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Clinical Profile and Outcome of Neonates Ventilated with Bubble Continuous Positive Airway Pressure in A Tertiary Care Centre

Dr. Pratyusha Bhupathi[1], Dr. Krishna Vamshy J[1], Dr. Keerthana Pinninti[1], Dr. Kumar G V[2]

[1]Post Graduate, Department of Pediatrics, Sri Siddhartha medical college and hospital, Tumkur-572107

[2]Professor and HOD, Department of Pediatrics, Siddhaganga medical college and Reasearch Institute, Tumkur-572107

[*]**Corresponding author:**

Dr. Kumar G V

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ABSTRACT

Introduction: Respiratory distress is one of the commonest conditions in preterm neonates requiring NICU admission especially among those less than 34 weeks of gestational age. Timely intervention of this with the usage of CPAP can significantly reduce neonatal mortality and morbidity.

Aim & Objectives: To study the clinical profile and outcome of non-invasive ventilation using BUBBLE CONTINUOUS POSITIVE AIRWAY PRESSURE in neonates with respiratory distress in a tertiary care centre.

Methodology: A prospective study was conducted among the first 200 neonates admitted in NICU with respiratory distress between November 2023 to October 2024. Downes score was used to assess the respiratory distress at the time of admission.

Results: 81.5% of the babies showed improvement with CPAP and were weaned to oxygen hood and 18.5% babies required mechanical ventilation. Earlier application of CPAP showed good outcome. Neonates between 32 to 36 weeks were highly benefitted with usage of CPAP. There was a statistical significance with usage of antenatal steroids and the outcome of the neonates.

Conclusion: CPAP is the best mode of treatment in neonates with respiratory distress. Application of CPAP does not require trained personnel and can be set up by staff with minimal training. Downes score helped in subsequent assessment of distress. Also, complications were very minimal while using CPAP.

Keywords: *NICU(newborn intensive care unit), continuous positive airway pressure(CPAP), respiratory distress, mechanical ventilation and Downes score.*

1. INTRODUCTION

In infants with progressive respiratory insufficiency, intermittent positive pressure ventilation (IPPV) with surfactant has been the usual treatment, but it is invasive, potentially resulting in airway and lung injury. Continuous positive airway pressure (CPAP) has been used for the prevention and treatment of respiratory distress, as well as for the prevention of apnoea, and in weaning from IPPV. Its use in the treatment of RDS might reduce the need for IPPV and its sequelae.[(1)]

CPAP was first used in 1971 to prevent distress in preterm neonates by Gregory et al first pioneered the use of Bubble-CPAP in neonatology in Columbian Medical Center New York using prongs. B-CPAP differs from conventional CPAP in that in B-CPAP the expiratory limb is placed under water and oscillatory vibrations transmitted into the chest resulting in wave forms similar to those produced by high frequency ventilation CPAP, often thought to be the missing link between supplemental oxygen and mechanical ventilation and is gaining immense popularity in neonatal intensive care units.[(2)]

Bubble CPAP provides continuous pressure that helps the collapse of alveoli on expansion, thereby increasing lung functional residual capacity and decreasing breathing work in neonates with respiratory distress. Moreover, B-CPAP is relatively inexpensive and easy to use, and gaining popularity in developing countries as the method of choice for delivering CPAP to distressed neonates.[(3,4)]

bCPAP stimulates/conserves endogenous surfactant production while providing end-distending pressure through positive end-expiratory pressure (PEEP) that prevents/reduces alveolar collapse and its downstream effects. The bCPAP system

benefits neonates by stabilizing the chest wall, reducing respiratory muscle fatigue, improving compliance, reducing airway resistance, and increasing FRC and lung volumes.(5)

It can be used in neonates when weaned from intubation to support the respiratory system and decrease the rate of reintubation.(6) B-CPAP is also used to manage various respiratory conditions in the newborn, including respiratory distress syndrome (RDS), transient tachypnea of the newborn (TTN), meconium aspiration, congenital pneumonia, pulmonary edema, and apnea(7)

With the above background the present study was undertaken to assess the clinical profile and various outcome of neonates treated with CPAP.

2. MATERIALS AND METHODOLOGY

A prospective study was conducted at Sri Siddhartha Medical College and Hospital, a tertiary care hospital. Data was collected from June,2023 to May,2025 of both preterm and term babies who fulfilled the criteria.

SAMPLE SIZE: According to the American Academy of Pediatrics, approximately 10% of neonates need some assistance to begin breathing at birth(8). Considering 10% of neonates develop respiratory distress at birth and in our hospital 1800 deliveries occurred in the last 2 years(sample size=180). Therefore, the first 200 Neonates admitted in NICU in view of respiratory distress during the study period.

INCLUSION CRITERIA:

- Neonates with respiratory distress [DOWNES SCORE 4 to 6] and
- Neonates with Oxygen Saturation [SPO2] < 85% even with supplemental oxygen.

EXCLUSION CRITERIA:

- Neonates with severe respiratory distress before the initiation of ventilation [DOWNES SCORE>7/10].
- Unstable cardiovascular status.
- Neonatal seizures.
- Major congenital anomalies including airway anomalies, pulmonary hypoplasia, diaphragmatic hernia.

Informed consent was taken from parents. The details of birth history, risk factors in pregnancy, type of delivery and need for resuscitation was recorded. Downes score was used at the time of admission to assess respiratory distress. A score of 4-6 were considered for application of CPAP and those with a score of above 6 indicated impending respiratory failure requiring intubation and mechanical ventilation.[8] Date and time of application of CPAP was noted. Necessary nursing care and suctioning were given appropriately. Neonates were assessed every 4 hrs after application of CPAP for improvement in respiratory distress and Downes score was calculated. Reduction in Downes score was used as an indicator to wean the neonate from CPAP. Whereas increase in Downes score indicated the requirement of mechanical ventilation.

Failure of B-CPAP was defined as(9):

1. Requirement of pressure >8cm H2O
2. FiO2 requirement >o.6
3. PaO2 <50mmHg on maximum acceptable settings
4. PaCO2>60mmHg and PH <7.25 on maximum acceptable settings
5. Air leak on B-CPAP
6. Recurrent apnea on B-CPAP despite caffeine citrate

DATA ANALYSIS:

Data was collected and entered into Microsoft excel sheet. All categorical data was summarized using frequency and percentages, all continuous data was described using mean and standard deviation. To study the association of clinical parameters between survivors and Non survivors, independent sample t test was applied for the continuous measurements after checking normality assumption and Chi square test or Fishers exact test was applied for categorical observations based on the expected frequency.

3. RESULTS

Out of the 200 babies analyzed 58.5% babies were male babies and 41.5% babies were female babies. As per the gestational age 6% babies were less than 28 weeks, 26.5% babies were between 28 to 32 weeks, 54.5% babies were between 32 and 36 weeks and 13% babies were above 37 weeks (table 1).

TABLE 1: Characteristics of the neonates and their association with the outcome

CLINICAL PROFILE	OUTCOMES		TOTAL n=200	p-value
	Survived	Mechanical ventilation		
1.GENDER				
Female	67(80.7%)	16(19.3%)	83	0.812
Male	96(82.1%)	21(17.9%)	117	
Total	163(81.5%)	37(18.5%)	200	
2.GESTATIONAL AGE				
<28 weeks	67(80.7%)	67(80.7%)	12	<0.01
28-32 weeks	67(80.7%)	67(80.7%)	53	
32-36 weeks	67(80.7%)	67(80.7%)	109	
37 weeks and above	67(80.7%)	67(80.7%)	26	
Total	67(80.7%)	67(80.7%)	200	
3.BASED ON DIAGNOSIS				
Respiratory distress syndrome	105(75%)	35(25%)	140	<0.01
Birth asphyxia	31(96.6%)	1(3.1%)	32	
Meconium aspiration syndrome	23(95.8%)	1(4.2%)	24	
Congenital pneumonia	4(100%)	0(0%)	4	
Total	163(81.5%)	37(18.5%)	200	

Regarding mode of delivery, 33.5% were delivered by normal vaginal delivery (labour naturale), 8% were delivered by assisted vaginal delivery [forceps or vaccum] and 58.5% babies were delivered by LSCS (figure 1).

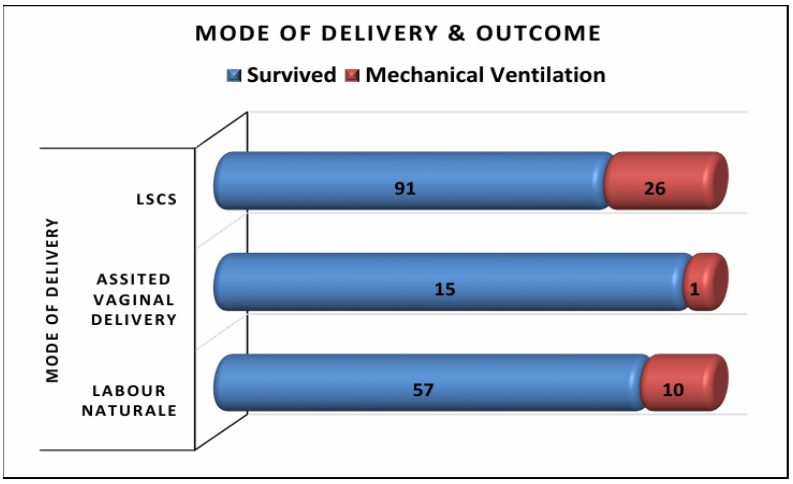

FIGURE 1: Mode of delivery and it's outcome

25.5% babies did not receive antenatal steroids, 29.5% babies received antenatal steroids but the course was not completed and 45% babies received complete course of steroids and survival is as showed in figure 2.

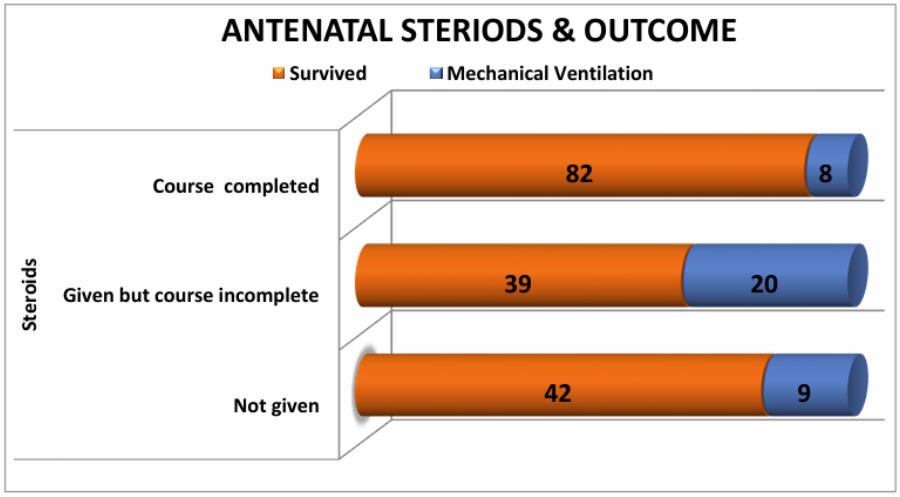

FIGURE 2: Antenatal steroids and it's outcome

Neonates with a birth weight of more than 1.5kg showed an increase in survival whereas those less than 1 kg required mechanical ventilation from CPAP and was statistically significant (table 2).

Table 2: Birth weight and its association with the outcome

OUTCOME	N=200	BIRTH WEIGHT MEAN	BIRTH WEIGHT STD. DEVIATION	P-VALUE
SURVIVED	163	2.00	0.64	<0.001
MECHANICAL VENTILATION	37	1.26	0.41	<0.001

Respiratory distress was due to various causes 70% babies were diagnosed to have respiratory distress syndrome. 16% babies were admitted in view if Birth Asphyxia.12% babies were diagnosed to have Meconium Aspiration Syndrome and 2% babies had Congenital Pneumonia.(Table 1)

0.5% babies had a Downes score of 3 at the time of admission, whereas 29% babies had a score of 4, and 51% babies had a score of 5 and 19.5% babies had a score of 6.(Table 3)

4% babies required CPAP for a duration of less than 6 hrs, 7.5% babies required for about 6-12 hrs ,23.5% babies required for 12-24 hrs and 65% babies required CPAP for a duration more than 24 hrs.

18% babies required a PEEP of 4 at the time of admission, 58% babies required a PEEP of 5 and 24% babies required PEEP of 6.

TABLE 3: Downes score and it's association with the survival

Downes score (DS)	Survived	Mechanical ventilation	p-value
DS mean	4.67	5.89	<0.01
DS standard deviation	0.56	0.31	
Total	163	37	

83% babies without any complications survived with CPAP while 17% babies required mechanical ventilation. Among those neonates who developed complications like pneumothorax 33.3% babies survived while 66.7% babies required mechanical ventilation.(Table 4)

TABLE 4: Complications and its association with the OUTCOME

Complications	OUTCOMES		TOTAL n=200	p-value
	Survived	Mechanical ventilation		
No complications	161(83%)	33(17%)	194(100%)	0.01
Complication (Eg: pneumothorax)	2(33.3%)	4(66.7)	6(100%)	
Total	163(81.5)	37(18.5%)	200(100%)	

Out of the 200 babies 81.5% babies showed improvement on usage of CPAP and were weaned from CPAP whereas 18.5% babies had CPAP failure and required mechanical ventilation in due course of treatment(table 5).

Table 5: outcome of Bubble CPAP

OUTCOMES:	Frequency n=200	Percentage(%)
Survived	163	81.5
Mechanical Ventilation	37	18.5
Total	200	100

4. DISCUSSION

In this study, 200 babies with respiratory distress were analyzed for the outcome of CPAP. Both Term and Preterm babies were included in the study. Neonates between gestational age of 32-34 weeks were very much benefitted with CPAP. There was no significant difference in outcome with the gender of the babies. Babies with birth weight of 1.5 kg and more had a better outcome with the usage of CPAP. Neonates weighing less than 1 kg either required prophylactic intubation or went in for CPAP FAILURE and required mechanical ventilation. A study on CPAP in preterm neonates by Neeraj Gupta et al[10] showed that CPAP had a good outcome on babies of more than 32 weeks gestational age and birth weight of more than 1000grams. A study by Nicolas Bamat et al[11] also showed that neonates with lesser gestational age required longer duration of CPAP. These results are comparable with the outcomes of our study.

A score of 3-6 was considered as an indication for CPAP while a score of more than 7 was taken as a sign of Impending Respiratory Failure requiring Mechanical Ventilation. Most of the babies with a score of 4 and 5 had a significant outcome with CPAP.

Neonates who required a PEEP of 4 and 5 survived well with the usage of CPAP. Those whose required a PEEP of 6 required a longer duration of CPAP. Neonates with Fio2 requirement of 40% and 50% had a good outcome. Infants with 60% Fio2 requirement mostly required mechanical ventilation. A prospective multicentre study by Ewa Gulczynska et al[12] on FiO2 as a predictor of CPAP failure showed that, increased FiO2 requirement can be used to predict the need for mechanical ventilation.

Steroids played a major role in the lung maturity of the neonates that reflected as the improvement of respiratory distress. Neonates who received a full course of antenatal steroids showed a drastic outcome with CPAP. Those who received incomplete course of steroid also showed a better survival. So even a single dose of steroid was found to be very much useful. In a study by Vivek Arora et al[13] it was noted that 30.5% of CPAP failure had occurred in babies who had not been exposed or who had been partially exposed to Antenatal Steroids. In this study 81.5% of babies who received complete course of steroids showed good outcome and 17.6% of babies who did not receive antenatal steroids had CPAP failure.

One of the major complications was Pneumothorax. Prolonged use of CPAP and application of higher pressure levels led to air leak. This can also be prevented by appropriate monitoring and and diagnosis.

5. CONCLUSION

From this study it is concluded that CPAP is one of the best methods of treatment in neonates with respiratory distress. It is highly beneficial among preterm neonates especially less than 34 weeks who were the major victims for lung immaturity.

Neonates diagnosed to have respiratory distress syndrome recovered more with usage of non-invasive ventilation like Bubble CPAP. This does not require trained personnel for setting up and thus can be implemented by staff nurse in the NICU.

Downes score can be used to rapidly assess the severity of respiratory distress and also can be used to monitor the improvement during CPAP treatment. Antenatal steroids played a major role in the outcome of preterm babies with immature lung function and thereby the outcome with CPAP. Complications were very minimal with CPAP and can be easily avoided with proper nursing care and monitoring.

6. LIMITATIONS

1. Sample size was smaller in this study.
2. Usage of Surfactant in the babies and its effect on recovery along with CPAP was not considered.

Extramural babies were not included in the study.

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