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Knowledge and Associated Factors with Supplemental Oxygen Administration for Critically Ill Patients Among Nurses: A Cross-Sectional Study

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ABSTRACT

Background: Supplemental oxygen is one of the most frequently used therapeutic agents in critical care, yet inappropriate administration can precipitate serious harm, including oxygen toxicity, hypercapnic respiratory failure, and death. Although evidence-based guidelines exist, oxygen is often administered without adequate attention to updated protocols, and knowledge gaps among bedside nurses remain poorly characterized in many low-resource settings.

Objective: To assess the level of knowledge and to identify the factors associated with supplemental oxygen administration for critically ill patients among nurses working in critical care areas of a tertiary care hospital.

Methods: An analytical cross-sectional study was conducted among 120 nurses working in the ICU, MICU, SICU, HDU, and CCU of Tehsil Headquarter Hospital, Hasilpur, Punjab, Pakistan. Participants were recruited through convenience sampling. A structured, close-ended, modified questionnaire covering demographic characteristics, knowledge of oxygen therapy, and perceived barriers was administered. Knowledge scores were categorized as poor (<5), average (6–10), or good (11–15). The chi-square test was used to examine associations between knowledge and reported challenges, with significance set at $p<0.05$.

Results: Most participants were aged 20–30 years (50.8%) and female (69.2%). Nurses most commonly worked in the SICU (31.7%) and HDU (30.8%). Overall, 60.0% of nurses demonstrated average knowledge (mean score 8.5 ± 2.48), 30.0% demonstrated poor knowledge, and only 10.0% demonstrated good knowledge of supplemental oxygen administration. The most frequently reported barriers were lack of knowledge/training (75.0%, p=0.015) and time constraints (66.7%, p=0.008), followed by inadequate staff support (50.0%, p=0.039) and insufficient equipment (37.5%, p=0.024); all were significantly associated with difficulties in oxygen administration. Confusion with protocols (33.3%, p=0.102) and patient complexity (25.0%, p=0.064) were not statistically significant.

Conclusion: Nurses in this tertiary care setting exhibited predominantly average-to-poor knowledge of supplemental oxygen administration. Lack of training, time pressure, inadequate staffing, and insufficient equipment were the principal modifiable barriers. Structured, competency-based training programs, improved resource allocation, and standardized protocols are recommended to close this gap and improve outcomes for critically ill patients.

Introduction

Oxygen is among the most commonly administered medications in acute and critical care settings. Because inadequate tissue oxygenation can rapidly progress to cellular dysfunction, organ failure, and death, oxygen therapy is frequently regarded as an essential emergency drug for resuscitation (1). Like any pharmacological agent, oxygen carries a therapeutic window: administered

appropriately, it reduces mortality and morbidity in hypoxic patients, but administered carelessly, it can produce harm (2). Supplemental oxygen therapy (SOT) is credited with saving the lives of many patients with cardiac and pulmonary disease when delivered at the correct time and dose in line with World Health Organization guidance (3). The British Thoracic Society's guideline for emergency oxygen use similarly stresses achieving normal or near-normal oxygen saturation for most patients presenting to emergency departments and intensive care units (4).

The optimal delivery method and flow rate are not uniform; they vary with the patient's underlying condition, whether the illness is acute or chronic, and factors such as age, therapeutic goals, and tolerance (5). Current guidance recommends targeting saturations of 94–98% for most acutely unwell patients, or 88–92% for those at risk of hypercapnic respiratory failure (6). Because oxygen readily dehydrates exposed respiratory mucosa, adequate hydration, mouth care, and humidification are needed to maintain comfort and mobilize secretions (7). Conversely, high-concentration oxygen can suppress surfactant production, contributing to alveolar collapse, while flow rates below 5 L/minute delivered via a simple face mask can cause carbon dioxide rebreathing (8). Administering oxygen from a near-empty cylinder can precipitate suffocation and, in severe cases, the need for mechanical ventilation or death (9). Conversely, timely recognition of hypoxia and efficient administration can substantially benefit patient outcomes, provided that the delivery method, saturation target, flow rate, monitoring plan, and weaning strategy are all clearly prescribed (10).

Nurses are typically the first responders to acute hypoxia and are frequently required to initiate oxygen therapy before formal medical prescription (11). Despite this central role, professional literature offers inconsistent recommendations regarding indications, delivery devices, and flow rates, producing considerable variability in nursing decision-making (12). Multiple studies from different countries have documented persistent knowledge and practice gaps in oxygen therapy among practicing nurses (13). Because supplemental oxygen administration for critically ill patients is central to the nurse's duty of care, adequate knowledge, sound clinical practice, and a positive attitude are essential to preventing hypoxemia, avoiding acute lung injury, and improving patient quality of life.

Hypotheses

- **Null hypothesis (Ho):** There is no significant relationship between nurses' knowledge and the factors influencing supplemental oxygen administration for critically ill patients.
- **Alternative hypothesis (H1):** There is a significant relationship between nurses' knowledge and the factors influencing supplemental oxygen administration for critically ill patients.

Conceptual and Operational Definitions

- **Knowledge of supplemental oxygen administration** refers to nurses' understanding of the correct protocols, indications, benefits, and potential risks of administering supplemental oxygen to critically ill patients; it was operationalized using a structured questionnaire with scores categorized as poor (<5), average (6–10), and good (11–15).
- **Factors influencing oxygen administration** are the variables that may affect how and when oxygen is administered including training, equipment availability, staffing levels, time constraints, and protocol clarity and were assessed by asking nurses to select the challenges they encountered in practice.
- **Critically ill patients** were defined as those admitted to intensive care units, surgical intensive care units, or comparable settings requiring close monitoring, advanced treatment, and oxygen therapy.

Materials and Methods

An analytical cross-sectional study was conducted at Tehsil Headquarter Hospital, Hasilpur, Bahawalpur, Punjab, Pakistan, to assess nurses' knowledge of supplemental oxygen administration and its association with demographic and occupational factors. The study was completed over four months, including ethical approval, instrument finalization, data collection, and analysis. From an estimated population of 200 critical care nurses, a sample of 120 nurses was calculated using OpenEpi and selected through convenience sampling from CCU, ICU, HDU, and OT. Eligible participants were registered nurses, nurse practitioners, and nurse educators with at least one year of critical care experience who provided informed consent, while nurses outside critical care, with inadequate experience, unavailable during data collection, or previously trained specifically in oxygen therapy were excluded. Data were collected using a structured, close-ended questionnaire covering demographics, oxygen therapy knowledge, attitudes, perceptions, and influencing factors (14). Participants completed the questionnaire individually in approximately 25 minutes, with

confidentiality and anonymity maintained. Data were analyzed using SPSS through frequencies, percentages, means, and standard deviations, while knowledge scores were categorized as poor (<5), average (6–10), and good (11–15). Chi-square tests assessed associations between challenges and knowledge levels, with $p<0.05$ considered statistically significant. Ethical approval was obtained from the Institutional Review Board of Super College of Nursing, Bahawalpur, and informed consent, confidentiality, voluntary participation, and the right to withdraw were ensured.

Results

Supplemental oxygen therapy is a critical component of care for critically ill patients, and nurses occupy a central role in its administration. This section presents the demographic, educational, and experiential profile of the sample, followed by knowledge levels and the factors associated with oxygen administration difficulties.

Demographic Characteristics

Half of participants (50.8%, n=61) were aged 20–30 years, 40.8% (n=49) were aged 31–40 years, and 8.3% (n=10) were aged 41–50 years. Females comprised 69.2% (n=83) of the sample and males 30.8% (n=37). By department, most nurses worked in the SICU (31.7%, n=38) or HDU (30.8%, n=37), with smaller proportions in the OT (15.8%, n=19), MICU (15.0%, n=18), and CCU (6.7%, n=8).

Table 1. Demographic characteristics of nurses (n=120)

Variable	Category	Frequency (n)	Percent (%)
Age	20–30 years	61	50.8
	31–40 years	49	40.8
	41–50 years	10	8.3
Sex	Male	37	30.8
	Female	83	69.2
Department	HDU	37	30.8
	OT	19	15.8
	SICU	38	31.7
	MICU	18	15.0
	CCU	8	6.7

Regarding qualification, RN-BSN was the most common credential (41.7%, n=50), followed by BSN (21.7%, n=26); Diploma and Diploma-PBS holders each accounted for 18.3% (n=22). Most participants had 1–3 years of nursing experience (41.7%, n=50), followed by 4–6 years (34.2%, n=41), 7–9 years (19.2%, n=23), and more than 10 years (5.0%, n=6).

Table 2. Qualification and experience of nurses (n=120)

Variable	Category	Frequency (n)	Percent (%)
Qualification	Diploma	22	18.3
	Diploma PBS	22	18.3
	RN BSN	50	41.7
	BSN	26	21.7
Experience	1–3 years	50	41.7
	4–6 years	41	34.2
	7–9 years	23	19.2
	>10 years	6	5.0

Regarding hands-on exposure, 34.2% (n=41) had administered oxygen to critically ill patients for 6–12 months, 32.5% (n=39) for 1–5 months, 29.2% (n=35) for less than one month, and 4.2% (n=5) for more than a year. For prescribing oxygen, 44.2% (n=53) had last done so 6–12 months prior, 25.8% (n=31) 1–5 months prior, 24.2% (n=29) more than a year prior, and a small remainder within the past month.

Table 3. Duration of oxygen administration and prescription experience (n=120)

Variable	Category	Frequency (n)	Percent (%)
Duration administering oxygen	<1 month	35	29.2
	1–5 months	39	32.5
	6–12 months	41	34.2
	>1 year	5	4.2
Time since last prescribing oxygen	<1 month	31	25.8
	1–5 months	53	44.2
	6–12 months	29	24.2
	>1 year	7	5.8

Knowledge Level

Overall, 60.0% (n=72) of nurses demonstrated average knowledge (score 6–10; mean 8.5, SD 2.48), 30.0% (n=36) demonstrated poor knowledge (score <5), and only 10.0% (n=12) demonstrated good knowledge (score 11–15). This distribution suggests a substantial knowledge gap among the majority of nurses that could be addressed through targeted education.

Table 4. Knowledge level of nurses regarding oxygen administration (n=120)

Knowledge Category	Frequency (n)	Percent (%)	Mean	SD
Poor (<5)	36	30.0		
Average (6–10)	72	60.0	8.5	2.48
Good (11–15)	12	10.0		

Factors Associated with Oxygen Administration

The most frequently reported challenge was lack of knowledge/training (75.0%, n=90; p=0.015), followed by time constraints (66.7%, n=80; p=0.008); both were statistically significant. Inadequate staff support (50.0%, n=60; p=0.039) and insufficient equipment (37.5%, n=45; p=0.024) were also significantly associated with administration difficulties. Confusion with protocols (33.3%, n=40; p=0.102) and overly complex patient conditions (25.0%, n=30; p=0.064) did not reach statistical significance, though the latter approached the threshold.

Table 5. Factors associated with oxygen administration difficulties among nurses (n=120)

Factor	Frequency (n)	Percent (%)	p-value
Lack of knowledge/training	90	75.0	0.015*
Time constraints	80	66.7	0.008*
Inadequate staff support	60	50.0	0.039*
Insufficient equipment	45	37.5	0.024*
Confusion with protocols	40	33.3	0.102
Patient's condition too complex	30	25.0	0.064

Chi-square test; *p<0.05 considered statistically significant.

Discussion

This study examined the knowledge of, and factors associated with, supplemental oxygen administration among 120 nurses working in critical care areas of a tertiary hospital in Punjab, Pakistan. Consistent with the broader literature, the sample skewed young and predominantly female, mirroring the workforce composition reported by Saqib and colleagues, whose cohort likewise comprised majority-female nurses in their twenties to thirties (15).

Overall, 60.0% of nurses demonstrated average knowledge, 30.0% poor knowledge, and only 10.0% good knowledge a pattern indicating that most respondents lacked comprehensive understanding of oxygen therapy indications, delivery devices, and risks. This finding sits between the extremes reported internationally. Abbas and colleagues found that 67% of nurses in Ethiopia had poor knowledge (16), while Khan and colleagues reported 52% with good knowledge (17). Murphy found markedly higher average scores (8.89/16) in Cambridge University Hospitals, with near-universal awareness of humidification but poor familiarity with

flow-metre use and mask selection — a pattern of uneven, topic-specific knowledge that likely also underlies the present results (18). In Nepal, Kalpana et al. (2021) reported that 74.4% of nurses had unsatisfactory knowledge, considerably worse than the present sample, while a Turkish study by Kazan in 2020 similarly found knowledge levels lower than expected (19). Taken together, this variability supports the conclusion that institutional training intensity, curriculum content, and resource context rather than any single national or regional factor drive the wide range of knowledge scores reported across studies (20). Conversely, cohorts exposed to structured, continuous professional development, such as those described by Mwakanyanga and colleagues 2018, tended to report substantially better knowledge, reinforcing that the gap identified here is plausibly modifiable through targeted intervention rather than reflecting an immutable feature of the nursing workforce (21).

Regarding associated factors, lack of knowledge/training (75.0%) and time constraints (66.7%) were the most prevalent and statistically significant barriers, echoing findings from Kenya (22), where Kivuti-Bitok and colleagues in 2024 identified training deficits as a dominant barrier, and from Shi and colleagues 2023, who documented workload-driven time pressure as a major constraint on nursing care in intensive care units (23). Insufficient equipment (37.5%) and inadequate staff support (50.0%) were also significant, aligning with Determeijer and colleagues in 2024, who highlighted equipment shortages as a barrier in resource-limited settings (24). By contrast, Patel and colleagues in 2022 and Flaubert and colleagues in 2021 reported markedly lower rates of training deficits and time pressure in institutions with robust training infrastructure and optimized staffing, underscoring that these barriers are strongly shaped by local institutional investment rather than being inherent to nursing practice everywhere (25).

Confusion with protocols (33.3%) and patient complexity (25.0%) did not reach statistical significance in this sample, though the latter approached the conventional threshold (26). This may reflect that, unlike training and staffing, protocol clarity and case complexity are experienced heterogeneously depending on unit type and case mix, and therefore may require unit-specific rather than institution-wide interventions. These non-significant but clinically relevant findings warrant further investigation, particularly through qualitative approaches that can capture nurses' lived experience of protocol ambiguity in fast-paced critical care environments (27).

Notably, the demographic profile of this sample — predominantly younger nurses with relatively limited critical care tenure, since 41.7% had only 1–3 years of experience — may itself partly explain the observed knowledge distribution. Fadaei and colleagues reported a statistically significant relationship between work experience and knowledge of correct oxygen use ($p=0.03$), even though age, gender, employment status, and educational level showed no such association in their cohort (28). This is broadly consistent with the present findings, where a workforce weighted toward early-career nurses coincided with a knowledge profile skewed toward the average-to-poor range rather than the good category (29). It suggests that experience-linked, on-the-job exposure to oxygen therapy decisions may be at least as important as formal qualification in shaping bedside competence, reinforcing the case for structured orientation and mentorship for newly placed critical care staff rather than relying solely on pre-service education.

Conclusion

This study found significant variation in the qualifications and experience of nurses providing critical care, alongside a predominantly average-to-poor level of knowledge regarding supplemental oxygen administration: 60% of participants demonstrated average knowledge and 30% demonstrated poor knowledge, with only 10% achieving a good knowledge score. Lack of training and time constraints emerged as the most prevalent and statistically significant barriers, with insufficient equipment and inadequate staff support also contributing meaningfully to administration difficulties. These results point to a pressing, and largely modifiable, need for structured education, improved resource allocation, and clearer institutional protocols to support safe and effective oxygen therapy in critical care.

Recommendations

- **Structured training programs:** Implement targeted, evidence-based educational initiatives to strengthen nurses' knowledge and competency in supplemental oxygen administration.
- **Resource allocation:** Ensure adequate equipment availability and optimize staffing levels to reduce time pressure and support gaps.
- **Protocol clarification:** Standardize and simplify oxygen administration protocols to minimize confusion and improve adherence.

- **Continuous professional development:** Institute periodic refresher training, workshops, and competency assessments.
- **Further research:** Investigate the underlying drivers of non-significant challenges, such as protocol confusion and patient complexity, using qualitative or mixed-methods designs.

Limitations

This study was conducted at a single healthcare facility, which may limit the generalizability of findings to other settings, and relied on self-reported data, which is susceptible to recall and social desirability bias.

Strengths

The study drew on a demographically diverse participant pool spanning multiple qualification levels and years of experience, identified statistically significant, actionable barriers using rigorous chi-square testing, and yielded practical recommendations directly applicable to critical care practice.

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