African Journal of Health, Nursing and Midwifery
ISSN: 2689-9418
Volume 7, Issue 1, 2024 (pp. 108-124)
www.abjournals.org

KNOWLEDGE OF OXYGEN THERAPY AMONG NURSES IN A TERTIARY HOSPITAL IN KENYA: IMPLICATIONS FOR PATIENT CARE AND TRAINING NEEDS

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Cite this article:

Kivuti-Bitok L. W., Odhiambo J., Omare S., Mugo C., Zgambo M., Ngune I. (2024), Knowledge of Oxygen Therapy among Nurses in a Tertiary Hospital in Kenya: Implications for Patient Care and Training Needs. African Journal of Health, Nursing and Midwifery 7(1), 108-124.
DOI: 10.52589/AJHNM-SGF3XZIT

Manuscript History

Received: 12 Oct 2023

Accepted: 30 Jan 2024

Published: 1 Mar 2024

ABSTRACT: ***Aim:*** *The aim of this study was to evaluate the knowledge of oxygen therapy among nurses working in pediatric and medical units at a referral hospital in limited resource setting.* ***Design:*** *A Cross-Sectional Survey.* ***Methods:*** *A total of 213 nurses participated after completing an acute oxygen therapy questionnaire that assessed their knowledge of oxygen therapy. The data were analyzed using descriptive statistics and explored the association between variables with chi-square or t-test at $P < 0.05$.* ***Results:*** *The mean age of participating nurses was 37 years, and over 50% were female. On average, participants had not undergone any refresher course on oxygen therapy in the preceding three years. Oxygen therapy knowledge was found to be higher in male nurses ($p = 0.008$), those who were aware of the WHO guidelines for oxygen therapy ($p = 0.006$), and those in senior positions (0.028). Paediatric nurses scored higher in the 'Recognizing Hypoxemia' domain than nurses in the medical department ($p = 0.003$). The domain with the lowest number of correct items identified by participants was 'Clinical Practices' (3.23 ± 1.04). Being older ($r2 = -0.135$) and having worked in the facility for longer ($r2 = -0.156$) correlated with low knowledge of correct oxygen therapy documentation.* ***Conclusion*** *This study identified gaps in knowledge of oxygen therapy among nurses at a referral hospital in Kenya and emphasized the importance of re-training nurses involved in oxygen therapy administration.*

KEYWORDS: Oxygen therapy, Knowledge, Nurses, Kenyatta National Hospital, Kenya.

Article DOI: 10.52589/AJHNM-SGF3XZIT
DOI URL: https://doi.org/10.52589/AJHNM-SGF3XZIT

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INTRODUCTION

Oxygen therapy is a life-saving therapy prescribed for the prevention or treatment of tissue hypoxia. In clinical settings, the World Health Organization (WHO) enlists oxygen as an essential drug used to treat patients at risk for low tissue oxygenation and low oxygen levels in the blood called hypoxaemia, which is life-threatening (Adeniyi et al., 2021). Oxygen therapy improves the quality of life and survival rate in patients with respiratory infections, shock, and respiratory distress (Forum of International Respiratory Societies, 2017; Navuluri et al., 2021).

Oxygen should be treated like a drug as it may pose adverse or deleterious effects when administered over a prolonged period or when delivered in high concentrations (Adeniyi et al., 2021). Therefore, many health policies in several countries, including Kenya, recommend that supplemental oxygen administration must be done by professionals trained in safe oxygen administration (O'Driscoll & Smith, 2019). Unfortunately, unprofessional practices around the management of oxygen have been reported (Enoch et al., 2019; Tuti et al., 2021). For instance, in 2019, the WHO estimated that 1.4 million people died due to a lack of supplemental oxygen therapy and inappropriate administration of oxygen (Adeniyi et al., 2021). Improper administration of oxygen by professionals has been associated with limited training and inadequate guidelines (King et al., 2018). Other factors that have been associated with poor oxygen administration practices include the diagnosis of the patients, the age of the patient, the attitude of health professionals, and a lack of resources (Graham et al., 2018; Maitland et al., 2021).

During the COVID-19 pandemic, supplemental oxygen therapy was recommended as a key component for managing moderate to severe COVID-19 (World Health Organization, 2020; 2021). Just as in many countries, the demand for oxygen therapy increased during the COVID-19 era in Kenya. The survival of COVID-19-infected patients depended on professionals having the right knowledge of oxygen administration, adequate resources, including enough oxygen supply and equipment, and a functional health system (Navuluri et al., 2021). Nurses continued to deliver the bulk of oxygen therapy even in the COVID-19 era. Oxygen therapy guidelines exist to direct professionals on the identification of hypoxaemia, evaluation, and basic standards for the administration of oxygen (Navuluri et al., 2021). However, the extent to which nurses in Kenyatta National Hospital(KNH) know and apply these guidelines to practice is barely known. A recent scoping review in sub-Saharan Africa highlighted that most studies conducted on oxygen focused on the availability and usage of oxygen, and only few have assessed how the implementation is carried out (Navuluri et al., 2021). Oxygen administration is a nursing procedure. Therefore, knowledge of oxygen therapy and its safe practice among nurses is crucial for patient safety, quality of care, adherence to standards, and overall healthcare system efficiency. Knowledge of oxygen therapy and its practice ensures that nurses are well-prepared to provide appropriate and safe oxygen therapy to patients in various clinical settings. In limited resource settings, efficient and appropriate use of oxygen resources is essential. Nurses who understand the principles of oxygen therapy can help manage resources effectively and avoid wastage.

Factors associated with knowledge levels of oxygen therapy among nurses include age, gender, awareness of oxygen therapy guidelines, year of practice, level of education and continuous medical education on oxygen therapy (Adeniyi et al., 2021; Aiken et al., 2018; Bizuneh et al., 2022; Diab et al., 2022; Hassanzad et al., 2022; Nabwire et al., 2018; Thabet et al., 2020). How these factors interplay in low-resource settings has been inadequately explored.

Article DOI: 10.52589/AJHNM-SGF3XZIT
DOI URL: https://doi.org/10.52589/AJHNM-SGF3XZIT

Therefore, the need to explore nurses' knowledge of oxygen therapy during the COVID-19 pandemic and beyond cannot be overstated. We conducted this study to explore the level of knowledge of oxygen therapy and identify factors that influence knowledge on oxygen therapy among nurses deployed at the medical and paediatric departments of KNH.

METHODS

Study Design: This was a cross-sectional descriptive study.

Study Site: We conducted the study at Medical and Pediatric departments of KNH which is the oldest primary national referral hospital in Kenya. Located in the capital city , Nairobi, KNH has a bed capacity of approximately 1800 and provides specialized healthcare to around 80,000 inpatients and 600,000 outpatients every year. The hospital is equipped with 50 wards, 24 operating theatres, and 22 outpatient consultant clinics. It is divided into medical, surgical, and paediatric departments, each comprising at least 12 wards and associated outpatient clinics. Kenya has a workforce of around 6000 employees, with approximately 2500 being nurses. (https://knh.or.ke/index.php/history/)

Study population and sampling

We performed convenience sampling of the nurses working in the Paediatric and Medical departments of KNH as they are most likely to encounter patients who require oxygen therapy. We excluded nurses in the critical care unit as they have specialised training and are more likely to routinely administer oxygen therapy. Our study population consisted of registered nurses deployed in the aforementioned departments at the time of the study. These nurses have basic professional training through their pre-registration programs, such as a Bachelor of Science in Nursing or a Diploma in Nursing, and some may have received additional training on oxygen therapy. The sample size of 213 nurses at a 95% confidence interval was deemed appropriate for our population of 472 nurses based on (Yamanae,1973).

Data Collection Tool and Measurement

The Data collection tool had two main sections: A section on sociodemographic characteristics and another section that captured nurses' knowledge of oxygen therapy. For the second section, we adopted and extended the acute oxygen therapy questionnaire (AOTQ), which has been used widely in similar settings, with a global content validity of 0.85 (Desalu et al., 2019, Desalu et al., 2022). The adopted AOTQ consists of questions on awareness of oxygen therapy guidelines as well as knowledge of oxygen therapy, grouped into six domains: awareness of oxygen therapy guidelines (3 questions), general knowledge of oxygen therapy/safety of oxygen (4 questions), recognition of hypoxaemia (5 questions), indications for oxygen therapy (4 questions), documentation (3 questions), and clinical practices on oxygen delivery (5 questions). Each question across all the last five (5) domains was scored from 0 to 1. We presented the data on oxygen therapy knowledge in percentage and mean scores.

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Ethical Considerations

To ensure ethical standards were met, we obtained approval UP/460/09/2020 from the KNH/UON ethics review board. All respondents were required to provide written informed consent as part of the Google Doc questionnaire. We ensured that participants' data was kept anonymous during the analysis and reporting stages of the study to protect their privacy.

Data Collection

Data was collected between May and June 2022. Before the main data collection, we pretested the study among 10 nurses working in the oncology ward at the same hospital. This was to confirm applicability to the study population, assess practicality, and identify potential issues before full-scale implementation of the study. Once the nurse provided consent to participate in the study, they accessed the survey through a Google Doc link. The nurses took approximately 15-20 minutes to complete the questionnaire. We ensured that nurses' data remained anonymous during the data collection process. The results of the pre-test did not influence the planned approach to data collection.

We invited consenting nurses who had worked in their unit for at least six months to respond to our survey. This timeframe was chosen because employee induction programs at KNH typically take approximately six months, providing nurses with an opportunity to attend to a patient requiring oxygen therapy. We shared the invitation, which included a link to the study information and consent form, in various WhatsApp groups used by nurses at KNH. The link to the study information and consent form remained open until we achieved our desired sample size. WhatsApp is a commonly used communication method for organizations in Kenya.

Data Management and Analysis

After data was collected through the Google Doc survey, we downloaded it as an Excel sheet and cleaned the data. Only the authors had access to the data. They could only access the data through secure accounts and using two-factor authentication. The team regularly monitored access to the data through logs interrogation, and any modification was discussed among the authors. We pseudonymised the data and removed any identifiers. We then transferred the data to SPSS for analysis. The assessment questions had two answers and one was correct. The correct answer was scored 1 and the wrong answer scored 0. We used descriptive statistics to summarise the data, such as means and standard deviations. Additionally, we explored the association between variables using either chi-square or t-test, with a significance level of $P < 0.05$.

To explore the correlation between knowledge, practice, socio-demographics, and additional variables, logistic regression was employed, with a predetermined significance level of 5%. This methodology aligns with the precedent utilisation of results from the tool as demonstrated in prior studies (DEMİREL and Kazan, 2020; Desalu et al., 2022).

In line with the ERC policy (KNH) Ethics and Research Committee, 2016), the data will be safely stored for 5 years after which it will be deleted from the Google Doc platform.

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RESULTS

Participants' demographic and oxygen therapy-related profiles, as well as their knowledge of oxygen therapy, are presented in **Table 1**.

Table 1: Comparison of baseline socio-demographics of nurses in paediatric and medicine departments at KNH

Variables/Domain	All participants	Individual groups		Differences between the groups	
		Medical (n = 139)	Paediatric (n = 84)	t-test or chi-square	P value
Demographics					
Age in yrs. (Mean± SD)	37.34 ± 9.16	37.54±8.907	37.02± 9.560	0.405	0.686
Years after graduation (Mean± SD)	11.95±8.66	11.81±8.74	12.19± 8.58	-0.309	0.757
Length of working in the current facility (years)	10.25±7.90	10.15±7.66	10.42±8.33	-0.246	0.806
Current position (Senior Nursing Officer, Nursing Officer 1)	NO1 and below (52.6%) SNO and above (47.4%)	NO1 and below 46.6%) SNO and above (53.4%)	NO1 and below (61.9%) SNO and above (38.1%)	4.830	0.028
Gender	Males (42.2%) Females (57.8%)	Males (49.1%) Females (53.9%)	Males (50.9%) Females (46.4%)	1.114	.573
Had additional qualifications to the basic nursing training	Yes (74.4%) No (23.5%)	Yes (55.4%) No (44.6%)	Yes (28.6%) No (71.4%	15.204	<0.001
Oxygen therapy-related variables					
Time since the last O_2 therapy administration	<1month ago (75.8%) > 1month ago (25.2%)	<1month ago (76.3%) > 1month ago (23.7%)	<1month ago (75%) > 1month ago (25%)	0.0452	0.831
Time since the last O_2 therapy prescribing	<1month ago (65 %) > 1month ago (35%)	<1month ago (67.6%) > 1month ago (32.4%)	<1month ago (60.7%)	1.100	0.294

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www.abjournals.org

Variables/Domain	All participants	Individual groups		Differences between the groups	
		Medical (n = 139)	Paediatric (n = 84)	t-test or chi-square	P value
			> 1month ago (39.3%)		
Time since the last O_2 therapy training (yrs.) (Mean± SD)	3.52±2.23	3.40±2.59	3.67±1.65	-0.785	0.434
Source of information on O_2 therapy - colleagues	Yes (49.3%) No (50.7%)	Yes (49.6%) No (50.4%)	Yes (52.4%) No (47.6%)	0.157	0.692
Source of information on O_2 therapy – Journals + Other Media	Yes (58.7%) No (41.3%)	Yes (52.5%) No (47.5%)	Yes (69 %) No (31%)	5.901	0.015
Aware of WHO guidelines for O_2 therapy	Yes (65.9%) No (34.1%)	Yes (59.7%) No (40.3%)	Yes (76.2%) No (23.8%)	6.328	0.011
Knowledge of Oxygen Therapy					
O_2 Safety (Mean± SD) [max score 5	3.80±0.89	3.77±0.89	3.85±0.90	-0.612	0.540
Recognise Hypoxaemia (Mean± SD)	4.28 ±0.62	4.19 ±0.60	4.44 ±0.63	-2.987	0.003
Indications for O_2 therapy (Mean± SD)	4.30± 0.84	4.30± 0.91	4.30± 0.72	-0.004	0.996
Documentation (Mean± SD)	2.84± 0.45	2.86± 0.37	2.81± 0.55	0.755	0.451
Clinical Practices on O_2 delivery (Mean± SD)	3.23 ± 1.04	3.22 ± 1.00	3.23 ± 1.11	-0.011	0.991
Overall knowledge of O_2 therapy (Mean± SD)	18.46 ±0.89	18.36 ±2.02	18.62 ±2.02	-0.923	0.357

Key: {O_2 Safety, Recognise Hypoxaemia, Indications for O_2 therapy, and Clinical Practices on O_2 delivery [minimum score =0 and maximum score =5]; Documentation [minimum score=0 and maximum score =5]; Overall knowledge of O_2 therapy [minimum score=0 and maximum score =23]

The study found that there were no significant differences in the demographic profiles of nurses across the two departments (medicine and paediatrics). The mean age of all participants was approximately 37 years, and more than half were female. On average, participants worked as nurses for around 12 years, with about 10 years of experience in their respective departments. The only significant differences between the two departments were observed in the variables 'current position' ($p = 0.028$) and 'additional qualifications' ($p < 0.001$), with more senior nurses and those with additional training being in the medicine department. However, the data

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DOI URL: https://doi.org/10.52589/AJHNM-SGF3XZIT

were analysed together because these differences were expected due to the larger number of wards in the medicine department and a higher number of nurse managers (SNOs) likely to have additional qualifications.

The recency of administering oxygen was high across both departments, with over 60% of participants having administered or prescribed oxygen to a patient in the month preceding the survey. More than half of the participants relied on their colleagues as their only source of current information on oxygen therapy, and on average, they had not received oxygen therapy refresher training in about three years

Oxygen therapy practice was assessed using five structured questions on oxygen delivery practices and three questions on documentation for the delivery of oxygen. All questions had two wrong answers and one correct answer. The correct answer got a score of 1 point and the wrong answer scored 0.

The summary responses for each of the questions are presented in **Table 2.**

Table 2: Nurses' knowledge and practice of oxygen therapy represented by the number and percentage (n=223)

	General Knowledge of Medical Oxygen.	Percentage (%) of those who answered Correctly	Percentage (%) of those who answered Wrongly
1.	Oxygen is a medication	140(62.8)	83(37.2)
2.	Oxygen is not medication but a supportive therapy	121(54.3)	102(45.7)
3.	Oxygen should only be given after doctor's prescription	157(70.4)	66(29.6)
4.	Oxygen can cause combustion	214(96)	9(4)
	Recognising Hypoxaemia		
1.	Hypoxaemia can be recognised by clinical signs	214(96)	9(4)
2.	Blood Gas Analysis is useful for confirming hypoxaemia	222(99.6)	1(0.4)
3.	Breathlessness is not always a sign of hypoxaemia	116(52.3)	106(47.7)
4.	Pulse Oximetry is useful in detecting and monitoring hypoxaemia	215(96.4)	8(3.6)
5.	SpO2 level < 90 % in adults defines hypoxaemia	188(84.3)	35(15.7)
	Indication for Acute Oxygen Therapy **Critical oxygen therapy should be suggested for**		
1.	Central Cyanosis	220(98.7)	3(1.3)
2.	Asymptomatic Anaemia	144(64.6)	79(35.4)
3.	Eclampsia	188(84.7)	34(15.3)
4.	Restlessness and Convulsion in children	193(86.6)	30(13.4)
5.	Respiratory distress (respiratory rate >24/min in adults or 60 in neonates)	212(95.1)	11(4.9)
	Documentation for Delivery of Oxygen		

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	Which of the following should be documented in the Treatment/Monitoring Chart of a patient receiving oxygen?		
1.	Oxygen Flow Rate or FIO2	207(92.8)	16(7.2)
2.	Oxygen Source and Delivery Device	208(93.3)	15(6.7)
3.	Frequency of Administration	218(97.8)	5(2.2)
	Oxygen Delivery Practices		
1.	Oxygen prescription should be to a target saturation range rather than a fixed dose	111(49.8)	112(50.2)
2.	A 72-year-old farmer with COPD has carbon dioxide retention (type II respiratory failure); which of these delivery devices is appropriate for oxygen delivery to achieve a target saturation of 88-92%? Nasal catheter at 1-2 L/min/ in the absence of Venturi masks	134(60.4)	88(39.6)
3.	A 12-year-old boy had type 1 respiratory failure, select one correct initial dose of oxygen to achieve a target saturation of 94-98%	182(81.6)	41(18.4)
4.	Humidification is essential for patients receiving oxygen through one of the following:	113(50.7)	110(49.3)
5.	Regarding weaning and discontinuation of oxygen, which of the following statements is correct?	180(80.7)	43(19.3)

Of the total participants, 140(62.8%) were aware that oxygen was a medication. The majority were aware that inappropriate use of oxygen can cause harm (96.4%) and can cause combustion (96%).

The majority of the participants were able to correctly identify the conditions that can be suggested for acute oxygen therapy (AOT) with above 80% correct answers for most conditions except in the case of Asymptomatic Anaemia where only 64.6% indicated that AOT can be suggested as a treatment.

For the questions on documentation of oxygen delivery, the correct responses were above 90% for all the questions. Regarding oxygen delivery practices questions, scores range from a maximum score of 81.6% to a minimum score of 49.8 % from all questions. The most correctly answered question was that of a 12-year-old boy who had type 1 respiratory failure (81.6%)) followed by one regarding weaning and discontinuation of oxygen (81.6%)). The least correctly answered question was that oxygen prescription should be to a target saturation range rather than a fixed dose (49.8%).

Each respondent's complete knowledge score was calculated by dividing the number of correct responses to the survey questions by the maximum possible score. Then, the scores were converted to a percentage. The total knowledge score per respondent was then classified based on the original Bloom's cut-off points into Low level (<60%), moderate level (60%-79%), and high level (≥80%) (Bloom, 1968).

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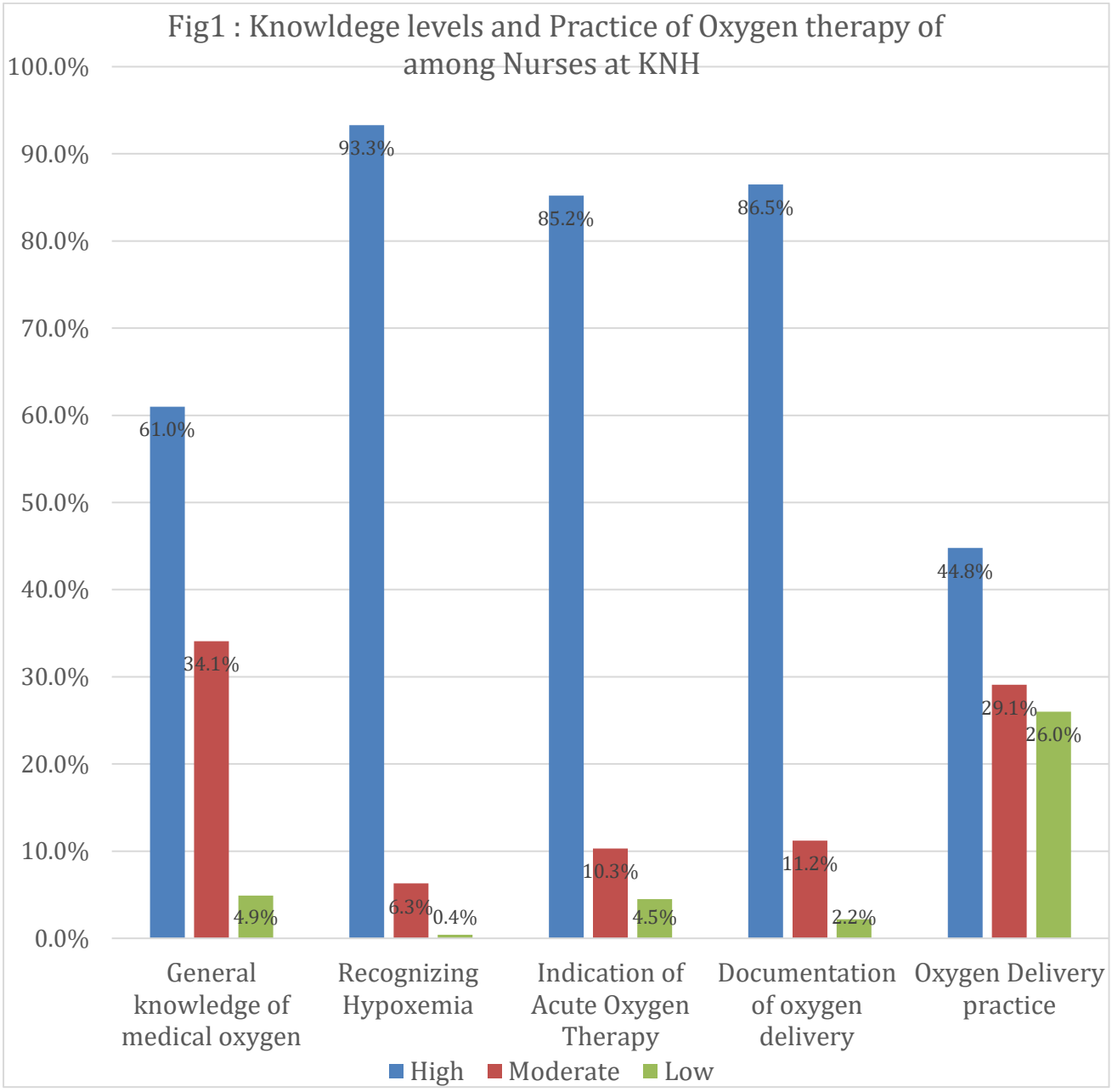
African Journal of Health, Nursing and Midwifery
ISSN: 2689-9418
Volume 7, Issue 1, 2024 (pp. 108-124)
www.abjournals.org

We further categorised the participants into two. Participants scoring the mean score or above (≥75.9%) were categorised as having good knowledge, while those scoring below the mean (<75.9%) were considered to have poor knowledge.

The results are presented in **Figure 1.**



Combining all the scores for all the questions, the scores range from 12 to 23 with a mean score of 18.44. Overall majority of the respondents (51%) had a high level of knowledge, awareness, and practice of oxygen therapy, 48% had moderate knowledge and 1% had low-level knowledge.

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On exploration of the association between variables using either chi-square or t-test, with a significance level of $P < 0.05$ for each of the five categories of the questions.

In terms of knowledge of oxygen therapy, participants had a good understanding of most of the items across four of the five domains. Paediatric nurses had higher scores in the 'Recognising Hypoxaemia' domain compared to nurses from the medicine department ($p = 0.003$). The domain with the highest mean score was the 'Documentation' domain, with all participants correctly identifying more than two out of the three items. However, the domain with the lowest number of correct items identified by participants was 'Clinical Practices,' with several participants unable to interpret clinical scenarios and select a suitable oxygen delivery device or identify the need for oxygen weaning or humidification of oxygen when a patient has a tracheostomy.

Impact of the Participant's Profile on Knowledge and Practice of Oxygen Therapy

The results were further explored using Spearman correlation, One-way analysis of variance, and an independent sample T-test to examine the influence of the participant's profile and other key variables on knowledge levels across the four domains (O2 safety, Recognise Hypoxemia, Indications for O2 therapy documentation, Clinical Practices and O2 delivery), and on the total knowledge of O2 therapy (Table 3).

Table 3: Univariate analysis – Relationships between participants' profiles on the scores across the five domains of the Oxygen therapy tool

Variable	O_2 Safety	Recognise Hypoxaemia	Indications for O_2 therapy	Documentation	Clinical Practices and O_2 delivery	Overall knowledge of O_2 therapy
Age (r^2)	-0.068	-0.054	-0.155*	-0.135*	-0.002	-0.123
Years after graduation (r^2)	-0.070	-0.086	-0.217**	-0.046	-0.044	-0.191**
Length of working in the current facility (years) (r^2)	-0.060	-0.038	-0.229**	-0.156*	0.001	-0.145*
Current position ≤Nursing Officer 1(NO1)/≥Senior Nursing Officer (SNO) (Mean scores, p values)	≤NO1 = 3.75 ≥SNO =3.85 p = 0.544	≤NO1 = 4.37 ≥SNO =4.21 p=0.0573	≤NO1 = 4.42 ≥SNO =4.12 p=0.010	≤NO1 = 2.86 ≥SNO =2.80 p = 0.380	≤NO1 = 3.23 ≥SNO =3.22 p=0.908	≤NO1 = 18.66 ≥SNO =18.23 p = 0.125

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Variable	O_2 Safety	Recognise Hypoxaemia	Indications for O_2 therapy	Documentation	Clinical Practices and O_2 delivery	Overall knowledge of O_2 therapy
Gender (Mean scores, p-value)	Male = 3.98, female =3.66 p = 0.006	Male = 4.29 Female =4.281 p = 0.994	Male 4.372, Female =4.24 p = 0.256	Male 2.872 Female =2.81 p = 0.336	Male 3.351 Female =3.133 p = 0.124	Male 18.872 Female =18.151 p = 0.008
Department medicine/ paediatrics (mean scores, p values)	Medicine 3.77, Paediatrics =3.85 p = 0.541	Medicine 4.19, Paediatrics =4.44 p = 0.003	Medicine 4.30, Paediatrics =4.30 p = 0.100	Medicine 2.86, Paediatrics =2.81 p = 0.451	Medicine 3.22, Paediatrics =3.23 p = 0.991	Medicine 18.36, Paediatrics =18.62 p = 0.357
Time since the last O_2 therapy administration (mean scores, p values)	<1month ago = 3.83 > 1month ago = 3.70 p = 0.371	<1month ago = 4.25 > 1month ago = 4.39 p = 0.153	<1month ago = 4.37 > 1month ago = 4.07 p = 0.062	<1month ago = 2.83 > 1month ago = 2.85 p = 0.802	<1month ago = 3.28 > 1month ago = 3.06 p = 0.170	<1month ago = 18.58 > 1month ago = 18.07 p = 0.107
Time since the last O_2 therapy prescription (mean scores, p values)	<1month ago = 3.80 > 1month ago = 3.79 p = 0.967	<1month ago = 4.24 > 1month ago = 4.37 p = 0.120	<1month ago = 4.31 > 1month ago = 4.28 p = 0.843	<1month ago = 2.82 > 1month ago = 2.87 p = 0.416	<1month ago = 3.32 > 1month ago = 3.05 p = 0.068	<1month ago = 18.51 > 1month ago = 18.37 p = 0.636
Aware of WHO guidelines for **O_2** therapy (mean scores, p values	Yes = 3.90 No = 3.59 p = 0.013	Yes = 4.34 No = 3.99 p = 0.051	Yes = 2.89 No = 2.72 p < 0.001	Yes = 2.90 No = 2.72 p = 0.005	Yes = 3.38 No = 2.93 p = 0.003	Yes = 18.99 No = 17.43 p < 0.001

Key: **Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed).

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Several variables are correlated with the level of knowledge of oxygen therapy. Being aware of WHO guidelines for oxygen therapy had the highest significant influence on participants' level of knowledge about oxygen therapy ($p < 0.001$). Participants who were aware of the WHO guidelines scored higher across all the questionnaire domains.

Being older ($r2 = -0.135$, $p = 0.047$) and having worked in the facility for longer ($r2 = -0.156$, $p = 0.021$) was correlated with low levels of knowledge of correct oxygen therapy documentation. However, this correlation was weak. A longer length of service was also associated with lower scores on indications of oxygen therapy ($p = 0.005$) and overall knowledge of oxygen therapy ($p = 0.015$). Senior nurses had higher levels of knowledge on indications of oxygen therapy ($p = 0.010$) and the male gender was associated with higher scores on oxygen safety ($p = 0.006$) and overall knowledge of oxygen therapy ($p = 0.008$).

DISCUSSION

We assessed participants' knowledge of oxygen therapy, distinguishing between those with good knowledge (scoring mean or above, ≥75.9%) and those with poor knowledge (scoring below the mean, <75.9%). In the realm of oxygen therapy knowledge, males emerged with higher expertise compared to females, while participants holding additional qualifications demonstrated a concerning trend toward a poorer understanding of oxygen therapy. This trend extended to specific facets, such as knowledge of hypoxemia and indications of Oxygen Therapy (AOT), where only individuals with additional qualifications exhibited a propensity for poorer scores.

Moreover, the investigation delved into the documentation practices related to oxygen, revealing a significant association with departmental differences at a 10% significance level. Various departments displayed distinct levels of correlation with the documentation of oxygen, underlining the importance of organisational factors. Additionally, the temporal aspect of oxygen therapy was scrutinised, indicating that the time since the last oxygen prescription was intricately linked to participants' oxygen delivery practices. Simultaneously, awareness of WHO guidelines emerged as a positive factor, correlating with participants exhibiting good knowledge of oxygen delivery practices. Intriguingly, a longer time since the last prescription was associated with a higher likelihood of poor oxygen delivery practices, shedding light on potential challenges in sustained adherence to prescribed practices.

In considering the overall knowledge of oxygen therapy, several factors emerged as influencers. The study highlighted that participants' sex, years of service at the current hospital, and awareness of WHO guidelines significantly affected their overall knowledge. Specifically, females tended to possess poorer knowledge compared to their male counterparts, and increasing years of service at the current hospital correlated with a higher likelihood of poor judgment in overall knowledge. On a positive note, participants informed about WHO guidelines were more likely to exhibit a commendable level of knowledge of oxygen therapy, emphasising the importance of guideline awareness in enhancing understanding and practices in clinical settings

Our results showed that higher qualifications, seniority, years of practice, age, and gender were influential factors in the nurses' knowledge of oxygen therapy. These findings are consistent with previous studies (Aiken et al., 2018; Bizuneh et al., 2022; Hassanzad et al., 2022).

Article DOI: 10.52589/AJHNM-SGF3XZIT
DOI URL: https://doi.org/10.52589/AJHNM-SGF3XZIT

Nurses in the medical department were found to have higher qualifications and additional training than those in the paediatric unit ($p < 0.001$). This could be because there are slightly more nurses working in the adult medical department, resulting in a higher number of nurse managers (SNOs) who are more likely to have additional qualifications or training. However, paediatric nurses were more knowledgeable in identifying hypoxemia ($p = 0.003$). Children have a smaller functional residual capacity, smaller airways, and higher metabolic oxygen demands that predispose them to rapid desaturation compared to adults (Saikia & Mahanta, 2019). Due to these anatomical and physiological features of children, there is a possibility that nurses working in the paediatric ward have an added advantage in expanding their knowledge of O_2 therapy through frequent exposure to children's oxygenation needs and procedures during practice compared to nurses in the medical wards. Irrespective of the patient's age, hypoxemia is both dangerous and deleterious to adult and paediatric patients. Thus, we recommend equipping all nurses in KNH hospitals with relevant knowledge and skills to identify and promptly manage hypoxemia to save lives (Adeniyi et al., 2021; O'Driscoll & Smith, 2019).

The study established that senior nurses had higher scores on oxygen therapy ($p = 0.006$) and oxygen safety ($p = 0.008$), which could be attributed to their higher educational level and level of experience (Aiken et al., 2018; Bizuneh et al., 2022)

Of concern, more than half of the participants had administered or prescribed O_2 therapy within one month before the survey, yet most of the respondents had their last training on O_2 therapy in over three years. This is consistent with findings from previous studies conducted in Nigeria, Saudi Arabia, Uganda, and Egypt (Adeniyi et al., 2021; Diab et al., 2022; Nabwire et al., 2018; Thabet et al., 2020) where more than half of their participants had not attended training or workshop on O_2 therapy in the recent past. In studies conducted in Ethiopia, a lack of training in oxygen therapy was associated with the poor practice of oxygen therapy (Bizuneh et al., 2022; Zeleke & Kefale, 2021). The lack of training in oxygen therapy could also explain why nurses in this study were unable to select the right oxygen delivery device and identify the need for oxygen therapy for patients in given scenarios. Nurses aware of the WHO guidelines scored higher than others in all five domains. In Ethiopia, nurses who had read international guidelines for oxygen therapy were found to have a 4.34 times higher likelihood of good knowledge of oxygen therapy than those who did not read these guidelines (Bizuneh et al., 2022).

Interestingly, this study found that the duration of service was conversely associated with lower scores on indications for oxygen therapy. A similar correlation was found in an Iranian study where nurses who had worked for longer than 16 years had lower levels of knowledge of oxygen therapy. The highest levels of knowledge were observed among those who had worked between 8 to 15 years (Hassanzad et al., 2022). Additionally, age was conversely associated with knowledge of oxygen therapy, consistent with findings by Hassanzad et al. (2022) and Demirel & Kazan (2020). Male gender scored higher on oxygen safety ($p = 0.006$) and overall knowledge of oxygen therapy ($p = 0.008$), consistent with findings by Hassanzad et al. (2022). Other studies, however, have not found a significant association between gender and knowledge of oxygen therapy (Adeniyi et al., 2021; Kadhim & Juma, 2021).

Our study highlights the importance of gender, additional qualifications, department, time since the last prescription, and awareness of WHO guidelines in influencing participants' knowledge and practices related to oxygen therapy. Addressing these factors may contribute to improving the overall understanding and application of oxygen therapy in clinical settings.

Article DOI: 10.52589/AJHNM-SGF3XZIT
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Overall, these findings highlight the importance of consistent regular training for nurses in oxygen therapy to keep them abreast of current knowledge and necessary skills, which has implications for the outcomes of patients in need of oxygen therapy (Diab et al., 2022).

STRENGTHS AND LIMITATIONS

This study has identified gaps in knowledge of oxygen therapy in nurses at a referral hospital in "REDACTED'' that have implications for extensive education regarding oxygen therapy. We used a validated tool specially developed to assess knowledge of oxygen therapy. The main limitation of the study is that it used only one social media platform to recruit the respondents and was conducted on a convenient sample in one hospital. The inherent weakness of convenient sampling limits the generalisation of findings (Obilor, 2023) to other hospitals in Kenya and elsewhere. The use of online surveys has its limitations including illegitimate participation, and skewed results among others (Nayak & Narayan, 2019; Shiyab et al., 2023) We used email identifiers and time stamps to avoid duplicate and illegitimate participation. These were not included in the data analysis. We did not offer any monetary benefits for participating in the study hence reducing the chances of multiple responses from individual respondents. Lastly, interpretation of the findings should be carried out with a consideration of limitations associated with the cross-sectional methodology.

CONCLUSION AND RECOMMENDATIONS

This study revealed that the knowledge of oxygen therapy among nurses in KNH is influenced by factors such as higher qualifications, seniority, years of practice, age, and gender. However, more than half of the participants had not attended any training or workshop on oxygen therapy in over three years. It is crucial to prioritise consistent regular training for nurses in oxygen therapy to keep them up-to-date with current knowledge and necessary skills. These will have significant implications on the outcomes of patients in need of oxygen therapy. The training programs should be tailored to meet the specific needs of nurses in both medical and paediatric departments.

Based on the findings of the study, and in line with advancing health professional education to enhance the quality of care (Brown et al., 2021), particularly in oxygen therapy practices KNH could undertake the following measures:

1. Continuous and targeted training programs should be instituted, focusing on areas where knowledge scores were identified as lower, especially in the 'Clinical Practices' domain.
2. Regular refresher training for nursing staff is essential to keep them abreast of the latest guidelines and practices in oxygen therapy.
3. Constructive feedback based on training performance should be integrated to create a continuous improvement loop.

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4. KNH management should prioritise improving awareness of international guidelines, particularly emphasising WHO guidelines for oxygen therapy, and integrating these guidelines into daily practices and decision-making processes. This strategic move can significantly contribute to an overall enhancement of knowledge levels.

5. Tailoring educational interventions based on demographic factors, such as the correlation between longer service and lower scores in certain domains, can address specific needs. For instance, tailored educational initiatives for senior nurses may be developed, focusing on areas related to documentation and indications for oxygen therapy.

   Additionally, considering gender-specific training programs, given the observed association between the male gender and higher scores on oxygen safety and overall knowledge, can further refine educational strategies.

6. Creating a culture of knowledge sharing among nursing staff is crucial, considering that a significant portion relies on colleagues for information. Encouraging an environment that fosters the sharing of experiences and best practices can contribute to continuous learning.

7. Furthermore, the establishment of mentorship programs, where less experienced nurses learn from their more seasoned counterparts, can facilitate the transfer of practical knowledge and instil a sense of shared responsibility for patient care.

8. Finally, the institution should commit to regular evaluations of the effectiveness of implemented interventions, making necessary adjustments based on feedback, performance data, and evolving best healthcare practices. These measures collectively aim to improve oxygen therapy knowledge and practices among nursing staff, ultimately enhancing patient care and safety at the hospital.

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

The authors received no funding for this study.

Acknowledgement

The nursing officers from Nursing Standards, students, and the research department of KNH reviewed the questionnaire and facilitated contacting of nursing staff from the two departments of focus.

Article DOI: 10.52589/AJHNM-SGF3XZIT
DOI URL: https://doi.org/10.52589/AJHNM-SGF3XZIT

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