Office of Evidence Based Practice (EBP) – Critically Appraised Topic: High Flow Nasal Cannula for Bronchiolitis Final 2018

Specific Care Question:
>   For the child with bronchiolitis (> 2 months and < 24 months of age) is high flow nasal cannula (HFNC) therapy as efficacious as conventional respiratory therapy?

Question Originator:
>   Kathleen Berg, MD and Amanda Nedved, MD- Bronchiolitis Clinical Practice Guideline Team Leaders

Literature Summary:

Background

The primary treatment for children admitted with bronchiolitis continues to be providing supplemental oxygen, suctioning to remove secretions, and encouraging feedings (Ralston et al., 2014). Conventionally, low-flow nasal prongs are the method used to deliver supplemental oxygen patients with bronchiolitis. High flow nasal cannula allows the delivery of a heated, humidified air/oxygen blend at higher flows, which may improve ventilation. High flow rates of > 1 L/min to 5 L/min for infants and up to 15 L/min in older children can be administered (Riese, Fierce, Riese, & Alverson, 2015). The High Flow Nasal Cannula Administration Policy became effective at Children's Mercy Adele Hall Campus on April 2016 (Children's Mercy Hospital, 2017). At Children's Mercy, the goals of HFNC therapy are (a) stabilization of FiO2 requirement with an increase in PaO2 or SpO2 levels, (b) maintain adequate minute ventilation (VE) with acceptable PaCO2 levels, (c) reduce the work of breathing, (d) improve lung volume and lungs appearance on chest x-ray, and (e) improve patient comfort.

Study characteristics

The search for suitable studies was completed on November 2017. Jeff Michael, DO reviewed the 100 titles and abstracts found in the search and identified 11 articles believed to answer the question. After an in-depth review 4 articles answered the question. Two of the articles were included in a previous review on this topic, and two are new. Kepreotes et al. (2017), a randomized control trial (RCT), along with Bressan et al. (2013), a prospective observational pilot study, are added to this synthesis. Since there is only one RCT, Kepreotes et al. (2017), a meta-analysis was not performed. Bressnan et al (2013 is a prospective cohort study. Other papers include a non-blinded pilot study (Hilliard et al., 2012), and cohort studies, and one retrospective (Riese et al., 2012).

Key results

Overall the quality of evidence is very low. With the addition of the new articles, there continues to be insufficient evidence to determine the effectiveness of HFNC for the treatment of bronchiolitis in children < 2 years of age. This concurs with the recommendations from the AAP (Ralston et al., 2014), the Canadian Pediatric Society (Friedman et al., 2014), and the National Institute for Health and Care Excellence, Guidelines (NICE, 2015). Further research on the efficacy of HFNC, either in the PICU or on an inpatient unit is likely to have important influence on our confidence in making a recommendation.

Summary by Outcome

Treatment Failure. Kepreotes et al., (2017) reported significantly lower odds *OR* = 0.33, *p* = .002, 95% CI [0.16,0.67] of treatment failures (critically abnormal observations that fell within the red zone on age-appropriate Standard Pediatric Observation Charts for heart rate, respiratory rate, SpO2 (<90%), or respiratory distress score (severe) while on maximum therapy) when treated with HFNC.

Escalation of care. Three studies reported on escalation of care, defined as either transfer to the PICU, or provision of mechanical ventilation. Kepreotes et al. (2017), reported no difference in the odds of being transferred to the PICU, *OR* = 1.19, *p* = .67, 95% CI [0.52, 2.73]. Likewise, Bressan et al. (2013) reported no transfers to the PICU. Riese, Fierce, Riese, and Alverson (2015) reported no difference in number of patients intubated or transferred back to the PICU after the implementation of a protocol to administer HFNC on the general pediatric floors. The latter two studies are non-randomized studies.

Length of stay. Riese et al. (2015) reported significantly, *p* < .001, shorter median length of stay and median total hospital charges. However, (Hilliard et al., 2012; Kepreotes et al., 2017) report no difference in the length of stay for those treated with HFNC and those treated with standard therapy for bronchiolitis.

Search Strategy and Results (see PRISMA diagram):

Searches performed on Nov 17, 2017
PubMed- Search: ("Respiratory Syncytial Virus Infections/therapy"[Mesh] OR "Bronchiolitis/therapy"[Mesh] OR "bronchiolitis") AND (HFNC[tiab] OR "high-flow nasal cannula" OR "high flow nasal cannula" OR (("Cannula"[Mesh] OR "nasal cannula" OR "nasal cannulae") AND "Oxygen Inhalation Therapy"[Mesh])) AND (infant OR child OR children OR childhood OR paediatr* OR pediatr*) Filters: From 2013/01/01 to 2017/12/31 70 results

CINAHL: (MH "Bronchiolitis+/TH") OR "bronchiolitis" OR (MH "Respiratory Syncytial Virus Infections/TH") AND (MH "Nasal Cannula") OR "nasal cannula" OR "nasal cannulae" AND (MH "Oxygen Therapy+") OR (MH "Oxygen Therapy Care (Saba CCC)") "HFNC" OR "high-flow nasal cannula" OR "high flow nasal cannula" 30 results
Total number and question originator: Bronchiolitis CPG Team

Studies included in this review:
    From previous CAT:
        Hilliard et al. (2012)
        Riese et al. (2015)

    New evidence added to update this CAT:
        Bressan et al. (2013)
        Kepreotes (2017)

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Studies _not_ included in this review with exclusion rationale:

Authors, Year	Reason for exclusion
Beggs et al. (2014)	Systematic review that only includes Hilliard et al. (2012)
Chowdhury (2013)	Does not answer the question
Franklin (2015)	Protocol
Gomes (2016)	Does not answer the question
Kelly (2013)	Does not answer the question
Mayfield (2017)	Case Control study
Milesi (2013)	All subjects treated in the PICU
Seliem (2017)	Does not answer the question

Method Used for Appraisal and Synthesis:

The Cochrane Collaborative computer program, Review Manager (Higgins & Green, 2011)[a] was used to synthesize the four included studies. GRADEpro GDT (Guideline Development Tool) is the tool used to create the Summary of Findings Tables for this analysis.

[a]Higgins, J. P. T., & Green, S. e. (2011). *Cochrane Handbook for Systematic Reviews of Interventions [updated March 2011]* (Version 5.1.0 ed.): The Cohcrane Collaboration, 2011.

EBP Scholar's responsible for analyzing the literature:
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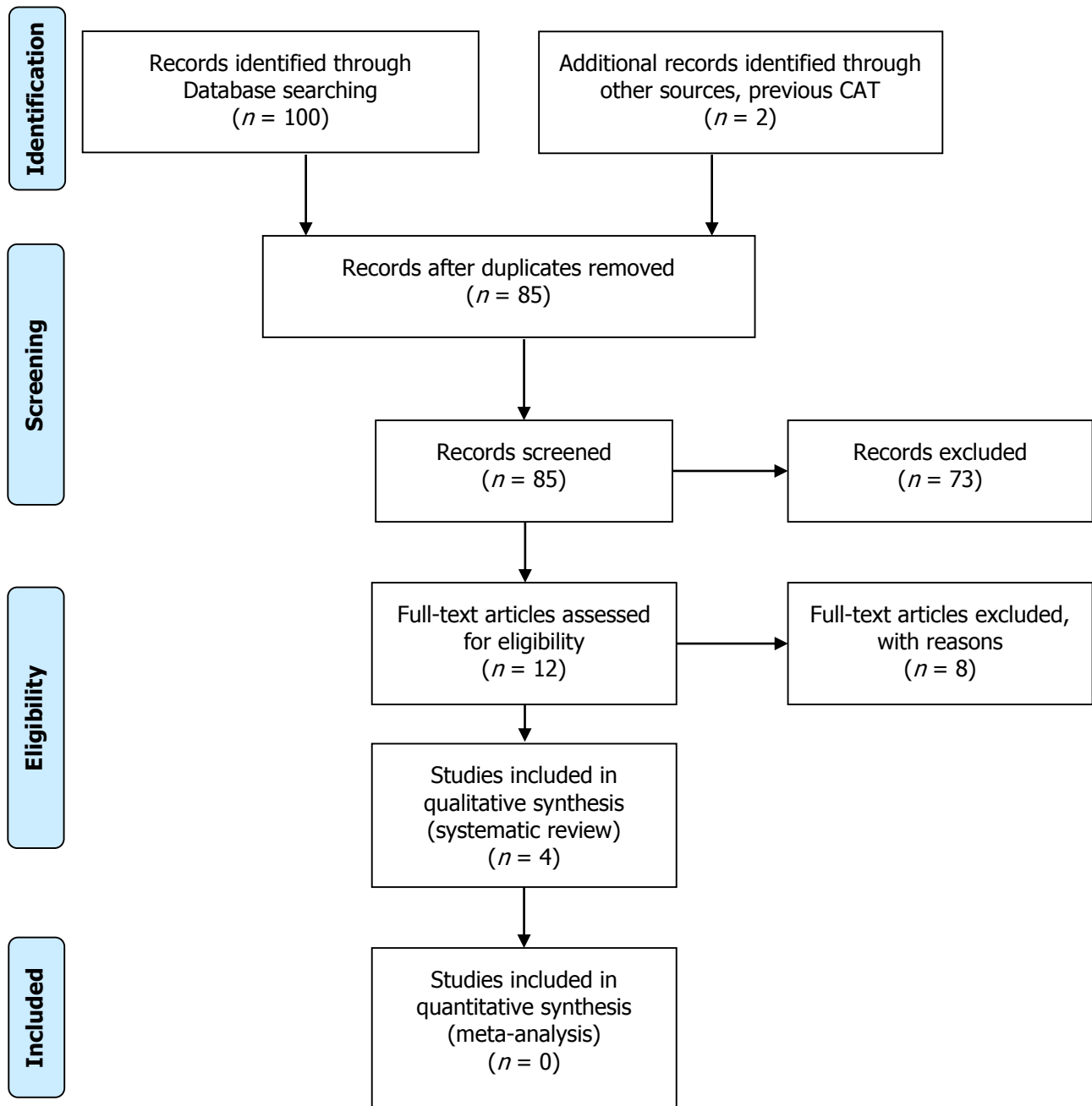   Nancy H. Allen, MS, MLS, RD, LD

Date Developed/Updated: January 2018

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Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRIMSA)[b]

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Identification

  ┌─────────────────────────┐      ┌─────────────────────────┐
  │ Records identified      │      │ Additional records      │
  │ through Database        │      │ identified through      │
  │ searching               │      │ other sources,          │
  │ (n = 100)               │      │ previous CAT (n = 2)    │
  └─────────────────────────┘      └─────────────────────────┘

Screening

  ┌──────────────────────────────────────┐
  │ Records after duplicates removed      │
  │ (n = 85)                              │
  └──────────────────────────────────────┘

  ┌─────────────────────────┐      ┌─────────────────────────┐
  │ Records screened        │─────▶│ Records excluded        │
  │ (n = 85)                │      │ (n = 73)                │
  └─────────────────────────┘      └─────────────────────────┘

Eligibility

  ┌─────────────────────────┐      ┌─────────────────────────┐
  │ Full-text articles      │─────▶│ Full-text articles      │
  │ assessed for            │      │ excluded, with reasons  │
  │ eligibility (n = 12)    │      │ (n = 8)                 │
  └─────────────────────────┘      └─────────────────────────┘

  ┌─────────────────────────┐
  │ Studies included in     │
  │ qualitative synthesis   │
  │ (systematic review)     │
  │ (n = 4)                 │
  └─────────────────────────┘

Included

  ┌─────────────────────────┐
  │ Studies included in     │
  │ quantitative synthesis  │
  │ (meta-analysis)         │
  │ (n = 0)                 │
  └─────────────────────────┘
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[b]Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097
For more information, visit www.prisma-statement.org.

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Table 1
AGREE Summary for the Ralston et al. (2014) AAP Guideline for Bronchiolitis.

Domain	Percent Agreement
1 - SCOPE AND PURPOSE	100%
2 - STAKEHOLDER INVOLVEMENT	87%
3 - RIGOR OF DEVELOPMENT	96%
4 - CLARITY AND PRESENTATION	87%
5 - APPLICABILITY	53%
6 - EDITORIAL INDEPENDENCE	96%
Overall Guideline Assessment	90%

Note: Three EBP Scholars completed the AGREE II on this guideline.

ᶜAGREE II is an international instrument* used to assess the quality and reporting of clinical practice guidelines.

A quality score is calculated for each of the six AGREE II domains (scope and purpose; stakeholder involvement; rigor of development; clarity of presentation; applicability; editorial independence). A higher domain percent reflects a stronger agreement that the guideline met the domain criteria. The AGREE II quality score does not judge the evidence used or the strength of the recommendations made by the guideline, only the process used to develop the guideline (Brouwers, et al., 2010).

*Brouwers, M.C. et al. for the AGREE Next Steps Consortium. (2010) AGREE II: Advancing guideline development, reporting and evaluation in healthcare. *Canadian Medical Association Journal, 182*, E839-842. Retrieved from https://www.agreetrust.org/wp-content/uploads/2017/12/AGREE-II-Users-Manual-and-23-item-Instrument-2009-Update-2017.pdf

Table 2
Characteristics of Included Studies

Bressan 2013

Methods	Prospective observational pilot study
Participants	**Setting:** Italy, Pediatric tertiary care academic center, Nov 2011-April 2012 **Number in study:** *N* = 27 **Age:** Range = 7 days to 12 months, median = 1.3 months **Gender, male:** 51% **Inclusion Criteria:** • Subjects admitted to hospital (General Pediatric Ward) • First episode of moderate-severe bronchiolitis (Wang score > 5 = moderate, >10 = severe) • Requiring supplemental O2 • Received HFNC O2 therapy **Exclusion Criteria:** • Recurrent wheezing • Underlying hemodynamically significant heart disease • Chronic lung disease • Neuromuscular disease • Oxygen therapy at home • Tracheostomy

Interventions	• Patients were treated with 3% nebulized hypertonic saline when presenting SpO2 was <= to 92%
	• Nebulized salbutamol was given if audible wheezing was present
	• In the ED, children with severe bronchiolitis were given 0.25 mg/kg nebulized epinephrine in 3% hypertonic saline and standard oxygen via nasal cannula, up to 2 liter/minute
	• HFNC was initiated on the ward as:
	   ○ Heated, humidified (3% hypertonic saline) high-flow nasal cannula (HFNC) oxygen therapy
	   ○ Flow rate 1-8 liter/minute
	   ○ FIO2 titrated to maintain SpO2>/=94%
	   ○ Flow rate weaned by 1 liter/minute q 6 hours with SpO2 >/=94 with FiO2 at 25%
	   ○ Pt weaned to standard O2 therapy once they remained stable at HFNC=2 liters/min

Outcomes	Respiration Rate (RR) Sat O2 at • t-1 hour of HFNC

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	• t+1 hours of HFNC • t+3 hours of HFNC
Notes	**Respiration Rate: median RR (absolute range)** • t-1 hour: 67 (35-90) • t=1 hour after HFNC initiation: 50 (30-80) • t=3 hour after HFNC initiation: 54 (38-75) **Oxygen saturation, Room air: % (absolute range)** • t-1 hour: 89 (82-93) **Oxygen saturation, Regular Nasal Cannula: % (absolute range)** • t-1 hour: 96 (90-99) **Oxygen saturation, HFNC: % (absolute range)** • t=1 hour after HFNC initiation: 97 (93-100) • t=3 hour after HFNC initiation: 98 (94-100) Escalation of respiratory effort was not the reason for transfer to the PICU. There was no comparison group, all patients received the HFNC intervention. Confounding factors were suctioning, provision of salbutamol, or racemic epinephrine prior to admission.

Hilliard et al., 2012

Methods	Prospective, randomized, open pilot study
Participants	**Number included:** N = 19 Gender: not reported Age: median age 3 months, range [0.3-11.3] Inclusion criteria: clinical diagnosis of moderately severe bronchiolitis Exclusion criteria: not reported Power analysis: not reported
Interventions	**Both groups:** Oxygen concentration adjusted to achieve target pulse oximeter oxygen saturation (SpO_2) of 92-96% **Treatment group:** HFNC, n = 11 Vapotherm 2000i (Vapotherm Inc., Stevensville, Maryland, USA) at 4 liters per minute with 100% oxygen and increased up to 8 liters per minute if tolerated. • Continued for at least 24 hours then flow rate decreased sequentially and switched to dry oxygen once 2 liters per minute. **Control group:** oxygen hood : n = 7

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Outcomes	Primary outcomes • SpO$_2$ at 8 hours post randomization • Length of stay, or time until ready for discharge
Notes	This is the only study included in the Beggs et al., (2014) a Cochrane SR/MA. The search strategy included records published until May 15, 2013.

Bias	Scholars' judgment	Support for judgment
Random sequence generation (selection bias)	Unclear risk	Method to generate the sequence was not described
Allocation concealment (selection bias)	High risk	Authors did not disclose
Blinding of participants and personnel (performance bias)	High risk	There was no attempt made to blind
Blinding of outcome assessment (detection bias)	High risk	There was no attempt made to blind
Incomplete outcome data (attrition bias)	Low risk	All subjects completed the study
Selective reporting (reporting bias)	Low risk	Not evident
Other bias	High risk	The weaning protocols for the two treatments were different. The HFNC protocol had a slower wean than did the head box oxygen protocol.

Kelly 2013

Methods	Retrospective Cohort review
Participants	**Participants:** All children 24 months or younger evaluated in 2 pediatric emergency departments between June 2011 and September 2012 **Setting:** Two tertiary care pediatric emergency departments **Number enrolled:** N = 498 **Number completed**: N = 306 **Gender, males (%):**

	• **Non-intubated:** n = 272 (59.6) • **Intubated:** n = 26 (61.9) **Age, years (mean):** • **Non-intubated:** n = 10.7 (6.1) • **Intubated:** n = 10.1 (6.6) **Inclusion Criteria:** • All children 24 months or younger who received HFNC within 24 hours of initial triage in the emergency department **Exclusion Criteria:** • Trauma or non-accidental trauma • Preexisting tracheostomy • DNR • Intubation occurring prior antecedent HFNC trial • Intubations occurring for reasons other than respiratory failure **Covariates Identified:** • Initial RR > 90th percentile • Initial Pco2 > 50 mm Hg • Initial PH < 7.3 • Previous intubation for respiratory failure • RSV positive • Corrected age <1 month • Diagnosis of acute bronchiolitis
Interventions	HFNC initiated in the emergency department as first therapy in children 24 months and younger within the first 24 hours of initial triage. Most started treatment in the ED or PICU; a minority started on inpatient units (location of treatment start not reported)
Outcomes	Investigate the patient characteristics that predict success or failure of HFNC in infants and young children presenting to the pediatric emergency department Therapy failure was defined as clinical deterioration in respiratory status or respiratory failure requiring intubation within 48 hours from the time of HFNC initiation. The decision to intubate was independent at the discretion of the ED or PICU physicians.
Notes	**Results**: • 690 charts of patients who received HFNC were reviewed • 498 cases met all inclusion criteria • 42 cases (8%) required intubation

	456 cases were successful with HFNC. Of these cases, the most common final diagnosis was acute bronchiolitis 192 cases were excluded from the regression model due to missing data. - Four variables were strongly associated with increased risk for intubation following HFNC trial model: - Triage RR greater than 90th percentile for age, $OR = 2.11$, $p = .047$, 95% CI [1.01, 4.43] - Initial venous PCO_2 greater than 50 mm Hg, $OR = 2.51$, $p = .037$, 95% CI [1.06, 5.98] - Initial venous PH less than 7.30, $OR = 2.53$, $p = .026$, 95% CI [1.12, 5.74] - One variable was found to be protective with respect to intubation following HFNC trial model: - Diagnosis of acute bronchiolitis $OR = 0.40$, $p = .041$, 95% CI [0.17, 0.96]

Kepreotes et al., 2017

Methods	Randomized control trial
Participants	**Setting:** Emergency department at John Hunter Hospital and medical unit of John Hunter Children's Hospital in New South Wales (NSW), Australia **Randomized into study:** $N = 202$ **Group 1:** High-flow warm humidified oxygen (HFWHO) $n = 101$ **Group 2:** Standard therapy $n = 101$ **Completed Study:** $N = 170$ **Group 1:** $n = 90$ followed up at 30 days post-discharge **Group 2:** $n = 80$ followed up at 30 days post-discharge **Gender, males:** **Group 1:** $n = 63\%$ **Group 2:** $n = 74\%$ **Age, months [median] (SD):** **Group 1:** 6 months, range [3-10 months] **Group 2:** 5 months, range [3-10 months] **Inclusion Criteria:** - Children ages less than 24 months presenting to the ED or admitted to the ward if they had a clinical diagnosis of bronchiolitis that was assessed as being of moderate severity using the NSW Health clinical practice guideline and required supplemental oxygen - Infants with chronic neonatal lung disease on home oxygen could be included, but they were weaned to their home oxygen rate rather than to room air **Exclusion Criteria:**

	• Children with mild bronchiolitis not requiring oxygen (although could be enrolled if condition deteriorated) • Children with severe or life-threatening bronchiolitis as defined by NSW Health including any of the following: witnessed apnea, severe tachypnea or bradypnea; moderate-severe grunting, cyanosis, or pallor • SpO_2 < 90% on room air or less than 92% on 2 L/minute oxygen via nasal cannula • Marked tachycardia or bradycardia; • Children admitted to the ward after ICU management • Children transferred from other facilities if they had received supplemental oxygen prior to arrival • Known diagnosis of asthma • Presence of pneumothorax or nasal trauma • Children with severe or life-threatening bronchiolitis were excluded because low-flow oxygen is not part of standard care for these patients **Power Analysis:** Total study sample size of 202 children required to provide 80% power
Interventions	• **Group 1:** High-flow warm humidified oxygen (HFWHO) delivered via age-appropriate Optiflow Junior nasal cannula and the MR850 humidifier using a maximum flow of 1 L/kg per min to a limit of 20 L/min using 1:1 air-oxygen ratio • **Group 2:** Cold wall oxygen 100% via infant nasal cannula at low-flow to a maximum of 2 L/min
Outcomes	**Primary outcome(s):** • Time to weaning off oxygen which is defined as the time from randomization to the first sustained room-air observation after oxygen, -- i.e., the first observation recorded in room air with no further need for subsequent supplemental oxygen **Secondary outcome(s)** • Length of hospital stay, baseline-adjusted heart rate and respiratory rate at 4 h and 24 h, parent-reported outcomes collected through the follow-up phone interviews **Safety outcome(s):** Time from randomization to treatment failure, proportion of serious adverse events, and transfer to ICU Treatment failure is defined as critically abnormal observations that fell within the red zone on age-appropriate Standard Pediatric Observation Charts for heart rate, respiratory rate, $SpO2$ (<90%), or respiratory distress score (severe) while on maximum therapy.
Notes	Time to oxygen weaning: • HFWHO—Median 20 hours [95% CI, 17-34] vs Standard therapy—Median 24 hours [95% CI, 18,28], p = 0.61 ○ Note the difference in hours on therapy HFNC vs Standard is 4 hours

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		- Unable to make a table because the study reported median time on therapy, not mean time on therapy - Charts were made for safety outcomes, treatment failure and PICU admission

Risk of bias table

Bias	Scholar's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomly allocated the patients using a block size of four and stratification for gestational age at birth.
Allocation concealment (selection bias)	Low risk	Concealed allocation, evidenced by group assignment kept in opaque, sealed envelopes. Children were randomly assigned according to gestational age to either standard therapy or HFWHO by a member of the research team or by the medical registrar.
Blinding of participants and personnel (performance bias)	Low risk	Masking of the allocation was not possible due to obvious visual differences between the two modes of oxygen delivery; but with the objectivity of the measured outcomes the review authors judge that the outcome is not likely to be influenced by lack of participant and personnel blinding
Blinding of outcome assessment (detection bias)	Low risk	The study did not address this outcome; but with the objectivity of the measured outcomes the review authors judge that the outcome is not likely to be influenced by lack of outcome assessor blinding
Incomplete outcome data (attrition bias)	Low risk	No missing outcome data; authors provided ITT and per protocol analysis
Selective reporting (reporting bias)	Low risk	Pre-specified outcomes are reported
Other bias	Low risk	The study appears to be free of other sources of bias.

Riese et al, 2015

Methods	Retrospective, nonrandomized, pre-intervention vs post-intervention by chart review

Participants	**Setting:** USA, large urban children's hospital
	Number Randomized: NOT randomized, but included total group size N= 290
	1. Infants <24 months of age
	2. Admitted to the PICU between April 1, 2010 and March 31, 2014
	3. Diagnosis of bronchiolitis by ICD9
	    1. 466.19 (not RSV bronchiolitis)
	    2. 466.11 (RSV bronchiolitis)

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	3. 786.03 (apnea) 4. 465.9 (acute upper respiratory infection) 5. V73.99 (unspecified viral illness) 4. *n* = 120 (24 months *prior* to protocol implementation) 5. *n* = 170 (24 months *post* protocol implementation) **Inclusion criteria:** • initially admitted to the PICU and received HFNC **Exclusion criteria:** • Greater than 24 months of age (to reduce inclusion of non-bronchiolitis acute respiratory infections) • Hospitalizations greater than 21 days (to reduce inclusion of more complex cases) • Infant's with gestation of less than 37 weeks • Specific diagnosis of chronic lung disease • Asthma • Chromosomal abnormalities • Heart disease • Neurological disease
Interventions	Application of HFNC by a prescribed HFNC protocol
Outcomes	**Primary:** • Length of stay after initiation of HFNC protocol **Secondary:** • Total hospital charges • Intubation rates • 30-day readmission
Notes	HFNC defined as a flow >2 LPM and using a heated humidification device **Intervention Outcome Measures (Median and IQR interquartile range)** Median Total LOS (days) Before: 4 (IQR 3-5) After: 3 (IQR 2-4) *p* < .001 Median Total Hospital Charges Before: $12,257 (IQR 8,365-17,226) After: $9,337 (IQR 6,882-12,624) *p* < .001

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| | Intubation (Adverse Outcome)
Before: 9/120 (7.5%)
After: 11/170 (6.5%)
p =. 73
30-d Readmission (Adverse Outcome)
Before: 11/120 (9.2%)
After: 13/170 (7.7%)
p = .64 |

References

National Institute for Health Care and Excellence (NICE), (2015). *Bronchiolitis in children: Diagnosis and management*. London: NICE.

Beggs, S., Wong, Z. H., Kaul, S., Ogden, K. J., & Walters, J. A. E. (2014). High-flow nasal cannula therapy for infants with bronchiolitis. *Cochrane Database of Systematic Reviews*(1). doi:10.1002/14651858.CD009609.pub2

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. doi:10.1007/s00431-013-2094-4

Brouwers, M., Kho, M. E., Browman, G. P., Cluzeau, F., Feder, G., Fervers, B., . . . Makarski, J. (2010). AGREE II: Advancing guideline developmkent, repoorting and evaluation in healthcare. *Can Med Assoc J., 182*, E839-842. doi:10.1503/cmaj.090449

Children's Mercy Hospital. (2017). High flow nasal cannula. Kansas City MO: Children's Mercy Hospital.

Chowdhury, M. M., McKenzie, S. A., Pearson, C. C., Carr, S., Pao, C., Shah, A. R., . . . Habibi, P. (2013). Heliox Therapy in Bronchiolitis: Phase III Multicenter Double-Blind Randomized Controlled Trial. *Pediatrics, 131*(4), 661-669. doi:10.1542/peds.2012-1317

Franklin, D., Dalziel, S., Schlapbach, L. J., Babl, F. E., Oakley, E., Craig, S. S., . . . Predict. (2015). Early high flow nasal cannula therapy in bronchiolitis, a prospective randomised control trial (protocol): A Paediatric Acute Respiratory Intervention Study (PARIS). *BMC Pediatr, 15*, 183. doi:10.1186/s12887-015-0501-x

Gomes, G. R., Calvete, F. P., Rosito, G. F., & Donadio, M. V. (2016). Rhinopharyngeal Retrograde Clearance Induces Less Respiratory Effort and Fewer Adverse Effects in Comparison With Nasopharyngeal Aspiration in Infants With Acute Viral Bronchiolitis. *Respir Care, 61*(12), 1613-1619. doi:10.4187/respcare.04685

Hilliard, T. N., Archer, N., Laura, H., Heraghty, J., Cottis, H., Mills, K., . . . Davis, P. (2012). Pilot study of vapotherm oxygen delivery in moderately severe bronchiolitis. *Archives of Disease in Childhood, 97*(2), 182-183. doi:10.1136/archdischild-2011-301151

Higgins, J. P. T., & Green, S. e. (2011). *Cochrane Handbook for Systematic Reviews of Interventions [updated March 2011]* (Version 5.1.0 ed.): The Cohcrane Collaboration, 2011.

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. doi:10.1097/PEC.0b013e31829e7f2f

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Kepreotes, E., Whitehead, B., Attia, J., Oldmeadow, C., Collison, A., Searles, A., . . . Mattes, J. (2017). High-flow warm humidified oxygen versus standard low-flow nasal cannula oxygen for moderate bronchiolitis (HFWHO RCT): an open, phase 4, randomised controlled trial. *Lancet, 389*(10072), 930-939. doi:10.1016/S0140-6736(17)30061-2

Mayfield, S., Jauncey-Cooke, J., Hough, J. L., Schibler, A., Gibbons, K., & Bogossian, F. (2014). High-flow nasal cannula therapy for respiratory support in children. *Cochrane Database of Systematic Reviews*(3). doi:10.1002/14651858.CD009850.pub2

Milesi, C., Baleine, J., Matecki, S., Durand, S., Combes, C., Novais, A. R., & Cambonie, G. (2013). Is treatment with a high flow nasal cannula effective in acute viral bronchiolitis? A physiologic study. *Intensive Care Med, 39*(6), 1088-1094. doi:10.1007/s00134-013-2879-y

Ralston, S. L., Lieberthal, A. S., Meissner, H. C., Alverson, B. K., Baley, J. E., Gadomski, A. M., . . . American Academy of, P. (2014). Clinical practice guideline: the diagnosis, management, and prevention of bronchiolitis. *Pediatrics, 134*(5), e1474-1502. doi:10.1542/peds.2014-2742

Riese, J., Fierce, J., Riese, A., & Alverson, B. (2015). Effect of a Hospital-wide High-Flow Nasal Cannula Protocol on Clinical Outcomes and Resource Utilization of Bronchiolitis Patients Admitted to the PICU. *Hospital Pediatrics*. doi:10.1542/hpeds.2014-0220

Seliem, W., & Sultan, A. M. (2017). Heliox delivered by high flow nasal cannula improves oxygenation in infants with respiratory syncytial virus acute bronchiolitis. *J Pediatr (Rio J)*. doi:10.1016/j.jped.2017.04.004

Willett, S., Allaby, M., Bailey, O., Stephenson, S., Nash, B., Thornton, J., . . . Haman, G. (2015). Bronchiolitis in children: diagnosis and management. *NICE Guideline*.

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If you have questions regarding this Specific Care Question – please contact Kathleen Berg, MD, Amanda Nedved, MD, or Jeff Michael, DO