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CANADIAN JOURNAL OF RESPIRATORY THERAPY
JOURNAL CANADIEN DE THÉRAPIE RESPIRATOIRE
Informing the Practice of Respiratory Therapists

Lilitwat W, Bhandari P, Mahindrakar N, Laisathit P, Mulrooney M, Vorakunthada Y. High-flow oxygen therapy delivered through tracheostomy: A scoping review of physiology, clinical applications, safety, and pediatric evidence gaps. *Canadian Journal of Respiratory Therapy*. 2026;62:227-238. doi:10.29390/001c.172971

Review Article

High-flow oxygen therapy delivered through tracheostomy: A scoping review of physiology, clinical applications, safety, and pediatric evidence gaps

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Keywords: respiratory therapy, ventilator weaning, humidification, airway management, mechanical ventilation, decannulation

https://doi.org/10.29390/001c.172971

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Canadian Journal of Respiratory Therapy

Vol. 62, 2026

Abstract

Introduction

High-flow oxygen therapy delivered through tracheostomy (HFTO) is used for oxygenation, heated humidification, secretion management, ventilator weaning, and decannulation. Its effects depend on flow, tracheostomy interface, cuff status, and the expiratory pathway, while pediatric evidence is poorly defined.

Methods

We conducted a PRISMA-ScR-guided scoping review of adult and pediatric HFTO evidence. MEDLINE/PubMed, Embase, Scopus, Web of Science, and CINAHL were searched from inception through June 30, 2026 without age or database-level language restrictions. Adult evidence was included as a comparator to define pediatric evidence gaps.

Results

Of 487 records identified, 319 remained after deduplication; 134 underwent full-text/full-record assessment, 99 were excluded, and 35 sources were included (32 completed and 3 ongoing trial/protocol records). Adult flows were commonly 40-60 L/min, with experimental settings of 10-80 L/min; the pediatric simulation used 5-30 L/min. Several adult studies reported improved oxygenation, whereas others found no change; effects on work of breathing, carbon dioxide clearance, airway pressure, and lung volume were variable. Safety reporting was inconsistent. Direct pediatric evidence was limited to one infant/toddler aerosol-delivery simulation.

Discussion

HFTO is an interface-dependent respiratory therapy rather than a tracheostomy equivalent of nasal high-flow therapy. Cuff status, speaking-valve configuration, expiratory patency, flow, humidification, and treatment purpose should be reported explicitly. Adult feasibility cannot be assumed to establish pediatric effectiveness or safety.

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Conclusion

HFTO is feasible but incompletely defined. Standardized reporting of flow, interface/cuff configuration, humidification, monitoring, adverse events, secretion outcomes, and pediatric-specific clinical outcomes is needed.

INTRODUCTION

High-flow oxygen therapy delivered directly through a tracheostomy bypasses upper-airway structures that contribute to humidification, dead-space washout, resistance, and pressure generation; its physiology therefore differs from nasal high-flow therapy.[1-4]

Tracheostomized patients may require support during prolonged ventilation, weaning, decannulation, postoperative airway care, chronic respiratory failure, and secretion management. HFTO has been used to provide heated humidification and stable oxygen delivery, reduce secretion burden, support ventilator liberation, and facilitate decannulation.[5-8]

The evidence is fragmented. Several adult studies reported improved oxygenation with HFTO.[2,9] Other studies found no change in oxygenation or arterial blood gases.[3,4,10] Effects on work of breathing, neuroventilatory drive, carbon dioxide clearance, airway pressure, and lung volume were likewise inconsistent.[2-4,9,10] Clinical evidence spans weaning and decannulation,[6,7,11] while respiratory-therapy studies address humidification, secretion management, speaking valves, and aerosol delivery.[5,8,12,13] Safety may depend on cuff status, expiratory resistance, and interface configuration.[6,14-16]

An independent prior scoping review by Neiva et al. included four adult HFTO studies focused on ventilator weaning and available through April 2021.[17] It did not aim to compare adult and pediatric evidence. The present review extends the scope to physiology, decannulation, humidification/secretion management, device/interface studies, aerosol delivery, safety/tolerance, ongoing trials, and pediatric evidence gaps.

For respiratory therapists, bedside implementation depends on the complete configuration: device, tube size, cuff status, interface, FiO2, temperature/humidification, speaking valve, expiratory pathway, secretion burden, aerosol setup, and escalation criteria.[5,6,8,12,14-16]

Children differ from adults in airway and tracheostomy dimensions, leak, secretion burden, ventilatory reserve, developmental tolerance, chronic technology dependence, caregiver involvement, and decannulation pathways. Adult evidence was therefore included as a comparator to identify domains studied in adults but untested in pediatric care, not as directly generalizable evidence.

This review mapped adult and pediatric HFTO evidence, summarized flow and interface characteristics (including cuff and speaking-valve status when available), synthesized physiologic and clinical applications, humidification/secretion outcomes, safety, tolerance, and monitoring, and compared adult with pediatric evidence to define research priorities.

METHODS

DESIGN

This scoping review was conducted using established scoping review methodology and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).[18,19] The protocol was registered on the Open Science Framework on June 30, 2026, after the final database search and before formal screening, data charting, and synthesis; the registration DOI is provided on the title page to preserve blinding.

ELIGIBILITY CRITERIA

We included adult and pediatric sources describing high-flow oxygen, heated humidified high-flow therapy, or high-flow tracheal oxygen delivered through a tracheostomy tube or related interface. Eligible sources included clinical/physiologic, implementation, bench/simulation, technical, and review reports. Case-based clinical evidence required at least two patients. Conference abstracts required an extractable population, HFTO exposure, and at least one outcome and were treated as emerging evidence. Trial records/protocols were retained only to map active research activity, not as completed evidence or support for effectiveness or safety conclusions. We excluded nasal high-flow only, conventional low-flow tracheostomy oxygen, intraoperative/apneic oxygenation without HFTO relevance, animal-only work without clinical/device-relevant contribution, and sources with insufficient HFTO-specific information. Two eligibility decisions required explicit judgment. Technical reports using a tracheostomy-compatible connector or exchange-catheter interface were retained because they inform expiratory-pathway and pressure considerations. One animal study without spontaneous ventilation was retained because it demonstrates a monitoring-relevant mechanism, preserved oxygenation with severe carbon dioxide retention; all other animal-only evidence was excluded.

INFORMATION SOURCES AND SEARCH STRATEGY

MEDLINE/PubMed, Embase, Scopus, Web of Science, and CINAHL were searched from inception through June 30, 2026 using tracheostomy and high-flow oxygen concepts. The PubMed strategy was: ("Tracheostomy"[Mesh] OR tracheostom* OR "tracheostomy tube" OR "tracheal cannula" OR "trach tube") AND ("high-flow oxygen" OR "high flow oxygen" OR "high-flow tracheal oxygen" OR HFTO OR HFT OR HFOT OR "heated humidified high flow" OR "high-flow therapy" OR Optiflow OR Airvo). No age restriction and no database-level language filter were applied. All 487

records were retrieved from these five databases, and all 35 included sources arose from those June 30 exports; no included source was added from outside the database set after the search. The three ongoing trial/protocol records were identified within the same database exports. A separate systematic clinical-trial-registry search was not prespecified in the original search strategy and was not added post hoc after screening; registry/protocol records encountered in the database exports were retained only to map the research pipeline. Supplementary File 1 provides the search log and reconstructed database-specific executable strategies.

STUDY SELECTION

Database records were exported, merged, deduplicated, and managed in a custom Microsoft Excel screening workbook. One reviewer performed the initial title/abstract screening and full-text eligibility assessment. A second reviewer then rechecked every record-level decision at both stages against the eligibility criteria. This was complete sequential verification rather than independent parallel duplicate screening. Disagreements were resolved by discussion, with senior adjudication available. During revision, the archived workbook was re-audited against the final included-source set to verify PRISMA full-text exclusion categories and counts.

DATA EXTRACTION

Data were charted with an author-developed, nonvalidated standardized form. No separate formal pilot of the charting form was documented in the archived methods materials. Variables included source design, population/model, setting, indication, device/interface, tube and cuff status when reported, speaking-valve configuration, flow, FiO2, temperature/humidification, comparator, physiologic and clinical outcomes, secretions, safety/adverse events, tolerance/monitoring, weaning/decannulation, and pediatric relevance. One reviewer performed the initial charting, after which a second reviewer rechecked every extracted field against the source and confirmed or corrected the entry. This was complete sequential verification rather than independent duplicate extraction.

SYNTHESIS

No meta-analysis or formal risk-of-bias assessment was planned because the purpose was evidence mapping. Domains were defined from the prespecified objective and charting framework: source characteristics; flow/cuff/interface and physiology; clinical applications and care settings; decannulation; humidification/secretion management; device/interface and aerosol delivery; safety/tolerance/monitoring; and adult-pediatric gaps. The three ongoing trials/protocols were summarized separately solely to map the active research pipeline and were not used to infer effectiveness or safety.

ETHICS

Ethics approval was not required because this review used publicly available published literature and did not involve human participants, patient-level data collection, or identifiable private information.

RESULTS

STUDY SELECTION

Searches identified 487 records; 168 duplicates were removed, leaving 319 records for title/abstract screening. Of these, 185 were excluded and 134 full texts or complete trial/protocol records were assessed. Ninety-nine were excluded: no tracheostomy-delivered HFTO or ineligible delivery route (n=64), insufficient HFTO-specific information or no unique extractable data (n=20), duplicate/companion/superseded report (n=10), intraoperative/apneic oxygenation outside scope (n=4), and animal-only evidence without relevant clinical/device applicability (n=1). Thirty-five sources remained: 32 completed sources and 3 ongoing trial/protocol records (**Figure 1**).

STUDY CHARACTERISTICS

The evidence was heterogeneous and predominantly adult. Completed sources included physiologic studies, observational cohorts, implementation studies, small case series, bench/simulation work, technical reports, one conference abstract, and reviews across intensive care, prolonged ventilation, weaning, lung-transplant recovery, postoperative care, and rehabilitation. One source directly modeled pediatric HFTO: a 2026 infant/toddler aerosol-delivery simulation.[13] The three ongoing sources addressed weaning, mucus properties/respiratory effort, and external diaphragm pacing with HFTO.[20-22] Source-level characteristics are provided in Supplementary Table S1.

FLOW SETTINGS, CUFF STATUS, AND PHYSIOLOGIC EFFECTS

Reported adult flow settings varied widely. Physiologic and bench studies tested approximately 10-80 L/min, with 40-60 L/min most common.[2,9,10,15,16,23-25] Musso et al. specifically evaluated 70 and 80 L/min in adults after liberation from invasive ventilation.[10] A systematic review of five physiologic studies identified oxygenation as the most consistent signal across the available adult literature.[26] Individual studies reporting improved oxygenation included Natalini et al., Corley et al., and Lytra et al.[2,9,27] In contrast, Stripoli et al., Lersritwimanmaen et al., and Musso et al. found no improvement or no additional change in arterial blood gases or oxygenation.[3,4,10] Effects on work of breathing, diaphragm effort, carbon dioxide clearance, end-expiratory lung volume, and clinically meaningful positive end-expiratory pressure were variable.[2-4,9,10,23,26,27] Cuff status was often incompletely reported and could not be isolated as an independent effect. In a size 8 uncuffed bench model, standard HFTO generated only about 0.3,

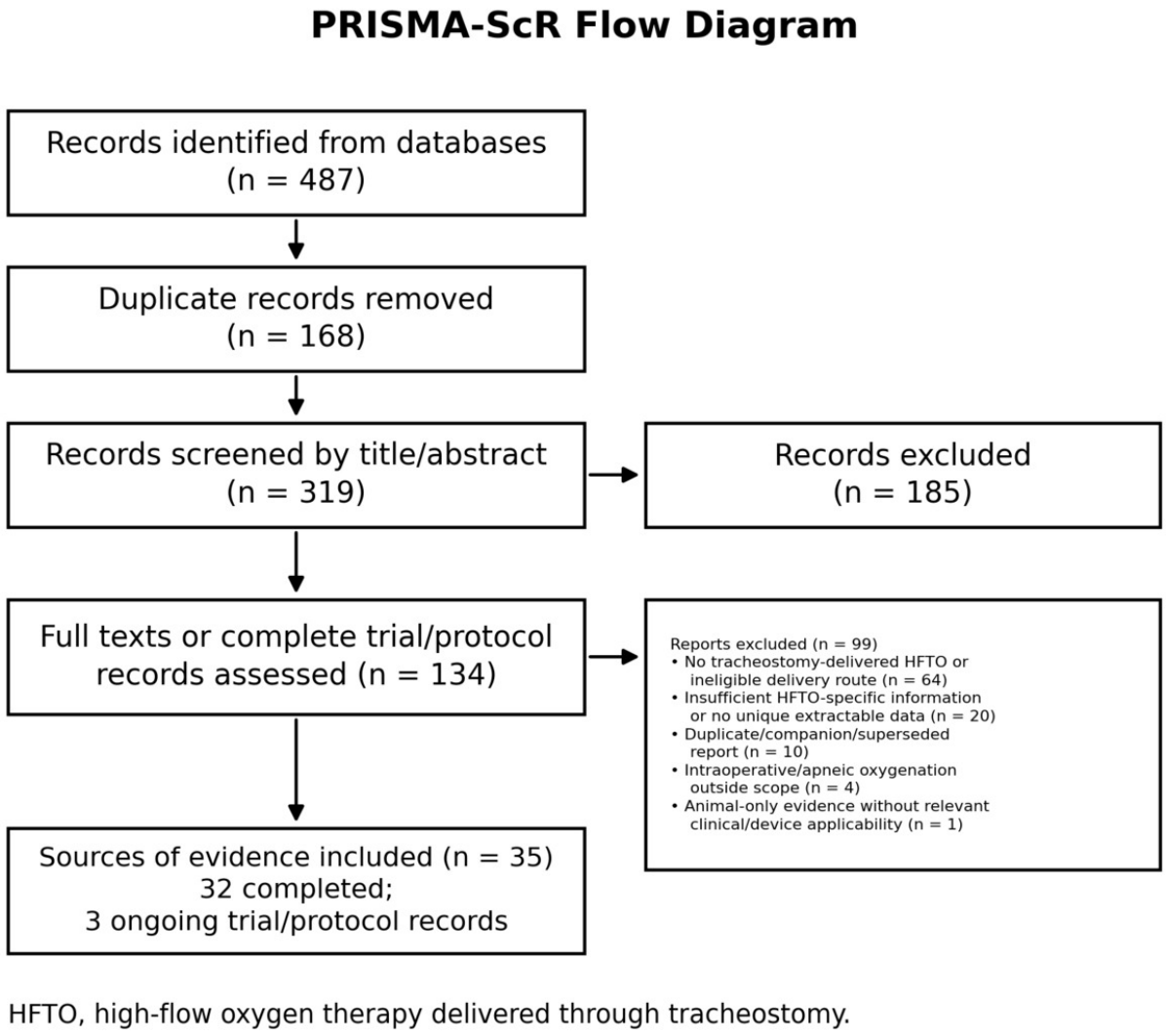


Figure 1. PRISMA-ScR flow diagram. HFTO, high-flow oxygen therapy delivered through tracheostomy

0.5, and 0.9 cm H2O of PEEP at 40, 50, and 60 L/min, respectively.[16] In contrast, a size 8 cuffed simulation using a novel higher-resistance interface generated greater PEEP and functional residual capacity across 10-80 L/min.[15] Because cuff status and interface resistance differed simultaneously, these studies demonstrate the importance of expiratory leak and circuit configuration but do not establish a cuffed-versus-uncuffed treatment effect.

CLINICAL APPLICATIONS AND CARE SETTINGS

Ventilator weaning was the most common clinical application. In a 77-patient retrospective cohort, 57 patients (74%) were liberated by 60 days, but early versus rescue HFTO did not change liberation or ventilator-free days.[11] Small case series described HFTO as a bridge after difficult weaning,[24,28-30] while an abstract-only controlled study reported similar dyspnea but higher RAND-36 quality-of-life scores; nonrandomized allocation and limited reporting constrain inference.[31] Other reported settings included lung-transplant recovery, postoperative head and neck free-flap care, COVID-era tracheostomy care, and inpatient rehabilitation/weaning.[5,31-33]

DECANNULATION PATHWAYS

HFTO was incorporated into adult tracheostomy-liberation pathways. A multicenter randomized trial of 330 conscious adults after ventilator weaning tested an HFTO-containing decannulation strategy in which patients received continuous high-flow oxygen and suctioning frequency was used as the readiness criterion. The strategy reduced median time to decannulation from 13 to 6 days without increasing failure; the effect should therefore be attributed to the combined pathway rather than to HFTO in isolation.[7] In lung-transplant recipients, tube removal occurred in 13/14 HFTO patients versus 6/13 controls in a small nonrandomized study.[32] A registry combining HFTO with an in-line one-way speaking valve demonstrated feasibility during weaning.[6]

HUMIDIFICATION AND SECRETION MANAGEMENT

Heated humidification and secretion management may be among the most clinically important practical roles of HFTO. In 82 adults after head and neck free-flap surgery, implementation of an AIRVO-based system was associated with a reduction in excessive secretions from 40% to 11.9% and in supplemental oxygen above baseline from 25% to 7.1%; no respiratory rapid responses or ICU escalations occurred in either group.[5] The study did not report flap viability, wound-healing, or flap-complication outcomes as prespecified outcomes, so the available evidence cannot determine whether heated humidification affects free-flap healing. Bench testing also showed that heat-moisture exchangers used with supplemental oxygen could provide less than 30 mg/L absolute humidity, whereas actively heated systems exceeded 30 mg/L across tested conditions.[8] Aerosol-delivery models further demonstrate that nebulizer type, placement, interface, humidification configuration, and flow alter delivered dose.[12,13] In the pediatric infant/toddler model, flows of 5-30 L/min were tested and aerosol dose decreased as flow increased.[13]

DEVICE AND INTERFACE STUDIES

Interface configuration modifies physiologic effect and safety. Added expiratory resistance or novel interfaces increased airway pressure/lung volume in bench or preclinical models,[14,15,25] whereas standard open configurations generated little pressure.[16] HFTO with an in-line one-way speaking valve was tolerated clinically, but obstructed exhalation produced dangerous pressures in bench testing.[6] Delivery route itself also matters: in a manikin and lung-simulator comparison of seven high-flow devices, measured work of breathing was statistically lower with tracheal than with nasal delivery, but the differences were small and of uncertain clinical importance.[34] A pandemic-era technical report described practical setup of HFTO in tracheostomized adults and contributed implementation rather than comparative outcome data.[33] Technical reports of alternative interfaces remain hypothesis-generating rather than definitive safety evidence.[35,36]

SAFETY, TOLERANCE, AND MONITORING

Across completed clinical studies, HFTO was usually described as feasible or well tolerated, but adverse-event ascertainment was inconsistent and often not a primary outcome. Egbers et al. reported no practice-related adverse events with the tested HFTO-speaking-valve configuration, while bench testing identified high-pressure risk when exhalation was obstructed.[6] Musso et al. reported no adverse events or respiratory distress during very-high-flow testing.[10] Several small clinical series reported no major adverse events,[24,28-30] and the free-flap implementation study reported no respiratory rapid responses or ICU escalation.[5] These observations indicate no major safety signal within those small samples but do not establish safety because adverse-event definitions and ascertainment were not standardized. Mechanistic concerns include inadequate humidification with secretion thickening or mucus plugging,[8] tube/interface disconnection or displacement,[12] excessive pressure when expiratory pathways are restricted,[6,14,15,36] and failure to recognize inadequate ventilation when oxygenation is preserved; an animal model without spontaneous ventilation, retained for its monitoring-relevant mechanism, demonstrated severe hypercapnic acidosis despite sustained oxygenation during direct tracheal oxygen delivery.[37]

Monitoring reflected treatment purpose. Physiologic studies followed oxygenation, respiratory rate, blood gases/carbon dioxide, respiratory effort, and hemodynamics.[2-4,9,10,23] Decannulation studies incorporated suctioning frequency, airway tolerance, and failure criteria.[6,7] During aerosol delivery, temporary flow reduction should be accompanied by oxygenation monitoring and prompt return to prescribed support.[13] Comfort, secretion quality, mucus plugging, tube stability, cuff/valve status, escalation to ventilation, and standardized adverse-event definitions were inconsistently reported.

ADULT-PEDIATRIC EVIDENCE COMPARISON

Adult evidence covered multiple physiologic, clinical, and implementation domains summarized in Table 1. Direct pediatric evidence was limited to one infant/toddler aerosol simulation showing flow-dependent reduction in delivered dose without clinical effectiveness or safety outcomes.[13] No pediatric clinical study evaluated oxygenation, work of breathing, cuff/interface physiology, secretion outcomes, tolerance, speaking-valve use, weaning, decannulation, home use, or adverse events. The pediatric evidence map is presented in Table 2, and the adult-pediatric comparison with priority gaps is summarized in Table 3.

DISCUSSION

INTERPRETATION OF FINDINGS

The evidence suggests that HFTO should be defined by purpose and configuration rather than treated as a single intervention. Oxygenation improved in some adult studies but not others, while pressure and mechanical assistance depended strongly on interface and expiratory pathway.[2-4,9,10,14-16,27] Clinically tangible benefits in some studies relate to humidification, secretion management, HFTO-containing decannulation pathways, or remaining off the ventilator rather than a large PEEP-like effect.[5-8,11]

CUFF STATUS, INTERFACE, AND PHYSIOLOGIC MECHANISM

Cuff status deserves explicit consideration because it changes the potential expiratory leak around the tracheostomy tube and therefore interacts with interface resistance and pressure generation. The available literature does not permit a controlled cuffed-versus-uncuffed comparison: cuff status is frequently unreported, and studies that do report it use different interfaces and models.[15,16] Accordingly, pressure data should not be extrapolated from

Table 1. Adult evidence by outcome domain

Outcome domain	Relevant adult sources	Synthesis	Safety/monitoring implications
Flow and physiology	Natalini 2019[2]; Stripoli 2019[3]; Lersritwimanmaen 2021[4]; Corley 2017[9]; Lytra 2024[27]; Musso 2026[10]; Fernandez Ceballos 2024[23]; Thomas 2021[16]; Janssen 2024[26]	Adult studies tested approximately 10-80 L/min, most often 40-60 L/min. Oxygenation improved in several studies, while others found no change; work of breathing, diaphragm measures, CO2, lung volume, and pressure effects were variable.	Cuff status was frequently unreported. Standard/open HFTO generated little PEEP; very-high flow or added resistance did not consistently translate into broader physiologic benefit.
Cuff/interface and speaking valve	Egbers 2023[6]; Chen 2019[14]; Hou 2025[15]; Hou 2026[25]; Thomas 2021[16]; Kodamanchili 2024[35]; Vaithialingam 2023[36]	Airway pressure and lung volume depended strongly on interface resistance and expiratory pathway. A carefully configured in-line speaking-valve pathway was feasible in adults.	Obstructed exhalation or pressure-generating modifications can be hazardous. Report tube size, cuff status, valve, interface, and expiratory route.
Ventilator weaning	Al Duhailib 2025[11]; Ramachandran 2021[28]; Vadi 2021[29]; Mitaka 2018[24]; Skok 2021[30]; Su and Peng 2025[31]	HFTO was used as early, rescue, or bridge support during ventilator liberation. Evidence supports feasibility but not clear superiority over conventional oxygen.	Monitor oxygenation, respiratory rate, work of breathing, gas exchange when indicated, comfort, and escalation/failure criteria.
Decannulation pathways	Hernandez Martinez 2020[7]; Lionello 2023[32]; Egbers 2023[6]	An HFTO-containing multicenter randomized decannulation strategy shortened time to decannulation; smaller comparative/registry data support use within broader tracheostomy-liberation pathways.	Readiness depends on airway patency, secretion/suction burden, cuff/valve configuration, and explicit failure criteria.
Humidification and secretion management	Masood 2023[5]; Chikata 2013[8]; Egbers 2023[6]	AIRVO implementation was associated with fewer excessive secretions and lower oxygen need above baseline. Bench work showed inadequate absolute humidity with some HME-plus-oxygen conditions.	Free-flap healing was not reported as an outcome. Monitor humidity, secretion quality, suctioning, tube patency, and mucus plugging.
Aerosol delivery	Chen, Albuainain, and Li 2025[12]	Delivered aerosol depended on nebulizer, placement, interface, humidification, and flow; lower flow often increased inhaled dose in simulation.	Any flow reduction for aerosol delivery requires oxygenation monitoring, preservation of circuit stability, and return to prescribed support flow.
Safety and tolerance	Across adult completed clinical sources	HFTO was often feasible or well tolerated, and several reports described no adverse events or no major safety signal; adverse-event definitions and ascertainment were inconsistent.	Potential hazards include inadequate humidification, secretion plugging, disconnection/displacement, excessive pressure with obstructed exhalation, and occult hypoventilation.

Abbreviations: CO2, carbon dioxide; HFTO, high-flow oxygen therapy delivered through tracheostomy; HME, heat-moisture exchanger; PEEP, positive end-expiratory pressure.

one configuration to another. A cuffed tube with a restrictive or obstructed expiratory pathway may increase pressure and risk, whereas an uncuffed or cuff-deflated configuration may dissipate pressure through leak. The clinically relevant unit of reporting should therefore be the complete configuration—tube size, cuff status, interface, flow, speaking valve, and expiratory route—rather than flow alone.

CLINICAL AND RESPIRATORY THERAPY IMPLICATIONS

HFTO protocols should define the treatment goal and complete configuration. Monitoring should be indication-specific: oxygenation, respiratory effort, gas exchange when indicated, and escalation criteria for oxygenation/weaning; temperature/humidification, secretions, suction burden, patency, and plugging for secretion-focused use; and airway patency, suction burden, tolerance, and failure criteria for decannulation pathways (Table 1).

SPEAKING VALVES, COMFORT, AND CARE SETTING

HFTO can be incorporated into a carefully configured one-way-valve pathway, but this should not be generalized without confirming an unobstructed expiratory route.[6] Patient-centered evidence remains limited: one abstract reported higher quality-of-life scores but no dyspnea difference and used nonrandomized allocation.[31] No direct comparison of comfort versus cold-nebulized tracheostomy humidification was identified.

Routine home/community HFTO is also not established; most studies were hospital-, ICU-, rehabilitation-, or post-operative-based. Future home studies should address care-

Table 2. Pediatric evidence map

Pediatric domain	Direct evidence identified	What can be inferred	Priority evidence needed
Clinical physiology/ oxygenation	No direct pediatric clinical study identified	Adult physiology cannot be assumed to generalize to smaller pediatric tubes/airways.	Prospective pediatric physiologic studies with age/weight, tube size, cuff, interface, flow, oxygenation, ventilation, and effort.
Humidification/ secretion	No direct pediatric HFTO clinical study identified	Adult implementation and bench data suggest relevance but do not establish pediatric outcomes.	Humidity targets, secretion quality, suction frequency, plugging, comfort, and caregiver workload.
Aerosol delivery	Albuainain, Man, and Li 2026[13]; 5-kg infant and 15-kg toddler simulation	Flows 5-30 L/min; aerosol dose decreased as flow increased; Optiflow and Airvo 2 were similar at comparable toddler flows.	Clinical validation, oxygenation during flow adjustment, device/interface-specific dosing, and medication-delivery outcomes.
Speaking valve/ communication	No direct pediatric HFTO study identified	Adult registry evidence cannot be generalized because pediatric airway patency and tube-to-airway ratios differ.	Pediatric valve/interface safety, expiratory patency, speech tolerance, pressure, and rescue procedures.
Weaning/ decannulation	No direct pediatric HFTO clinical study identified	Adult RCT/cohort evidence defines candidate domains but pediatric pathways differ.	Ventilator-free time, suction burden, sleep/awake tolerance, decannulation criteria, failure and recannulation.
Safety/ tolerance	No direct pediatric clinical safety study identified	Absence of pediatric adverse-event evidence is a major gap.	Standard adverse-event definitions, plugging, pressure events, desaturation, hypercapnia, disconnection, accidental decannulation, comfort.
Home/ community use	No direct evidence identified	Evidence base is predominantly inpatient.	Caregiver training, equipment/power reliability, water/humidifier management, emergency backup, home escalation criteria.

Abbreviations: HFTO, high-flow oxygen therapy delivered through tracheostomy; RCT, randomized controlled trial.

Table 3. Adult-pediatric evidence comparison and priority gaps

Domain	Adult evidence	Pediatric evidence	Priority gap
Physiology and flow	Multiple adult crossover/bench studies; common clinical/research flows 40-60 L/min, experimental range about 10-80 L/min.	One pediatric aerosol simulation used 5-30 L/ min; no pediatric clinical physiology study.	Define age/weight-referenced flow and physiologic endpoints.
Cuff/interface/ pressure	Adult bench/preclinical studies show interface and expiratory resistance alter pressure; speaking-valve pathway studied in adults.	No pediatric clinical or bench study designed specifically to compare cuff/interface pressure effects.	Tube-size/cuff/ interface-specific pressure and expiratory-patency studies.
Humidification/ secretion	Adult implementation and bench evidence support heated humidification and secretion-focused use.	No direct pediatric clinical HFTO secretion/ humidification study.	Pediatric humidity, secretion, plugging, suction, comfort, and caregiver outcomes.
Weaning/ decannulation	Adult cohort, case-series, registry, comparative studies, and one randomized HFTO-containing decannulation strategy.	No pediatric HFTO weaning or decannulation study.	Pediatric liberation pathways and clinically meaningful outcomes.
Aerosol delivery	Adult simulation evidence shows strong device/ flow effects.	Direct infant/toddler simulation evidence; aerosol dose falls with increasing flow.	Clinical dose-response and medication-effectiveness studies.
Safety/ tolerance	Several adult studies reported no adverse events or no major safety signal, but reporting was inconsistent; bench work identified pressure and humidification hazards.	No pediatric clinical safety dataset.	Prospective standardized adverse-event, tolerance, comfort, and escalation reporting.

Abbreviation: HFTO, high-flow oxygen therapy delivered through tracheostomy.

giver training, equipment reliability, humidifier-water management, secretion surveillance, backup power, emergency plans, and escalation criteria.

PEDIATRIC TRANSLATION

Adult findings should be treated as hypothesis-generating for children, not as evidence of pediatric effectiveness or safety. The sole direct pediatric source was a 5-kg infant and 15-kg toddler aerosol simulation showing flow-dependent delivery changes across 5-30 L/min.[13] No pediatric clinical data address oxygenation, work of breathing, humidification/secretion outcomes, speaking-valve use, weaning, decannulation, home use, tolerance, or adverse events. Pediatric priorities are summarized in Tables 2 and 3.

RESEARCH PRIORITIES

Future studies should use a standardized minimum dataset covering device/interface, tube and cuff/valve status, expiratory route, flow and FiO2, humidification, indication, oxygenation/ventilation, work of breathing, secretions/suction, comfort, adverse events, escalation, and weaning/decannulation outcomes. Pediatric studies should also report age, weight, diagnosis, chronic ventilator dependence, caregiver workflow, and home feasibility (Tables 2 and 3).

STRENGTHS AND LIMITATIONS

A strength of this scoping review is its broad mapping of physiology, clinical application, respiratory-therapy implementation, safety, and pediatric gaps rather than ventilator weaning alone, with source-level charting for all included records. Limitations remain. The evidence is heterogeneous and predominantly adult; many studies are small, short-term, or observational, and configuration and humidification are inconsistently reported. Safety outcomes and patient-centered measures are particularly incomplete. Conference abstracts and technical reports provide useful signals but limited detail, and ongoing protocols were included only to map the research pipeline. No meta-analysis or formal risk-of-bias assessment was performed. A separate systematic clinical-trial-registry search was not prespecified and was not added post hoc, so the mapped research pipeline may be incomplete.

IMPLICATIONS FOR INTERPRETATION

Reports of “no adverse events,” “well tolerated,” or “no major safety signal” in small studies should not be interpreted as established safety, and adult feasibility does not establish pediatric effectiveness. Current evidence supports cautious, purpose-specific HFTO implementation with explicit attention to humidification, expiratory patency, cuff/interface configuration, secretion burden, and monitoring while comparative and pediatric studies are developed.

CONCLUSION

HFTO is feasible across several adult respiratory-care applications but should not be assumed to reproduce nasal high-flow physiology. Oxygenation is the most consistently reported physiologic benefit, but findings are not uniform; work of breathing, carbon dioxide clearance, airway pressure, and lung volume vary by configuration. Cuff/interface and speaking-valve setup, expiratory patency, flow, and humidification are central to the benefit-risk profile. Adult evidence suggests roles in secretion management, weaning, and HFTO-containing decannulation pathways, but direct pediatric clinical evidence is absent. Standardized adverse-event, monitoring, and pediatric outcome reporting are priorities.

ETHICS APPROVAL

Ethics approval was not required because this scoping review used publicly available published literature and did not involve human participants, patient-level data collection, or identifiable private information.

FUNDING

The authors received no specific funding for this work.

CONFLICTS OF INTEREST

All authors have completed the ICMJE uniform disclosure form and declare no conflict of interest.

DATA AVAILABILITY

Search strategies and source-level charted data are provided in Supplementary File 1 and the OSF registration. The archived master screening workbook and study-selection audit materials are available from the corresponding author upon reasonable request.

AI-ASSISTED LANGUAGE STATEMENT

During preparation and revision of this work, the authors used ChatGPT (OpenAI; GPT-5.6 Sol; most recently accessed October 3, 2026) to improve language, clarity, readability, and presentation of author-provided text and to assist with consistency checking of author-provided search documentation and references. The tool did not conduct the original database searches, select studies, generate data, or perform analyses. The authors reviewed and edited all AI-assisted text, checked citations against source records, and take full responsibility for the content of the publication.

Submitted: July 23, 2026 EST. Accepted: October 23, 2026 EST.
Published: November 02, 2026 EST.

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REFERENCES

1. Lin SB, Chiang CE, Tseng CW, Liu WL, Chao KY. High-flow tracheal oxygen: what is the current evidence? *Expert Rev Respir Med*. 2020;14(11):1075-1078. doi:10.1080/17476348.2020.1794830

2. Natalini D, Grieco DL, Santantonio MT, et al. Physiological effects of high-flow oxygen in tracheostomized patients. *Ann Intensive Care*. 2019;9(1):114. doi:10.1186/s13613-019-0591-y

3. Stripoli T, Spadaro S, Di Mussi R, et al. High-flow oxygen therapy in tracheostomized patients at high risk of weaning failure. *Ann Intensive Care*. 2019;9(1):4. doi:10.1186/s13613-019-0482-2

4. Lersritwimanmaen P, Rittayamai N, Tscheikuna J, Brochard LJ. High-flow oxygen therapy in tracheostomized subjects with prolonged mechanical ventilation: a randomized crossover physiologic study. *Respir Care*. 2021;66(5):806-813. doi:10.4187/respcare.08585

5. Masood MM, Yu K, Penn D, Ramirez J, Michaels A, Shnayder Y. Implementation of AIRVO system for postoperative tracheostomy care in head and neck free flaps. *Ann Otol Rhinol Laryngol*. 2023;132(12):1626-1630. doi:10.1177/00034894231179013

6. Egbers PH, Sutt AL, Petersson JE, Bergström L, Sundman E. High-flow via a tracheostomy tube and speaking valve during weaning from mechanical ventilation and tracheostomy. *Acta Anaesthesiol Scand*. 2023;67(10):1403-1413. doi:10.1111/aas.14305

7. Hernández Martínez G, Rodriguez ML, Vaquero MC, et al. High-flow oxygen with capping or suctioning for tracheostomy decannulation. *N Engl J Med*. 2020;383(11):1009-1017. doi:10.1056/NEJMoa2010834

8. Chikata Y, Oto J, Onodera M, Nishimura M. Humidification performance of humidifying devices for tracheostomized patients with spontaneous breathing: a bench study. *Respir Care*. 2013;58(9):1442-1448. doi:10.4187/respcare.02093

9. Corley A, Edwards M, Spooner AJ, Dunster KR, Anstey C, Fraser JF. High-flow oxygen via tracheostomy improves oxygenation in patients weaning from mechanical ventilation: a randomised crossover study. *Intensive Care Med*. 2017;43(3):465-467. doi:10.1007/s00134-016-4634-7

10. Musso GA, Appendino G, Gomez MC, et al. High-flow tracheal oxygen therapy effect on end-expiratory lung impedance. *Respir Care*. Published online May 12, 2026. doi:10.1177/19433654261444697

11. Al Duhailib Z, Hajja A, Shacfe G, et al. High-flow tracheal oxygen for weaning mechanically ventilated tracheostomized critically ill patients: a retrospective study. *Acta Anaesthesiol Scand*. 2025;69(8):e70104. doi:10.1111/aas.70104

12. Chen X, Albuainain FA, Li J. Aerosol delivery to simulated spontaneously breathing tracheostomized adult patients with heated humidified high-flow oxygenation. *Respir Care*. 2025;70(7):873-878. doi:10.1089/respcare.12467

13. Albuainain FA, Man X, Li J. Aerosol delivery to simulated spontaneously breathing tracheostomized children's models with high-flow tracheal oxygen. *Respir Care*. 2026;71(2):203-206. doi:10.1177/19433654251360623

14. Chen GQ, Sun XM, Wang YM, et al. Additional expiratory resistance elevates airway pressure and lung volume during high-flow tracheal oxygen via tracheostomy. *Sci Rep*. 2019;9(1):14542. doi:10.1038/s41598-019-51158-0

15. Hou A, Mi S, Jiao F, Zhang L, Tong Z. Design and simulation-based evaluation of a novel tracheostomy high-flow therapy device interface: a preclinical study. *PeerJ*. 2025;13:e20445. doi:10.7717/peerj.20445

16. Thomas M, Joshi R, Cave G. How much PEEP does high flow deliver via tracheostomy? A literature review and benchtop experiment. *Crit Care Res Pract*. 2021;2021:6036891. doi:10.1155/2021/6036891

17. Neiva S, Maia D, Pacheco A, Marques F, Ribeiro O, Oliveira JP. High-flow oxygen therapy for ventilator weaning of tracheostomized patients: scoping review. *Rev Port Enferm Reabil*. 2021;4(1):64-72. doi:10.33194/rper.2021.v4.n1.172

18. Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467-473. doi:10.7326/M18-0850

19. Peters MDJ, Marnie C, Tricco AC, et al. Updated methodological guidance for the conduct of scoping reviews. *JBI Evid Synth*. 2020;18(10):2119-2126. doi:10.11124/JBIES-20-00167

20. ClinicalTrials.gov. High flow tracheal oxygen for weaning of tracheostomized patients (HFTO-WEAN trial). ClinicalTrials.gov identifier: NCT07559591. Accessed June 30, 2026. https://clinicaltrials.gov/study/NCT07559591

21. Yang L, Zheng K, Li N, Xing K, Zhang J. Efficacy of external diaphragm pacing combined with high-flow oxygen via tracheostomy for weaning in patients requiring prolonged mechanical ventilation: a study protocol for a randomized controlled trial. *medRxiv*. Published online March 2026. doi:10.64898/2026.03.07.26347833

22. ClinicalTrials.gov. Physiological effect of high-flow tracheal oxygen on viscosity of airway mucus and respiratory effort in patients weaning from invasive mechanical ventilation. ClinicalTrials.gov identifier: NCT06776939. Accessed June 30, 2026. https://clinicaltrials.gov/study/NCT06776939

23. Fernández Ceballos I, Huespe IA, Venuti MS, et al. High-flow tracheal oxygen: assessment of diaphragmatic functionality by ultrasonography in adults during weaning from mechanical ventilation. *Med Intensiva (Engl Ed)*. 2024;48(10):614-616. doi:10.1016/j.medine.2024.06.006

24. Mitaka C, Odoh M, Satoh D, Hashiguchi T, Inada E. High-flow oxygen via tracheostomy facilitates weaning from prolonged mechanical ventilation in patients with restrictive pulmonary dysfunction: two case reports. *J Med Case Rep*. 2018;12(1):292. doi:10.1186/s13256-018-1832-7

25. Hou A, Jiao F, Xu R, Mi S, Zhang L, Tong Z. Investigating a novel tracheostomy high-flow therapy device interface in COPD models: design and preclinical validation. *Eur J Med Res*. 2026;31:581. doi:10.1186/s40001-026-04129-x

26. Janssen ML, Weller D, Endeman H, Heunks LMA, Wils EJ. Physiological effects of high-flow tracheal oxygen in tracheostomized patients weaning from mechanical ventilation. *Respir Care*. 2024;69(10):1336-1344. doi:10.4187/respcare.11755

27. Lytra E, Kokkoris S, Poularas I, et al. The effect of high-flow oxygen via tracheostomy on respiratory pattern and diaphragmatic function in patients with prolonged mechanical ventilation: a randomized, physiological, crossover study. *J Intensive Med*. 2024;4(2):202-208. doi:10.1016/j.jointm.2023.11.008

28. Ramachandran L, Jha OK, Sircar M. High-flow tracheal oxygenation: a new tool for difficult weaning. *Indian J Crit Care Med*. 2021;25(2):224-227. doi:10.5005/jp-journals-10071-23724

29. Vadi S, Phadtare S, Shetty K. High-flow oxygen therapy via tracheostomy to liberate COVID-19-induced ARDS from invasive ventilation: a case series. *Indian J Crit Care Med*. 2021;25(6):724-728. doi:10.5005/jp-journals-10071-23858

30. Skok K, Golub J, Kunej D, Sinkovič A, Markota A. Weaning from mechanical ventilation with high flow oxygen therapy via tracheal cannula. *Zdrav Vestn*. 2021;90(1-2):96-101. doi:10.6016/ZdravVestn.2979

31. Su CH, Peng YH. High-flow oxygen therapy improves quality of life in tracheotomized patients who weaned from mechanical ventilation: a controlled trial. [Conference abstract]. *Eur Respir J*. 2025;66(suppl 69):PA3136. doi:10.1183/13993003.congress-2025.PA3136

32. Lionello F, Guarnieri G, Arcaro G, et al. High-flow tracheal oxygen for tracheostomy tube removal in lung transplant recipients. *J Clin Med*. 2023;12(24):7566. doi:10.3390/jcm12247566

33. Epstein D, Miller A, Ben-Avi R, Matan M. High-flow tracheal oxygen in tracheostomised COVID-19 patients. *J Crit Care*. 2020;59:35-36. doi:10.1016/j.jcrc.2020.05.015

34. Cour M, Guérin C, Degivry F, Argaud L, Louis B. Delivery of high flow oxygen through nasal vs. tracheal cannulas: a bench study. *Front Med (Lausanne)*. 2022;9:1068428. doi:10.3389/fmed.2022.1068428

35. Kodamanchili S, Priyanka TN, Anand A, Panda R. Catheter mount used as tracheostomy interface in high-flow oxygen therapy. *J Anaesthesiol Clin Pharmacol*. 2024;40(1):168-169. doi:10.4103/joacp.joacp_75_22

36. Vaithialingam B, Arun BG. High-flow tracheal oxygenation with airway exchange catheter: a novel approach. *Indian J Crit Care Med*. 2023;27(6):456. doi:10.5005/jp-journals-10071-24476

37. Meggs WJ, Carroll RG, Brewer KL, Hack JB, Reeder TJ. Sustained oxygenation without ventilation in paralyzed pigs with high-flow tracheal oxygen. *Am J Emerg Med*. 2005;23(7):864-867. doi:10.1016/j.ajem.2005.05.004

SUPPLEMENTARY MATERIALS

Supplementary file

Download: https://cjrt.ca/article/172971-high-flow-oxygen-therapy-delivered-through-tracheostomy-a-scoping-review-of-physiology-clinical-applications-safety-and-pediatric-evidence-gaps/attachment/372889.docx