

High-flow nasal cannula versus Nasal continuous positive airway pressure among preterm babies with respiratory distress syndrome

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ABSTRACT

Background: HHFNC(humidified high-flow nasal cannula) and NCBAP(Nasal Continuous Positive Airway Pressure) are Known ventilator support widely used in pediatric intensive care unit with specific indications. Advantage and disadvantages of both we discussed in many literatures and both improved outcome of patients with proper setting and less side effects.Objectives: We aimed to evaluate the use of both procedures in very to moderate preterms with RDS and to study the predictors associated with their success/failure

Materials and Methods : A cross-sectional study was conducted at Intensive Care Unit of Rapareen Teaching Hospital in Erbil during the period from January till December 2023, sixty-five preterm babies of 28-33 weeks with respiratory distress syndrome (RDS) were enrolled in this study.

Results: The study included 65 patients with Mean gestational age of 30.62 ± 1.62 and median GA 31m, majority were aged 3 days and male mainly product of caesarian delivery. Significant association was evident between need for NCPAP upon HHFNC with female gender and lower birth weight. Pneumothorax was among serious complications noted highly among NCPAP patients compared to HHFNC.

Conclusions: NCPAP more frequent among low birth weight and increase likelihood of pneumothorax in comparison to HHFNC. No one of procedures have advantage over other regarding length of stay at hospital or death rate.

Keywords: Distress, Nasal, Newborn, Respiratory

INTRODUCTION

Premature babies constitute around 8-10% of live births but could reason for 90% of early neonatal morbidity and mortality.(1)The etiology of Broncho-pulmonary dysplasia (BPD) in very preterm babies is due to many causes, but ventilator induced pulmonary injury have a great role. (2)

Lately techniques of intubation and mechanical ventilation for preterm neonates adapted to decrease risk of lung damage and BPD in preterm babies. Non- invasive ventilation can be applied by different ways like Nasal Cannula (NC), Nasal Continuous Positive Airway Pressure (NCPAP) and Nasal Intermittent Positive Pressure Ventilation (NIPPV). (3)

the NCPAP is non-invasive respiratory support for preterm infants without need for intubation. As a result, continuous airway positive pressure expands the lungs which led to proper ventilation.(4)The humidified high-flow nasal cannula (HHFNC) is another commonly used technique for the managing RDS. The use of lighter and smaller cannula in HHFNC keep neonates away from minor traumas like nasal injury. (5,6)

Appropriate use of NCPAP or HHFNC during neonatal life is associated with reduced risk of bronchopulmonary dysplasia (BPD) and even mortality among risky very low birth weight infants, in addition to lowering in the likelihood of severe intraventricular hemorrhage, significant patent ductus arteriosus (PDA), days needed on ventilation with its known complications like pneumo-thorax, pulmonary emphysema and pneumonia (7 ,8).

Aim of the study is to evaluate the use of both procedures in very to moderate preterms with RDS and to study the predictors associated with their success or failure

MATERIALS AND METHODS

A cross-sectional study was conducted at Intensive Care Unit of Rapareen Teaching Hospital in Erbil during the period from January till December 2023, sixty-five preterm babies of 28-33 weeks with respiratory distress syndrome (RDS) were enrolled in this study. Exclusion criteria were Apgar score at 5 minutes less than 4, birth

asphyxia with encephalopathy, those with major anomalies. RDS was diagnosed by presence of tachypnea (more than 60/min), retractions, expiratory grunting and cyanosis were present in combination with radiological signs of poor lung expansion. Any newborn with respiratory severity score of 4-7 and oxygen need of <60% were eligible for this study.

Humidified high flow nasal cannula at flow 6 L/min was used for HFNC group using short binasal prong to supply adequate distending pressure to reduce work of breathing and provide good oxygen saturation.

Indications for NCPAP were increased respiratory effort and also FiO_2 requirement exceeding 30%. Intubation and mechanical ventilation were commenced either when oxygen saturation were less than 85% or when $\text{PaO}_2 \leq 50$ mmHg while receiving $\text{FiO}_2 \geq 0.4$ or the PCO_2 exceed 65 mmHg with a $\text{pH} < 7.2$ on arterial blood gas analysis or once there are more than 4 apneic episodes in the first hour of life or need more than 2 episodes of bagging per hour.

NCPAP was delivered by the Infant Flow CPAP or ventilator using short single nasal prong with variable sizes according to weight. This group initially received positive end-expiratory pressure (PEEP) of 5 cmH₂O which was arranged between 4-6 cmH₂O according to the neonate's respiratory efforts. A fraction of inspired oxygen (FiO_2) of 0.4 was started, and it was adapted until SpO_2 of 92-96% was maintained. Weaning was initiated with a gradual lowering of the set FiO_2 to 0.25 and PEEP to 4 cmH₂O.

HHFNC support was applied using the Medin[©] blender System. Here, the short binasal cannula with variable sizes according to weight were used. The neonates on HHFNC given a low of 5 L/min at start, then adjusted between 3-7 L/min according to the infants' respiratory condition. FiO_2 of 0.4 was initiated, and again adjusted until SpO_2 of 92-96% was settled. Weaning was initiated with a gradual reduction of FiO_2 to 25% and decrease up to 3 L/min.

Outcome

The primary outcome was treatment failure in both NCPAP and HHFNC group. Secondary outcomes included conditions like pneumothorax, patent ductus arteriosus (PDA), chronic lung disease, need for intubation and ventilation, necrotizing enterocolitis (NEC), increased hospital stay and finally death.

Treatment failure defined as Respiratory acidosis ($\text{PaCO}_2 > 65$ mmHg with $\text{pH} < 7.2$) at the maximum setting with low 7 L/min or PEEP 6 cmH₂O, hypoxia ($\text{FiO}_2 > 0.6$ to maintain SpO_2 92-96%) or apnea (>2-3 episodes of apnea/hour need frequent stimulation or bag-mask ventilation) despite proper prong fixation and flow or PEEP delivery.

Informed and written consent were obtained from parents or caregivers after explaining the aim and way of conducting the study.

SPSS version 23 statistical software was used for data analysis. Also, descriptive statistical tests were used to report demographic variables, chi-square test to compare qualitative variables between groups while Student's t-test to compare averages.

RESULTS

The study included 65 patients with a Mean gestational age of 30.62 ± 1.62 and median GA 31m, majority were aged 3 days and male mainly product of caesarian delivery. Large proportion were referred from private sectors rather than public one. Among studied sample, 72.3% were improved and discharged with no or minimal problem. (table 1)

In table 2, significant association was evident between need for NCPAP upon HHFNC with female gender and lower birth weight. Pneumothorax was among serious complications noted highly among NCPAP patients compared to HHFNC.

Table 1: Demographic and clinical data of studied sample

Variables		no. = 65	%
Gestational age	28 weeks	13	20.0
	29 weeks	4	6.2
	30 weeks	11	16.8
	31 weeks	37	57
Gender	Male	34	52.3
Age	3 days	46	70.8
Weight	1.44 \pm 0.46		
Site of referral	Private	48	73.8
Mode of delivery	Caesarian section	42	64.6
Outcome	Improved	47	72.3

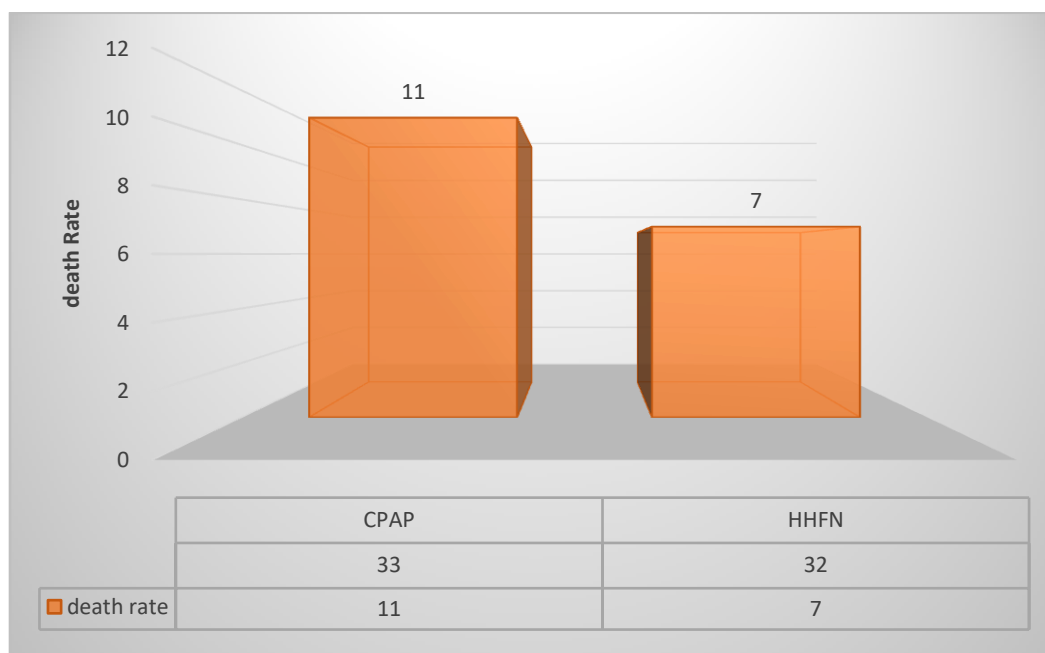


Figure 1: death rate among two groups (CPAP, HHFN)

Table 2: Comparison of HHFNC vs NCPAP in association to certain variables

		HHFNC no.=32	NCPAP no.=33	P value	OR
1	Birth Weight	1.56 ± 0.48	1.33 ± 0.41	0.044	
2	GA	30.88± 1.36	30.36±1.81	0.25	
3	Gender			0.034	2.93 (1.07 – 8.06)
	Male	21 (65.6%)	13 (39.4%)		
	Female	11 (34.4%)	20 (60.6%)		
4	Site of referral			0.181	0.462 (0.15 -1.45)
	Public	6 (18.8%)	11 (33.3%)		
	Private	26 (81.3%)	22 (66.7%)		
5	Mode of delivery			0.87	0.917 (0.331-2.54)
	NVD	11 (34.4%)	12 (36.4%)		
	CS	21 (65.6%)	21 (63.6%)		
6	Outcome			0.302	0.56 (0.185-1.695)
	Death	7 (21.9%)	11 (33.3%)		
	Improved	25 (78.1%)	22 (66.7%)		
7	Length of stay	8.59± 10.32	5.21 ± 5.87	0.108	
8	Treatment failure*	3 (9.4%)	7 (21.2%)	0.303	0.38 (0.09 – 1.64)
9	Pneumothorax *	1 (3.1%)	6 (18.2%)	0.05	6.89 (0.78 -60.88)
10	IVH*	2 (6.3%)	5 (15.2%)	0.43	2.67 (0.48-14.94)

* Fisher exact test

DISCUSSION

This study demonstrated effectiveness and safety of HHFNC in comparison to NCPAP among very to moderate preterm babies in NICU, sixty five patients were studied of nearly equal gender.

Babies with less weight and lower gestational age were more vulnerable to be exposed to NCPAP rather than HHFNC but this still controversial compared to other studies as indications may varies according to national protocols and individual experience. Shirvani et al reported there was no any association as Mostafa-Gharehbaghi M et al also revealed. (2 ,7) Female significantly associated with later need for NCPAP unlike other studies (2,8) Understanding the value of gender differences in respiratory morbidity and also mortality among male and female preterm infants may lead to more proper therapies. (9)

Since a study by Wylliedone long time ago, many papers have underestimated the “disadvantage” in the overall morbidity and mortality of male babies especially preterm newborns with poor outcomes mainly RDS and CLD at a much higher rate than female. This may be explained by earlier surfactant production and activation of

some receptors in females which can secure them from significant illness. In this study surprisingly Female significantly associated with later need for NCPAP unlike other studies (2,8) Again this could be justified by earlier male neonatal deaths related to their severity of symptoms and complications.(9)

Despite fewer patients were referred from public hospital due to availability of NCPAP in most of governmental hospitals while financial issue urge families to refer from private hospitals, data revealed in this study was not supported by other reports as such health system is different and most didn't include it. The high percentage of neonates need for HHFNC from private may be explained by early referral due to reason mentioned before.

Although there was no major difference between the two techniques concerning therapeutic outcomes, the use of any technique usually depends on the expert's judgment. Only length of stay (mean) was longer among those underwent HHFNC despite being insignificant as approved by many papers. (7,8)

Failure of treatment and mortality were not significantly related with these modalities of interventional therapy as most articles reported with a study sample of term or preterm newborns (7,14). Among children with acquired respiratory distress younger than 2 years, HHFNC appears to be associated with higher risk of treatment failure and possibly, an increased risk of need for intubation and even mortality. (15) Only Yoder et al. reported that the length of hospital stay among the neonates with RDS in the HHFNC treatment group was significantly higher than that of the NCPAP treatment group (16). Preterm infants in general have higher risk of neonatal intensive care unit admission and longer stay (17), this may be reduced by appropriate therapy modality.

Most common complication stated among preterm underwent NCPAP was BPD and explain failure of treatment in majority.(12) Patient on NCPAP showed significant high frequency of pneumothorax when compared to HHFNC, such finding may be due to lack of surfactant introduction among studied patients as could have a protective impact in most preterm babies (10) Morley et al reported the incidence of pneumothorax after NCPAP was 9% regardless gestational age of newborns (11) while higher by Malek et al reach up to 26 % in a study includes 400 newborn subjected to different mechanical ventilation modalities. (10) Holleman-Duray et al. (13) evaluated humidified high flow nasal cannula system in 65 neonates with RDS and concluded that HHFNC is safe and well tolerated

CONCLUSIONS

NCPAP more frequent among low birth weight and increase likelihood of pneumothorax in comparison to HHFNC. No one of procedures have advantage over other regarding length of stay at hospital or death rate.

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