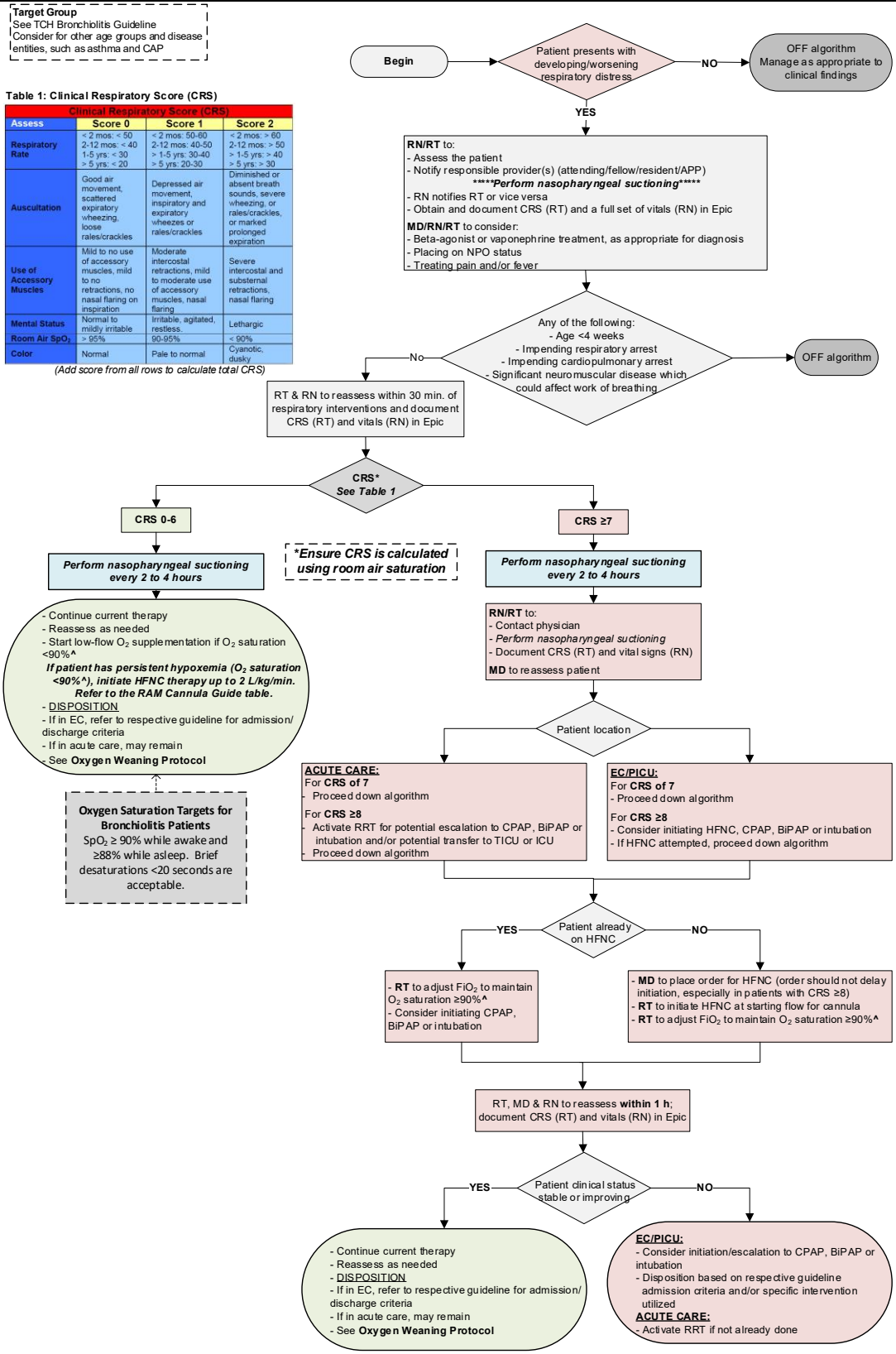
TEXAS CHILDREN'S HOSPITAL
EVIDENCE-BASED OUTCOMES CENTER
High Flow Nasal Cannula (HFNC) Therapy: Initiation and Escalation for Respiratory Distress
Evidence-Informed Pathway

Target Group
See TCH Bronchiolitis Guideline
Consider for other age groups and disease entities, such as asthma and CAP

Table 1: Clinical Respiratory Score (CRS)

Clinical Respiratory Score (CRS)			
Assess	**Score 0**	**Score 1**	**Score 2**
Respiratory Rate	< 2 mos: < 50 2-12 mos: < 40 1-5 yrs: < 30 > 5 yrs: < 20	< 2 mos: 50-60 2-12 mos: 40-50 > 1-5 yrs: 30-40 > 5 yrs: 20-30	< 2 mos: > 60 2-12 mos: > 50 > 1-5 yrs: > 40 > 5 yrs: > 30
Auscultation	Good air movement, scattered expiratory wheezing, loose rales/crackles	Depressed air movement, inspiratory and expiratory wheezes or rales/crackles	Diminished or absent breath sounds, severe wheezing, or rales/crackles, or marked prolonged expiration
Use of Accessory Muscles	Mild to no use of accessory muscles, mild to no retractions, no nasal flaring on inspiration	Moderate intercostal retractions, mild to moderate use of accessory muscles, nasal flaring	Severe intercostal and substernal retractions, nasal flaring
Mental Status	Normal to mildly irritable	Irritable, agitated, restless.	Lethargic
Room Air SpO_2	> 95%	90-95%	< 90%
Color	Normal	Pale to normal	Cyanotic, dusky

(Add score from all rows to calculate total CRS)



****Patient disposition should NOT be based on HFNC settings (i.e., FiO_2, flow). Patient disposition should be determined by the overall clinical condition, which is mainly defined by CRS. See next page for additional guidance.**

Critical Points of Evidence

Evidence Supports

- Use HFNC therapy in children experiencing respiratory distress. Use the maximum flow rate for the patient's appropriate cannula size. [1-12] – Strong recommendation, low quality evidence
- Identify nonresponders as patients exhibiting no response (e.g., HR, RR) within 1 hour of therapy. [13-16] – Strong recommendation, low quality evidence
  The clinical respiratory score (CRS) used at TCH includes respiratory rate, among other markers. Patients with a significant cardiopulmonary disorder may have a higher HFNC therapy failure rate than the general population.

Evidence Lacking/Inconclusive

- Utilize the Oxygen Weaning Protocol for HFNC therapy weaning. – Consensus recommendation
- There is no definitive recommendation on whether pulse oximeters systematically overestimate oxygen saturation in patients with darker skin tones and the impact on clinical outcomes. [17-24] – Evidence Lacking (Recommendation adopted from TCH Bronchiolitis Guideline)
  Remarks: Recent studies concluded that overestimation of saturation by pulse oximetry may be associated with darker skin tones[23]; however, there is a paucity of pediatric evidence on the clinical impact of this occurrence. The studies reviewed for this topic have significant limitations due to the methodological procedures. There is ongoing research at Texas Children's Hospital to explore this topic. Guidelines will be updated as new research is published.

Table 1: Exacerbation Severity Assessment Tool- Clinical Respiratory Score (CRS)

Clinical Respiratory Score (CRS)			
Assess	**Score 0**	**Score 1**	**Score 2**
Respiratory Rate	< 2 mos: < 50 2-12 mos: < 40 1-5 yrs: < 30 > 5 yrs: < 20	< 2 mos: 50-60 2-12 mos: 40-50 > 1-5 yrs: 30-40 > 5 yrs: 20-30	< 2 mos: > 60 2-12 mos: > 50 > 1-5 yrs: > 40 > 5 yrs: > 30
Auscultation	Good air movement, scattered expiratory wheezing, loose rales/crackles	Depressed air movement, inspiratory and expiratory wheezes or rales/crackles	Diminished or absent breath sounds, severe wheezing, or rales/crackles, or marked prolonged expiration
Use of Accessory Muscles	Mild to no use of accessory muscles, mild to no retractions, no nasal flaring on inspiration	Moderate intercostal retractions, mild to moderate use of accessory muscles, nasal flaring	Severe intercostal and substernal retractions, nasal flaring
Mental Status	Normal to mildly irritable	Irritable, agitated, restless.	Lethargic
Room Air SpO_2	> 95%	90-95%	< 90%
Color	Normal	Pale to normal	Cyanotic, dusky

(Add score from all rows to calculate total CRS)

Table 2: RAM Cannula Guide

Infant Cannula Size/Color	Maximum Liter Flow	Minimum Liter Flow
Blue (M)	20 LPM	No minimum flow
Orange (L)	20 LPM	No minimum flow

Pediatric Cannulas Color/Size	Maximum Liter Flow	Minimum Liter Flow
Yellow (S-Pedi)	35 LPM	No minimum flow
Teal (M-Pedi)	35 LPM	No minimum flow
Purple (L-Pedi)	35 LPM	No minimum flow

Goals and Outcome Measures

Process

- Rapid Response Team activation for reintubation

Outcome

- Therapy failure
- Length of stay

References

1. Arora, B., Mahajan, P., Zidan, M. A., & Sethuraman, U. (2012). Nasopharyngeal airway pressures in bronchiolitis patients treated with high-flow nasal cannula oxygen therapy. *Pediatric Emergency Care, 28*(11), 1179-1184.
2. Beggs, S., Wong, Z. H., Kaul, S., Ogden, K. J., & Walters, J. A. (2014). High-flow nasal cannula therapy for infants with bronchiolitis. *Cochrane Database of Systematic Reviews, 1*, CD009609.
3. Bressan, S., Balzani, M., Krauss, B., Pettenazzo, A., Zanconato, S., & Baraldi, E. (2013). High-flow nasal cannula oxygen for bronchiolitis in a pediatric ward: a pilot study. *European Journal of Pediatrics, 172*(12), 1649-1656.
4. Hilliard, T. N., Archer, N., Laura, H., Heraghty, J., Cottis, H., Mills, K., et al. (2012). Pilot study of vapotherm oxygen delivery in moderately severe bronchiolitis. *Archives of Disease in Childhood, 97*(2), 182-183.
5. Hough, J. L., Pham, T. M., & Schibler, A. (2014). Physiologic effect of high-flow nasal cannula in infants with bronchiolitis. *Pediatric Critical Care Medicine, 15*(5), e214-219.
6. McKiernan, C., Chua, L. C., Visintainer, P. F., & Allen, H. (2010). High flow nasal cannulae therapy in infants with bronchiolitis. *Journal of Pediatrics, 156*(4), 634-638.
7. Metge, P., Grimaldi, C., Hassid, S., Thomachot, L., Loundou, A., Martin, C., et al. (2014). Comparison of a high-flow humidified nasal cannula to nasal continuous positive airway pressure in children with acute bronchiolitis: Experience in a pediatric intensive care unit. *European Journal of Pediatrics, 173*(7), 953-958.
8. Milesi, C., Baleine, J., Matecki, S., Durand, S., Combes, C., Novais, A. R. et al. (2013). Is treatment with a high flow nasal cannula effective in acute viral bronchiolitis? A physiologic study. *Intensive Care Medicine, 39*(6), 1088-1094.
9. Rubin, S., Ghuman, A., Deakers, T., Khemani, R., Ross, P., & Newth, C. J. (2014). Effort of breathing in children receiving high-flow nasal cannula. *Pediatric Critical Care Medicine, 15*(1), 1-6.
10. Schibler, A., Pham, T. M., Dunster, K. R., Foster, K., Barlow, A., Gibbons, K., et al. (2011). Reduced intubation rates for infants after introduction of high-flow nasal prong oxygen delivery. *Intensive Care Medicine, 37*(5), 847-852.
11. Spentzas, T., Minarik, M., Patters, A. B., Vinson, B., & Stidham, G. (2009). Children with respiratory distress treated with high-flow nasal cannula. *Journal of Intensive Care Medicine, 24*(5), 323-328.
12. Wing, R., James, C., Maranda, L. S., & Armsby, C. C. (2012). Use of high-flow nasal cannula support in the emergency department reduces the need for intubation in pediatric acute respiratory insufficiency. *Pediatric Emergency Care, 28*(11), 1117-1123.
13. Abboud, P. A., Roth, P. J., Skiles, C. L., Stolfi, A., & Rowin, M. E. (2012). Predictors of failure in infants with viral bronchiolitis treated with high-flow, high-humidity nasal cannula therapy*. *Pediatric Critical Care Medicine, 13*(6), e343-349.
14. Kelly, G. S., Simon, H. K., & Sturm, J. J. (2013). High-flow nasal cannula use in children with respiratory distress in the emergency department: predicting the need for subsequent intubation. *Pediatric Emergency Care, 29*(8), 888-892.
15. Mayfield, S., Bogossian, F., O'Malley, L., & Schibler, A. (2014). High-flow nasal cannula oxygen therapy for infants with bronchiolitis: Pilot study. *Journal of Paediatrics and Child Health, 50*(5), 373-378.
16. Wraight, T. I., & Ganu, S. S. (2015). High-flow nasal cannula use in a paediatric intensive care unit over 3 years. *Critical Care & Resuscitation, 17*(3), 197-201.
17. Andrist, E., Nuppnau, M., Barbaro, R., Valley, T., & Sjoding, M. (2022). Association of race with pulse oximetry accuracy in hospitalized children. *JAMA Open Network, 5*(3), e224584.
18. Coghill, M., Law, M., Webb, L., Asfari, A., & Borasino, S. (2025). Race and the inaccuracy of pulse oximetry with hypoxemia in a pediatric cardiac ICU. *Critical Care Explorations, 7*(4), e1237.
19. Foglia, E., Whyte, R., Chaudhary, A., Mott, A., Chen, J., Propert, K., & Schmidt, B. (2017). The effect of skin pigmentation on the accuracy of pulse oximetry in infants with hypoxemia. *Journal of Pediatrics, 182*, 375-377.
20. Jones, G., Wiegand, M., Ray, S., Gould, D., Agbeko, R., Giallongo, E., et al. (2024). Fraction of inspired oxygen, and clinical outcomes: A Post-hoc analysis of the Oxy-PICU trial of conservative oxygenation. *Pediatric Critical Care, 25*(10), 912-917.
21. Ruppel, H., Makeneni, S., Faerber, J., Lane-Fall, M., Foglia, E., O'Byrne, M., & Bonafide, C. (2023). Evaluating the accuracy of pulse oximetry in children according to race. *JAMA Pediatrics, 177*(5), 540-543.
22. Savorgnan, F., Hassan, A., Borges, N., & Acosta, S. (2023). Pulse oximetry and arterial saturation difference in pediatric COVID-19 patients: Retrospective analysis by race. *Pediatric Critical Care, 24*(6), 458-462.
23. Starnes, J., Welch, W., Henderson, C., Hudson, S., Risney, S., Nicholson, G., et al. (2025). Pulse oximetry and skin tone in children. *The New England Journal of Medicine, 392*(10), 1033-1034.
24. Vesoulis, Z., Tims, A., Lodhi, H., Lalos, N., & Whitehead, H. (2022). Racial discrepancy in pulse oximeter accuracy in preterm infants. *Journal of Perinatology, 42*, 79-85.

Clinical Standards Preparation

This clinical standard was prepared by the Evidence-Based Outcomes Center (EBOC) team in collaboration with content experts at Texas Children's Hospital. Development of this clinical standard supports the TCH Quality and Patient Safety Program initiative to promote clinical standards and outcomes that build a culture of quality and safety within the organization.

HFNC Therapy Content Expert Team

Darlene Acorda, RN, CNS, Pediatric Intensive Care Unit
Brian Bassham, MD, Emergency Center
Dexter Buelow, RT
Danny Castro, MD, Critical Care
Jamie Causey, MD, Critical Care
Charlene Davis, RN, CNS, Emergency Center
Mindy Fein, MD, Emergency Center
Bryan Greenfield, MD, Emergency Center
Suzanne Iniguez, RT
Jamie Jump, MD, Critical Care
Sarah Meskill, MD, Emergency Center
Brent Mothner, MD, Pediatric Hospital Medicine
Vipul Parikh, MD, Pediatric Hospital Medicine
Angela Stutts, RN, CNS, Pediatric Intensive Care Unit
Cheryl Trumble-Wilkins, RN, CNS, Acute Care
Jenny Werdenberg, MD, Pediatric Hospital Medicine
Elizabeth Wuestner, RN, CNS, Emergency Center
EBOC Team

Development Process

This clinical standard was developed using the process outlined in the EBOC Manual. The literature appraisal documents the following steps:

1. Review Preparation
   - PICO questions established
   - Evidence search confirmed with content experts
2. Review of Existing Internal and External Guidelines
   - N/A
3. Literature Review of Relevant Evidence
   - Searched: Cochrane, PubMed, Google
4. Critically Analyze the Evidence
   - 1 randomized controlled trial and 14 nonrandomized studies
5. Summarize the Evidence
   - Materials used in the development of the clinical standard, literature appraisal, and any order sets are maintained in a HFNC Therapy evidence-based review manual within EBOC.

Evaluating the Quality of the Evidence

Published clinical guidelines were evaluated for this review using the **AGREE II** criteria. The summary of these guidelines are included in the literature appraisal. AGREE II criteria evaluate Guideline Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity and Presentation, Applicability, and Editorial Independence using a 4-point Likert scale. The higher the score, the more comprehensive the guideline.

This clinical standard specifically summarizes the evidence *in support of* or *against* specific interventions and identifies where evidence is *lacking/inconclusive*. The following categories describe how research findings provide support for treatment interventions.

"Evidence Supports" provides evidence to support an intervention
"Evidence Against" provides evidence against an intervention.
"Evidence Lacking/Inconclusive" indicates there is insufficient evidence to support or refute an intervention and no conclusion can be drawn *from the evidence.*

The **GRADE** criteria were utilized to evaluate the body of evidence used to make practice recommendations. The table below defines how the quality of the evidence is rated and how a strong versus weak recommendation is established. The literature appraisal reflects the critical points of evidence.

Recommendation	
STRONG	Desirable effects clearly outweigh undesirable effects or vice versa
WEAK	Desirable effects closely balanced with undesirable effects
Quality	**Type of Evidence**
High	Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies
Moderate	Evidence from RCTs with important limitations (e.g., inconsistent results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies
Low	Evidence for at least 1 critical outcome from observational studies, RCTs with serious flaws or indirect evidence
Very Low	Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence

Recommendations

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The Content Expert Team and EBOC team remain aware of the controversies in the initiation and escalation of HFNC therapy in children. When evidence is lacking, options in care are provided in the clinical standard and the accompanying order sets (if applicable).

Approval Process

Clinical standards are reviewed and approved by hospital committees as deemed appropriate for its intended use. Clinical standards are reviewed as necessary within EBOC at Texas Children's Hospital. Content Expert Teams are involved with every review and update.

Disclaimer

Practice recommendations are based upon the evidence available at the time the clinical standard was developed. Clinical standards (guidelines, summaries, or pathways) do not set out the standard of care and are not intended to be used to dictate a course of care. Each physician/practitioner should use his or her independent judgment in the management of any specific patient and is responsible, in consultation with the patient and/or the patient's family, to make the ultimate judgment regarding care.

Permission of Use

Version History

Date	Comments
Sep 2016	Originally completed
Jan 2018	Changed CRS cutoff for HFNC therapy, removed hypertonic saline, and added Woodlands Acute Care to the table on pg. 2
Feb 2023	Pathway and algorithm updated
Mar 2025	RAM Cannula Changes
July 2025	Revision – Adopted recommendation from the Bronchiolitis Guideline on pulse oximetry accuracy added.
Dec 2025	Pulse Oximetry Targets Revised for Bronchiolitis Patients