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ORIGINAL RESEARCH

Practice of High-Flow Nasal Cannula in Patients with Mild to Moderate COPD Among Healthcare Providers in Saudi Arabia: A Cross-Sectional Study

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Background: High-flow nasal cannula (HFNC) has emerged as a promising non-invasive oxygen therapy for patients with chronic obstructive pulmonary disease (COPD), particularly those with mild to moderate hypercapnia. Despite its growing use, no studies in Saudi Arabia have explored healthcare providers' clinical practices or perceived barriers related to HFNC application in this patient population. This study aimed to assess the current clinical use and implementation challenges of HFNC among physicians and respiratory therapists (RTs) in Saudi Arabia.

Methods: A cross-sectional survey was conducted among physicians and RTs across Saudi Arabia from October 27, 2024, to May 20, 2025. The survey, distributed via several channels, collected data on HFNC practices, initial settings, weaning approaches, and perceived barriers. Descriptive statistics presented as frequencies and percentages. Chi-square tests were used to assess differences between physicians and RTs, with a significance level set at $p < 0.05$.

Results: A total of 1724 healthcare providers completed the survey, including 636 (36.9%) physicians and 1,088 (63.1%) RTs. Significant variations were found between the two groups regarding who initiates HFNC, preferred flow rates, and temperature settings ($p < 0.05$). The most common flow rate selected was 30–40 L/min (47.2%), and initial FiO_2 levels typically ranged between 41% and 60%. Regarding weaning, 43% of respondents reduced flow by 5–10 L/min every 2–4 hours, and 48% disconnected HFNC when the flow rate dropped below 20 L/min. The primary barriers reported by both groups included lack of standardized protocols, insufficient training, and limited HFNC knowledge.

Conclusion: There is an inconsistent clinical practice regarding HFNC use in mild to moderate COPD among healthcare providers in Saudi Arabia. Addressing knowledge gaps and standardizing protocols may enhance the effective implementation of HFNC therapy and improve patient outcomes.

Keywords: high flow nasal cannula, COPD, mechanical ventilation, healthcare providers, Saudi Arabia

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Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive and debilitating respiratory illness that represents a leading global cause of morbidity and mortality.[1] Patients with COPD often experience episodes of acute or chronic hypercapnia, even during mild exacerbations, which can prolong recovery, increase healthcare utilization, and reduce quality of life.[2,3] In Saudi Arabia, the prevalence of COPD is estimated at 4.2% in the general population and 14.2% among smokers.[4] A recent analysis revealed a 329.82% increase in the number of individuals diagnosed with COPD in Saudi Arabia between 1990 and 2019.[5] Despite the growing incidence of COPD, it remains a frequently neglected disease, with many patients receiving inadequate or suboptimal therapies, further complicating disease management and contributing to poor clinical outcomes.[6]

High-flow nasal cannula (HFNC) is a non-invasive oxygen therapy that delivers heated, humidified gas at flow rates exceeding a patient's inspiratory demand.[7] This modality ensures effective oxygenation and offers several benefits, including stable FiO_2 delivery, mild positive airway pressure, reduced work of breathing, and enhanced mucociliary clearance.[8,9] HFNC is generally better tolerated than conventional oxygen therapy, thereby improving patient comfort.[10] Numerous clinical studies have demonstrated the efficacy of HFNC in managing acute hypoxemic respiratory failure, with evidence showing a reduced need for intubation without increasing mortality or length of ICU stay.[11,12] A meta-analysis of randomized controlled trials found that HFNC significantly lowered the risk of intubation compared to conventional oxygen therapy.[13] Further evidence suggests HFNC reduces reintubation rates in low-risk post-extubation patients and offers long-term benefits by decreasing COPD exacerbations and hospital admissions in stable hypercapnic individuals.[14,15] However, despite its well-established role in hypoxemic respiratory failure, the application of HFNC in patients with mild to moderate hypercapnic COPD remains underexplored.[8]

Our previous studies identified key barriers to the broader implementation of HFNC therapy, including high costs, limited equipment availability, and insufficient clinician familiarity, which restricted its effective use among respiratory therapists managing ARDS patients.[16,17] In contrast, the present study broadens this perspective by examining HFNC use in patients with mild to moderate COPD and surveying a wider group of healthcare providers, thereby providing novel insights into the challenges of applying HFNC in chronic respiratory disease management. Additional barriers, such as inconsistent clinical guidelines, inadequate training, limited confidence among healthcare providers, insufficient inter-disciplinary education, and a prevailing reliance on physician-led decision-making, further contribute to delays and suboptimal use of this modality.[18,19] The absence of standardized protocols and limited opportunities for healthcare provider practice also impedes efficient initiation, management, and weaning of HFNC therapy.[20]

In Saudi Arabia, no published studies have yet investigated healthcare providers' clinical practices or perceived barriers related to HFNC use in managing mild to moderate hypercapnic COPD. This study aims to assess the current clinical application of HFNC among healthcare providers and to identify the primary obstacles affecting its effective utilization in this patient population.

Materials and Methods

Study Design and Study Population

A cross-sectional survey was administered to physicians and respiratory therapists (RTs) in Saudi Arabia. The survey was distributed through social media platforms, beginning on October 27, 2024, and concluding on May 20, 2025.

Sampling Strategy

Participants were selected using a convenience sampling approach. The survey invitation, shared through various social media channels, targeted physicians with respiratory background and RTs currently practicing in Saudi Arabia. Prior to participation, individuals were required to provide written informed consent by responding to a mandatory question: "Do you agree to participate?" To uphold data integrity, the survey platform employed mechanisms that restricted multiple entries, allowing each participant to complete the survey only once. The accompanying invitation clearly outlined the study's purpose and inclusion criteria. Only licensed physicians with respiratory background and RTs actively working in clinical settings were eligible to participate, while students and interns were excluded from the study.

Study Instrument

A structured questionnaire was developed by expert pulmonologists and RTs, all of whom have prior experience with HFNC. The survey comprised 19 questions, including multiple-choice and checklist formats, organized into four main sections:

- Demographic information (7 questions): Participants were asked about their gender, profession, role within their department, geographical location, primary workplace setting, years of clinical experience, and usual clinical practice areas.
- Training and clinical decision-making (3 questions): This section inquired whether participants had received training on HFNC use, who typically decides on HFNC initiation in their practice area, and their personal experience using HFNC to manage mild hypercapnic COPD.
- Clinical practice and protocols (8 questions): Questions addressed the existence of hospital protocols for HFNC management in mild hypercapnic COPD, initial clinical settings (oxygen flow thresholds, FiO_2, flow rates, temperature), criteria for switching to HFNC, and strategies used for management and weaning of patients from HFNC.
- Barriers to HFNC use (1 question): Participants were asked about common obstacles to HFNC implementation in clinical practice, such as inadequate training, absence of protocols, lack of knowledge, device availability, workload issues, patient cooperation, and diversity of HFNC devices.

Before distributing the questionnaire, it underwent evaluation by subject matter experts to confirm content validity. Subsequently, a pilot test was carried out with 10 healthcare professionals to assess the clarity, relevance, and overall understandability of the survey items, ensuring they accurately reflected the study's aims.

Ethical Consideration

Ethical approval for the study was obtained from the Research Ethics Committee at King Abdulaziz University prior to its commencement (Reference No. FMRS-EC2024-002; approval date: October 22, 2023).

Statistical Analysis

Data collection was performed electronically using Microsoft Excel before being imported into SPSS version 28 (IBM Corp., Armonk, NY, USA) for further statistical analysis. Descriptive statistics summarized the data, with categorical variables expressed as frequencies and percentages. To assess differences between respiratory therapists and physicians, the chi-square test was applied, with statistical significance set at a p-value less than 0.05.

Results

Demographic Data of the Study Participants

Overall, 1,724 completed the survey, which include 636 (36.9%) physicians and 1,088 (63.1%) RTs. More than half of participants were male (1,070, or 62.1%) with a higher proportion among RTs (629, or 63.6%) compared to physicians (378, or 59.4%). The highest proportion of physicians were director/ manager (192, or 30.2%) whereas clinical staff represent the highest proportion (296, or 27.2%) with significant difference between physicians and RTs ($p < 0.001$). Participants were distributed across several regions, with the highest percentage from the central region (744, or 43.2%) followed by western region (306, or 17.7%) with significant difference between physicians and RTs ($p < 0.001$).The highest proportion of physicians and RTs work at the Ministry of Health (physicians 163, or 25.6%; RTs 214, or 19.7%; $p < 0.001$), whereas only 38 (6%) of physicians and 43 (4%) work at the Royal Commission hospitals. Regarding clinical experience, 691 (40.1%) of participants had between one to five years of clinical experience with physicians accounted for 236 (37.1%) and RTs 455 (41.8%) with significant difference between physicians and RTs ($p < 0.001$). Both physicians (320. Or 50.3%) and RTs (586, or 53.9%) mainly work at non-critical areas followed by critical areas such as cardiac, surgical and intensive critical areas (physicians 285, or 44.8%) and (RTs 473, or 39.1%). Training on HFNC was reported by 1,188 (68.9%) participants, with significant variation in percentages between physicians and RTs (physician, 65.7% vs RT, 70.8%; $p=0.029$). Similarly, 1,157 (67.1%) of participants had ever used HFNC in clinical

settings with significant difference between groups (physician, 63.4% vs RT, 69%; p=0.011) and 1,135 (65.8%) had used HFNC to treat mild hypercapnia in COPD patients. When asked about the existence of an HFNC protocol at their hospital, more than half of participants confirmed its presence (911, or 52.8%), with no significant difference between physicians (345, or 54.2%) and RTs (566, or 52%) (Table 1).

Initiation and Initial Settings of High Flow Nasal Cannula

When asked about who has the authority to initiate HFNC, 271 (42.6%) physicians believed that the assigned physician was the primary decision-makers for initiating HFNC, while 431 (39.6%) attribute this role to the assigned RT which significantly varies between both groups (p<0.001).

Table 1 Demographic Data of the Study Participants (N = 1,724)

Variables	Total	Physician	RT	P value
	N = 1724	N = 636	N = 1088	
Gender n (%)				
Male	1070 (62.1%)	378 (59.4%)	629 (63.6%)	0.085
Female	654 (37.9%)	258 (40.6%)	396 (36.4%)	
Role within department n (%)				
Director/ Manager	327 (19%)	192 (30.2%)	135 (12.4%)	<0.001
Supervisor lead/ in-charge	420 (24.4%)	158 (24.8%)	262 (24.1%)	
Clinical Specialist	400 (23.2%)	123 (19.3%)	277 (25.5%)	
Educator	175 (10.2%)	57 (9%)	118 (10.8%)	
Staff	402 (23.3%)	106 (16.7%)	296 (27.2%)	
Region n (%)				
Southern Region	298 (17.3%)	109 (17.1%)	189 (17.4%)	<0.001
Eastern Region	284 (16.5)	153 (24.1%)	131 (12%)	
Central Region	744 (43.2%)	224 (35.2%)	520 (47.8%)	
Western Region	306 (17.7%)	116 (18.2)	190 (17.5%)	
Northern Region	92 (5.3%)	34 (5.3%)	58 (5.3%)	
Primary place of work n (%)				
Ministry of Health Hospitals	377 (21.9%)	163 (25.6%)	214 (19.7%)	<0.001
Private Hospitals	295 (17.1%)	109 (17.1%)	186 (17.1%)	
Ministry of Defense Hospitals	267(15.5%)	74 (11.6%)	193 (17.7%)	
Ministry of National Guard Health Affairs Hospitals	209 (12.1%)	72 (11.3%)	137 (12.6%)	
Ministry of Interior Hospitals	191(11.1%)	57 (9%)	134 (12.3%)	
King Faisal Specialist Hospitals & Research Centre (Riyadh, Jeddah, Medina)	184 (10.7%)	75 (11.8%)	109 (10%)	
University Hospitals	120 (7%)	48 (7.5%)	72 (6.6%)	
Royal Commission Hospitals	81 (4.7%)	38 (6%)	43 (4%)	

(*Continued*)

Table 1 (Continued).

Variables	Total	Physician	RT	P value
Years of experience, n (%)				
Less than 1 year	462 (26.8%)	157 (24.7%)	305 (28%)	<0.001
1-5 years	691 (40.1%)	236 (37.1%)	455 (41.8%)	
6-10 years	386 (22.4%)	145 (22.8%)	241 (22.2%)	
More than 10 years	185 (10.7%)	98 (15.4%)	87 (8%)	
Usual Clinical practice area n (%)				
Non critical areas (Medical ward, Surgical ward, etc)	906 (52.6%)	320 (50.3%)	586 (53.9%)	
Critical care areas (ICU, CCU, SIC, etc)	758 (44%)	285 (44.8%)	473 (39.1%)	
Emergency room	681 (39.5%)	256 (40.3%)	425 (39.1%)	
Training on HFNC n (%)				
Yes	1188 (68.9%)	418 (65.7%)	770 (70.8%)	0.029
No	536 (31.1%)	218 (34.3%)	318 (29.2%)	
Ever use HFNC n (%)				
Yes	1157 (67.1%)	403 (63.4%)	754 (69.3%)	0.011
No	567 (31.1%)	233 (36.6%)	334 (30.7%)	
Use HFNC to treat Mild hypercapnia in COPD patients n (%)				
Yes	1135 (65.8%)	407 (64%)	728 (66.9%)	0.218
No	589 (34.2%)	229 (36%)	360 (33.1%)	
Existing HFNC protocol at my hospital, n (%)				
Yes	911 (52.8%)	345 (54.2%)	566 (52%)	0.299
No	507 (29.4%)	173 (27.2%)	334 (30.7%)	
I do not Know	306 (17.7%)	118 (18.6%)	188 (17.3%)	

Notes: Data are presented as frequency and percentage. *P* values < 0.05 were considered statistically significant.

We asked the participants about the conventional oxygen level required to switch COPD patient to HFNC, 677 (39.3%) of participant reported that oxygen flow rate of more than or equal to 6 L/min was the required oxygen flow rate to switch COPD patient to HFNC, with no difference between physicians and RTs (physicians 38.8% vs RT 39.5%; p = 0.88).

Regarding the preferred initial HFNC settings reported by participants, 630 (36.5%) of participants preferred FiO_2 of 41% to 60% with no difference between physicians and RTs (physicians 36.3% vs RT 36.7%; p = 0.57). Moreover, 814 (47.2%) of participants predominantly chose flow rate of 30 to 40 L/min with significant variation between physicians and RTs (physicians 45.4% vs RT 48.3%; p = 0.003). Similarly, physicians (332, or 52.2%) were more likely to set the initial temperature at 37 °C, whereas RTs (460, or 42.3%) were more likely to set the initial temperature at 34 °C (p <0.001) (Table 2).

Weaning and Disconnection of High Flow Nasal Cannula

Participants provided insights into their approaches to wean and disconnect HFNC according to patients' clinical status. The most common approach reported by participants were to wean COPD patients from HFNC by initially reducing gas flow by 5–10 L/min every two to four hours (741, or 43%) with significant variation between physicians and RTs (38.8% vs 45.4%; p = 0.021).

Table 2 Initiation, Initial Settings, Weaning and Disconnection of HFNC

Variables	Total	Physician	RT	P value
	N = 1724	N = 636	N = 1088	
Initiation* n *(%)				
Decision Maker for HFNC Initiation, n (%)				
Respiratory therapist	585 (33.9%)	154 (24.2%)	431 (39.6%)	<0.001
Physician	474 (27.5%)	271 (42.6%)	203 (18.7%)	
Both (Physician & Respiratory therapist)	434 (25.2%)	136 (21.4%)	298 (27.4%)	
Nurse	231 (13.4%)	75 (11.8%)	156 (14.3%)	
The following conventional O2 flow level required to switch COPD patients to HFNC				
Oxygen flow ≥ 3 L /min	571 (33.1%)	210 (33%)	361 (33.2%)	0.880
Oxygen flow ≥ 6 L /min	677 (39.3%)	247 (38.8%)	430 (39.5%)	
Oxygen flow ≥ 12 L /min	331 (19.2%)	121 (19%)	210 (19.3%)	
Oxygen flow ≥ 15 L /min	145 (8.4%)	58 (9.1%)	87 (8%)	
Initial settings* n *(%)				
FiO_2 level (%)				
FiO_2 between 21–40%	530 (30.7%)	198 (31.1%)	332 (30.5%)	0.575
FiO_2 between 41–60%	630 (36.5%)	231 (36.3%)	399 (36.7%)	
FiO_2 between 61–80%	422 (24.5%)	148 (23.3%)	274 (25.2%)	
FiO_2 between 81–100%	142 (8.2%)	59 (9.3%)	83 (7.6%)	
Flow rate levels (L/min)				
< 30 L/min	481 (27.9%)	207 (32.5%)	274 (25.2%)	0.003
Between 30–40 L/min	814 (47.2%)	289 (45.4%)	525 (48.3%)	
Between 41–50 L/min	355 (20.6%)	110 (7.3%)	245 (22.5%)	
Between 51–60 L/min	74 (4.3%)	30 (4.7%)	44 (4%)	
Temperature level (°C)				
37 °C	739 (42.9%)	332 (52.2%)	407 (37.4%)	<0.001
34 °C	648 (37.6%)	188 (29.6%)	460 (42.3%)	
32 °C	337 (19.5%)	116 (18.2%)	221 (20.3%)	
Weaning n (%)				
Parameters used to wean patients from HFNC				
First reduce FiO2 by 5–10% every 2–4 hours	714 (41.4%)	288 (45.3%)	426 (39.2%)	0.021
First reduce gas flow by 5–10 L/min every 2–4 hours	741 (43%)	247 (38.8%)	494 (45.4%)	
Reduce both together at the same time	269 (15.6%)	101 (15.9%)	168 (15.4%)	

(*Continued*)

Table 2 (Continued).

Variables	Total	Physician	RT	P value
Disconnection n (%)				
When oxygenation goals are achieved and the patient is clinically stable, criteria used to disconnect patients from HFNC				
FiO_2 < 35%	456 (26.5%)	185 (29.1%)	271 (24.9%)	0.157
Gas flow < 20 L/min	828 (48%)	292 (45.9%)	536 (49.3%)	
Both criteria (FiO_2 < 35% and Gas flow < 20 L/min)	440 (25.5%)	159 (25%)	281 (25.8%)	

Notes: Data are presented as frequency and percentage. *P* values < 0.05 were considered statistically significant.

Regarding HFNC disconnection, 828 (48%) of participants believed that a gas flow of less than 20 L/min was the most criterion used to disconnect COPD patients from HFNC with no difference between physicians (292, or 45.9%) and RTs (536, or 49.3%) (Table 2).

Barriers to High Flow Nasal Cannula Implementation by Profession

Physician reported several barriers that negatively impacted the utilization of HFNC. The most common reported barriers among physician were inadequate training (314, or 49%), followed by absence of standardized or institutional protocol (309, or 49%) and lack of knowledge about HFNC (304, or 48%) (Figure 1).

Similarly, RTs cited absence of standardized or institutional protocol (554, 51%), lack of knowledge about HFNC (552, or 52%) and inadequate training (462, or 42%) were the most common reported barriers of implementing HFNC by RTs (Figure 2).

Discussion

Among the 1,724 survey respondents (36.9% physicians, 63.1% RTs), most were male and based in the country's central region, with the modal clinical experience falling between one and five years. Around Two-thirds of participants had received HFNC training and had already used in clinical practice, however, just over half reported an institutional HFNC protocol. Although the majority of both groups agreed that a conventional oxygen flow ≥ 6 L min warranted switching a COPD patient to HFNC, RTs favored slightly higher initial flow rates (30–40 L min) and lower gas temperatures (34 °C), whereas physicians tended toward 37 °C. Weaning practices also diverged, with RTs more inclined to reduce flow

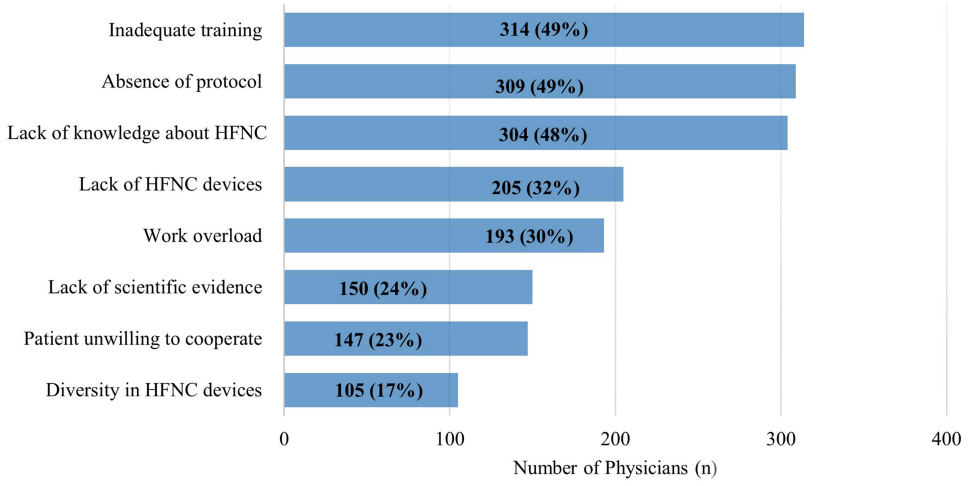

Figure 1 Barriers to HFNC implementation by Physicians (n=636).

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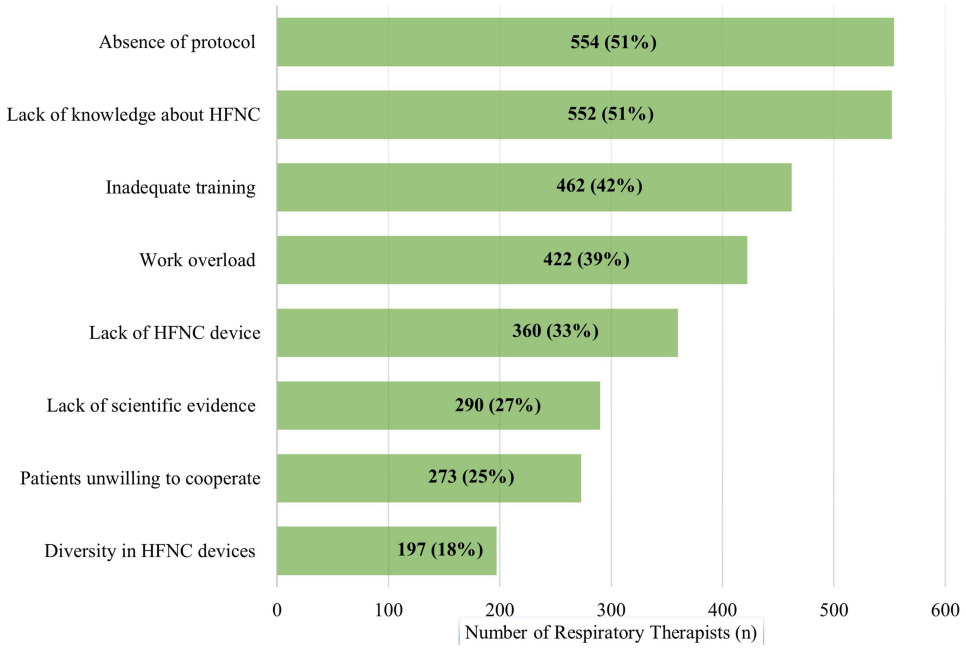

Figure 2 Barriers to HFNC implementation by Respiratory Therapists (n=1,088).

first and physicians to lower FiO_2. Despite these variations, both professions most disconnected HFNC once flow fell below 20 L min. Across disciplines, the principal barriers to wider HFNC adoption were the absence of standardized protocols, limited knowledge, and inadequate training.

The preferred initial FiO2 settings (36.5% choosing 41–60%) align with contemporary clinical recommendations for moderate initial oxygen concentrations with subsequent titration based on patient response.[21,22] However, the significant variation in initial flow rate preferences between physicians and RTs (45.4% vs 48.3% preferring 30–40 L/min) reflects ongoing uncertainty in optimal HFNC initiation strategies. Recent evidence suggests that higher initial flow rates (50–60 L/min) may provide superior physiological benefits in terms of meeting inspiratory demand and reducing work of breathing.[21,23,24] The observed preference for lower flow rates may represent conservative clinical practice or institutional protocols designed to minimize patient discomfort during initiation.

In terms of temperature setting, a variation between physicians and RTs were found, with physicians favoring 37°C (52.2%) whereas RTs preferred 34°C (42.3%). Evidence supports lower temperature settings for improved patient comfort and tolerance.[22,25] Studies have demonstrated that patients report significantly greater comfort when HFNC is delivered at lower flow rates and with lower temperature settings.[25] The RT preference for lower temperatures may reflect their direct patient interaction and clinical experience with therapy tolerance, suggesting that their practical knowledge aligns with emerging evidence on optimal temperature settings.

The finding that 43% of participants preferred initial gas flow reduction during weaning which reflects emerging evidence suggested that flow-first weaning strategies may be more physiologically appropriate.[6] The discontinuation criterion of gas flow <20 L/min (chosen by 48% of participants) appears conservative compared to recent evidence suggesting that earlier discontinuation may be safe and beneficial at higher flow rates.[26] Studies have shown successful weaning at higher flow rates (up to 25–30 L/min in some populations) with appropriate clinical assessment.[7,21] This conservative approach may contribute to unnecessarily prolonged HFNC therapy and increased healthcare resource utilization.

Despite the growing evidence supporting high-flow nasal cannula (HFNC) therapy, its implementation in clinical settings continues to face notable barriers. In this study, physicians most frequently identified inadequate training, absence of standardized institutional protocols, and insufficient knowledge as major obstacles. Similarly, respiratory therapists highlighted limited knowledge, lack of formal protocols, and inadequate training as common challenges. These findings are consistent with our previous study reported that the absence of clinical guidelines and training significantly

hindered the effective use of HFNC among RTs in managing adult ARDS patients.[16] Unlike that study, which focused on ARDS and surveyed only RTs, the present work investigates HFNC use in patients with mild to moderate COPD among a broader group of healthcare providers, thereby contributing new insights into chronic respiratory disease management. Moreover, our study findings also align with a study that emphasized the role of structured discharge protocols and clinician education in improving the quality of respiratory care, noting that without such frameworks, the integration of advanced therapies like HFNC remains inconsistent.[27] Similarly, gaps in training and protocol availability have been widely reported in pediatric care settings, where a lack of clear guidance has hindered the effective use of HFNC.[28,29]

Evidence from both high- and low-resource environments highlights the importance of comprehensive training and structured implementation strategies to overcome resistance and operational challenges during HFNC deployment.[30,31] Additionally, extending HFNC use beyond intensive care units has been shown to require not only sufficient infrastructure but also clinician readiness and the presence of clear, protocol-based guidance.[19] Collectively, these findings underscore the pressing need for standardized training, consistent clinical protocols, and institutional investment to enable the safe and effective integration of HFNC therapy across healthcare environments.

Strengths and Limitations

A key strength of this study lies in its large, nationwide sample that includes a diverse representation of healthcare providers from various regions, institutions, and levels of clinical experience. The inclusion of both physicians and RTs provides a comprehensive perspective on current practices, decision-making processes, and perceived barriers related to HFNC use in managing COPD. Although the study's consistency with previous research and expert-validated survey instrument enhances its credibility, several limitations merit acknowledgment. The use of a convenience sampling strategy and online survey distribution may introduce selection bias, as those more familiar with or interested in HFNC might have been more likely to participate. Self-reported responses may introduce recall or social desirability bias, compromising practice accuracy. The cross-sectional design also prevents assessment of causal relationships or practice changes over time. Although participant diversity enhances generalizability, varying local policies and HFNC access may influence findings.

Conclusion

Healthcare providers in Saudi Arabia, including both physicians and respiratory therapists, exhibited a reasonable level of familiarity with the use of HFNC in managing COPD patients. However, notable inconsistencies emerged concerning the initiation process, selection of initial settings, and approaches to weaning and disconnection. These discrepancies were largely attributed to insufficient training, lack of standardized institutional protocols, and limited clinical knowledge surrounding HFNC therapy. These findings underscore the need for the development of unified, evidence-based clinical guidelines and structured educational programs to ensure the consistent, safe, and effective use of HFNC across healthcare settings.

Data Sharing Statement

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Research Ethics Committee at King Abdulaziz University, Faculty of Medicine, under reference number 2024-002. All participants provided informed consent prior to participation. All methods were carried out in accordance with the principles of the Declaration of Helsinki.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

All authors declare no conflict of interest.

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