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Original Research Article.

Comparative Evaluation of High-Flow Nasal Cannula and Conventional Oxygen Therapy in Infants with Moderate Acute Bronchiolitis: A Prospective Randomized Study

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ABSTRACT

Background: Acute bronchiolitis is a leading cause of hospitalization among infants because of lower respiratory tract infection. Oxygen supplementation remains the cornerstone of treatment for hypoxemic children. High-flow nasal cannula (HFNC) therapy has gained increasing attention as a non-invasive respiratory support technique that may enhance oxygenation and reduce respiratory effort compared with conventional oxygen therapy (COT). This study compared the clinical outcomes of HFNC and COT in infants admitted with moderate acute bronchiolitis.

Methods: A prospective randomized comparative study was conducted over one year in the Department of Respiratory Medicine at the National Institute of Medical Sciences (NIMS), Jaipur. Ninety infants aged between 2 and 24 months who fulfilled the diagnostic criteria for moderate acute bronchiolitis were enrolled. Participants were randomly assigned to receive either HFNC (n = 45) or conventional oxygen therapy (n = 45). Clinical parameters, including respiratory distress score, respiratory rate, heart rate, oxygen saturation, duration of oxygen supplementation, length of hospitalization, treatment failure, need for escalation of respiratory support, and adverse events, were evaluated and compared.

Results: Infants managed with HFNC demonstrated earlier improvement in respiratory distress, oxygen saturation, respiratory rate, and heart rate than those receiving conventional oxygen therapy. The HFNC group also required a shorter duration of oxygen supplementation and experienced a reduced hospital stay. Treatment failure occurred less frequently among infants treated with HFNC, whereas the incidence of adverse events remained low and comparable between the two treatment groups.

Conclusion: High-flow nasal cannula therapy provided superior clinical recovery compared with conventional oxygen therapy in infants hospitalized with moderate acute bronchiolitis. The findings indicate that HFNC is a safe and effective non-invasive respiratory support strategy that can reduce oxygen requirements, shorten hospitalization, and improve overall clinical outcomes.

Keywords: Acute bronchiolitis, High-flow nasal cannula, Conventional oxygen therapy, Infant, Respiratory support, Oxygen supplementation.

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INTRODUCTION

Acute bronchiolitis is one of the most frequently encountered viral lower respiratory tract illnesses in infants and young children, accounting for a substantial proportion of pediatric hospital admissions worldwide. The disease predominantly affects children younger than two years of age, particularly during the first year of life when the airways are anatomically small and more susceptible to obstruction. Although most episodes are self-limiting, a considerable number of infants develop respiratory compromise that necessitates hospitalization and supportive management[1].

Respiratory syncytial virus (RSV) remains the principal pathogen responsible for acute bronchiolitis, contributing to the majority of reported cases. Other respiratory viruses, including rhinovirus, human metapneumovirus, parainfluenza virus, influenza virus, adenovirus, and seasonal coronaviruses, can produce a similar clinical presentation. Annual outbreaks, especially during the winter months, create a significant burden on healthcare services because of increased emergency visits, inpatient admissions, and utilization of pediatric intensive care resources[2].

The disease process involves inflammation of the bronchiolar epithelium, mucosal edema, excessive mucus production, and accumulation of cellular debris within the small airways. These pathological changes narrow the airway lumen, increase airflow

resistance, and impair ventilation. As a consequence, affected infants commonly present with tachypnea, wheezing, chest retractions, nasal flaring, hypoxemia, and feeding difficulties. The limited pulmonary reserve and immature respiratory muscles of young infants further increase their vulnerability to respiratory failure when the disease becomes more severe[2].

Several host-related factors influence the severity of bronchiolitis. Prematurity, low birth weight, congenital heart disease, chronic pulmonary disorders, neuromuscular disease, immunodeficiency, environmental tobacco smoke exposure, lack of breastfeeding, overcrowded living conditions, and poor socioeconomic status have all been associated with an increased likelihood of hospitalization and adverse clinical outcomes[3].

Despite extensive research, no pharmacological therapy has consistently demonstrated meaningful clinical benefit in the routine management of bronchiolitis. Agents such as bronchodilators, corticosteroids, antibiotics, antiviral medications, and nebulized hypertonic saline have been investigated, yet current evidence does not support their routine use in uncomplicated disease. Consequently, international clinical guidelines recommend supportive care as the primary treatment approach. Maintenance of adequate hydration, nutritional support, gentle airway clearance when required, and supplemental oxygen for hypoxemic infants remain the essential components of management[3,4].

Conventional oxygen therapy delivered through low-flow nasal cannulae or face masks has long been the standard method of correcting hypoxemia in hospitalized infants. Although widely available and easy to administer, low-flow systems may fail to satisfy the inspiratory flow requirements of infants experiencing significant respiratory distress. This limitation can result in variable inspired oxygen concentrations because of entrainment of room air. In addition, insufficient humidification may reduce patient comfort, impair mucociliary function, and promote drying of airway secretions[5]. High-flow nasal cannula (HFNC) therapy has become an increasingly important non-invasive respiratory support modality in pediatric practice. By delivering heated and humidified oxygen-air mixtures at flow rates that equal or exceed the patient's inspiratory demand, HFNC provides several physiological advantages. These include improved humidification of the respiratory tract, reduction of nasopharyngeal dead space, more stable oxygen delivery, decreased inspiratory resistance, and generation of a modest level of positive airway pressure. Collectively, these effects reduce the work of breathing and improve gas exchange while allowing infants to remain comfortable and interact more easily with caregivers[5,6].

Clinical investigations conducted over the past decade have reported encouraging outcomes with HFNC in infants with bronchiolitis. Many studies have demonstrated earlier improvement in respiratory distress, better oxygenation, and a lower frequency of treatment escalation compared with conventional oxygen therapy. Nevertheless, differences in study design, patient populations, and outcome measures have resulted in variable conclusions, and additional prospective research remains valuable for defining the role of HFNC in routine clinical practice[6-9]. The growing use of HFNC in tertiary care hospitals has increased the need for evidence from diverse healthcare settings, particularly in low- and middle-income countries where seasonal bronchiolitis places considerable pressure on pediatric services. Locally generated data are important because patient characteristics, disease burden, healthcare infrastructure, and resource availability may differ from those reported in international studies.

In view of these considerations, the present prospective randomized comparative study was undertaken at the National Institute of Medical Sciences (NIMS), Jaipur, to evaluate the clinical effectiveness of high-flow nasal cannula therapy in comparison with conventional oxygen therapy among infants admitted with moderate acute bronchiolitis. The study assessed whether HFNC could provide faster clinical recovery, reduce treatment failure, shorten oxygen therapy and hospital stay, and decrease the need for escalation of respiratory support while maintaining an acceptable safety profile.

AIM AND OBJECTIVES

AIM

To evaluate and compare the clinical effectiveness and safety of High-Flow Nasal Cannula (HFNC) therapy and conventional oxygen therapy in infants hospitalized with moderate acute bronchiolitis.

Objectives

Primary Objective

To determine whether the incidence of treatment failure differs between infants managed with High-Flow Nasal Cannula therapy and those receiving conventional oxygen therapy.

Secondary Objectives

- To compare the rate of improvement in respiratory distress following initiation of oxygen therapy.
- To evaluate changes in respiratory rate, heart rate, and peripheral oxygen saturation in both treatment groups.
- To compare the total duration of oxygen supplementation.
- To assess differences in the length of hospital stay.
- To evaluate the requirement for escalation of respiratory support, including non-invasive ventilation and invasive mechanical ventilation.
- To document and compare adverse events associated with each oxygen delivery method.

METHODOLOGY

Study Design

A prospective, randomized, hospital-based comparative study was conducted to evaluate the effectiveness of High-Flow Nasal Cannula therapy relative to conventional oxygen therapy in infants diagnosed with moderate acute bronchiolitis. Eligible participants were randomly assigned in a 1:1 ratio to one of the two treatment groups using a computer-generated randomization schedule. Allocation concealment was maintained through sequentially numbered opaque sealed envelopes, ensuring unbiased group assignment.

Study Setting

The investigation was carried out in Department of Respiratory Medicine at the National Institute of Medical Sciences (NIMS), Jaipur.

Study Duration

Participant recruitment, treatment, and follow-up were completed over a one-year study period.

Study Population

The study population consisted of infants between 2 and 24 months of age who were admitted with a clinical diagnosis of

moderate acute bronchiolitis and fulfilled all predefined eligibility criteria.

Sample Size

Sample size estimation was performed using OpenEpi Version 3.01. Assuming a treatment failure rate of 30% in the conventional oxygen therapy group and 10% in the HFNC group, with a confidence level of 95%, statistical power of 80%, and equal allocation between groups, the minimum required sample size was calculated to be 43 participants per group. To compensate for possible participant loss or incomplete data, 45 infants were enrolled in each treatment arm, resulting in a total study population of 90 infants.

The study groups were defined as follows:

- **Group A (HFNC Group):** Forty-five infants received heated and humidified High-Flow Nasal Cannula therapy.
- **Group B (Conventional Oxygen Therapy Group):** Forty-five infants received supplemental oxygen through low-flow nasal prongs or a simple face mask according to institutional treatment protocols.

Inclusion Criteria

Participants were considered eligible if they fulfilled all of the following criteria:

- Age between 2 and 24 months.
- Clinical diagnosis of moderate acute bronchiolitis.
- Peripheral oxygen saturation below 92% while breathing room air, requiring supplemental oxygen.
- First episode of wheezing associated with an acute viral respiratory infection.
- Written informed consent provided by a parent or legally authorized guardian.

Exclusion Criteria

Infants were excluded if any of the following conditions were present:

- Severe bronchiolitis requiring immediate ventilatory support at presentation.
- Hemodynamically significant congenital heart disease.
- Chronic lung disease, including bronchopulmonary dysplasia.
- Major congenital abnormalities involving the upper or lower airway.
- Neuromuscular disorders affecting respiratory function.
- Primary or secondary immunodeficiency.
- Previous hospitalization for the same illness during the current episode.
- Declined parental or guardian consent.

Study Procedure

After obtaining written informed consent, all eligible infants underwent a standardized baseline assessment. Demographic information, relevant medical history, and findings from a comprehensive physical examination were documented. Baseline clinical variables included respiratory rate, heart rate, body temperature, peripheral oxygen saturation, and respiratory distress score.

Infants allocated to the HFNC group received heated and humidified oxygen through a high-flow nasal cannula system. Therapy was initiated at a flow rate of 2 L/kg/min, while the fraction of inspired oxygen (FiO_2) was individually adjusted to maintain peripheral oxygen saturation between 92% and 96%. Continuous clinical monitoring was performed throughout treatment. Once respiratory status improved and the FiO_2 requirement decreased to approximately 0.30–0.40, flow rates were gradually reduced in a stepwise manner until discontinuation of HFNC was clinically appropriate.

Participants assigned to the conventional oxygen therapy group received supplemental oxygen via low-flow nasal cannulae or a simple face mask, depending on individual clinical requirements and institutional practice. Oxygen flow rates were adjusted to achieve target oxygen saturation values between 92% and 96%, with gradual weaning as respiratory status improved.

All enrolled infants received standard supportive management throughout hospitalization. This included maintenance of adequate hydration, nutritional support appropriate for age, gentle nasal suctioning whenever clinically indicated, and continuous monitoring of vital signs. Pharmacological treatment was administered only when clinically justified and was not routinely prescribed as part of the study protocol.

Clinical observations were recorded at predefined intervals during hospitalization. Parameters assessed included respiratory rate, heart rate, oxygen saturation, respiratory distress score, duration of oxygen therapy, length of hospital stay, treatment failure, need for escalation of respiratory support, and occurrence of treatment-related adverse events.

Respiratory distress was evaluated using the Respiratory Distress Assessment Instrument (RDAI), a validated clinical scoring system based on the severity of wheezing and chest retractions. Scores obtained at baseline and during follow-up were used to objectively monitor the response to treatment.

Outcome Measures

Primary Outcome

Treatment failure requiring escalation to a higher level of respiratory support.

Secondary Outcomes

- Improvement in respiratory distress score.
- Changes in respiratory rate during hospitalization.
- Changes in heart rate during treatment.
- Improvement in peripheral oxygen saturation.
- Total duration of oxygen supplementation.
- Length of hospital stay.
- Requirement for non-invasive ventilation or invasive mechanical ventilation.
- Frequency and nature of adverse events.

Ethical Considerations

Prior to initiation of the study, ethical approval was obtained from the Institutional Ethics Committee of the National Institute of Medical Sciences (NIMS), Jaipur. All study procedures were performed in accordance with the ethical principles outlined in the Declaration of Helsinki and the recommendations of Good Clinical Practice.

Informed Consent

Written informed consent was obtained from the parent or legally authorized guardian of every participant before enrollment. Participation was entirely voluntary. Confidentiality was maintained by removing personal identifiers from study records, and all collected information was used exclusively for research purposes.

Statistical Analysis

Data were compiled using Microsoft Excel and analyzed with IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were summarized as mean ± standard deviation (SD), whereas categorical variables were expressed as frequencies and percentages.

The distribution of continuous variables was evaluated using the Shapiro–Wilk test. Between-group comparisons for normally distributed variables were performed using the independent Student's *t*-test, whereas the Mann–Whitney *U* test was applied when data were not normally distributed. Categorical variables were analyzed using the Chi-square test or Fisher's exact test whenever appropriate. Repeated measurements of clinical variables obtained during follow-up were analyzed using repeated-measures analysis of variance (Repeated-Measures ANOVA). Statistical significance was defined as a two-sided *p* value of less than 0.05.

RESULTS

A total of 90 infants with moderate acute bronchiolitis were enrolled during the study period. The participants were equally allocated into two groups: 45 infants received High-Flow Nasal Cannula (HFNC) therapy (Group A) and 45 infants received Conventional Oxygen Therapy (COT) (Group B). All enrolled participants completed the study protocol and were included in the final analysis, resulting in a 100% follow-up rate.

Baseline Characteristics

The baseline demographic characteristics of the study population are presented in Table 1. The mean age of infants in the HFNC and COT groups was 8.6 ± 4.2 months and 8.9 ± 4.0 months, respectively (p = 0.74). Male infants constituted 57.8% of the HFNC group and 55.6% of the COT group (p = 0.83). The two groups were also comparable with respect to body weight and duration of illness prior to admission, with no statistically significant differences observed (all p > 0.05).

Similarly, baseline clinical parameters were comparable between the two treatment groups (Table 2). There were no significant differences in respiratory rate, heart rate, oxygen saturation, respiratory distress score, or body temperature at admission (all p > 0.05), indicating good baseline homogeneity.

Clinical Response During Follow-up

Both treatment groups demonstrated progressive clinical improvement following initiation of oxygen therapy. However, infants receiving HFNC showed significantly faster improvement in respiratory parameters than those receiving conventional oxygen therapy.

Respiratory rate declined steadily in both groups throughout hospitalization (Table 3). Although no significant difference was observed one hour after treatment initiation (p = 0.11), the reduction became significantly greater in the HFNC group from 6 hours onward, with highly significant differences at 12, 24, and 48 hours (all p < 0.001).

A similar trend was observed for heart rate (Table 4). Baseline values were comparable, while significantly lower heart rates were recorded in the HFNC group from 6 hours onward, indicating earlier clinical stabilization.

Peripheral oxygen saturation improved rapidly in both groups (Table 5). Infants treated with HFNC achieved significantly higher oxygen saturation as early as 1 hour after therapy initiation (93.8 ± 2.1% vs. 92.4 ± 2.3%; p = 0.005). This difference remained statistically significant throughout the subsequent follow-up period (all p < 0.001).

Respiratory distress scores also demonstrated progressive improvement (Table 6). Compared with conventional oxygen therapy, HFNC resulted in significantly greater reductions in respiratory distress beginning at 6 hours and continuing through 48 hours (all p ≤ 0.01).

Table 1. Comparison of Baseline Demographic Characteristics Between the Study Groups

Variable	HFNC (n = 45)	Conventional Oxygen Therapy (n = 45)	p-value
Age (months), Mean ± SD	8.6 ± 4.2	8.9 ± 4.0	0.74
Male, n (%)	26 (57.8)	25 (55.6)	0.83
Female, n (%)	19 (42.2)	20 (44.4)	0.83
Weight (kg), Mean ± SD	7.4 ± 1.6	7.2 ± 1.5	0.52
Duration of illness before admission (days), Mean ± SD	3.1 ± 1.0	3.0 ± 1.1	0.68

Data are presented as Mean ± Standard Deviation or number (%).

Table 2. Comparison of Baseline Clinical Characteristics Between the Study Groups

Parameter	HFNC	Conventional Oxygen Therapy	p-value
Respiratory rate (breaths/min), Mean ± SD	62.4 ± 6.8	61.9 ± 7.1	0.74
Heart rate (beats/min), Mean ± SD	154.8 ± 12.6	153.9 ± 11.9	0.71
Oxygen saturation (%), Mean ± SD	90.2 ± 2.6	90.5 ± 2.4	0.56
Respiratory distress score, Mean ± SD	6.2 ± 1.1	6.1 ± 1.0	0.62
Temperature (°C), Mean ± SD	37.4 ± 0.5	37.3 ± 0.4	0.48

Table 3. Comparison of Respiratory Rate During Follow-up

Time Point	HFNC (Mean ± SD)	Conventional (Mean ± SD)	p-value
Baseline	62.4 ± 6.8	61.9 ± 7.1	0.74
1 Hour	58.1 ± 6.3	60.2 ± 6.8	0.11
6 Hours	51.6 ± 5.9	55.7 ± 6.4	0.003
12 Hours	46.3 ± 5.4	51.2 ± 5.8	<0.001
24 Hours	41.5 ± 4.8	46.7 ± 5.2	<0.001
48 Hours	36.8 ± 4.2	40.9 ± 4.7	<0.001

Table 4. Comparison of Heart Rate During Follow-up

Time Point	HFNC	Conventional	p-value
Baseline	154.8 ± 12.6	153.9 ± 11.9	0.71
1 Hour	147.3 ± 11.8	150.1 ± 11.4	0.26
6 Hours	139.2 ± 10.9	145.8 ± 11.2	0.005
12 Hours	132.5 ± 10.1	140.6 ± 10.8	0.001
24 Hours	125.7 ± 9.4	134.1 ± 10.0	<0.001
48 Hours	118.9 ± 8.7	126.8 ± 9.2	<0.001

Table 5. Comparison of Oxygen Saturation During Follow-up

Time Point	HFNC	Conventional	p-value
Baseline	90.2 ± 2.6	90.5 ± 2.4	0.56
1 Hour	93.8 ± 2.1	92.4 ± 2.3	0.005
6 Hours	95.6 ± 1.6	94.1 ± 1.8	<0.001
12 Hours	96.8 ± 1.2	95.0 ± 1.5	<0.001
24 Hours	97.4 ± 1.0	95.8 ± 1.3	<0.001
48 Hours	98.0 ± 0.8	96.6 ± 1.1	<0.001

Table 6. Comparison of Respiratory Distress Scores During Follow-up

Time Point	HFNC	Conventional	p-value
Baseline	6.2 ± 1.1	6.1 ± 1.0	0.62
6 Hours	4.8 ± 0.9	5.3 ± 1.0	0.01
12 Hours	3.7 ± 0.8	4.4 ± 0.9	<0.001
24 Hours	2.5 ± 0.7	3.4 ± 0.8	<0.001
48 Hours	1.4 ± 0.5	2.1 ± 0.6	<0.001

Table 7. Duration of Oxygen Therapy

Variable	HFNC	Conventional	p-value
Duration of oxygen therapy (hours), Mean ± SD	30.4 ± 8.6	38.7 ± 9.3	<0.001

Table 8. Length of Hospital Stay

Variable	HFNC	Conventional	p-value
Hospital stay (days), Mean ± SD	3.6 ± 1.1	4.5 ± 1.2	<0.001

Table 9. Treatment Outcomes

Outcome	HFNC, n (%)	Conventional, n (%)	p-value
Treatment success	42 (93.3)	36 (80.0)	0.045
Treatment failure	3 (6.7)	9 (20.0)	0.045

Table 10. Escalation of Respiratory Support

Variable	HFNC, n (%)	Conventional, n (%)	p-value
Non-invasive ventilation	2 (4.4)	6 (13.3)	0.14
Mechanical ventilation	1 (2.2)	3 (6.7)	0.31
PICU admission	2 (4.4)	5 (11.1)	0.23

Table 11. Adverse Events

Adverse Event	HFNC, n (%)	Conventional, n (%)	p-value
Nasal trauma	2 (4.4)	1 (2.2)	0.56
Abdominal distension	3 (6.7)	1 (2.2)	0.30
Air leak syndrome	0	0	—
Feeding intolerance	4 (8.9)	3 (6.7)	0.69
Any adverse event	8 (17.8)	5 (11.1)	0.37

Data are presented as Mean ± Standard Deviation or number (%). Continuous variables were compared using the Independent Student's *t*-test, while categorical variables were analyzed using the Chi-square test or Fisher's exact test, as appropriate. A *p*-value < 0.05 was considered statistically significant.

Clinical Outcomes

Clinical outcome measures are summarized in Tables 7–11. The mean duration of oxygen therapy was significantly shorter in the HFNC group compared with the conventional oxygen therapy group (30.4 ± 8.6 vs. 38.7 ± 9.3 hours; $p < 0.001$) (Table 7). Similarly, infants receiving HFNC had a significantly shorter hospital stay than those receiving conventional oxygen therapy (3.6 ± 1.1 vs. 4.5 ± 1.2 days; $p < 0.001$) (Table 8).

Treatment success was achieved in 42 (93.3%) infants in the HFNC group compared with 36 (80.0%) infants in the conventional oxygen therapy group. Treatment failure occurred significantly less frequently among infants treated with HFNC (6.7% vs. 20.0%; $p = 0.045$) (Table 9).

Although fewer infants in the HFNC group required escalation to non-invasive ventilation, mechanical ventilation, or PICU admission, these differences were not statistically significant (Table 10).

Both treatment modalities were well tolerated. The incidence of adverse events was low in both groups, and no episode of air leak syndrome was observed. There was no statistically significant difference in the overall frequency of adverse events between the two groups (Table 11).

DISCUSSION

Acute bronchiolitis continues to be one of the most frequent causes of hospitalization among infants with viral lower respiratory tract infection. Because no pharmacological treatment has consistently demonstrated a meaningful effect on disease progression, supportive care remains the foundation of management, with oxygen supplementation playing a central role in children who develop hypoxemia. In recent years, High-Flow Nasal Cannula (HFNC) therapy has become increasingly incorporated into pediatric respiratory care because of its ability to deliver heated and humidified oxygen at high flow rates while reducing the work of breathing. The present study was undertaken to compare the clinical performance of HFNC with conventional oxygen therapy in infants admitted with moderate acute bronchiolitis[3,6]. An important strength of this investigation was the similarity of baseline characteristics between the two treatment groups. Age distribution, sex, body weight, duration of symptoms before admission, and clinical severity at presentation were comparable. This balanced distribution minimizes the possibility that observed differences in clinical outcomes resulted from baseline variation rather than the intervention itself.

One of the principal observations of the present study was the faster improvement in respiratory rate among infants treated with HFNC. Although respiratory rates were similar immediately after enrollment, a significantly greater reduction became evident during subsequent follow-up in the HFNC group. This finding suggests that HFNC decreases respiratory effort more efficiently than conventional oxygen delivery. The physiological effects of heated and humidified high-flow gas, including improved airway patency, reduction of nasopharyngeal dead space, and partial positive airway pressure, may collectively explain this earlier clinical improvement. Similar reductions in respiratory distress have been described in previous clinical studies evaluating HFNC in infants with bronchiolitis[8,9]. Heart rate demonstrated a comparable pattern of recovery. Infants receiving HFNC showed earlier normalization of heart rate during hospitalization compared with those managed using conventional oxygen therapy.

Tachycardia commonly reflects increased respiratory effort and physiological stress in infants with bronchiolitis; therefore, its earlier resolution may indicate more effective stabilization of respiratory function. These findings support previous reports that have described rapid improvement in cardiovascular and respiratory parameters following initiation of HFNC therapy[8].

Improvement in oxygenation represented another significant outcome of this study. Although oxygen saturation increased progressively in both treatment groups after initiation of supplemental oxygen, infants managed with HFNC consistently achieved higher saturation values throughout the observation period. Unlike low-flow oxygen systems, HFNC is capable of delivering a more reliable inspired oxygen concentration while simultaneously decreasing room-air entrainment. Adequate humidification also improves mucociliary clearance and secretion mobilization, contributing to more effective gas exchange. These physiological mechanisms provide a plausible explanation for the superior oxygenation observed in the HFNC group[5,10].

Respiratory distress scores also declined more rapidly among infants receiving HFNC therapy. Earlier improvement in chest retractions and wheezing suggests a reduction in the work of breathing and better overall respiratory mechanics. The beneficial effects of HFNC on airway resistance and end-expiratory lung volume described in previous physiological studies are consistent with the clinical improvements observed in our patients[11].

An important practical finding was the significantly shorter duration of oxygen supplementation among infants treated with HFNC. Earlier discontinuation of oxygen therapy benefits both patients and healthcare providers by reducing treatment time, improving patient comfort, and decreasing nursing workload. Reduced oxygen requirements may also contribute to more efficient utilization of hospital resources, particularly during seasonal epidemics of bronchiolitis[12] when pediatric beds are frequently occupied.

Hospital stay was likewise significantly shorter in the HFNC group. Earlier clinical stabilization and reduced oxygen dependence likely contributed to earlier discharge. Shortening hospitalization is particularly relevant in resource-limited healthcare systems because it improves bed availability, decreases healthcare expenditure, and reduces the burden on pediatric inpatient services during periods of increased respiratory viral activity[12,13].

The incidence of treatment failure was significantly lower among infants receiving HFNC therapy. Although relatively few participants required escalation to non-invasive ventilation, invasive mechanical ventilation, or Pediatric Intensive Care Unit admission, the overall trend consistently favored HFNC. The absence of statistically significant differences for these secondary outcomes is likely related to the relatively small number of such events rather than a lack of clinical benefit. Larger multicenter studies may provide sufficient statistical power to evaluate these outcomes more precisely[6].

Safety remains an essential consideration when introducing newer respiratory support techniques in young infants. In the present study, both treatment strategies demonstrated favorable safety profiles. Minor adverse events occurred infrequently and were similar in both treatment groups. Importantly, no episodes of air leak syndrome or other serious complications attributable to HFNC were observed. These findings reinforce the growing body of evidence supporting the safe use of HFNC when appropriate equipment, monitoring, and trained healthcare personnel are available[5,14].

The present study has several notable strengths. Its prospective randomized design minimized selection bias, while complete follow-up of all enrolled participants ensured comprehensive outcome assessment. Serial evaluation of objective clinical parameters enabled detailed monitoring of treatment response. Furthermore, clinically relevant endpoints—including treatment failure, duration of oxygen therapy, and hospital stay—enhance the practical significance of the findings for everyday pediatric practice.

Several limitations should also be acknowledged. Because the study was conducted at a single tertiary-care institution, the results may not be directly applicable to all healthcare settings. Although the calculated sample size was sufficient to detect differences in the primary outcome, it may have been inadequate for identifying statistically significant differences in less common events such as mechanical ventilation or intensive care admission. In addition, this study focused exclusively on short-term in-hospital outcomes and did not assess long-term respiratory health, patient satisfaction, or economic implications associated with each treatment strategy.

Overall, the findings of the present investigation indicate that High-Flow Nasal Cannula therapy offers important clinical advantages over conventional oxygen therapy in infants hospitalized with moderate acute bronchiolitis. More rapid improvement in respiratory parameters, better oxygenation, shorter oxygen dependence, reduced hospitalization, and a lower rate of treatment failure collectively support its role as an effective non-invasive respiratory support modality. These observations are consistent with the evolving evidence supporting HFNC as an increasingly valuable component of modern pediatric respiratory care[6,14].

CONCLUSION

This prospective randomized comparative study demonstrated that High-Flow Nasal Cannula (HFNC) therapy is an effective and well-tolerated non-invasive respiratory support modality for infants admitted with moderate acute bronchiolitis. Compared with conventional oxygen therapy, HFNC was associated with earlier improvement in respiratory rate, heart rate, oxygen saturation, and respiratory distress, indicating faster clinical stabilization following treatment initiation.

Infants managed with HFNC also required a significantly shorter duration of supplemental oxygen and experienced reduced hospital stays, suggesting more rapid recovery and improved utilization of healthcare resources. Furthermore, treatment failure occurred less frequently in the HFNC group, while the requirement for escalation to advanced respiratory support showed a favorable trend, although these differences were not statistically significant within the present sample.

Both treatment approaches demonstrated acceptable safety profiles, with only a small number of minor adverse events and no serious treatment-related complications observed during the study period. These findings indicate that HFNC can be administered safely when appropriate monitoring, equipment, and trained healthcare personnel are available.

Taken together, the results of this study support the use of High-Flow Nasal Cannula therapy as an effective first-line option for

oxygen supplementation in hospitalized infants with moderate acute bronchiolitis. Incorporating HFNC into routine clinical practice may contribute to faster symptom resolution, reduced oxygen dependence, and shorter hospitalization without compromising patient safety.

Future multicenter randomized controlled trials involving larger and more diverse patient populations are recommended to confirm these findings. Additional research should also examine long-term clinical outcomes, economic impact, and standardized treatment protocols to further define the role of HFNC in the management of pediatric bronchiolitis across different healthcare settings.

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