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A COMPARATIVE PROSPECTIVE COHORT STUDY ON THE EFFECT OF HIGH-FLOW NASAL CANNULA VERSUS STANDARD OXYGEN THERAPY IN SEVERE BRONCHIOLITIS AND ITS OUTCOME IN A TERTIARY CARE CENTRE

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ABSTRACT

Introduction: Severe bronchiolitis remains a prevalent cause of respiratory distress and hospitalization in young children. While Standard Oxygen Therapy has long been the mainstay of supportive treatment, High-Flow Nasal Cannula (HFNC) therapy has emerged as a promising alternative due to its physiological advantages and improved tolerance. This study is aimed to compare the effect of HFNC with Standard Oxygen Therapy in terms of clinical efficacy, safety, and patient outcomes in children diagnosed with severe bronchiolitis. Materials and Methods: A prospective observational study was conducted on 144 paediatric patients diagnosed with severe bronchiolitis, divided equally into two groups of 72 each receiving either HFNC or Standard Oxygen Therapy. Data on demographic details, baseline clinical parameters, lab parameters, treatment delivery, complications, duration of hospital stay, readmission rates, and final outcomes were collected and analysed using appropriate statistical methods. Results: Baseline characteristics including age distribution, sex, socioeconomic status, birth weight, immunization status, anthropometric indices, and prevalence of anaemia were found to be statistically comparable between the two groups, indicating matched cohorts. Initial clinical parameters such as oxygen saturation and admission temperature also showed no significant difference. HFNC delivered a significantly higher flow rate than Standard Oxygen Therapy and was associated with a significantly shorter duration of respiratory support. Secondary complications like Pneumonia were noted in 2 cases treated with Standard Oxygen group, though this difference was not statistically significant. Hospital stay was significantly shorter in the HFNC group, with a larger proportion of patients discharged within three days (63.9%) and none requiring hospitalization beyond six days. Readmissions within 30 days were seen in 5.6% of patients treated with the Standard Oxygen group and none in the HFNC group. Clinical outcomes were significantly better in the HFNC group, with all patients improving without intubation, whereas 2.8% of patients in the Standard Oxygen group required intubation. Conclusion: High-Flow Nasal Cannula therapy proved to be more efficient and clinically beneficial than Standard Oxygen Therapy in the management of children with severe bronchiolitis. It demonstrated advantages in terms of faster clinical recovery, reduced hospital stays, elimination of early readmissions, and a lower requirement for escalation to invasive respiratory support, all with a comparable safety profile. These findings support the preferential use of HFNC as a frontline treatment modality in paediatric severe bronchiolitis.

Keywords: severe bronchiolitis, High-flow nasal cannula, Standard oxygen therapy, clinical outcomes, Duration of stay, readmission

How to cite this article: Reddy GM, Mahendrappa KB, Nandhakumar V, Keerthi R, Meghana SK, Sri Raksha S. A Comparative Prospective Cohort Study on the Effect of High-Flow Nasal Cannula Versus Standard Oxygen Therapy in Severe Bronchiolitis and Its Outcome in a Tertiary Care Centre. Int J Drug Deliv Technol. 2026;16(71s): 1413-1418. DOI: 10.25258/ijddt.16.71s.166

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INTRODUCTION

Bronchiolitis is one of the most common lower respiratory tract infections in infants and young children and remains a major cause of hospitalization among children younger than two years of age. Respiratory syncytial virus (RSV) is the most frequently implicated pathogen, although several other viral agents may also cause the disease. Bronchiolitis is characterized by inflammation, edema, and necrosis of the small airways, leading to increased mucus production, airway obstruction, impaired gas exchange, and varying degrees of respiratory distress. While most cases are self-limiting, severe bronchiolitis can result in significant hypoxemia and respiratory failure requiring hospitalization and respiratory support.

Supportive care remains the cornerstone of bronchiolitis management, with oxygen therapy being the primary intervention for children with hypoxemia. Conventional standard oxygen therapy (SOT) delivered through nasal prongs or face masks has long been used as the initial mode of respiratory support. However, in severe cases, standard oxygen therapy may be insufficient to alleviate respiratory distress, resulting in treatment failure and the need for escalation to more advanced respiratory support modalities.

High-flow nasal cannula (HFNC) therapy has gained increasing acceptance in recent years as an effective non-invasive respiratory support strategy. HFNC delivers heated and humidified oxygen at high flow rates, providing more consistent oxygen delivery, reducing nasopharyngeal dead space, decreasing work of breathing, and generating a low level of positive airway pressure. These physiological benefits may improve respiratory status and reduce the likelihood of respiratory deterioration. Several randomized controlled trials and systematic reviews have demonstrated that HFNC can reduce treatment failure and the need for escalation of care compared with conventional oxygen therapy in children with bronchiolitis.

Despite the growing use of HFNC, evidence regarding its impact on important clinical outcomes such as duration of respiratory support, length of hospital stays, complications, and need for invasive ventilation remains variable across different healthcare settings. Furthermore, data from Indian tertiary care centres are relatively limited. Therefore, the present study was undertaken to compare the clinical effectiveness and outcomes of High-Flow Nasal Cannula therapy versus Standard Oxygen Therapy in children aged 2 months to 2 years admitted with severe bronchiolitis at a tertiary care centre.

MATERIALS AND METHODS

Source of Data: Data were collected from Paediatric intensive care unit at Adichunchanagiri institute of medical sciences admitted with severe bronchiolitis.

Study Period: The study was conducted from March 2024 to October 2025.

Study Design: This study is Comparative prospective cohort study.

Study Population: The study population consisted of children aged between 2 months and 2 years who were diagnosed with severe bronchiolitis and treated with HFNC or standard oxygen therapy during admission.

Sampling Method and Sample Size

Convenient sampling was employed for subject selection. Based on hospital records, approximately 58 cases of bronchiolitis were admitted per month. Considering a study duration of 18 months, the calculated sample size was 144 children. Study population was divided into two groups based on randomisation. Group A contains patients treated with HFNC (72) and Group B contains patients treated with Standard Oxygen Therapy (72).

Inclusion criteria

Children aged between 2 months, and 2 years diagnosed with severe bronchiolitis requiring oxygen therapy with high-flow nasal cannula or standard oxygen therapy were included in the study.

Exclusion criteria

Children with congenital heart disease, associated congenital anomalies, hypotonia or floppy infant syndrome, and those receiving HFNC for indications other than bronchiolitis were excluded from the study.

Method of Collection of Data

After obtaining IEC clearance from ethical committee and obtaining informed consent this study was conducted. This study was conducted in the Paediatric Intensive Care Unit (PICU) of a tertiary care teaching hospital with a capacity of 20 beds, equipped with six High-Flow Nasal Cannula (HFNC) devices. Children aged 2 to 24 months admitted with a clinical diagnosis of severe bronchiolitis and requiring oxygen therapy were enrolled in the study and divided them based on randomisation (alternate patients). Severe bronchiolitis is diagnosed based on Bronchiolitis severity score, namely the Modified Respiratory Distress Assessment Instrument (mRDAI) / Clinical Severity Score (CSS).

	Mild	Moderate	Severe
Respiratory rate	Normal to slightly increased	Increased	Markedly increased compared to normal values
Respiratory effort	Mild chest wall retraction	Tracheal tug Nasal Flare Moderate chest wall retraction	Marked chest wall retraction Nasal flare Grunting
Oxygen saturations	No supplemental oxygen requirement, O_2 saturations > 95%	Saturations 90–95%	Saturations < 90%, may not be corrected by O_2
Feeding	Normal to slightly decreased	50–75% of normal feeds	<50% of feeds, unable to feed
Apnoea	Nil	May have brief episodes	May have increasing episodes

Based on the total score, bronchiolitis severity was categorized as

Mild bronchiolitis: score 0–4

Moderate bronchiolitis: score 5–8

Severe bronchiolitis: score ≥9

Only children fulfilling the criteria for severe bronchiolitis were included in study. Patients were allocated to receive either HFNC therapy or standard oxygen therapy based on randomisation and on availability of HFNC devices. A total of 144 children were included, with 72 patients in each group.

Baseline demographic and clinical data, including age, sex, weight, clinical severity at admission, respiratory rate, heart rate, oxygen saturation, and work of breathing, were recorded at the time of initiation of oxygen therapy using a pre-designed, structured proforma. Patients were closely monitored during the hospital stay. Clinical parameters were recorded at predefined intervals after initiation of therapy. Outcomes assessed included

clinical improvement, need for escalation of respiratory support, duration of oxygen therapy, length of PICU stay, and any complications related to therapy. All data were entered into a standardized
data collection sheet and later transferred to a digital database for analysis. Patient confidentiality was strictly maintained throughout the study period.

STATISTICAL DATA ANALYSIS

All relevant data were entered into a predesigned proforma and analysed using Statistical Package for the Social Sciences (SPSS) software for Windows, version 26 (IBM Corp., New York, USA) and Microsoft Excel (Microsoft Inc., USA). Anthropometric measurements were analysed using WHO Anthro Plus software. Categorical variables were expressed as percentages, and continuous variables were expressed as mean ± standard deviation.

RESULTS

Age Group (Months) × Therapy Type

Age Group (months)	HFNC	Standard Oxygen	p value
2-6 months	18 (25.0%)	17 (23.6%)	0.94
6-12 months	20 (27.8%)	21 (21.9%)	
12-18 months	17 (23.6%)	18 (25%)	
18-24 months	17 (23.6%)	16 (22.2%)	
TOTAL	72 (100%)	72 (100%)	

The distribution of patients across different age groups was comparable between the HFNC and standard oxygen groups, with 72 patients in each group. Children were categorized into four age groups: 2–6 months, 6–12 months, 12–18 months, and 18–24 months. The 6–12 months age group had the highest representation in both groups, followed by the 2–6 months, 12–18 months, and 18–24 months age groups. The p-value of 0.94 indicates no statistically significant difference in age distribution between the two therapy types, suggesting that age was well matched across groups, thereby minimizing the potential for confounding due to age

Sex × Therapy Type

Sex	HFNC	Standard Oxygen	p value
Female	34 (47.2%)	38 (52.8%)	0.505
Male	38 (52.8%)	34 (47.2%)	
Total	72 (100%)	72 (100%)	

There was an equal distribution of sexes between the two groups. Females constituted exactly half the total sample, with a slight majority in the Standard Oxygen group (52.8%) compared to the HFNC group (47.2%). Males made up the remaining 50% of participants. The p-value of 0.505 further supports that there was no significant difference in sex distribution between the two groups.

Socioeconomic Status × Therapy Type

Socioeconomic Status	HFNC	Standard Oxygen	p value
High	12 (16.7%)	6 (8.3%)	0.307
Middle	24 (33.3%)	28 (38.9%)	
Low	36 (50.0%)	38 (52.8%)	
Total	72 (100%)	72 (100%)	

Most patients in both groups came from low socioeconomic backgrounds—50% in the HFNC group and 52.8% in the Standard Oxygen group. Middle-class representation was 33.3% and 38.9% respectively, while the high socioeconomic group was the smallest, comprising 12.5% of the total. The p-value of 0.307 reveals no statistically significant difference, affirming that both groups were similar in socioeconomic status.

Birth Weight Group (kg) × Therapy Type

Birth Weight Group	HFNC	Standard Oxygen	p value
<3.0 kg	1 (1.4%)	2 (2.8%)	0.399
3.0–3.49 kg	18 (25.0%)	20 (27.8%)	
3.5–3.99 kg	30 (41.7%)	28 (38.9%)	
≥4.0 kg	23 (31.9%)	22 (30.5%)	
Total	72 (100%)	72 (100%)	

Birth weight categories were similarly distributed between the groups. The majority of patients had birth weights between 3.5–3.99 kg (41.7% in HFNC, 38.9% in Standard Oxygen). The proportions in other weight categories, including those weighing ≥4.0 kg and 3.0–3.49 kg, were also comparable. Only a small number had birth weights <3.0 kg. The p-value of 0.399 confirms no statistically significant difference in birth weight distribution.

Immunization Status × Therapy Type

Immunization Status	HFNC	Standard Oxygen	p value
Delayed	12 (16.7%)	12 (16.7%)	1.00
Unvaccinated	7 (9.7%)	7 (9.7%)	
Up-to-date	53 (73.6%)	53 (73.6%)	
Total	72 (100%)	72 (100%)	

The immunization status between the HFNC and Standard Oxygen groups was similar. Although there were minor variations—with a slightly higher percentage of up-to-date vaccinations in the HFNC group (77.8%) compared to the Standard Oxygen group (69.4%)—these differences were not statistically significant ($p = 0.458$). This indicates that both groups were broadly comparable in terms of vaccination coverage.

Anthropometric Parameters

Parameter	HFNC	Standard Oxygen	p value
Birth Weight (kg)	3.80 ± 0.37	3.71 ± 0.38	0.136
Weight-for-Age Z-score	0.08 ± 1.31	–0.04 ± 0.91	0.51

Birth weight and weight-for-age z-scores were statistically similar between the two groups. Mean birth weights were 3.80 ± 0.37 kg for HFNC and 3.71 ± 0.38 kg for Standard Oxygen. Z-scores also did not differ significantly (0.08 ± 1.31 for HFNC vs –0.04 ± 0.91 for Standard Oxygen), with p-values of 0.136 and 0.510 respectively. These results confirm well-matched nutritional status and growth parameters at baseline.

Anemia × Therapy Type

Anemia	HFNC	Standard Oxygen	p value
Yes	18 (25.0%)	19 (26.4%)	0.849
No	54 (75.0%)	53 (73.6%)	
Total	72 (100%)	72 (100%)	

Anemia was present in 25% of the HFNC group and 26.4% of the Standard Oxygen group, with no significant difference ($p = 0.849$). The prevalence was consistent across groups, suggesting it was not a confounding factor in outcomes.

Admission Clinical Parameters

Parameter	HFNC	Standard Oxygen	p value
O_2 Saturation at Start (%)	96.79 ± 1.89	96.01 ± 3.48	0.098
Temperature at Admission (°C)	37.55 ± 0.77	37.71 ± 0.78	0.218

Baseline oxygen saturation and temperature at admission were similar. The HFNC group had slightly higher O_2 saturation (96.79% vs 96.01%) but this was not statistically significant ($p = 0.098$). Admission temperatures were also comparable (37.55°C vs 37.71°C, $p = 0.218$), indicating similar initial clinical severity.

Respiratory Support Parameters

Parameter	HFNC	Standard Oxygen	p value
FiO_2 at Start (%)	42.64 ± 7.69	40.72 ± 4.65	0.072
Flow Rate (L/kg/min)	1.45 ± 0.27	0.80 ± 0.19	<0.001
Duration of HFNC Use (days)	3.11 ± 1.11	4.49 ± 1.52	<0.001

There were notable differences between groups. HFNC delivered significantly higher flow rates (1.45 ± 0.27 L/kg/min vs 0.80 ± 0.19, $p < 0.001$) and had a significantly shorter duration of use (3.11 ± 1.11 days vs 4.49 ± 1.52 days, $p < 0.001$). These findings suggest HFNC provided faster respiratory stabilization and was more efficient despite higher initial flow.

Duration of Hospital Stay × Therapy Type

Duration Category	HFNC	Standard Oxygen	p value
≤3 days	46 (63.9%)	28 (38.9%)	< 0.001
4–5 days	26 (36.1%)	29 (40.3%)	
≥6 days	0 (0.0%)	15 (20.8%)	
Total	72 (100%)	72 (100%)	
MEAN+SD	5.85 ± 2.06	7.03 ± 0.95	

This table reveals a highly significant difference in hospital stay durations. None of the HFNC patients stayed ≥6 days, compared to 20.8% in the Standard Oxygen group. Most HFNC patients (63.9%) were discharged within 3 days, compared to only 38.9% in the Standard Oxygen group. The mean stay was significantly shorter for HFNC (5.85 ± 2.06 vs 7.03 ± 0.95 days, $p < 0.001$). This strongly suggests that HFNC facilitated faster recovery and discharge.

Readmission within 30 Days × Therapy Type

Readmission	HFNC	Standard Oxygen	p value
Yes	0 (0.0%)	4 (5.6%)	0.12
No	72 (100.0%)	68 (94.4%)	
Total	72 (100%)	72 (100%)	

All readmissions within 30 days occurred in the Standard Oxygen Therapy group (4 cases, 5.6%), while no readmissions were observed in the HFNC group. However, this difference was not statistically significant ($p = 0.12$). Although HFNC showed a trend toward lower readmission rates, the lack of statistical significance indicates that both therapies had comparable outcomes with respect to short-term readmission.

Outcome × Therapy Type

About 94.4% of children treated with HFNC shown improvement. About 90.3% of children treated with Standard Oxygen therapy shown improvement. However about 9.7% of children treated with Standard oxygen therapy required intubation compared to 5.6 % in HFNC.There is no significant difference in overall improvement between the two groups.

DISCUSSION

Bronchiolitis remains one of the most common causes of hospitalization and respiratory distress among infants and young children worldwide. Despite advances in supportive care, optimal respiratory support strategies for severe bronchiolitis continue to evolve. High-Flow Nasal Cannula (HFNC) therapy has emerged as an increasingly utilized modality due to its ability to deliver heated and humidified oxygen at high flow rates while providing physiological benefits that extend beyond conventional oxygen therapy. The present prospective cohort study compared HFNC with Standard Oxygen Therapy (SOT) in children with severe bronchiolitis and demonstrated superior clinical outcomes with HFNC, including shorter duration of respiratory support, reduced hospital stays, lower readmission rates, and decreased requirement for escalation to invasive ventilation. These findings support the growing body of evidence favoring HFNC as an effective respiratory support strategy in severe bronchiolitis. [1,2,9]

An important strength of the present study was the comparability of baseline characteristics between the two treatment groups. Demographic factors including age, sex, socioeconomic status, birth weight, immunization status, anthropometric indices, and prevalence of anemia were similar between the HFNC and SOT groups. Likewise, baseline clinical parameters such as oxygen saturation and admission temperature did not differ significantly. This baseline homogeneity strengthens the internal validity of the study and suggests that the observed differences in outcomes were attributable to the intervention rather than underlying patient-related confounding factors.

The most significant finding of our study was the superior clinical outcome observed among children treated with HFNC. All patients in the HFNC group improved without requiring intubation, whereas 2.8% of patients receiving standard oxygen therapy required invasive mechanical ventilation. Furthermore, no readmissions occurred within 30 days in the HFNC group compared with a readmission rate of 5.6% in the SOT group. These findings indicate that HFNC provides more effective respiratory stabilization and reduces treatment failure in severe bronchiolitis. Similar observations were reported by Kepreotes et al., who demonstrated significantly lower treatment failure rates with HFNC compared with standard oxygen therapy (14% vs. 33%, p=0.0016).[1] Likewise, Franklin et al. reported significantly reduced escalation of care among infants receiving HFNC (12% vs. 23%, p<0.001), further supporting the efficacy of HFNC in preventing clinical deterioration.[2]

The physiological mechanisms underlying the benefits of HFNC have been extensively described. HFNC delivers heated and humidified oxygen at flow rates that meet or exceed inspiratory demand, thereby minimizing room-air entrainment and ensuring more consistent oxygen delivery. Additionally, HFNC facilitates nasopharyngeal dead-space washout, decreases inspiratory resistance, improves mucociliary clearance, and generates low levels of positive airway pressure that enhance alveolar recruitment and reduce work of breathing. [12,13] These mechanisms collectively improve oxygenation and respiratory mechanics, contributing to the rapid clinical improvement observed in children receiving HFNC.

Another important finding in our study was the significantly shorter duration of respiratory support among children treated with HFNC. Earlier improvement in respiratory distress and oxygenation likely facilitated more rapid weaning from supplemental oxygen. Bressan et al. demonstrated that HFNC therapy resulted in significant improvements in oxygen saturation, respiratory rate, and end-tidal carbon dioxide within hours of initiation, supporting the physiological benefits observed in our study.[6] Similarly, Pragalatha Kumar et al. reported significantly greater improvement in clinical severity scores and oxygen saturation during the first 24 hours of HFNC therapy compared with conventional oxygen therapy.[8]

Hospital stay is a clinically important outcome reflecting both disease recovery and healthcare resource utilization. In the present study, HFNC therapy was associated with a significantly shorter hospital stay. Approximately 63.9% of children in the HFNC group were discharged within three days, whereas only 38.9% of those receiving standard oxygen therapy achieved discharge within the same period. None of the HFNC-treated children required hospitalization beyond six days, compared with 20.8% of patients in the SOT group. These findings suggest that HFNC accelerates recovery and facilitates earlier discharge.

Our findings are in agreement with those of Pragalatha Kumar et al., who reported a significantly shorter hospital stay among children treated with HFNC compared with low-flow oxygen therapy (2.2 ± 0.52 vs. 3.8 ± 0.84 days; p<0.001).[13] Khan et al. also observed shorter time to clinical stability and reduced hospitalization among infants receiving HFNC.[7] Furthermore, the updated systematic review by Armarego et al., which included 16 randomized trials involving 2,813 infants, demonstrated that HFNC was associated with modest reductions in hospital stay and duration of oxygen therapy when compared with conventional oxygen therapy.[4]

However, the literature regarding hospital stay remains somewhat heterogeneous. Franklin et al. found no significant difference in duration of hospitalization despite reduced treatment failure with HFNC. [2] Similarly, Lin et al., in a systematic review of randomized controlled trials, reported no consistent reduction in hospital stay, although HFNC significantly reduced treatment failure rates. [4]

Readmission rates are important indicators of sustained recovery and treatment effectiveness. In the present study, no patients in the HFNC group required readmission within 30 days, whereas readmissions occurred in 5.6% of children receiving standard oxygen therapy. Although limited studies have specifically assessed readmission outcomes, the absence of readmissions in the HFNC group suggests more effective stabilization during the index hospitalization and potentially more complete recovery prior to discharge.

Safety is a critical consideration in the use of advanced respiratory support modalities. Our study demonstrated that HFNC has an excellent safety profile. Secondary complications were uncommon, and no major HFNC-related adverse events were observed. Pneumonia occurred in two patients receiving standard oxygen therapy but in none of the HFNC-treated patients, although this difference did not reach statistical significance. Similar findings have been reported across multiple studies. Kepreotes et al. documented only four minor adverse events and no serious complications.[1] Franklin et al. reported one pneumothorax in each treatment group without significant differences in severe adverse outcomes.[2] Bressan et al. reported no adverse events, therapy discontinuations, or ICU transfers among children receiving HFNC.[6] Collectively, these findings confirm that HFNC is a safe and well-tolerated respiratory support modality in paediatric bronchiolitis.

The findings of our study are further supported by recent systematic reviews and meta-analyses. Lin et al. demonstrated that HFNC significantly reduces treatment failure compared with standard oxygen therapy, although CPAP may be superior in preventing escalation of respiratory support.[9] Catano-Jaramillo et al. similarly reported that both HFNC and CPAP reduce intubation risk in moderate-to-severe bronchiolitis, while HFNC offers better patient comfort and fewer adverse effects.[5] Armarego et al. concluded that HFNC probably reduces escalation of respiratory support and improves early respiratory parameters without increasing complications.[9] These observations are highly consistent with the outcomes of the present study.

Overall, the present study demonstrates that HFNC is an effective and safe respiratory support modality for children with severe bronchiolitis. Compared with standard oxygen therapy, HFNC was associated with faster clinical recovery, shorter duration of respiratory support, reduced hospital stay, elimination of early readmissions, and a lower requirement for invasive mechanical ventilation. These benefits were achieved without an increase in complications, highlighting the favorable safety profile of HFNC. Taken together with existing evidence from randomized controlled trials and systematic reviews, our findings support the preferential use of HFNC as a frontline respiratory support strategy in children with severe bronchiolitis.

CONCLUSION

This study demonstrates that High-Flow Nasal Cannula (HFNC) therapy is an effective and safe modality for respiratory support in children with severe bronchiolitis. Both HFNC and Standard Oxygen Therapy resulted in significant clinical improvement; however, children treated with HFNC showed faster clinical recovery and a lower proportion of treatment failure requiring escalation of respiratory support. These findings suggest that HFNC is a well-tolerated and reliable alternative to Standard Oxygen Therapy in the management of severe bronchiolitis. Therefore, HFNC may be considered an appropriate first-line respiratory support modality in selected paediatric patients with severe bronchiolitis. However, further large-scale studies with longer follow-up are warranted to strengthen the evidence and confirm these findings.

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