Impact and efficacy of High-flow nasal cannula oxygen in Bronchiolitis

Impact et efficacité de l'oxygène à haut débit dans la Bronchiolite

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ABSTRACT :

Introduction : High flow nasal cannula (HFNC) is a new device for ventilatory support in children with bronchiolitis. The aim of this study is assess of the efficacy of HFNC therapy as compared to conventional respiratory support in the treatment of bronchiolitis.

Methods : A retrospective study of infants under 24 months of age with moderate and severe bronchiolitis admitted in pediatric university hospital´s Pediatric intensive care unit (PICU) before (P0 : November 2013 to October 2015) and after introduction of HFNC (P1: November 2015 to October 2017). We compared intubation rate, length of hospital stay, intensive care length stay; length of oxygen therapy and adverse events in the two periods.

Results : In P1, HFNC use decreased markedly the respiratory and heart rates with improvement of blood gas parameters in P1. After the introduction of HFNC, only 8% of infants admitted to the PICU with bronchiolitis required intubation, compared with 20,7% in P0 (P<10-3). The HFNC group needed oxygen supplementation for three days less than the other group (p <10-3) and hospital and PICU stays were 4 days shorter ($p<10^{-3}$). Few adverse events were reported in P1 (35% vs 14.9%, p<10-3).

Conclusion : HFNC decreases the treatment failure rate and the duration of both oxygen therapy and PICU treatment by providing a comfortable and well-tolerated means of non invasive ventilatory support which implies that the HFNC should be the first choice for treating patients admitted to the PICU with moderate and severe bronchiolitis.

Key words : Bronchiolitis, High flow nasal cannula, Pediatric intensive care unit, Standard oxygen therapy

RESUME :

Introduction : La canule nasale à haut débit (HFNC) est un nouveau dispositif d'assistance ventilatoire chez les enfants atteints de bronchiolite. L'objectif de cette étude est d'évaluer l'efficacité du traitement HFNC par rapport à la prise en charge conventionnelle dans le traitement de la bronchiolite modérée et sévère.

Matériel et Méthodes : Une étude rétrospective incluant les nourrissons âgés de moins de 24 mois atteints de bronchiolite modérée ou sévère admis dans l'unité de soins intensifs pédiatriques (USIP) de l'hôpital universitaire pédiatrique avant (P0 : novembre 2013 à octobre 2015) et après l'introduction du HFNC (P1 : novembre 2015 à octobre 2017). Nous avons comparé le taux d'intubation, la durée du séjour à l'hôpital, la durée du séjour en soins intensifs; durée de l'oxygénothérapie et événements indésirables au cours des deux périodes .

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Résultats : En P1, l'utilisation de HFNC a permis de baisser de façon significative la fréquence respiratoire et cardiaque avec une amélioration des paramètres des gaz sanguins en P1. Après l'introduction du HFNC, seulement 8 % des nourrissons admis à l'USIP pour bronchiolite ont nécessité une intubation, comparativement à 20,7 % dans P0 (P<10-3). : la durée de l'oxygénation du groupe HFNC était moins que l'autre groupe de 3 jours (p <10-3) et les séjours à l'hôpital et à l'USIP étaient 4 jours plus courts (p<10-3). Peu d'événements indésirables ont été rapportés dans P1 (35 % vs 14,9 %, p<10-3).

Conclusion : HFNC diminue le taux d'échec du traitement et la durée de l'oxygénothérapie et De la prise en charge en USIP , ce qui implique que le HFNC devrait être le premier choix pour traiter les patients admis à l'USIP avec une bronchiolite modérée et sévère

Mots clés : Bronchiolite, Canule nasale à haut débit, Unité de soins intensifs pédiatriques, Oxygénothérapie standard

INTRODUCTION :

Bronchiolitis is an acute infection of the lower respiratory tract and the leading cause of hospitalization in infants during the first 24 months of life. It is usually caused by the respiratory syncytial virus (RSV) [1]. Although most cases are self-limiting and can be managed at home, between 2 and 10% require hospital admission, and of the latter, 5-7% require respiratory support at the pediatric intensive care unit (PICU) [2]. Supportive therapy, in the form of supplemental oxygen, fluid therapy and respiratory support, remains the mainstay of treatment [3]. Respiratory support has traditionally been the domain of intensive care settings, and has been provided through an escalation of therapy from simple oxygen delivery by nasal cannula, to non-invasive ventilation with Continuous Positive Airway Pressure (CPAP) and finally to intubation and mechanical ventilation (MV) [4]. These strategies require highly skilled staff, are costly, and are associated with a greater incidence of adverse events including ventilator-induced lung injury, barotrauma, and potential neurotoxicity associated with sedation [5].
In recent years, there has been increasing interest in using nasal high flow oxygen cannula as a treatment for bronchiolitis. It delivers a heated and humidified blend of air and oxygen through nasal cannula at rates exceeding the peak inspiratory flow and there by result in more efficient delivery of oxygen to the terminal airways. Physiological studies have demonstrated reduced work of breathing and improved gas exchange [6,7]. Studies have suggested its usefulness for improving oxygenation and alleviating the requirement for MV in children with bronchiolitis [8,9]. The objective of this study was to assess the effects of high-flow nasal cannula therapy compared with conventional respiratory support in the treatment of infants with severe bronchiolitis by comparing the two periods before and after the introduction of HFNC in the intensive care unit of our department pediatrics.

METHODS :

Study design and setting: We conducted a retrospective study at the pediatric intensive care unit of Farhat Hached hospital in Sousse - Tunisia investigating patients admitted with a diagnosis of moderate and severe bronchiolitis. This study took place over two consecutive comparable time periods before and after introduction of HFNC.

Participants : The inclusion criteria were age between 0 to 24 months with diagnosis of moderate or severe bronchiolitis. Bronchiolitis was clinically defined as the first episode of acute wheezing in children less than two years of age, starting as a viral upper respiratory infection (coryza, cough or fever) [1]. The assessment of the severity of bronchiolitis was made by Wang Respiratory Score [10].

Study description: This study took place over two consecutive time periods:
- P0: Before the introduction of the HFNC (November 2013 to October 2015).
- P1: After the introduction of the HFNC (November 2015 to October 2017).
In P0, the ventilation supports used were:
- Standard oxygen therapy (SOT) with standard nasal cannula and high concentration oxygen mask.
- Non invasive ventilation with nCPAP.
- Intubation and MV.
In P1, HFNC was used in addition of those supports from P0. HFNC was introduced in the pediatric department of Farhat Hached Hospital of Sousse in November 2015. Infants in the HFNC group received heated and humidified gas flow of 2 L/kg/min with the Fisher and Paykel Healthcare® HFNC system. The cannula size was chosen to fit the child's nares and adjusted for comfort. The amount of oxygen varied depending on the degree of hypoxemia and was adjusted to maintain saturations ≥ 94%. The study included children with bronchiolitis receiving HFNC as the first, second or third respiratory support.
Failure of high flow oxygen therapy was defined as lack of clinical improvement or worsening in the condition of the patient despite the optimisation of therapy with delivery of maximum FiO2 and flow rates, requiring transition to another modality of respiratory support. Treatment failure criteria were an increased work of breathing (retractions, flaring, grunting), increase of polypnea, pulse oximetry (SpO2) < 94% and hypercapnia in control blood gaz. The intubation criteria used were prolonged respiratory arrest, refractory hypoxemia, exhaustion secondary to increased breathing effort, consciousness abnormalities, and acidosis with hypercapnia. Once failure criteria were met, escalation of treatment may be from standard oxygen therapy to HFNC therapy or escalation to nCPAP from HFNC

or MV from SOT, HFNC or nCPAP. The success of the treatment was defined by no need for an escalation of care during hospitalization.

Data collection: Patients data were collected from medical records. The data collected included age, weight, sex, comorbidity, respiratory rate (RR), Heart rate (HR), SpO2, blood gas (pH, pCO2), and viral status.

In HFNC group (P1), RR and HR were recorded for each patient for a baseline at the time of HFNC initiation (T0) and at different time intervals:

I1 = interval between T0 (just before the initiation of the HFNC) and the 2nd hour.

I2= interval between the 2nd hour and the 6th hour.

I3= interval between the 6th hour and the 12th hour.

We recorded capillary blood gas parameters (pH, PCO2) at T0 and 4 hours from initiation of HFNC oxygen therapy.

For the two periods (P0, P1), Hospital and PICU stay, length of oxygen therapy and intubation rate were measured. The type of 1st ventilatory support used, the change of support if necessary (2nd and 3rd support) was also collected. We documented adverse effects (air leak syndrome, abdominal distension, nosocomial infection and skin erosion at the area of contact with the cannula).

Study outcomes:

Primary outcomes was to assess the impact of HFNC on clinical (HR and HH) and gazometric (pH, pCO2) parameters on different time intervals.

Secondary outcomes were to compare the proportion of infants requiring intubation, length of hospital stay, including intensive care length of stay ; length of oxygen therapy and adverse events in the two periods. HFNC therapy failure was defined as children requiring nCPAP or invasive ventilation based on the clinical decision of the attending physician.

Statistical analysis: The Statistical Package for Social Sciences (IBM-SPSS, version 23) was used for data entry and statistical analysis. The quantitative variables were expressed as means and standard deviations. The qualitative variables were expressed as absolute values and percentages. The two periods were compared using the student t-test or the Mann–Whitney U-test for quantitative variables and the chi-square test or the Fisher exact test for qualitative variables. The study of parameters at time intervals was made by variance analysis and to identify the predictive factors for intubation, a multivariate regression analysis was used. P values <0.05 were considered statistically significant.

RESULTS :

We included a total of 179 infants, 87 in the cohort of the HFNC period (P1) and 92 in the cohort of the period preceding the introduction of HFNC oxygen therapy (P0). Baseline characteristics of the two groups are presented in Table 1.

Table 1 : Patients characteristics between periods P0 and P1

Variables	P0 N=92	P1 N=87	P
Demographic parameters			
Age month (min-max)	2 [1-20]	2[1-25]	0,08
Sexe N(%)	66 (71,7%)	47 (54%)	**0,01**
Weight Mean (DS)	5 ,15 ± 2,14	5,09 ± 1,8	0,8
Hypotrophy N (%)	33 (35,9%)	20 (23%)	0,59
Comorbidities N (%)	35 (38%)	27 (31%)	0,32
Prematurity	20 (21,7%)	14 (16,1%)	0,33
Bronchopulmonary dysplasia	5 (5,4%)	1 (1,1%)	0,21
Heart disease	11 (12%)	9 (10,3%)	0,73
Neuromuscular disease	4 (4,3%)	2 (2,3%)	0,68
Malformations	7 (7,6%)	8 (9,2%)	0,70
Clinical features			
SpO2 (Mean ± SD)	88,2 ± 5,7	87,8 ± 6,5	0,66
RR (breath/min) (Mean ± SD)	66,17 ± 7,8	69,7 ± 7,9	**<10^{-3}**
HR (beat/min) (Mean ± SD)	154,2 ± 21	158,7 ± 21	0,15
Blood gas parameters			
pH (Mean ± SD)	7,38 ± 0,8	7,34±0,8	**<10^{-3}**
PaCO2 (Mean ± SD)	34,38± 11	38,08 ± 12	0,05
PaO2 (Mean ± SD)	89,70 ± 42	87,50 ± 45	0,75
RSV N (%)	37 (40,2%)	16 (18,3%)	**<10^{-3}**
First ligne respiratory support			
SNC N(%)	71 (77,2%)	22 (25,3%)	
HCOM N(%)	20 (21,7%)	6 (6,9%)	
HFNC N(%)	0	51(58,6%)	
N-CPAP N(%)	1 (1,1%)	5 (5,8%)	
MV N(%)	0	3 (3,4%)	

SNC : standard nasal cannula, **HCOM :** High concentration oxygen mask, **HFNC :** high flow nasal cannula, **NCPAP :** Nasal continuous positive airway pressure, **MV :** mechanical ventilation, **SpO2 :** Pulse oximetry, **SD :** standard deviation, **RSV :** respiratory syncytial virus, **RR :** respiratory rate, **HR :** heart rate.

We did not find statistically significant differences between the cohorts in the baseline characteristics of the patients: age (p=0.08), trophicity (p=0.59) and weight (p=0.80). However, the percentage of boys was higher in P0 (p=0.01). The presence of comorbidities was similar between the two periods (p=0.32). Prematurity was the most frequent comorbidity in the two populations of P0 and P1.

SpO2 and HR were similar between the two periods. But, the RR was significantly higher in P1 (69,7 versus 66,17; p=0.001). Respiratory acidosis was more present in patients in P1 (p <10-3). PaCO2 was higher in P1 but without significant difference. P0 infants appeared to be significantly more infected with RSV (40.2% versus 18.3%).

The respiratory support techniques used in each period were different. The first means of oxygenation used in P0 was the standard nasal cannula (77.2%). In P1, HFNC was first-line treatment in 58,6% of cases.

Primary outcomes : Both the RR and the HR improved significantly with the passing of the hours. The RR decreased significantly between T0 and I1 by an 13 breath/min (18%), then by 7 breath/min in I2 and around 5 breath/min in I3 (Figure 1).

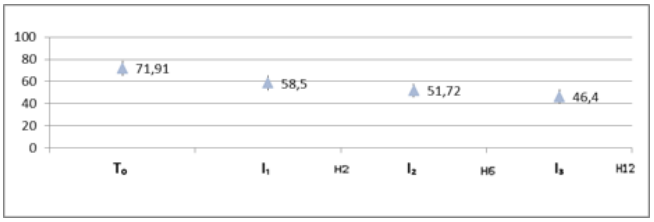


Figure 1 : Evolution of the respiratory rate in patients in the HFNC group

Similarly the HR decreased significantly from 163 to 142, 130 and 120 bpm respectively in I1, I2 and I3 (figure 2).

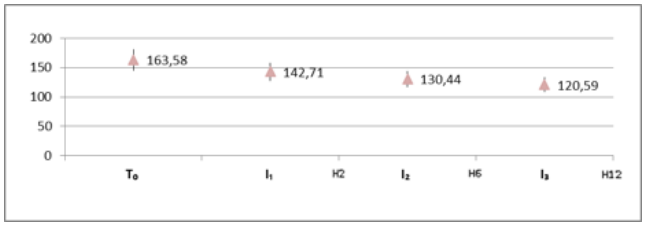


Figure 2 : Evolution of heart rate in patients in the HFNC group

For patients who initially had respiratory acidosis, blood gas control was performed 4 hours after HFNC therapy. The pH increased significantly by an average of 0.03. For capnia, there was a significant decrease by an average of 5 mmHg (Table 2).

Table 2 : Blood gas parameters in HFNC group

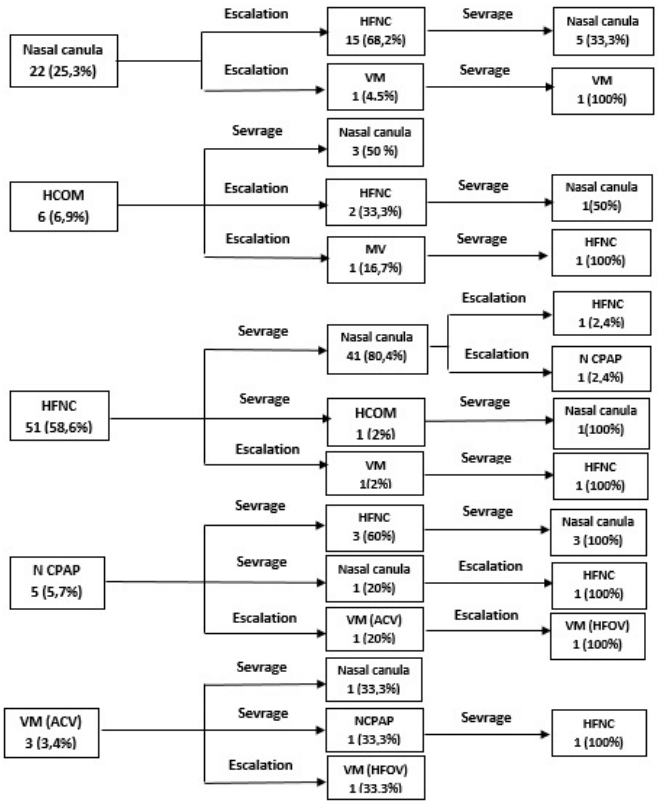
Variable	Gasometric values	p
Initial pH mean ± SD	7,34 ± 0,064	**p=0,01**
pH at H 4 mean ± SD	7,37 ± 0,05	
Initial pCO2 mean in mm Hg ± SD	40,28 ± 11,79	
pCO2 at H4 Mean in mmHg ± SD	35,77 ± 5,73	**p < 10^{-3}**

Secondary outcomes: HFNC oxygen therapy was associated with a significant reduction in the need for intubation (20.7% in P0 vs 7% in P1; p=0,01). In univariate analysis, the introduction of HFNC in P1 reduced intubation rate. In multivariate analysis, and including parameters (hypotrophy, age < 3 months and comorbidities), HFNC does not seem to protect against intubation (p=0,06). The length of the hospital stay and PICU stay were significantly reduced in P1.The mean duration of HFNC oxygen therapy was 4,97 ± 3,6 days versus 8,18 ± 8,02 days for the other respiratory supports (p < 10-3). Adverse events were significantly more frequent in the first period (35.9% vs 14.9%; p<10-3). Their occurrence with HFNC was 10.8% versus 36.2% with all the other supports (p < 10-3). We found a higher frequency nasal skin lesions with CPAP compared to the HFNC group but with no statistically significant (p=0.2). No differences were observed among the groups in terms of abdominal distention (p=0.73) and air leak syndrome (p=0.63). Nosocomial infections decreased significantly (32.6% in P0 vs 14.9% in P1; p <10-3) and it was significantly lower with HFNC therapy (10.8%) compared to with the other respiratory supports (33.3%) (p<10-3). Mortality rate decreased significantly from 13% in P0 to 3.4% in P1 (p= 0.02) (Table 3).

Table 3 : Secondary outcomes of HFNC therapy

Variables	P0 N=92	P1 N=87	P
Intubation rate N (%)	19 (20,7%)	7 (8%)	**<10^{-3}**
Hospital stay (days) (Mean ± DS)	14,60 ± 10,54	10,32 ± 9,88	**<10^{-3}**
PICU stay (days) (Mean ± DS)	10,95 ± 8,81	6,71 ± 7,20	**<10^{-3}**
Adverse events N (%)	33 (35,9)	13 (14,9)	**<10^{-3}**
Nasal injury N (%)	7 (7,6)	2 (2,3)	0,20
Barotrauma N (%)	3 (3,3)	3 (3,4)	0,63
Abdominal distension N (%)	1 (1,1)	1 (1,1)	0,73
Nosocomial infection N (%)	30 (32,6)	13 (14,9)	**<10^{-3}**
Death N (%)	12 (13)	3 (3,4)	**0,02**

Escalation therapy: In P1, HFNC was the 1st most frequent means of oxygenation (58.6%) followed by nasal cannula (25.3%), high concentration oxygen mask (6.9%), nCPAP (5.7%) and MV (3.4%). Escalation therapy was required in 28.7% of patients. High-flow oxygen therapy failed in 3 patients (5,8%), who required MV (1 patient), CPAP (1 patient), put back on HFNC after secondary clinical worsening (1 patient). The causes of failure were respiratory acidosis, increased breathing effort for 2 patients and apnea in one patient. We found that 19 patients (26%) who used HFNC as their 1st or 2nd ventilatory support did not need another ventilatory support for progressive oxygen weaning (Figure 3).



HCOM : High concentration oxygen mask ; HFNC : High flow nasal canule ; VM : Mechanical ventilation ; ACV : Assist control ventilation ; HFOV : High frequency oscilation ventilation

Figure 3 : Escalation therapie in HFNC group

DISCUSSION :

During recent years, heated and humidified high flow oxygen administration, using nasal cannula, has become increasingly popular for respiratory support in children with bronchiolitis. In this pilot study, we describe the use of HFNC in infants hospitalized for moderate and severe bronchiolitis in a pediatric intensive care unit and its effects on ventilatory parameters. There were significant improvements in clinical and laboratory findings of children who received HFNC within 6 hours after HFNC use. HFNC therapy would probably be most effective during the first few hours of respiratory failure, when the inspiratory flow is sufficient [8]. Including 28 patients prospectively, Pham et al [6]. showed a decrease of RR associated with a reduction in breathing effort (decrease of esophageal pressure and decrease of diaphragmatic electrical activity) with the use of HFNC with a flow rate of 2 L/kg/ min. In the randomized controlled study of Milani et al. [11], both the respiration rate and the HR decreased more markedly, particularly within the first 8 h, in patients receiving HFNC therapy than in those treated using a standard nasal prongs . The study of Schibler et al. [8] showed that children with a 20% decrease in RR and HR at 90 minutes did not require therapeutic escalation.

Our study showed a significant improvement in gasometric parameters in HFNC group. For patients who initially had respiratory acidosis, the pH increased significantly by an average of 0.03. For capnia, there was a significant decrease by an average of 5 mmHg. These results were consistent with those of the prospective observational pilot study of Bressan and al. [12] showed that the median PaCO2 and RR rapidly decreased by 6–8 mmHg and 13–20 breath/ minute, respectively, in the first 3 hours of HFNC therapy.

Most literature data on safety and effectiveness are based on retrospective cohort studies and suggest that the use of HFNC compared to SOT reduces the risk for intubation and need for invasive ventilation [13,14]. Mc Kiernan et al. [15] retrospectively studied 115 children (57 from before the introduction of HFNC and 58 from the season after the introduction of HFNC) and showed a 68 % decrease in intubations and a decrease in the median PICU length of stay from 6 to 4 days after the introduction of HFNC. Australian investigators noted a decline in intubation rate from 37 to 7 % in a retrospective chart review over a 5-year period of 167 children with bronchiolitis treated with HFNC in the PICU [8]. Similar to our results, both studies found a reduction in RR at 60 (15) and 90 min [8] after initiation of HFNC therapy. In the study of by Schibler et al [8], treatment failure was indeed lower in the HFNC group compared to the SOT group; very few children needed invasive ventilation. In the small semi-randomized pilot study by Milani et al. [11] involving patients with moderate to severe bronchiolitis who were younger than 12 months old, the duration of oxygen therapy and length of hospital stay were lower in patients receiving HFNC therapy than in those receiving SOT. To break free from the different biases of retrospective studies, a multicenter, randomized trial, conducted by Franklin et al. [16] that compared oxygen therapy treatment with SOT and HFNC in New Zealand and Australia, involving 1472 patients, the percentage of infants receiving escalation of care was 12% (87 of 739 infants) in the high-flow group, as compared with 23% (167 of 733) in the standard-therapy group (p <0.001).

Oxygen therapy via HFNC creates positive pressure in the nasopharyngeal area and decreases respiratory workload and respiratory stress due to the high velocity of oxygen delivery. When therapy is provided using an HFNC, oxygen consumption decreases because the activity of the diaphragm increases. The workload of the accessory respiratory muscles is also reduced; therefore, HNFC slows progression to respiratory failure and decreases the intubation rate. The oxygen supplied is heated and humidified, preventing mucosal injury by reducing inflammatory reactions [11,17]. This may explain the greater benefit of HFNC over standard oxygen therapy in some patients

When compared to CPAP, the effectiveness of HFNC is not that high. The clinical response to nCPAP was more favorable than the response to HFNC in moderate to severe respiratory distress [18]. Treatment failure was higher comparing HFNC to nCPAP and patients failing with HFNC could be successfully switched to nCPAP therapy in around 70% of cases [18] and no difference was seen between the treatment groups concerning the duration of oxygen therapy and length of PICU stay. Recent study reported that the effectiveness of HFNC as initial respiratory support among children with moderate to severe acute viral bronchiolitis was less than that of nCPAP. They suggested that nCPAP may be more efficient than HFNC for initial respiratory support in young infants hospitalized in a PICU for moderate to severe acute viral bronchiolitis [19].

Two recent systematic reviews investigated the effects of HFNC versus other forms of oxygen therapy for bronchiolitis. The reviews found no differences in length of stay, length of oxygen supplementation, intubation rates, length of stay in PICU, RR, HR or adverse events. A significant reduction of the incidence of treatment failure was observed in the HFNC group compared with standard therapy, but there was a significant increase of the incidence of treatment failure in HFNC group compared with nCPAP group [20,21]. Consistency of PEEP is the advantage of nCPAP, although the influential factors of PEEP during HFNC, such as mouth breathing and flow setting are more inclined to be impacted by younger pediatrics [21]. This may explain that the clinical response to nCPAP was more favorable than the response to HFNC in moderate-to severe respiratory distress.

The definition of treatment failure in literature was

not homogenous. In most studies who included treatment, failure as an outcome there was an option for individual clinicians to independently decide that patient had failed a particular therapy, in addition to objective markers such as worsening of physiological parameters. This potentially creates significant bias and is a limitation of this systematic review and meta-analysis. Failure of HFNC may be anticipated in case of high pCO2 and low pH on arterial blood gases, while HR and RR on admission did not seem to be predictive [17]. In non-responders, HR and RR did not significantly decrease after start of high flow compared to the responders [15,17].Furthermore; higher FiO2 need was considered as the predictor of HFNC treatment failure [18]. These factors should be considered when initiating HFNC for bronchiolitis to identify patients at risk for deterioration. Milési et al [18] identified clinicians' familiarity with HFNC devices as another important factor in the success of HFNC utilization.

Noninvasive ventilation has some immediate advantages over intubation. It decreases airway damage and ventilator-associated pneumonia, and decreases the requirement for sedation [5]. nCPAP has this own complications (skin or eye complications, gastric distension, pneumothorax, anxiety and need for sedation) [22]. HFNC has been shown to be a safe mode of respiratory support and in clinical practice, the use of HFNC is much easier than the use of nCPAP since the nasal masks are not well tolerated and interfere with normal care for the child [14]. Only mild adverse events have been reported like skin irritation and epistaxis. Air leak syndromes can however occur especially with inappropriate application of cannula size or an inappropriately high flow rate [23]. Only one study compared different flow rates with regard to safety and efficacy [24]. HFNC failure rate, intubation rate, and duration of invasive ventilation were similar between flows of 2 l/kg/min and 3 l/kg/min. With use of higher flow, there was more discomfort and longer PICU stay. No air leak syndromes occurred.

Studies on HFNC in Tunisia are scarce. Our study showed the clinical effectiveness and easiness of use of HFNC by comparing two periods before and after HFNC introduction. However, this study has several limitations. First, the study was retrospective and it was conducted in a single center with a small number of patients, which increased the chance of bias and limited the study generalization. In addition, requiring nCPAP ventilation or invasive ventilation after HFNC failed was based on subjective judgment of the physician and possibly the pCO2 value.

CONCLUSION :

HFNC is a safe mode of respiratory support. It provides more rapid improvement of clinical and laboratory findings in patients with severe and moderate bronchiolitis. HFNC use decreased the treatment failure rate and the duration of both oxygen therapy and PICU treatment with few complications compared to other respiratory support. Therefore, HFNC should be considered the first choice for oxygen therapy in patients admitted to the PICU with moderate and severe bronchiolitis.

What is already know on this topic

-High flow nasal cannula therapy has emerged as a new method to provide respiratory support for bronchiolitis.

-There is limited evidence on its effects and safety.

What this study adds

-High flow nasal cannula was safe and efficient in moderate and severe bronchiolitis.

-HFNC should be the first choice for treating patients admitted to the PICU with moderate and severe bronchiolitis

ABBREVIATION

HFNC : high flow nasal cannula
HR : Heart rate
MV : mechanical ventilation
nCPAP : Continuous Positive Airway Pressure nasal
PICU : pediatric intensive care unit
RR : respiratory rate
RSV : respiratory syncytial virus
SOT : Standard oxygen therapy
SpO2 : pulse oximetry
PEEP : Positive End Expiratory Pressure

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