DETERMINANTS OF SUPPLEMENTAL OXYGEN THERAPY COMPETENCIES AMONG NURSES WORKING IN PAEDIATRIC WARDS IN KAJIADO COUNTY, KENYA

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FEBRUARY, 2024

DECLARATION

I, Kiruja Gitonga Jason, declare that this research thesis is my original work and has not been presented for the award of any degree in any university or for any other award.

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DEDICATION

This research work is dedicated to my family.

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ABBREVIATIONS AND ACRONYMS

FIO2: Fraction of Inspired Oxygen

HFNHO: High Flow Nasal Humified Oxygen

KNBS: Kenya National Bureau of Statistics

MOH: Ministry of Health

PaCO2: The partial pressure of CO2 in arterial blood. Measures adequacy of ventilation.

PaO2: The partial pressure of oxygen in arterial blood. Measures adequacy of oxygenation.

PEEP: Positive end-expiratory pressure

ROP: Retinopathy of Prematurity

ROS: Reactive oxygen species

SAO2: Arterial oxygen saturation when measured by gas analysis. Hypoxaemia is SAO2 <60 mmHg

SOT: Supplemental Oxygen Therapy

SPO_2: Arterial oxygen saturation when measured by a pulse oximeter. Hypoxaemia is SPO2 <90%

WHO: World Health Organization

OPERATIONAL DEFINITIONS OF TERMS

Competence: Ability to apply the clinical oxygen administration clinical practice guidelines.

Determinants: A factor which significantly affects the outcome of a therapy.

Individual Nurse Factors: Nurse features especially; knowledge that determines nurse actions on oxygen

Hypercabia: Increased carbon dioxide concentration in the blood.

Hyperoxaemia: Increase in arterial oxygen partial pressure to a level greater than 120mmHg.

Hyperoxia: State of excess supply of oxygen in tissues and organs.

Hypoxaemia: Low levels of oxygen in the blood- (low oxygen saturation or content).

Hypoxia: Inadequate oxygen in tissues for normal cell and organ function.

Institutional factors: Circumstances created by the hospital management system that affect the availability of oxygen and oxygen delivery equipment.

Supplemental Oxygen: Is the oxygen used in medical treatment of hypoxaemia and hypoxia.

Paediatric Nurse: Registered or enrolled nurses, working in paediatric wards.

Pulse oximetry: Noninvasive method for detecting hypoxaemia by measuring the percentage of oxygenated haemoglobin in arterial blood.

Titration of oxygen: Slow adjustment of oxygen flow rate to achieve the desired SpO2 based on the patient's need. Increase flow rates by 0.5 l/min till every 20-30 minutes target SpO2 of 90-94% are achieved.

Weaning off oxygen: The gradual decrease in oxygen flow rate with an aim of eventually taking the patient off oxygen. Decrease the flow by 0.8-1Litres per minute every 15-30 minutes and assess patient status and SpO2

ABSTRACT

Hypoxaemia is common in paediatric patients and increases the risk of mortality fivefold in patients with varied diagnoses. Patients miss supplemental oxygen therapy or get inappropriate oxygen therapy due to a deficit of clinical knowledge and skills on supplemental oxygen therapy among nurses resulting in (impact). The main objective of this study was to establish determinants of supplemental oxygen therapy competencies among nurses working in paediatric wards in Kajiado County, Kenya. The research was a cross-sectional hospital-based survey**.** The study was carried out in the four main public hospitals in Kajiado County involving the 81 nurses who work in the paediatric wards. The 81 nurses were invited to the study and after consenting they filled a self-administered questionnaire. The questionnaires were clinical vignettes and direct questions**.** Responses from the questionnaires were cleaned and coded and then keyed into the SPSS version 27 computer programme for data analysis, the data was also coded in R studio statistical programme for further analysis. In the study 75.3% (n=55) of the nurses working in Kajiado County paediatric department, demonstrated competence in oxygen therapy while 24.7% (n=18) of the nurses working in paediatric wards in Kajiado County demonstrated less competence in oxygen therapy. There were gaps in knowledge and practice on oxygen therapy, not all nurses were able to make the correct diagnosis of hypoxaemia and hypoxia and selecting the right oxygen dosage. This indicates the need for continued in-service training of all cadres of nurses on oxygen therapy.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter dealt with the background of the study, statement of the problem, and purpose of the study. It also looked at the Research Objectives, Research Questions, significance of the study and highlighted the scope and limitations of the study.

1.2 Background of the Study

Respiratory infections account for 15% of the global under under-five demise, with the majority of these deaths being reported in developing countries (Bénet *et al*., 2017). Hypoxaemia is a common complication in childhood respiratory infections and is associated with a high risk of death. Failure to detect hypoxaemia leads to delay in treatment, tissue hypoxia and ultimately leads to irreversible organ damage (Walsh & Smallwood, 2017). Clinical signs can be used in combination with pulse oximetry to detect hypoxaemia (Graham *et al*., 2019).

Oxygen is the main therapy used in the treatment of hypoxaemia, and the therapy needs to be delivered to the patient in the right dose and in the correct method (Rudd & Helmerhorst, 2019). The method selected to administer oxygen, depends on the patient's clinical state, the amount required and its availability (Walsh & Smallwood, 2017). Healthcare workers need to know when oxygen is needed, know how much oxygen is needed, the right oxygen dispensing equipment, to help select the best way to administer the oxygen to the specified patient (Hardavella *et al*., 2019). Correctly administered oxygen therapy results in faster recovery and shorter hospital stay (Newland *et al*., 2019).

Though there have been guidelines in oxygen therapy, global reports indicate that prescription and administration of oxygen has always led to poor results (Al-Otaibi,

2019). Reports have also placed nurses at the core of oxygen therapy and therefore their competence in oxygen therapy has always been considered to play an important role in ensuring effectiveness and efficiency. For instance, in England, only 36% of children under oxygen therapy received that which matched the required prescription putting the children under risk (Franklin, Babl & Schibler, 2021). To address this, registered nurses have been considered to be vital for successful administration of oxygen therapy and have been required to undertake training (formally and informally) in addition to the government addressing other external factors that may affect their competence in oxygen therapy such as issues related to their motivation when working with children under critical care and in need of oxygen therapy (Hvidberg *et al.,* 2021). New Zealand reports on the other hand noted that a third of the children received the oxygen therapy not matching prescription with 75% of the prescriptions being inadequate (O'Brien *et al.,* 2022).

Nigeria reports high mortality rates for children under 5 years with an estimated mortality rate of 104.3 children under 5 years per every 1000 live births (Bakare *et al.,* 2020). Further, pneumonia is ranked as the top killer of children under 5 years in Nigeria. For instance, in 2017, 19% of children died as a result of pneumonia (Graham *et al.,* 2019). With the government having recognized pneumonia as a killer disease in children, oxygen therapy is regarded as an important method of reducing deaths related to pneumonia in childhood. Nigerian government has emphasized on healthcare workers' skills, experience and knowledge in oxygen therapy as a priority to enhance their competency in hypoxaemia recognition, oxygen therapy administration, monitoring and treatment (Bakare *et al.,* 2020).

According to Gebre *et al.,* (2022), one of the leading mortality and morbidity causes in children below 5 years in Ethiopia is acute respiratory infection, specifically pneumonia. It is responsible for approximately one fifth of deaths of children under five years. Further, hypoxaemia is regarded as the main risk factor as a result of pneumonia in children and is observed in more than 20% of the children in Ethiopia. This positions oxygen therapy among the top treatment methods in Ethiopian hospitals. Further, Jamie (2021) noted that nurses in Ethiopia are considered as the core healthcare personnel in oxygen therapy administration. As a result, their oxygen therapy competence has been prioritized in order to reduce deaths related to hypoxaemia in children. Factors such as the nursing training curriculum, institutional factors and hospital related factors that may affect their expertise and competence in oxygen administration have been put into consideration so as to ensure that nurses in Ethiopia are at their best during oxygen therapy treatment in children.

In a study conducted in Kigali, Rwanda, Rudd and Helmerhorst (2019) demonstrated that avoiding under treatment and overtreatment of hypoxaemia resulted in reduced oxygen usage in the hospital. In Uganda, especially the eastern region of Uganda, there are large numbers of hypoxaemia deaths in children aged 5 years and below due to pneumonia severity. In order to reduce these deaths, most hospitals in this region have increased their oxygen supply. Despite this, there are other challenges associated with effective oxygen use. Key among the challenges is gaps in training for the nurses administering the oxygen and lack of clear protocols on how and when to administer oxygen, oxygen use monitoring and the time to stop therapy (Nabwire, Namasopo & Hawkes, 2018).

Paediatric nurses competency in oxygen therapy, enhanced efficiency in oxygen utilization and helps in reducing the shortfall in oxygen supply in Kenyan hospitals (Nabwire *et al*., 2018). Competence in supplemental oxygen therapy is enhanced by use of reference clinical guidelines, as they lead to precise prescription of oxygen therapy, resulting to few undesired therapy outcomes (Kalil *et al*., 2016). However, there are no studies that have been carried out in the area of study that document determinants of supplemental oxygen therapy competencies among nurses. Therefore, this study was aimed at establishing the determinants of supplemental oxygen therapy competencies, among nurses working in paediatric wards in Kajiado County, Kenya.

1.3 Statement of the Problem

Globally acute respiratory infections causing hypoxaemia, account for approximately one million deaths (Troeger *et al*., 2018). Hypoxaemia increases the risk of death in children four-fold (Lazzerini *et al*., 2015). More than 13% of admitted children in low-income countries, have low oxygen saturations and require oxygen therapy (Graham *et al.*, 2019). Kajiado County Health assessment report shows that the county has 67% of hospital visits being attributed to acute respiratory infections, coupled with a 40% malnutrition rate most of the infections could get to the severe form of disease requiring oxygen therapy (Ministry of Health, 2018). Mathematical models have shown in some centres, up to 50% of sick admitted children could be having undetected hypoxaemia and therefore untreated hypoxaemia (Bassat *et al*., 2016). One of the most often recommended treatment strategies for hypoxaemia in acute care settings worldwide is oxygen therapy. Insufficient blood oxygen levels, or hypoxaemia, are a severe condition that often arises from illnesses such as severe pneumonia or bronchiolitis, upper airway obstruction, severe asthma, common neonatal conditions like respiratory distress syndrome and birth asphyxia, severe

sepsis, heart failure, cardiac arrest, trauma, carbon monoxide poisoning and obstetric and perioperative emergencies (Grieco *et al.,* 2021). Children who are hypoxemic often exhibit symptoms such as nasal flaring, strider, grunting, tachypnea, hypotension, subcutaneous emphysema, and tachycardia (Gugsa, 2021). Supplemental oxygen therapy is regarded as a life-saving measure and first-line therapy for the treatment of documented hypoxaemia in critically unwell children. But the way things are done now often leads to hyperoxaemia, which is linked to bad hospital outcomes and higher mortality in children. Health care providers, specifically nurses that possess the necessary training, the appropriate mindset, and evidence-based practice in oxygen treatment are necessary for the safe, efficient delivery and monitoring of oxygen therapy (Karlis *et al.,* 2020). Numerous criteria, such as the patient's age, treatment goals, hospital factors, health care workers' characteristics and level of tolerance, influence the choice of the optimal oxygen delivery device and oxygen flow rate (Gottlieb *et al.,* 2022). Specialized nursing care is required for oxygen therapy in order to enhance patient outcomes and avoid problems. Even though professional practice guidelines advise prescribing oxygen like any other medication, oxygen is frequently given excessively, selectively, without a prescription, and to patients who appear to be experiencing dyspnea (Lacasse *et al.,* 2022). When used appropriately, oxygen treatment has several benefits. Nevertheless, in addition to its therapeutic benefit, when done incorrectly, it has serious negative repercussions. As a result, the nurses must be sufficiently knowledgeable and possess the necessary requirements about oxygen therapy. In Kenya, there is scanty research on determinants of supplemental oxygen therapy competencies among nurses. The focus of this study will therefore be to establish the determinants of supplemental oxygen therapy competencies among nurses working in paediatric wards in Kajiado

County, Kenya.

1.4 Justification of the Study

Oxygen has been known as a lifesaving gas and has been used in treatment of respiratory infections, in surgery and in treatment of other life-threatening health problems. The Covid 19 pandemic has increased the global demand for oxygen calling for the need to use this scarce medical commodity effectively and efficiently. Previous studies have demonstrated gaps in knowledge and skills of nurses in the recognition of hypoxaemia and in the correct use of oxygen in treatment of hypoxaemia. This study aimed at measuring the determinants of oxygen therapy competences of nurses working in paediatric units in Kajiado County Hospital, Ngong Sub-County hospital, Kitengela Sub-County hospital and Loitokitok Sub-County hospital.

An understanding of the determinants of nurses' competencies in oxygen therapy in children will be beneficial to different stakeholders. First, the findings of the study will benefit the nurses and hospitals since it will unearth the competence levels of the nurses in oxygen therapy. This will help them in addressing the skills gap in oxygen therapy and thus minimize hypoxaemia related mortality. The study will also be of benefit to policy makers in health. By understanding the determinants of oxygen therapy competencies, specifically the institutional determinants, the policy makers will be in a position to come up with policies to address some of these factors and improve the overall efficiency in oxygen therapy. The study advances knowledge on determinants of oxygen therapy competencies among nurses. Scholars, academicians and researchers will therefore benefit as the findings of the study will form a basis upon which they can further the research on oxygen therapy. The study will also act as a reference for other scholars, researchers and academicians.

1.5 Research Objectives

1.5.1 General Objective of the Research

To establish determinants of supplemental oxygen therapy competencies among nurses working in paediatric wards in Kajiado County, Kenya.

1.5.2 Specific Objectives of the Research

i. To determine individual factors that influence paediatric nurses' competence in supplemental oxygen therapy in Kajiado County, Kenya.
ii. To determine the institutional factors that influence competence of paediatric nurses in administration of supplemental oxygen therapy in Kajiado County, Kenya.
iii. To measure the competence of paediatric nurses in the administration of supplemental oxygen therapy in Kajiado County, Kenya.
iv. To establish the relationship between the individual, institutional factors and paediatric nurses' competence on supplemental oxygen therapy in Kajiado County, Kenya.

1.6 Research Questions

i. What are the individual factors that influence paediatric nurses' competence in supplemental oxygen therapy in Kajiado County, Kenya?
ii. What are the institutional factors that influence competence of paediatric nurses in administration of supplemental oxygen therapy in Kajiado County, Kenya?
iii. What is the competence of paediatric nurses in the administration of supplemental oxygen therapy in Kajiado County, Kenya?
iv. What is the relationship between the individual, institutional factors and paediatric nurses' competence on supplemental oxygen therapy in Kajiado

County, Kenya?

1.7 Significance of the Study

The World Health Organization (WHO) has listed oxygen among the essential drugs so as to enhance access and utilization of oxygen in treatment of hypoxaemia in children (WHO Updates Essential Medicines List, 2017) . The findings of the study highlighted gaps in skills, knowledge, and procurement of oxygen administration among Paediatric nurses in Kajiado County, Kenya. Highlighting the gaps in oxygen therapy may inform design of educational programs focusing on training to increase efficiency and safety of oxygen administration medically. It will also inform policy on training and clinical practice guidelines, to ensure safe–oxygen delivery to the paediatric patients in Kajiado County, Kenya. The findings of the study will help in designing strategies and policies that may improve the utilization of scarce medical gas by providing data and information on oxygen use and administration.

1.8 Scope of the Study

The study assessed the determinants of supplemental oxygen therapy among nurses working in paediatric wards of Kajiado County. The study covered oxygen therapy competencies and practices among paediatric nurses in four public hospitals in Kajiado County. The theoretical scope for the study was Donabedian’s Quality framework. The geographical scope was Kajiado County’s paediatric wards. The target population for the study was 81 nurses working in paediatric wards of Kajiado County.

1.9 Limitations of the Study

The research involved data collected by use of self-administered questionnaires. The self-reported data may have had bias in that some aspects of the responses were not independently verified, and this may have compromised the reliability of the

questionnaires. The study focused on competence in supplemental oxygen therapy administration, among nurses and the findings from the study may not apply to other health care professionals. Kajiado County has a total population of 81 nurses who work in the paediatric wards making the study population small.

1.10 Conceptual Framework

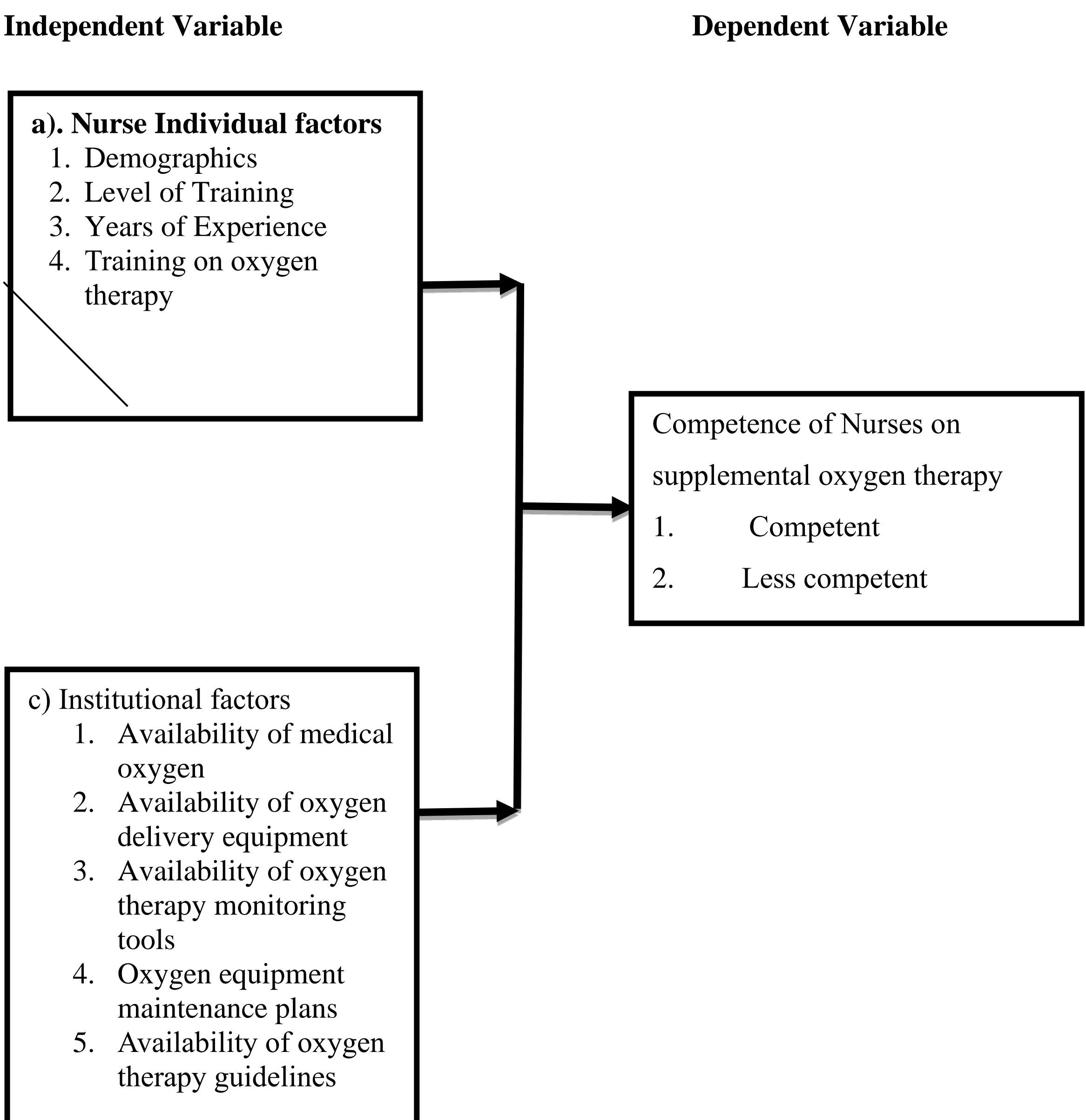

Figure 1.1: Conceptual Framework
Source: Berwick & Fox, 2016

The dependent variable was measured by tabulating the nurses in knowledge, practice and attitude questions leading to nurses being categorised as competent or less competent depending on the score achieved.

1.11 Theoretical Framework

The research study was guided by Donabedian's Quality framework (Figure 1.2). It is a model used to understand the links in the structural, process and outcome concepts used in quality assessment (Moore *et al*., 2015). The structures are the resources available for provision of care, the processes are the care activities performed, and how they interact to bring about the desired health outcomes. The care structure included facilities, equipment, personnel, operational and financial process that support new born care (Edwards *et al.,* 2020). The research was determining the influence of availability of oxygen equipment and training as part of structures on interventions like recognition of hypoxaemia, selection of the right oxygen delivery equipment, monitoring and adjusting oxygen levels as processes in oxygen therapy with the safe administration of oxygen being the health outcome.

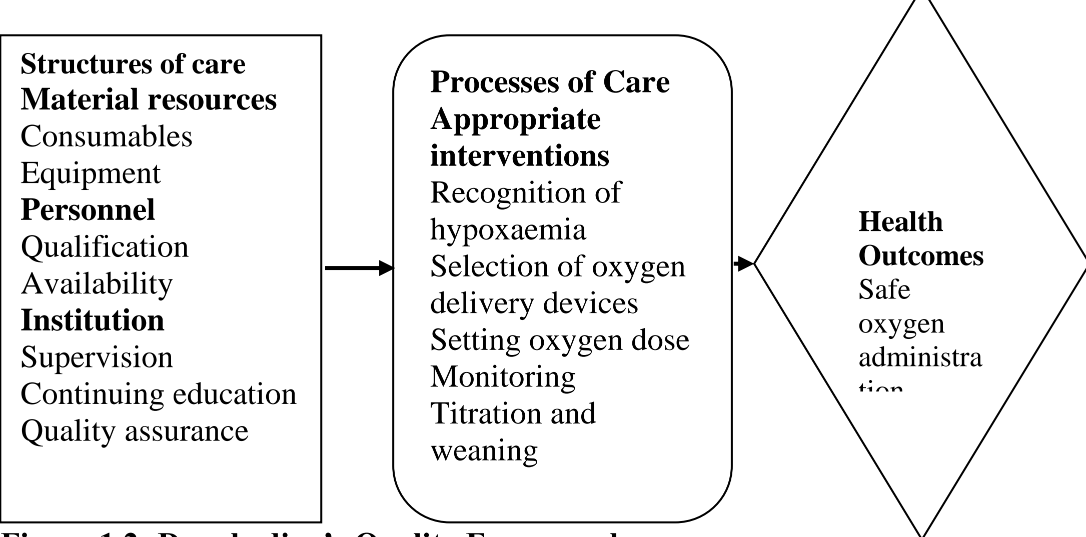

Figure 1.2: Donabedian's Quality Framework
Source: Moore *et al.,* (2015)

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Hypoxaemia is common in severely ill patients ,with or without primary lung disease and increases significantly the risk of death (Grimaldi *et al*., 2018). One Kenyan study showed a five-fold increase in mortality rate in children with hypoxaemia when collated with children with normal oxygen level (Maitland *et al*., 2018). Treatment of hypoxaemia requires a systematic assessment of patients using clinical signs, SaO_2, SPO_2 and administration of oxygen (Flower & Martin, 2020). The WHO guides that oxygen therapy in children, should be started when the SpO_2 is less than 90% on pulse oximetry and oxygen saturation to be maintained between 92% (Langley & Cunningham, 2017) and 98% to avoid hypoxaemia and hyperoxemia (Lellouche & L'Her, 2020). Hyperoxia causes tissue injury in multiple organs through generation of reactive oxygen species (ROS) ,which overwhelm the body's antioxidants leading to cell death and fibrosis (Vincent *et al*., 2017). In Kenya, according to the MOH basic paediatric protocols, oximetry levels are used to classify and guide treatment of acute respiratory infections.

2.2 Theoretical Review

The Donabedian's quality model was used to inform the conceptual framework in the proposed study. The model uses system thinking whereby, different components work to achieve a specified outcome (Guta, 2022). Donabedian points out the need to unceasingly assessment of the health care process and gives extra focus on the working of health care workers (Berwick & Fox, 2016). The Donabedian model guides assessment of structures and processes with a view to initiating quality improvement activities and having better clinical outcomes (Binder *et al*., 2021).

Focusing on improving the equipment available for care and having an efficient diagnosis process greatly improves patient satisfaction and health outcomes (Ameh *et al*., 2017). The Donabedian model was used and aimed at guiding the study in the development of data collection tools to ensure collection of data on structures and processes.

2.3 Empirical Literature

2.3.1 Individual Factors that Influence Paediatric Nurses' Competence in Supplemental Oxygen Therapy

Nimbalkar *et al.,* (2023) conducted a study in India and evaluated the competence of medical and nursing personnel in oxygen therapy. Through assessing their knowledge on oxygen therapy, the personnel's competency was evaluated. The study found significant differences in the personnel's oxygen therapy competence with their training. Nurses who had informal therapy training were found to be more competent in oxygen therapy as compared to those who had formal training. The study recommended that formal training in oxygen therapy should be practical-based so as to equip medical personnel with the most relevant competences in oxygen therapy.

In a Turkish study, the competency of nursing students in oxygen administration was assessed in intensive care units hosting newborns by Al *et al.,* (2019). Overall, the nursing students were found to be knowledgeable in oxygen administration to newborns. The study further found significant differences in oxygen administration competency based on gender of the students. Female students were found to be more competent as compared to male students. No significant difference was found in competency based on experience and the nursing students' interests to work in neonatal units.

Younas *et al.,* (2023) conducted a study in Pakistan to establish the factors associated with nurses' oxygen therapy competency in critically ill patients. Through a descriptive cross-sectional study in one of the select hospitals in Pakistan, the study found that the nurses selected for the study had good competence levels measured in terms of their knowledge in oxygen therapy. The study further found that there was a significant relationship between competence and experience. However, gender, qualification and age had no significant association with nurses' competence in oxygen therapy in critically ill patients.

Kalpana *et al.,* (2021) conducted a study in Nepal so as to establish the competence of nurses in oxygen therapy and the associated socio-demographic determinants. Majority of the nurses were found to have unsatisfactory oxygen therapy competence. The study further revealed that age, status of education and experience of the nurses had a significant influence on nurses' competence in oxygen therapy.
A study conducted in Ethiopia, South Gondar Zone, by Demilew *et al.,* (2022) evaluated the demographic factors that determine health professionals' competence in oxygen therapy. Competence was assessed in terms of knowledge, attitude and practices. According to the results, health professionals' training and experience were significantly related to their competence in oxygen therapy.

In a Tanzanian study, Kimario, Ambikile and Iseselo (2023) evaluated the competence of nurses in oxygen administration in critically ill patients. Competence of the nurses was evaluated by assessing their knowledge and practices. The study found that close to a half of the nurses had poor competence in oxygen administration to critically ill patients. Education and experience of the nurses were found to have a significant effect on their competence in oxygen administration. Nurses with higher professional

education and short experiences were found to have higher competence.

2.3.2 Institutional Factors and Nurses' Competence on Supplemental Oxygen Therapy

Aloushan *et al.,* (2019) conducted a study in Saudi Arabia, Riyadh City. The study was conducted in emergency departments to evaluate health professionals' competence on oxygen therapy. Competence was assessed in terms of knowledge, attitude and practices of the health professionals. The study generally found that the health professionals' knowledge, attitude and practices were associated with hospital workload and availability (or lack of) hospital guidelines on oxygen therapy.

In Ethiopia, Getahun *et al.,* (2022) assessed the barriers towards nurses' practice in oxygen therapy. Half of the nurses sampled were found to have good practices in oxygen therapy. Among the factors identified to affect oxygen therapy practice in nurses, equipment was found to be significant. Hospitals will well labeled oxygen therapy equipment were found to have their nurses being more competent in oxygen therapy practice. The study found that hospital guidelines and workload as not being significant determinants of oxygen therapy practice in nurses.

In the entire Sub-Saharan Africa context, Stein *et al.,* (2020) noted the importance of oxygen in hypoxaemia treatment but established that its inadequate supply in the low income countries of Sub-Saharan Africa is a hindrance to nurses' practice in oxygen therapy. In an Egyptian study, Mayhob (2017) evaluated nurses' competence in oxygen administration in terms of their knowledge and practices. The study further established barriers to their practice in oxygen administration and found that protocol unavailability, substandard maintenance of oxygen therapy equipment and incomplete and unclear written oxygen therapy prescription as the significant institutional factors

affecting oxygen therapy competence in nurses.

In Malawi, Cashman (2017) evaluated hospital related factors affecting oxygen therapy in hospitals under the category of low-resource facilities. The study found that oxygen therapy competence by nurses was affected by functionality and longevity of oxygen therapy equipment, over-reliance on donated equipment that quickly break due to over-use before donation, lack of user manuals and unavailability of repair and maintenance spare parts. The study further found availability of staff, insufficient funds and insufficient electricity supply were also significant determinants of oxygen therapy competence.

An integrated review by Jun *et al.,* (2016) revealed that printed instructions and training are important tools for high impact on the quality care the patients receive from the healthcare workers. Prior training, availability of the guidelines in the right format, perceptions, and an improved organizational culture, are some of the factors that influence utilization of evidence based clinical practice guidelines (CPGs). The review further revealed that provision of medical diagnostic equipment, needs to be followed by training for better use of the apparatus.

2.3.3 Measuring Competency of Nurses

Measuring competence of nurses has been demonstrated by use of knowledge assessment, practice assessment and attitude assessment can be used to measure nurses competence in oxygen therapy Demilew *et al*., (2022) to ensure nurses are performing evidence based practices (Kaseka & Mbakaya, 2022).

2.3.3.1 Principles of Safe Oxygen Therapy

Oxygen is known to be a lifesaving medication and use of oxygen has been used liberally with healthcare workers, not worrying about oxygen overdose. To administer oxygen safely; follow guidelines on oxygen indication, use appropriate oxygen

delivery equipment, monitor oxygen levels closely and titrate oxygen delivered to achieve the recommended saturation levels (Weekley & Bland, 2021). A meta-analysis done by Cousins *et al.,* (2016) points out that unsafe oxygen administration is caused by a lack of knowledge on the use of oxygen delivery equipment, a high rate of staff changes, lack of knowledge on the adverse effects of giving high concentration of oxygen and lack of training and mentorship on oxygen therapy. Oxygen supply by use of oxygen cylinders was available only in 30% of the hospital studied in East Africa, other hospitals were relying on oxygen concentrators (Maitland *et al*., 2018). Uncontrolled use of oxygen resulting in a high concentration of oxygen in blood causes harm to patients (Damiani *et al.*, 2018). Oxygen prescription has been found to be unsafe with inadequate information of the equipment to be/being used, the flow rate, the FiO2 to be delivered and targeted Spo2 to be achieved showing a gap in the right dose among the rights of medicine administration (Devoe *et al*., 2021). The safe administration of oxygen should be guided by correct diagnosis of hypoxaemia, followed by a prescription which specifies the correct oxygen delivery equipment to use, the flow rate depending on the delivery equipment and continuous need to monitor and adjust oxygen dosage (Rolfe & Paul, 2018). Compressed medical oxygen (CMO) is delivered to hospital units by use of highly pressurized oxygen cylinders, which when improperly handled, could fall and explode resulting in severe injuries and burns (Bikkina *et al*., 2020).

2.3.3.2 Hypoxaemia Recognition

Using clinical signs independently to detect hypoxaemia, results in patients with hypoxaemia being missed and patients without hypoxaemia, being treated with oxygen (Weid *et al*., 2018). Pulse oximetry is critical in the detection of hypoxaemia

and especially the 'silent hypoxaemia' whereby, the clinical signs that depict hypoxaemia are not elicited (Jouffroy *et al*., 2020). Pulse oximeters can pick 30% more cases of hypoxaemia than using clinical signs. In Kenya, the use of pulse oximeters is not consistent ,indicating possibility of many children with hypoxaemia not getting the right treatment (Enoch *et al.*, 2019). Knowledge on application of pulse oximeters and knowledge on factors like; low perfusion, anaemia and carbon monoxide poisoning, that make pulse oximeters to give unreliable reading was found not to be acquired through more years of clinical experience, but by updated pre-clinical and clinical teaching (Seeley *et al*., 2015). Health care workers in Low Income countries (LIC) pointed out pulse oximetry as valuable equipment for quick detection of patients with hypoxaemia and also for continuous monitoring of patients (Baker *et al.,* 2021). The hurdles of need for recharging batteries and replacing probes can be overcome by scheduled maintenance plans (King *et al*., 2018).

2.3.3.3 Oxygen Delivery Methods and Equipment

Medical-grade oxygen needs to achieve a concentration of pure oxygen of 82% and should not have contaminants (WHO, 2020). A study in 231 hospitals in Africa, found 56% of the hospitals had interruptions in oxygen supply (Maitland *et al*., 2018). In Kenya, Barasa *et.al.,* (2020), found out that hospitals have a shortage in the amount of oxygen available to provide critical lifesaving treatment.

Oxygen delivery devices like nasal prongs and oxygen masks need to be matched with levels of oxygen demand for each patient and health care workers ,need to have access to the different types of devices (Hardavella *et al*., 2019). There is need to create awareness among the health care workers on availability of the different oxygen delivery equipment, the best method of using them and the amount of oxygen levels

required to obtain best results (Hardavella *et al.*, 2019). The oxygen delivery equipment used should be dependent on the amount of inspired oxygen (FIO_2) at the baby airways (Yanez *et al*., 2020). The use of a wrong device could lead to distress, with dosage targeted oxygen not being achieved. Wrong oxygen equipment may lead to accumulation of carbon dioxide in the blood and this can be detrimental to the baby (Herren *et al*., 2017). The provision of the essential medical merchandise, influences the excellence of care offered to sick children (Hosheh *et al*., 2020). The two main devices used in delivering oxygen to sick children are nasal prongs and non-rebreather masks. Hence, the need to establish the availability of the two in County and Sub-County hospitals. In respiratory distress there is need to improve alveoli ventilation and having systems like CPAP's help in improving alveoli ventilation by using higher positive end-expiratory pressure [PEEP] (Flower & Martin, 2020). High flow nasal humidified oxygen (HFNHO) is also another promising method of delivering oxygen to patients and also providing a high PEEP. The assessment of the accessibility of therapeutic equipment within the hospital and making sure that unavailability is addressed would then mean quality of care delivered (Hoshe *et al*., 2020). This implies that, there should be continuous assessment and improvement of the medical facilities.

When clinical guidelines are adhered to, the accurate medical therapies offered, leads to improved and effective care, reducing cases of undesired therapy outcomes (Kalil *et al*., 2016). A study by Morgan *et al*., (2018) shows that Kenyan hospitals have not been able to achieve the required neonatal therapeutic levels, although the treatment for hypoxaemia is available and sick children receive oxygen. There was no clear indication in the study whether oxygen therapy guidelines were available in the hospitals.

2.3.3.4 Nurses Role in Oxygen Therapy

Correct administration of oxygen by nurses depends majorly on nurses own knowledge of individual patients oxygen needs and to a lesser extent by the prescription (Bunkenborg & Bundgaard, 2019). Prescription of oxygen by clinical teams has been routine without considering individual patient oxygen needs, leading to longer duration of treatment and use of higher than needed oxygen. This has been attributed to worse patient outcomes (Cousins *et al*., 2016). Prescription and administration of oxygen needs to be a balance between giving oxygen liberally and controlling oxygen levels strictly ,to achieve targeted oxygen saturations (Srinivasan & Panigrahy, 2021). Prescription and administration of oxygen needs to be a balance between giving oxygen liberally and controlling oxygen levels accurately, to achieve targeted oxygen saturations (Srinivasan & Panigrahy, 2021). Improvement in clinical presentation and easing in the work of breathing is the key trigger to start weaning a child off oxygen, there was a lower incidence of retinopathy of prematurity in babies where gradual weaning of oxygen was done, as opposed to abrupt weaning (Cherian *et al*., 2014). Monitoring and documentation of vital signs, pulse oximetry and oxygen flow, enables paediatric nurses to monitor patients over time to identify patients who are deteriorating or improving and are able to titrate the oxygen flow, or start weaning the patient off oxygen (Lellouche & L'Her, 2020). To prevent hyperoxia in recovering patients ,there is need to have a systematic way of weaning the patient off oxygen and administer the lowest possible FiO_2 to maintain oxygen saturation at 92% (Ouanes *et al*., 2021). In a Rwandan hospital 81% of hypoxemic patients were either receiving lower oxygen concentration than they needed, or higher concentration of oxygen than they needed hence the need to keep titrating and weaning off oxygen (Sutherland *et al*., 2019).

A study carried out in Britain on sending updates and oxygen material to paediatric nurses through their email addresses and sticking cards with therapeutic oxygen ranges near the patient's bed, found out that these were some of the cost-effective ways which were able to improve oxygen prescription. A recommendation by Choudhury *et al.,* (2018) was that the two approaches could achievable in low-income countries. Clinicians and nurses can improve patient safety while receiving oxygen therapy by documenting the oxygen requirement, monitoring of treatment and documentation of unresolved therapy concerns. The nurses therefore, need to be empowered by these guidelines to detect need for oxygen, start patient on oxygen or change dosage of oxygen delivered by observing vital signs, including pulse oximetry (*Clinical Guidelines (Nursing) : Oxygen Delivery*, 2019).

2.4 Summary of Literature Review

For oxygen to be used effectively and efficiently in treatment of hypoxaemia, there is need for correct diagnosis of hypoxaemia, selecting the best oxygen delivery equipment to give the required FiO2, oxygen being saturated, monitoring of the targeted SPO2 and documentation of the therapy process.

2.5 Research Gap

There is paucity of literature on capabilities of paediatric nurses in Kajiado County to detect hypoxaemia and administer oxygen correctly and safely indicating a gap in research in Kajiado County. Oxygen is delivered to hospitals wards through a piped system from bulk storage, use of portable oxygen cylinders and use of concentrators. The study aimed at determining the knowledge, the practice and attitude of paediatric nurses in Kajiado County in recognizing need for oxygen, administering oxygen in the right dose and monitoring oxygen use. The study was to determine factors that influence competence of nurses in oxygen therapy.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This chapter described the methodology that was used in the study. It formed a framework for specifying the relationships among the study variables and covers various aspects of the target population, sampling methodology, data collection procedure and methods, and data analysis.

3.2 Research Design

The study was a cross-sectional hospital-based survey. The design allows for a one-time collection of data. Cross-sectional based surveys are quantitative-based designs seeking to collect data from respondents at one point in time with the purpose of measuring the link between the dependent and independent variables. Cross-sectional surveys in most cases utilize surveys or questionnaires in data collection (Brown, 2017). Cross-sectional surveys also enable researchers to establish the prevalence of an attribute at a given time moment (Connelly, 2016). The design was appropriate in this study since it allowed collection of data on paediatric nurse's knowledge and practices, assessment of facility structures and availability of guidelines these being the independent variables. It is expected that nurses need to always provide safe care.

3.3 Study Area

The study was carried out in four hospitals in Kajiado County. Ngong Sub-County hospital in Kajiado North Sub-County, Kitengela Sub-County hospital in Kajiado East Sub-County, Loitokitok Sub-County hospital in Kajiado South Sub-County and Kajiado County Hospital in Kajiado Central Sub-County. The four hospitals are the main public hospitals attending to approximately 49% of the county population. Kajiado County is in the South Western part of Kenya. The County borders; Nairobi, Machakos and Makueni Counties to the North Eastern Side, Kiambu and Nakuru

counties to the North and North Western side, Taita-Taveta County to the Eastern side, Narok County to the Western Side and the Republic of Tanzania to the Southern Side. Kajiado County has a total of 309 health facilities 93 of the health facilities are public. The county covers an area of approximately 21,902 square kilometers and has approximately 1.1 million people based on the KNBS 2019 census. Kajiado County being in the Nairobi metropolis receives patients from other counties and from across the border from Tanzania. Kajiado County has 70% of the population being rural with livestock and crop farming being the main economic activities with majority of the households using wood fuel.

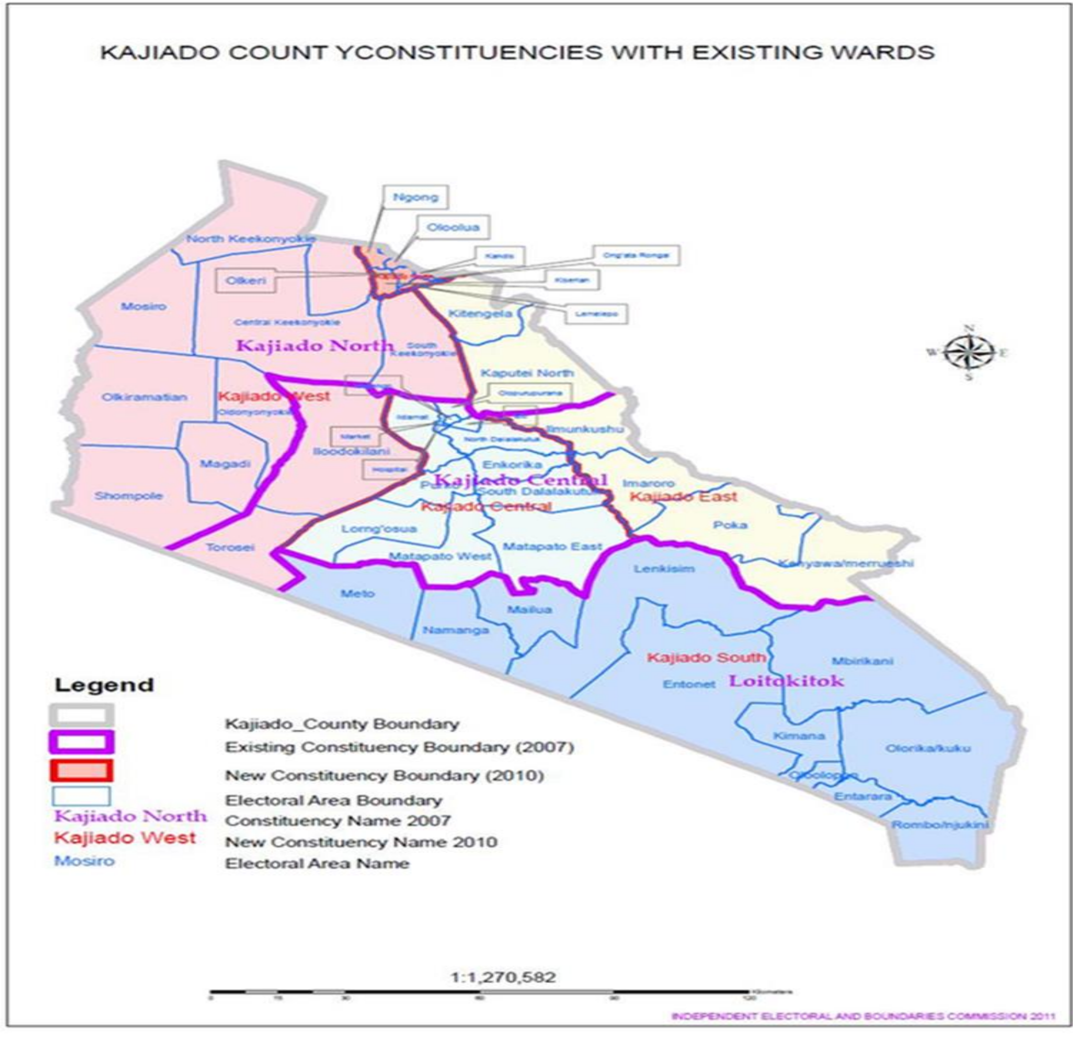

Figure 3.1: Map of Kajiado Showing Local Administrative Areas

The reason for picking Kajiado as a study area is because the area has many children being affected by respiratory diseases and oxygen dependency hence the need to identify whether the nurses are able to supplement oxygen correctly.

3.4 Study Population

The study involved the 81 nurses working in paediatric wards in Kajiado County. The nurses were the preferred sample for this study since they give direct care and have more medical interaction with patients than other cadres of hospital staff. Hence, this study sought to understand their competence in oxygen supplementation therapy. Kajiado County hospital has 30 paediatric nurses, Ngong Sub-County has 15 paediatric nurses, Kitengela Sub-County hospital has 22 paediatric nurses and Loitokitok Sub-County hospital has 14 paediatric nurses. All the nurses who consented were included in the study.

3.5 Inclusion and Exclusion Criteria

3.5.1 Inclusion Criteria

Registered or enrolled nurses working in Kajiado County hospital, Ngong Sub-County hospital, Kitengela Sub-County and Loitokitok Sub-County hospital paediatric wards for more than four (4) weeks.

3.5.2 Exclusion Criteria

Nurses who are in training and who have worked in Kajiado County hospital, Ngong Sub-County hospital, Kitengela Sub-County and Loitokitok Sub-County hospital paediatric wards for less than four (4) weeks.

3.6 Sampling Technique

A consecutive sampling was used. This sampling method is a process of including all available participants who satisfy the inclusion criteria. The study employed the consecutive sampling method whereby all nurses working in paediatric wards of the

four study hospitals and meeting the inclusion criteria were invited to participate in the study voluntarily. This was preceded by enumeration of all members of the population. Therefore, all the 81 nurses working in paediatric wards in Kajiado County were invited to participate in the study as they had met the inclusion criteria.

3.7 Study Instruments

Self-administered structured questionnaires with clinical vignettes (appendix II) were used to assess nurses' knowledge on hypoxaemia, recognition and supplemental oxygen administration. The questions in the questionnaire were adapted from pool of validated questions from a study by Desalu *et al.*, (2022) and in line with the WHO Oxygen Therapy for Children booklet 2016. Clinical vignettes are important, since they give a summary of pertinent account, physical checkup discoveries, investigation data and treatment. The responses from the clinical vignettes were scored using a preset marking key derived from the WHO oxygen therapy guidelines and validated study tools. Availability of oxygen delivery equipment was assessed by use of a checklist adopted from WHO health facility readiness assessment tools. Questionnaires were distributed and the researcher filled in the checklist. The name of the hospital represented was indicated in both the questionnaire and the skills checklist. Data from the questionnaires and the skills checklist was checked for completeness and tallied.

3.8 Pre-Testing

Pre-testing was carried out among paediatric nurses working in Machakos County. Machakos borders Kajiado County and there is cross referral of patients between the counties. The pre-test involved 23 respondents from Machakos County, representing 31.5% of the sample size. The findings from the pre-test were used to adjust the questionnaire and the skills checklist.

3.9 Validity and Reliability of Research Instruments

The structured questionnaires used in the study were standardized with the WHO clinical practice guidelines and previously validated clinical questions used in studies measuring competence among nurses. Parts of the questionnaires were adapted from validated questions by Desalu *et al*., (2022) and content of questionnaires and skills checklist were in line with WHO oxygen therapy for children guideline. The questions adopted from the Desalu *et al.,* (2022) study had gone through face and content validity and had achieved a content validity index of greater than 0.78. The findings of the pre-testing of the data collection tools were used to improve the data collection tools and to ensure validity. To ensure reliability, the same questionnaires were administered to the same group of nurses after two weeks to check for test-retest consistency.

3.10 Data Collection Technique

The number of nurses eligible and had volunteered to take part in the study was noted and a code randomly allocated to each of the questionnaires given to the nurses participating in the study and the code was used during data entry from the self-administered questionnaire. The questionnaires were distributed or sent electronically to the paediatric nurses. The researcher travelled to the four hospitals and distributed the questionnaires to the paediatric nurses in paediatric units who met the inclusion criteria. A duplicate online questionnaire was developed and sent to the consenting paediatric nurses who were away from the workstations. The paediatric nurses filled either the printed or the online questionnaire; the filled questioners were collected, labeled the questionnaires, checked for completeness and arranged them for data entry. Data was entered into the SPSS statistical program. Data from the online questionnaires was downloaded and printed for data entry. Data was also entered and

coded into the R-Studio statistical program for additional analysis. The researcher filled the checklist during each of the visit to the hospital, by checking the oxygen equipment used and dosage of oxygen being administered to paediatric patients. The checklist was dated the same way the questionnaires were dated.

3.11 Data Analysis

Data from the questionnaire and checklist was coded and entered to statistical computer program the SPSS version 27 and R-Studio statistical program for analysis. Proportions were used to describe the characteristics of nurses in the paediatric wards. The effects of the many variables observed on the dependent variable were determined by performing a multiple regression on SPSS. Binary logistic analysis was used to analysis formulas were used to find out if any of the independent variables could predict competence of the nurses. There is a relationship between the performance of paediatric nurses and nurse demographics and characteristics and hospital factors. The R- Studio program was used for Fischer's exact analysis and the SPSS program was used for binary logistic regression analysis.

Table 3.1: Data Analysis Table

Data	**Analysis**
Objective 1 –composite knowledge scores	Frequency tables
Objective 2 – Individual factors; demographics	Frequency tables
Objective 3 – Institutional factors	Frequency tables
Objective 4 – Relationship among variables	Inferential statics; Fischer's exact and binary logistic regression

Source: Author (2021)

3.12 Ethical Issues

Approval and ethical review were sought from the Kenyatta University Institutional Research Ethic Committee (IREC) and the Graduate school. A research license number was obtained from the National Commission for Science, Technology and Innovation (NACOSTI). Authorization to conduct research was obtained from Kajiado County health management team to conduct the study in the county hospital.

CHAPTER FOUR: RESULTS

4.1 Introduction

This chapter contains results of the findings of data collected following analysis and interpretation of the raw quantitative data obtained from 73 respondents who took part in the study. The questionnaires collected data on nurses' knowledge, practice, attitudes, clinical decision making on oxygen administration, oxygen availability and availability of oxygen therapy equipment. The results are presented according to the specific objectives of study.

These objectives include; to measure the competence of nurses working in paediatric wards in administration of supplemental oxygen therapy; to determine individual paediatric nurse factors that influence their competence in supplemental oxygen therapy; to determine the institutional factors that influence competence of paediatric nursing in administration of supplemental oxygen therapy and to establish the relationship between the individual nursing factors, institutional factors and competency on supplemental oxygen therapy in Kajiado County.

4.2 Response Rate

A sample of 81 respondents, from the selected study population and sites were approached and asked to take part in the study by completing the self-administered questionnaire on supplemental oxygen therapy knowledge. There ware a total of 73 questionnaires that were completed out of the 81 questionnaires distributed, giving a 90.1% response rate. According to Kothari (2007), a response rate of more than 50 % is good, while 60% and above is very good. Hence, the response rate of 90.1% for the study is appropriate for data analysis.

4.3 Participants' Level of Competence on Administration of Supplemental Oxygen Therapy

To measure competence in supplemental oxygen therapy, participants were asked a series of questions (20questions) to assess their knowledge, practice and attitude on supplemental oxygen therapy during practice. For each correct response, the participants were awarded one point and zero for incorrect responses. A total score was then obtained for each participant based on correct responses. To grade knowledge, practice and attitude levels from the questions answered by the respondents, Bloom's grading cut-offs were used to determine knowledge level and hence competence (Chand et al., 2022). Using Bloom's cut-off of 60%, the respondents were categorised as having more knowledge level, good practice and good attitude if they got a score of 60%, on each of the area of assessment. To determine the final category of competence or less competence, the respondents had to get a score of above 60% on two or more of the area assessment; being knowledge, practice and attitude. Section 4.4.1 shows performance on knowledge questions.

4.3.1 Supplemental Oxygen Therapy Knowledge

To assess knowledge on supplemental oxygen therapy, nurses working in paediatric wards in Kajiado County were asked a series of questions (7 questions) encompassing clinical signs and indications for oxygen, hypoxaemia diagnosis, oxygen saturation levels targets and oxygen weaning rates. Nearly all 97.2% (n=71) the respondents were knowledgeable on the level of Spo2 that indicates hypoxaemia (*85-90% SPO2*) as shown in Table 4.1.

When asked about tests used to recognize hypoxaemia and hypercarbia in a child, 24.7% (n = 18) of the respondents were able to identify all the three tests correctly,

that is blood gas analysis, oximetry and use of capnography, whereas 94.6% (n=69) were able to identify at least one correct test for recognizing hypoxaemia and hypercarbia as shown in Table 4.3. Although 94.5% (n=69) of respondents were able to identify both cyanosis and grunting as were identified as clinical signs for an absolute indication for oxygen, although they were also able to indicate clinical signs that do not qualify for absolute indication for oxygen therapy. Still in identifying absolute indications of oxygen 60.3% (n=44) of the respondents, indicated acidotic breathing as an absolute indication for oxygen, and another 9.6% (n=7) indicated altered level consciousness without respiratory distress as an absolute indication for oxygen which were incorrect responses.

Table 4.1: Participants' Responses on Selected Oxygen Therapy Questions

Variable	Frequency **(N=73)**	Percent (%)
The SPO2 range that is targeted during therapy		
90-100%	21	28.8
87-92%	5	6.8
94-98%	35	48.0
95-100%	12	16.4
The SPO2 range that is indicative of hypoxaemia		
SPO2 91-95%	2	2.8
SPO2 85-90%	71	97.2
Test selected to detect hypoxaemia and hypercarbia		
Blood gas analysis	29	39.7
Blood gas analysis and oximetry	34	46.6
Blood gas analysis, oximetry and capnography	18	24.7
Complete blood count	4	5.4
Blood gas analysis and capnography	3	4.1
Oximetry	18	24.7
Clinical signs that are absolute indicators for oxygen		
Cyanosis	65	89.0
Acidotic(deep) breathing	3	4.1
Grunting	19	26.0
Altered consciousness without respiratory distress	7	9.6
Triggers to start weaning the paediatric patient off oxygen		
Reduction in work of breathing and SPO2 above 95%	29	39.7
Reduction in work of breathing	8	11.0
SPO2 above 95 %	36	49.3

Source: Field Data (2021)

4.3.1.2 Overall Knowledge Rating of the Respondents

This study had seven questions that were assessing knowledge of the paediatric nurses. The researcher added up the scores for the respondents and this was able to give an overall knowledge rating. The paediatric Nurses categorised as more knowledgeable were 72.6% (n=53) of the respondents and nurses categorised as having less knowledge were 27.4% (n=20) of the respondents. The summary of the oxygen therapy knowledge scores as shown on Figure 4.1.

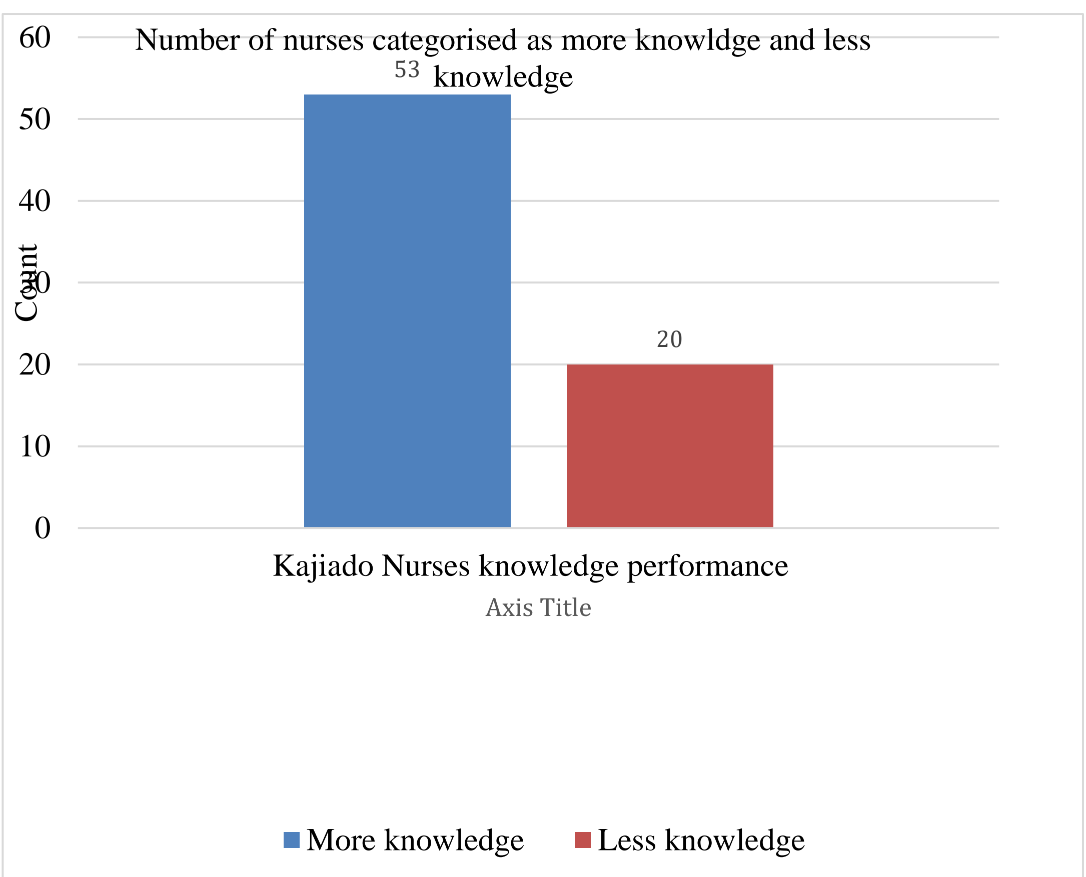

Figure 4.1: Showing the Number of Nurses Based on Oxygen Therapy Knowledge Level

Source: Field Data (2021)

4.3.2 Supplemental Oxygen Therapy Practice Assessment

Supplemental oxygen therapy practices among nurses working in paediatric wards in Kajiado County was assessed by asking questions around selection and use of supplemental oxygen equipment, as well as what informs such decisions. The practice questions were aimed at assessing the nurses' clinical practices of diagnosis and selection of the appropriate oxygen delivery equipment. From Table 4.2 majority of the respondents 83.6% (n=61), were able to identify distilled water as the solution to humidify oxygen. Concerning flow rate when using nasal prongs 83.6% (n= 61) of the respondents were also able to identify the maximum standard flow rate in litres/minute using nasal prongs in neonates. On titration rates for oxygen dosage 80.8% (n=59) of the respondents were able to correctly identify the rate of titrating up oxygen levels during treatment, 64.4% (n=47) had the best guide for oxygen dosage on prescription, while 83.6% (n=61) correctly identifying the minimum flow rate in Litre/minute when suing non-rebreather mask. More than half of the nurses 60.3% (n=44) were able to correctly titrate in litres/minute when weaning paediatric patients off oxygen. In making diagnosis of hypoxaemia using low oxygen saturation and central cyanosis, 46.6% (n=34) of the nurses working in paediatric wards were able to make the right diagnosis from a clinical question. It is also important to note that 45.2% (n=33) were able to make the right diagnosis of hypoxia from a clinical question of a asthmatic child with altered level of consciousness.

In selecting the equipment to deliver specified oxygen concentration 47.9% (n=35) of the respondents made the right selection of nasal prongs, as the equipment that delivers oxygen concentration (FiO2) of 35 % in standard flow and 50.7% (n=37) of the respondents correctly selected the non-rebreather mask as the equipment that

delivers oxygen concentration (FiO2) of 80.0% in standard flow. Overall, 64.4% (n=47) of the respondents demonstrated high standards of practice, in line with recommended guidelines, during supplemental oxygen therapy.

Table 4.2: Table Showing Proportion of Respondents who correctly answered Supplemental Oxygen Therapy Practice Questions

Question	Frequency of correct responses (N=73)	Proportion (%)
Solution for humidifying oxygen	65	89.0
Maximum standard flow rate in litres per minute using nasal prongs in neonates	61	83.6
Rate of titrating up (increasing) oxygen levels during treatment	59	80.8
Best guide for oxygen dosage during prescription	47	64.4
Minimum flow rate in litres per minute when suing nonrebreather mask	49	67.1
Rate in litres per minute of weaning paediatric patients off oxygen	44	60.3
Central cyanosis and SPO2 of 87% diagnosis of a nine-month infant	38	52.1
Asthma patient with altered consciousness diagnosis	33	45.2
Equipment for delivery of oxygen concentration (FiO2) of 35% in standard flow	35	47.9
Equipment for delivery of oxygen concentration (FiO2) of 80% in standard flow	37	50.7

Source: Field Data (2021)

4.3.3 Attitude towards Supplemental Oxygen Therapy

Assessment of the nurses' attitude towards supplemental oxygen therapy was done through a set of questions to determine how adaptable they were in challenging situations. The nurses' responses to such questions were then assessed against expected appropriate actions applicable in the given situation. Approach to challenges with administration of oxygen to multiple patients, difficulty using, removing, or setting up the oxygen regulator and oxygen leak action during oxygen therapy were assessed. Overall, the nurses were very adaptable and appropriately identified correct actions for the given challenging situations. Table 4.3 shows the attitude questions which were used to assess the respondent's adaptability to challenges during oxygen therapy. Majority of the respondents 87.6% (n=64), indicated "taking action" to solve issues with the oxygen cylinder when it was difficult to use, remove or set up the oxygen regulator as one of the decisions they took to solve oxygen therapy challenge. Another 68.5 % (n=50) of the respondents also made the correct decision on equipment for use to administer oxygen to more than one patient from a single source while solving oxygen therapy challenges and 47.9 % (n=36) understood what to do in case of oxygen leaks during oxygen therapy. This implied that, the paediatric nurses made decisions that would solve the problem/s at hand through the use of oxygen supplementary therapy.

Table 4.3: Showing Proportion of Respondents and their Decisions in Solving Oxygen Therapy Challenges

	Frequency of correct responses (N=73)	Proportion (%)
Equipment for use to administer oxygen to more than one patient from a single source	50	68.5
Action when it is difficult to use, remove or set up the oxygen regulator into an oxygen cylinder	64	87.6
What to do in case of oxygen leaks during oxygen therapy	36	47.9

Source: Field Data (2021)

4.3.4 Combined Scores on Knowledge, Attitude, and Practice to get Overall Competence Level

Performance was measured using three variables that included knowledge, attitude and practice questions was combined and converted into percentages, using the Blooms cut off of 60%. The respondents with a score of 60% and above were graded as competent and respondents with score of less than 60% were graded as less competent. Majority of the respondents (75.3%, n=55) of the respondents were graded as competent and 24.7% (n=18), of the respondents were graded as less competent as shown in Table 4.4.

Table 4.4: Proportion of Respondents Categorized in Levels of Competence

	Frequency	Percent
Competence	55	75.3
Less Competence	18	24.7
Total	73	100.0

Source: Field Data (2021)

4.4 Individual Factors that Influence Paediatric Nurses' Competence in Supplemental Oxygen Therapy in Kajiado County

4.4.1 Socio-Demographic Characteristics of the Respondents

As part of demographic data, information on respondents' age, gender, highest level of education, years of work experience and employment status was collected and results presented in Table 4.5. Respondents in this study were spread across four facilities in Kajiado County with a majority 37.0% (n=27) of the respondents domiciled Kajiado County Referral Hospital. Almost all the respondents were female 93.0% (n=68). Nearly half 45.2% (n=32) of the respondents were aged below 30 years and 12 (15.0%) respondents were more than 40 years old. The highest level of education among the respondents was a college degree and the lowest level of education was a certificate. Majority 76.7% (n=56) of the respondents had a diploma, 15.1% (n=11) had a degree and 8.2% (n=6) had a certificate as the highest academic qualification.

Most 80.8% (n=59) of the respondents were employed on a permanent basis. Nurses working in paediatric wards were employed on a permanent basis, 80.8% (n=59) and 19.2% (n=14) were employed on temporary basis. On assessment of work experience, 61.6%(n=45) of the respondents had two years or less of experience. Of the nurses working in paediatric wards in Kajiado County 45.2% (n=33) were 30 years or

younger, whereas a majority of those with more than three years of experience were aged between 31 and 40 years.

Table 4.5: Showing the Socio-Demographic Characteristics of Respondents

Variable	Frequency(n)	Percentage
Age group		
21 – 30	32	43.8
31-40	30	41.2
41-50	9	12.3
51-60	2	2.7
Gender		
Female	68	93.2
Male	5	6.8
Level of education		
Certificate	6	8.2
Diploma	56	76.7
Degree	11	15.1
Employment status		
Permanent	59	80.8
Temporary	14	19.2
Hospital working in		
Kajiado County Referral Hospital	27	37.0
Kitengela Sub-County Hospital	22	30.1
Loitoktok Sub-County Hospital	10	13.7
Ngong Sub-County Hospital	14	19.2

Source: Field Data (2021)

4.4.2 Participant Work Experience, Training on Oxygen Therapy and Access to Guidelines

In additional to the social demographic characteristics shown in section 4.4.1 above additional individual factors were analysed. Table 4.6 the nurses who had less than 2 years' experience were more at 61.6 percent while 23.3 % had 3 years working experience and 15.1% had more than 5 years of working experience. For additional 57.5 % (n= 42) of the peadiatric nurses had acquired additional training on oxygen therapy while 42.5 % (n=31) had no additional training on oxygen therapy. When asked about availability of oxygen therapy guidelines 61.6% (N=45) of the peadiatric

nurses had access to oxygen therapy guidelines while 38.4% had no access to oxygen therapy guidelines.

Table 4.6: Showing Work, Training on Oxygen Therapy and Access to Oxygen Therapy Guidelines by the Respondents

	Frequency (n)	Percentage (%)
Work experience		
Less than 2 years	45	61.6
3 – 5 years	17	23.3
More than 5 years	11	15.1
Additional training on oxygen therapy		
Got additional training on oxygen therapy	42	57.5
No additional training on oxygen therapy	31	42.5
Access to guidelines		
Has access to oxygen therapy guidelines	45	61.6
No access to oxygen therapy guidelines	28	38.4

Source: Field Data (2021)

Fisher's exact test was used to measure associations between the dependent (supplemental oxygen therapy competence) and independent variables (socio-demographic factors). Fisher's test was used because, at least one cell in the contingency tables for the variables of interest had an expected frequency of less than 5. Fisher's exact test showed no significant statistical differences, between the calculated aggregate competency levels and socio-demographic characteristics. Table 4.7 shows a detailed report on the results obtained from the analysis of association between variables

Table 4.7: Socio-Demographic Factors Associated with Supplemental Oxygen Therapy Competency Levels

Variable	Supplemental oxygen therapy competency level		P-value
	Low	**High**	
Age			**0.642**
18 – 30	19	13	
31-40	20	10	
41-50	5	4	
51-60	2	0	
Gender			**0.2425**
Female	56	12	
Male	3	2	
Level of education			**0.589**
Certificate	4	2	
Diploma	46	10	
Degree	9	2	
Employment status			**0.2788**
Permanent	46	13	
Temporary	13	1	
Work experience			**0.8787**
Less than 2 years	39	6	
3 – 5 years	11	6	
More than 5 years	9	2	
Oxygen therapy training			**0.3682**
Training	27	4	
No training	32	10	

Source: Field Data (2021)

4.5 Institutional Factors that Influence Competence of Paediatric Nurses in Administration of Supplemental Oxygen Therapy in Kajiado County

The availability of oxygen equipment among the paediatric nurses was scored by giving two points for the available equipment or policy. A point was awarded for partial availability and unavailable equipment or policy no point was awarded. The

points were summed up and each hospital was scored. The final scores were converted to percentages, the responses as cited by Acharya and Paudel (2019) on the service availability and readiness assessment manual. Kajiado County referral hospital had an average score of 72.70%, Kitengela Sub-County hospitals 78.42%, Ngong Sub-County hospital 78.18% and Loitoktok hospital 70%. The scores indicated for each of the hospitals was used as one of the predictor variables in binary logistic regression analysis, as shown under heading 4.6. The four hospitals under the study have various sources for oxygen as shown in Table 4.8.

It shows majority of the respondents (93.9%) had oxygen from cylinders, while (75.5%) of the hospital had oxygen from an oxygen concentrator and (30.6%) percent have oxygen supplied from an oxygen plant. The results show that all the institutions within which the respondents were working, had more than one source of oxygen.

Table 4.8: Showing Sources of Oxygen available in Paediatric Wards in Kajiado County

	Frequency	Percent
Oxygen from a cylinder	46	93.9
Oxygen from an oxygen concentrator	37	75.5
Piped oxygen from a cylinder manifold	8	16.3
Piped oxygen from bulk storage tanks	4	8.2
Piped oxygen from a plant	15	30.6

Source: Field Data (2021)

In terms of access to supplemental oxygen therapy guidelines, more than half i.e. 63.3% (n=31) stated that they did not have access to these guidelines, whereas slightly more than half i.e. 53.1% (n=26) of the respondents, mentioned that they had obtained supplemental oxygen therapy training. The most common type of training obtained was from ETAT guidelines. Pulse oximeters were available to the 47 (95.9%) of respondents, 32 (65%) of the pulse oximeter units had paediatric probes and 23 (46.9%) had the neonatal probe. The study sought to identify the availability of the

oxygen delivery equipment as shown in Table 4.9.

The results on paediatric nasal prongs 22.4 % (n=27) shows that they were always available, 59.0% (n=43) of the respondents indicated that they were available at times, while 4.1% (n=3) indicated they were never available. The availability of non-rebreather masks, 28.8 % (n=21) reported availability at all times, while 60.3% (n=44) reported that neonatal non-rebreather masks were available at times, while 11.0 % (n=8) indicated that they were never available. The study established that the neonatal nasal prongs were always available among 45.2 % (n=33) of the respondents, 50.2 % (n=37) reported they were available at times while and 4.1 % (n=3) indicated they were never available.

On the availability of paediatric non-rebreather masks, shows that 32.9% (n=16) indicated that they were always available, 38.4% (n=28) of the respondents indicated that paediatric non-rebreathers masks were available at times while, 28.8% (n=21) indicated they were never available.

Table 4.9: Showing availability of the Various Oxygen Delivery Equipment

Oxygen delivery equipment	**Always Available**	**Available sometimes**	**Never Available**
Neonatal nasal prongs	33(45.2%)	37(50.2%)	3(4.1%)
Paediatric nasal prongs	27(22.4%)	43(59.0%)	3(4.1%)
Neonatal non-rebreather mask	21(28.8%)	44(60.3)	8(11.0%)
Paediatric non-rebreather mask	24(32.9%)	28(38.4%)	21(28.8%)
CPAP	16(21.9%)	19(26.0%)	38(52.1%)

Source: Field Data (2021)

Majority of the respondents 83.6% (n=61) indicated that the hospital had a policy of

using nasal prongs or non-rebreather masks on a single use oxygen delivery equipment, 8.2% (n=6) indicated that they can be reused after decontamination while 8.2% (n=6) indicated there were no general policies or guidelines on the use available nasal prongs as shown in Table 4.10.

Table 4.10: Showing Availability of Hospital Policy on Use of Nasal Prongs or Non-Rebreather Mask

Hospital policy	**Frequency**	**Percent (%)**
Single use of oxygen delivery equipment	61	83.6
Can be reused after decontamination	6	8.2
No general policy or guidelines on use available	6	8.2
Total	73	100.0

Source: Field Data (2021)

To examine institutional factors that might affect supplemental oxygen therapy competence, Fisher's test was also used for the same reasons described above. Fisher's exact test showed no significance statistical differences between the calculated aggregate competence levels and the institutional factors, for nearly all the factors except for '*Equipment used for Oxygen delivery to multiple patients*', where there was a significant statistical difference (p-value=0.0310) in competence level rating and equipment used for oxygen delivery to multiple patients. There was also a significant statistical difference (p-value=0.0452) in competence rating for those participants who reported availability of neonatal non-rebreather masks, in the hospital they work. Table 4.11 shows a detailed report on the results obtained from the analysis of association between variables.

Table 4.11: Table Showing Analysis of Association between Institutional Variables and Supplemental Oxygen Therapy Competence

Variable	**P-Value**
Access to supplemental oxygen therapy guidelines	*0.175*
Neonatal nasal prongs availability	*1.000*
Paediatric nasal prongs availability	*1.000*
Oxygen supply stock outs	*1.000*
Neonatal non-rebreather mask availability	***0.045***
Paediatric non-rebreather mask availability	*0.418*
CPAP availability	*0.667*
Hospital policy on use of non-rebreather masks/nasal prongs	*0.071*
Oxygen safety during transport and use	*1.000*
Gross particle cleaning frequency	*0.571*
Pulse oximeter availability	*1.000*
Maintenance status of oxygen flow meters	*0.650*
Maintenance status of oxygen concentrators	*1.000*
Maintenance status of cylinder flowmeters	*0.324*
Oxygen leak action	*1.000*
Oxygen delivery to multiple patients	***0.001***
Regulator difficulty action	*1.000*
Provision for pulse oximeter documentation	*0.072*

Source: Field Data (2021)

4.6 Relationship between Individual and Institutional Factors and Competence of Paediatric Nurses on Supplemental Oxygen Therapy in Kajiado County

Binary logistic regression, was used to assess if the individual and institutional factors could predict the competence levels on supplemental oxygen therapy among nurses, working in paediatric wards in Kajiado County. With the dependent variable being dichotomous (‘competence’ and ‘less competence’), binary logistic regression was used as the analysis, to check if the different independent variables could predict the two categories of the dependent variable. (Harris, 2021). The predictor variables used in analysis were: age, gender, education level, work experience, employment status,

hospital respondent works and combination score of institution factors, were selected as predictor variables to assess the relationship between individual factors and institutional factors and how they affect supplemental oxygen therapy competence, as shown in Table 4.12. Only work experience showed statistically significant prediction with the dependent variable with a positive regression coefficient of {1.06} with p value of 0.019. Similar results were shown in the bootstrap analysis as shown in Table 4.13.

Table 4.12: Showing the Relationship of the Independent Variables and Oxygen Therapy Competence

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a,b]	Gender of respondents	-19.675	17624.917	.000	1	.999	.000
	Hospitals	.574	.300	3.661	1	.056	1.776
	Age of Respondents	-.840	.500	2.824	1	.093	.432
	Level of Education	-.346	.705	.241	1	.624	.708
	employment status	.178	.745	.057	1	.812	1.194
	Work Experience	**1.060**	**.453**	**5.483**	**1**	**.019**	**2.887**
	Institutional	.250	.575	.190	1	.663	1.284
	Constant	-2.935	2.116	1.924	1	.165	.053

a. Variable(s) entered on step 1: Gender of respondents, Hospitals, Age of Respondents, Level of Education, employment status, Work Experience, institutional.
b. Variable(s) entered on step 1: Hospitals, Age of Respondents, Level of Education, employment status, Work Experience, institutional.

Source: Field Data (2021)

Table 4.13: Showing Bootstrap Analysis of the Relationship of the Independent Variables and Oxygen Therapy competence

Bootstrap for Variables in the Equation

			Bootstrap[a]				
						95% Confidence Interval	
		B	Bias	Std. Error	Sig. (2-tailed)	Lower	Upper
Step 1	Gender of respondents	-19.675	.061[b]	.855[b]	.001[b]	-21.169[b]	-17.645[b]
	Hospitals	.574	.107[b]	.407[b]	.055[b]	-.050[b]	1.561[b]
	Age of Respondents	-.840	-.101[b]	.626[b]	.071[b]	-2.371[b]	.170[b]
	Level of Education	-.346	-.276[b]	1.782[b]	.621[b]	-2.926[b]	1.122[b]
	employment status	.178	-.357[b]	2.704[b]	.798[b]	-1.923[b]	1.959[b]
	Work Experience	1.060	.188[b]	.624[b]	.010[b]	.026[b]	2.558[b]
	Institutional	.250	.057[b]	1.040[b]	.678[b]	-1.222[b]	2.035[b]
	Constant	-2.935	.207[b]	5.066[b]	.188[b]	-9.825[b]	3.715[b]

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

b. Based on 995 samples

Source: Field Data (2021)

CHAPTER FIVE: DISCUSSION, CONLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter, a discussion of the research findings is presented. The chapter also presents the conclusion drawn from the findings of the study and recommendations for policy and suggestion for further studies.

5.2 Discussion

5.2.1 Competence of Nurses Working in Paediatric Wards on Oxygen Therapy

The next objective was to measure the competence of nurses working in paediatric wards on oxygen therapy. The literature review showed that competence assessment can be done by use of knowledge, practice and attitude assessment (Demilew *et al*., 2022). Assessing that nurses have the requisite knowledge, skills, attitudes, leadership and decision making competencies is common in nursing and is done on a regular basis using different kinds of tools to assess abilities used in patient care (Kaseka & Mbakaya, 2022). Nurses' competence in oxygen therapy entails making the correct diagnosis of hypoxaemia and hypoxia, recognizing need for oxygen, giving oxygen in the right dosage, using the right equipment and monitoring the use of oxygen.

Majority of the nurses working in Kajiado County paediatric wards were categorized as having high competence in oxygen therapy this compares with an Ethiopian study by Demilew *et al*., (2022). The study by Demilew *et al.,* (2022) showed 54.6% of the respondents had high score knowledge and attitude while 65.1% had a high score in practice.

5.2.1 Individual Factors that Influence Paediatric Nurses' Competence in Oxygen Therapy

The first objective of the study was to determine the individual factors that influence

competence of nurses working in paediatric wards on oxygen therapy. In the literature review it was found out that training and availability of guidelines led to increased competence on oxygen therapy. From the study an overwhelming number of nurses working in paediatric wards in Kajiado county are female. This does not reflect the national ratio of 76% of nurses being female and 24% being male (Enoch *et al*., 2019). Majority of the nurses working in paediatric wards in Kajiado County main public hospitals are below 40 years old. Further, more than half of the respondents having worked for less than 2 years. This implies Kajiado County has been recruiting new nurses and there will be need for a detailed orientation program. Orientation programmes improve competence of nurses as demonstrated by Lalithabai *et al.,* (2021). Majority of the nurses have Diploma level training. The findings were like findings by Kokwaro *et al.,* (2018), that showed majority of the nurses in Kajiado County had diploma level training. There less than 10% of nurses who had certificate level qualification, this is a much lower percentage than what was reported by Enoch *et al.,* (2019) which showed a ratio of registered nurses to enrolled nurses being respectively in Kajiado County.

The study findings on work experience, training on oxygen therapy and access to guidelines indicated that majority of the participants had worked for less than 2 years, close to one quarter percent had 3 years of experience and less than 20 percent had more than 5 years of experience. This implies that majority of the paediatric nurses were new young nurses hence were still applying the knowledge gained in class. The results concur Demirel and Kazan (2020) who found that experience obtaining among nurses in Turkey who had a long work experience did not lead to increase in level of knowledge regarding oxygen therapy but the younger nurses had more knowledge about the same since the curriculum covers these areas extensively. On enquiring

about the training received 57.5 more than half of the nurses had acquired additional training while close to two fifths had no additional training on oxygen therapy. The study also established that most of the paediatric nurses had access to oxygen guidelines while approximately two fifths had no access to oxygen therapy guidelines. The corresponds with Ayuk and Nwosu (2021) who found that training on oxygen therapy was lacking many parts of Africa, Asia and South America on oxygen supplementation appropriately. The study recommended training and re-training of nurses on oxygen appropriate administration to be organized regularly since this would impact both knowledge and practice of oxygen therapy.

5.2.2.1 Performance of Nurses Working in Paediatric Wards on Oxygen Therapy Knowledge Assessment

The World Health Organization-UNICEF (2019) recommends that oxygen therapy as core item essential medicine should be effectively and safely administered by nurses under the instructions of a physician on the application method, treatment process and targeted oxygen saturation. This necessitated the need to assess the knowledge of the nurses working in paediatric wards, with close to three quarters categorized as having good oxygen therapy knowledge. This study shows better results than those of Zeleke and Kefale (2021) who found that two thirds of nurses from Debre Tabor General Hospital had poor knowledge of oxygen supplemental therapy.

Majority of the nurses were able to identify central cyanosis as an absolute indication for oxygen, which is lower than a percentage of 98.9 (n=174) of health care workers, who were able to identify central cyanosis as an absolute indication of oxygen as reported by Adeniyi *et al*., (2021) in a Nigerian study. On identification of the correct range of oxygen saturation during supplemental oxygen therapy less than half of the respondents were able to give the correct saturation target. This finding is similar to

results by Zeleke and Kefale (2021) who found that only 40% of their respondents identified the correct oxygen saturation.

5.2.2.2 Performance of Nurses Working in Paediatric Wards on Oxygen Therapy Practice Assessment

On diagnosis of hypoxaemia only half of the nurses surveyed made the correct diagnosis. In the diagnosis of hypoxia slightly less than half of the nurses made the correct diagnosis, indicating a gap in knowledge in making the two diagnoses or gap in proper definition of terminologies used in oxygen therapy. Majority of the paediatric nurses were able to make the correct diagnosis of hypoxaemia by use of oximeter.

On recognizing adverse effects related to oxygen therapy, more than half of the respondents were able to identify retinopathy of prematurity as a side effect of oxygen overdose and only one quarter were able to identify harmful effect of oxygen overdose to other tissues and organs. This is because oxygen toxicity is not easy to identity and there is minimal sensitization of health care workers on the dangers of oxygen overdose (Cooper, 2022).

In selecting the oxygen delivery equipment only half of the nurses were able to correctly indicate the concentration of oxygen delivered by a non-rebreather mask and only slightly less than half were able to identify the correct concentration of oxygen delivered by use of nasal prongs. These findings differ with the findings on correct flow rate, where more than half of the nurses were able to give the correct flow rate when using a non-rebreather mask and more than three quarters of the nurses indicated the correct flow rate for oxygen when using the nasal prongs. This indicates majority of the respondents were knowledgeable on oxygen dosage with regards to flow rates and less knowledgeable on the dosages with regards to concentrations of oxygen

delivered to the patient. A few of the nurses at were able to correctly indicate all the laboratory tests involved in detecting hypoxaemia. This could be because nurses routinely in the county do not order laboratory tests. The correct humidification fluid was identified by more than three quarters of the nurses. The knowledge on the correct fluid was high despite gaps in supply of distilled water in the four hospitals.

5.2.3 Individual Factors Influencing Competence of Nurses Working in Paediatric Wards on Oxygen Therapy

The next objective was to determine if nurse individual factors influence performance on nurses on oxygen therapy. None of the social demographic factors among nurses working in paediatric wards in Kajiado County had significant statistical influence on their competence on oxygen therapy. The findings of this study agree with the following statement that, "the nurses level of education, years of work experience and nurses' participation in continuous professional development learning sessions do not predict nurses knowledge and skills of oxygen therapy". These findings contradict Nimbalkar *et al.,* (2023) who conducted a study in India and found that nurses' training in oxygen therapy influence their competence in oxygen therapy. Nurses with informal oxygen therapy training in India were found to be more competent in oxygen therapy. The findings are also in contradiction with Kalpana *et al.,* (2021) who conducted a study in Nepal and revealed that age, status of education and experience of the nurses had a significant influence on nurses' competence in oxygen therapy.

The findings that oxygen therapy competence was not dependent on experience and age contradicted Al *et al.,* (2019) who found that oxygen therapy competence in ICU nurses dependent on gender. Female nurses in turkey were found to be more competent as compared to the male nurses. However, the finding that oxygen therapy

competence was not dependent on experience is in agreement with Al *et al.,* (2019) who found no significant differences between oxygen therapy and experience of the nurses.

However, the binary regression results indicate that only work experience was significant predictor to nurses' oxygen therapy competence. The results agree with those of Younas *et al.,* (2023), who found that nurses gained more knowledge when they practiced the use of delivering oxygen and this minimized the barriers of administrating the oxygen. The findings are also in agreement with Demilew *et al.,* (2022) who conducted a study in Ethiopia and established that health professionals' training and experience were significantly related to their competence in oxygen therapy. The findings of the study could be explained by the challenge of a rapidly changing nursing education environment where by nurses continuous exposure to varying nursing education content from different sources as also observed.

5.2.4 Institutional Factors Affecting Competency of Nurses Working in Paediatric Wards on Oxygen Therapy

The next objective was to determine if hospital factors like availability of equipment and protocols had an effect of oxygen therapy competence among nurses working in paediatric wards of Kajiado County. The study established that each hospital had a mixed source of oxygen, with more than nine tenths of the respondents indicating they had oxygen cylinders, three quarter of them indicating they had oxygen concentrator and one third had piped oxygen from an oxygen plant. These findings are different from those by Nabwire *et al.,* (2018) who were able to establish that the common source of oxygen for the surveyed hospitals in Uganda was the oxygen concentrator. This study has shown evidence of improved performance in units that have displayed hospitals policies and guidelines. This agrees with the finding of Aloushan *et al.,*

(2019) who demonstrated that nurses in Saudi Arabia adhered more to patient safety principles in units where guidelines were availed and care was standardized through policies.

The literature review showed that nurses had identified lack of oxygen delivery equipment, unclear prescriptions and lack of guidelines as barriers to oxygen therapy competence in Egypt (Mayhob, 2017). In Egypt, medical equipment are essential in provision of safe and timely nursing care, disruption in the supply of medical equipment, faulty equipment and poorly serviced equipment have been identified as barriers to provision of proper nursing care (Getahun *et al.,*, 2022).

There was no link between nurses' performance on oxygen therapy and hospital dependent factors like supply of oxygen and oxygen therapy equipment. On the availability of supplemental oxygen therapy guidelines access, majority of the nurses surveyed indicated that they did not have access to supplemental oxygen therapy guidelines, which could affect their competence on oxygen therapy as was also found out by Getahun *et al.*, (2022). The results from the Fishers's Test shows that equipment used for oxygen delivery to multiple patients had a statistically significant difference at a p-value 0.045 a participant's reported availability of neonatal non-rebreather masks in the hospital they work in. The results agree with those of Cashman (2017) who conducted a study in Malawi and noted that availability of well-functioning equipment was also important in oxygen therapy competence.

5.2.5 Implications to Policy Guidelines on Oxygen Therapy

The findings of this can inform modification of oxygen therapy practice guidelines and teaching protocols. The oxygen therapy practice guidelines can be improved to bridge gaps observed in knowledge on oxygen therapy dosage and monitoring of

treatment.

5.2.6 New Knowledge Contributed by this Study

The study produced results which showed knowledge gaps on specific areas of oxygen in therapy, especially knowledge on oxygen therapy saturation targets and oxygen dosages among nurses working in paediatric units. Based on the findings of this study teaching content for oxygen therapy can be modified to emphasize on oxygen saturation target levels and include the knowledge area in future oxygen therapy competence assessment.

5.3 Conclusion

Majority of the nurses working in paediatric wards in Kajiado County, generally have high competence but have gaps in identifying oxygen saturation targets during supplemental oxygen therapy, which would lead to either administration of an overdose or underdose. There were gaps in knowledge and practice on oxygen therapy, not all nurses were able to make the correct diagnosis of hypoxaemia and hypoxia and selecting the right oxygen dosage. This indicates the need for continued in-service training of all cadres of nurses on oxygen therapy. There was no individual characteristics to predict how nurses will perform in oxygen therapy there will be need to target all staff in training programs.

5.4 Recommendation for Practice

The study found that administration of oxygen to multiple patients from a single source was a significant institutional determinant of oxygen therapy competence among nurses in Kajiado County. Based on this, the study recommends that the County Government of Kajiado should invest in modern oxygen therapy equipment that enhances administration of oxygen to multiple patients. The study further found that only half of the nurses had extra training on oxygen therapy. Therefore, the study

recommends that there be frequent training on oxygen therapy for all nurses and policies and care guidelines; need to be availed in all paediatric units of Kajiado County hospitals to improve care to children who need oxygen therapy. The study recommends that the training to focus on practice and on oxygen dosages and saturation levels to be targeted during oxygen therapy.

5.5 Recommendations for Further Research

To answer questions arising from this study, more research should be undertaken on the following areas

- Relationship between patient outcomes and practices on hypoxaemia diagnosis.
- The effects of choice of oxygen delivery methods and equipment on cost of hypoxaemia and hypoxia treatment.
- Relationship between patient outcomes and practices on hypoxaemia and hypoxia diagnosis and oxygen prescription practices.

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APPENDICES

Appendix I: Informed Consent

Kiruja G. Jason
P.O Box 20723 00202
Nairobi
0721966220

SUBJECT: INFORMED CONSENT

Dear Respondent,

My name is **Kiruja Gitonga Jason** a MSc Nursing (Paediatrics) student at Kenyatta University. I am conducting a study titled: Determinants of supplemental oxygen therapy competencies among nurses working in paediatric wards In Kajiado County, Kenya. The findings will be utilized in improving oxygen therapy strategies in Kenya and other Low-in- come countries.

Procedure to be followed

Participation in this study will require that you fill a self-administered questionnaire. You have the right to refuse participation in this study. You will not be penalized nor victimized for not joining the study and your decision will not be used against you nor affect you at your place of employment.

Please remember that participation in the study is voluntary. You may ask questions related to the study at any time. You may also stop being in the study at any time without any consequences to the services you are rendering.

Discomforts and risks

The study requires filling of a questionnaire. No procedures that can lead to injury or discomfort will be performed.

Benefits

If you participate in this study, you will help us to strengthen the health systems in Kenya and other Low-in-come countries. As a result, countries, communities and individuals will benefit from improved quality of healthcare services through knowledge generated on oxygen administration that will inform decision makers.

Rewards

There is no reward for anyone who chooses to participate in the study.

Confidentiality

Your name will not be recorded on the questionnaire and the questionnaires will be kept in a safe place at the University.

Contact Information

If you have any questions you may contact the following; **Kiruja G. Jason** Medical Surgical Department, School of Nursing, Kenyatta University/

Participant's Statement

The above statement regarding my participation in the study is clear to me. I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I understand that my records will be kept private and that I can leave the study at any time. I understand that I will not be victimized at my place of work whether I decide to leave the study, and my decision will not affect the way I am treated at my workplace.

Name of Participant…………………………………. Date…………………………..

Signature………………………………………

Investigator's Statement

I, the undersigned, have explained to the volunteer in a language s/he understands the procedures to be followed in the study and the risks and the benefits involved.

Name of

Interviewer…………………………………………Date…………………….

Interviewer Signature…………………………………………

Appendix II: Research Questionnaire

The Determinants of Supplemental Oxygen Therapy Competencies Among Nurses Working in Paediatric Wards in Kajiado County, Kenya

Serial No-------------- Date---------------------- Hospital ---------------

----**Part A: Individual Nurse Factors**

Tick the appropriate one answer and specify where indicated.

1. **Age**

Less than 25 [ ]

25-30 [ ]

31-35 [ ]

36-40 [ ]

41-45 [ ]

46-50 [ ]

51-55 [ ]

Above 56 [ ]

2. **Gender**

Male [ ]

Female [ ]

3. **Highest level of Academic Qualification**

Certificate [ ]

Diploma [ ]

Degree [ ]

Masters [ ]

Doctorate [ ]

Others specify ----------------------------

4. **What is your employment status in the hospital?**

   Permanent staff [ ]

   Temporary (locum) [ ]

   Volunteer [ ]

5. **For how long have you been working in the paediatric unit post orientation?**

   Between 1 month – 12 months [ ]

   Between to 1 - 2 years [ ]

   Between 3-5 years [ ]

   Over 5 years [ ]

Part B. Recognition of Need for Oxygen

6. **Can clinical signs on their own be used to recognize hypoxaemia in children?**
   Yes [ ]
   No [ ]
7. **Which of the following clinical signs are absolute indications for oxygen? (Tick all that apply)**
   Cyanosis [ ]
   Acidotic (deep) breathing [ ]
   Grunting [ ]
   Altered consciousness without respiratory distress [ ]
8. **What is the SPO_2 level that indicates hypoxaemia?**
   SPO2 95-100% [ ]
   SPO2 91-95% [ ]
   SPO2 85-90% [ ]
9. **Which tests are used to recognize hypoxaemia and hypercabia in a child? (tick all that apply)**
   Complete blood count [ ]
   Blood gas analysis [ ]
   Oximetry [ ]
   Capnography [ ]
10. **What range of SPO_2 will you target to achieve during oxygen therapy in children?**
    90-100% [ ]
    87-92% [ ]
    95– 98% [ ]
    95-100% [ ]
11. **Does oxygen overdose cause any adverse effects?**
    Yes [ ]
    No [ ]

12. Name two adverse effects of oxygen overdose? (Tick all that apply)
Retinopathy of prematurity [ ]
Lung fibrosis [ ]
Brain injury [ ]
Heart muscle injury [ ]

Part B: Oxygen Sources and Oxygen Delivery Equipment

13. What are the sources of oxygen available in your ward? tick all that apply
Oxygen from a cylinder
Oxygen from an oxygen concentrator [ ]
Piped oxygen from a cylinder manifold [ ]
Piped oxygen form bulk storage tanks [ ]
Piped oxygen from a plant [ ]

14. What is the availability of the following oxygen delivery equipment, tick the appropriate box

Oxygen delivery equipment	Always Available	Available	Never Available
Neonatal nasal prongs			
Paediatric nasal prongs			
Neonatal non-rebreather mask			
Paediatric non-rebreather mask			
CPAP			

15. What is your hospital policy on use of nasal prongs or non-rebreather mask? Tick one
Single use of oxygen delivery equipment [ ]
Can be reused after decontamination [ ]
No general policy or guideline on use available [ ]

Part C oxygen Administration and Regulation

16. Which of the following statements best guides oxygen dosage during prescription. Tick one
Start oxygen therapy by use of high flow delivery equipment then change to low flow if need be [ ]
Oxygen prescription is guided by targeted oxygen saturation and not a fixed dose [ ]
Start oxygen therapy by use of low flow delivery equipment then change to high flow if need be [ ]

17. What oxygen delivery equipment will you use to deliver oxygen concentration (FiO_2) of 35% in standard flow? Write your answer on the space provided. Tick one.
- ☐ Nasal prongs
- ☐ Venturi mask
- ☐ Nonrebreather mask
- ☐ Simple oxygen mask

18. What oxygen delivery equipment will you use in standard flow to deliver oxygen concentration (FiO_2) of above 80%? Tick one

- ☐ Nasal prongs
- ☐ Venturi mask
- ☐ Nonrebreather mask
- ☐ Simple oxygen mask

19. What is the maximum standard flow rate in Litres per minute using nasal prongs in neonates?

- ☐ **2litres per minute**
- ☐ **5litres per minute**
- ☐ **15litres per minute**
- ☐ **10litres per minute**

20. What is the minimum flow rate in Litres per minute when suing nonrebreather mask?

- ☐ 5litres per minute
- ☐ 2litres per minute
- ☐ 10litres per minute
- ☐ 8litres per minute

21. What triggers you to start weaning the paediatric patient off oxygen? Tick all that apply

- ☐ Completion of antibiotic therapy
- ☐ Reduction in work of breathing
- ☐ SPO2 above 95%

22. What is the rate in litres per minute of weaning off oxygen of a paediatric patient? Tick one

- ☐ Half litre every half hour
- ☐ Half a litre every half a day
- ☐ Half a litre every day

23. What is rate of titrating up (increasing) oxygen levels during treatment

- ☐ Half litre every half hour
- ☐ Half a litre every half a day
- ☐ Half a litre every day

24. What solution do you use to humidify oxygen? Tick one

- ☐ Distilled water
- ☐ Normal saline
- ☐ Ringer's lactate
- ☐ Tap water

<u>Part C Oxygen regulating equipment safety and maintenance</u>

25. Is there a way of securing oxygen cylinders during transport and use?

- ☐ Yes
- ☐ No

26. How often is the oxygen cylinder gross particle filter cleaned by the staff in the ward

- ☐ Never
- ☐ Weekly
- ☐ Monthly
- ☐ I do not know

27. Is pulse oximeter available in your ward?

☐ Yes
☐ No

28. If yes in above, what sizes of probes does it have? Tick all that apply

☐ Neonatal probe
☐ Paediatric probe
☐ Adult probe

29. For the oxygen equipment available, what is the maintenance status

Equipment	Available	Good working order	Maintenance schedule (sticker) up to date	No maintenance schedule (sticker) on equipment	Faulty
Pulse oximeter					
Oxygen concentrator					
Oxygen regular or, gauge and flowmeter for cylinder					
Wall flowmeters					

30. What do you do in case of oxygen leaks during oxygen therapy? Tick all that apply

☐ continue using the oxygen point
☐ use strapping to seal the leak
☐ stop using the oxygen point
☐ call the biomedical engineering team

31. What equipment would you use to administer oxygen to more than one patient from a single source? Tick all that apply

☐ Oxygen splitter
☐ Fluid bottle and giving sets
☐ Y pieces and oxygen tubes

32. When you find that is difficult to use, remove or set up the oxygen regulator into an oxygen cylinder? Tick one response

☐ Use oil to lubricate the regulator
☐ Use a bigger spanner to attach the regulator
☐ Alert the biomedical engineer to service the regulator

33. Do you experience stock out of oxygen?

☐ Yes
☐ No

Part D: Documenting oxygen therapy, training on oxygen and availability of oxygen guidelines

34. Does your vitals monitoring chart have a place to document pulse oximetry –

- ☐ Yes
- ☐ No

35. Have you had any updates or training on oxygen therapy?

- ☐ Yes
- ☐ No

36. If yes in above state which one(s). Tick all that apply

- ☐ ETAT guidelines
- ☐ Basic paediatric protocols
- ☐ Paediatric Advanced Life Support guidelines
- ☐ WHO guidelines on oxygen therapy

37. Do you have access to any oxygen therapy guidelines?

- ☐ Yes
- ☐ No

38. If yes in 35 above, which guidelines are available in your ward?

Thank you for your cooperation

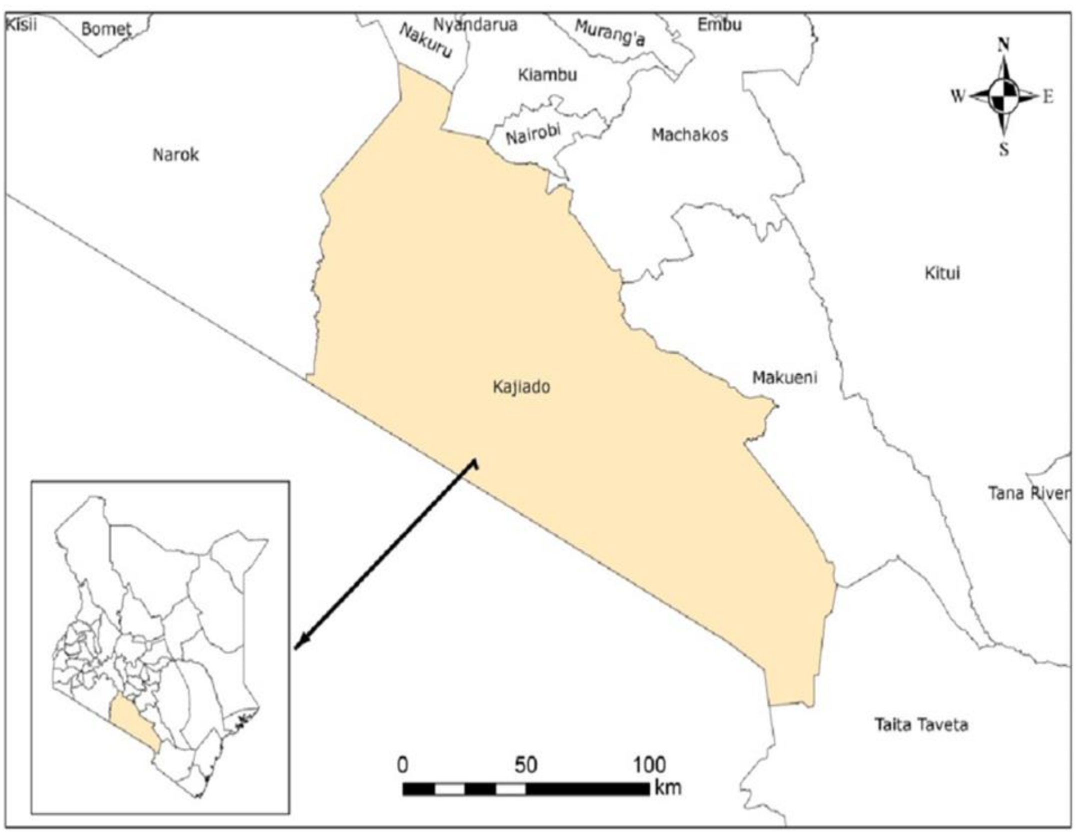
Appendix III: Oxygen Therapy Skills Checklist

Checklist for oxygen therapy for paediatric patients on oxygen therapy to be filled by the researcher as the study participants fill the study questionnaires

Serial No-------------- Date---------------------- Hospital --------------------

SN	Item	Achieved	Not achieved
1.	Indication for oxygen documented		
2.	Oxygen prescription includes flow rate		
3.	Oxygen prescription includes oxygen delivery equipment		
4.	Oxygen prescription includes targeted saturation		
5.	Oxygen flow matches prescribed rate		
6.	Oxygen flow matches flow for nasal prongs		
7.	Oxygen flow matches for NRM		
8.	Flow meters and gauge connected to oxygen cylinder without leaks		
9.	Flow meters connected to wall oxygen socket without leaks		
10.	Humidifier bottle filled to the recommend level with distilled water		
11.	Neonatal NRM used to deliver oxygen to the neonatal patient		
12.	Paediatric NRM used to deliver oxygen to the paediatric patient		
13.	Neonatal prongs used to deliver oxygen to the neonatal patient		
14.	Paediatric prongs used to deliver oxygen to the paediatric patient		

Appendix IV: Kajiado County Map



Appendix V: Graduate School Approval

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 020-8704150

Internal Memo

FROM: Dean, Graduate School **DATE:** 2nd November, 2021

TO: Mr. Kiruja Gitonga Jason **REF:** R50/20270/2020
C/o Medical Surgical Nursing &
Pre-Clinical Sciences Department

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that Graduate School Board, at its meeting on **27th October, 2021**, approved your Research Proposal for the M.Sc. Degree entitled, **"Determinants of Supplemental Oxygen Therapy Competencies among Nurses Working in Paediatric Wards in Kajiado County, Kenya."**

You may now proceed with your Data collection, subject to clearance with the Director General, National Commission for Science, Technology & Innovation and Ethics Review Committee, Kenyatta University.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking and Progress Report Forms per semester. The Forms are available at the University's Website under Graduate School webpage downloads.

Thank you.

JULIA GITU
FOR: DEAN, GRADUATE SCHOOL

KENYATTA UNIVERSITY OFFICE OF DEAN 22 NOV 2021

CC. Chairman, Medical Surgical Nursing & Pre-Clinical Science Department

Supervisors:

1. Dr. Nickcy Mbuthia
C/o Medical Surgical Nursing & Pre-Clinical Sciences Dept.
Kenyatta University

2. Mr. James Ndambuki
C/o Medical Surgical Nursing & Pre-Clinical Sciences Dept.
Kenyatta University

Appendix VI: Graduate School Authorization

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 020-8704150

Our Ref: R50/20270/2020 **DATE: 2nd November, 2021**

Director General,
National Commission for Science, Technology
and Innovation
P.O. Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MR. KIRUJA GITONGA JASON – REG. NO. R50/20270/2020

I write to introduce Mr. Kiruja Gitonga Jason who is a Postgraduate Student of this University. He is registered for M.Sc. degree programme in the **Department of Medical Surgical Nursing & Pre-Clinical Science.**

Mr. Kiruja intends to conduct research for a M.Sc. thesis Proposal entitled, **"Determinants of Supplemental Oxygen Therapy Competencies among Nurses Working in Paediatric Wards in Kajiado County, Kenya."**

Any assistance given will be highly appreciated.

Yours faithfully,

KENYATTA UNIVERSITY OFFICE OF DEAN 22 NOV 2021 GRADUATE SCHOOL

PROF. ELISHIBA KIMANI,
DEAN, GRADUATE SCHOOL

Appendix VII: Ethical Clearance

KENYATTA UNIVERSITY
CENTRE FOR RESEARCH ETHICS AND SAFETY

Fax: 8711242/8711575
Email: chairman.kuerc@ku.ac.ke
Nairobi, 00100

P. O. Box 43844,

Tel: 8710901/12

Website: www.ku.ac.ke
Our Ref: **KU/ERC/APPROVAL/VOL.1**

Date: 8th /03/2022

Kiruja Gitonga Jason
P.O Box 43844, 00100
Nairobi.

Dear Mr. Kiruja,

APPLICATION NUMBER: PKU/2409/I15543 - DETERMINANTS OF SUPPLEMENTAL OXYGEN THERAPY COMPETENCIES AMONG NURSES WORKING IN PAEDIATRIC WARDS IN KAJIADO COUNTY, KENYA

This is to inform you that ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE*** has reviewed and approved your above research proposal. Your application approval number is **PKU/2409/I15543.** The approval period is ***8th/03/2022 to 8th/03/2023***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE***
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE*** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE*** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.

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

vii. Submission of an executive summary report within 90 days upon completion of the study to ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE***

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

To serve you better, researchers are kindly requested to access and complete a customer feedback form and sent it back online as you continue with research and upon completion of data collection found on the following website link; ;(https://docs.google.com/forms/d/1ytWefDwvyz5h1oz_VIn0xbxg3uGdlDzMXFWNDsMrRPQ/edit?usp=sharing

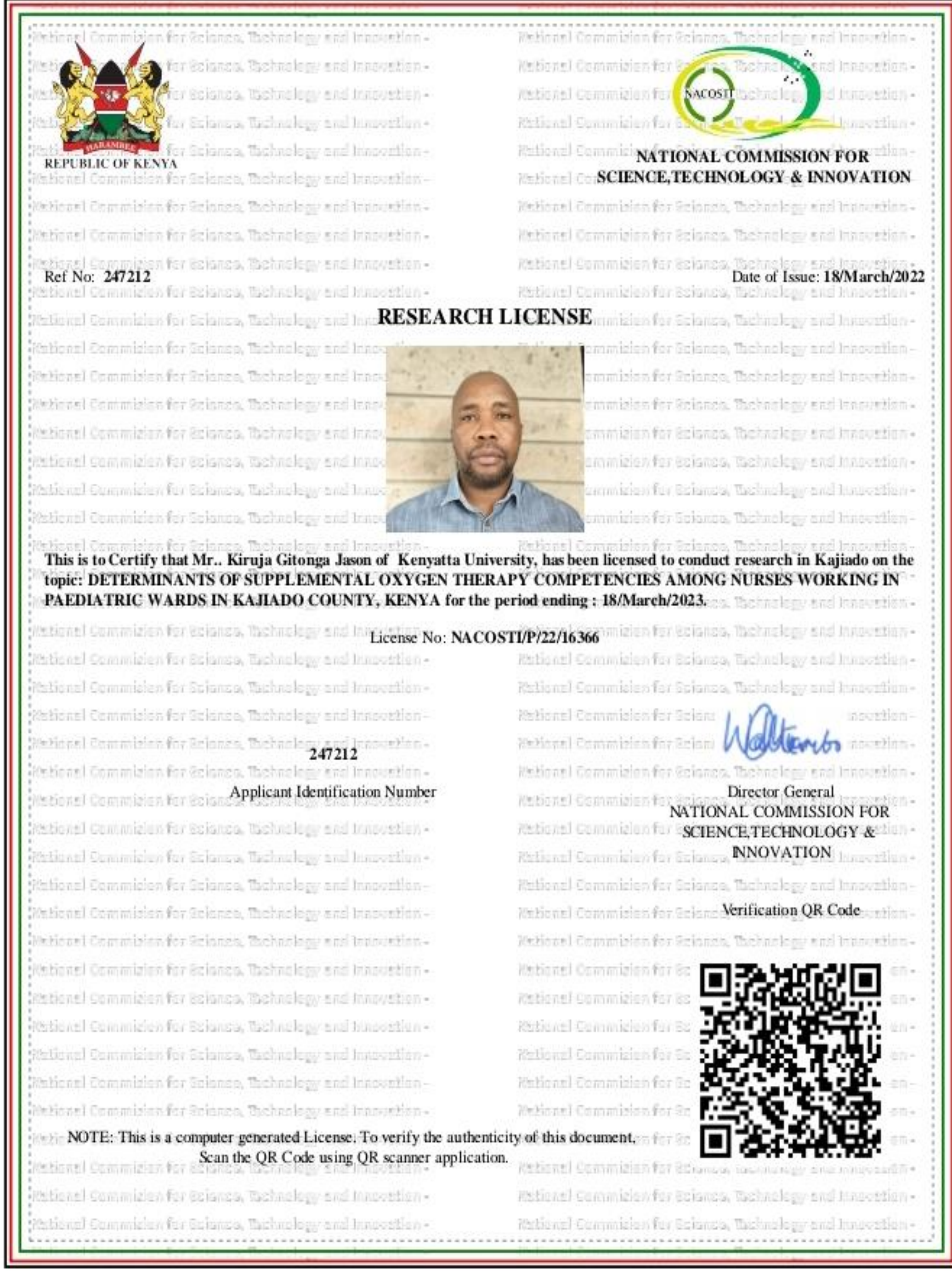
Yours sincerely

KENYATTA UNIVERSITY
OFFICE OF THE CHAIRMAN
08 MAR 2022
ETHICS REVIEW COMMITTEE
P.O. BOX 43844 - 00100 NAIROBI

Prof. Judith Kimiywe

Director: Centre for Research Ethics and Safety

Appendix VIII: Nacosti Permit



REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 247212

Date of Issue: 18/March/2022

RESEARCH LICENSE

This is to Certify that Mr.. Kiruja Gitonga Jason of Kenyatta University, has been licensed to conduct research in Kajiado on the topic: DETERMINANTS OF SUPPLEMENTAL OXYGEN THERAPY COMPETENCIES AMONG NURSES WORKING IN PAEDIATRIC WARDS IN KAJIADO COUNTY, KENYA for the period ending : 18/March/2023.

License No: NACOSTI/P/22/16366

247212

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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

Appendix IX: Kajiado County Government Approval

COUNTY GOVERNMENT OF KAJIADO

DEPARTMENT OF MEDICAL SERVICES & PUBLIC HEALTH
OFFICE OF THE COUNTY DIRECTOR OF MEDICAL SERVICES
P. O. BOX 31, KAJIADO

REF: CGK/MEDICAL SERVICES/01/VOL.11/030 — 24th June, 2022

KIRUJA GITONGA JASON
P. O. BOX 43844-00100
NAIROBI

RE: RESEARCH AUTHORIZATION

Reference is made to communication on your approval from Kenyatta University , Center for Research Ethics and Safety dated 8th March 2022 and Research License reference 247212 from the National Commission for Science, Technology and innovation License no. NACOSTI1/P/22/16366 on the above subject for the period ending 18th March 2023.

The Department has no objection in you carrying out research on '***Determinants of supplemental oxygen therapy competencies among nurses working in Paediatric Wards in Kajiado County, Kenya*** '. You are however required to share findings of your research with this office.

Thank you.

COUNTY DIRECTOR OF HEALTH
KAJIADO COUNTY
24 FEB 2022
P.O Box ... 01100
KAJIADO

DR. EZEKIEL KAPKONI
COUNTY DIRECTOR OF HEALTH SERVICES

CC:

CHIEF OFFICER FOR MEDICAL SERVICES
CHIEF OFFICER FOR PUBLIC HEALTH & SANITATION SERVICES
THE RESPECTIVE, MEDICAL SUPERITENDENTS.