Humidified high flow nasal cannula oxygen therapy in acute bronchiolitis

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ABSTRACT

Background: Bronchiolitis is a major cause of morbidity and leading cause of hospitalization, mostly in early childhood without coexisting illnesses. Traditionally dry oxygen is provided at 100% concentration via low flow nasal prongs. However, the latest studies have revealed that oxygen therapy via heated, humidified, high flow nasal cannula (HFNC) allows the delivery of high inspired gas flows which is better than the traditional one. **Methods:** All previously healthy children between 1 and 24 months of age with an established clinical diagnosis of moderate to severe bronchiolitis (clinical severity score ≥4) were enrolled for study. The patients were divided into two groups: Patients in Group 1 received HFNC oxygen therapy (HFNC group) while those in Group 2 received conventional oxygen therapy (non-HFNC group). The patients were randomized in each arm by simple randomization. Outcome parameters measured were duration of hospital stay, duration of pediatric intensive care unit (PICU) stay, oxygen saturation (SPO_2), respiratory rate, adverse event (respiratory failure), need for *intermittent positive pressure ventilation* or continuous positive airway pressure. **Results:** Out of 100 patients studied, 50 received HFNC oxygen and 50 received conventional oxygen. There was early and better improvement in SPO_2 and respiratory rate ($p<0.001$), decreased length of hospital stay ($p<0.001$) and PICU stay ($p<0.01$) among the patients in HFNC group as compared to non-HFNC group. The most common adverse event during the hospital course was respiratory failure which was seen among 4 patients in non-HFNC group and none among HFNC group developed such complication. **Conclusion:** The use of HFNC oxygen therapy in infants hospitalized with acute bronchiolitis reduces PICU and hospital stay as well as the potential complications which will substantially reduce the hospital cost.

Key words: *Bronchiolitis, High flow oxygen, Hospital stay, Infants*

Bronchiolitis is an acute inflammatory injury of the bronchioles that is usually caused by a viral infection in a child <2 years of age. This is one of the most common and serious lower respiratory tract infections in infants causing breathlessness, cough, and wheezing [1]. It is the major cause of morbidity in this age group and leading cause of hospitalization with annual hospitalization rates of 17 per 1000 children under 6 months of age and 3 per 1000 under 2 years of age, mostly in children without coexisting illnesses [2]. The most common cause (>50%) is respiratory syncytial virus [3], in addition to influenza virus, parainfluenza virus, adenovirus, corona viruses, human metapneumovirus, and mycoplasma pneumonia [4]. Clinical score is generally considered a relative objective instrument to assess the severity of bronchiolitis. There are two clinical severity scoring systems, more commonly used in viral bronchiolitis. One is a respiratory distress assessment instrument which provides a score ranging from 0 to 17, with a higher score indicating more severe respiratory distress. The other scoring system described by Wang et al. provides a score ranging from 0 to 12. A clinical score of <4 is considered as mild, score between 4 and 8 as moderate and score >9 as severe disease [5].

Despite the high prevalence and morbidity of bronchiolitis therapy remains controversial and without widely accepted therapeutic guidelines and pharmacotherapy [6]. The current treatment of acute bronchiolitis is supportive care in the form of supplemental oxygen, fluid therapy, and hypertonic saline nebulization [7]. Traditionally, oxygen is provided at 100% concentration via low flow nasal prongs as a dry gas which is not heated or humidified. However, the latest studies have revealed that heated, humidified oxygen therapy high flow nasal cannula (HFNC) allows the delivery of high inspired gas flows (up to 12 L/min in infants) of an air/oxygen mixture which is better than the traditional one [8]. The inspired oxygen concentration (FiO_2) can be varied from 21% to 100% [9]; therefore, giving the greater ability to titrate the concentration of oxygen delivered.

HFNC therapy has been used primarily in preterm infants with apnea of prematurity and respiratory distress syndrome [10,11]. It is possible that HFNC may have similar benefits in older infants with bronchiolitis as has been used in children with bronchiolitis [12]. Working on the similar hypothesis, we conceived our study to assess the efficacy of HFNC oxygen therapy compared with conventional low flow nasal cannula oxygen therapy in acute bronchiolitis.

METHODS

The study was conducted in the postgraduate Department of Pediatrics and Neonatology of a Government Medical College, Srinagar. It was a comparative study, conducted from April 2014 to October 2015. The study was duly approved by the ethical committee of the institute. All previously healthy children between 1 and 24 months of age with an established clinical diagnosis of moderate to severe bronchiolitis (clinical severity score ≥4, Wang et al.) were included in the study. All those with pre-existing cardiac disorder, previous wheezing history, pneumonia, upper airway abnormality such as choanal atresia, tracheoesophageal fistula and cleft palate, and history of foreign body were excluded. The patients were randomized into two groups by simple randomization to receive either conventional (non-HFNC group) or HFNC oxygen therapy (HFNC group). Outcome parameters measured were total duration of hospital stay, duration of stay in pediatric intensive care unit (PICU), oxygen saturation (SpO_2), respiratory rate, adverse events (respiratory failure), and need for *intermittent positive pressure ventilation* or continuous positive airway pressure. SpO_2 and respiratory rate was recorded at different time intervals, i.e., at the time of admission and then 4 h, 8 h, 12 h, and 24 h of admission.

Procedure was explained and an informed consent was taken from the parent/guardian before enrolling them in the study. Patients were examined at the time of enrollment and thereafter. Relevant demographic and clinical data was obtained which included the following parameters: Age, sex, duration of symptoms, and history of previous wheezing, cardiac disease, and foreign body aspiration. Vital parameters (heart rate, respiratory rate, and oxygen saturation [SpO_2]) were measured and recorded at regular intervals. Patients were examined for the presence of cyanosis, pallor, and chest retractions. In systemic examination, emphasis was laid on breath sounds and presence of rhonchi or rhonchi with crepitations. A complete blood count, arterial blood gas, and chest X-ray were done in all patients. A clinical score was assigned using clinical severity score described by Wang et al. [5].

Statistical analysis was done using SPSS version 20.0. Data were entered in Microsoft Excel. Continuous variables were presented as mean±standard deviation. Categorical variables were presented as absolute numbers and percentages. Unpaired t-test, and repeated measures ANOVA were used to test the variation of continuous variable through time and χ^2 test was used to test the difference between the two groups. $p<0.05$ was considered statistically significant.

RESULTS

Out of 100 patients studied, 50 received HFNC oxygen and 50 received conventional oxygen. Out of 100 patients, 68 were males and 32 were females with M: F ratio of 2.3:1 among HFNC and 1.9:1 among non-HFNC group (p=0.668). The mean age among HFNC and non-HFNC group was 5.54±2.11 months and 5.69±1.59 months, respectively (p=0.562). There was early and better improvement in SpO_2 and respiratory rate among the patients in HFNC group as compared to non-HFNC group as described in Tables 1 and 2. The mean PICU stay among HFNC and non-HFNC group was 1.41±0.45 and 3.11±0.76 days, respectively ($p<0.01$). The mean hospital stay among HFNC and non-HFNC group was 3.94±0.99 and 6.92±1.34 days, respectively ($p<0.001$). The most common adverse event was respiratory failure which was seen in 4 patients in non-HFNC group while none of child from HFNC group developed such complication. All the 4 patients from non-HFNC group required mechanical ventilation ($p<0.04$).

Table 1: SpO_2 level at various points of time intervals of the study population

Group	n	Mean SpO_2	SD	Standard error mean	p value (unpaired t-test)
SpO_2 0					
HFNC	50	82.20	1.161	0.164	0.004
Non-HFNC	50	81.52	1.165	0.165	
SpO_2 4					
HFNC	50	85.28	0.991	0.140	<0.001
Non-HFNC	50	83.12	1.062	0.150	
SpO_2 8					
HFNC	50	87.60	0.881	0.125	<0.001
Non-HFNC	50	84.46	1.249	0.177	
SpO_2 12					
HFNC	50	91.38	0.780	0.110	<0.001
Non-HFNC	50	86.90	1.359	0.192	
SpO_2 24					
HFNC	50	95.90	1.581	0.224	<0.001
Non-HFNC	50	89.88	1.272	0.180	

HFNC: High flow nasal cannula, SD: Standard deviation, SEM: Standard error mean, SPO_2: Oxygen saturation

Table 2: Respiratory rate at various points of time intervals of the study population

Group	n	Mean±SD	Standard error mean	p value
Respiratory rate 0				
HFNC	50	73.46±2.501	0.354	0.506
Non-HFNC	50	73.14±2.286	0.323	
Respiratory rate 4				
HFNC	50	66.54±3.170	0.448	<0.001
Non-HFNC	50	71.10±2.476	0.350	
Respiratory rate 8				
HFNC	50	59.66±2.967	0.420	<0.001
Non-HFNC	50	68.64±2.546	0.360	
Respiratory rate 12				
HFNC	50	49.20±3.387	0.479	<0.001
Non-HFNC	50	61.74±2.954	0.418	
Respiratory rate 24				
HFNC	50	33.08±2.481	0.351	<0.001
Non-HFNC	50	58.64±2.678	0.379	

HFNC: High flow nasal cannula, SD: Standard deviation, SEM: Standard error mean

DISCUSSION

A total of 100 patients with moderate to severe bronchiolitis were included in this study. The mean age at presentation in our study was 5.75 months in both groups which is similar to earlier reports [13]. The mean respiratory rate (breaths/min) at presentation was 73.16 in HFNC and 73.14 in non-HFNC (p=0.5). The mean SpO_2 at presentation between the two groups was 82% and 81% (p=0.41). SPO_2 improved more in HFNC group than non-HFNC at various point of time intervals (p<0.01). These results are quite similar with the study done by McKiernan et al. [14], who observed that infants who were treated with HFNC had a decrease in respiratory rate 1 h after initiation of therapy (18±16 breaths/min) compared with (6±14 breaths/min) those who did not receive HFNC therapy (p<0.001). In another study, Bressan et al. observed that use of HFNC for oxygen administration in infants with moderate to severe bronchiolitis improves SpO_2 levels and seems to be associated with decrease in respiratory rate [15].

In our study, duration PICU stay as well as hospital stay decreased significantly in the HFNC group. However, it is contrary to the studies from other areas of the world [16,17]. This could be because of the fact that our study did not have very sick population and more stress on mother's milk. None of the patients, who received HFNC oxygen therapy, developed adverse event in terms of respiratory failure whereas 4 out of 50 patients, who received conventional oxygen developed respiratory failure and needed mechanical ventilation (p<0.04). This finding is in accordance to the results of the earlier studies [14,18]. However, it is contrary to the study done by Kelly et al. where noninvasive ventilation failure and recourse to mechanical ventilation was 8% [19]. In our study, 4 (8%) among the non-HFNC group developed respiratory failure and needed mechanical ventilation to tie over the crises. HFNC was well tolerated by infants and no complication of therapy was seen including nasal or facial trauma from the application of the therapy which is congruent with the findings of Mayfield et al. [20].

CONCLUSION

We found that the patients treated with humidified heated high flow oxygen had statistically significant decrease in the length of hospital stay, early improvement in the SPO_2, and decrease in respiratory rate in comparison to the patients treated with conventional low flow oxygen. The patients treated with high flow oxygen had significant reduction in the adverse events and need for mechanical ventilation as compared to non-high flow group.

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