INSTITUTIONAL DETERMINANTS OF OXYGEN DELIVERY DEVICE UTILIZATION IN CRITICAL CARE UNITS AT A LEVEL 6 HOSPITAL IN KENYA

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International Academic Journal of Health, Medicine and Nursing (IAJHMN) | ISSN 2523-5508

Received: 12th May 2025

Published: 15th May 2025

Full Length Research

Available Online at: https://iajournals.org/articles/iajhmn_v2_i2_1_14.pdf

Citation: Ndambuki, N. M., Meng'anyi, L. M., Masika, J. W. (2025). Institutional determinants of oxygen delivery device utilization in critical care units at a level 6 hospital in Kenya. *International Academic Journal of Health, Medicine and Nursing, 2*(2), 1-14.

ABSTRACT

Background: Oxygen is among the most commonly used drugs in hospitals. Although it is crucial for human survival, it might cause toxicity when delivered erroneously, either by delivering the wrong dose or method. With different pulmonary diseases requiring different oxygen requirements, it is crucial to understand if health practitioners can select an oxygen delivery device for a specific condition. This study aims to establish the institutional factors that affect the utilization of oxygen delivery devices in the Critical Care Units(CCUS) at Kenyatta National Hospital(KNH).

Methods: This study adopted a descriptive-analytical design. A Convenience sampling technique was used to collect data from the 151 participants from different critical care units at KNH from November 2023 to December 2023.

Findings: The findings were as follows: healthcare providers who participated in continuing professional development (CPD) on oxygen delivery devices had a significant increase in the odds (OR = 1.959, 95% CI: 1.025-3.747, p = 0.042) of good practice. Additionally, the results showed that 50.3% of providers demonstrated good practice, while 49.7% fell into the poor practice category—indicating nearly an even split.

Conclusion: Results indicate that institutional support through CPD and Standard Operating Procedures (SOPS) positively correlates with effective oxygen device utilization. Recommendations emphasize creating structured training protocols, developing SOPS, and enhancing CPD participation for improved oxygen therapy outcomes.

Keywords: Oxygen Therapy, Institutional Factors, Healthcare Provider Factors, Continuous Professional Development, Sops, Kenya

INTRODUCTION

Background

Globally, approximately 1.4 million deaths occur yearly as a result of the improper administration of oxygen or a lack of oxygen administration. The culture of liberal oxygen administration is deeply rooted in most of the practices according to literature. Oxygen is like a double sword, on one side it's beneficial, on the other side it can have toxic effects" It is therefore crucial to understand institutional factors that affect the utilization of oxygen delivery devices('Practice')(Mayhob, 2017; Organization, 2019)

Oxygen therapy is critical for managing respiratory conditions, especially in critical care units where hasty responses are crucial. The World Health Organization (WHO) lists oxygen as an important medicine, requiring accurate dosages and delivery based on patient needs However, in many healthcare settings, especially those in resource-limited countries, inconsistent practices in oxygen therapy have been reported due to varying levels of training, institutional support, and access to protocols(Adeniyi et al., 2021; Organization, 2017).

A study conducted in Australia on the understanding of critical care nurses on oxygen therapy identified that oxygen practice was lacking. Moreover, a study at Waikato Hospital and in a study done by Susanto & Thomas identified that it was common practice for health care workers to administer un titrated oxygen to COPD patients. un-titrated administration of oxygen to COPD patients is a common practice (Eastwood et al., 2012; Holbourn & Wong, 2014; N. Navuluri et al., 2021; Susanto & Thomas, 2015).

In Riyadh Saudi Arabia a study was done in four main tertiary hospitals which pointed out the lack of oxygen therapy guidelines and workload as institutional factors that affected good oxygen therapy practice.(Aloushan et al., 2019)

In Africa, a study done in Cairo Egypt which was done to different critical care units, and Addis Ababa Ethiopia on midwives and nurses in emergency department units in one federal and three regional hospitals listed institutional factors that affected oxygen therapy as: a lack of standard protocol for oxygen therapy, lack of oxygen equipment's and lack of training on oxygen therapy in this study done in Ethiopia only 18% of the participants had a good practice (Lemma, 2015; Mayhob, 2017)

In Kenya there is paucity of information in regards to institutional factors affecting oxygen practice. In a study done by Mwita et al that was done was done to assess compliance with traumatic brain injury management criteria, listed oxygen among the management criteria, and

only 28.8% of the patients received supplemental oxygen as required which highlighted inadequate oxygen practice(Mwita et al., 2016)

Additionally, oxygen shortages have been experienced in most African countries including Kenya, in one of the local newspapers dated 8th April 2021 Kenyatta National Hospital (KNH) was reported to be worst hit by oxygen shortage" during the third wave of Covid 19. In Kenya, critical care units like those at KNH handle diverse patient cases, making it essential to assess how institutional factors impact oxygen therapy practices.(Kahenda, n.d.)

The purpose of this study is to establish the association between institutional factors and the utilization of oxygen delivery devices at Kenyatta National Hospital Critical Care Units. The study Explored how factors like availability of oxygen and oxygen delivery devices, presence of SOPs (standard operating procedures) and participation in Continuous Professional Development(CPD) trainings on oxygen affected the overall practice on oxygen

Statement of the Problem

Pulmonary diseases account for the leading cause of death worldwide, thus increasing the medical burden dramatically. They are categorized mainly as obstructive and restrictive each of them requiring different oxygen needs (Bhattacharjee et al., 2022)
Oxygen is among the most widely used drugs in the clinical areas, it is mostly administered in critical areas and emergency areas. In most situations oxygen is used as first-line treatment in various conditions with most organizations recommending titration of oxygen, its implementation remains inadequate in much of the world (Adipa et al., 2015; Beasley et al., 2015)

Despite the publication of the first United Kingdom emergency medicine guidelines which challenged to establish custom, audits still suggest poor practice on oxygen therapy. As a result of Poor practice of oxygen administration, may result in conditions e.g. pulmonary oxygen toxicity, absorption atelectasis and oxygen-induced hypercapnia (Kane et al., 2013; Roberts et al., 2013).

The researcher therefore aims to establish the utilization of oxygen delivery devices by healthcare providers at Kenyatta National Hospital, among healthcare providers in critical care units. This will aid in recognizing knowledge gaps and make future commendations for research in this area. There is a paucity of local studies assessing the utilization of oxygen delivery devices among healthcare providers. It is therefore crucial to understand if health care providers that are at the KNH, CCUs can select the proper device for the patient's condition and needs.

SUBJECTS AND METHODS

Study setting, design and population

A cross-sectional descriptive study was conducted within the critical care units at KNH, Kenya's largest referral hospital. The hospital provides care across multiple critical care units, including those focused on cardiac, neuro, Medical and maternity patients, offering a comprehensive view of oxygen therapy practices in diverse patient populations.

Sample selection and size

The study involved 151 healthcare providers, including nurses, anesthesiologists, registrars of anaesthesia, and medical officers. The fisher's formula was used in this study to calculate the sample size for nurses while a census study was done on the medical officers, registrar anesthesia and intensivist due to the small sample size. Convenience sampling accounted for varying shift schedules, enabling a diverse participation range.

Data collection

Data was collected using a structured questionnaire that captured demographic information, and institutional factors (e.g., SOPs, CPD participation). The questionnaire included clinical scenario questions to assess practical decision-making in oxygen therapy.

Pre-test of the questionnaire

A pretest was done at Kenyatta National Hospital Accident and Emergency Critical Care Unit on 10 participants

Data analysis and presentation

Statistical analysis was conducted using descriptive statistics for demographic data and multivariable binary logistic regression to examine associations between independent variables and device utilization. Odds ratios (OR) and 95% confidence intervals (CI) were calculated for each predictor. The data was analyzed using IBM SPSS Statistics 28.

Ethical consideration

Approval was acquired from the Kenyatta University Ethics and Research Committee (KUERC) ref number *PKU/27718/11903*. A permit was obtained from the National Commission of Science and Technology and Innovation (NACOSTI) ref number *NACOSTI/P/23/29674*. Additionally, approval was obtained from the Kenyatta National Hospital administration, Kenyatta National Hospital-university of Nairobi ethics and research committee (KNH-UON ERC) ref number *KNH-ERC/RR/863* and approval was obtained from Kenyatta National Hospital department of anesthesia. The purpose and the benefits of the study were communicated and informed consent was obtained.

RESEARCH RESULTS

Descriptive statistics

Most participants (62.3% female) had a median of 5 years of experience in critical care, with nurses making up the majority (77.5%). About 58.3% of healthcare providers had access to SOPs for oxygen device utilization, while 52.9% participated in CPD related to oxygen therapy

Institutional factors

Availability of Oxygen and Oxygen Delivery Devices

The responses concerning the availability of different oxygen delivery devices were as follows; All the respondents ascertained that nasal prong was readily available in their CCU,149(99.3%) agreed that NRM is readily available in their CCU,46(62.2%) agreed that a partial rebreather is readily available in their department,96(70.6%) ascertaining that simple face mask is readily available in their CCU and 38(37.3%) stating that a venturi mask is readily available (Table 1) Half of the participants 76(50.33%) experienced oxygen shortages and 57(75%)experienced oxygen shortages 1-3 times.(Table 4)

Standard operating procedures on oxygen therapy and oxygen delivery devices

The responses concerning the availability of standard operating procedures(SOPS) are as follows; the majority of the participants 88(58.28%) had standard operating procedures on the type of oxygen delivery devices to use for different respiratory conditions (Table 4).

CPD on oxygen therapy and oxygen delivery devices

Table 4 represents the presence and frequency of CPD across the critical care units in KNH. About half of the participants 71(52.98%) had participated in CPD on oxygen and oxygen delivery devices. In regards to the frequency of participating in CPD on oxygen and oxygen delivery devices 21(29.58%) always participated,11(15.49%) rarely participated and 39(54.93%) sometimes participated in CPD.

Practice on utilization of oxygen delivery devices

Clinical scenarios

The participants were presented with three clinical scenarios regarding the practice of healthcare providers in utilizing oxygen delivery devices. Firstly, when presented with a patient with COPD saturating at about 75% on room air, 61(40.4%) of the participants preferred nasal prongs,55 (36.4%)preferred NRM, 26(17.2%) Preferred a venturi mask, and 9(6%) preferred a simple face mask.

Secondly, when presented with a patient saturating at about 82% on room air, 72(47.7%) of the participants preferred nasal prongs,60 (39.7%) preferred Non Rebreather mask, 16 (10.6%) preferred Partial Rebreather Mask and 3(2%) preferred T piece.

Lastly in the context of a 48-year-old male patient diagnosed with pneumonia and saturating between 70%-75% on room air, the majority of the respondents122 (80.8%) preferred the Non-rebreather mask,17(11.3%) preferred simple face mask,7(4.6%) preferred nasal prongs and 5(3.3%) preferred t-piece (Table 1)

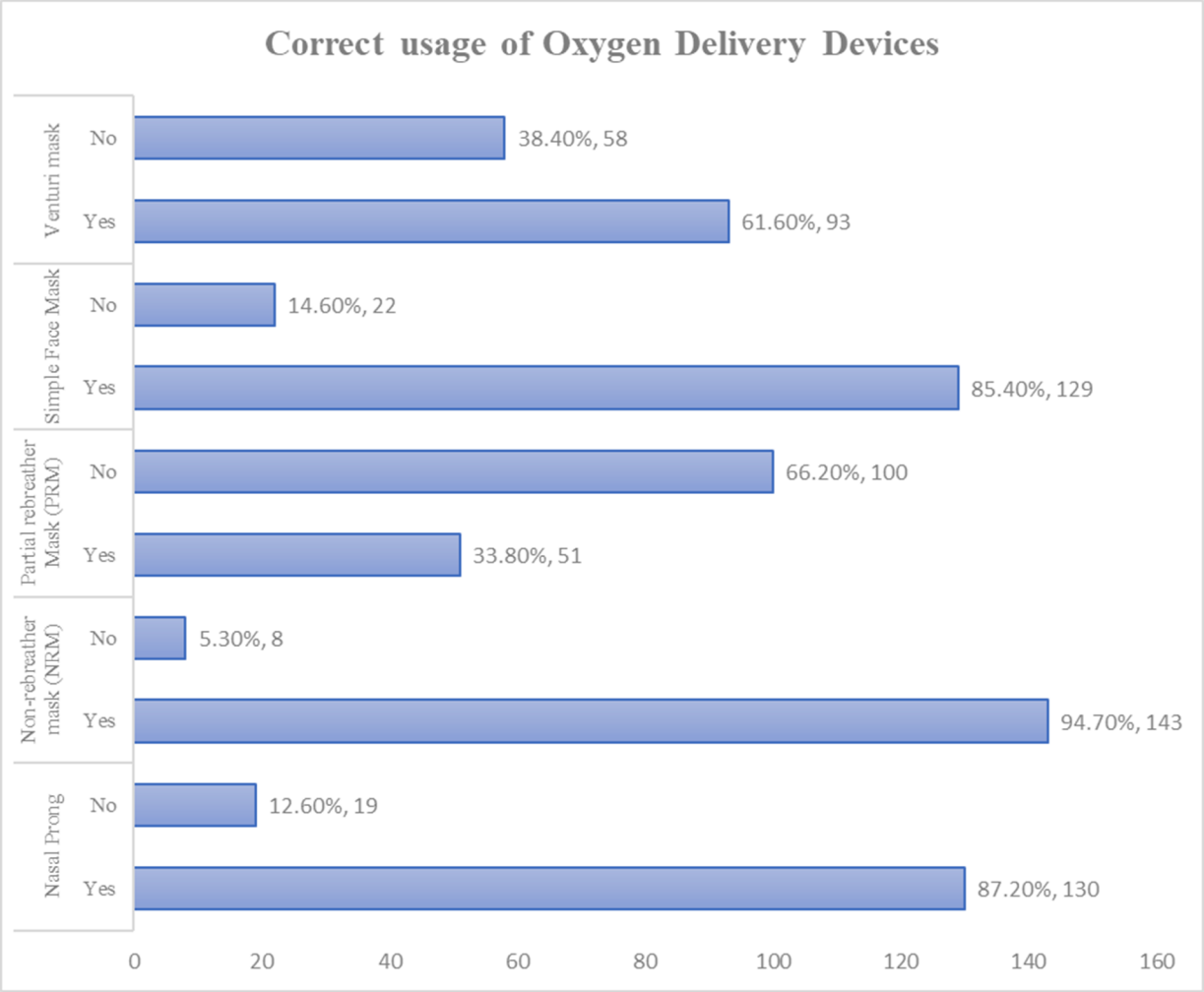
Table 1. Correct choice of oxygen administration method according to patient's condition

Question	Category	Frequency	Percent
A patient with a diagnosis of COPD has been admitted to your unit with an Spo2 of 75% on room air. I always use one of the following as my first-line choice of oxygen delivery devices in the management of this patient	Nasal prongs	61	40.4
	Non-rebreather (NRM)	55	36.4
	Venturi mask	**26**	**17.2**
	Hudson mask (Simple face mask)	9	6
A lady has been admitted to the critical care unit you work in, post appendectomy. She is saturating at 82% on room air which oxygen delivery device do you normally use to manage this patient	**Nasal prongs**	**72**	**47.7**
	Non- rebreather mask (NRM)	60	39.7
	Partial rebreather mask (PRM)	16	10.6
	T-piece	3	2
A 48-year-old male patient is admitted to the critical care unit with a diagnosis of pneumonia saturating between 70-75 on room air which oxygen delivery device do you normally use as first line management of this patient?	**Non-rebreather mask (NRM)**	**122**	**80.8**
	Simple face mask	17	11.3
	Nasal prong	7	4.6
	T-piece	5	3.3

Correct usage of oxygen delivery devices

The participants were asked on correct liters of oxygen per minute that they set for the oxygen delivery devices and the responses were as follows; 130(87.2%) correctly knew how to use a nasal prong,143(94.7%) knew how to correctly use a non-rebreather, 51(33.8%) correctly knew how to correctly use a partial rebreather mask,129(85.4%) knew how to use a simple face mask correctly and finally 93(61,6%) correctly knew how to properly use a venturi mask (Table 2).

Table 2: Correct usage of Oxygen Delivery Devices



Frequency in checking various parameters during oxygen administration

The practice was measured by examining how frequently the healthcare providers checked various parameters while administering oxygen. The practice was categorized based on the frequency of checking Oxygen saturation, clinical condition and requirement, age and compliance to oxygen delivery devices.

Table 3 represents the frequency of checking the various parameters. The majority of the health care providers 93.4%, reported they always checked oxygen saturation; however, 6.6 % stated they often check it. The frequency of checking the patients' age varied widely, with 62.9% of the respondents stating they always checked, while 17.2% often do, and 11.9% sometimes check it. A smaller percentage of 3.3% rarely check age and 4.6% never check age. While age is an important consideration during oxygen administration, the study highlights that health care providers do not equally prioritize age.

Part of the practice included monitoring the clinical condition and requirements. The majority of the respondents (85.4%) always checked this parameter, 11.9% often checked it, 2% sometimes check it and only 0.7% never check it. This emphasizes the need to assess the clinical condition and requirements in determining the appropriate oxygen delivery device. Concerning compliance with oxygen delivery devices (78.8%) of the respondents always monitor this, 11.9% often do, and 6% sometimes check compliance. A lesser percentage of the respondents rarely monitor 2% and 1.3% never do.

Table 3

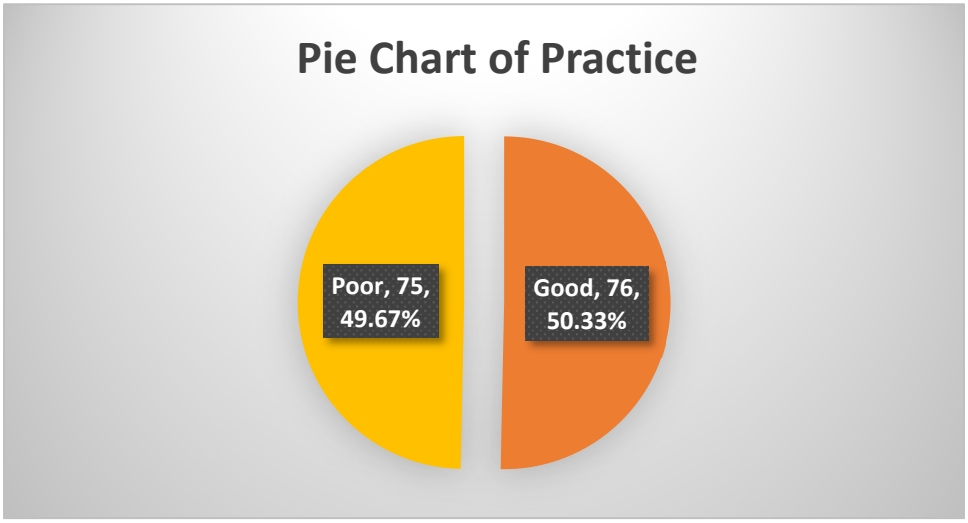
Variable		Categories	Frequency	Percent
The practice of health care providers in the utilization of oxygen delivery devices	Oxygen Saturation	**Always**	**141**	**93.4**
		Often	10	6.6
	Age	**always**	**95**	**62.9**
		often	26	17.2
		sometimes	18	11.9
		rarely	5	3.3
		Never	7	4.6
	Clinical condition and requirement	**always**	**129**	**85.4**
		often	18	11.9
		sometimes	3	2
		never	1	0.7
	Compliance with oxygen delivery devices	**always**	**119**	**78.8**
		often	18	11.9
		sometimes	9	6
		rarely	3	2
		never	2	1.3

Overall practice score

The study assessed how well healthcare providers at Kenyatta National Hospital used different oxygen delivery methods. A "practice" score was created, where correct responses were given a score of 1, and incorrect ones were scored 0. This covered the proper use of nasal prongs, various oxygen masks (PRM, NRM, simple face mask, Venturi mask), and regular checks on patient factors like age, compliance, oxygen saturation, and clinical condition. The score also factored in responses to three clinical scenario questions.

On average, providers scored **8.29**, with a median of **9**, suggesting a generally high level of competency. To categorize practice levels, scores above the mean were considered **"good"**, while those below were **"poor."** The results showed that **50.3% of providers demonstrated good practice**, while **49.7% fell into the poor practice category**—indicating nearly an even split.

Figure 1: Pie chart of Practice



Association between Institutional Factors and Utilization of Oxygen Delivery Devices

The relationship between practice score and various institutional factors was analyzed using chi-square tests. A summary of the results is in table ten below. Continuous Professional Development (CPD) on oxygen delivery devices showed a statistical friendship with better practice (Chi square= 4.174, p-value= 0.041). Those health care providers who participated in CPD were more likely to demonstrate good practice with 59.20% demonstrating good practice. Although the frequency of CPD did not influence better practice (Chi-square=0.582, p-value=0.748)

No statistical significance was noted in regards to the presence of standard operating, procedures (SOPs), oxygen shortages and availability of PRM, Venturi and Hudson mask with practice levels (Table 4)

Table 4: institutional factors affecting practice and association between institutional factors and utilization of oxygen delivery devices

Variable	Categories	Practice			Chi-Square	P-Value
		Good	Poor	Total		
Venturi Mask (Availability)	Yes	22(57.90)	16(42.10)	38(37.30%)	0.891	0.345
	No	43(67.20)	21(32.80)	64(62.70%)		
PRM (Availability)	Yes	29(63.00)	17(37.00)	46(62.20%)	0.012	0.914
	No	18(64.30)	10(35.70)	28(37.80%)		
Hudson Mask (Availability)	Yes	53(55.20)	43(44.80)	96(70.60%)	0.083	0.773
	No	21(52.50)	19(47.50)	40(29.40%)		
CPD on Oxygen Delivery Devices	Yes	42(59.20)	29(40.80)	71(52.98%)	4.174	0.041
	No	34(42.50)	46(57.50)	80(47.02%)		
CPD on Oxygen Delivery Devices (Frequency)	Always	11(52.40)	10(47.60)	21(29.58%)	0.582	0.748
	Rarely	7(63.60)	4(36.40)	11(15.49%)		
	Sometimes	24(61.50)	15(38.50)	39(54.93%)		
SOP on type of Oxygen Delivery device	Yes	49(55.70)	39(44.30)	88(58.28%)	2.416	0.12
	No	27(42.90)	36(57.10)	63(41.72%)		
Oxygen Shortages	Yes	43(56.60)	33(43.40)	76(50.33%)	2.389	0.122
	No	33(44.00)	42(56.00)	75(49.67%)		
Oxygen Shortages (Frequency)	1-3 times	33(57.90)	24(42.10)	57(75.0%)	0.161	0.689
	3-5 times	10(52.60)	9(47.40)	19(25.0%)		

Factors Influencing Healthcare Utilization: A Binary Logistic Regression Analysis of Nurses' Characteristics and Institutional Factors

Finally, in regards to institutional factors healthcare providers who Participated in continuing professional development (CPD) on oxygen delivery devices had a significant increase in the odds (OR = 1.959, 95% CI: 1.025-3.747, p = 0.042) of good practice. some significantly higher odds (OR = 1.959, 95% CI: 1.025-3.747, p = 0.042) of good practice (Table 4**)**

Table 4: Factors Influencing Healthcare Utilization: A Binary Logistic Regression Analysis of Nurses' Characteristics and Institutional Factors

		Practice			95% CI for OR		
Variables	**Categories**	**Good**	**Poor**	**Odds Ratio**	**Lower**	**Upper**	**P-value**
CPD oxygen delivery devices	Yes	42(59.20)	29(40.80)	1.959	1.025	3.747	0.042

RESEARCH DISCUSSION

The Role of CPD in Enhancing Practice

CPD was a critical factor influencing proper oxygen device utilization. Previous studies indicate that structured CPD programs effectively enhance clinical skills, including device handling and dosage adjustments (Sutherland et al., 2016). This study supports these findings, showing that healthcare providers who regularly attend CPD sessions demonstrate better oxygen therapy practices.

Standard Operating Procedures and Clinical Consistency

SOPs, although not statistically significant in this study, offer a valuable structure for clinical consistency in oxygen therapy. SOPs can reinforce good practice by providing clear guidelines on device usage and dosage based on patient conditions. Studies from similar settings suggest that departments with well-established SOPs show reduced variance in clinical practice, even in high-pressure situations (Cousins et al., 2020).

Impact of Resource Availability on Practice

Frequent oxygen shortages hinder effective oxygen therapy; as healthcare providers must adapt device choices based on availability rather than patient needs. This finding aligns with reports from other resource-limited settings, where shortages force improvisations that may compromise patient outcomes (Desalu et al., 2019). Ensuring a consistent oxygen supply can improve therapy adherence and patient care.

Device Familiarity and Utilization Accuracy

The study highlights the importance of device familiarity in proper oxygen administration. Familiarity with different masks, particularly high-flow devices, significantly impacts the accuracy

of oxygen delivery. Providers well-versed in device mechanisms can adjust oxygen flow to meet patient requirements better. Research indicates that familiarity training directly correlates with improved device handling in critical care settings (Riviello et al., 2016).

Conclusion

This study underscores the combined influence of healthcare providers and institutional factors on oxygen therapy practices at KNH. Institutional support, particularly through CPD programs and SOPs, enhances device utilization. Resource limitations, however, hinder consistent practices, emphasizing the need for a reliable oxygen supply. Familiarity with oxygen devices further improves healthcare providers' decision-making in oxygen therapy.

Recommendations

1. **Expand CPD Programs**: Increase access to CPD for critical care providers, focusing on practical oxygen therapy applications.
2. **Implement and Standardize SOPs**: Develop SOPs across critical care units to guide oxygen therapy practices.
3. **Address Oxygen Supply Issues**: Collaborate with healthcare policymakers to improve resource availability, ensuring uninterrupted oxygen supply.

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