 2021 9:25:19 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna.

Zammit Emanuel B at Health-MDH <emanuel.b.zammit@gov.mt> 27 July 2021 at 09:26
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>

Mr Spiteri

Permission granted and we will be willing to help in any way we can throughout your research in our ward,

Best of luck regards

Emanuel Zammit

Charge Nurse

Permission e-mail from ED Charge Nurse

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

dissertation permission letter

3 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 09:01
To: maria.c.schembri@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Maria,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the ED.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter Maria Scehmbri.docx
16K

Schembri Maria C at Health-MDH <maria.c.schembri@gov.mt> 27 July 2021 at 09:26
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>

Der Peter

Permission granted from my end on condition that all approvals mentioned in your email are given and that this is approved by DPO.

Also I would appreciate an update on the findings of your research so we can where possible take action on recommendations that you will be making.

Permission e-mail from ITU Charge Nurse

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

dissertation permission letter

5 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 09:52
To: carmen.a.tabone@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Ms Carmen Tabone,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the ITU.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter ITU.docx
16K

Peter Spiteri <peter.spiteri.03@um.edu.mt> 4 August 2021 at 20:32
To: carmen.a.tabone@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Ms. Carmen Tabone,

With reference to the previous email, a gentle reminder for permission to conduct my study with nurses working in ITU.

Thank you for your time and kind consideration.

Best regards
Peter Spiteri
[Quoted text hidden]

permission letter ITU.docx
16K

Permission e-mail from MAU3 Charge Nurse

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

dissertation permission letter

3 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 09:18
To: tommy.dimech@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Mr Tommy Dimech,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the MAU 3.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter MAU3.docx
16K

Dimech Tommy at Health-MDH <tommy.dimech@gov.mt> 27 July 2021 at 09:26
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>, Ciappara Charlene at Health-MDH <charlene.ciappara@gov.mt>

Dear Mr Spiteri,

Good Morning.

You have my permission to conduct the research study with nurses working in MAU3.

Permission e-mail from MAU2 Charge Nurses

Dear Peter,

Request granted from our end. On the other hand, it is important to know that since the beginning of COVID we do not do NIV on the ward and most of the staff are new.

(In copy Josianne who is also a charge Nurse at MAU2)

Wish you success in your studies

Best Regards
Aaron.

Sent from my iPhone

On 04 Aug 2021, at 20:30, Peter Spiteri <peter.spiteri.03@um.edu.mt> wrote:

[Quoted text hidden]

Peter Spiteri <peter.spiteri.03@um.edu.mt> 5 August 2021 at 08:59
To: Zammit Aaron at Health-MDH <aaron.b.zammit@gov.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>, Sammut Josianne at Health-MDH <josianne.sammut@gov.mt>

Dear Mr. Aaron Zammit,

First of all, thank you for granting me permission. I am aware of the situation and therefore nurses from your unit will form part of the pilot study because although they do not have recent exposure, still have years of experience on NIV.

Thanks again for your time,
Best Regards,
Peter Spiteri

[Quoted text hidden]

Permission e-mail from MAU1 Charge Nurse

Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Dear Peter

I will give you my permission .Just for your information that we do not have NIV`s anymore since COVId struck.It has been over 18 months since last NIV patient in MAU1.

Thanks

From: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Sent: Tuesday, 27 July 2021 09:07
To: Galea Charles at Health-MDH <charles.galea@gov.mt>
Cc: trevor.abela-fiorentino@um.edu.mt
Subject: dissertation permission letter

[Quoted text hidden]

Peter Spiteri <peter.spiteri.03@um.edu.mt> 28 July 2021 at 16:19
To: Galea Charles at Health-MDH <charles.galea@gov.mt>

Dear Mr Galea

Thanks for your immediate reply and for approving my study.

Regards
Peter
[Quoted text hidden]

Appendix 3: Permission approval from Departmental Chairpersons

Permission e-mail from the Chairperson of the Department of Cardiology

Best Regards
Peter Spiteri
[Quoted text hidden]

permission letter Mr Robert Xuereb.docx
16K

Xuereb Robert G at Health-MDH <robert-g.xuereb@gov.mt> 6 August 2021 at 11:54
To: "peter.spiteri.03@um.edu.mt" <peter.spiteri.03@um.edu.mt>

Your message

To: Xuereb Robert G at Health-MDH
Subject: Re: Dissertation permission letter
Sent: Friday, August 6, 2021 10:10:12 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna

was read on Friday, August 6, 2021 11:54:28 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna.

Xuereb Robert G at Health-MDH <robert-g.xuereb@gov.mt> 6 August 2021 at 11:55
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>, "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Dear Peter

Interesting. Permission granted.

Regards

Dr Robert G Xuereb

MD FRCP(L) FRCP(E) FESC FACC

Chairman Department of Cardiology

Permission e-mail from the Chairperson of the Department of Emergency Care

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

Dissertation permission letter

3 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 08:54
To: michael.b.spiteri@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Michael,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the ED.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter Dr Micheal Spiteri.docx
16K

Spiteri Michael B at Health-MDH <michael.b.spiteri@gov.mt> 27 July 2021 at 10:14
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Dear Mr Spiteri

Approved my end

Rgds

Permission e-mail from the Chairperson of the Department of Anesthesiology

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

Dissertation permission letter
4 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 10:41
To: carmel.c.abela@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Dr Carmel Abela,
I am currently reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "*Acute and critical nurses' knowledge of non-invasive ventilation*". Through the attached letter I am asking your permission to conduct my study with nurses working in the ITU.

Permissions are being requested from respective Charge Nurses, Departmental Managers, Departmental Chairs, Medical Superintendent and Director of Nursing Services. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter Dr Carmel Abela.docx
16K

Abela Carmel at Health-MDH <carmel.c.abela@gov.mt> 29 July 2021 at 15:16
To: "peter.spiteri.03@um.edu.mt" <peter.spiteri.03@um.edu.mt>

Your message

To: Abela Carmel at Health-MDH
Subject: Dissertation permission letter
Sent: Tuesday, July 27, 2021 10:41:57 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna

was read on Thursday, July 29, 2021 3:15:48 PM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna.

Abela Carmel at Health-MDH <carmel.c.abela@gov.mt> 29 July 2021 at 15:16
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Dear Mr Spiteri

You have my approval.

Thank you

Permission e-mail from the Chairperson of the Department of Medicine

Permissions are being requested from respective Charge Nurses, Departmental Chairs, Medical Superintendent, Director of Nursing Services and Chief Executive Officer. Data protection and Ethical clearance will also be sought. Additionally a copy of the questionnaire is attached to this email.
[Quoted text hidden]

2 attachments

permission letter Prof Stepehn Fava.docx
47K

Nurses Knowledge & Skill exploration on Non Invasive Ventilation - Google Forms.pdf
112K

Tonna Lucy-Anne at Health-MDH <lucy-anne.tonna@gov.mt> 17 August 2021 at 10:51
To: "peter.spiteri.03@um.edu.mt" <peter.spiteri.03@um.edu.mt>

From: Stephen Fava <stephen.fava@um.edu.mt>
Sent: Tuesday, 17 August 2021 10:46
To: Tonna Lucy-Anne at Health-MDH <lucy-anne.tonna@gov.mt>
Subject: Re: FW: Dissertation permission letter

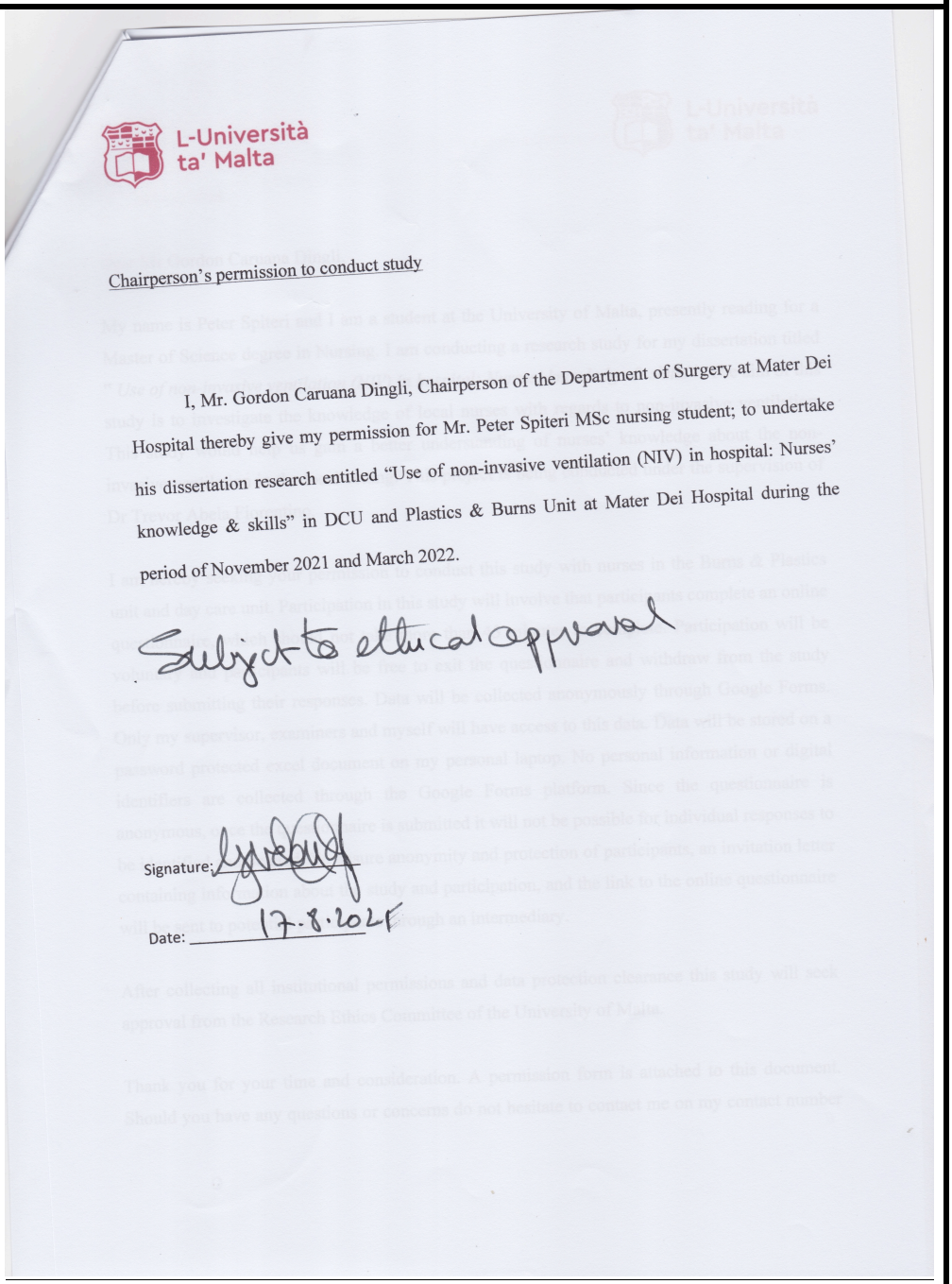
CAUTION: This email originated from OUTSIDE the Government Email Infrastructure. DO NOT CLICK LINKS or OPEN attachments unless you recognise the sender and know the content is safe.

Approved from my end.

On Tue, 17 Aug 2021 at 10:42, Tonna Lucy-Anne at Health-MDH <lucy-anne.tonna@gov.mt> wrote:

> Please approve

Permission letter from the Chairperson of the Department of Surgery



L-Università ta' Malta

Chairperson's permission to conduct study

I, Mr. Gordon Caruana Dingli, Chairperson of the Department of Surgery at Mater Dei Hospital thereby give my permission for Mr. Peter Spiteri MSc nursing student; to undertake his dissertation research entitled "Use of non-invasive ventilation (NIV) in hospital: Nurses' knowledge & skills" in DCU and Plastics & Burns Unit at Mater Dei Hospital during the period of November 2021 and March 2022.

Subject to ethical approval

Signature:

Date: 17.8.2021

Appendix 4: Permission approval from the Director of Nursing

Permission e-mail from the Director of Nursing

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

Dissertation permission letter
2 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 11:16
To: carmela.damato@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Ms Carmela D'amato,

My name is Peter Spiteri. I am a student at the University of Malta, reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "Acute and critical nurses' knowledge of non-invasive ventilation". Through the attached letter I am asking your permission to conduct my study with nurses working in the ED, ITU, CCCU, CICU, DCU, MAUs 1, 2 & 3, and Burns & Plastics Unit.

Permissions are being requested from respective Charge Nurses, Departmental Chairs, Medical Superintendent and Chief Executive Officer. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter Nursing Director.docx
16K

Damato Carmela at Health-MDH <carmela.damato@gov.mt> 27 July 2021 at 18:27
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Dear Peter

I wish you the very best for your studies. Approved.

Regards
Carmen

Get Outlook for Android

From: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Sent: Tuesday, July 27, 2021 11:16:55 AM
To: carmela.damato@gov.mt <carmela.damato@gov.mt>
Cc: trevor.abela-fiorentino@um.edu.mt <trevor.abela-fiorentino@um.edu.mt>
Subject: Dissertation permission letter

CAUTION: This email originated from OUTSIDE the Government Email Infrastructure. DO NOT CLICK LINKS or OPEN attachments unless you recognise the sender and know the content is safe.

[Quoted text hidden]

Appendix 5: Permission approval from Medical Director

Permission e-mail from the Medical Director

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

Dissertation permission letter
4 messages

Peter Spiteri <peter.spiteri.03@um.edu.mt> 27 July 2021 at 11:12
To: walter.j.busuttil@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Mr Walter Busuttil,

My name is Peter Spiteri. I am a student at the University of Malta, reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled "Acute and critical nurses' knowledge of non-invasive ventilation". Through the attached letter I am asking your permission to conduct my study with nurses working in the ED, ITU, CCCU, CICU, DCU, MAUs 1, 2 & 3, and Burns & Plastics Unit.

Permissions are being requested from respective Charge Nurses, Departmental Chairs, Director of Nursing Services and Chief Executive Officer. Data protection and Ethical clearance will also be sought.

Thank you for your time and kind consideration of this request.

Best Regards
Peter Spiteri

permission letter Medical Director.docx
16K

Peter Spiteri <peter.spiteri.03@um.edu.mt> 4 August 2021 at 20:19
To: walter.j.busuttil@gov.mt
Cc: trevor.abela-fiorentino@um.edu.mt

Dear Mr Walter Busuttil,

A gentle reminder regarding permission to conduct my study with nursing working in units offering non-invasive ventilation care.
I am attaching a formal permission letter.

Thank you for you time and kind consideration.

Best Regards
Peter Spiteri
[Quoted text hidden]

permission letter Medical Director.docx
16K

Busuttil Walter J at Health-MDH <walter.j.busuttil@gov.mt> 5 August 2021 at 00:14
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino@um.edu.mt" <trevor.abela-fiorentino@um.edu.mt>

Permission granted
Walter Busutttil

Sent from my iPhone

> On 04 Aug 2021, at 20:20, Peter Spiteri <peter.spiteri.03@um.edu.mt> wrote:
>
> CAUTION: This email originated from OUTSIDE the Government Email Infrastru. DO NOT CLICK LINKS or OPEN attachments unless you recognise the sender and know the content is safe.
> [Quoted text hidden]
> <permission letter Medical Director.docx>

Peter Spiteri <peter.spiteri.03@um.edu.mt> 5 August 2021 at 08:49

Appendix 6: Permission Approval from Chief Executive Officer

Permission e-mail from the Chief Executive Officer

Sent: Thursday, August 19, 2021 8:59:35 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna

was read on Thursday, August 19, 2021 9:12:18 AM (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna.

Farrugia Carmen at Health-MDH <carmen.farrugia@gov.mt> 19 August 2021 at 09:14
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>

Dear Mr Spiteri,

Kindly note that approval has been given by Ms Celia Falzon for you to conduct this study in line with applicable hospital protocols.

Regards

[Quoted text hidden]

Appendix 7: Permission approval from Data Protection Officer

Permission e-mail from the Data Protection Officer

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

FW: Data Protection Approval Form - Peter Spiteri between Data Protection Approval Form and Peter Spiteri is Signed and Filed!

1 message

Data Protection Approval Form at Health-MDH <dpaform.mdh@gov.mt> 19 August 2021 at 13:11
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>

Good Afternoon

Form received. You may now proceed.

Regards

Graziella Aquilina

Personal Assistant to Health Informatics Director (A210 092)

https://health.intra.gov.mt/mdh/itservices/_layouts/15/start.aspx#/SitePages/Home.aspx

SPTAR MATER DEI

T +356 25455334

E graziella.aquilina@gov.mt

Mater Dei Hospital, Triq id-Donaturi tad-Demm, l-Imsida, Malta MSD 2090 | Tel +356 2545 0000 | https://deputyprimeminister.gov.mt/en/MDH/Pages/Home.aspx | https://www.facebook.com/materdeihospital/

From: Adobe Sign <adobesign@adobesign.com>
Sent: Thursday, 19 August 2021 13:01
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>; Data Protection Approval Form at Health-MDH <dpaform.mdh@gov.mt>
Subject: Data Protection Approval Form - Peter Spiteri between Data Protection Approval Form and Peter Spiteri is Signed and Filed!

CAUTION: This email originated from OUTSIDE the Government Email Infrastructure. DO NOT CLICK LINKS or OPEN attachments unless you recognise the sender and know the content is safe.

Appendix 8: FREC approval for research

Permission e-mail from the FREC

L-Università ta' Malta

Peter Spiteri <peter.spiteri.03@um.edu.mt>

UREC FORM V_15062020 9570 Peter Spiteri

Rita Pace Parascandalo <rita.pace-parascandalo@um.edu.mt> 28 October 2021 at 09:25
To: Peter Spiteri <peter.spiteri.03@um.edu.mt>
Cc: "trevor.abela-fiorentino" <trevor.abela-fiorentino@um.edu.mt>, Research Ethics HEALTHSCI <research-ethics.healthsci@um.edu.mt>

Dear Peter,

your recently submitted amendments have been reviewed and all issues have been addressed. Approval for your study is granted oBo FREC. You may proceed with your study and collect the data.

Good luck.

Regards
Dr Rita PP

L-Università ta' Malta

Dr Rita Pace Parascandalo PhD (UCLan)
BSc(Hons) (Melit.), MSc(Melit.), RM

Senior Lecturer, Department of Midwifery
Chairperson, Faculty Research Ethics Committee

Faculty of Health Sciences
Office No. 48
+356 2340 1176
rita.pace-parascandalo@um.edu.mt

[Quoted text hidden]

Appendix 9: Participants' Study Invitation Letter

Participation Invitation letter

L-Università ta' Malta

Date

Dear Colleague,

My name is Peter Spiteri. I am a student at the University of Malta, reading for a Master of Science Degree in Nursing. I am conducting a research study for my dissertation titled " *Use of non-invasive ventilation (NIV) in hospital: Nurses' knowledge & skills*". The aim of this study is to investigate the knowledge of local nurses with regards to non-invasive ventilation (NIV). The use of NIV has increased over the years and literature shows that the scope of nurses' involvement in caring for patients on NIV also expanded. This study would help us gain a better understanding of local nurses' knowledge on non-invasive ventilation, thus your contribution to this study is extremely valuable. This project is being conducted under the supervision of Dr Trevor Abela Fiorentino.

I am hereby kindly inviting you to participate in this study. Participation in this study will require you to complete an online questionnaire, which should not take more than 30 minutes. Participation will be voluntary and you will be able to choose to skip any question, stop completing the questionnaire at any time, and also withdraw from the study as desired before submitting their responses, without any repercussions. By submitting your response you will be giving consent to participate in the study. Data will be collected anonymously through Google Forms. Access to this data will only be available to the supervisor, examiners and myself. Data will be stored on a password protected personal laptop in a protected private excel document. While no personal or digital identifiers are collected as part of this study, when you click on the hyperlink to be redirected to the Google Forms platform, data such as your IP address may be collected by Google Forms platform. These questionnaires are anonymous, and therefore once submitted it will not be possible for your responses to be retrieved and deleted. To ensure complete anonymity this invitation is being distributed through an intermediary. However, should you have any queries do not hesitate to contact me on 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt.

All required permission to conduct this study have been given, together with data protection clearance and ethical approval.

Kindly follow the address link below to access this questionnaire: https://forms.gle/2K9bYNt11dLg1xwn9

Thank you for your time and participation.

Yours Sincerely,

Peter Spiteri
Researcher

Dr Trevor Abela Fiorentino
Research Supervisor

Appendix 10: Information Letter for Study Permission

16th August 2021

Dear _____,

My name is Peter Spiteri and I am a student at the University of Malta, presently reading for a Master of Science degree in Nursing. I am conducting a research study for my dissertation titled " *Use of non-invasive ventilation (NIV) in hospital: Nurses' knowledge & skills*". The aim of this study is to investigate the knowledge of local nurses with regards to non-invasive ventilation**.** This study would help us gain a better understanding of nurses' knowledge about the non-invasive ventilation in the local setting. This project is being conducted under the supervision of Dr Trevor Abela Fiorentino.

I am hereby seeking your permission to conduct this study with nurses in the Burns & Plastics unit and day care unit. Participation in this study will involve that participants complete an online questionnaire, which should not take more than 45 minutes to complete. Participation will be voluntary and participants will be free to exit the questionnaire and withdraw from the study before submitting their responses. Data will be collected anonymously through Google Forms. Only my supervisor, examiners and myself will have access to this data. Data will be stored on a password protected excel document on my personal laptop. No personal information or digital identifiers are collected through the Google Forms platform. Since the questionnaire is anonymous, once the questionnaire is submitted it will not be possible for individual responses to be identified and deleted. To ensure anonymity and protection of participants, an invitation letter containing information about the study and participation, and the link to the online questionnaire will be sent to potential participants through an intermediary.

After collecting all institutional permissions and data protection clearance this study will seek approval from the Research Ethics Committee of the University of Malta.

Thank you for your time and consideration. A permission form is attached to this document. Should you have any questions or concerns do not hesitate to contact me on my contact number 25454050 or by e-mail peter.spiteri.03@um.edu.mt or my supervisor Dr Trevor Abela Fiorentino on 23401113 or by e-mail trevor.abela-fiorentino@um.edu.mt.

Appendix 11: Pre-validated questionnaire

Use of non-invasive ventilation (NIV) in hospital: Nurses' knowledge & skills

The questionnaire is based on the British Thoracic Society Guidelines, the European Respiratory Society Guidelines and the Mater Dei Hospital Guidelines.

1.Age Group

Mark only one oval.

- o <25
- o 26-30
- o 31-35
- o 36-40
- o 41-45
- o >46

2.Gender *Mark only one oval.*

- o Female
- o Male
- o Prefer not to disclose

3.Current working at

Mark only one oval.

- o Burns & Plastics Unit
- o Cardiac Critical Care Unit
- o Cardiac Intensive Care Unit
- o Day Care Unit
- o Emergency Department
- o Intensive Therapy Unit
- o Medical Admission Unit

4.Years providing NIV patient care *Mark only one oval.*

- o <6 months
- o 6-11 months
- o 1-2 years
- o 3-5 years
- o 6-10 years
- o 11-15 years
- o >15 years

5. Qualifications

- Nursing Diploma
- Nursing Degree
- Master Degree
- Post graduate Nursing Diploma

6.Years providing NIV patient care *Mark only one oval.*

- <6 months
- 6-11 months
- 1-2 years
- 3-5 years
- 6-10 years
- 11-15 years
- >15 years

7.How confident do you feel to practice NIV?

Non confident 1 2 3 4 5 Extremely Confident

8.Are you aware of any international guidelines on NIV? *Mark only one oval.*

- Yes
- No
- Prefer not to disclose

9.Have you read any international guidelines on NIV? *Mark only one oval.*

- Yes
- No
- Prefer not to di

10.Are you aware of the MDH guidelines on NIV?

Mark only one oval.

- Yes
- No
- Prefer not to disclose

11.Have you read the Mater Dei Hospital NIV guidelines?

Mark only one oval.

- Yes
- No
- Prefer not to disclose

12..Have you attended training on NIV?

Mark only one oval.

- Yes
- No
- Prefer not to disclose

13.If yes, how long was this training?

Mark only one oval.

- 30 minutes
- 1 hour
- 2 hours
- 3 hours
- 4 hours
- 6 hours
- 8 hours
- 9-12 hours
- >12 hours

14.Did this training include nursing related topics, such as patient hygiene, nutrition, mobility, bowel habit, pressure, eye/mouth care and psychological care?

Tick all that apply.

- Yes
- No
- I prefer not to disclose

Physiology related to NIV

15.Which of the follow denes type 1 respiratory failure? *Tick all that apply.*

- Pa02 of <60mmhg and PaCO2 of 35mmHg
- PaO2 of <60mmHg and PaCO2 of 70mmHg
- PaO2 of <60mmHg and PaCO2 of 20mmHg
- PaO2 of 80mmHg and PaCO2 of 35mmHg

16.Which of the follow denes Type 2 Respiratory Failure? *Tick all that apply.*

- Pa02 of <60mmhg and PaCO2 of 35mmHg
- PaO2 of <60mmHg and PaCO2 of 70mmHg
- PaO2 of <60mmHg and PaCO2 of 20mmHg
- PaO2 of 80mmHg and PaCO2 of 35mmHg

17.Which of the following conditions would benet from NIV? *Tick all that apply.*

- Pneumonia
- Acute hypercapnic COPD
- Post op respiratory failure
- Acute LVF with hypercapnia
- Increased work of breathing with muscle fatigue
- COPD with secretion retention

18. Which of the following are absolute contraindications for NIV?

Tick all that apply.

- o Facial Burns
- o High Co2 and Low O2
- o Fixed upper airway obstruction
- o Gastric Distension
- o Vomiting
- o Claustrophobia
- o Active pulmonary TB
- o Severe facial deformity
- o Raised lactate level
- o Raised carboxyhaemoglobin levels

19. Which of the following physiological variables differ between an acute and acute on chronic exacerbation of COPD?

Tick all that apply.

- o Level of CO2
- o Level of HCO3
- o Level of O2
- o Level of pH

NIV set up & function

20. What mode(s) is/are used to treat patients with an acute hypercapnic episode of COPD? *Tick all that apply.*

- o CPAP
- o Pressure Support
- o Pressure Control

21. How would you set the back up rate in pressure suppo ventilation? *Tick all that apply.*

- o RR -5
- o RR -10
- o RR +5
- o RR +10

22. Which modes of ventilatory support have a timed inspiratory phase? *Tick all that apply.*

- o CPAP
- o Pressure Support Ventilation (Spontaneous mode)
- o Pressure Control
- o Pressure Support Ventilation (Spontaneous/Timed mode)

23. When is an expiratory valve required in a circuit? *Tick all that apply.*

- o When using a single limb system with a non-vented interface (mask).

- When using double limb tubing with a non-vented interface (mask).
- When using single limb tubing with a vented interface (mask
- When using double limb tubing with a vented interface (mask).
- All the above

24. All machines have a high flow and low flow alarms. What could the low flow alarm indicate? *Tick all that apply.*

- Circuit occlusion
- Sputum Plug
- Excessive Leak
- Circuit Disconnection
- All the above

25.All machines have a high flow and low flow alarms. What could the high flow alarm indicate? *Tick all that apply.*

- Circuit occlusion
- Sputum Plug
- Excessive Leak
- Circuit Disconnection
- All the above

26.If the machine is cycling at the back up rate, what could this indicate? *Tick all that apply.*

- The patient stopped breathing
- The patient is not triggering breaths
- The machine is faulty
- None of the above

27.What might you change to improve synchronization between the patient and the ventilator? *Tick all that apply.*

- Trigger sensitivity
- EPAP
- IPAP
- FIO2
- Mask size

28.Pressure support administered during NIV with a bi-level positive airway pressure (BPAP) modality is: *Mark only one oval.*

- EPAP + IPAP
- IPAP-EPAP
- Maximum airway pressure reached
- Pressure support does not exist in NIV
- None of the above

Patient Monitoring

29.Which of the following indicate that NIV is falling? *Tick all that apply.*

- Failure of CO2 to decrease
- Failure to increase O2
- 1 hour after starting NIV
- GCS <12
- SaO2>92%
- HCO3- rising
- Occasional lack of synchrony

30.Following initiation of NIV, when should the first ABG be taken following initiation of NIV? *Tick all that apply.*

- 15 minutes
- 30 minutes
- 1 hour
- 2 hours
- 3 hours

31.Which of the parameters listed below are essential in the monitoring of NIV patient? *Tick all that apply.*

- Blood glucose
- Heart rate & rhythm
- Oxygen saturation
- Temperature
- Peak Flow Meter
- Blood pressure
- Respiratory Rate
- Strict urine output

32. In an acute exacerbation of COPD, the first ABG post initiation of NIV shows no change. How long should one spend trying to optimize NIV settings before considering invasive ventilation?

Mark only one oval.

- Intubate immediately
- Up to 1 hour
- 1-4 hours
- 4-6 hours
- 6-8 hours

33. When should the weaning process from NIV be initated? Mark only one oval

- Once parameters and underling cause and symptoms are resolved
- Once patient tolerates breaks of 15-20minutes
- After24 hours from initiation of NIV

- After 48 hours from initiation of NIV
-

NIV Nursing Care

34. Which of the following positions is recommended for patients who are being treated with NIV for an acute hypercapnic episode of COPD?

Tick all that apply.

- Fowler Semi-fowler
- Supine
- Recovery position
- Other:

35. Which of the following methods are recommended to preserve skin integrity in patients who are being treated with NIV?

Tick all that apply.

- Change interface to full-face mask
- Reposition mask interface
- Use hydrocolloid dressing
- Apply moisturizer
- Give short breaks
- Apply the mask loosely
- All the above

36.Which of the following complications may occur during NIV care? *Tick all that apply.*

- Patient agitation
- Lack of patient synchronization of ventilator
- Atelectasis
- Hypotension
- Pnuemothorax
- Aspiration pneumonia
- Hypertension
- Epistaxis

37.Is this statement True or False? "BTS guidelines do not recommend NIV use for end-of-life care or palliative patients". *Tick all that apply.*

- True
- False

38.Which of the following instances is an / are appropriate for use in a patient being treated with NIV for acute respiratory failure? *Tick all that apply.*

- Oronasal mask
- Nasal mask
- Helmet
- Total facemask

- All the above

39. When applying an interface (mask) in place how tight must the straps be? *Tick all that apply.*

- The straps must be as tight as possible to prevent leaks.
- The straps must be adjusted to the "2 finger" fit
- The straps must be loosely fitted to prevent skin pressure.
- The straps must be tightened to the patient's preference.

40. In what sequence should NIV be initiated? 0 points *Tick all that apply.*

- First apply interface, check that it is well fitted, adjust settings, and then initiate ventilation
- Begin ventilation and then adapt the interface to the patient's face, adjust settings and check that it is well-fitted
- Apply settings first, initiate ventilation, apply interface to the patient face and check that it is well-fitted
- Apply setting first, apply interface to the patient face, initiate ventilation and check that it is well-fitted

41. In which of the following cases can a patient with NIV eat?

Tick all that apply.

- If the patient is able to tolerate small periods off NIV.
- If the patient has decreased level of consciousness.
- If the patient has a respiratory rate of 45rpm
- When ever the patient feels hungry.

42. In which of the following situations is a nasogastric tube indicated?

Tick all that apply.

- It is indicated in abdominal distension due to NIV.
- It is indicated if the patient has nausea and vomiting without signs of intestinal obstruction.
- It is indicated if the patient is in respiratory distressed and cannot tolerate breaks.
- all of the above

43. Which of the following statements about NIV and eye care below are true?

Tick all that apply.

- Humidified air prevents eye irritation and dryness.
- Leaks from the Interface (mask) causes eye irritation and dryness.
- Encouraging patient to perform frequent eye blinking prevents dryness.
- Artificial drops prevent eye irritation and dryness.

44. Which of these statements about oral hygiene for patients being treated with NIV are true?

Tick all that apply.

- Oral hygiene should be carried out every 2 hours, only if breaks longer than 5 minutes tolerated
- Oral hygiene is required once daily in all patients on NIV.
- Oral hygiene should be provided every 2 hours in all NIV patients.
- Oral hygiene should only be provided after eating.

45.Which of the following solutions should be used for oral hygiene in patients with NIV?

Tick all that apply.

- Chlorhexidine oral solution
- Saline solution
- Distilled water
- None of the above

46.Which of the following statements on patient's hygiene are true?

Tick all that apply.

- Daily or more often oral hygiene is required according to patient tolerance.
- Oral hygiene should not be performed to prevent respiratory distress.
- Prior to weaning phase only ice cubes and water sips should be provided.
- Oral hygiene should only be performed if patient has normal parameters.

47.Which of the following statements about mobility and NIV are true?

Tick all that apply.

- Encourage patient to ambulate if tolerated.
- Self ambulation should not be encouraged before weaning phase.
- When in bed the patient should be kept in Folwer's position.
- Daily walking is recommended even in poor tolerance patients

48.In which of the following situations is suction in patient with NIV required?

Tick all that apply.

- In all NIV patients with productive cough with phlegm.
- In patients with crackles and in respiratory distressed.
- In any upper airway secretions and weak cough.
- In alert patients that are actively vomiting.

49.How would you improve communication with a patient on NIV?

Tick all that apply.

- Reassure patient and ensure they are comfortable
- Encourage patient to communicate and explain other means such a writing template
- Ask relatives/ carer to stay with patient
- Talk louder and at a slow pace
- All the above

50.Is this statement True or False? Physiotherapy can be received even during NIV, not

necessarily during 'NIV breaks'.

Tick all that apply.

- True
- False

Appendix 12: Questionnaire CVI relevance score before questions exclusion

Experts' (R) relevance scores, number of agreements and CVI score per question, and total score											
Q	R1	R2	R3	R4	R5	R6	R7	R8	R9	No of Agreement	I CVI
1	3	1	4	4	3	4	1	4	3	7	0.78
2	1	1	4	4	1	3	2	4	3	5	0.56
3	4	4	4	4	4	4	4	4	4	9	1
4	3	4	4	4	3	4	4	4	4	9	1
5	2	4	4	4	4	4	4	4	4	8	0.89
6	4	4	4	4	4	4	4	4	4	9	1
7	4	3	2	4	3	4	4	4	4	8	0.89
8	4	3	4	4	4	4	4	4	4	9	1
9	4	3	4	4	4	4	4	4	4	9	1
10	4	3	4	4	4	4	4	4	4	9	1
11	4	3	4	4	4	4	4	4	4	9	1
12	4	4	4	4	4	4	4	4	4	9	1
13	2	2	4	4	4	4	4	4	4	7	0.78
14	3	4	4	4	2	1	4	4	4	7	0.78
15	4	4	4	4	4	3	4	4	4	9	1
16	4	4	4	4	4	4	4	4	4	9	1
17	4	4	4	4	4	4	4	4	4	9	1
18	4	4	4	4	4	4	4	4	4	9	1
19	4	4	4	2	4	2	4	4	4	7	0.78
20	4	4	4	4	4	3	4	4	4	9	1
21	4	4	4	4	4		4	4	4	8	0.89
22	4	4	4	2	4	1	4	4	4	7	0.78
23	4	4	4	4	4	4	4	4	4	9	1
24	4	4	4	4	4	3	4	4	4	9	1
25	4	4	4	4	4	3	1	4	4	8	0.89
26	4	4	4	4	4	1	4	4	4	8	0.89
27	4	4	4	4	4	4	4	4	4	9	1
28	4	4	4	4	4	3	2	4	4	8	0.89
29	4	4	4	4	4	4	4	4	4	9	1
30	4	4	4	4	4	4	4	4	3	9	1
31	4	4	4	4	4	4	4	4	4	9	1
32	3	4	4	4	4	3	2	4	3	8	0.89
33	4	4	4	4	4	3	3	4	4	9	1
34	4	4	4	4	4	1	4	4	4	8	0.89
35	4	4	4	4	4	2	3	4	4	8	0.89
36	4	4	4	4	4	1	4	4	4	8	0.89
37	4	4	4	4	4	1	4	4	4	8	0.89
38	3	4	4	4	4	3	4	4	4	9	1
39	4	4	4	4	4	1	4	4	4	8	0.89
40	4	4	4	4	4	4	4	4	4	9	1
41	4	4	4	4	4	1	4	4	4	8	0.89
42	4	4	4	4	4	1	4	4	4	8	0.89
43	4	4	4	4	4	3	4	4	4	9	1
44	3	4	4	4	4	1	4	4	4	8	0.89
45	3	4	4	4	4	1	4	4	4	8	0.89
46	4	3	4	4	4	1	4	4	4	8	0.89
47	4	4	4	4	4	1	4	4	4	8	0.89
48	4	4	4	4	4	2	4	4	4	8	0.89
49	4	4	4	4	4	3	4	4	4	9	1
50	4	4	4	4	4	1	4	4	4	8	0.89
									S CVI/AVE		**0.92**
									Total Agreement		**23**
									SCVI/UA		**0.46**

Appendix 13: Questionnaire clarity score before exclusion of certain questions

Experts' (R) clarity scores, number of agreements and CVI score per question, and total score										
Q	R1	R2	R3	R4	R5	R6	R7	R8	R9	Average score
1	4	4	4	4	4	4	4	4	4	4
2	4	4	4	4	4	4	4	4	4	4
3	4	4	4	4	4	3	3	4	4	4
4	3	4	4	4	3	4	3	4	4	4
5	4	4	2	4	4	4	4	4	3	3.67
6	4	4	4	4	4	4	3	4	3	3.78
7	4	2	2	4	3	4	3	4	2	3.78
8	3	4	4	4	4	4	4	4	3	3.78
9	4	4	4	4	4	4	4	4	3	3.89
10	4	4	4	4	4	4	4	4	3	3.89
11	4	4	4	4	4	4	4	4	3	3.89
12	4	4	4	4	4	4	4	4	3	3.89
13	2	3	4	4	4	4	3	4	3	3.44
14	3	2	4	4	2	4	4	4	3	3.33
15	2	3	4	4	4	3	1	4	4	3.22
16	2	2	4	4	4	4	4	4	4	3.56
17	4	4	4	4	4	3	1	4	3	3.44
18	4	3	4	4	4	4	1	4	4	3.56
19	4	4	4	4	4	4	4	4	3	3.89
20	3	4	4	4	4	3	2	4	3	3.44
21	4	4	4	4	4	1	4	4	2	3.44
22	4	4	4	4	4	4	2	4	3	3.67
23	1	4	4	4	4	4	4	4	4	3.67
24	4	4	4	4	4	4	4	4	4	4
25	4	4	4	4	4	1	1	4	4	3.33
26	4	4	4	4	4	1	4	4	3	3.56
27	4	4	4	4	4	4	3	4	4	3.89
28	3	4	4	2	4	4	1	4	3	3.22
29	3	4	4	4	3	4	1	4	2	3.22
30	3	4	4	4	4	4	1	4	4	3.56
31	3	4	4	4	4	4	1	4	4	3.56
32	2	4	4	3	4	3	2	4	4	3.33
33	4	4	4	4	4	3	1	4	4	3.56
34	4	4	4	4	4	1	4	4	4	3.67
35	4	4	4	4	4	4	3	4	2	3.67
36	4	4	4	4	4	4	1	4	3	3.56
37	4	4	4	4	4	2	4	4	4	3.78
38	4	4	4	4	4	4	4	4	4	4
39	4	4	4	4	4	1	4	4	4	3.67
40	4	4	4	4	1	4	4	4	4	3.67
41	4	4	4	4	4	1	4	4	4	3.67
42	4	4	4	4	4	1	4	4	4	3.67
43	4	4	4	4	4	4	4	4	4	4
44	4	4	4	4	4	4	4	4	4	4
45	4	4	4	4	4	1	4	4	4	3.67
46	4	3	4	4	4	4	1	4	4	3.56
47	4	4	4	4	4	4	4	4	3	3.89
48	4	4	4	4	4	4	4	4	4	4
49	3	4	4	4	4	4	1	4	3	3.44
50	4	4	4	4	4	4	4	4	4	4
							Total average score			3.69

Appendix 14: Questionnaire CVI relevance score after exclusion of certain questions

Experts' (R) relevance scores, number of agreements and CVI score per question, and total score after questions' exclusions											
Q	R1	R2	R3	R4	R5	R6	R7	R8	R9	No of Agreement	I CVI
3	4	4	4	4	4	4	4	4	4	9	1
4	3	4	4	4	3	4	4	4	4	9	1
5	2	4	4	4	4	4	4	4	4	8	0.89
6	4	4	4	4	4	4	4	4	4	9	1
8	4	3	4	4	4	4	4	4	4	9	1
10	4	3	4	4	4	4	4	4	4	9	1
12	4	4	4	4	4	4	4	4	4	9	1
14	3	4	4	4	2	1	4	4	4	7	0.78
15	4	4	4	4	4	3	4	4	4	9	1
16	4	4	4	4	4	4	4	4	4	9	1
17	4	4	4	4	4	4	4	4	4	9	1
18	4	4	4	4	4	4	4	4	4	9	1
23	4	4	4	4	4	4	4	4	4	9	1
24	4	4	4	4	4	3	4	4	4	9	1
25	4	4	4	4	4	3	1	4	4	8	0.89
26	4	4	4	4	4	1	4	4	4	8	0.89
28	4	4	4	4	4	3	2	4	4	8	0.89
29	4	4	4	4	4	4	4	4	4	9	1
31	4	4	4	4	4	4	4	4	4	9	1
33	4	4	4	4	4	3	3	4	4	9	1
34	4	4	4	4	4	1	4	4	4	8	0.89
35	4	4	4	4	4	2	3	4	4	8	0.89
36	4	4	4	4	4	1	4	4	4	8	0.89
37	4	4	4	4	4	1	4	4	4	8	0.89
38	3	4	4	4	4	3	4	4	4	9	1
39	4	4	4	4	4	1	4	4	4	8	0.89
40	4	4	4	4	4	4	4	4	4	9	1
41	4	4	4	4	4	1	4	4	4	8	0.89
42	4	4	4	4	4	1	4	4	4	8	0.89
43	4	4	4	4	4	3	4	4	4	9	1
44	3	4	4	4	4	1	4	4	4	8	0.89
47	4	4	4	4	4	1	4	4	4	8	0.89
48	4	4	4	4	4	2	4	4	4	8	0.89
49	4	4	4	4	4	3	4	4	4	9	1
50	4	4	4	4	4	1	4	4	4	8	0.89
										S CVI/AVE	**0.95**
										Total Agreement	**19**
										SCI/UA	**0.54**

Appendix 15: Questionnaire question CVI clarity post-exclusion

Experts' (R) clarity scores and the total score after exclusion of questions from the questionnaire										
Q	R1	R2	R3	R4	R5	R6	R7	R8	R9	Average Score
3	4	4	4	4	4	3	3	4	4	3.78
4	3	4	4	4	3	4	3	4	4	3.78
5	4	4	2	4	4	4	4	4	3	3.67
6	4	4	4	4	4	4	3	4	3	3.78
8	3	4	4	4	4	4	4	4	3	3.78
10	4	4	4	4	4	4	4	4	3	3.89
12	4	4	4	4	4	4	4	4	3	3.89
14	3	2	4	4	2	4	4	4	3	3.33
15	2	3	4	4	4	3	1	4	4	3.22
16	2	2	4	4	4	4	4	4	4	3.56
17	4	4	4	4	4	3	1	4	3	3.44
18	4	3	4	4	4	4	1	4	4	3.56
23	1	4	4	4	4	4	4	4	4	3.67
24	4	4	4	4	4	4	4	4	4	4
25	4	4	4	4	4	1	1	4	4	3.33
26	4	4	4	4	4	1	4	4	3	3.56
28	3	4	4	2	4	4	1	4	3	3.22
29	3	4	4	4	3	4	1	4	2	3.22
31	3	4	4	4	4	4	1	4	4	3.56
33	4	4	4	4	4	3	1	4	4	3.56
34	4	4	4	4	4	1	4	4	4	3.67
35	4	4	4	4	4	4	3	4	2	3.67
36	4	4	4	4	4	4	1	4	3	3.56
37	4	4	4	4	4	2	4	4	4	3.78
38	4	4	4	4	4	4	4	4	4	4
39	4	4	4	4	4	1	4	4	4	3.67
40	4	4	4	4	1	4	4	4	4	3.67
41	4	4	4	4	4	1	4	4	4	3.67
42	4	4	4	4	4	1	4	4	4	3.67
43	4	4	4	4	4	4	4	4	4	4
44	4	4	4	4	4	4	4	4	4	4
47	4	4	4	4	4	4	4	4	3	3.89
48	4	4	4	4	4	4	4	4	4	4
49	3	4	4	4	4	4	1	4	3	3.44
							Total average score			3.78

Appendix 16: Table with excluded questions and reason for exclusion

CVI relevance and clarity scores for the excluded questions together with the exclusion reasons.			
Question number	**Relevance Score**	**Clarity Score**	**Reason for exclusion**
1	0.78	1	*Question had lower relevance score.*
2	0.56	1	*Question had lower relevance score.*
7	0.89	0.67	*Question had lower clarity score.*
9	1	1	*Question similar to question 8*
11	1	1	*Question similar to question 10*
13	0.78	0.89	*Question had lower relevance score.*
19	0.78	1	*Question had lower relevance score.*
20	1	0.78	*Question had lower clarity score.*
21	0.89	0.89	*Question similar to question 26*
22	0.78	0.89	*Question had lower relevance score.*
27	1	0.78	*Question had lower clarity score.*
30	1	0.78	*Question had lower clarity score.*
32	0.89	0.78	*Question had lower clarity score.*
45	0.89	0.89	*Question excluded as another question covering same topic.*
46	0.89	0.89	*Question similar to question 44*

Appendix 17: Post-validated Questionnaire

Use of non-invasive ventilation (NIV) in hospital: Nurses' knowledge & skills

The questionnaire is based on the British Thoracic Society Guidelines, the European Respiratory Society Guidelines and the Mater Dei Hospital Guidelines.

1.Current working at

Mark only one oval.

- o Burns & Plastics Unit
- o Cardiac Critical Care Unit
- o Cardiac Intensive Care Unit
- o Day Care Unit
- o Emergency Department
- o Intensive Therapy Unit
- o Medical Admission Unit

2.Years providing NIV patient care *Mark only one oval.*

- o <6 months
- o 6-11 months
- o 1-2 years
- o 3-5 years
- o 6-10 years
- o 11-15 years
- o >15 years

3. Please select all forms of formal nurse training that you have completed *Tick all that apply.*

- o Traditional EN training
- o Traditional SRN training
- o EN to SN conversion course
- o Diploma/ Higher Diploma in Nursing
- o B.Sc. (Hons.) in Nursing/ Health Science
- o Postgraduate certificate
- o M.Sc. degree (in any healthcare area)
- o PhD (in any healthcare area)
- o Other

4. For how many months or years have you been providing care to patients receiving non invasive ventilation (NIV)? *Mark only one oval.*

- o None
- o <6 months
- o 6-11 months
- o 1-2 years
- o 3-5 years
- o 6-10 years
- o 11-15 years
- o >15 years

5.Are you aware of any international guidelines on NIV? *Mark only one oval.*

- o Yes
- o No

6. Are you aware of the MDH guidelines on NIV?

Mark only one oval.

- o Yes
- o No

7. Have you been offered training on non invasive ventilation (NIV)? (Kindly skip next question if you choose No)

Mark only one oval.

- o Yes
- o No

8. In the NIV training provided, did it include any of the nursing related topics listed below?

Tick all that apply.

- o Patient hygiene
- o Patient nutrition
- o Patient mobility
- o Bowel care
- o Pressure injury prevention
- o Eye care
- o Mouth care
- o Psychological care
- o Other_____

Physiology related to NIV

9.Which of the follow defines type 1 respiratory failure? *Tick all that apply.*

- o Pa02 of <60mmhg and PaCO2 of 35mmHg
- o PaO2 of <60mmHg and PaCO2 of 70mmHg
- o PaO2 of <60mmHg and PaCO2 of 20mmHg
- o PaO2 of >80mmHg and PaCO2 of 35mmHg

10.Which of the follow defines Type 2 Respiratory Failure? *Tick all that apply.*

- o Pa02 of <60mmhg and PaCO2 of 35mmHg
- o PaO2 of <60mmHg and PaCO2 of 70mmHg
- o PaO2 of <60mmHg and PaCO2 of 20mmHg
- o PaO2 of >80mmHg and PaCO2 of 35mmHg

11.Which of the following conditions would benefit from non invasive ventilation (NIV)? *Tick all that apply.*

- Pneumonia
- Acute hypercapnic COPD
- Post op respiratory failure
- Acute LVF with hypercapnia

12.Which of the following are absolute contraindications for NIV?

Tick all that apply.

- Facial Burns
- High Co2 and Low O2
- Fixed upper airway obstruction
- Gastric Distension
- Vomiting
- Claustrophobia
- Active pulmonary TB
- Severe facial deformity
- Raised lactate level
- Raised carboxyhaemoglobin levels

NIV set up & function

13.When is an expiratory valve required in a circuit? *Tick all that apply.*

- When using a single limb system with a non-vented interface (mask).
- When using double limb tubing with a non-vented interface (mask).
- When using single limb tubing with a vented interface (mask).
- When using double limb tubing with a vented interface (mask).
- All the above
-

14. All machines have a high flow and low flow alarms. What could the low flow alarm indicate? *Tick all that apply.*

- Circuit occlusion
- Sputum Plug
- Excessive Leak
- Circuit Disconnection
- All the above

15.All machines have a high flow and low flow alarms. What could the high flow alarm indicate? *Tick all that apply.*

- Circuit occlusion

- Sputum Plug
- Excessive Leak
- Circuit Disconnection
- All the above

16.If the machine is cycling at the back up rate, what could this indicate? *Tick all that apply.*

- The patient stopped breathing
- The patient is not triggering breaths
- The machine is faulty
- None of the above

17. Pressure support administered during NIV with a bi-level positive airway pressure (BPAP) modality is: *Mark only one oval.*

- EPAP added to IPAP
- IPAP minus EPAP
- Maximum airway pressure reached
- None of the above

Patient Monitoring

18.Which of the following indicate that non invasive ventilation (NIV) treatment is falling? *Tick all that apply.*

- Failure of CO2 to decrease
- Failure to increase PaO_2
- 1 hour after starting NIV GCS <12
- SaO2>92%
- HCO3- rising
- Occasional lack of synchrony

19.Which of the parameters listed below are essential in the monitoring of NIV patient? *Tick all that apply.*

- Blood glucose
- Heart rate & rhythm
- Oxygen saturation
- Temperature
- Peak Flow Meter
- Blood pressure
- Respiratory Rate
- Strict urine output

20. When should the weaning process from NIV be initated? *Mark only one oval.*

- Once parameters and underling cause and symptoms are resolved
- Once patient tolerates breaks of 15-20minutes

- After24 hours from initiation of NIV
- After 48 hours from initiation of NIV

NIV Nursing Care

21. Which of the following positions is recommended for patients who are being treated with NIV for an acute hypercapnic episode of COPD?

Tick all that apply.

- Fowler Semi-fowler
- Supine
- Recovery position

22. Which of the following methods are recommended to preserve facial skin integrity in patients who are being treated with non invasive ventilation (NIV)?

Tick all that apply.

- Alternate interface
- Reposition mask interface
- Use hydrocolloid dressing over bony prominent skin in contact with interface
- Apply moisturiser over face
- Give short breaks
- Apply the mask loosely
- All the above

23.Which of the following complications may occur during NIV care? *Tick all that apply.*

- Patient agitation
- Atelectasis
- Hypotension
- Pnuemothorax
- Aspiration pneumonia
- Hypertension
- Epistaxis

24. Is this statement True or False? "BTS guidelines do not recommend NIV use for end-of-life care or palliative patients". *Tick all that apply.*

- True
- False

25.Which of the following is/are appropriate for use in a patient being treated with NIV for acute respiratory failure? *Tick all that apply.*

- Oronasal mask

- Nasal mask
- Helmet
- Total facemask
- All the above

26.When applying an interface (mask) in place how tight must the straps be? *Tick all that apply.*

- The straps must be as tight as possible to prevent leaks.
- The straps must be adjusted to the "2 finger" fit.
- The straps must be loosely fitted to prevent skin pressure.
- The straps must be tightened to the patient's preference.

27. In what sequence should NIV be initiated? 0 points *Tick all that apply.*

- First apply interface, check that it is well fitted, adjust settings, and then initiate ventilation
- Begin ventilation and then adapt the interface to the patient's face, adjust settings and check that it is well-fitted
- Apply settings first, initiate ventilation, apply interface to the patient face and check that it is well-fitted
- Apply setting first, apply interface to the patient face, initiate ventilation and check that it is well-fitted

28. In which of the following cases can a patient with NIV eat?
Tick all that apply.

- If the patient is able to tolerate small periods off NIV.
- If the patient has decreased level of consciousness.
- If the patient has a respiratory rate of 45rpm.
- When ever the patient feels hungry.

29.In which of the following situations is a nasogastric tube indicated?

Tick all that apply.

- It is indicated in abdominal distension due to NIV.
- It is indicated if the patient has nausea and vomiting without signs of intestinal obstruction.
- It is indicated if the patient is in respiratory distressed and cannot tolerate breaks.
- all of the above

30.Which of the following statements about NIV and eye care below are true?

Tick all that apply.

- Humidified air prevents eye irritation and dryness.
- Leaks from the interface (mask) causes eye irritation and dryness.
- Encouraging patient to perform frequent eye blinking prevents dryness.
- Artificial drops prevent eye irritation and dryness.

31.Which of these statements about oral hygiene for patients being treated with NIV are

true?

Tick all that apply.

- Oral hygiene should be carried out every 2 hours, only if breaks longer than 5 minutes tolerated
- Oral hygiene is required once daily in all patients on NIV.
- Oral hygiene should be provided every 2 hours in all NIV patients.
- Oral hygiene should only be provided after eating.

32.Which of the following statements about mobility and NIV are true?

Tick all that apply.

- Encourage patient to ambulate if tolerated.
- Self ambulation should not be encouraged before weaning phase.
- When in bed the patient should be kept in Folwer's position.
- Daily walking is recommended even in poor tolerance patients

33.In which of the following situations is suction in patient with NIV required?

Tick all that apply.

- In all NIV patients with productive cough with phlegm.
- In patients with crackles and in respiratory distressed.
- In any upper airway secretions and weak cough.
- In alert patients that are actively vomiting.

34.How would you improve communication with a patient on NIV?

Tick all that apply.

- Reassure patient and ensure they are comfortable
- Encourage patient to communicate and explain other means such a writing template
- Ask relatives/ carer to stay with patient
- Talk louder and at a slow pace
- All the above

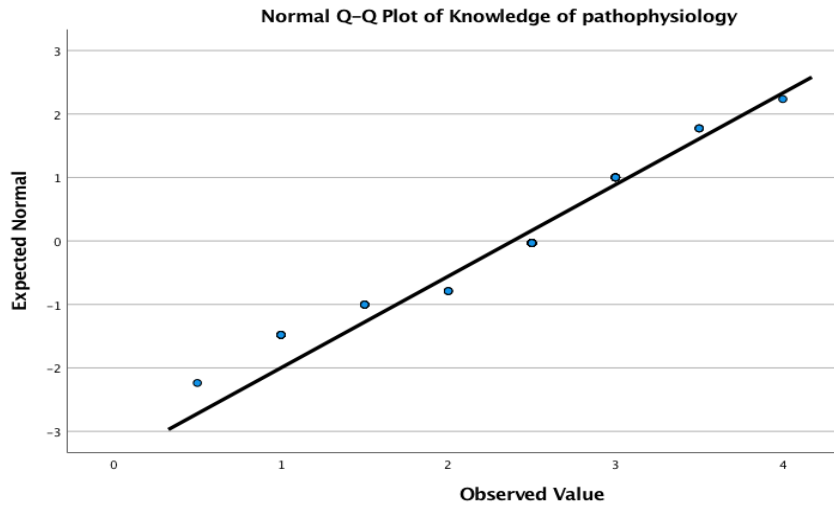
35.Is this statement True or False? Physiotherapy can be received even during NIV, not necessarily during 'NIV breaks'.

Tick all that apply.

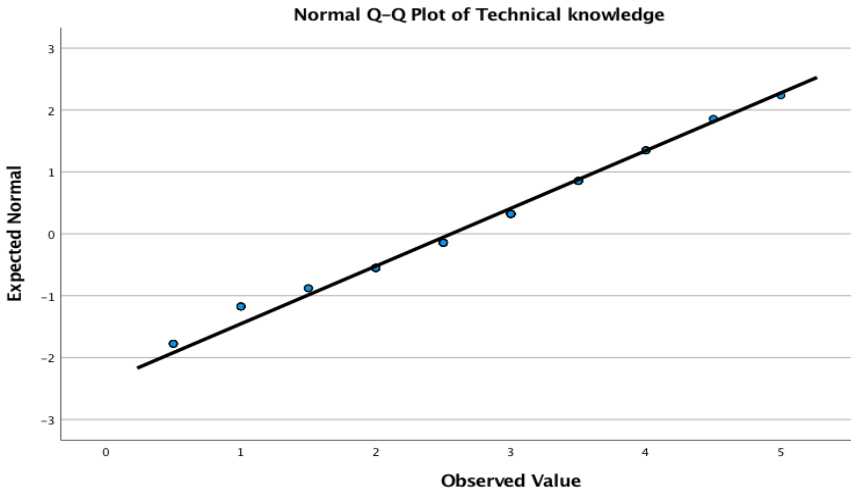
- True
- False

Appendix 18: Knowledge domains Q-Q plots

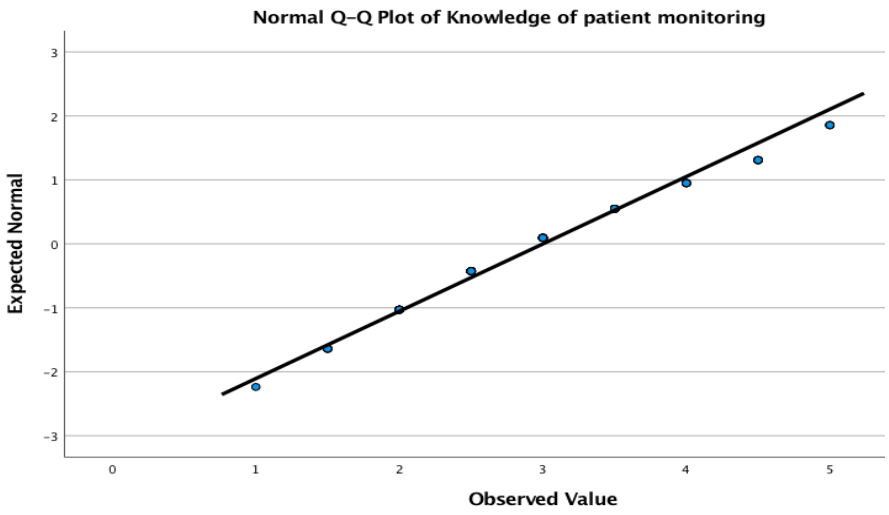
Pathophysiology knowledge domain distribution of knowledge score & normality Q-Q Plot graph



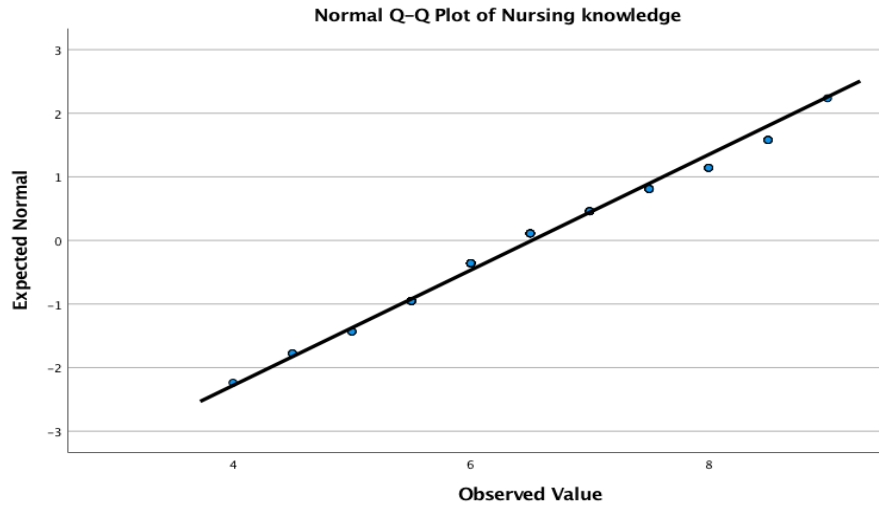
Technical knowledge domain distribution of knowledge score & normality Q-Q Plot graph



Monitoring knowledge domain distribution of knowledge score and normality Q-Q Plot graph



Nursing knowledge domain distribution of knowledge score & normality Q-Q Plot graph



Appendix 19: Table with individual questions scores

Total correct, incorrect and partially correct answers for each knowledge question

Domain	Question	Topic	Answer	Participant Frequency	Participant Percentage
Pathophysiology Knowledge	Q 1	Type 1 Respiratory Failure	Correct	13	16.7%
			Partially correct	50	64.1%
			Incorrect	15	19.2%
	Q2	Type 2 Respiratory Failure	Correct	61	78.2%
			Partially correct	3	3.8%
			Incorrect	14	17.9%
	Q3	Medical Conditions requiring NIV	Correct	9	11.5%
			Partially correct	67	85.9%
			Incorrect	2	2.6%
	Q4	Absolute Contra-indications	Correct	8	10.3%
			Incorrect	70	89.7%
Technical Knowledge	Q5	Expiratory Valve	Correct	16	20.5%
			Partially correct	48	61.5%
			Incorrect	14	17.9%
	Q9	Pressure support	Correct	40	51.3%
			Incorrect	38	48.7%
	Q17	Recommended interfaces	Correct	14	17.9%
			Partially correct	61	78.2%
			Incorrect	3	3.8%
	Q18	Straps application	Correct	29	37.2%
			Incorrect	49	62.8%
	Q19	NIV sequence	Correct	46	59%
			Incorrect	32	41%
Monitoring Knowledge	Q6	High flow alarm indications	Correct	18	23.1%
			Partially correct	29	37.3%
			Incorrect	31	39.7%

	Q7	Low flow alarm indications	Correct	16	20.5%
			Partially correct	18	23.1%
			Incorrect	44	56.4%
	Q8	Back-up rate meaning	Correct	16	20.5%
			Partially correct	44	56.4%
			Incorrect	18	23.1%
	Q10	Sings of NIV failure	Correct	12	15.4%
			Partially correct	64	82.1%
			Incorrect	2	2.6%
	Q11	Required NIV parameters	Correct	24	30.8%
			Partially correct	53	67.9%
			Incorrect	1	1.3%
	Q15	NIV therapy complications	Correct	10	12.8%
			Partially correct	68	87.2%
Nursing care Knowledge	Q12	Indication for weaning	Correct	37	47.4%
			Incorrect	41	52.6%
	Q13	Patient's recommended positions	Correct	15	19.2%
			Partially correct	58	74.4%
			Incorrect	5	6.4%
	Q14	Facial skin integrity measures	Correct	4	5.1%
			Partially correct	71	91.0%
			Incorrect	3	3.8%
	Q16	Palliative care	Correct	21	26.9%
			Incorrect	57	73.1%
	Q20	Nutrition	Correct	62	79.5%
			Incorrect	16	20.5%
	Q21	NGT indications	Correct	8	10.3%
			Partially correct	61	78.2%
			Incorrect	9	11.5%
	Q22	Eye care	Correct	6	7.7%
			Partially correct	65	83.3%

			Incorrect	7	9.0%
	Q23	Oral Hygiene	Correct	26	33.3%
			Incorrect	52	66.7%
	Q24	Patient mobility	Correct	19	24.4%
			Partially correct	48	61.5%
			Incorrect	11	14.1%
	Q25	Indications for suction	Correct	31	39.7%
			Partially correct	34	43.6%
			Incorrect	13	16.7%
	Q26	Comm - unication	Partially Correct	75	96.2%
			Incorrect	3	3.8%
	Q27	Physiotherapy indication	Correct	73	93.6%
			Incorrect	5	6.4%

Appendix 20: Table with excluded studies and reason for exclusion

Excluded Study	Reason for exclusion
Cherisn et al., (2019). *Improving Care of Patients on Non-invasive Ventilation in General Wards.*	Inclusion and exclusion criteria not clearly defined, and no tool validation process mentioned.
Moon-Sook et al., (2021*). The Effect of a Non-Invasive Positive Pressure Ventilation Simulation Program on General Ward Nurses' Knowledge and Self-Efficacy.*	The study analyzed perceived knowledge rather than actual knowledge
Goktas et al., (2017) *Effect of Provided Training Regarding Non-Invasive Mechanical Ventilation on the Knowledge Level of Nurses.*	The study was a comparison of a pre and post study focusing on the their difference, and statistical significance of the knowledge pre intervention could not be obtained
Ballard et al., 2010. *British Thoracic Society survey of knowledge of healthcare professionals managing patients with acute hypercapnic exacerbation of chronic obstructive pulmonary disease requiring non-invasive ventilation.*	Not enough information to critically analyse study. Additionally studied population included both nurses and doctors. Therefore nurses' knowledge could not be separately analysed.