

## CLINICAL OUTCOME OF BUBBLE CPAP (CONTINUOUS POSITIVE AIRWAY PRESSURE) IN NEONATES ADMITTED WITH RESPIRATORY DISTRESS IN A NEONATAL INTENSIVE CARE UNIT

Abhinav Kachare<sup>1</sup>, Harshal Wagh<sup>2</sup>, Sambhaji Wagh<sup>3</sup>

<sup>1</sup>Junior Resident, Department of Paediatrics, Government Medical College, Miraj, Maharashtra, India.

<sup>2</sup>Assistant Professor, Department of Paediatrics, Government Medical College, Miraj, Maharashtra, India.

<sup>3</sup>Associate Professor, Department of Paediatrics, Government Medical College, Miraj, Maharashtra, India.

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Corresponding Author:

**Dr. Abhinav Kachare,**

Email: abhinavkachare2@gmail.com

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### Abstract

**Background:** In spite of all the recent advances, respiratory distress remains the most common presentation among neonates both term and preterm, requiring admission to a Neonatal Intensive Care Unit. The simplicity of the BUBBLE-CPAP system makes them ideal for use in resource-limited settings. It can be successfully introduced and independently operated by neonatal intensive care unit (NICU) nurses after a relatively short period of training. **Materials and Methods:** This retrospective, observational study was conducted in a NICU in a tertiary care center. All preterm, term, and post-term neonates presenting with respiratory distress to Neonatal Intensive Care Unit and started on indigenous bubble CPAP during the study period were enrolled after applying the inclusion and exclusion criteria. All the relevant data were recorded and analyzed using appropriate statistical analysis. **Result:** 150 neonates with respiratory distress were included in this study. The mean birth weight was  $1.937 \pm 1.34$  kilograms and the gestational age was  $34.64 \pm 6.6$  weeks. Out of 150 neonates, 71.33% of neonates showed improvement after starting Bubble-CPAP and were weaned successfully whereas 28.67% of neonates required mechanical ventilation. **Conclusion:** The study concludes the usefulness of indigenous bubble CPAP in neonates with respiratory distress.

## INTRODUCTION

In spite of all the recent advances, respiratory distress remains the most common presentation among neonates both term and preterm, requiring admission to a Neonatal Intensive Care Unit.<sup>[1]</sup> These newborns are frequently in distress due to the failure of the transition from the fetal to the extrauterine environment due to residual lung fluid, which is prevalent in cesarean delivery neonates, being immature with relative surfactant deficiency, or having Meconium Aspiration Syndrome (MAS). The majority of the neonates requiring hospitalisation suffer from respiratory distress with high morbidity and mortality rates. Information on infant and child mortality is relevant to a demographic assessment of the population and is an important indicator of the country's socioeconomic development and quality of life. The Neonatal Mortality Rate is defined as the number of deaths during the first 28 completed days of life per 1000 live births in a specified period. Mortality during the neonatal period accounts for a large proportion of child deaths and is considered to

be a useful indicator of maternal and neonatal health and care.<sup>[2]</sup> For the five-year period before the 2019-21 NFHS, the neonatal mortality rate in India was 25 deaths per 1,000 live births.<sup>[3]</sup>

Continuous positive airway pressure [CPAP] is an important non-invasive treatment modality used for the maintenance of increased transpulmonary pressure during the process of expiration to maintain lung volume in a neonate who can breathe spontaneously so as to improve oxygenation. The simplicity of the BUBBLE-CPAP system makes them ideal for use in resource-limited settings. It can be successfully introduced and independently operated by neonatal intensive care unit (NICU) nurses after a relatively short period of training.

### Aim

To study the clinical outcome of indigenous bubble-continuous positive airway pressure (CPAP) in neonates admitted with respiratory distress in a neonatal intensive care unit of a tertiary care hospital.

## Objectives

1. To find out how many neonates with respiratory distress who were started on bubble-CPAP required mechanical ventilation
2. To find out how many neonates with respiratory distress who were started on bubble-CPAP are weaned from CPAP
3. To find out the complications associated with the use of CPAP

## MATERIALS AND METHODS

This retrospective, observational study was conducted in a NICU in a tertiary care center. All preterm, term, and post-term neonates presenting with respiratory distress to Neonatal Intensive Care Unit and started on indigenous bubble CPAP during the study period were enrolled after applying the inclusion and exclusion criteria. All the relevant data were recorded and analyzed using appropriate statistical analysis.

### Materials

Setting: NICU, GMC MRAJ

Study Design: Retrospective Observational Study

Study period: 12 months

Sample size: 150

Study population: Neonates admitted with respiratory distress to Neonatal Intensive Care Unit and started on indigenous bubble CPAP

### Inclusion Criteria

1. Neonates who were admitted to the Neonatal Intensive Care Unit with respiratory distress and have been started on indigenous bubble-CPAP
2. Parents who are willing to be part of the study

### Exclusion Criteria

1. Severe cardiorespiratory instability in the form of shock and severe hypotension
2. Prolonged and refractory seizures
3. Unstable respiratory drive with frequent apnoeic episodes resulting in desaturation and/or bradycardia
4. Surgical causes interfering with nasal indigenous Bubble-CPAP application
5. Parents who withdrew consent

## RESULTS

Out of the 150 neonates, male neonates were 60.67 % and female neonates were 39.33 %

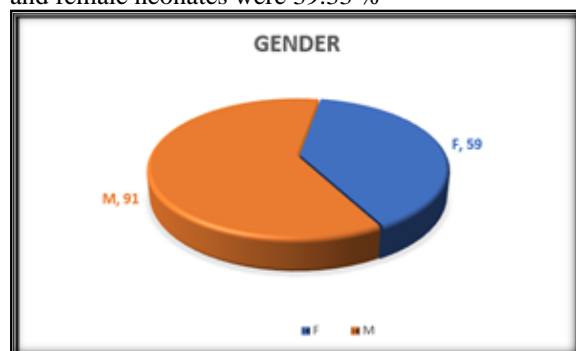


Figure 1: Gender Distribution

Out of the 150 neonates, according to gestational age, 10.67 % of neonates were  $\leq 28$  weeks, 14.67 % of neonates were between 28 to 32 weeks, 37.33 % of neonates were between 32 to 36 weeks, 37.33 % of neonates were more than 37 weeks.

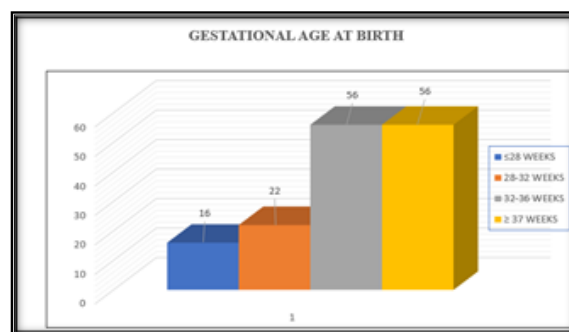


Figure 2: Gestational Age at Birth

Out of the 150 neonates, as per the mode of delivery, 51.33 % neonates were born by vaginal delivery and 48.67% neonates were born by Caesarean section.

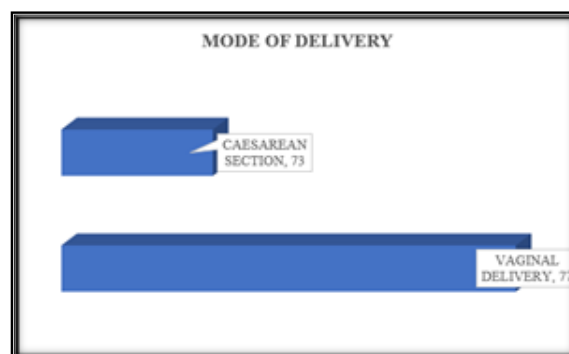


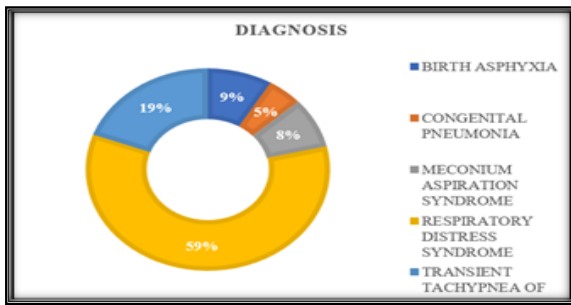
Figure 3: Mode of Delivery

Out of 150 neonates, according to birth weight, 6% of neonates were less than 1 kg, 20.67% of neonates were between 1 to 1.49 kg, 49.33 % of neonates were between 1.59 kg to 2.49 kg, and 24% of neonates were more than 2.5 kg.



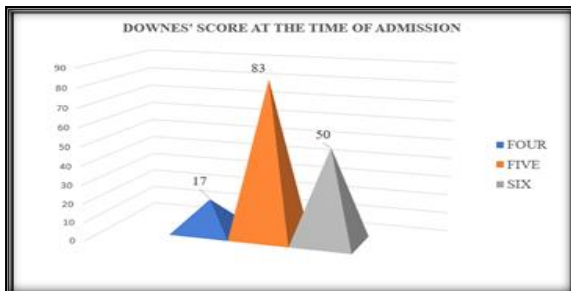
Figure 4: Birth Weight of Neonates

Out of 150 neonates, 9% of neonates were admitted in view of birth asphyxia, 5 % of neonates were diagnosed with congenital pneumonia, 8% of neonates were diagnosed with meconium aspiration syndrome, 59% of neonates were diagnosed with respiratory distress syndrome, and 19% of neonates had transient tachypnea of newborn.



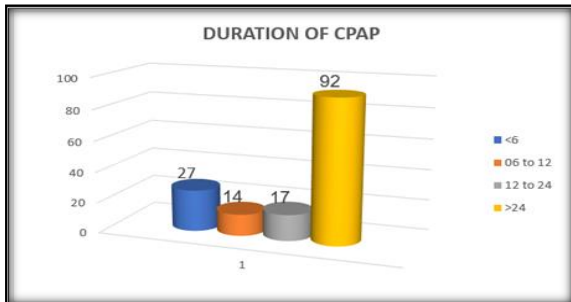
**Figure 5: Diagnosis**

Out of 150 neonates, 11.33% of neonates had a Downes's score of 4 at the time of admission, whereas 55.33% of neonates had a Downes's score of 5 and 33.33% of neonates had a Downes's score of 6 at the time of admission.



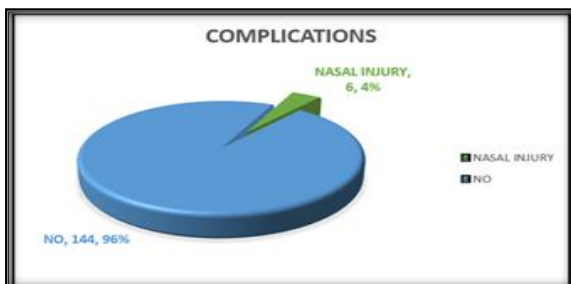
**Figure 6: Downes' Score at The Time Of Admission**

Out of 150 neonates, 61.33 % of neonates required Bubble-CPAP for more than 24 hours 11.33 % of neonates required Bubble-CPAP between 12 to 24 hours whereas 18 % of neonates were on CPAP for less than 6 hours. 9.33 % of neonates were on Bubble-CPAP between 6 to 12 hours.



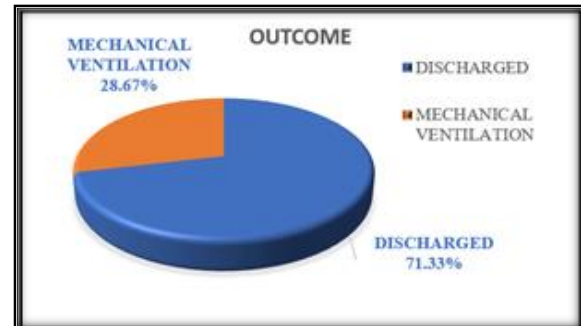
**Figure 7: Duration of CPAP**

Out of 150 neonates, 96% of neonates did not have any complication related to use of Bubble-CPAP, while 4% of neonates sustained nasal injury as a complication. Apart from nasal injury, no other complication was encountered during the study.



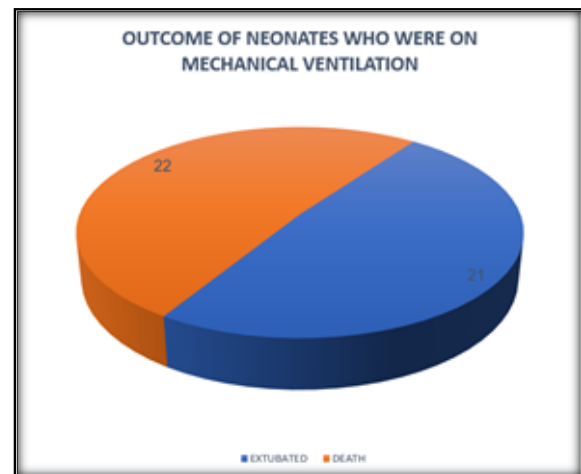
**Figure 8: Complications**

Out of 150 neonates, 71.33% of neonates showed improvement after starting Bubble-CPAP and were weaned successfully whereas 28.67% of neonates required mechanical ventilation.



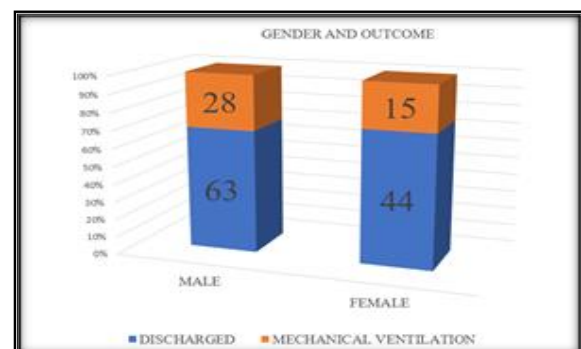
**Figure 9: Outcome**

Out of the 43 neonates who required mechanical ventilation, 21 were successfully extubated whereas 22 neonates succumbed.



**Figure 10: outcome of neonates who were on mechanical ventilation**

Out of 91 male neonates, 69.23% were discharged whereas 30.77% required mechanical ventilation. Out of 59 female neonates, 74.58% were discharged whereas 25.42% required mechanical ventilation.



**Figure 11: Gender And Outcome**

Out of 56 neonates  $\geq 37$  weeks, 91.07 % were discharged. Out of 56 neonates between 32 to 36 weeks, 69.64 % were discharged. Only 12.5 % of neonates  $\leq 28$  weeks were discharged.

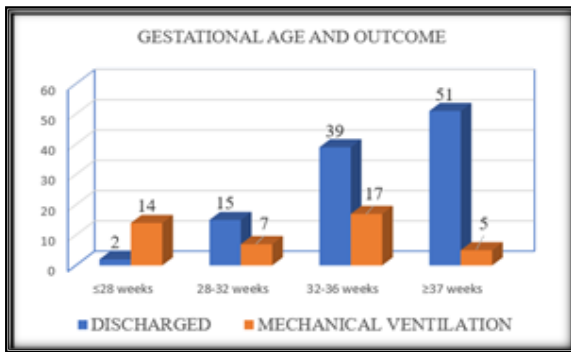


Figure 12: Gestational Age and Outcome

Out of 73 neonates born by caesarean section, 76.71 % were discharged whereas out of 77 neonates born by vaginal delivery, 66.23 % were discharged.

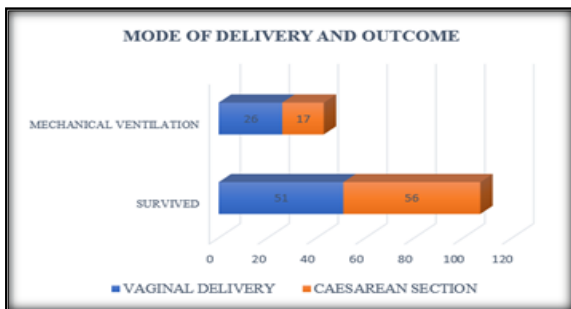


Figure 13: Mode of Delivery And Outcome

Out of 36 neonates with birth weight more than 2.5 kg, 94.44% were discharged whereas out of 74 neonates with birth weight between 1.5 to 2.49 kg, 78.38 % were discharged.

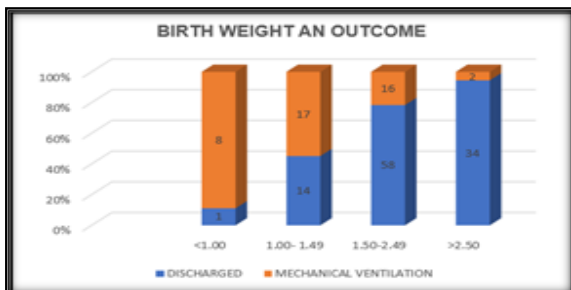


Figure 14 A: Birth Weight and Outcome

The mean birth weight of the neonates who were discharged was 2.13 kg whereas the mean birth

weight of neonates who required mechanical ventilation was 1.46 kg.

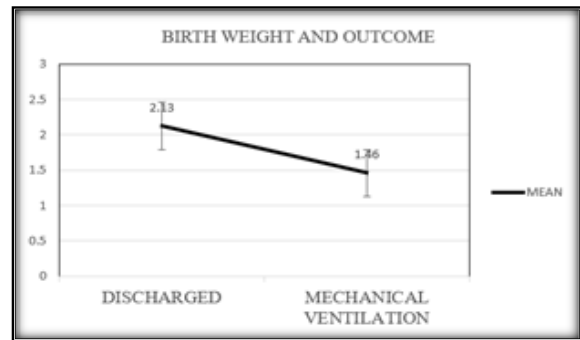


Figure 14 B: Birth Weight and Outcome

Out of 89 neonates with RDS, 58.43% were discharged whereas out of 12 neonates with birth asphyxia, 92.30 % of neonates were discharged.

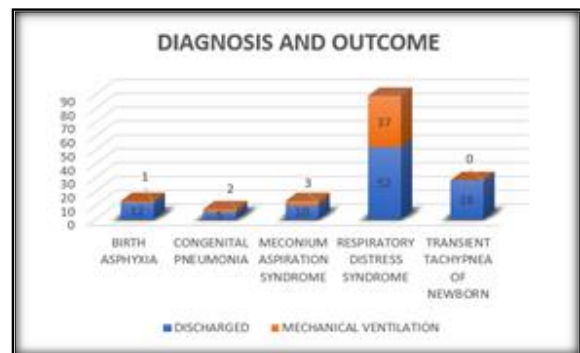


Figure 15: Diagnosis and Outcome

The neonates who were discharged had a mean Downes' score of 4.97 at the time of admission whereas the neonates who required mechanical ventilation had a mean Downes' score of 5.84.

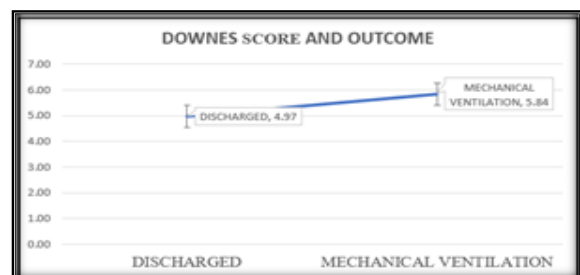


Figure 16: Downes' Score and Outcome

Table 1: Gender

Gender	Frequency N=150	Percentage (%)
Male	91	60.67
Female	59	39.33
Total	150	100

Table 2: gestational age at birth

Gestational age	Frequency N=150	Percentage (%)
≤28 weeks	16	10.67
28-32 weeks	22	14.67
32-36 weeks	56	37.33
≥37 weeks	56	37.33
Total	150	100

**Table 3: mode of delivery**

Mode of delivery	Frequency n=150	Percentage (%)
Vaginal delivery	77	51.33
Caesarean section	73	48.67
Total	150	100

**Table 4: birth weight of neonates**

Birth weight	Frequency n=150	Percentage (%)
<1.00	9	6
1.00- 1.49	31	20.67
1.50-2.49	74	49.33
>2.50	36	24
Total	150	100

**Table 5: diagnosis**

Diagnosis	Frequency n=150	Percentage (%)
Birth asphyxia	13	9
Congenital pneumonia	7	5
Meconium aspiration syndrome	13	8
Respiratory distress syndrome	89	59
Transient tachypnea of newborn	28	19
Total	150	100

**Table 6: downes' score**

Downes' score at the time of admission	Frequency n=150	Percentage (%)
Four	17	11.33
Five	83	55.33
Six	50	33.33
Total	150	100

**Table 7: duration of cpap**

Duration of cpap (hours)	Frequency n=150	Percentage (%)
<6	27	18
6-12	14	9.33
12-24	17	11.33
>24	92	61.33
Total	150	100

**Table 8: complication**

Complication	Frequency n=150	Percentage %
Complication (nasal injury)	6	4
No complication	144	96%
Total	150	100

**Table 9: outcome**

Outcome	Frequency n=150	Percentage (%)
Discharged	107	71.33%
Mechanical ventilation	43	28.67%
Total	150	100

**Table 10: outcome of neonates who required mechanical ventilation**

Outcome if required mechanical ventilation	Frequency n=43	Percentage (%)
Extubated	21	48.84
Death	22	51.16
Total	43	100

**Table 11: gender and outcome**

Gender	Outcome		Total	P-value¶
	Discharged	Mechanical ventilation		
Male	63(69.23%)	28(30.77%)	91(100%)	0.48
Female	44(74.58%)	15(25.42%)	59(100%)	
Total	107(71.33%)	43(28.67%)	150(100%)	

**Table 12: gestational age and outcome**

Gestational age	Discharged	Mechanical ventilation	Total	P-value¶
<28 weeks	2(12.5%)	14(87.5%)	16(100%)	<0.001
28-32 weeks	15(68.18%)	7(31.82%)	22(100%)	
32-36 weeks	39(69.64%)	17(30.36%)	56(100%)	

≥37 weeks	51(91.07%)	5(8.93%)	56(100%)
Total	107(71.33%)	43(28.67%)	150(100%)

**Table 13: mode of delivery and outcome**

Mode of delivery	Outcome		Total	P-value¶
	Survived	Mechanical ventilation		
Vaginal delivery	51(66.23%)	26(33.77%)	77(100%)	0.16
Caesarean section	56(76.71%)	17(23.29%)	73(100%)	
Total	107(71.33%)	43(28.67%)	150(100%)	

Chi-square test

**Table 14a: birth weight and outcome**

Birth weight	Discharged	Mechanical ventilation	Frequency n=150	P-value¶
<1.00	1 (11.11%)	8 (88.89%)	9(100%)	P<0.001
1.00- 1.49	14 (45%)	17 (55%)	31	
1.50-2.49	58 (78.38%)	16 (21.62%)	74	
>2.50	34 (94.44%)	2 (5.56%)	36	
Total	107 (71.33%)	43 (28.67%)	150	

**Table 14b: birth weight and outcome**

Outcome	N=150	Birth weight		P-value
		Mean	Standard deviation	
Discharged	107	2.13	0.49	<0.001
Mechanical ventilation	43	1.46	0.21	

**Table 15: diagnosis and outcome**

Diagnosis	Outcome		Total	P-value¶
	Discharged	Mechanical ventilation		
Birth asphyxia	12 (92.30%)	1 (7.70%)	13 (100%)	
Congenital pneumonia	5 (71.43%)	2 (28.57%)	7 (100%)	
Meconium aspiration syndrome	10 (76.92%)	3 (23.07%)	13 (100%)	
Respiratory distress syndrome	52 (58.43%)	37 (41.57%)	89 (100%)	
Transient tachypnea of newborn	28 (100%)	0 (0%)	28 (100%)	
Total	107 (71.33%)	43 (28.67%)	150 (100%)	

Chi-square test

**Table 16: downes score and outcome**

Outcome	Frequency N=150	Downes sore		P-value
		Mean	Standard deviation	
Discharged	107	4.97	0.54	P<0.001
Mechanical ventilation	43	5.84	0.37	

## DISCUSSION

In this study, 150 neonates were analysed for the outcome of CPAP.

### Gender and Outcome

Out of the 150 neonates, male neonates were 60.67 % and female neonates were 39.33 %. Out of the 91 male neonates, 63 neonates were discharged whereas 28 neonates required mechanical ventilation. Out of the 59 female neonates, 44 neonates were discharged whereas 15 neonates required mechanical ventilation. 69.23 % of male neonates were discharged whereas 74.58 % of female neonates were discharged. There was no significant difference between the male and female neonates with respect to the outcome. (p-value=0.48). In a study conducted by Hyalyad Sunita Parasuramappa et al,<sup>[4]</sup> on the use of Bubble-CPAP in a level 2 neonatal intensive care unit, it was found that the success of Bubble-CPAP was independent of the gender of the neonate. Similarly, in a study conducted by Prashanth S URS et al,<sup>[5]</sup> on the use of Bubble-CPAP in neonates with RDS, it was found that the outcome did not vary between the gender of

the neonates. In another study conducted by Hima Bindu Singh et al,<sup>[6]</sup> it was noticed that the gender of the neonate had no impact on the success of CPAP.

### Gestational Age

Out of the 150 neonates, according to gestational age, 10.67 % of neonates were ≤28 weeks, 14.67 % of neonates were between 28 to 32 weeks, 37.33 % of neonates were between 32 to 36 weeks, 37.33 % of neonates were more than 37 weeks. 12.5% of neonates with gestational age≤28 weeks were discharged while 68.18 % of neonates with gestational age between 28 to 32 weeks were discharged. Out of the neonates between 32 to 36 weeks, 69.64% of neonates were discharged whereas 91.07% of neonates ≥37 weeks were discharged. Thus, neonates with gestational age at birth belonging to 32 to 36 weeks and ≥37 weeks had better outcomes than those with gestational age ≤28 weeks (p-value<0.001). This is similar to the study conducted by Dr. Paka Rajanna Rajender et al,<sup>[7]</sup> in neonates with respiratory distress syndrome (RDS) in which the highest rate of CPAP success was observed in neonates with gestational age between 35 to 37

weeks (51%) whereas the rate of CPAP success was 32 % in neonates with gestational age between 32-34 weeks. Similarly, in a study conducted by V S Anjankumar et al,<sup>[8]</sup> the success rate was 74 % in 33 to 34 weeks, and 88.8 % in 35 to 36 weeks respectively. In another study conducted by Hameed et al,<sup>[9]</sup> it was found that higher gestational age had a statistically significant positive effect on the outcome of Bubble-CPAP.

#### **Mode of Delivery**

Out of the 150 neonates, as per the mode of delivery, 51.33 % neonates were born by vaginal delivery and 48.67% neonates were born by Caesarean section. In a study conducted by Sunil B et al,<sup>[10]</sup> 68.8 % of neonates were born by Lower Segment Caesarean Section [LSCS], whereas 31.2 % of neonates were born by normal delivery.

66.23 % of neonates born via vaginal delivery were discharged whereas 76.71% of neonates born via caesarean section were discharged. There was no statistically significant difference between neonates born via vaginal delivery and caesarean section with regard to outcome (p-value 0.16).

#### **Birth Weight**

Out of 150 neonates, according to birth weight, 6% of neonates were less than 1 kg, 20.67% of neonates were between 1 to 1.49 kg, 49.33 % of neonates were between 1.59 kg to 2.49 kg, and 24% of neonates were more than 2.5 kg. The mean birth weight of neonates who were discharged was 2.13 kg with a standard deviation of 0.49 whereas the mean birth weight of neonates who required mechanical ventilation was 1.46 with a standard deviation of 0.21. 58 % of neonates with birth weight between 1.50 to 2.49 kg were discharged whereas 94.44% of neonates with birth weight more than 2.5 kg were discharged. Thus, neonates with birth weight  $\geq$  1.5 kg who were started on Bubble-CPAP had better outcome which was statistically significant ( $p < 0.001$ ). This is similar to the Cochrane review done by Jacqueline J Ho et al,<sup>[11]</sup> where the effect of CPAP on spontaneous breathing preterm neonates was reviewed and it was found to reduce mortality in neonates with birth weight more than 1.5 kg. In a study conducted by Sunitha Kumari Byram et al,<sup>[12]</sup> there was higher incidence of failure of CPAP in very low birth weight i.e., in neonates weighing less than 1.5 kg.

#### **Diagnosis**

Out of 150 neonates, 9% of neonates were admitted in view of birth asphyxia, 5 % of neonates were diagnosed with congenital pneumonia, 8% of neonates were diagnosed with meconium aspiration syndrome, 59% of neonates were diagnosed with respiratory distress syndrome, and 19% of neonates had transient tachypnea of newborn. Thus, majority of neonates (59%) were diagnosed with respiratory distress syndrome. Among neonates diagnosed with transient tachypnea of newborn, all neonates (100%) were discharged whereas 92.30% of neonates diagnosed with birth asphyxia were discharged. Among neonates diagnosed with meconium

aspiration syndrome, 76.92% of neonates were discharged whereas 71.43% of neonates with congenital pneumonia were discharged. Among neonates diagnosed with respiratory distress syndrome, 58.43% of neonates were discharged. Hence, neonates who were started on Bubble-CPAP had a better come which was statistically significant ( $p$ -value  $< 0.001$ ). In a study conducted by Byram et al,<sup>[12]</sup> the most common diagnosis was respiratory distress syndrome (56%) followed by meconium aspiration syndrome (16%). In a study conducted by Murki and Bhagwat et al,<sup>[13]</sup> CPAP when applied early may reduce the need for mechanical ventilation in neonates with moderate to severe meconium aspiration syndrome. In a study conducted by V S Anjankumar et al,<sup>[8]</sup> the success rate of CPAP in pneumonia and meconium aspiration syndrome was 64.6% and 64.7% respectively.

#### **Downes' Score**

Out of 150 neonates, 11.33% of neonates had a Downes's score of 4 at the time of admission, whereas 55.33% of neonates had a Downes's score of 5 and 33.33% of neonates had a Downes's score of 6 at the time of admission. The neonates who were discharged had a mean score of 4.97 with a standard deviation of 0.54 whereas those neonates who required mechanical ventilation had a mean score of 5.84 with a standard deviation of 0.37. Thus, most of the neonates who had a Downes score of 6 required mechanical ventilation which was statistically significant ( $p$ -value  $< 0.001$ ).

In a study conducted by Christy Maria Viagulum J and Saravanan S,<sup>[14]</sup> the clinical outcome of Bubble-CPAP was better when the Downes' score was lower. In another study done by Koti et al,<sup>[15]</sup> the probability of Bubble-CPAP failure was higher in neonates with a Downes' score of more than 7.

#### **Duration of CPAP**

Out of 150 neonates, 61.33 % of neonates required Bubble-CPAP for more than 24 hours 11.33 % of neonates required Bubble-CPAP between 12 to 24 hours whereas 18 % of neonates were on CPAP for less than 6 hours. 9.33 % of neonates were on Bubble-CPAP between 6 to 12 hours. In a study done by Koti et al., the median duration of CPAP was 23.5 hours.<sup>[16]</sup>

#### **Complications**

The complication which was observed in this study was nasal injury. It mostly occurs in neonates who were on CPAP for a prolonged duration. 4% of neonates sustained nasal injury as a complication. In a study conducted by S S Mathai et al. [16], the main complication was skin abrasions (30%) followed by feed intolerance (26%) and gastric distension (26%). In a review conducted by Sara Dada et al,<sup>[17]</sup> the most common complications were nasal.

## **CONCLUSION**

From this study, it can be concluded that

- Bubble-CPAP is an effective method of non-invasive ventilation for management of neonates presenting with respiratory distress
- Bubble-CPAP is easy, cost-effective, and excellent method of management in resource limited settings.
- Neonates who are started on Bubble-CPAP need ongoing assessment and Downes score can be used to guide management.
- Neonates whose respiratory distress is persistent in spite of starting Bubble-CPAP and who fail to improve need to be started on mechanical ventilation.
- The incidence of complications like nasal injury can be minimized by taking adequate precautions.

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