ORIGINAL ARTICLE

OUTCOME OF USE OF NASAL CONTINUOUS POSITIVE AIRWAY PRESSURE THROUGH INFANT FLOW DRIVERS IN NEONATES WITH RESPIRATORY DISTRESS IN A TERTIARY CARE HOSPITAL IN PAKISTAN

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Background: Nasal continuous positive pressure has been used for management of respiratory distress in neonates in various conditions as a primary modality. Objective of the study is t**o** evaluate the frequency of improved outcome and complications of use of nasal CPAP through infant flow drivers in neonates with respiratory distress. The study was conducted from 2nd April 2017 to 2nd October 2017 in neonatal intensive care unit of Allama Iqbal Memorial Teaching Hospital Sialkot. **Methods:** All neonates with respiratory distress fulfilling the clinical criteria (Neonates with gestational age 28 weeks to 40 weeks having clinical signs of respiratory distress classified according to down score (tachypnea, grunting, decreased air entry, cyanosis, recessions), neonates having pc02 <60 mmhg, neonates having x-ray findings consistent with respiratory distress syndrome (RDS), Transient tachypnea of newborn (TTN) and pneumonia) were included in the study. Nasal CPAP was used at variable settings. Outcome, complications, indications, associated diseases and hospital stay along with other baseline characteristics were assessed. Success was defined as improvement of the respiratory distress as assessed by down score, maintenance of SPO2 above 90% in room air after weaning from CPAP for about consecutive 4 hours and normalization of blood gases while the failure as need for mechanical ventilation. **Results:** Total 60 neonates were included in the study. Mean weight was 2113.3±580.32 g while mean gestational age was 33.35±2.59 weeks. Total 52 (86.7%) babies were successfully weaned off from nCPAP while only 8 (13.3%) neonates required mechanical ventilation. Main indication of use of CPAP was RDS (65%). No complications were observed in 73.3% babies while 26.7% had complications of which nasal deformities accounted for 20% and abdominal distension for 6.37%. **Conclusion:** Nasal CPAP can be safely and easily used as primary support for neonates with respiratory distress even in resource limited developing countries. It reduces the need for mechanical ventilation and thus hospital stay.

Keywords: Continuous positive airway pressure; Noninvasive ventilation; Respiratory distress Syndrome; Developing countries

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INTRODUCTION

Nasal Continuous Positive Airway Pressure (nCPAP) has emerged as the primary ventilatory support in neonates with respiratory distress over the last few decades.[1] CPAP is a method of non-invasive ventilation that opens the airways by providing continuous pressure throughout the respiratory cycle.[2] It increases Functional Residual Capacity and decreases the work of breathing and thus improves gaseous exchange in neonates with respiratory distress.[3] Nasal CPAP has shown to reduce the need for mechanical ventilation and surfactant administration. It is also helpful in reducing hospital stay and need for referral to up-level tertiary care centers.[4]

Nasal CPAP is commonly used to treat respiratory distress syndrome (RDS), Congenital pneumonia, Transient tachypnea of newborn (TTN) and Apnea of prematurity. It is also used post extubation while weaning from conventional mandatory ventilation in a self-breathing baby.[5]

Nasal CPAP is administered either through conventional bubble CPAP or through CPAP generator machines like infant flow drivers (IFDs).[6] Infant flow drivers have shown to decrease the work of breathing by about 75% in respiratory distress when compared with conventional bubble CPAP.[7]

In resource limited countries the rate of preterm deliveries is very high. Pakistan, a small developing country in South East Asia has the 4th highest rate of preterm births (15.8%).[8] Most of the deaths in these preterm babies are attributed to respiratory failure. Most neonatal units in Pakistan still use only oxygen as the standard of care for these patients while some use handmade bubble CPAP.

However very few units have now started to use nCPAP generators but still the published data is limited. Only two studies from Pakistan have been reported in this context but their sample size is small.[9,10]

The rationale of our study is to determine the efficacy and feasibility of use of nCPAP generators in developing countries with multiple restraints like suboptimal nurse to patient ratio, lack of monitoring devices and cost issues. Our data will sensitize healthcare providers for early use of CPAP through IFDs and will help health administration to plan up scaling of this intervention in neonatal centers.

MATERIAL AND METHODS

This was an epidemiological study conducted from April to October 2017 at the neonatal intensive care unit (NICU) of Allama Iqbal Memorial Teaching Hospital Sialkot. After approval of Hospital Ethical Committee total of 60 neonates were enrolled using non-probability consecutive sampling technique. Informed and written consents were taken.

The sample size was calculated using online open Epi sample size calculator, by taking success percentage of babies placed on nasal CPAP as 92.7%[11], margin of error as 6.6% & confidence level as 95%. All neonates with gestational age 28 to 40 weeks (according to Ballard scoring) having clinical signs of respiratory distress classified according to down score (tachypnea, grunting, decreased air entry, cyanosis, recessions), neonates having pc02 <60 mmhg, neonates having x-ray findings consistent with respiratory distress syndrome (RDS), transient tachypnea of newborn (TTN) and pneumonia fulfilling the clinical criteria and neonates weaned off from mechanical ventilation were included in the study. All neonates with severe birth asphyxia, severe cardiac instability, congenital abnormalities, neuromuscular diseases, persistent prolonged apneas and worsening respiratory type 2 failure were excluded from the study.

In this study we used SLE 1000 which is a servo-controlled flow CPAP generator. Infant nasal prongs of different sizes were used as interface. These were fixed through flexible attachment straps passed through button holes in special head covers (bonnets) of different colours according to the head sizes of the neonates. The details of the patients including gestational age, birth weight, gender, clinical and radiological severity of illness, associated illnesses, complications and duration of stay on nCPAP and in hospital were recorded on a specially designed study proforma.

The initial settings of pressure and FIO2 were selected according to the severity of illness. The range of pressure was from 5-10 cmH2O and FIO2 not more than 60%.

Success of nCPAP was defined as improvement of the respiratory distress as assessed by down score, maintenance of SPO2 above 90% in room air after weaning from CPAP for about consecutive 4 hours and normalization of blood gases.

CPAP failure was defined as the need for invasive ventilation on the basis of: worsening ABGs (pH <7.2 and pCO2 >60 mmhg), not maintaining SPO2 up to or above 90% at FIO2 of 60% and pressures of 10 cmH20 and apnoeic episode non-responsive to bag and mask ventilation.

Statistical analysis was done using SPSS version 24. All categorical variables were represented as numbers as well as percentages. Quantitative variables were summarized as mean and standard deviations (SD). All p-values less than 0.05 were considered statistically significant.

RESULTS

Total sixty neonates were enrolled in the study. Out of them 33(55%) were males and 27(45%) were females. Mean birth weight±SD was 2113.3±580.32 grams. Mean gestational age was 33.35±2.59 weeks. Total percentage of neonates that were born preterm was 85%. Our main indication of CPAP use was RDS, i.e., 39(65%) which was followed by congenital pneumonia 16(26.7%), apnoea of prematurity 3 (5%) and TTN 2 (3.3%). Out of 60 patients surfactant was given to 6 (10%) patients.

In our study 86.7% of the babies were successfully weaned off and discharged while 13.3% babies on CPAP required mechanical ventilation. Success of nasal CPAP in mild, moderate and severe RDS was 7 (21.9%),14 (43.8%) and 11 (34.4%) respectively (Figure-2). According to the X-ray grading RDS was also divided into mild, moderate and severe groups each having 21.9%, 43.8% and 34.4% success percentage respectively. In <34 weeks gestational age group 35 (59.6%) neonates were successfully weaned off while in >34 weeks gestational group success rate was 100%.

Complications were observed in 26.7% babies while 73.3% babies remained free of complications. Nasal deformities were observed in 20% of the babies that included redness of nares, snubbing of nose and nasal flaring. Other minor complication was abdominal distension which was observed in 6.37% of the babies. None of the babies in our study developed pneumothorax. The associated problems of the babies placed on nasal CPAP were 43.3% in total which included sepsis (31.7%), mild to moderate asphyxia (5%) and Jaundice neonatorum (6.7%).

Table-1: Characteristics of babies on nasal CPAP

Characteristics	Number (%)
Males Females	33 (55) 27 (45
Gestational Age (week) Mean±SD	33.35±2.59
Birth weight (g) Mean ± SD	2113.3±580.32
Multiple pregnancies	4 (6.7%)
Gestation <34 weeks >34 weeks	 39 (65) 21 (35)
Birth weight <2.5 Kg >2.5 Kg	 43 (71.7) 17 (28.3)
Caesarean SVD	34 (56.7) 26 (43.3)
Surfactant	6 (10)
Down score Mild Moderate Severe	 12 (21.05) 31 (54.38) 14 (24.56)
X-ray grading for RDS Mild Moderate Severe	 7 (11.7) 15 (25) 17 (28.3)
Diagnosis RDS Congenital pneumonia Apnoea of prematurity Transient tachypnoea of new-born	 39 (65) 16 (26.7) 3 (5) 2 (3.3)
Hospital stays Upto 3 days Upto 7 days >7 days	 21 (35) 30 (50) 9 (15)
Duration on CPAP Upto 36 hrs Upto 72 hrs >72 hrs	 20 (33.3) 35 (58.3) 5 (8.3)

Table-2: Variables in CPAP success and failure (n=60)

Variables	Success	Failure	*p*-value
Gender Males Females	 27 (51.9%) 25 (48.1%)	 6 (75%) 2 (25%)	0.222
Gestational age (week) Mean±SD	33.85±2.32	30.13±1.89	-
Birth weight (g) Mean±SD	2207.7±541.9	1500±450.4	-
Multiple pregnancies Single Multiple	 49 (94.2%) 3 (5.8%)	 7 (87.5%) 1 (12.5%)	0.477
Gestation <34 weeks >34 weeks	 31 (59.6%) 21 (40.4%)	 8 (100%)	0.026
Birth weight <2.5 kg >2.5 kg	 35 (67.3%) 17 (32.7%)	 8 (100%)	0.056
Mode of delivery Caesarean Svd	 30 (57.7%) 22 (42.3%)	 4 (50%) 4(50%)	0.683
Surfactant	5 (83.3%)	1 (16.7%)	0.800
Down score Mild Moderate Severe	 12 (24%) 28 (56%) 10 (20%)	 3(42.9%) 4(57.1%)	0.070
X-ray grading for RDS Mild Moderate Severe	 7 (21.9%) 14 (43.8%) 11 (34.4%)	 1 (14.3%) 6 (85.7%)	0.043
Diagnosis RDS Congenital pneumonia Apnoea of prematurity Transient tachypnoea of new-born	 32 (61.5%) 16 (30.8%) 2 (3.8%) 2 (3.8%)	 7 (87.5%) 1 (12.5%)	0.210
Hospital stays Upto 3 days Upto 7 days >7 days	 18 (34.6%) 29 (55.8%) 5 (9.6%)	 3 (37.5%) 1 (12.5%) 4 (50%)	0.006
Duration on CPAP Upto 36 hrs Upto 72 hrs >72 hrs	 20 (33.3%) 35 (58.3%) 5 (8.3%)	 2 (25%) 4 (50%) 2 (25%)	0.185

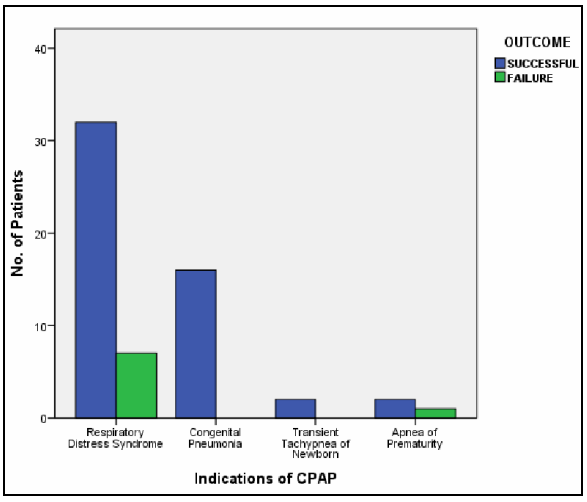

Figure-1: Frequency of CPAP outcome and indications.

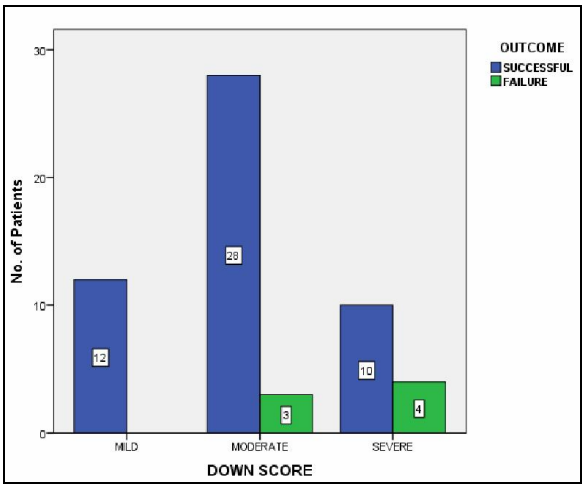

Figure-2: Frequency of CPAP outcome and down score

DISCUSSION

Respiratory distress is the most common illness leading to admission in neonatal intensive care units. Nasal CPAP has emerged as treatment of choice in neonates with respiratory distress. Evidence from multiple observational studies shows the safety and efficacy of the intervention. The literature regarding the use of nasal CPAP through IFDs in resource limited setups is still sparse. This study was conducted to evaluate the outcome of use of nCPAP through IFDs in a neonatal unit with multiple restraints.

Infant flow driver is a variable flow CPAP system. It has shown to be more effective in reducing the work of breathing and oxygen requirement. Mazella *et al* in a randomized control study showed decreased oxygen requirement and respiratory rate with use of variable flow CPAP as compared to

continuous flow[12] while Ellina *et al* concluded that work of breathing with use of variable flow CPAP is greatly reduced leading to lesser failure rates[13]. In our study success percentage of babies placed on nasal CPAP was 86.67% while only 13.3% babies required mechanical ventilation. In a local study by Amjad et al variable flow CPAP was used and 28.9% neonates required mechanical ventilation.[9] The difference in results can be attributed to change in failure criteria as they used maximum pressure of 6 cmH2O while we allowed pressures up to 8–10 cmH2O. Currently use of higher continuous distending pressures up to 10 cmH2O is considered standard of care as used in our study. So, we suggest that paediatricians using CPAP should use higher pressures.

A study conducted by Hameed *et al* in Baghdad included 70 neonates, of which 52.9% babies failed on CPAP. Their criteria for failure included FiO2 requirement ≥ 50% at 20 min of CPAP, PIP ≥5.5 cm water, birth weight ≤1500 grams, gestational age ≤30 weeks and white out lung on chest X-ray. We had lesser failures as we used higher pressures and FiO2 before shifting the patients to mechanical ventilation.[14]

In a study by Saxena *et al* 61.24% patients were successfully managed on nasal CPAP alone while 38.76% were shifted to mechanical ventilation.[15]

In a study conducted in Mexico only 17% babies were shifted from variable flow CPAP to mechanical ventilation while rest of the 83% were successfully weaned off. The results are comparable to results of our study as the population included in their study was almost similar in gestational age and birth weight to ours.[16]

The most common indication of use of nCPAP in our study was RDS (n=39,65%). In two of the local studies in Pakistan RDS was the commonest indication of use of nCPAP like in ours. In a study by Amjad *et al* 28 (62.2%) neonates with RDS were placed on CPAP[9] while in a study by Hameed *et al* CPAP was started in 39.2% babies with RDS.[10]

In our cohort though RDS severity did not have statistical significance on outcome due to smaller sample size but the results showed 100% success in mild disease,90.32% success in moderate disease and 71.42% success in severe disease. In a study by Lata *et al* use of CPAP in mild, moderate and severe RDS showed 100%, 97.50% and 84.60% success respectively.[11]

In our study there is statistical significance in gestational age and outcome of the patients (*p*-value <0.05). All the babies that failed CPAP belonged to <34 weeks gestational age group. Peter *et al* in a large multicentre randomized trial concluded that CPAP failure was significantly associated with lesser gestational age.[17]

Surfactant (beractant100 mg/kg) was given through INSURE method to 6 (10%) neonates having moderate to severe RDS in our study. Out of them 5(83.3%) were successfully weaned off and just 1 (16.7%) required mechanical ventilation. In a study conducted in India surfactant was given to 54.79% neonates that were placed on nCPAP. Out of them 92.7% babies were successfully weaned off and only 7.5% failed.[11]

Nasal CPAP is a non-invasive ventilation technique due to which there are very fewer complications when compared with ventilator CPAP. In our study 73.3% babies had no complications which is comparable to study conducted in CMH Lahore in which 77.8% neonates did not have any complication.[9] Most common complication of nCPAP in our study was nasal deformities which included snubbing of nose, flaring of nose and redness of nares (20%). This result is supported by a study conducted in London which also had nasal deformities in 20% of their patients.[18]

Other minor complication in our study was abdominal distension (CPAP belly syndrome) which was observed in 6.37% of the babies. To minimize this complication, we passed orogastric tube to every patient that was placed on IFD.

Pneumothorax is a known complication of ventilation and has been reported in literatures with use of nCPAP as well. However, in our study none of the patients developed pneumothorax. In a recent local study conducted by Tufail Soomro *et al* only 3 out of total 121 neonates placed on CPAP developed pneumothorax.[19] In a study by Kawaza *et al* no patient developed pneumothorax[20] while in another study conducted in South Africa by Kristen *et al* pneumothorax was not observed in any neonate placed on nCPAP.[21] These results reinforce the changing trend from invasive to non-invasive ventilation. The risk of pulmonary air leaks is higher with invasive ventilation than when compared with nasal CPAP.

Limitations:

Limitations of our study included non-comparative nature of the study and suboptimal monitoring facilities. Larger multicenter randomized comparative trials in resource limited setups are needed to assess feasibility of its implementation in these setups.

CONCLUSION

Use of nasal CPAP through IFDs is effective, safe and feasible even in the resource limited neonatal centers. Early use of these devices as primary respiratory support can lead to better outcomes in neonates with respiratory distress.

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AUTHORS' CONTRIBUTION

OA: Literature search, data collection, data analysis, data interpretation, write-up. MH: Conceptualization and study design, proof reading, write-up. MS: Data collection, write-up. MMAB: Conceptualisation of study design, proof reading.

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