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2 **British Thoracic Society Clinical statement on the use and monitoring of High**
3 **Flow Nasal Therapy (HFNT) in adult patients**

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6 *Draft for consultation:20 October 2026*

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15 **On behalf of the British Thoracic Society**

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18 **Available for public consultation from**

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20 20 October 2026 to 20 November 2026

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British Thoracic Society Clinical statement on the use and monitoring of High Flow Nasal Therapy (HFNT) in adult patients

Abbreviations List

Section 1: Summary of clinical practice points

Section 2: Introduction, scope and methodology

Section 3: Physiological effects of HFNT

Section 4: Acute hypoxaemic respiratory failure

Section 5: Acute hypercapnic respiratory failure

Section 6: Practical aspects of managing HFNT in patients with acute respiratory failure

Section 7: Domiciliary HFNT in chronic respiratory failure

Section 8: Practical aspects of managing HFNT in community settings

Section 9: Secretion management

Section 10: Withdrawal and palliation

Section 11: Research recommendations and future priorities for HFNT

References

Abbreviations List

ADRT:	advance decision to refuse treatment
AECOPD:	acute exacerbation of chronic obstructive pulmonary disease
AE-IPF:	acute exacerbation of idiopathic pulmonary fibrosis
AHRF:	acute hypercapnic respiratory failure
APACHE II:	Acute Physiology and Chronic Health Evaluation II
ARF:	acute respiratory failure
BMI:	body mass index
BTS:	British Thoracic Society
CAP:	community-acquired pneumonia
CHRF:	chronic hypercapnic respiratory failure
CI:	confidence interval
COPD:	chronic obstructive pulmonary disease
COT:	conventional oxygen therapy
CPAP:	continuous positive airway pressure
CrI:	credible interval
DNI:	do not intubate
DVT:	deep vein thrombosis
ED:	emergency department
FiO ₂ :	fraction of inspired oxygen
ERS:	European Respiratory Society
HFNT:	high-flow nasal therapy
HDU:	high dependency unit
HCP:	healthcare professional
HR:	hazard ratio
HRQoL:	health-related quality of life
ICER:	incremental cost-effectiveness ratio
ICS:	Intensive Care Society
ICU:	intensive care unit
ILD:	interstitial lung disease
IMV:	invasive mechanical ventilation
IPF:	idiopathic pulmonary fibrosis
LOS:	length of stay
LPA:	lasting power of attorney
LTOT:	long-term oxygen therapy

- 86 MCA: Mental Capacity Act
- 87 MDT: multidisciplinary team
- 88 NEWS2: National Early Warning Score 2
- 89 NIV: non-invasive ventilation
- 90 OSA: obstructive sleep apnoea
- 91 OR: odds ratio
- 92 PaCO₂: arterial partial pressure of carbon dioxide
- 93 PaO₂: arterial partial pressure of oxygen
- 94 PE: pulmonary embolism
- 95 QALY: quality-adjusted life year
- 96 RCT: randomised controlled trial
- 97 ROX index: respiratory rate–oxygenation index
- 98 RR: respiratory rate
- 99 RSU: respiratory support unit
- 100 RV: right ventricular
- 101 SGRQ: St George's Respiratory Questionnaire
- 102 SpO₂: peripheral oxygen saturation
- 103 VAP: ventilator-associated pneumonia
- 104 VTE: venous thromboembolism

Section 1: Summary of clinical practice points

Acute hypoxaemic respiratory failure: HFNT compared with COT, NIV and CPAP

- HFNT may be considered over COT where adequate oxygenation cannot be maintained, but CPAP/NIV may be more appropriate where positive pressure, alveolar recruitment, or ventilatory support is required.
- HFNT may be considered as an alternative to NIV in selected patients with hypoxaemic ARF where positive-pressure or ventilatory support is not specifically required, taking account of clinical trajectory and patient tolerance.
- Patient comfort should be considered when selecting respiratory support; however, this should not supersede clinical indications for NIV, CPAP or IMV where these are required.
- HFNT may be better tolerated than NIV.
- There is little evidence to support the use of HFNT compared to other methods of oxygen delivery in patients who are not suitable for intubation and ventilation.

Specific clinical conditions: mortality and risk of endotracheal intubation

Immunocompromised

- HFNT may be considered in immunocompromised patients with hypoxaemic ARF. Current evidence does not demonstrate a mortality benefit, while evidence for reducing intubation compared with COT is inconsistent.

COVID-19

- HFNT can safely be used in patients with hypoxaemic ARF secondary to COVID-19. It may be more effective than COT in reducing risk for intubation, but CPAP/NIV are at least as effective and may support oxygen delivery better in some patients.
- Patient choice and tolerance need consideration when making management decisions to treat hypoxaemic ARF in COVID-19 patients.

Interstitial lung disease

- HFNT may be considered on an individualised basis in ILD-related hypoxaemic ARF where a potentially reversible contributor is being treated, recognising the limited evidence of clinical benefit and poor prognosis, particularly in advanced fibrotic disease.
- HFNT may support palliative care in patients with ILD-related hypoxaemic ARF by improving symptom control, facilitating communication, and allowing time for patient/family discussions.
- Institution of HFNT in patients with ILD should include a weaning plan for respiratory support, developed with palliative care input.

Cardiogenic pulmonary oedema

- HFNT should be considered over COT to treat ARF in patients with acute cardiogenic pulmonary oedema to reduce work of breathing, improve oxygenation and reduce risk of intubation.

- No clear superiority of HFNT over CPAP/NIV has been established.
- HFNT in patients with cardiogenic pulmonary oedema should be delivered in a critical care setting or a high monitoring area such as a coronary care unit.

Asthma

- HFNT has not demonstrated an improvement in oxygenation, risk of IMV or hospital LOS compared with COT, but limited evidence from small trials suggests possible improvement in dyspnoea.
- If non-invasive respiratory support is applied in acute asthma, this should only be undertaken in a critical care environment to monitor for treatment failure and to enable rapid endotracheal intubation.

Pulmonary embolism

- HFNT could be considered to treat hypoxaemic ARF in patients with acute PE to reduce respiratory rate and work of breathing and improve oxygenation.
- HFNT in patients with acute PE should be delivered in a critical care setting or a high monitoring area.

Bronchiectasis

- HFNT may be considered as an adjunct in selected patients with bronchiectasis exacerbations and ARF where oxygenation, comfort or secretion clearance are problematic; however, evidence is indirect and limited.

Acute hypercapnic respiratory failure

Compared with COT

- NIV remains first-line for treatment of acidaemic AHRF.
- HFNT should not be routinely used in patients with compensated AHRF to prevent progression of hypercapnia.
- HFNT may be considered in selected patients with mild COPD-related AHRF, particularly where controlled oxygen delivery is required and there is no acidaemia.
- HFNT should not delay escalation to NIV where NIV is clinically indicated, particularly in patients with pH <7.35, worsening acidaemia, rising PaCO₂, increasing work of breathing or clinical deterioration.
- HFNT is not recommended as primary ventilatory support for AHRF due to neuromuscular disease, chest wall disease, severe obesity-related respiratory failure, or other causes of ventilatory failure where NIV is indicated.
- Patients should be managed with target oxygen saturations of 88–92% in known or suspected hypercapnia.
- Early reassessment (within 1–2 hours) is essential to identify non-responders.
- HFNT use in hypercapnia should only occur with a clear escalation plan specifying when NIV or IMV should be instituted, where appropriate.

- Patients receiving HFNT should be closely monitored for rising PaCO₂, respiratory fatigue, or progression of acidaemia.

Compared with NIV

- NIV should remain first-line therapy for AHRF with acidaemia (pH <7.35).
- HFNT should not be used as a replacement for NIV in acidaemic AHRF.
- HFNT may be considered where NIV is not tolerated or is contraindicated, but supporting clinical evidence is limited and low certainty.
- In patients with acidaemic AHRF who remain eligible for IMV, HFNT should only be considered where NIV is not tolerated or cannot be delivered. This should be delivered in a critical care setting with close monitoring and immediate access to intubation, as HFNT must not delay IMV where clinically indicated.

During planned NIV breaks

- Based on limited evidence, HFNT may be considered on an individualised basis during planned NIV breaks to improve comfort and tolerance, while maintaining oxygenation and supporting CO₂ washout.
- HFNT should not replace NIV unless there is clear intolerance or contraindication.
- NIV should be restarted promptly if hypercapnia worsens during HFNT use on blood gas or transcutaneous CO₂ monitoring, or if work of breathing increases.

Comfort, tolerance and patient experience

- HFNT settings should be individualised and titrated to patient comfort and work of breathing.
- Flow rates ≥30 L/min should generally be used to achieve physiological effect.
- Temperature and humidity settings may require adjustment during treatment and recovery according to patient tolerance and secretion burden.
- Comfort should not supersede clinical indications for NIV when required.

Practical aspects of acute respiratory failure

- HFNT is a high-risk therapy indicative of severe acute respiratory failure.
- Early senior clinical review should occur in all patients initiated on HFNT.
- HFNT should be delivered in enhanced monitoring environments such as RSU, HDU, ICU, coronary care or equivalent areas with trained staff and escalation pathways.
- Delivery in standard unenhanced ward environments without adequate monitoring, trained staff and escalation pathways is not appropriate for patients with significant oxygen requirements or clinical instability.
- The BTS/ICS RSU guidance specifically states that the minimum ratio recommended for an RSU is 1:4, with more staff required as acuity increases.
- HFNT must only be initiated with a documented escalation plan agreed by a senior clinician (ST3+/respiratory or critical care equivalent).

- 221 ● Escalation plans should define:
 - 222 ▪ suitability for NIV
 - 223 ▪ suitability for IMV
 - 224 ▪ any agreed limits to treatment escalation, where appropriate
 - 225 ▪ palliative care strategy and weaning or withdrawal plan where NIV or IMV is not
 - 226 appropriate
- 227 ● Failure to respond should prompt early senior review, with timely escalation of
- 228 respiratory support or transition to symptom-focused palliative care in accordance with
- 229 the agreed treatment escalation plan.
- 230 ● Local HFNT protocols should include objective reassessment criteria, such as serial
- 231 ROX index measurement in hypoxaemic ARF, alongside clinical assessment of work
- 232 of breathing, oxygen requirement, gas exchange and mental status.
- 233 ● All institutions using HFNT should maintain a formal HFNT policy, including:
 - 234 ▪ indications and contraindications
 - 235 ▪ initiation pathway or flowchart
 - 236 ▪ initiation protocols
 - 237 ▪ monitoring requirements
 - 238 ▪ definition of HFNT failure
 - 239 ▪ escalation and ceiling-of-care pathways
 - 240 ▪ weaning strategies
- 241 ● HFNT use should be evaluated in routine audit and morbidity/mortality review
- 242 processes.
- 243 ● Staff delivering HFNT must demonstrate documented competency-based training.
- 244 ● HFNT should be integrated into structured acute respiratory failure pathways, not used
- 245 as an isolated therapy.
- 246 ● Oxygen infrastructure must support safe delivery of multiple high-flow devices where
- 247 used at scale.
- 248 ● HFNT should not delay escalation to ventilatory support such as NIV or IMV when
- 249 clinically indicated.

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251 Domiciliary HFNT in chronic respiratory failure

252 Chronic hypoxaemic respiratory failure

- 253 ● Home HFNT may be considered as an adjunct to LTOT in selected patients with stable
- 254 COPD and chronic hypoxaemic respiratory failure to reduce exacerbation frequency
- 255 and improve symptom control.
- 256 ● Home HFNT could be considered in selected patients with bronchiectasis and ILD, but
- 257 evidence is currently insufficient to recommend its routine use; where considered,
- 258 treatment should form part of a specialist-led, individualised clinical management plan.
- 259 ● The practical utility of HFNT is limited by the requirement for a power supply and circuit
- 260 length.
- 261 ● Early involvement of palliative teams should be considered when starting home HFNT
- 262 in patients with advanced, progressive or life-limiting respiratory disease.

- An action plan for device management including servicing, failure, cleaning, and backup during disruption to power supply should be instituted prior to initiating home HFNT.

Chronic hypercapnic respiratory failure

- NIV remains the standard of care for patients with CHRF.
- Home HFNT may be considered in selected patients with stable COPD and CHRF where NIV is not tolerated or accepted; however, evidence specifically evaluating HFNT following NIV intolerance or failure is very limited, and NIV remains the established standard of care.
- Monitoring should be tailored to identify treatment failure, with individualised failure criteria and escalation plans based on the patient's clinical context and suitability for further respiratory support.
- There is insufficient evidence to advocate for home HFNT in stable COPD patients with $\text{PaCO}_2 > 7.0$ kPa, persistent hypercapnia following an exacerbation with AHRF, COPD–OSA overlap, obesity-related respiratory failure, neuromuscular disease or other non-COPD causes of chronic hypercapnic respiratory failure.

Practical aspects of managing HFNT in community settings

- Home HFNT delivery should involve liaison between acute and community multidisciplinary teams to support safe setup, clinical oversight and continuity of care.
- Transport of patients dependent on HFNT should be undertaken by appropriately trained transport or ambulance teams, with detailed handover to the receiving community team.
- Care plans should be developed for device management, transport and contingencies during device or power failure.
- Commissioning arrangements should be proportional to the complexity of the management of the home HFNT service and dependent on the local funding model.

Secretion management

- There is a paucity of high-quality clinical trials evaluating HFNT for secretion management in both acute and chronic respiratory disease.
- HFNT should not be initiated primarily or solely for mucus clearance in acute respiratory failure.
- HFNT should not be initiated primarily or solely for mucus clearance in the domiciliary setting outside specialist respiratory supervision.
- Established physiotherapy-led ACTs should remain the primary airway-clearance strategy, while HFNT should be considered an adjunct rather than a replacement.

301 Withdrawal and palliation

- 302 ● HFNT withdrawal should occur within a structured multidisciplinary and palliative care
303 framework, with senior clinical leadership and early specialist palliative care
304 involvement.
- 305 ● Withdrawal planning should consider the distinction between oxygenation-dependent
306 and symptom-control–dependent patients.
- 307 ● Capacity assessment and legal frameworks (ADRT, LPA, MCA 2005) must be followed
308 and documented.
- 309 ● Withdrawal planning should include anticipatory prescribing for dyspnoea, anxiety, and
310 terminal agitation.
- 311 ● Non-pharmacological measures for symptom management, including fan therapy,
312 mouth care and environmental optimisation, should be routinely used.
- 313 ● Monitoring should prioritise comfort and symptom burden rather than physiological
314 targets.
- 315 ● Escalation pathways must be clearly defined, including access to senior clinicians and
316 palliative care teams.
- 317 ● Withdrawal may occur in hospital, hospice, or home settings depending on patient
318 preference and clinical stability.
- 319 ● Some patients may continue HFNT until death where symptom benefit outweighs
320 burdens.
- 321 ● Clear documentation of decision-making, rationale, and care plans is essential.
- 322 ● Complex or disputed decisions should prompt senior multidisciplinary review and,
323 where appropriate, independent clinical or ethics support; unresolved significant
324 disagreement may require legal advice or referral to the Court of Protection.

Section 2: Introduction, scope and methodology

Introduction

High Flow Nasal Therapy (HFNT) is a non-invasive respiratory therapy administered through a nasal cannula that delivers heated and humidified room air. Oxygen can be entrained to deliver a stable fraction of inspired oxygen (FiO₂) up to 100% at flow rates of up to 60 L/min in routine clinical practice.¹ HFNT may also be delivered through a tracheostomy interface in selected patients.² HFNT is applied in clinical practice to support patients in the acute inpatient and stable home settings, to provide respiratory support for the management of respiratory failure, airway clearance and breathlessness in a range of underlying conditions.^{3,4} This British Thoracic Society (BTS) Clinical Statement aims to address the role of HFNT in a variety of scenarios with additional recommendations/descriptions on monitoring, safety and practical delivery, with key clinical practice points in each of the sections. The lack of robust evidence for several clinical applications is acknowledged. In areas where evidence is significantly lacking, expert opinion is provided along with research direction to address the evidence gap.

This statement was commissioned to address increasing clinical applications of HFNT, including areas where robust evidence is lacking. The purpose of this clinical statement is to provide an overview of clinical scenarios where HFNT could be applied, evidence supporting such application or expert opinion where robust clinical trial evidence is lacking, research recommendations, and clinical practice points for the general respiratory clinician. A summary of clinical practice points is provided in Section 1. Evidence summary tables are provided in Appendix 1.

Scope

This clinical statement covers a broad range of clinical conditions where HFNT use is prevalent. This includes acute and chronic hypoxaemic and hypercapnic respiratory failure in hospital and domiciliary settings. This statement also provides practice points in secretion management and palliation in all settings. The statement acknowledges the lack of evidence in many of the above settings and provides research priorities for each of the sections.

Methodology

The Clinical Statement Group (CSG) was chaired by Dr Ingrid du Rand and Dr Murali Shyamsundar. Membership of the CSG was selected through an expression of interest process. The final membership was decided based on a scoring system performed by the chairs independent of each other. The CSG membership is multidisciplinary in nature. The CSG identified key areas requiring clinical practice points. The overall content was developed to reflect the scope approved by the BTS Standards of Care Committee (SOCC). Following discussions of broad statement content, individual sections were drafted by group members. A final edited draft was developed iteratively with feedback from the CSG and reviewed by SOCC. Following SOCC review, the revised statement will undergo public consultation and peer review through the BTS before further revision and final approval.

Section 3: Physiological effects of HFNT

Physiological effects of HFNT

The physiological effects of HFNT are summarised in Table 1. Clinical trials in human subjects as well as bench studies indicate that HFNT confers a range of physiological effects,⁵ summarised in Table 1.

Physiological effect	Clinical impact
Mucociliary clearance	Bench and small clinical studies suggest heated humidification supports mucociliary function and secretion clearance^{6,7}
Dead space washout	- Reduced anatomical dead space in a flow-dependent manner,⁸ with clearance further enhanced by an asymmetrical nasal cannula interface in a benchside study⁹ - Creation of oxygen reservoir where supplementary oxygen is entrained - Carbon dioxide washout
Pulmonary mechanics	- Increases expiratory resistance, mean airway pressure and expiratory time¹⁰ - Improved oxygenation through counteracting peak inspiratory flow rates and reducing entrainment of ambient air¹¹ - Delivery of positive airway pressure that is proportional to flow and dependent on mouth position^{12,13} - Increased end-expiratory lung volume and dynamic compliance in hypoxaemic acute respiratory failure (ARF)¹⁴ - Reduced ventilation inhomogeneity and dead space ventilation - Reduced work of breathing^{14–16}

Table 1: Summary of physiological effects of high flow nasal therapy

Respiratory epithelium functions optimally at core body temperature and 100% relative humidity. The consequence of altered airway conditions is impaired mucociliary function, with altered volume and viscosity of respiratory secretions, reduced ciliary beat frequency and mucus transport velocity, and risk of bronchoconstriction.^{6,17} This increases airway resistance, reduces lung compliance and increases work of breathing, and clinically increases risk of mucus plugging and alveolar decruitment as well as infection. Use of radio-labelled aerosol demonstrates that in patients with Chronic Obstructive Pulmonary Disease (COPD) and bronchiectasis, secretion clearance increases following heating and humidification of inhaled air after 3 hours, which is sustained over 7 days when used as a daily intervention.⁷

HFNT has been shown in patients with acute and chronic respiratory failure to alter pulmonary mechanics. The effects are physiologically different compared to other mechanisms by which respiratory support such as Non-Invasive Ventilation (NIV), Continuous Positive Airway Pressure (CPAP) and Invasive Mechanical Ventilation (IMV) operate, since these use a closed or semi-closed interface/circuit to deliver positive pressure. HFNT is an open-interface system, and the positive airway pressure generated is modest and dependent on total flow and interface leak, including whether the mouth is open or closed. Mean nasopharyngeal pressure

increases with flow: in one study it was approximately 3.3 cmH₂O at 50 L/min with the mouth closed.¹² At very high flows of up to 100 L/min, airway pressure and end-expiratory lung impedance increase progressively with flow.¹³ Higher total flows also reduce ambient-air entrainment and improve the reliability of delivered FiO₂ when they better match or exceed inspiratory demand.¹¹

Introducing flow to the upper airway dilutes and eliminates exhaled gas, thus reducing dead space ventilation. Experimental upper-airway models demonstrate rapid, flow-dependent clearance of exhaled gas from the anatomical dead space during nasal high flow.⁸ Physiological studies in hypoxaemic ARF and COPD demonstrate reductions in respiratory effort and minute ventilation without a corresponding rise in CO₂.^{14,18} Lung model studies demonstrate that application of gas under high flow rates enables continuous flushing of exhaled gas thereby reducing CO₂ rebreathing and can create an oxygen reservoir, which is proportional to flow rate. In stable hypercapnic COPD, variation in prong size did not significantly alter measured respiratory parameters or PaCO₂, although increasing flow increased mean airway pressure and reduced PaCO₂.¹⁹ In bench models, an asymmetrical nasal interface increased anatomical dead-space CO₂ clearance compared with a symmetrical interface.⁹

Invasive measurements of transdiaphragmatic pressure and diaphragm pressure-time product demonstrate that HFNT reduces work of breathing and improves dynamic compliance compared to facemask oxygen in patients with hypoxaemic ARF,¹⁴ and reduces work of breathing and dynamic hyperinflation in COPD patients with chronic hypercapnic respiratory failure albeit to a lesser degree than NIV.^{15,16}

Summary

- HFNT is a non-invasive respiratory therapy that delivers heated humidification to the airways at flow rates of up to 100 L/min depending on device capability.
- Bench and clinical trial data demonstrate that HFNT can optimise respiratory epithelial function with increased ciliary beat frequency and mucus transport velocity observed at 37°C compared to lower temperatures, and improved airway clearance.
- Physiological and bench studies suggest potential benefits of HFNT for mucociliary clearance and of asymmetric nasal interfaces for dead-space washout; however, these findings have not yet been confirmed in clinical trials evaluating patient-important outcomes.
- When total flow adequately matches inspiratory demand, HFNT can provide more reliable delivery of the prescribed FiO₂ than conventional open oxygen systems.
- Lung models demonstrate that continuous flow to the upper airway facilitates dead space washout, through flushing of exhaled gas and creation of an oxygen reservoir.
- HFNT generates modest positive airway pressure that increases with flow and is influenced by interface leak and mouth position.
- Compared to no intervention or face mask oxygen, HFNT reduces work of breathing in patients with acute and chronic respiratory failure.

Section 4: Acute hypoxaemic respiratory failure

Acute hypoxaemic respiratory failure (also termed type 1 respiratory failure) describes the physiological consequence of ventilation-perfusion mismatch, diffusion limitation, right-to-left shunt or reduced inspired oxygen tension.²⁰ These phenomena may arise due to infection, pulmonary oedema, pulmonary embolism and acute exacerbation of airways or parenchymal lung disease. Supplementary oxygen to achieve a target peripheral oxygen saturation (SpO₂) or arterial partial pressure of oxygen (PaO₂) is required to address the physiological derangement whilst disease-specific treatment is instituted.²¹

The aim of oxygen therapy in hypoxaemic ARF is to reduce risk of mortality from hypoxia and reduce the need for intubation with associated complications and mortality. Supplementary oxygen may be delivered at flow rates of up to 5 L/min via conventional nasal cannula or up to 8 L/min via face mask in mild hypoxaemic ARF.²¹ Higher flow rates are provided through venturi masks for FiO₂ of up to 60% at 15 L/min and non-rebreathe masks for FiO₂ >60% via 10-15 L/min. Oxygen may be entrained through non-invasive respiratory support therapies including HFNT, NIV and CPAP. IMV may be required where non-invasive oxygen therapy fails. Conventional oxygen therapy (COT) can be defined as oxygen delivered via standard devices such as nasal cannulae, Venturi mask, simple face mask or non-rebreathe mask, excluding HFNT, CPAP, NIV and invasive ventilation.

The main goals of oxygen therapy in this group of patients are to reduce the risk of mortality related to hypoxaemia and to reduce the risk of intubation, which is known to be associated with considerable morbidity. The optimum method of oxygen delivery to achieve these goals is unknown. Many studies have attempted to address this question in patients with hypoxaemic ARF. There is considerable variability between studies in terms of severity of respiratory failure, clinical setting, intervention and outcome.

Physiological effects of HFNT in acute hypoxaemic respiratory failure as compared to COT, NIV and CPAP

Physiological effects: respiratory rate and gas exchange

The evidence synthesis underpinning the 2022 ERS clinical practice guideline found that, compared with COT, HFNT was associated with a significant increase in PaO₂, with a mean difference of 2.26 kPa, equivalent to 16.7 mmHg, with no significant difference in PaCO₂. HFNT was also associated with an increase in the PaO₂:FiO₂ ratio (mean difference 3.33 kPa), although this did not reach statistical significance.²²

A reduction in respiratory rate (RR) was observed with HFNT compared to COT (mean difference -2.25 breaths/min).²² These findings are supported by the SOHO study, which enrolled 1116 patients and demonstrated a reduction in RR in the HFNT group compared with COT. Furthermore, patient-reported outcomes from the SOHO study showed subjective improvement in patient-perceived dyspnoea in 49.5% of patients receiving HFNT compared to 34.6% in the COT group (absolute difference 14.9%).²³

These results are consistent with a Cochrane systematic review of eight randomized controlled trials, which found no significant difference in PaO₂:FiO₂ ratio after 24 hours between HFNT and COT, but confirmed a modest reduction in RR with HFNT (mean difference -2.02 breaths/min).²⁴

In contrast, when HFNT was compared with NIV or CPAP, meta-analyses demonstrated a lower PaO₂:FiO₂ ratio with HFNT. One analysis reported a mean difference of -7.45 kPa (-58.1 mmHg), while another reported -5.77 kPa (-43.26 mmHg).^{22,24} There was no significant difference in PaCO₂ between HFNT and NIV or CPAP, and either no difference or a small reduction in RR favouring HFNT (mean difference -1.06 breaths/min).²⁴

Summary

- Compared with COT, HFNT is associated with improved oxygenation without consequent CO₂ rise and reduced RR. The reduced RR may be beneficial for minute ventilation if it allows for increased tidal volume.
- NIV or CPAP may lead to improved oxygenation compared to HFNT by recruiting additional alveolar space through positive pressure.

ARF secondary to mixed aetiology: mortality, risk of intubation, comfort and hospital stay

Most large Randomised Controlled Trials (RCTs) evaluating HFNT in ARF typically include patients with mixed causes of respiratory failure, with inclusion determined by severity of hypoxaemia rather than the aetiology of respiratory failure. Of note, community-acquired pneumonia (CAP) was the most common aetiology in the presented evidence base, hence the evidence presented largely relates to CAP.

Mortality

The FLORALI trial compared HFNT with COT and NIV in Intensive Care Unit (ICU) patients with ARF, 64% of whom had pneumonia. The hazard ratio (HR) for death at 90 days, a secondary outcome favoured HFNT compared to both COT (HR 2.01 [95% CI 1.01 to 3.99]) and NIV (HR 2.50 [95% CI 1.31 to 4.78]), acknowledging that NIV is not the standard of clinical care in ARF particularly secondary to pneumonia.²⁵ The SOHO study recruited 1116 patients with hypoxaemic ARF and found no difference in 28-day mortality between HFNT and COT.²³ Pneumonia (including viral pneumonia) was the primary cause of ARF in 88.1% of patients.

Subsequent studies comparing HFNT with COT have not found a difference in mortality.²⁶⁻²⁸ A 2019 systematic review and meta-analysis of 9 RCTs including 2093 patients with ARF concluded there was no mortality difference (relative risk (RR) 0.94 (95% CI 0.67 to 1.31)).²⁹ This conclusion was supported by a further 2020 systematic review and network meta-analysis, which demonstrated no difference in mortality (absolute risk difference -0.04 (95% CrI -0.15 to 0.04)).³⁰ Community acquired pneumonia was the most common cause of ARF in 16 of the 25 included studies in this meta-analysis.

A 2021 meta-analysis including five studies demonstrated no difference in mortality between HFNT and NIV; risk ratio 0.92 (95% CI 0.64 to 1.31).²⁴ More recently, the 2025 RENOVATE multicentre adaptive non-inferiority RCT compared NIV with HFNT in five patient groups. The study included 485 immunocompetent patients with hypoxaemia and demonstrated non-inferiority in terms of the composite primary outcome of intubation or death within 7 days between HFNT and NIV.³¹

Summary

- HFNT does not influence mortality in ARF compared to COT and NIV.

Need for intubation

Avoiding intubation and mechanical ventilation is desirable, both in terms of reducing morbidity, including ventilator-associated pneumonia, and reducing pressure on frequently scarce intensive care resources. A number of studies have compared the effectiveness of HFNT and COT in reducing the need for endotracheal intubation;^{25–28,32,33} a systematic review and meta-analysis concluded HFNT was associated with a reduced risk of intubation compared to COT; relative risk 0.85 (95% CI 0.74 to 0.99).²⁹ A larger meta-analysis which included both patients post-extubation as well as those without prior mechanical ventilation found a stronger treatment effect, although in this case the outcome was defined as treatment failure which included both need for intubation and need for escalation to NIV in those already receiving HFNT; risk ratio 0.62 (95% CI 0.45 to 0.86).²⁴ In both meta-analyses the certainty of evidence was low due to risk of bias and imprecision. The SOHO study demonstrated a reduction in intubation in patients receiving HFNT when compared to COT from 48.4% (268 of 554) in the COT group to 42.4% (236 of 556) in the HFNT group (absolute difference, –5.93 percentage points; 95% CI, –11.78 to –0.08) but the study was not powered to detect a difference in intubation.

In contrast, HFNT has not demonstrated a clear reduction in intubation compared with NIV/CPAP; however, direct comparative evidence remains less extensive than the evidence versus COT.^{24,25,30,31} Although the RENOVATE study used a composite outcome of intubation or death within 7 days, the percentage of patients requiring intubation was similar between HFNT and NIV groups; 31.2% and 29.2% respectively, in keeping with this conclusion.³¹

Summary

- HFNT is likely to reduce the risk of intubation when compared to COT in ARF; there is no significant difference between HFNT and NIV in intubation risk.

Comfort

Patients with severe ARF are frequently tachypnoeic with respiratory distress and comfort is an important factor when deciding upon method of oxygen delivery. The delivery of heated humidified gas via a nasal interface makes HFNT an attractive option in this situation. A comprehensive overview of this comes from a meta-analysis of studies evaluating patient-reported comfort. This concluded HFNT is associated with higher comfort scores compared to NIV, although when compared to COT there is a smaller and more variable effect.²⁴ The certainty of evidence in this meta-analysis for both comparisons was very low.

Summary

- Patient comfort generally favoured HFNT over NIV in a multicentre non-inferiority RCT in patients with hypoxaemia.³¹

Hospital length of stay

Meta-analyses have demonstrated HFNT does not affect hospital length of stay or ICU length of stay compared to COT and NIV.^{24,29,30}

Outcome	HFNT vs COT	HFNT vs NIV/CPAP	Interpretation
Mortality	No consistent mortality benefit demonstrated.	No clear mortality difference compared with NIV/CPAP.	HFNT should not be selected primarily to reduce mortality in mixed-aetiology ARF.
Intubation / treatment failure	HFNT probably reduces intubation or treatment failure compared with COT, although certainty is limited.	HFNT does not clearly reduce intubation compared with NIV/CPAP.	The main benefit of HFNT over COT is reduction in escalation to intubation or higher-level support.
Oxygenation / respiratory rate	HFNT improves oxygenation and reduces respiratory rate in some studies.	NIV/CPAP may improve oxygenation more through positive pressure and alveolar recruitment.	HFNT provides physiological support but less positive-pressure effect than NIV/CPAP.
Comfort / tolerance	Comfort benefit over COT is variable.	HFNT is generally better tolerated than NIV.	Comfort is an advantage, but should not override indications for NIV, CPAP or IMV.
Hospital / ICU length of stay	No consistent reduction.	No consistent reduction.	HFNT should not be expected to reduce hospital or ICU length of stay.

Table 2: Summary of clinical effects of HFNT compared with COT and NIV/CPAP in hypoxaemic ARF of mixed aetiology.

Summary

- In patients with ARF of mixed aetiology, the main benefit of HFNT is in reducing the need for intubation.
- While NIV may be similarly effective in this setting, HFNT is often better tolerated; modality choice should reflect the indication for positive pressure or ventilatory support, clinical trajectory and patient tolerance.
- The benefits of HFNT in patients in whom intubation and ventilation is not considered appropriate are less certain.

Clinical practice points:

- ✓ HFNT may be considered over COT where adequate oxygenation cannot be maintained, but CPAP/NIV may be more appropriate where positive pressure, alveolar recruitment, or ventilatory support is required.

- ✓ HFNT may be considered as an alternative to NIV in selected patients with hypoxaemic ARF where positive-pressure or ventilatory support is not specifically required, taking account of clinical trajectory and patient tolerance.
- ✓ Patient comfort should be considered when selecting respiratory support; however, this should not supersede clinical indications for NIV, CPAP or IMV where these are required.
- ✓ HFNT may be better tolerated than NIV.
- ✓ There is little evidence to support the use of HFNT compared to other methods of oxygen delivery in patients who are not suitable for intubation and ventilation.

Specific clinical conditions: mortality and risk of endotracheal intubation

Immunocompromised patients

Hypoxaemic ARF is the main cause of admission to ICU in immunocompromised patients and the need for intubation and IMV is associated with high mortality rates.^{34–37} Immunocompromised patients are more likely to develop complications such as ventilator-associated pneumonia (VAP).^{34,38} There has therefore been interest in evaluating HFNT in this cohort.

The 2026 SOHO study recruited 1116 patients of which 22.3% of patients were immunocompromised where a prespecified sub-group analysis did not demonstrate a difference in mortality or the rate of intubation.²³ A post-hoc propensity-score analysis of 353 immunocompromised patients with hypoxaemic ARF found no significant reduction in intubation or day-28 mortality with HFNT compared with standard oxygen.³⁹ A larger RCT in 2018 of immunocompromised patients with ARF compared HFNT to COT had a similar conclusion with no difference in mortality as primary outcome or need for intubation as secondary outcome.²⁸ Post-hoc analysis of the FLORALI study also demonstrated no difference in the need for intubation in immunocompromised patients between HFNT and COT.⁴⁰ A retrospective analysis of lung transplant patients with ARF showed a risk reduction for IMV in patients treated with HFNT compared to COT.⁴¹ Systematic review and meta-analysis of the available studies concluded that HFNT reduces the need for intubation and mechanical ventilation in immunocompromised patients compared to COT, although there was no difference in mortality.^{42,43} The reduction in need for intubation in these meta-analyses was driven by a trend favouring HFNT across several studies, and it should be noted that this has not been demonstrated in any RCTs.

For the comparison with NIV, a retrospective observational study suggested a reduced rate of intubation and 28-day mortality for patients treated with HFNT compared to NIV;⁴⁴ a smaller retrospective study suggested similar mortality in patients treated with HFNT and NIV.⁴⁵ The FLORALI-IM RCT randomised 299 immunocompromised patients with ARF to HFNT alone or NIV with a first session of at least 4 hours until clinical improvement and then at least 12 hours per day with additional HFNT.⁴⁶ There was no difference in the primary outcome of 28-day mortality; absolute difference 1.2% (95% CI -9.6 to 11.9) $p = 0.83$ or in the secondary outcome of intubation rate at 28 days.⁴⁶ In the more recent RENOVATE study, non-inferiority between HFNT and NIV for the primary outcome of intubation or death within 7 days was not met in immunocompromised patients with ARF.³¹ The number of patients included in this study was relatively low following early termination of enrolment after an interim analysis.

Summary

- HFNT has not demonstrated a mortality benefit over COT in immunocompromised patients. Meta-analyses suggest a possible modest reduction in intubation compared with COT, although individual RCTs have not consistently demonstrated this effect. Evidence comparing HFNT with NIV remains uncertain.
- Evidence comparing HFNT with NIV in immunocompromised populations remains heterogeneous.

Clinical practice points:

- ✓ HFNT may be considered in immunocompromised patients with hypoxaemic ARF. Current evidence does not demonstrate a mortality benefit, while evidence for reducing intubation compared with COT is inconsistent.

COVID-19 pneumonia and viral pneumonia

Severity of hypoxaemia is a key determinant of disease severity in COVID-19.⁴⁷ Alongside disease-specific therapies, HFNT, CPAP and NIV have all been evaluated as non-invasive respiratory support strategies in COVID-19-related hypoxaemic respiratory failure.

Several RCTs have evaluated the efficacy of HFNT in COVID-19. However, most COVID-19 respiratory support trials were conducted in earlier pandemic waves, before current vaccination, antiviral and immunomodulatory treatment patterns, which may limit applicability to contemporary severe COVID-19.

The HiFLo-COVID trial demonstrated a significant reduction in the need for intubation and a shorter time to clinical recovery, defined as hospital discharge or requirement for no or low-flow conventional oxygen therapy, within 28 days with HFNT compared to COT.⁴⁸

The HENIVOT trial found no difference between NIV and HFNT in the number of days free of respiratory support within 28 days in patients with COVID-19-associated hypoxaemia.⁴⁹

The RECOVERY-RS trial, a parallel-group, adaptive, open-label randomised clinical trial, evaluated CPAP or HFNT compared with COT in patients hospitalised with hypoxaemic ARF secondary to COVID-19. CPAP reduced the composite outcome of tracheal intubation or mortality within 30 days compared to COT (36.3% vs 44.4%; 95% CI -15% to -1%; $P = 0.03$). However, there was no significant difference between HFNT and COT (44.3% vs 45.1%; 95% CI -8% to 6%; $P = 0.83$).⁵⁰ Despite its pragmatic design and low loss to follow-up, the trial was limited by early termination due to declining hospital admissions. Additional limitations included its open-label design, lack of standardisation for escalation to tracheal intubation, longer time to intubation in the CPAP arm (potentially reflecting delayed decision-making or resource factors), and crossover between treatment arms in 17% of participants.

The SOHO-COVID trial reported no difference in 28-day mortality between HFNT and COT (10% vs 11%; $P = 0.60$).⁵¹ Similarly, the COVIDICUS trial found no significant difference in the cumulative incidence of IMV criteria at 28 days between HFNT, CPAP, and standard oxygen strategies.⁵²

The COVID-HIGH trial, the first multicentre RCT evaluating HFNT in hospitalised patients with COVID-19 pneumonia and mild hypoxaemia ($\text{PaO}_2\text{:FiO}_2$ ratio 200–300 mmHg), demonstrated

no significant difference in escalation of respiratory support within 28 days compared to COT. Secondary outcomes—including clinical recovery, time to escalation, ICU admission, and mortality at 28 and 60 days—were also similar between groups.⁵³

A more recent SOHO study (2026) recruited 1116 patients, of whom 53% had viral pneumonia; 87% of these cases (517/592) were attributable to COVID-19. In a predefined subgroup analysis, there was no difference in mortality or intubation rates between HFNT and COT.²³

Systematic reviews and meta-analyses of patients with COVID-19 and hypoxaemic respiratory failure have reported mixed findings. Some demonstrate no difference in mortality or treatment failure between HFNT, COT, and NIV,⁵⁴ while others report reduced 28-day ICU mortality and intubation rates with HFNT compared to COT,⁵⁵ or reduced need for intubation without a mortality benefit.⁵⁶

The RENOVATE trial, a multicentre non-inferiority RCT including 882 patients with COVID-19 and hypoxaemia, demonstrated non-inferiority of HFNT compared to NIV for the primary outcome of intubation or death within 7 days (OR 1.13, 95% CrI 0.94 to 1.38).³¹ There were no significant differences in secondary outcomes, including 28- and 90-day mortality.

The evidence for the use of HFNT in ARF secondary to COVID-19 is summarised in Table S3 (Appendix 1).

Summary

- In patients with COVID-19 and hypoxaemic ARF, HFNT was non-inferior to NIV for intubation or death within 7 days in RENOVATE, while evidence comparing HFNT with COT and CPAP remains mixed.
- HFNT does appear to reduce the need for intubation when compared to COT in ARF secondary to COVID-19.

Clinical practice points:

- ✓ HFNT can safely be used in patients with hypoxaemic ARF secondary to COVID-19. It may be more effective than COT in reducing risk for intubation, but CPAP/NIV are at least as effective and may support oxygen delivery better in some patients.
- ✓ Patient choice and tolerance need consideration when making management decisions to treat hypoxaemic ARF in COVID-19 patients.

Interstitial lung disease

Interstitial lung diseases (ILDs) are a heterogeneous group of diseases characterised by widespread fibrotic and/or inflammatory abnormalities of the lung parenchyma.^{57,58} Respiratory failure is a common complication of advanced ILD or following acute worsening of ILDs and can be classified on the basis of different parameters, including time of onset (acute or chronic), severity (mild to severe), and causes (reversible or irreversible). Patients with ILD also present with acute exacerbations which are associated with a very poor prognosis and are frequently accompanied by an accelerated decline in lung function. These exacerbations are thought to be either idiopathic or precipitated by acute events such as infection, aspiration, surgery and heart failure.⁵⁹ Whilst acute exacerbations have thus far been

most widely studied within the IPF group of ILD, they are becoming increasingly recognised as a complication of other fibrosing ILD.

Management of ARF in ILD frequently presents a clinical and ethical challenge, given the lack of benefit of IMV in the majority of patients and poor overall prognosis.⁶⁰ The decision to start non-invasive respiratory support is complex and is determined by a number of factors, including the nature of the underlying ILD and the acute insult leading to ARF. Either way, there is a high risk of mortality in this group and patients with advanced ILD should receive appropriate counselling about the prognosis of the disease and early palliative care input. Due consideration should be given to formulation of a weaning plan if the patient transitions to palliative care.

Oxygen therapy is the mainstay of supportive treatment of acute respiratory failure in ILD. The evidence for HFNT in this context is limited; a retrospective analysis demonstrated HFNT had a survival rate equivalent to NIV and was better tolerated by patients with ARF in ILD who had a do not resuscitate order and who were not for ICU admission.⁶¹ HFNT in this setting can enable oral intake and the ability to communicate when deteriorating towards death, suggesting that HFNT may be a reasonable palliative intervention alongside clearly communicated boundaries of its role and planning for withdrawal. A small retrospective cohort analysis of 17 patients with AE-IPF showed implementation of a treatment algorithm incorporating HFNT led to a lower-than-expected short term mortality.⁶² A recent systematic and narrative synthesis showed that HFNT as compared to NIV as a support for ARF was more comfortable and better tolerated with no clear difference in mortality.⁶³

Summary

- There is limited evidence to support the use of HFNT in ILD related ARF.
- HFNT appears to be well tolerated and may have a role with palliative intent to support oxygenation and allow time for discussion with patients and families as well as optimisation of symptom control.

Clinical practice points:

- ✓ HFNT may be considered on an individualised basis in ILD-related hypoxaemic ARF where a potentially reversible contributor is being treated, recognising the limited evidence of clinical benefit and poor prognosis, particularly in advanced fibrotic disease.
- ✓ HFNT may support palliative care in patients with ILD-related hypoxaemic ARF by improving symptom control, facilitating communication, and allowing time for patient/family discussions.
- ✓ Institution of HFNT in patients with ILD should include a weaning plan for respiratory support, developed with palliative care input.

Cardiogenic pulmonary oedema

International guidelines recommend the use of CPAP and NIV in acute heart failure in patients with respiratory distress to improve gas exchange and reduce the risk of endotracheal

intubation.⁶⁴ A previous meta-analysis has demonstrated a reduction in mortality and need for intubation when CPAP was used compared to COT.⁶⁵ The use of HFNT is associated with the generation of a small amount of positive end expiratory pressure, and there has been interest as to whether this may translate into clinical benefits for patients with cardiogenic pulmonary oedema.^{12,66} In an emergency-department RCT of 128 patients with cardiogenic pulmonary oedema, HFNT improved early respiratory distress/physiological parameters compared with conventional oxygen.²⁷

A systematic review and meta-analysis of 16 studies comparing HFNT, COT and NIV or CPAP in patients with acute heart failure was performed in 2023.⁶⁷ This demonstrated a reduction in rate of intubation for HFNT compared to COT; odds ratio 0.29 (95% CI 0.14 to 0.58), although there was no difference between HFNT and NIV or CPAP. There was also a reduction in respiratory rate and improvement in oxygenation with HFNT compared to COT, with no difference between HFNT and NIV or CPAP.⁶⁷

The RENOVATE multicentre non-inferiority RCT compared NIV and HFNT in 272 patients with acute cardiogenic pulmonary oedema. Non-inferiority for the primary outcome of intubation or death within 7 days was met, with no difference in the secondary outcomes of 28- and 90-day mortality.³¹ Of note, patients who required NIV prior to randomisation were excluded, potentially limiting the generalisability.

Summary

- HFNT demonstrated lower intubation rates, reduced respiratory rate, and improved oxygenation in patients with acute cardiogenic pulmonary oedema when compared to COT.
- There is insufficient evidence to recommend HFNT, CPAP or NIV as the preferred modality in acute cardiogenic pulmonary oedema.

Clinical practice points:

- ✓ HFNT should be considered over COT to treat ARF in patients with acute cardiogenic pulmonary oedema to reduce work of breathing, improve oxygenation and reduce risk of intubation.
- ✓ No clear superiority of HFNT over CPAP/NIV has been established.
- ✓ HFNT in patients with cardiogenic pulmonary oedema should be delivered in a critical care setting or a high monitoring area such as a coronary care unit.

Asthma

Asthma is the most common chronic respiratory disease and is characterised by airway hyperresponsiveness and reversible airflow obstruction.^{68–71} An episode of acute exacerbation results in expiratory airflow obstruction due to airway inflammation, bronchospasm and mucus hypersecretion.^{70,72}

Three RCTs have demonstrated HFNT may reduce dyspnoea compared to COT, but with no difference in PaCO₂, PaO₂, intubation or hospital length of stay. The trials were small, with HFNT flow rates ranging from 15–40 L/min, and the certainty of evidence therefore remains

limited.^{73–75} Larger adequately powered RCTs are required to clarify the role of HFNT in acute asthma.

The possibility of nebulising drugs via HFNT represents a potential additional treatment feature, allowing the administration of inhaled bronchodilation therapy uninterrupted with concomitant oxygen therapy.⁷⁶ The safety and efficacy of delivering inhaled therapy in this way still need to be assessed with RCTs. There are concerns about the potential increased upper airway drug deposition and drug dilution in the anatomical dead space, affecting drug delivery in clinical practice. Reducing the HFNT flow rate will improve aerosol delivery within the lungs but might reduce respiratory support.⁷⁷ Larger RCTs are needed to clarify the role of HFNT in severe asthma exacerbations.

Summary

- HFNT is well tolerated in asthmatic patients with ARF due to acute asthma exacerbations but should only be considered in a critical care setting.
- There is insufficient evidence to recommend bronchodilation therapy via HFNT or that HFNT reduces intubation or mortality in this group of patients.

Clinical practice points:

- ✓ HFNT has not demonstrated an improvement in oxygenation, risk of IMV or hospital LOS compared with COT, but limited evidence from small trials suggests possible improvement in dyspnoea.
- ✓ If non-invasive respiratory support is applied in acute asthma, this should only be undertaken in a critical care environment to monitor for treatment failure and to enable rapid endotracheal intubation.

Pulmonary embolism

Venous thromboembolism (VTE), clinically presenting as deep vein thrombosis (DVT) and/or pulmonary embolism (PE), is globally the third most frequent cause of acute cardiovascular syndrome behind myocardial infarction and stroke.⁷⁸ Right ventricular (RV) failure due to acute pressure overload is considered the primary cause of death in severe PE. Severe respiratory failure in PE is predominantly a consequence of haemodynamic disturbances,⁷⁹ although milder hypoxaemia is commonly observed and is mostly due to ventilation perfusion mismatch.

There are a small number of studies specifically evaluating the use of HFNT in acute PE. In a retrospective case series of 17 patients admitted to ICU with ARF due to acute PE, HFNT improved oxygenation and respiratory rate within two hours of transitioning from low-flow oxygen to HFNT.⁸⁰ In a small comparative study with early end points of 58 patients in ICU with acute PE, HFNT led to an improvement in oxygenation and respiratory rate compared with COT.⁸¹

Summary

- HFNT may improve oxygenation and reduce respiratory rate in hypoxaemic ARF due to acute pulmonary embolism, although evidence is limited to small ICU studies.

Clinical practice points:

- ✓ HFNT could be considered to treat hypoxaemic ARF in patients with acute PE to reduce respiratory rate and work of breathing and improve oxygenation.
- ✓ HFNT in patients with acute PE should be delivered in a critical care setting or a high monitoring area.

Bronchiectasis

Bronchiectasis is characterised by chronic airway dilatation with recurrent exacerbations, which may be infective, inflammatory, viral, or of uncertain trigger.⁸²

ARF is a common cause of death in patients with bronchiectasis.⁸³ HFNT has emerged as a promising intervention,²² offering both clinical and physiological benefits including alveolar recruitment, dead space washout,⁸⁴ and airway clearance,⁸⁵ and is well tolerated by patients.⁸⁶

A single-centre feasibility study, without a control arm, evaluating the effects of HFNT in 15 patients with exacerbations of COPD with bronchiectasis identified that HFNT improved dyspnoea score, RR, gas exchange, and increased mucus clearance.⁸⁵ A randomised crossover physiological study comparing HFNT with NIV in patients with cystic fibrosis found that HFNT and NIV have similar effects on diaphragmatic work, but HFNT conferred additional physiological benefits by decreasing RR and Minute Ventilation.⁸⁷

Summary

- HFNT may improve dyspnoea, comfort, RR and mucus production in patients with acute exacerbation of bronchiectasis, but the evidence is based on small clinical studies.

Clinical practice points:

- ✓ HFNT may be considered as an adjunct in selected patients with bronchiectasis exacerbations and ARF where oxygenation, comfort or secretion clearance are problematic; however, evidence is indirect and limited.

Section 5: Acute hypercapnic respiratory failure

Acute Hypercapnic Respiratory Failure (AHRF) reflects ventilatory failure due to increased physiological load relative to respiratory muscle capacity. The most common causes are COPD exacerbations, obesity hypoventilation syndrome, and neuromuscular disease.⁸⁸

NIV remains the established first-line ventilatory support for AHRF, with strong evidence demonstrating reductions in mortality and intubation rates in COPD.⁸⁹ NIV is also effective in obesity-related ventilatory failure and is considered standard of care in acute acidaemic hypercapnia.⁸⁸

HFNT is increasingly used as an alternative or adjunctive respiratory support modality despite limited high-certainty evidence in hypercapnic disease states. It delivers heated humidified gas at high flow rates, generating washout of anatomical dead space and mild positive airway pressure, lowering arterial CO₂.¹

A retrospective study demonstrated that HFNT used as initial respiratory support in hypercapnic patients was associated with reductions in PaCO₂ within 24 hours, with higher APACHE II scores predicting treatment failure.⁹⁰

Physiological studies demonstrate favourable changes in respiratory mechanics and reduced work of breathing, although the magnitude of effect is substantially less than NIV, which offers inspiratory support and thus greater direct ventilatory assistance in established AHRF.^{15,16,88} For this reason, HFNT should not be considered a substitute for NIV in patients with acidaemic AHRF, or in patients with ventilatory pump failure due to neuromuscular disease, chest wall disease, severe obesity-related respiratory failure, or other conditions where NIV is clinically indicated.

HFNT compared to COT: clinical effects

Several randomised controlled trials and meta-analyses have evaluated HFNT in acute COPD-related hypercapnic respiratory failure compared with conventional oxygen therapy.

Li et al. demonstrated reduced treatment failure (defined as escalation to NIV or intubation) in patients with acute compensated hypercapnia treated with HFNT compared with COT.⁹¹ However, this study excluded acidaemic patients, limiting generalisability.

In contrast, Xia et al. conducted a multicentre RCT in mild hypercapnic COPD exacerbations and found no significant reduction in intubation criteria or progression to NIV with HFNT compared with COT in acute exacerbations of COPD (AECOPD) with mild hypercapnia (pH ≥ 7.35).⁹²

Physiological crossover data from Pilcher et al. demonstrated reductions in transcutaneous CO₂ with HFNT without changes in RR or oxygen saturation.⁹³

Systematic reviews suggest small physiological improvements in gas exchange but highlight significant heterogeneity and low certainty of evidence across trials.⁹⁴

Observational evidence also suggests that HFNT may be feasible as rescue respiratory support in selected patients with moderate hypercapnic respiratory failure who cannot tolerate or have contraindications to NIV, but treatment failure and need for intubation remain important concerns.⁹⁵

Summary

- Evidence for HFNT over COT in AHRF is limited and inconsistent; it should not be extrapolated to acidaemic or non-COPD ventilatory failure.
- HFNT may provide modest physiological benefit in mild AHRF without acidaemia, but there is inconsistent evidence for reduction in treatment failure or escalation to ventilatory support.

Clinical practice points:

- ✓ NIV remains first-line for treatment of acidaemic AHRF.
- ✓ HFNT should not be routinely used in patients with compensated AHRF to prevent progression of hypercapnia.
- ✓ HFNT may be considered in selected patients with mild COPD-related AHRF, particularly where controlled oxygen delivery is required and there is no acidaemia.
- ✓ HFNT should not delay escalation to NIV where NIV is clinically indicated, particularly in patients with pH <7.35, worsening acidaemia, rising PaCO₂, increasing work of breathing or clinical deterioration.
- ✓ HFNT is not recommended as primary ventilatory support for AHRF due to neuromuscular disease, chest wall disease, severe obesity-related respiratory failure, or other causes of ventilatory failure where NIV is indicated.
- ✓ Patients should be managed with target oxygen saturations of 88–92% in known or suspected hypercapnia.^{21,88}
- ✓ Early reassessment (within 1–2 hours) is essential to identify non-responders.
- ✓ HFNT use in hypercapnia should only occur with a clear escalation plan specifying when NIV or IMV should be instituted, where appropriate.
- ✓ Patients receiving HFNT should be closely monitored for rising PaCO₂, respiratory fatigue, or progression of acidaemia.

HFNT compared to NIV: clinical effects

NIV remains the gold-standard treatment for acidaemic AHRF.

Direct comparisons of HFNT and NIV in AHRF have produced heterogeneous physiological results,^{96–100} but NIV provides established pressure support and remains the standard intervention for acidaemic AHRF.^{88,101} Di Mussi et al. showed reduced neuroventilatory drive and work of breathing with HFNT post-extubation, but without equivalent ventilatory correction compared with NIV.¹⁶

A more recent randomised study comparing HFNT at 30 or 50 L/min with NIV also demonstrated short-term blood-gas improvement across treatment groups, although it was not designed to establish superiority for major clinical outcomes.¹⁰²

Cortegiani et al. performed a multicentre non-inferiority RCT in COPD exacerbation and found HFNT non-inferior to NIV for short-term PaCO₂ reduction at 2 hours using the prespecified

non-inferiority margin; however, 32% of patients initially receiving HFNT required NIV by 6 hours, and one required IMV.¹⁰³

Pantazopoulos et al. reported numerically higher treatment failure with HFNT (19.6% vs 14.8%) without a statistically significant difference. HFNT was associated with lower dyspnoea and discomfort, although the study was underpowered.¹⁰⁴

Tan et al. conducted a larger multicentre trial and reported significantly higher treatment failure and intubation rates with HFNT compared with NIV in patients with mild-to-moderate acidaemia.¹⁰⁵

Systematic reviews confirm inconsistent results but overall trend toward superior ventilatory efficacy of NIV, particularly in acidaemic patients.^{101,106}

Summary

- The current evidence comparing HFNT vs NIV indicates HFNT does not reliably correct hypercapnia or acidaemia: although some trials show similar short-term physiological outcomes, treatment failure may be more frequent with HFNT in acidaemic AECOPD, and NIV should remain first-line therapy.

Clinical practice points:

- ✓ NIV should remain first-line therapy for AHRF with acidaemia (pH <7.35).
- ✓ HFNT should not be used as a replacement for NIV in acidaemic AHRF.
- ✓ HFNT may be considered where NIV is not tolerated or is contraindicated, but supporting clinical evidence is limited and low certainty.
- ✓ In patients with acidaemic AHRF who remain eligible for IMV, HFNT should only be considered where NIV is not tolerated or cannot be delivered. This should be delivered in a critical care setting with close monitoring and immediate access to intubation, as HFNT must not delay IMV where clinically indicated.

HFNT during planned NIV breaks

HFNT has been evaluated as a bridging strategy during NIV interruptions, aiming to maintain oxygenation, improve comfort and reduce interface-related complications.

Spoletini et al. demonstrated improved comfort and reduced eye irritation when HFNT was used during NIV breaks, although the study was underpowered for clinical outcomes.¹⁰⁷

Longhini et al. demonstrated physiological stability during HFNT use following NIV interruption in hypercapnic patients, with no deterioration in gas exchange compared with oxygen therapy.¹⁰⁸

However, there is no high-quality evidence demonstrating improved survival or reduced intubation rates with this strategy.

Summary

- HFNT may improve patient comfort during NIV breaks but has no proven clinical outcome advantage.

Clinical practice points:

- ✓ Based on limited evidence, HFNT may be considered on an individualised basis during planned NIV breaks to improve comfort and tolerance, while maintaining oxygenation and supporting CO₂ washout.
- ✓ HFNT should not replace NIV unless there is clear intolerance or contraindication.
- ✓ NIV should be restarted promptly if hypercapnia worsens during HFNT use on blood gas or transcutaneous CO₂ monitoring, or if work of breathing increases.

HFNT compared with COT and NIV: comfort, tolerance, and patient experience

Delivering oxygen via HFNT is recommended under physiological conditions (flow rate that matches patient effort, core body temperature, 100% relative humidity). However, patient tolerance of these settings is variable.

HFNT is generally better tolerated than NIV due to avoidance of mask interfaces, with improved comfort and reduced skin breakdown reported in multiple RCTs.^{104–106} However, comfort outcomes are inconsistent across studies due to variability in scoring systems and study design.

Survey data indicate widespread HFNT use in COPD-related AHRF despite limited high-certainty evidence.³

Variability in flow settings, temperature titration, and patient adaptation likely contributes to heterogeneity in reported outcomes.

D'Cruz et al. demonstrated that HFNT settings often require down-titration during recovery from COPD exacerbations, highlighting the dynamic nature of patient demand and tolerance.¹⁰⁹

Summary

- There is conflicting evidence for the ability of HFNT to improve comfort, tolerability and dyspnoea when compared to COT. HFNT use cannot be recommended for this purpose over COT in patients with AHRF.
- HFNT is better tolerated than NIV in many patients but does not consistently improve physiological or clinical outcomes.

Clinical practice points:

- ✓ HFNT settings should be individualised and titrated to patient comfort and work of breathing.
- ✓ Flow rates ≥30 L/min should generally be used to achieve physiological effect.

- 1021 ✓ Temperature and humidity settings may require adjustment during treatment and
- 1022 recovery according to patient tolerance and secretion burden.
- 1023 ✓ Comfort should not supersede clinical indications for NIV when required.

Section 6: Practical aspects of managing HFNT in patients with acute respiratory failure

Practical aspects of acute respiratory failure

HFNT is increasingly used in ARF across emergency departments, respiratory wards, respiratory support units and critical care settings. Despite its physiological benefits and increasing clinical familiarity, HFNT remains a support modality associated with significant disease severity and high short-term mortality in real-world cohorts.

Unlike NIV, HFNT has no universally mandated governance framework, resulting in wide variability in monitoring, staffing, escalation planning, competency requirements, and location of care. This section addresses mortality risk, appropriate clinical environment, monitoring standards, escalation pathways, and governance principles for safe HFNT delivery.

Real-world use of HFNT is widespread across acute hospital settings, including outside critical care environments, despite limited high-certainty evidence, and variable governance structures and monitoring. An international survey of 1176 clinicians demonstrated frequent use of HFNT in ARF and in AECOPD with AHRF, highlighting significant heterogeneity in practice and supporting the need for standardised guidance.^{3,4}

Mortality rates

Although HFNT may improve outcomes in selected acute settings, patients requiring HFNT often have severe ARF and are therefore at high risk of mortality. HFNT is frequently used in patients with severe hypoxaemia or mixed respiratory failure, and mortality rates reflect underlying disease severity rather than device-related harm.

Reported mortality varies widely according to underlying diagnosis, treatment limitations and care setting. In a recent five-hospital retrospective cohort, 24.5% of HFNT episodes were followed by intubation and 29.3% by death or discharge to hospice.¹¹⁰ Mortality is highest in patients with advanced ILD or do-not-intubate status, and lower in mixed ARF cohorts. Emergency department and RSU cohorts also demonstrate substantial mortality, reinforcing that HFNT use is usually a marker of high acuity rather than low-risk oxygen supplementation.^{26,27,100}

Across studies, HFNT use is consistently associated with moderate-to-high mortality reflecting advanced respiratory failure, reinforcing its role as a treatment for high-acuity patients rather than low-risk oxygen supplementation.

A large multi-hospital retrospective cohort study by Bouhassira et al. examined real-world HFNT use across heterogeneous acute respiratory failure populations.¹¹⁰ The study confirmed that HFNT is predominantly used in patients with high illness severity and demonstrated substantial variability in outcomes depending on underlying diagnosis, escalation decisions, and location of care. Mortality remained significant across cohorts and was strongly associated with treatment limitation decisions, baseline hypoxaemia, and failure to escalate to ventilatory support when required. This reinforces that HFNT use is best interpreted as a marker of advanced respiratory failure rather than a therapy associated with intrinsic mortality risk.¹¹⁰

1065 **Monitoring and location of use**

1066 The physiological severity of patients receiving HFNT is often comparable to those triggering
1067 high NEWS2 scores.

1068 Patients with NEWS2 ≥ 5 :

- 1069 • represent a threshold for urgent clinical review and enhanced monitoring¹¹¹
- 1070 • require at least hourly observations¹¹¹
- 1071 • warrant continuous monitoring and emergency clinical response once NEWS2 ≥ 7 ¹¹¹

1072 In comparison, HFNT cohorts frequently demonstrate:

- 1073 • high FiO₂ requirements (often ≥ 0.6 –1.0)
- 1074 • significant baseline hypoxaemia
- 1075 • frequent escalation to NIV or intubation

1076 Despite this, HFNT is often delivered in ward environments, including surgical and general
1077 medical wards.

1078 A UK/North American survey reported HFNT use in non-respiratory ward environments in
1079 >25% of cases, including surgical wards.³

1080 The BTS Respiratory Support Unit (RSU) audit identified:

- 1081 • that at least 40% of patients receiving acute high-flow therapy were managed in
1082 general ward environments with unenhanced staffing¹¹²
- 1083 • lower mortality among high-risk patients managed in enhanced respiratory-care
1084 settings, although these observational data cannot establish a causal effect of location
1085 of care¹¹²

1086 A recommendation from the BTS RSU audit was that:

1087 *“Acute respiratory support (NIV, HFNT, CPAP) for patients with acute lung disease should be*
1088 *delivered in an RSU or equivalent area with appropriate staffing levels (including HDU and*
1089 *critical care areas) and should not be used routinely in unenhanced, standard ward areas.”¹¹²*

1090 Unlike HFNT, NIV:

- 1091 • is restricted to designated clinical areas¹¹³
- 1092 • requires trained staff and escalation pathways¹¹³
- 1093 • has mandated monitoring standards and audit frameworks¹¹³

1094 There is strong evidence that NIV outcomes improve in specialist RSUs compared with
1095 general wards.¹¹² HFNT, although less invasive, is now used in comparable severity
1096 populations, supporting similar governance expectations.¹¹⁴

1097 In patients receiving HFNT with symptom-focused intent, monitoring should prioritise comfort
1098 and symptom burden rather than physiological targets (see Section 10).

1099

1100 **Objective assessment of HFNT response**

1101 The ROX index (Respiratory Rate-Oxygenation index), calculated as $(\text{SpO}_2/\text{FiO}_2) \div$
1102 respiratory rate, may be used as an adjunctive bedside tool to support early recognition of
1103 HFNT failure in hypoxaemic ARF. In patients with pneumonia-associated hypoxaemic ARF,
1104 the ROX index may support early identification of HFNT success or failure, with lower values
1105 and falling serial values associated with higher risk of treatment failure. Original validation
1106 work identified ROX values below 2.85, 3.47 and 3.85 at 2, 6 and 12 hours respectively as
1107 predictors of HFNT failure, with ROX >4.88 as reassuring for likely success and ROX <3.85
1108 as high risk for failure.¹¹⁵

1109 ROX should not be used in isolation or as a substitute for clinical judgement. Escalation
1110 decisions must also consider work of breathing, trajectory of oxygen requirement, mental
1111 status, haemodynamic stability, arterial blood gases, underlying diagnosis, the agreed
1112 treatment escalation plan, and patient preference. A falling ROX across serial measurements
1113 should prompt urgent senior review even if the absolute value has not crossed a predefined
1114 threshold.

1115

1116 **Escalation**

1117 HFNT is associated with substantial rates of escalation to NIV, IMV, or death, particularly in
1118 ARF cohorts.

1119 Given this, HFNT should be treated similarly to NIV regarding:

- 1120 • treatment limitation decisions
- 1121 • escalation planning
- 1122 • senior clinician involvement

1123 NIV guidelines require early documented treatment escalation plans due to high failure rates
1124 in AHRF.^{88,113} Given the acuity and failure risk associated with HFNT, the same governance
1125 principle is appropriate for acute HFNT.

1126 Failure to recognise HFNT non-response may delay escalation to life-saving ventilation.¹¹⁶

1127

1128 **Governance**

1129 Multiple UK, European, and international surveys demonstrate:^{3,4}

- 1130 • lack of HFNT protocols
- 1131 • limited audit structures
- 1132 • variability in escalation thresholds
- 1133 • inconsistent training requirements

1134 This contrasts sharply with NIV,^{113,114} which is supported by:

- 1135 • national guidelines
- 1136 • mandatory documentation standards
- 1137 • RSU governance frameworks

- 1138 • structured competency training

1139 The BTS RSU framework recommends that acute respiratory support (including HFNT) should
1140 be delivered in RSU or equivalent areas with appropriate staffing and monitoring and not in
1141 standard unenhanced wards.¹¹⁴

1142 An example local protocol covering the initiation, monitoring, escalation and weaning is
1143 provided in Appendix 2. Suggested indications for HFNT across different respiratory failure
1144 phenotypes are summarised in Appendix 3. A standalone HFNT management and
1145 reassessment flowchart for hypoxaemic ARF is provided in Appendix 6 for quick reference.
1146 These resources should be adapted to local escalation, monitoring and governance pathways.

1147 HFNT should not delay urgent intubation, NIV or CPAP where these are clinically indicated.
1148 Particular caution is required in patients with inability to protect the airway, severe or
1149 worsening acidaemia, rapidly rising PaCO₂, severe respiratory muscle fatigue, haemodynamic
1150 instability, untreated pneumothorax, facial or nasal trauma preventing safe interface use, or
1151 where adequate monitoring and escalation cannot be provided.

1152 **Summary**

- 1153 ➤ HFNT is predominantly used in moderate–severe acute respiratory failure, with
1154 mortality reflecting underlying disease severity rather than device effect.
- 1155 ➤ Mortality and escalation rates vary substantially depending on:
 - 1156 • diagnosis (e.g. ILD, pneumonia, COVID-19)
 - 1157 • treatment limitation decisions
 - 1158 • escalation to ventilatory support
- 1159 ➤ HFNT is commonly used in high-acuity patients outside critical care environments,
1160 including general wards.
- 1161 ➤ International survey data show widespread HFNT use with major variability in
1162 indications, settings, and escalation thresholds.
- 1163 ➤ HFNT use is frequently associated with subsequent escalation to NIV, intubation, or
1164 death, reflecting severity of illness rather than treatment efficacy.
- 1165 ➤ Outcomes appear to be influenced by location of care and escalation practices, with
1166 better outcomes reported in structured respiratory support environments.
- 1167 ➤ HFNT requires standardised failure criteria, monitoring requirements, escalation
1168 pathways and governance structures.
- 1169 ➤ Compared with NIV, HFNT has no proven equivalent efficacy in ventilatory failure and
1170 no established mortality benefit in AHRF.

1171

1172 **Clinical practice points:**

- 1173 ✓ HFNT is a high-risk therapy indicative of severe acute respiratory failure.
- 1174 ✓ Early senior clinical review should occur in all patients initiated on HFNT.
- 1175 ✓ HFNT should be delivered in enhanced monitoring environments such as RSU, HDU,
1176 ICU, coronary care or equivalent areas with trained staff and escalation pathways.

- 1177 ✓ Delivery in standard unenhanced ward environments without adequate monitoring,
1178 trained staff and escalation pathways is not appropriate for patients with significant
1179 oxygen requirements or clinical instability.
- 1180 ✓ The BTS/ICS RSU guidance specifically states that the minimum ratio recommended
1181 for an RSU is 1:4, with more staff required as acuity increases.¹¹⁴
- 1182 ✓ HFNT must only be initiated with a documented escalation plan agreed by a senior
1183 clinician (ST3+/respiratory or critical care equivalent).
- 1184 ✓ Escalation plans should define:
1185 • suitability for NIV
1186 • suitability for IMV
1187 • any agreed limits to treatment escalation, where appropriate
1188 • palliative care strategy and weaning or withdrawal plan where NIV or IMV is
1189 not appropriate
- 1190 ✓ Failure to respond should prompt early senior review, with timely escalation of
1191 respiratory support or transition to symptom-focused palliative care in accordance with
1192 the agreed treatment escalation plan.
- 1193 ✓ Local HFNT protocols should include objective reassessment criteria, such as serial
1194 ROX index measurement in hypoxaemic ARF, alongside clinical assessment of work
1195 of breathing, oxygen requirement, gas exchange and mental status.
- 1196 ✓ All institutions using HFNT should maintain a formal HFNT policy, including:
1197 • indications and contraindications
1198 • initiation pathway or flowchart
1199 • initiation protocols
1200 • monitoring requirements
1201 • definition of HFNT failure
1202 • escalation and ceiling-of-care pathways
1203 • weaning strategies
- 1204 ✓ HFNT use should be evaluated in routine audit and morbidity/mortality review
1205 processes.
- 1206 ✓ Staff delivering HFNT must demonstrate documented competency-based training.
- 1207 ✓ HFNT should be integrated into structured acute respiratory failure pathways, not used
1208 as an isolated therapy.
- 1209 ✓ Oxygen infrastructure must support safe delivery of multiple high-flow devices where
1210 used at scale.
- 1211 ✓ HFNT should not delay escalation to ventilatory support such as NIV or IMV when
1212 clinically indicated.

Section 7: Domiciliary HFNT in chronic respiratory failure

The impact of HFNT on physiological, clinical and patient-reported outcomes in chronic hypoxaemic respiratory failure

In patients with COPD, home HFNT may reduce exacerbation frequency and breathlessness, and improve health-related quality of life (HRQoL) in stable hypoxaemic COPD patients, when used as an adjunct to long-term oxygen therapy (LTOT).¹¹⁷ Studies conducted independently of, and during, pulmonary rehabilitation programmes indicate improved exercise endurance when used during physical activity in this population.^{118–120} Mechanisms of action, and optimal duration of use or settings inclusive of flow rate or temperature have not been fully established.

There is little evidence exploring its use as an oxygen delivery tool in non-COPD populations with hypoxaemic respiratory failure.

Safe implementation of domiciliary HFNT requires clearly defined clinical management plans, appropriate equipment provision and electrical supply prior to initiation. Interruptions to therapy, including those required for routine device maintenance or resulting from electrical failure, may lead to periods of inadequate oxygenation without adequate backup oxygen delivery systems. Patient education and appropriate management plans are therefore essential to ensure safe continuity of care in the community setting. Treatment burden should be considered when selecting patients for domiciliary HFNT with practical considerations made in relation to device adherence, power dependency, and provision of alternative oxygen delivery during device interruption (see Section 8).¹²¹

Long-term home HFNT has been evaluated predominantly in COPD and bronchiectasis, with a smaller evidence base in ILD.¹²¹ A systematic review of long-term home HFNT (≥4 weeks) use (n = 701) reported reductions in exacerbations and improvements in quality of life compared to usual care or respiratory therapies, with good adherence and safety profile, but was limited by variable study quality and heterogeneity.¹²¹

Chronic hypoxaemic respiratory failure

Chronic hypoxaemic respiratory failure arises from mechanisms including ventilation–perfusion mismatch, diffusion limitation, right-to-left shunt, and reduced inspired oxygen tension. LTOT is recommended in appropriately selected patients to improve survival and reduce symptom burden.¹²²

HFNT has been evaluated as an oxygen delivery modality in the domiciliary setting, primarily as an adjunct to LTOT. The current evidence base is largely derived from studies in patients with COPD, with limited data available in other causes of chronic hypoxaemic respiratory failure.

Chronic obstructive pulmonary disease

In a randomised crossover physiological study, Fraser et al. compared HFNT delivered at 30 L/min with entrained oxygen to low-flow oxygen (2–4 L/min via nasal cannula) in stable COPD patients receiving LTOT.¹²³ HFNT maintained comparable SpO₂ while reducing respiratory rate and transcutaneous CO₂ and increasing tidal and end-expiratory lung volumes.

1254 Storgaard et al. conducted a 12-month randomised controlled trial evaluating 200 patients with
1255 stable hypoxaemic COPD.¹¹⁷ HFNT (20 L/min with entrained oxygen) used for a mean of
1256 approximately 6 hours/day reduced exacerbation frequency and improved dyspnoea, HRQoL
1257 and exercise capacity. Hospital admission rates were also lower in modelling related to
1258 treatment exposure, while all-cause mortality did not differ.

1259 An economic evaluation based on the Danish Storgaard cohort estimated an ICER of £3,605
1260 per quality-adjusted life year (QALY), with an 83–92% probability of cost-effectiveness at
1261 thresholds of £20,000–£30,000/QALY.¹²⁴

1262 A feasibility RCT has also explored home HFNT during recovery from severe COPD
1263 exacerbation, demonstrating feasibility and acceptability but not providing definitive efficacy
1264 evidence.¹⁰⁹

1265 Evidence for HFNT during pulmonary rehabilitation remains limited and heterogeneous. A
1266 systematic review demonstrated no consistent improvement in exercise capacity, dyspnoea
1267 or HRQoL compared with conventional oxygen therapy.¹²⁰

1268

1269 **Bronchiectasis**

1270 Evidence for domiciliary HFNT in bronchiectasis is limited and largely derived from
1271 observational and mixed-population studies.

1272 In a mixed COPD/bronchiectasis RCT, long-term humidified high-flow therapy reduced
1273 exacerbation days and prolonged time to first exacerbation compared with usual care.¹²⁵

1274 In a matched retrospective case-control study in patients with bronchiectasis, Crimi et al. found
1275 fewer exacerbations and hospitalisations with long-term HFNT, alongside small improvements
1276 in pulmonary function.¹²⁶ A subsequent single-arm long-term crossover study by Simioli et al.
1277 similarly reported reductions in exacerbations and hospitalisations without significant
1278 improvement in spirometric lung function.¹²⁷

1279

1280 **Interstitial lung disease**

1281 Evidence for HFNT in ILD is limited to small pilot and observational studies.

1282 In a small heterogeneous ILD cohort (n=9), HFNT use over six weeks was associated with
1283 improvements in dyspnoea and exercise capacity.¹²⁸

1284 Exercise crossover trials have produced mixed results. Harada et al. demonstrated improved
1285 endurance time with HFNT compared with Venturi-mask oxygen in IPF, whereas Suzuki et al.
1286 found no significant overall difference in fibrotic ILD, although a responder subgroup appeared
1287 to benefit.^{129,130}

1288

1289 **Summary**

1290 ➤ Current evidence is strongest in COPD but limited elsewhere, and indicates that home
1291 HFNT, when used as an adjunct to LTOT in selected patients with stable COPD and
1292 chronic hypoxaemic respiratory failure, may reduce exacerbation frequency and
1293 improve symptoms, HRQoL and exercise capacity.

1294 ➤ Based on limited and mostly observational evidence, home HFNT may reduce
1295 exacerbation frequency and improve symptoms or airway clearance in selected
1296 patients with bronchiectasis.

1297 ➤ In patients with ILD and hypoxaemic respiratory failure, HFNT may improve exercise
1298 tolerance and capacity, although evidence is limited to small studies and short-term
1299 physiological or exercise outcomes.

1300

1301 ***Clinical practice points:***

1302 ✓ Home HFNT may be considered as an adjunct to LTOT in selected patients with stable
1303 COPD and chronic hypoxaemic respiratory failure to reduce exacerbation frequency
1304 and improve symptom control.

1305 ✓ Home HFNT could be considered in selected patients with bronchiectasis and ILD, but
1306 evidence is currently insufficient to recommend its routine use; where considered,
1307 treatment should form part of a specialist-led, individualised clinical management plan.

1308 ✓ The practical utility of HFNT is limited by the requirement for a power supply and circuit
1309 length.

1310 ✓ Early involvement of palliative teams should be considered when starting home HFNT
1311 in patients with advanced, progressive or life-limiting respiratory disease.

1312 ✓ An action plan for device management including servicing, failure, cleaning, and
1313 backup during disruption to power supply should be instituted prior to initiating home
1314 HFNT.

1315

1316 **Chronic hypercapnic respiratory failure**

1317 There is currently insufficient evidence that home HFNT is superior to NIV in COPD patients
1318 experiencing chronic hypercapnic respiratory failure (CHRF). Physiological data indicate
1319 non-inferiority compared to non-invasive ventilation with respect to PaCO₂ reduction and
1320 clinical trial data indicate an effect on time to first exacerbation in mild hypercapnia (PaCO₂
1321 <7 kPa). Home HFNT has not been evaluated in patients with non-COPD CHRF, therefore
1322 no recommendations can be made in this population.

1323

1324 **Chronic obstructive pulmonary disease**

1325 NIV is established as the standard of care to offload the respiratory muscle pump and improve
1326 physiological, clinical and patient-reported outcomes in patients with COPD and stable
1327 hypercapnia, as well as in those with persistent hypercapnia following AHRF. NIV is also
1328 widely used in other causes of CHRF, including obesity-related respiratory failure and
1329 neuromuscular disease.^{131–136}

1330 To date, domiciliary HFNT has been evaluated primarily in COPD populations with CHRF.
1331 Evidence remains limited, and prospective long-term data are required to clarify its role in both
1332 COPD and non-COPD populations.

1333 Direct physiological comparisons demonstrate reductions in CO₂ with both HFNT and NIV in
1334 stable hypercapnic COPD. Short-term crossover data suggest a greater CO₂ reduction with

NIV, while longer-term crossover studies have reported HFNT to be non-inferior within prespecified margins for CO₂ reduction. Interpretation is limited by small samples, heterogeneous treatment durations and differences in treatment adherence.^{137–139}

In a randomised crossover study conducted by Bräunlich et al., HFNT was reported to be non-inferior to NIV in terms of PaCO₂ reduction over a 6-week period.¹³⁹ Interpretation is limited by differential adherence between treatments and relatively low HFNT flow rates, including relatively low adherence to NIV (mean 3.9 hours/day), greater HFNT usage (5.2 hours/day), and the use of relatively low HFNT flow rates (20 L/min).

Nagata et al. have evaluated the clinical effects of domiciliary HFNT in combination with LTOT in stable hypercapnic COPD. In a randomised crossover trial, 6 weeks of HFNT plus LTOT was associated with improvements in dyspnoea and HRQoL, as well as reductions in both daytime and nocturnal PaCO₂, compared with LTOT alone.¹⁴⁰

In a subsequent 12-month randomised controlled trial, HFNT in combination with LTOT was associated with reduced exacerbation frequency and prolonged time to first exacerbation compared with LTOT alone.¹⁴¹ However, the study did not meet its target recruitment, and attrition introduced potential bias. No significant differences were observed in PaCO₂, exercise capacity or HRQoL at 12 months.

Meta-analysis of HFNT in hypercapnic COPD populations suggests a modest improvement in HRQoL, with a mean reduction in St George's Respiratory Questionnaire (SGRQ) score of 8.12 units (95% CI 2.95 to 13.30 lower), although the certainty of evidence is low and some included studies did not exclusively enrol hypercapnic patients.¹⁴²

In a pilot randomised crossover physiological study of 20 hypercapnic COPD patients recovering from acute exacerbation, asymmetric and standard HFNT interfaces produced similar overall PaCO₂ responses. In patients with more severe baseline hypercapnia, the asymmetric interface was associated with greater dead-space clearance and ventilatory efficiency.¹⁴³

Caution is warranted when applying HFNT in hypercapnic individuals. In the post-exacerbation setting following AHRF, differential effects have been observed, with one study reporting benefit in patients with COPD alone but not in those with coexistent COPD–obstructive sleep apnoea overlap syndrome. Trials of domiciliary HFNT have generally applied strict eligibility criteria and often excluded patients with higher BMI, recent acute NIV requirement, established domiciliary NIV, overlap syndrome or more severe ventilatory failure. This limits generalisability to patients with more severe disease or higher clinical instability.

Non-COPD populations

There is insufficient comparative evidence to support domiciliary HFNT in non-COPD causes of chronic hypercapnic respiratory failure.

Summary

- HFNT reduced PaCO₂ to a lesser extent than NIV in COPD patients with stable hypercapnia.

- 1376 ➤ HFNT with LTOT compared with LTOT alone reduced exacerbation rates, along with
1377 improving breathlessness and HRQoL scores in COPD patients with stable
1378 hypercapnia.
- 1379 ➤ Home HFNT may require monitoring to assess treatment response; optimal flow rates
1380 and treatment duration for CO₂ clearance are not established.
- 1381 ➤ Regulatory status and device indications for domiciliary HFNT vary by device and
1382 setting; clinicians should confirm local governance, commissioning and manufacturer
1383 guidance before initiation.
- 1384 ➤ There are no UK studies with health economic evaluation for the role of domiciliary
1385 HFNT.
- 1386 ➤ There is insufficient evidence to assess the use of domiciliary HFNT in management
1387 of CHRF in any patient group other than COPD.

1388

1389 ***Clinical practice points:***

- 1390 ✓ NIV remains the standard of care for patients with CHRF.
- 1391 ✓ Home HFNT may be considered in selected patients with stable COPD and CHRF
1392 where NIV is not tolerated or accepted; however, evidence specifically evaluating
1393 HFNT following NIV intolerance or failure is very limited, and NIV remains the
1394 established standard of care.
- 1395 ✓ Monitoring should be tailored to identify treatment failure, with individualised failure
1396 criteria and escalation plans based on the patient's clinical context and suitability for
1397 further respiratory support.
- 1398 ✓ There is insufficient evidence to advocate for home HFNT in stable COPD patients
1399 with PaCO₂ >7.0 kPa, persistent hypercapnia following an exacerbation with AHRF,
1400 COPD–OSA overlap, obesity-related respiratory failure, neuromuscular disease or
1401 other non-COPD causes of chronic hypercapnic respiratory failure.

Section 8: Practical aspects of managing HFNT in community settings

Clinical oversight of care

Evidence for community HFNT delivery remains limited. Home HFNT may be used as planned long-term therapy in selected patients with chronic respiratory disease or, in some circumstances, to facilitate discharge of patients who remain dependent on HFNT.¹²¹

Teams involved in the provision of HFNT at home may include acute and community respiratory teams, interstitial lung disease specialty multiprofessional teams, palliative care teams, complex home mechanical ventilation services, sleep and ventilation services, and home oxygen teams. It is important that such teams retain clinical oversight of the patient's overall condition during the transition from acute hospital to home. It is equally important to assure safe continuity of care in the community, and it should be recognised that the acute clinical team may lack the infrastructure to provide safe long-term care in the community. Care plans should define markers of deterioration, who should be contacted, and the appropriate escalation pathway, recognising the delays that can occur in the community when responding to acute clinical decline.^{122,144} In patients receiving HFNT with palliative intent or a treatment ceiling, anticipatory symptom-management plans should also be documented (see Section 10).

Familiarity with community HFNT devices and the ability to troubleshoot commonly encountered problems are vital. HFNT should be delivered through a service model with appropriate respiratory, oxygen, ventilation, community and palliative care expertise, with clear responsibility for both clinical oversight and equipment support. A regional shared-care model, similar to home ventilation services, may support safe implementation where local services do not have all required expertise.

Referral criteria

Referral criteria for home HFNT should be locally agreed upon and adapted as the evidence base evolves. Referring teams must understand the capabilities of community settings, particularly the trade-off between prescribed flow rate and FiO_2 .

For example, with two or three oxygen concentrators, the overall oxygen flow rate is unlikely to exceed 15 L/min. At 40 L/min of total flow, this would result in a delivered FiO_2 of just over 0.5. Increasing the total flow to 60 L/min would result in an FiO_2 of just over 0.4.

Some examples are given in the table below.

Oxygen flow rate ↓ Flow setting on HFNT machine →

	30	40	50	60
5	0.34	0.31	0.29	0.28
10	0.47	0.41	0.37	0.34
15	0.61	0.51	0.45	0.41

Table 4: Approximate delivered FiO_2 with different oxygen flow rates and total HFNT flow settings. Values are expressed as FiO_2 fractions. Values are illustrative estimates assuming supplemental oxygen at FiO_2 1.0 is blended with room air at FiO_2 0.21 to achieve the stated total flow. Actual inspired FiO_2 may be lower if patient inspiratory demand exceeds total HFNT flow because of additional room-air entrainment.¹¹

Transfer to the home/community setting

The transfer to home from an acute hospital is high-risk, particularly if the patient is unable to manage short periods of time off HFNT. Interruption of HFNT has caused serious harm during intrahospital transfer.¹⁴⁵ Accordingly, any transfer of an HFNT-dependent patient should include an explicit plan for continuity of respiratory support, compatible power and oxygen supplies, and an alternative strategy if HFNT cannot be maintained.

The receiving community team should have a documented handover and arrangements should be made to ensure that HFNT equipment is safely established and functioning at the destination.

Practical considerations in the community setting

Many devices used to deliver HFNT do not have an internal battery, while battery capability varies by device and should be confirmed before discharge or transfer. An individualised safety plan is therefore required. Patients dependent on electrically powered HFNT should be advised to register with their energy supplier's Priority Services Register and should have an individualised contingency plan for power interruption.¹⁴⁶

Home HFNT devices require regular device-specific cleaning and maintenance, which may necessitate interruption of therapy. Cleaning frequency and procedure should follow the manufacturer's instructions for the prescribed device. A clear, bespoke plan is therefore required to ensure patient safety during this period, which may require a second HFNT device or another mode of respiratory support, depending on the patient's clinical status and preferences. A lower-intensity oxygen device should not be assumed to provide equivalent support in an HFNT-dependent patient.¹⁴⁵

Patients receiving HFNT require a clear plan for what to do in the event of equipment failure. Where available, existing national guidance should be followed in terms of out-of-hours equipment replacement.¹⁴⁷

Commissioning

The commissioning arrangements will depend on the team delivering the clinical oversight of HFNT and their funding model (e.g., block contract, payment by results). Commissioning arrangements should reflect the complexity of the service and explicitly fund clinical oversight, equipment provision and maintenance, consumables, review and urgent troubleshooting. This ensures adequate funding for outpatient appointments and/or home visits. UK-specific health-economic evidence for domiciliary HFNT remains lacking.¹²¹

Local commissioning and service agreements should clearly define responsibility for provision and replacement of consumables.

Summary

- Evidence for domiciliary HFNT remains limited; current use includes planned long-term therapy in selected patients and, in some circumstances, facilitation of discharge for patients who remain HFNT-dependent.
- Delivery in the community requires coordinated multidisciplinary input, with clear clinical oversight to ensure continuity of care across acute and community teams.
- Shared-care models, like home ventilation services, may support safe and effective implementation.
- Referral criteria are not standardised and should reflect local capabilities, particularly limitations in oxygen delivery systems and the relationship between oxygen flow, total flow and achievable FiO₂.
- Transfer from hospital to home is a high-risk period, especially in patients unable to tolerate interruption of HFNT, and requires experienced teams and structured handover processes.
- Practical challenges include device power and battery limitations, potential interruption of therapy for device-specific cleaning and maintenance, and risks related to equipment failure or power loss, requiring individualised safety and contingency planning.
- Commissioning models vary, and there is currently no UK-specific health economic evidence to support widespread implementation, particularly in patients with complex or advanced respiratory disease.

Clinical practice points:

- ✓ Home HFNT delivery should involve liaison between acute and community multidisciplinary teams to support safe setup, clinical oversight and continuity of care.
- ✓ Transport of patients dependent on HFNT should be undertaken by appropriately trained transport or ambulance teams, with detailed handover to the receiving community team.
- ✓ Care plans should be developed for device management, transport and contingencies during device or power failure.

1510 ✓ Commissioning arrangements should be proportional to the complexity of the
1511 management of the home HFNT service and dependent on the local funding model.

1512

1513

1514

Section 9: Secretion management

The use of HFNT to improve secretion burden and clearance in patients with chronic respiratory disease

Evidence for HFNT specifically as a secretion-management intervention remains limited and is derived mainly from small physiological studies and observational or exploratory clinical studies in bronchiectasis and COPD.^{7,125,126} Available data suggest HFNT may improve subjective mucus clearance and sputum expectoration in selected patients, but robust evidence for patient-important clinical outcomes remains limited.^{109,126}

Across available studies, HFNT has been associated with reductions in exacerbation frequency and hospitalisations in some chronic airway disease populations, although causality remains uncertain due to study design limitations.^{125–127,148} Further multicentre randomised controlled trials are required to define whether HFNT has a role as an adjunct to standard airway clearance strategies in COPD and bronchiectasis, including cystic fibrosis-related bronchiectasis.

Acute and short-term effects in airway disease

In a 15-patient feasibility study of acute exacerbations of COPD with bronchiectasis, Crimi et al. reported increased mucus production and improved self-reported ease of expectoration over 72 hours during HFNT at 50 L/min, with maximal effect observed after 24 hours of therapy.⁸⁵ HFNT was delivered at 37°C with FiO₂ titrated to maintain oxygen saturations ≥92%. Interpretation is limited by the single-arm design, small sample size and absence of comparison with standard pharmacological or physiotherapy-based airway clearance techniques.

Chronic respiratory disease and domiciliary HFNT

Bronchiectasis (non-cystic fibrosis)

In non-cystic fibrosis bronchiectasis, mucus burden and impaired clearance correlate with exacerbation frequency and quality of life impairment.

In a mixed COPD/bronchiectasis RCT, Rea et al. found fewer exacerbation days and a longer time to first exacerbation with long-term humidification therapy; annual exacerbation frequency was numerically lower (2.97 vs 3.63 per patient-year, $p=0.067$).¹²⁵ A subsequent bronchiectasis-specific post-hoc analysis of this cohort demonstrated a significant 31.3% reduction in exacerbation rate and improved HRQoL with HFNT.¹⁴⁸

Simioli et al. reported a reduction in exacerbation rate from 1.65 to 0.65 per year using HFNT at 35–60 L/min over a two-year crossover study, with reported adherence of ≥2 hours/day on at least 4 days per week.¹²⁷

Calabrese et al. reported significant reductions in annual exacerbation rate after 12 months of HFNT in both mild/moderate and severe bronchiectasis cohorts.¹⁴⁹

More recently, Crimi et al. demonstrated a significant reduction in CT mucus-plug burden following long-term HFNT in patients with bronchiectasis.¹⁵⁰

COPD

Although long-term HFNT trials in COPD have reported reductions in exacerbations and symptom burden, secretion-specific outcomes have rarely been primary endpoints.^{109,125} Direct evidence that HFNT improves mucus clearance in COPD therefore remains limited. The physiological effects of humidification and improved mucociliary function suggest a plausible mechanism for improved secretion clearance, but direct evidence in COPD populations remains limited.

In a 2025 mixed-methods feasibility RCT of home HFNT following severe AECOPD, D'Cruz et al. reported that quantitative cough scores did not clearly differ between groups, but participants using HFNT frequently reported looser sputum and easier secretion clearance.¹⁰⁹

Further studies are required to evaluate the effect of HFNT on secretion burden specifically in COPD populations.

Practical approaches to HFNT for secretion clearance

Home HFNT has demonstrated clinical benefit even with relatively short daily usage (approximately 1.7 hours/day).¹⁴⁸ Reported HFNT protocols vary considerably, with temperatures commonly around 37°C and flow rates ranging from approximately 20 to 60 L/min across studies.^{127,148} The optimal flow, temperature and daily duration for secretion management remain unknown.

Effective mucus clearance depends on airway-surface hydration, ciliary function, airway patency and sufficient expiratory airflow.^{151,152} These are impaired in obstructive lung disease due to reduced airway calibre and impaired ciliary function.

Physiotherapy and airway clearance

Airway clearance techniques (ACTs) are a core component of bronchiectasis management and should be individualised by appropriately trained respiratory physiotherapists. Where airway clearance is clinically indicated, HFNT should be regarded as a potential adjunct rather than a replacement for established ACTs.^{153–156}

Summary

- Evidence for HFNT in secretion management is limited and mainly derived from non-randomised, retrospective, and small prospective studies in COPD and bronchiectasis populations; hence HFNT should not replace physiotherapy-led airway clearance.
- HFNT may improve subjective mucus clearance and sputum expectoration in selected patients with acute exacerbations or stable chronic airway disease.
- In bronchiectasis, domiciliary HFNT has been associated with reduced exacerbation frequency, improved symptom burden, and improved quality of life in observational and crossover studies.
- In COPD, evidence for direct effects on sputum burden is limited, although improvements in symptoms and exacerbation-related outcomes have been reported in mixed populations and post-exacerbation recovery studies.

- 1596 ➤ Physiological plausibility is supported by heated humidification, improved airway-
1597 surface hydration and mucociliary function.
- 1598 ➤ Acute studies suggest HFNT may increase sputum production during exacerbations,
1599 but these findings are limited by small sample sizes and lack of control groups.
- 1600 ➤ Optimal HFNT settings and minimum effective daily duration for secretion
1601 management remain uncertain.
- 1602 ➤ All studies are limited by heterogeneity, small sample sizes, and risk of bias, with no
1603 robust randomised controlled trials specifically powered for secretion outcomes.
- 1604 ➤ HFNT should be considered an adjunct to, rather than a replacement for,
1605 physiotherapy-led airway clearance techniques.
- 1606 ➤ Evidence is insufficient to support HFNT as a primary stand-alone therapy for mucus
1607 clearance in either acute or domiciliary settings.

1608

1609 ***Clinical practice points:***

- 1610 ✓ There is a paucity of high-quality clinical trials evaluating HFNT for secretion
1611 management in both acute and chronic respiratory disease.
- 1612 ✓ HFNT should not be initiated primarily or solely for mucus clearance in acute
1613 respiratory failure.
- 1614 ✓ HFNT should not be initiated primarily or solely for mucus clearance in the domiciliary
1615 setting outside specialist respiratory supervision.
- 1616 ✓ Established physiotherapy-led ACTs should remain the primary airway-clearance
1617 strategy, while HFNT should be considered an adjunct rather than a replacement.

1618

Section 10: Withdrawal and palliation

Introduction

Withdrawal of respiratory support, including HFNT, may be required when treatment is no longer clinically effective, is no longer tolerated, or is inconsistent with patient preferences and goals of care. This may occur in the acute hospital setting or following anticipatory discussions in outpatient or community contexts.

Withdrawal may be considered where HFNT no longer provides overall clinical benefit, where its burdens outweigh its benefits, or where a patient with capacity chooses to discontinue treatment. Evidence specifically addressing HFNT withdrawal remains limited and is largely restricted to case-series data and expert guidance.¹⁵⁷ Practice is also informed by established experience with withdrawal of other forms of non-invasive respiratory support.^{158,159}

All withdrawal decisions should be considered within a palliative and end-of-life care framework, with early involvement of specialist palliative care teams.

Clinical context and withdrawal settings

Withdrawal of HFNT may occur in either acute or planned settings. Acute withdrawal typically occurs in hospital or hospice environments in patients with a prognosis of hours to days. These patients usually have advanced or irreversible respiratory failure, such as severe pneumonia or end-stage interstitial lung disease, where HFNT is providing essential oxygenation and respiratory support. In this context, withdrawal is often followed by rapid physiological deterioration and carries a high risk of distressing dyspnoea.¹⁵⁷

Planned withdrawal occurs in more stable patients whose decision is driven primarily by quality-of-life considerations rather than immediate physiological failure. These patients may still be partially dependent on HFNT, with support used predominantly for symptom relief rather than life-prolongation, although it can be a mixed picture. The trajectory following withdrawal is more variable and may range from hours to days, allowing for anticipatory planning and coordination of care in home, hospice, or inpatient settings.

It is important to distinguish between withdrawal of HFNT that will lead to death, and cessation of HFNT when it has been used as part of disease management but is no longer tolerated or indicated. For example, ceasing the use of 6 hours/day HFNT in hypoxaemic COPD to reduce exacerbations will not cause a deterioration towards death in the immediate hours or days and therefore is not classed as a withdrawal.

Acute withdrawal (hospital or hospice setting)

- Patients with prognosis of hours to days.
- Typically, severe or irreversible respiratory failure despite HFNT (e.g. pneumonia, advanced ILD).
- HFNT dependence is primarily related to oxygenation and respiratory-support requirements.
- Withdrawal usually results in rapid physiological deterioration.

- 1659 • High risk of severe dyspnoea and distress.
- 1660 • Requires frequent symptom assessment and anticipatory symptom control.

1661

1662 **Planned / domiciliary withdrawal (community or inpatient elective setting)**

- 1663 • Patients with more stable trajectories (days to weeks or longer prognosis).
- 1664 • Often driven by quality-of-life considerations rather than immediate physiological failure.
- 1665
- 1666 • HFNT dependence may be:
 - 1667 ○ partial oxygenation dependence, or
 - 1668 ○ predominantly symptom relief dependence (dyspnoea control rather than life-prolongation)
 - 1669
- 1670 • Time to deterioration is more variable (hours to days, sometimes longer).
- 1671 • Allows structured planning of location (home, hospice, hospital).
- 1672 • May be triggered by acute admission but still undertaken in a planned manner.

1673

1674 **Dependency phenotypes**

1675 For withdrawal planning, it may be clinically useful to distinguish patients who are
1676 predominantly dependent on HFNT for oxygenation from those in whom HFNT is being used
1677 predominantly for symptom relief. These categories are pragmatic rather than validated
1678 phenotypes and may overlap.

1679 In oxygenation-dependent patients, HFNT is primarily supporting gas exchange, and
1680 withdrawal typically results in rapid hypoxaemia and respiratory deterioration. These patients
1681 are considered highly dependent, with a high likelihood of rapid symptom escalation following
1682 withdrawal.

1683 In contrast, symptom-control-dependent patients use HFNT primarily for relief of dyspnoea,
1684 air hunger, or anxiety. In these patients, gas exchange may remain partially preserved without
1685 support, and the decline following withdrawal may be slower and more variable. These
1686 distinctions are clinically useful in anticipating symptom trajectory and guiding planning but
1687 should not replace individual assessment.

1688

1689 **Oxygenation-dependent patients**

- 1690 • HFNT primarily sustains gas exchange.
- 1691 • Withdrawal may lead to rapid worsening of gas exchange and respiratory distress.
- 1692 • High likelihood of rapid deterioration.
- 1693 • Requires intensive anticipatory prescribing and monitoring.

1694

Symptom-control–dependent patients

- HFNT is used primarily for relief of dyspnoea, air hunger, or anxiety.
- Gas exchange may be partially preserved off therapy.
- Deterioration may be slower and more variable.
- Greater emphasis on symptom-directed withdrawal strategies.

Medicolegal and ethical framework

Patients with fully informed capacity have a legal right to refuse or discontinue any medical treatment, including HFNT. Withdrawal of HFNT is legally considered withdrawal of treatment and is distinct from assisted dying or euthanasia.^{160–162} Where patients lack capacity, decisions must follow established legal frameworks. Valid and applicable advance decisions to refuse treatment must be respected. Where a lasting power of attorney for health and welfare is in place, decisions should be made in consultation with the appointed attorney. In the absence of these, a best interests decision must be made under the Mental Capacity Act 2005.¹⁶¹

Multidisciplinary decision-making is essential, with involvement of senior clinicians, typically respiratory or intensive care consultants. The underlying disease process remains the cause of death, rather than withdrawal of treatment.¹⁶⁰ Complex or disputed decisions should prompt senior multidisciplinary review and, where appropriate, independent clinical or ethics support. Unresolved significant disagreement may require legal advice and referral to the Court of Protection.¹⁶⁰

Such decisions, whilst grounded in a clear ethical and legal framework, can be emotive and challenging for the wider MDT. Clinical leadership should ensure that the rationale for decisions is clearly communicated and that staff are supported before, during and after withdrawal where needed.

Palliative care integration

Withdrawal of HFNT should be explicitly recognised as a palliative intervention. Early involvement of specialist palliative care teams is recommended to support symptom management, communication, and family support. Care should address physical symptoms such as dyspnoea, as well as psychological, emotional, and spiritual distress.

Some patients may continue to derive symptomatic benefit from HFNT until the end of life, and continuation of therapy may be appropriate where it aligns with patient goals and improves comfort.^{163,164}

The potential symptomatic benefits of HFNT should be balanced against treatment burden and its impact on place of care, as patients who become dependent on HFNT may be difficult to discharge where community HFNT is unavailable.¹⁶⁵

Withdrawal planning and escalation

Withdrawal of HFNT should be individualised and may be gradual or more rapid depending on clinical urgency and patient preference.¹⁵⁷ Some patients may prioritise awareness and

interaction during the dying phase, while others may prioritise symptom relief even at the expense of consciousness. The withdrawal strategy should therefore be tailored to patient values and documented preferences.¹⁶⁶

Pre-withdrawal planning

- Clear documentation of goals of care and agreed withdrawal plan.
- Identification of dependency phenotype (oxygenation vs symptom control).
- Anticipatory prescribing for:
 - dyspnoea (opioids)
 - anxiety/agitation (benzodiazepines)
- Agreement on preferred place of care (hospital, hospice, home).

Escalation plan during withdrawal

- Requires frequent reassessment of:
 - respiratory distress
 - anxiety/agitation
 - family distress
- Escalation of symptom control medications as required.
- Rapid access to senior clinician and palliative care support.
- Clear plan for conversion between oxygen delivery modalities if HFNT is discontinued abruptly or unintentionally.

Monitoring

- Focus is symptom-based rather than physiological targets.
- Monitoring includes:
 - respiratory distress scores (clinical observation)
 - comfort level and agitation
 - patient-reported breathlessness where possible
- Avoid burdensome or non-contributory physiological monitoring.

Practical symptom management considerations

Symptom control during withdrawal requires both pharmacological and non-pharmacological strategies. Breathlessness should be managed according to established palliative care principles, including the use of opioids and anxiolytics where appropriate. Guidance from

1769 chronic respiratory disease palliative frameworks, including those used in COPD and
1770 interstitial lung disease, supports structured symptom management approaches.^{166–168}

1771 Non-pharmacological measures for symptom management remain important. The use of
1772 handheld fans directed toward the face may reduce the sensation of breathlessness.¹⁶⁶
1773 Environmental modification, reassurance, and positioning strategies are also important
1774 components of care. Following withdrawal, regular mouth care and management of dry mouth
1775 should be provided according to patient need.¹⁶⁶ Replacement of HFNT flow with alternative
1776 oxygen delivery systems, such as nasal cannulae, Venturi masks, or reservoir masks, may be
1777 used depending on symptom burden and patient preference.

1778 See Appendix 4 for suggested flowchart for palliative withdrawal of HFNT.

1779

1780 **Summary**

1781 ➤ Evidence for HFNT withdrawal remains very limited, with no comparative trials of
1782 withdrawal strategies; available evidence comprises small case series, retrospective
1783 cohorts and expert guidance.

1784 ➤ Practice is extrapolated from withdrawal literature in NIV and acute respiratory support.

1785 ➤ Withdrawal may be considered where HFNT no longer provides overall clinical benefit,
1786 is not tolerated, or is inconsistent with patient preference, and may occur in acute or
1787 planned settings.

1788 ➤ Patients may be highly oxygenation-dependent or predominantly symptom-dependent,
1789 influencing symptom trajectory after withdrawal.

1790 ➤ The trajectory after withdrawal is variable and depends on underlying disease, degree
1791 of HFNT dependence and the extent to which HFNT is sustaining oxygenation versus
1792 providing symptom relief.

1793 ➤ Symptom burden, particularly dyspnoea and anxiety, is a key clinical challenge
1794 requiring anticipatory management.

1795 ➤ HFNT withdrawal is a palliative intervention requiring multidisciplinary, structured, and
1796 ethically grounded decision-making.

1797

1798 **Clinical practice points:**

1799 ✓ HFNT withdrawal should occur within a structured multidisciplinary and palliative care
1800 framework, with senior clinical leadership and early specialist palliative care
1801 involvement.

1802 ✓ Withdrawal planning should consider the distinction between oxygenation-dependent
1803 and symptom-control-dependent patients.

1804 ✓ Capacity assessment and legal frameworks (ADRT, LPA, MCA 2005) must be followed
1805 and documented.

1806 ✓ Withdrawal planning should include anticipatory prescribing for dyspnoea, anxiety, and
1807 terminal agitation.

- 1808 ✓ Non-pharmacological measures for symptom management, including fan therapy,
1809 mouth care and environmental optimisation, should be routinely used.
- 1810 ✓ Monitoring should prioritise comfort and symptom burden rather than physiological
1811 targets.
- 1812 ✓ Escalation pathways must be clearly defined, including access to senior clinicians and
1813 palliative care teams.
- 1814 ✓ Withdrawal may occur in hospital, hospice, or home settings depending on patient
1815 preference and clinical stability.
- 1816 ✓ Some patients may continue HFNT until death where symptom benefit outweighs
1817 burdens.
- 1818 ✓ Clear documentation of decision-making, rationale, and care plans is essential.
- 1819 ✓ Complex or disputed decisions should prompt senior multidisciplinary review and,
1820 where appropriate, independent clinical or ethics support; unresolved significant
1821 disagreement may require legal advice or referral to the Court of Protection.
- 1822
- 1823
- 1824

Section 11: Research recommendations and future priorities for HFNT

Introduction

HFNT is increasingly used across acute and chronic respiratory disease pathways, including ARF, chronic hypoxaemic respiratory failure, CHRF, secretion management in airway disease, and palliative respiratory care. Despite growing adoption, evidence gaps remain regarding optimal patient selection, treatment protocols, long-term clinical effectiveness, health economics, treatment burden, and integration into palliative and community respiratory pathways.

Current evidence is strongest in hypoxaemic ARF and COPD, while evidence in non-COPD populations, chronic domiciliary use, secretion management, and end-of-life withdrawal remains limited. Much of the existing literature comprises single-centre observational studies, physiological crossover studies, feasibility studies, or heterogeneous cohorts with variable treatment protocols.

This document outlines key research priorities and recommendations intended to guide future multicentre clinical trials, translational research, implementation science, and health service evaluation. Detailed research recommendations and future priorities across each clinical domain are provided in Appendix 5.

Overarching research priorities

Standardisation of HFNT Definitions and Protocols

Future studies should standardise:

- definitions of acute and chronic respiratory failure phenotypes
- flow rate protocols
- humidification temperature settings
- oxygen delivery strategies
- duration of therapy and adherence thresholds
- criteria for treatment escalation and failure
- definitions of respiratory-support dependence
- outcome reporting frameworks

Consensus definitions are required to improve comparability between studies and facilitate future meta-analysis.

Patient-centred outcomes

Future trials should prioritise:

- breathlessness scores
- HRQoL
- sleep quality
- symptom burden, patient comfort and treatment tolerance
- treatment burden, including equipment burden, noise, sleep disruption, mobility restriction and cleaning requirements
- functional status and physical activity
- carer burden
- place of care and place of death

1868 Many current studies focus predominantly on physiological endpoints while under-reporting
1869 patient-reported outcomes.

1870 **Long-term outcomes**

1871 Future research should evaluate different respiratory disease groups, reporting on:

- 1872 • long-term exacerbation frequency
- 1873 • hospitalisation rates
- 1874 • survival outcomes
- 1875 • longitudinal physiological trajectories
- 1876 • healthcare utilisation
- 1877 • cost-effectiveness
- 1878 • treatment adherence over time

1879 Longitudinal data extending beyond 12 months are currently sparse.

1880 **Health economic and sustainability evaluation**

1881 Robust health economic analyses are required across different respiratory disease groups,
1882 particularly in:

- 1883 • acute hospital use
- 1884 • hospital-at-home pathways
- 1885 • domiciliary HFNT provision
- 1886 • community respiratory care
- 1887 • palliative care settings

1888 Future evaluations should include:

- 1889 • QALYs
- 1890 • cost per admission avoided
- 1891 • community service utilisation
- 1892 • staffing implications
- 1893 • oxygen and equipment costs
- 1894 • informal caregiver burden
- 1895 • environmental impact and sustainability

1896

1897 **Conclusion**

1898 HFNT is increasingly integrated across acute, chronic, and palliative respiratory care
1899 pathways; however, major evidence gaps remain across virtually all indications outside
1900 hypoxaemic ARF.

1901 Future research priorities should focus on high-quality multicentre clinical trials, mechanistic
1902 physiology, implementation science, health economics, and patient-centred outcomes.
1903 Priorities include chronic domiciliary HFNT, secretion management, non-COPD respiratory
1904 failure, and palliative withdrawal pathways.

1905 Improved evidence will be essential to define evidence-based clinical practice guidance on
1906 the appropriate role of HFNT within modern respiratory medicine and ensure equitable,
1907 evidence-based, and patient-centred care.

1908

1909

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