ORIGINAL ARTICLE

# Outcome of Bubble CPAP in Neonate with Respiratory Distress

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**Abstract**

***Background:*** *Continuous Positive Airway Pressure (CPAP) is a well-established mode of respiratory support in newborns. Bubble CPAP (bCPAP) is safe, efficacious and easy to use in preterm and term neonates with mild to moderate respiratory distress.*

***Objectives:*** *To find out the outcome of bCPAP in neonate with respiratory distress.*

***Methods:*** *This cross sectional study was conducted over 6 months in Bangladesh Shishu Hospital & Institute. Total 108 term and preterm neonates were enrolled who were presented with respiratory distress. Neonate with type II respiratory failure, congenital heart disease and structural malformations of lung and GI tract causing respiratory distress at birth and neonate needed intubatuin at birth were excluded. Detailed information were obtained in each case. Thorough clinical examinations were done. Relevant investigation reports were collected. All the information were recorded. Statistical analysis was done by using SPSS version 23.*

***Results:*** *In this study the mean age was found 43.3±43.1 hours with range from 2 to 204 hours. Majority 62(57.4%) patients were male and male female ratio was 1.3:1. Two third (66.7%) patients had birth weight ≥2500 gm, 14(12.9%) had <1499 gm and 22(20.4%) patients had birth weight 1500-2499 gm. Majority (59.3%) patients belonged to gestational age between 37-41 wks, followed by 27(25%) belonged between 33-36 wks and 17(15.7%) belonged between 28-32 wks. Among the enrolled cases 18(16.7%) were RDS, 18(16.7%) were PNA, 14(13%) were PPHN, 9(4.3%) were MAS, 6(5.6%) were TTN, 13(12%) were congenital Pneumonia, 15(13.9%) were Pneumonia, 10(9.3%) were Sepsis and 5(4.6%) were Laryngomalacia. Among 108 patients who were put on bCPAP, 85(78.7%) patients were weaned and 23 (21.3%) were failed and needed mechanical ventilation. Out of 85 weaned patients hundred percent were survived and got discharge. Out of 23 failed cases 16(69.6%) cases were died and 7 (30.4%) cases were survived and got discharge.*

***Conclusion:*** *It is concluded from this study that bCPAP is an effective way of management of neonates with respiratory distress due to various causes. Patients who were failed in bCPAP, died more in final outcome.*

***Keywords:*** *Bubble CPAP, outcome, respiratory distress.*

*DS (Child) HJ 2022;38(1):27-33*
*DOI: https://doi.org/10.3329/dshj.v38i1.66998*

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**Received**: 7 February 2022; **Accepted**: 17 April, 2022

## Introduction

Respiratory distress occurs in 0.96-12% of life birth and is responsible for about 20% of neonatal mortality.[1] It is the most common presenting problem of newborn encountered within the first 48-72 hours of life and remains the primary indication for admission to neonatal intensive care unit to combat respiratory failure.[1]

Continuous Positive Airway Pressure (CPAP) is a well-established mode of respiratory support in newborns. Advancement in technology, increasing survival of extremely preterm newborns and better understanding of various respiratory diseases led to new evidence in this field over last decade.[2] Other than RDS, during post-extubation, apnoea of prematurity CPAP may be useful in conditions that result in alveolar collapse or airway narrowing. It relieves the signs of cardiac failure due to patent ductus arteriosus. Similarly, it is often used in the management of pneumonia, transient tachypnea of newborn, postoperative respiratory management, pulmonary edema and pulmonary hemorrhage. In meconium aspiration syndromes (MAS), application of CPAP can be beneficial by resolving the atelectatic alveoli due to alveolar injury and secondary surfactant deficiency.[3]

It can be applied via a face mask, nasopharyngeal tube, or nasal prongs, using a conventional ventilator, bubble circuit or a CPAP driver. Bubble CPAP is one of the lowcost nasal CPAP delivering systems, with underwater seal. CPAP delivered by underwater seal causes vibration of the chest due to gas flow under water; and these vibrations simulate waveforms produced by high frequency ventilation.[4]

Gregory et al[5] first pioneered the use of bCPAP in Neonatology with their landmark paper in the 70s in Columbia. bCPAP differs from conventional CPAP in that in bCPAP the expiratory limb is placed under water and oscillatory vibrations are transmitted into the chest resulting in waveforms similar to those produced by high-frequency ventilation.[6]

Conventionally neonates with respiratory distress are managed by respiratory support with positive pressure ventilation (delivered usually by mechanical ventilator) and surfactant replacement therapy.[7] In study of Verder et al[8] in 1994, remarkably reduced the need for mechanical ventilator from 85% to 41% in the neonate. In the developed world mechanical ventilator and CPAP machines are the mainstays of respiratory support in neonates but these machines are too expensive and many resources constrained in low socioeconomic countries.[7] The effectiveness of locally adapted bCPAP has been documented.[9,10] bCPAP is a simple and cost effective respiratory support system (RSS) which consists of products that are easily available and health care provider can easily be trained to make and use this RSS.[9] bCPAP is as effective as the other forms of CPAP, and can reduce the CPAP failure rate and the length of hospital stay.[11] bCPAP prevents the alveolar collapse and ensures gas exchange throughout the respiratory cycle and allows the lung inflation to be maintained. It can be effectively given through the nasal prongs which eliminate the need for the endotracheal intubation.[12]

bCPAP circuits consisted of inspiratory limb, the interface (nasal prongs) and the proximal part of the expiratory limb. The proximal end of the inspiratory limb connects the humidified oxygen source (wall piped oxygen) through the interface to the baby.[9] These tubes are carefully secured with an adhesive plaster to ensure that the length immersed in water remains constant.[9] The bCPAP generator is a cylindrical, transparent bottle filled to predetermined level with distilled water. The expiratory limb of the circuit is immersed in this bottle and the depth of the immersion in centimeters below the water surface correspond to the desired bCPAP in cm $H_2O$ usually between 5 cm to 8 cm of $H_2O$.[9] This provides positive pressure in the whole respiratory cycle, increases the functional residual capacity of lungs and lowers work of breathing.[10] Ultimately, bCPAP reduces the need for mechanical ventilation, morbidity, mortality.[13] Many studies have been shown that locally manufactured bCPAP system showed promising results.[14] bCPAP is more acceptable because of its simplicity, low cost and yet a powerful and effective technique of respiratory support, particularly suitable for neonatal units with limited resources.[15] But there is a paucity of studies on bCPAP in Bangladesh. In this study, we intend to observe outcome of bCPAP in the management of neonates with respiratory distress.

**Materials and Methods**

This Cross-sectional study was conducted in the Department of Neonatal Medicine, Bangladesh Shishu (Children) Hospital and Institute, Dhaka, Bangladesh from April 2017 to September 2017. Neonate with respiratory distress admitted at the department of Neonatology in Bangladesh Shishu (Children) Hospital & Institute were enrolled. Inclusion criterias were both term and preterm neonates presented with respiratory distress having two or more of the findings- respiratory rate >70/min, Grunting respiration, cyanosis, moderate or severe intercostals, supraclavicular, suprasternal retractions, oxygen saturation in pulse oxymeter <85%. Exclusion criteria were neonate with type II respiratory failure, congenital heart disease and structural malformation of lungs and GI tract causing respiratory distress at birth and neonate needed intubatuin at birth.

After obtaining written informed consent from parent/guardian, relevant information was recorded in predesigned proforma which includes particulars of the patient such as age on admission, sex, birth weight, gestational age and mode of delivery. Then examination findings such as weight, length, OFC, heart rate, respiratory rate, temperature, CRT, conciousness status, pallor, jaundice, cyanosis, dehydration, chest retraction, tone, primitive reflexes were also noted. Oxygen saturation was seen by using pulse oxymetry. Requirement of inotrop was recorded. Investigation findings such as RBS, CXR and ABG were also recorded. After fulfillment of enrollment criteria patients were put into bCPAP and monitoring was done clinically, with pulse oxymetry and ABG for requirement of change in settings, to see failure and outcome. Weaning was done in absence of respiratory distress (Minimal or no retraction and respiratory rate between 30 and 60 per min) and $SpO_2$>90% with PEEP <5 cm of $H_2O$ and $FiO_2$ <50%. Failure of bCPAP was considered when neonate remained hypoxic with $SpO_2$<87% with $FiO_2$ >70% and PEEP >7cm of $H_2O$, had severe retractions on PEEP >7cm of $H_2O$, $PO_2$<60 mmHg, $PCO_2$>60 mm Hg and pH <7.25 on maximum acceptable settings, had prolonged (>20 seconds) or recurrent apneas (>2 episodes within 24 hours associated with bradycardia) requiring bag and mask ventilation, had severe metabolic acidosis or shock requiring inotropic support (dopamine and or dobutamine) >20ìg/kg/min. Those who were weaned were observed for final outcome whether those were survived and discharged or died. Those who failed bCPAP were identified and their outcome was noted. Factors responsible for failure were also noted. Permission was taken from ethical review committee, Bangladesh Institute of Child Health.

Statistical analyses were carried out by using the Statistical Package for Social Sciences version 23.0 for Windows (SPSS Inc., Chicago, Illinois, USA). The mean values were calculated for continuous variables. The quantitative observations were indicated by frequencies and percentages. Chi-Square test and Fisher's exact test was used to analyze the categorical variables, shown with cross tabulation. Unpaired t-test and paired t-test was used to analyze the continuous variables. P values <0.05 was considered as statistically significant.

**Results**

Total 108 neonates were enrolled. Majority (45.4%) patients belonged to age ≤24 hours. The mean age was found 43.3±43.1 hours with range from 2 to 204 hours. Among them majority (57.4%) patients were male and 46(42.6%) patients were female. Male female ratio was 1.3:1. Regarding birth weight of the study patients, it was observed that two third (66.7%) patients had birth weight ≥2500 gm, 14(12.9%) had <1499 gm and 22(20.4%) patients had birth weight 1500-2499 gm. Regarding gestational age, it was observed that majority (59.3%) patients belonged to gestational age between 37-41 weeks, followed by 27(25%) between 33-36 weeks and 17(15.7%) between 28-32 weeks of gestation. It was also observed that majority (58.3%) patients were delivered by LUCS and 45(41.7%) were by NVD. (Table I). Among the neonates with respiratory distress who needed bCPAP support 18(16.7%) had RDS, 18(16.7%) had PNA, 15(13.9%) had Pneumonia and 14(13.0%) had PPHN (Table II).

**Table I**
*Distribution of the study patients by age, sex, birth weight, gestational age and mode of delivery*

| Variables | Number | Percentage | |
|---|---|---|---|
| **Age (in hour)** | | | |
| ≤24 | 49 | 45.4 | Mean ±SD: |
| 25-48 | 23 | 21.3 | 43.3 + 43.1 |
| 49-72 | 15 | 13.9 | Range |
| >72 | 21 | 19.4 | (min-max): |
| **Sex** | | | 2-204 |
| Male | 62 | 57.4 | |
| Female | 46 | 42.6 | |
| **Birth weight (gm)** | | | |
| <1499 | 14 | 12.9 | |
| 1500-2499 | 22 | 20.4 | |
| ≥2500 | 72 | 66.7 | |
| **Gestational Age (wk)** | | | |
| 28-32 | 17 | 15.7 | |
| 33-36 | 27 | 25.0 | |
| 37-41 | 64 | 59.3 | |
| **Mode of delivery** | | | |
| NVD | 45 | 41.7 | |
| LUCS | 63 | 58.3 | |

**Table II**
*Distribution of the study patients according to diagnosis (n=108)*

| Diagnosis | Number | Percentage |
|---|---|---|
| RDS | 18 | 16.7 |
| PNA | 18 | 16.7 |
| PPHN | 14 | 13.0 |
| MAS | 9 | 8.3 |
| TTN | 6 | 5.6 |
| Cong. Pneumonia | 13 | 12.0 |
| Pneumonia | 15 | 13.9 |
| Sepsis | 10 | 9.3 |
| Laryngomalacia | 5 | 4.6 |

**Table III**
*Distribution of the study patients according to outcome of bCPAP (n=108)*

| Outcome of bCPAP | Number | Percentage |
|---|---|---|
| Wean | 85 | 78.7 |
| Failure | 23 | 21.3 |

Table III shows outcome of bCPAP of the study patients, it was observed that out of 108 patient more than three fourth (78.7%) patients were found successfully weaned and 23(21.3%) were failed.

Table IV shows neonatal variables like age, sex, birth weight and gestational age which were not statistically significant (p>0.05) when compared with outcome of bCPAP.

Table V shows out of 23 failure cases who were put into mechanical ventilation, 16(69.6%) cases were died and 7(30.4%) cases were survived and got discharge. All (100.0%) patients were survived and got discharge in weaned group. The difference was statistically significant (p<0.05) between two groups. That means among the patients who were failed in bCPAP, died more in final outcome.

**Table IV**
*Association of neonatal variables with outcome of bCPAP (n=108)*

| Variables | Outcome of bCPAP | | p value |
|---|---|---|---|
| | Wean Mean (±SD) | Failure Mean (±SD) | |
| Age | 56.11±44.58 | 71.83±48.42 | $0.14^{ns}$ |
| Sex (Male/Female) | 49/3658/42 % | 13/10 56/44 % | $1.0^{ns}$ |
| Birth weight | 2461.17±616.84 | 2417.39±578.12 | $0.76^{ns}$ |
| Gestational age | 36.47±3.44 | 36.52±3.72 | $0.95^{ns}$ |

ns = Not significant

**Table V**
*Association between outcome of bCPAP with final outcome (n=108)*

| Final outcome | Weaned (n=85) | | Failed (n=23) | | p value |
|---|---|---|---|---|---|
| | n | % | n | % | |
| Discharge | 85 | 100.0 | 7 | 30.4 | 0.001[s] |
| Death | 00 | 0.0 | 16 | 69.6 | |

s= significant
p value reached from chi square test

**Discussion**

In this study it was observed that majority (45.4%) patients belonged to age ≤24 hours. The mean age was found 43.3±43.1 hours with range from 2 to 204 hours. Similar observation was found Soomro et al[16] study they reported that the mean age of enrolled infants was 1.35±0.60 days.

In this study it was observed that majority (57.4%) patients were male and 46(42.6%) patients were female. Male female ratio was 1.3:1. Similar result was found different studies, in study of Arora et al.[17] study observed that 66% were males and 34% were female. Soomro et al[16] study also observed that 70(57.9%) were males and 51(42.1%) were female.

In this study majority (59.3%) patients belonged to gestational age between 37-41 wks, followed by 27(25%) belonged between 33-36 wks and 17(15.7%) belonged between 28-32 wks of gestation.

In this series it was observed that majority (58.3%) patients belonged to LUCS group and 45(41.7%) belonged to normal delivery group. Arora et al[17] study found 30(17.6%) patients belonged to LUCS group and 140(82.4%) belonged to NVD group. Sharba et al[18] study observes 23(54.7%) patients in success group and 12(57.1%) in failed CPAP group were delivered by LUCS. The difference was not statistically significant (p>0.05) between two groups.

In this study it was observed that 18(16.7%) had RDS, 18(16.7%) had PNA, 15(13.9%) had Pneumonia and 14(13.0%) had PPHN. So, according to this study, the most common causes for starting bCPAP in neonate with respiratory distress are RDS, PNA, PPHN, pneumonia, congenital pneumonia, MAS, TTN, sepsis and laryngomalacia. Sethi et al[4] observed, the most common disease for starting bCPAP was RDS (80%) followed by pneumonia (17%), TTNB (0%) and MAS (2%). In Soomro et al[16] study 96 (79.3%) had subcostal recession and 81 (66.9%) had typical X-ray findings of RDS. Mathai et al[19] observed the most common disease for starting b-CPAP was RDS (n = 32) followed by pneumonia (n = 8), TTNB (n = 6) and Apnoea (n =4). In my study PNA is as equally responsible as RDS for causing respiratory distress in neonate. But in other studies, only RDS is the major cause. This may be due to irregular ANC, poverty, illiteracy, negligence, delay in intervention etc.

In this study it was observed that more than three fourth (78.7%) patients were weaned successfully and 23(21.3%) were failed. These 23 patients were put into mechanical ventilator out of which 7 were survived and got discharge and 16 were died finally. The patients who were weaned successfully, among them 100% survived and got discharged. Soomro et al[16] observed that overall 77 (63.6%) preterm infants were successfully weaned off from bCPAP. Arora et al[17] observed 118(69.4%) patients were found successfully weaned and 52(30.6%) were failed. Mathai et al[19] showed overall survival rate of the study population was 94%. Sethi et al[4] observed that 51 patients were put on bCPAP and out of them 60% were weaned successfully while other were intubated and was considered in failure group. Sharba et al[18] observed that 42 (66.67%) newborns were survived and weaned successfully from CPAP and 21 (33.33%) failed to weaned from CPAP and turn to mechanical ventilation.

Here neonatal variables like age, sex, birth weight and gestational age were not statistically significant (p>0.05) when compared with outcome of bCPAP. Soomro et al[16] found the mean age was 1.32±0.5 days in failure group and 1.36±0.6 days in success group. The difference was not statistically significant (p>0.05) between two groups. Soomro et al[16] had similar observation that 42(54.5%) were male in

failure group and 46(59.7%) in success group. The difference was not statistically significant (p>0.05) between two groups. Arora et al[17] observed, 78(66.1%) were male in success group and 34(65.4%) in failure group.

Regarding final outcome of the study patients, it was observed that majority (78.7%) patients were improved and 23(21.3%) needed mechanical ventilation. So, bCPAP is very much effective for the neonates with respiratory distress who fulfill the enrollment criteria. Because, it improves oxygenation and decreases chest retraction, tachypnoea and granting respiration by decreasing work of breathing.

Sharba et al[16] observed that 42 (66.67%) newborns were survived and weaned successfully from CPAP and 21 (33.33%) failed to weaned successfully from CPAP and turn to mechanical ventilation.

In current study, it was observed that, out of 23 failure cases that were put into mechanical ventilation, 16(69.6%) cases were died and 7(30.4%) cases were survived and got discharge. All (100.0%) patients were survived and got discharge in weaned group. The difference was statistically significant (p<0.05) between two groups. That means among the patients who were failed in bCPAP, died more in final outcome. Koti et al[12] showed 1(2.4%) patient died in weaned group and 5(35.7%) in failed group. The difference was statistically significant (p<0.05) between two groups. Sharba et al[18] also observed 2(4.7%) patients were died in weaned group and 16(76.19%) in failed group. The difference was statistically significant (p<0.05) between two groups.

## Conclusion

It is concluded from this study that bCPAP is an effective way of management of neonates with respiratory distress due to various causes. Patients who were failed in bCPAP, died more in final outcome.

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