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Original Research Article

High-flow nasal cannula versus standard oxygen therapy for acute bronchiolitis in infants: a retrospective analytical study

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ABSTRACT

Background: Acute Bronchiolitis is a highly prevalent lower respiratory tract infectious diseases among infants. Despite accounting for most hospitalizations in children under 5 years, all pharmaceutical treatments have not demonstrated clear efficacy. Thus, management is mostly by oxygen support. High-flow nasal cannula (HFNC) therapy was recently incorporated as an alternative to standard oxygen therapy (SOT). Given the conflicting results, its efficacy in the treatment of acute bronchiolitis remains unclear. Our study aimed to assess the efficacy of HFNC compared with SOT in terms of length of hospital stay, child discomfort and early discharge.

Methods: This retrospective analytical study was conducted at Ghayathi-AlDhafra hospitals, Abu Dhabi, United Arab Emirates, between January 2023 and December 2024. Data were extracted from electronic health records of infants admitted with acute bronchiolitis. All statistical analyses were performed using R version 4.4.1 in RStudio. Between-group comparisons used Fisher's exact and Mann-Whitney U tests, with multivariable linear and logistic regression models employing bootstrap confidence intervals to assess length of stay and early discharge.

Results: A total of 81 infants (HFNC: n=15; SOT: n=66) were included in the analysis. Median length of stay was significantly longer in the HFNC group compared with SOT (4 (IQR 3-5) vs 3 (IQR 2-3) days; p=0.002) and HFNC use remained independently associated with prolonged hospitalization after adjustment (β=1.31 days; 95% CI 0.41-2.18). Early discharge within 48 hours was less frequent among infants receiving HFNC (13.33% vs 37.88%), although this difference did not reach statistical significance.

Conclusions: Use of HFNC is associated with longer hospital stays, suggesting that early HFNC use does not alter the course of disease in moderate bronchiolitis. Large-scale studies with standardized protocols are needed to accurately assess the efficacy of HFNC in the treatment of bronchiolitis to identify patients who would benefit most.

Keywords: Acute bronchiolitis, SOT, HFNC, Respiratory support

INTRODUCTION

Acute bronchiolitis is a lower respiratory tract infectious disease primarily caused by the respiratory syncytial virus (RSV), which accounts for 3.2 million hospitalizations and 60,000 annual deaths in children under 5 years old.[1] It is highly prevalent among infants under 2 years old, with a peak age of onset between 2 and 6 months. Bronchiolitis is characterized by airway inflammation, edema, mucus plugging and airflow obstruction, manifesting clinically as infectious wheezing, hypoxemia and tachypnea in infants.[2] Most cases are self-limiting. Nevertheless, Bronchiolitis is the most common cause of hospitalization in infants, where 2-3% out of 150 million new cases reported worldwide every year require hospitalization.[3] Thus, it strains healthcare resources. Despite advances in medical care, it remains a main cause of death, particularly among infants

born preterm and those with underlying cardiopulmonary disease.[4] None of the pharmacological or non-pharmacological studies conducted have shown clear efficacy in the management of acute bronchiolitis in infants. Moreover, recent guidelines advise against the routine administration of corticosteroids, bronchodilators, antibiotics and antivirals.[5]

In this context, management is minimal. It mainly depends on maintaining hydration and nutritional support and providing oxygen support for those with hypoxemia. Oxygen support modalities include standard oxygen therapy (SOT), nasal high-flow therapy, non-invasive ventilation, continuous positive airway pressure and invasive mechanical ventilation.[6] Low-flow SOT delivered via nasal cannula or face mask has been the gold standard treatment. Nevertheless, depending on the course of the illness, SOT may be inadequate to manage symptoms, requiring invasive ventilation in case of progressive respiratory failure.[7,8]

Nasal high flow therapy is a new modality for respiratory support in which a heated and humidified oxygen-air mixture is delivered at up to 2 l/min/kg body weight through a high-flow nasal cannula (HFNC), also known as nasal prongs.

HFNC supports continuous FiO2 delivery, improves washout of the nasopharyngeal dead space, decreases inspiratory resistance, reduces energy use by fully conditioning the inspired air, increases airway compliance, reduces bronchoconstriction and improves hydration of the airway mucosa, thereby improving mucociliary clearance.[9,10]

Lastly, it creates a small amount of positive end-expiratory pressure, between 2 and 6 cm H_2O. Being potentially beneficial, HFNC has been increasingly incorporated into paediatric wards and emergency departments as an intermediate support between SOT and CPAP. Nevertheless, HFNC costs up to 16 times more than that of SOT and requires specific training.[11] Thus, it is critical to clearly assess the treatment's efficacy to allocate health care resources more effectively.

Initial results from retrospective studies were promising. However, prospective randomized controlled trials (RCTs) comparing HFNC with either SOT or nCPAP showed conflicting results regarding HFNC's superiority over SOT. In detail, some studies report reduced treatment failure and need for escalation of care with HFNC.[12] In contrast, other trials show no significant differences in several outcomes, including ICU admission and length of stay.[13,14]

Overall, systematic reviews report variability in disease severity, settings and protocols.[15] Thus, indicating that further research is required to accurately assess the efficacy of HFNC and thereby provide insight into the optimal approach to managing acute bronchiolitis in infants. This retrospective study aimed to compare HFNC with SOT in infants hospitalized with acute bronchiolitis, regarding clinical outcomes, including length of hospital stay, child discomfort and hospital discharge. It also seeks to assess the associations between treatment modalities and such clinical outcomes, identifying potential predictors of treatment outcomes.

METHODS

Study design and settings

This study employed a retrospective analytical design. The study was carried out at Ghayathi-AlDhafra hospitals, Abu Dhabi, United Arab Emirates between Jan 2023-Dec 2024.

All data were extracted from patient medical records and maintained with data confidentiality, security, and safety. All eligible patient medical records within the study period were reviewed. The study followed the STROBE guidelines to ensure appropriate methodological and reporting standards.

Study population

Infants aged between 2 and 10 months, admitted to a clinical diagnosis of acute bronchiolitis, were included in the study. Diagnosis was based on clinical features of a viral lower respiratory tract infection, which include cough, wheezing, tachypnea and increased work of breathing, following an upper respiratory prodrome.

Infants with preterm birth, congenital heart disease, chronic lung disease, neuromuscular disorders, immunocompromised status, or requirement for immediate ventilatory support at admission were excluded from the study, as these conditions are known to influence disease severity and outcomes. Patients with incomplete data were also not included.

Sampling method

A non-probability convenience sampling technique was used in this retrospective analytical study. Medical records of infants admitted with a diagnosis of acute bronchiolitis during the study period were retrospectively reviewed. All eligible infants who received either HFNC therapy or SOT and had complete clinical data were included in the analysis.

Data sources and data collection procedures

The required data was extracted using a standardized data extraction sheet. The study variables included in the data collection were selected based on a literature review and the availability of data.

Clinical and demographic data included the following variables: age, gender, baseline clinical characteristics,

oxygen therapy modality, caregiver-reported outcomes, child discomfort, length of hospital stay, discharge timing and need for escalation of care. Early discharge was defined as discharge within 48 hours of admission.

Statistical analysis

All statistical analyses were performed using R version 4.4.1 in RStudio. Descriptive statistics were generated for all variables, with categorical data presented as frequencies and percentages, while continuous variables were expressed as medians with interquartile ranges. The Kolmogorov–Smirnov test was used to assess the normality of the data.

The Fisher's exact test was used to examine the association between two categorical variables. The primary outcome, length of stay (LOS), was compared using Mann Whitney U test, with effect size reported as Cohen's D, and further evaluated using multivariable linear regression adjusting for age, gender.

Secondary outcomes, early discharge (≤48 hours) was compared using Fisher exact tests and effect sizes (odds ratios and Cramér's V), with logistic regression used for multivariable adjustment including the same covariates.

Bootstrapping techniques were applied to regression models to provide more reliable confidence intervals. Odds ratio and 95% confidence interval were reported. A p value of <0.05 was considered statistically significant. Additional sensitivity analyses were conducted to ensure robustness of findings.

Ethical approval

Ethical approval for this study was obtained from the AlDhafra Hospitals Research Ethics Committee (Approval No: ADH REC 040925, dated 10 October 2025). Institutional details are blinded within the manuscript for peer review.

RESULTS

Study population

A total of 81 infants with bronchiolitis were included in the analysis (HFNC n=15; SOT n=66). The majority were male (74.1%) and all were term infants with clinical features of bronchiolitis at presentation. None had a history of preterm birth, congenital heart disease, chronic lung or neuromuscular disease, immunocompromised status or required immediate invasive ventilation on admission. All infants had an initial oxygen saturation below 92% and demonstrated clinical improvement with oxygen therapy. Because these characteristics showed no variability across the cohort, they were not included in comparative or multivariable analyses. Baseline demographic and clinical characteristics are presented in Table 1.

Table 1: Baseline characteristics of the study population (n=81).

Variables	Category	Frequency (%)
Gender	Female	21 (25.93)
	Male	60 (74.07)
Preterm	No	81 (100)
Congenital heart disease	No	81 (100)
Chronic lung/neuromuscular disorder	No	81 (100)
Immunocompromised	No	81 (100)
Immediate ventilation needed at admission	No	81 (100)
Bronchiolitis features	Yes	81 (100)
O_2 saturation <92%	Yes	81 (100)
Initial oxygen therapy (HFNC/SOT)	SOT	66 (81.48)
	HFNC	15 (18.52)
Caregiver aware of oxygen therapy	Yes	81 (100)
Caregiver concern level (mild/moderate/severe)	Mild	66 (81.48)
	Moderate	15 (18.52)
Improved with oxygen therapy	Yes	81 (100)
Satisfaction with oxygen method	Satisfied	81 (100)
Child discomfort	No	66 (81.48)
	Yes	15 (18.52)
Clear communication from staff	Yes	14 (17.28)
Caregiver confident post-discharge	Yes	14 (17.28)
Discharged within 48 h	No	54 (66.67)
	Yes	27 (33.33)
Transferred to ICU	No	81 (100)

HFNC: High-flow nasal cannula; SOT: Standard oxygen therapy; ICU: Intensive care unit.

Table 2: Comparison of outcomes between SOT and HFNC groups.

		Therapy		P value
		SOT	HFNC	
Gender	Female	16 (24.24)	5 (33.33)	0.520
	Male	50 (75.76)	10 (66.67)	
Child discomfort	No	66 (100)	0 (0.00)	<0.001
	Yes	0 (0.00)	15 (100)	
Discharged within 48 h	No	41 (62.12)	13 (86.67)	0.069
	Yes	25 (37.88)	2 (13.33)	
Length of hospital stay, days, median (IQR)		3 (2-3)	4 (3-5)	0.002*
Age, median (IQR)		6 (3.75-8)	7 (2-10)	0.502

*Significant association; HFNC: High-flow nasal cannula; SOT: Standard oxygen therapy; IQR: Inter quartile range.

Unadjusted comparisons between HFNC and SOT

There were no statistically significant differences between the SOT and HFNC groups in terms of age or gender distribution. Median LOS was significantly longer among infants treated with HFNC compared with those receiving SOT (4 (IQR 3-5) vs 3 (IQR 2-3) days; Mann–Whitney U p=0.002), corresponding to a moderate effect size (r=0.34).

Child discomfort was reported exclusively in the HFNC group (100% vs 0% in the SOT group; p<0.001). A smaller proportion of infants in the HFNC group were discharged within 48 hours compared with those in the SOT group (13.3% vs 37.9%), although this difference did not reach conventional statistical significance (p=0.069). The strength of the association between therapy type and early discharge, quantified using Cramér's V, was in the small-to-moderate range (V=0.20) (Table 2 and 3).

Table 3: Effect size estimates for unadjusted comparisons.

Outcome	Effect size	Value	Interpretation
Length of stay	R (Wilcoxon)	0.34	Moderate effect
Early discharge (≤48 h)	Cramér's V	0.20	Small–moderate association

Multivariable analyses

In the multivariable linear regression model adjusted for age and gender, initial HFNC therapy was associated with a longer LOS compared with SOT (β=1.31 days; 95% bootstrap CI 0.41-2.18; p<0.001(Table 4). Age and gender were not significantly associated with LOS in this model. The model explained approximately 12% of the variance in LOS (adjusted R^2=0.12). In the multivariable logistic regression model for early discharge (≤48 hours), HFNC therapy was associated with lower odds of early discharge compared with SOT (adjusted OR 0.25; 95% CI 0.04-1.01; p=0.085), although this association did not meet the predefined threshold for statistical significance. Age was not significantly associated with early discharge (adjusted OR 1.01; 95% CI 0.86-1.18; p=0.918) (Table 4 and 5).

Table 4: Multivariable linear regression for length of hospital stays.

Predictor	B (days)	95% CI (Bootstrap)	P value
HFNC vs SOT	1.31	0.41-2.18	<0.001*
Age	−0.01	−0.10-0.08	0.770
Gender	0.11	−0.54-0.77	0.740

Adjusted R^2=0.12; Bootstrap replications=2000; *significant p value; CI: Confidence interval.

Table 5: Multivariable logistic regression for early discharge (≤48 h).

Predictor	Adjusted OR	95% CI	P value
HFNC vs SOT	0.25	0.04-1.01	0.085
Age	1.01	0.86-1.18	0.918

Model fit: AIC=105.3; Nagelkerke R^2≈0.22; HFNC: High-flow nasal cannula; SOT: Standard oxygen therapy sensitivity analyses.

Table 6: Sensitivity analyses results.

Analysis	Result
Mann–Whitney U (LOS)	P=0.0019
Fisher's exact (early discharge)	P=0.078
Bootstrap LOS CI	Robust positive association

LOS: Length of stay; CI: Confidence interval.

Sensitivity analyses supported the robustness of the main findings. The Mann-Whitney U test for LOS remained statistically significant (p=0.0019) and Fisher's exact test for early discharge yielded a similar p value (p=0.078) compared with the primary analysis. Bootstrap confidence intervals for the association between HFNC therapy and LOS consistently indicated a positive

association, supporting the stability of the observed longer hospital stay among infants treated with HFNC (Table 6).

DISCUSSION

Given that bronchiolitis remains a leading cause of hospitalization among infants worldwide, optimizing respiratory support strategies is essential for both patient outcomes and healthcare resource allocation. In the context of previous literature, some studies have presented HFNC as a promising non-invasive modality that reduces the work of breathing and improves gas exchange. Nevertheless, accumulating evidence indicates that it fails as a first-line therapy but has marked efficacy in patients who fail SOT. Owing to these conflicting findings, this retrospective study analysed the efficacy of HFNC compared with SOT in the treatment of infants hospitalized with acute bronchiolitis. The main outcome measures included the length of hospital stay, child discomfort, and early discharge.

Comparative Analysis demonstrated that HFNC is not superior to SOT in the treatment of acute bronchiolitis among infants. In detail, HFNC increased child discomfort and was not associated with early discharge, resulting in a longer hospital stay than with SOT. Regarding baseline characteristics, the study cohort was homogeneous, with full-term infants who did not require immediate ventilation at presentation and had no significant comorbidities. Thus, the observed differences are more likely to be related to treatment. Oxygen therapy was clinically indicated in all cases, owing to the presentation of hypoxemia. Moreover, cases were mostly mild to moderate and did not require ICU transfer. In such patients, supportive care alone is often sufficient, which may explain the limited benefit observed with HFNC.

In terms of outcomes, infants who received HFNC had higher rates of discomfort and reported a significantly longer hospital stay. No statistically significant difference was reported in early discharge. Consistent with multicentre studies, including a multicentre randomized controlled trial by Franklin et al involving 1,472 infants with bronchiolitis, there was no difference in hospital stay between children initially treated with HFNC and those who received SOT.[16] Similarly, Kepreotes et al reported no reduction in length of hospital stay or disease course with HFNC in a single-centre randomized trial.[11]

Results were also supported by a recent quasi-experimental analysis by Antilici et al, consistent with Hilliard et al who earlier reported no significant difference between the two modalities in treatment failure rates and length of hospital stay.[12,17] In defiance of HFNC, Alexander et al reported that despite having a slightly higher risk of treatment failure, particularly in severe bronchiolitis, HFNC shows no significant difference in patient outcomes.[18] Thus, it is clinically effective and safe to use in cases of bronchiolitis with different severities. For instance, HFNC has been reported to improve child tolerance and reduce adverse outcomes. He further demonstrated that HFNC is more readily available in community hospitals. Thus, it serves as a better first-line option than SOT. In contrast, shorter stays and a lower risk of treatment failure associated with HFNC were also reported by Lou et al.[19]

Similarly, Eşki et al reported lower treatment failure rates associated with HFNC, with no statistically significant difference in length of stay compared to SOT.[20] In this context, it was reported to be safe and to reduce the escalation of care and improve time to stability compared with SOT. Nevertheless, it demonstrated better efficacy in moderate bronchiolitis and requires standardized flow titration and time to wean off. Collectively, a systematic review by Moreel et al demonstrated the safety of HFNC as an alternative therapy for children not adequately supported by SOT.[15] However, it does not seem to shorten the duration of oxygen therapy or hospital admission.

These contradicting findings can be attributed to differences in disease severity, timing of initiation, and institutional practices. Heterogeneity in HFNC protocols, including variations in oxygen flow rates, limits comparability and may influence outcomes. The significantly longer hospital stay observed in the HFNC group might be confounded by clinical decision-making. In this context, clinicians may prefer to use HFNC for cases that appear clinically severe, regardless of similar measured characteristics.

Moreover, HFNC therapy requires close monitoring and time to wean off, which may delay discharge. Device-related discomfort, reported exclusively in the HFNC group, may also affect feeding and sleep patterns, which further prolongs the recovery period. Effect size analysis revealed a moderate association between HFNC use and longer hospital stay and a small-to-moderate association with early discharge. These findings indicate that respiratory support modalities and protocols directly influence length of stay. Multivariate regression analysis confirmed that there was an independent association between HFNC therapy and prolonged hospitalization after adjusting for age and gender, neither of which significantly influenced length of stay. Logistic regression analysis revealed that HFNC was associated with lower odds of discharge within 48 hours.

Sensitivity analysis further supports the primary findings, demonstrating consistent associations between HFNC and length of hospital stay across different statistical methods. Thus, it is less likely that the results were driven by model assumptions or sampling variability.

These findings strengthen confidence in the conclusion that early HFNC use did not improve short-term clinical outcomes in this cohort. This study is limited by its

retrospective nature, which introduces potential selection bias and limits control over confounding variables such as feeding status, viral subtype, and disease severity. It is further limited by the small sample size of the HFNC group, which results in low statistical power. Thus, hindering the detection of minor improvements and the generalizability of findings. Future research should focus on multicentre RCTs based on standardized protocols. Prospective studies are also required to assess cost-effectiveness and identify patients who could benefit most from HFNC.

CONCLUSION

The use of HFNC is associated with longer hospital stays, suggesting that early use of HFNC does not alter the course of disease in moderate bronchiolitis. Given its complexity and low cost-effectiveness, it is not recommended to use HFNC as a first-line treatment in infants with mild to moderate bronchiolitis presenting with hypoxemia. Importantly, large-scale studies with standardized protocols are needed to accurately assess the efficacy of HFNC in the treatment of bronchiolitis and identify patients who would benefit most.

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