

A Comparative Study on Efficacy of High Flow Nasal Canula versus Standard Oxygen Therapy in Children with Bronchiolitis: A Randomized Controlled Trial from South India

P. Guna¹, S. Murugesa Lakshmanan², P. Ramasubramaniam³, S. Prasanna⁴

¹Associate Professor, Department of Paediatrics, Government Sivagangai Medical College and Hospital, Tamilnadu

²Associate Professor, Department of Paediatrics, Government Medical College Virudhunagar

³Associate Professor, Department of Paediatrics, Government Theni Medical College and Hospital.

⁴Assistant Surgeon, Government Hospital Manamadurai, Sivagangai District.

Received: 02-01-2023 / Revised: 30-01-2023 / Accepted: 10-02-2023

Corresponding author: Dr P. Guna

Conflict of interest: Nil

Abstract

Background: Prompt instigation of suitable non-invasive respiratory support like oxygen therapy, heated humidified high flow oxygen through nasal canula (HHHFNC), Continuous positive airway pressure are chief intrusions to evade mechanical ventilation in severe bronchiolitis.

Objectives: 1. To assess and compare the clinical improvement and the clinical outcomes with HHHFNC and conventional oxygen therapy in children with bronchiolitis 2. To estimate the danger of treatment failure with HHHFNC and conventional oxygen therapy.

Materials and Methods: It is a single centre, prospective, and randomized control study at Paediatric ICU of a tertiary care hospital in Madurai, Tamil Nadu from July 2019 to September 2020. Hundred children who were aged between 6 to 18 months admitted in hospital due to bronchiolitis.

Results: Total 100 children with 50 were allotted in each group. Clinical response in heart rate, respiratory rate, Work of breathing and SPO₂ in children with bronchiolitis who received HHHFNC treatment at different time intervals at 2 hours, 4 hours, 6 hours was better than those received conventional oxygen therapy and difference was statistically significant. Treatment failure was very less (8%) in HHFNC treatment compared to 28% of in oxygen therapy group ($P <0.05$). there was a 57% decrease in management failure in HHFNC therapy group in comparison with conventional oxygen treatment.

Conclusion: This RCT discovered that HFNC treatment had a proven clinical benefit over conventional oxygen therapy in managing kids admitted with bronchiolitis.

Keywords: Bronchiolitis, High Flow Nasal Canula, Children, Randomized Controlled Trial.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Acute bronchiolitis is one of the frequent reason for hospitalization in infants [1].

Incidence of bronchiolitis can be up to 94% amongst children below two years in India

[2]. Suggested treatment modalities of bronchiolitis are mainly of supportive treatment such as respiratory support and hydration [3]. Timely commencement of suitable non-invasive respiratory support is the ultimately significant intervention to evade mechanical ventilation in severe bronchiolitis [4]. Moist oxygen support supplied through either face mask, nasal cannula, non-invasive continuous positive airway pressure (nCPAP) or hot humidified high-flow nasal cannula (HFFNC) [3]. HFFNC delivers non-invasive respiratory support to children in the form of oxygen or a mixture of oxygen and air at flow rates $\geq 1\text{L/min}$ [5]. HFFNC is attaining admiration because of comfort of use, increased bond between mother and baby [6]. The beneficial effects of HFFNC includes reduction of respiratory resistance, abolishing the nasopharyngeal dead space, reducing metabolic work due to gas conditioning, improving mucociliary clearance and facility of low level of positive airway pressure. Through this study we wanted to compare the efficacy of HFFNC and conventional oxygen therapy in the management of infants and children with bronchiolitis. Based on this aim of our study is to evaluate and compare the clinical progress with type of therapy also to compare the prognostic outcome and treatment failure between these two groups in children with bronchiolitis.

Materials and Methods

It is a prospective, parallel group, open-labelled, and randomized control study at Paediatric ICU in Madurai Medical College for a period of 15 months. Ethics committee approval was obtained. Informed consent was acquired from parent or a guardian.

Total of hundred and twenty children were admitted for bronchiolitis out of them Hundred children who were aged from 6 mon to 1 and half years who had clinical symptoms of bronchiolitis like fever,

breathlessness, cough and tachypnoea, dyspnoea and saturation $<95\%$ were included. While those with cardiac co morbidities, having airway deformity, having features of respiratory failure and proven pneumonia were excluded.

Randomization was done using opaque sealed envelopes in fixed-block method into 2 groups. HFFNC therapy and conventional oxygen therapy. HFFNC therapy was given using high flow cannula with heat humidification system..nasal canula size should cover the half of nostril diameter. Humidification was maintained between $34\text{-}37^\circ\text{C}$. Flow rates were maintained for infants $>2\text{l/min}$ and for children $>6\text{l/min}$. Level of comfort, heart rate, respiratory rate, work of breathing, SpO_2 , blood pressure, blood gas analysis were measured and monitored at the time of admission, 2, 4, and at 6 hours

If the children could not achieve any two or more of these criteria's: RR decrease by 20 % or to normal. HR decrease by 20 % or to normal. $\text{FiO}_2 < 0.5$, within first 2 hours of therapy were considered as treatment failure. These failure cases were upgraded to mechanical ventilation for further management

Data was collected regarding basic demographic variables age and sex. Other variables include body weight, underlying disease, and treatment taken. Clinical signs and symptoms were noted.

Statistical Analysis

Descriptive statistics was used. Mann Whitney U test was used to compare variables between groups and Chi Square used for categorical data. p value of < 0.05 was considered significant.

Results

Total 100 children were included in the study. 50 were allotted for HFFNC and 50

were allotted for conventional oxygen therapy. The participants were between 6 months to 18 months.

Socio demographic characteristics:

Out of 100 participants 52 (52%) were males and 48 (48%) were females. Among 50 who got HHHFNC therapy 31 (62%) were male children and 19 (38%) were females. Among 50 who got conventional oxygen therapy 21(42%) were male children and 29 (58%) were females. Out of 100 participants 38

(38%) were between 6 to 12 months of age and 62 (62 %) were between 12 to 18 months of age.

Clinical improvement with HHHFNC and conventional oxygen therapy:

Clinical response was analysed in various parameters in our study group, we compared between groups at 2 hrs, 4 hrs and 6 hrs and HHHFNC therapy was better than conventional therapy which was statistically significant too. (Table 1).

Table 1: Changes in RR, HR, SPO₂ between two treatment groups (Mann whitney u test)

RR	HHHFNC group		Conventional O ₂ group		P value
	Mean	SD	Mean	SD	
On admission	77.14	5.322	76.96	4.716	0.847
at 2 hours	56.56	8.676	65.4	7.025	0.001*
at 4 hours	48.2	2.986	64.72	7.801	0.001*
at 6 hours	36.96	4.147	57	10.2	0.001*
HR					
On admission	174.72	2.061	175.38	1.883	0.098
at 2 hours	156.56	6.247	168.2	4.699	0.001*
at 4 hours	142.89	3.725	158.64	9.909	0.001*
at 6 hours	127.96	4.628	152.32	13.687	0.001*
SPO ₂					
On admission	89.96	1.84	89.76	1.869	0.583
at 2 hours	96.7	2.261	94.9	3.671	0.015*
at 4 hours	98.98	0.147	96.34	4.129	0.001*
at 6 hours	99	0	96.42	4.031	0.001*

Table 2 shows changes in the Respiratory effort after the intervention among study participants improvement was better with HHHFNC and the difference was found to be significant statistically.

Table 2: Respiratory effort between groups (Fisher exact test)

Work out for breathing		HHHFNC group		Conventional O ₂ group		P value
		N	N	N	N	
At presentation	Increased	50		50		
After intervention						
at 2 hrs	Decreased	46		35		0.005*
	Increased	4		15		
at 4 hrs	Normal	3		3		0.001*
	Decreased	43		32		
	Increased	0		15		
at 6 hrs	Normal	5		6		0.001*
	Decreased	41		29		
	increased	0		15		

Treatment failure

Treatment failure was very less (8%) in HHFNC therapy compared to 28% of failure in conventional oxygen therapy patients and this was significant statistically

As shown in Table3 we did logistic regression evaluation with confounding factors like body weight, underlying diseases and severity of distress which showed a 57% decrease in risk of going for mechanical ventilation due to treatment failure in the group of children treated with HHFNC

Table 3: Risk reduction among study participants with HHHFNC[#] and conventional oxygen therapy

Intervention	Odds ratio	95% CI		P value
		Lower	Upper	
Conventional O ₂ therapy	1.0 (reference)			
HHHFNC [#] therapy grp	0.423	0.190	0.943	0.035*

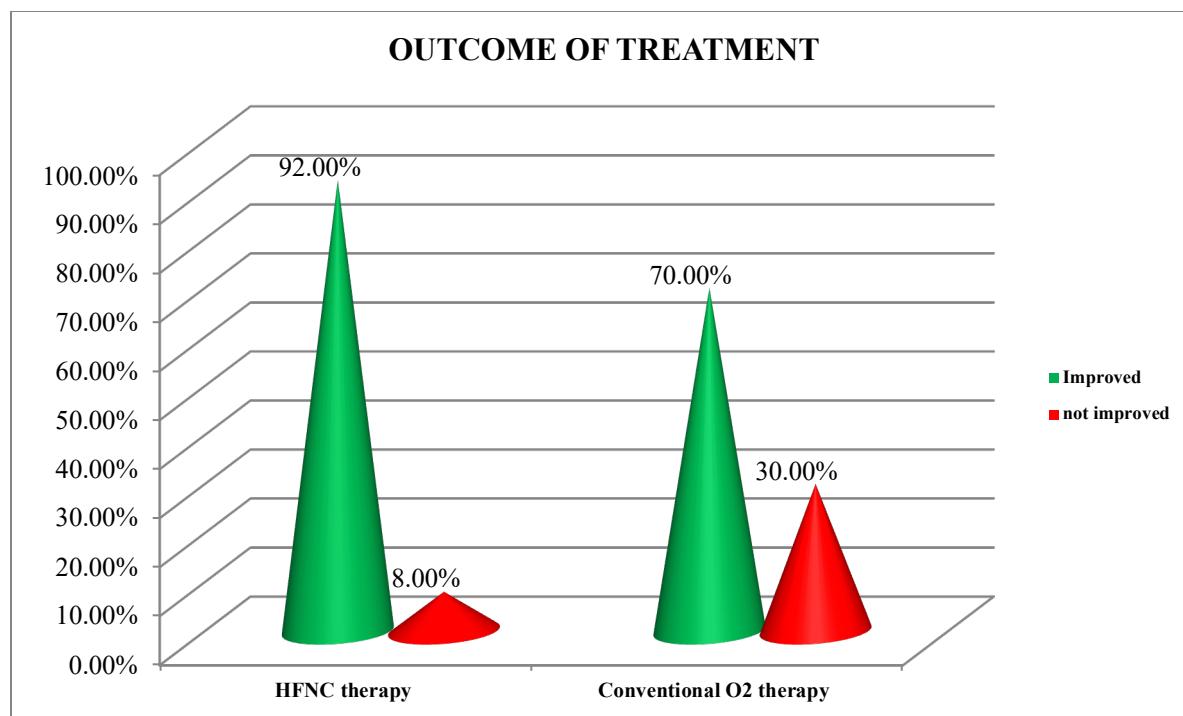


Figure 1: Outcome assessment

Discussion

This randomized controlled study was done in 100 children with bronchiolitis in a tertiary care teaching hospital for a period of 15 months and assigned into two groups of treatment modality. Clinical improvement was better with HHHFNC when compared to treatment with conventional oxygen therapy and difference was significant. The treatment

failure was less in HFNC therapy than that of conventional therapy. Even after adjusting for confounding variables to logistic regression it showed 57% reduction in risk of treatment failure in HFNC therapy group.

In our study population in patients who were treated with HHHFNC therapy, there was a substantial decrease in parameters like RR,

HR at different time intervals after starting treatment in comparison with other group. Similarly in a systematic review by Beggs S *et al* 2014 there was significant improvement in SpO₂ at different time intervals in HFNC group [7]. Similarly in a study done in 2016 the study was done against low flow O₂ group and there was better improvement in HFNC group in parameters like RR, Feed and respiratory effort [8-11]. HFNC therapy improves oxygen saturation levels with a decrease of EtCO₂ and RR in a pilot study done in 2013 [12]. In an Indian study done in 2019 there was similar results to our study with decrease in heart rate and respiratory rate and an improvement in SpO₂ levels. [13] But in a metanalysis done by Jilei Lin *et al*, the results were contradictory [9].

In our study the failure rate between groups were 8% versus 28% in HHFNC and conventional treatment respectively which was found statistically significant. Similar to our study findings a metanalaysis done in china showed significant reduction in failure rates[9]. In one more study by Donna Franklin *et al*, in 2019, highest level of intervention required in HHFNC group was 12 percent against 23% in conventional treatment group [10].

We did logistic regression evaluation with confounding factors like body weight, underlying diseases and severity of distress which showed a 57% decrease in risk of going for mechanical ventilation due to treatment failure. Similar findings were seen with Jilei Lin *et al*, 2019 study where the risk ratio reduction was around 50% in HHFNC group [9]. In one more study the risk of requiring admission in ICU was four fold higher in patients given standard treatment, due to this requirement for mechanical ventilation decreased from 37% to 7 % in patients on HFNC treatment [11]. A systemic review published in 2021 confirmed HHFNC is better than Standard O₂ therapy in concern with failure rate [14].

Conclusion

This RCT discovered that HFNC treatment had a proven clinical benefit over conventional oxygen therapy in managing kids admitted with bronchiolitis.

Starting HHFNC early in high risk population who present with moderate to severe respiratory distress will reduce need of Mechanical ventilation or NIPPV.

Strength of the Study: It is a randomized controlled trial and ample sample size

Limitations: Not blinded study and interrater reliability

References

- Verma N, Lodha R, Kabra S K. Recent Advances in Management of Bronchiolitis. Indian Pediatr. 2013;50: 939-949.
- Chatterjee K, Sen S, Chaudhuri N. Acute Bronchiolitis – Update on Management. New Indian journal of paediatrics. 2016;5(1): 20-27
- Sarkar M, Sinha R, Chowdhury R S, Mukhopadhyay S, Ghosh P, Dutta K, *et al*. Comparative study between non-invasive continuous positive airway pressure and hot humidified high-flow nasal cannula as a mode of respiratory support in infants with acute bronchiolitis in paediatric intensive care unit of a tertiary care hospital. Indian J Crit Care Med 2018; 22:85-90.
- Ramsden V, Babl F B, Dalziel S R, Middleton S, Ed Oakley, Haskell L, Lithgow A, Orsini F, Schembri R, Wallace A, Wilson C A, McInnes E, Wilson P H, Tavende E. Sustainability of evidence-based practices in the management of infants with bronchiolitis in hospital settings - a PREDICT study protocol. BMC Health Services Research. 2022 ;22:1099
- Kugelman A, Riskin A, Said W, Shoris I, Mor F, Bader D. A randomized pilot study comparing heated humidified high-

- flow nasal cannulae with NIPPV for RDS. *Pediatr Pulmonol.* 2015 Jun;50(6):576-83.
6. Panayiotou E, Vakharia B. Clinical Guideline: Heated Humidified High Flow Nasal Cannula (HFFNC) Guideline. NHS (East of England Neonatal ODN). [Online] <https://www.eoeneonatalpccsiconetwork.nhs.uk/wpcontent/uploads/2022/05/HFFNC-final-draft.pdf>.
 7. Beggs S, Wong ZH, Kaul S, Ogden KJ, Walters JA. High-flow nasal cannula therapy for infants with bronchiolitis. *Cochrane Database Syst Rev.* 2014 Jan 20;(1): CD009609.
 8. Milani GP, Plebani AM, Arturi E, Brusa D, Esposito S, Dell'Era L, Laicini EA, Consonni D, Agostoni C, Fossali EF. Using a high-flow nasal cannula provided superior results to low-flow oxygen delivery in moderate to severe bronchiolitis. *Acta Paediatr.* 2016 Aug; 105(8):e368-72
 9. Lin J, Zhang Y, Xiong L, Liu S, Gong C, Dai J. High-flow nasal cannula therapy for children with bronchiolitis: a systematic review and meta-analysis. *Arch Dis Child.* 2019 Jun;104(6):564-576.
 10. Franklin D, Shellshear D, Babl FE, et al. Multicentre, randomised trial to investigate early nasal high-flow therapy in paediatric acute hypoxaemic respiratory failure: a protocol for a randomised controlled trial—a Paediatric Acute respiratory Intervention Study (PARIS 2). *BMJ Open* 2019;9: e030516.
 11. Schibler A, Pham TM, Dunster KR, Foster K, Barlow A, Gibbons K, Hough JL. Reduced intubation rates for infants after introduction of high-flow nasal prong oxygen delivery. *Intensive Care Med.* 2011 May;37(5):847-52.
 12. Bressan S, Balzani M, Krauss B, Pettenazzo A, Zanconato S, Baraldi E. High-flow nasal cannula oxygen for bronchiolitis in a pediatric ward: a pilot study. *Eur J Pediatr.* 2013 Dec;172(12):1649-56.
 13. Sunil V Kapur, Jitendra S Oswal, Bhakti Sarangi. Efficacy and Safety of High-Flow Nasal Cannula Oxygen Therapy in Moderate and Severe Bronchiolitis. *Journal of Clinical and Diagnostic Research.* 2019 Mar; 13(3): SC11-SC14
 14. Dafydd C, Saunders BJ, Kotch SJ, Edwards MO. Efficacy and safety of high flow nasal oxygen for children with bronchiolitis: systematic review and meta-analysis. *BMJ Open Respir Res.* 2021 Jul;8(1): e000844.