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Original Article

Disease Pattern and Its Association with Outcome of Bubble CPAP in Neonates with Respiratory Distress Who Received Bubble CPAP

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ABSTRACT

Background: *Respiratory distress arises in 0.96-12% of life birth and is accountable for about 20% of newborn mortality and is the most usual presenting complaint of newborn encountered within the first 48-72 hours of life and remains the main indication for admission to neonatal intensive care unit to combat respiratory failure.* ***Methods and Materials:*** *This cross-sectional study was conducted in the neonatal intensive care unit, Bangladesh Shishu Hospital & Institute from April 2017 to June 2017 with a total of fifty-two neonates with respiratory distress.* ***Result:*** *Among the study patients most of the neonates (46.1%) belonged to age ≤24 hours. It was observed that forty-nine patients (94.2%) had chest retraction followed by forty-one (78.8%) had tachypnoea, about half (52.0%) had cyanosis, twenty-five (48.0%) had H/O apnoea and twenty (38.4%) had pallor. Of the neonates with respiratory distress which needed Bubble CPAP support nine (17.3%) had RDS, nine (17.3%) had PNA, seven (13.5%) had pneumonia, seven (13.5%) had PPHN, five had (9.6%) sepsis, and two had (4.0%) Laryngomalacia. More than three-fourth of the patients (78.8%) were found successfully weaned and one-fifth of the patients (21.2%) were found failed. Out of eleven failure cases who were put into mechanical ventilator, eight cases (72.7%) died and three (27.3%) cases survived and got discharge.* ***Conclusion:*** *This current study concluded that Bubble CPAP is an effective way of improving oxygenation of neonates with respiratory distress due to numerous reasons. Sepsis and PPHN has significant relation with Bubble CPAP failure.*

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INTRODUCTION

Respiratory distress syndrome is one of the common respiratory disorders in newborn babies during admission to Neonatal Intensive Care Unit. Hyaline membrane disease, meconium aspiration syndrome, septicemia, congenital pneumonia, and transient tachypnea of newborns are the prime causes of respiratory distress in neonates [1]. Respiratory distress occurs in 0.96-12% of life birth and is responsible for about 20% of neonatal mortality and is the most usual presenting problem of newborns encountered within the first 48-72 hours of life and remains the main indication for admission to neonatal intensive care unit to combat respiratory failure [2,3]. Bubble Continuous Positive Airway Pressure (Bubble CPAP) is non-invasive respiratory support delivered to instinctively breathing neonates to sustain long volume during expiration [4]. Bubble CPAP is a well-established mode of respiratory support in newborns. Advancements in technology, increasing survival of extremely preterm newborns and a better understanding of various respiratory diseases led to new evidence in this field over the last decade [5]. During post-extubation, apnoea & RDS of prematurity CPAP may be suitable in situations that consequence in alveolar collapse or airway narrowing [6]. 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 newborns, postoperative respiratory management, pulmonary oedema and pulmonary haemorrhage [7]. In meconium aspiration syndromes (MAS), the application of CPAP can be beneficial by resolving the atelectatic alveoli due to alveolar injury and secondary surfactant deficiency [8]. Gregory et al first founded the use of Bubble CPAP in Neonatology with their landmark paper in Columbia [9]. Bubble CPAP varies from conventional CPAP in that in Bubble CPAP 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 [10]. Conventionally neonates with respiratory distress are managed by respiratory support with positive pressure ventilation (delivered usually by mechanical ventilator) and surfactant replacement therapy. In the developed world mechanical ventilator and CPAP machines are the mainstays of respiratory support in neonates7 but these machines are too expensive and many resources are constrained in low socioeconomic countries [11]. Bubble CPAP is a simple and cost-effective respiratory support system (RSS) which consists of products that are easily available and healthcare providers can easily be trained to make and use this RSS [12]. Bubble CPAP is more suitable because of its ease, low cost and yet a powerful and effective technique of respiratory support, particularly suitable for neonatal units with limited resources [13]. The study intended to observe disease pattern and their association with the outcome of Bubble CPAP in neonates with respiratory distress.

OBJECTIVE

To observe disease pattern and its association with outcome of Bubble CPAP in neonates with respiratory distress.

METHODS AND MATERIALS

A cross-sectional study was conducted in the neonatal intensive care unit (NICU), Bangladesh Shishu Hospital & Institute from April 2017 to June 2017. A total of fifty-two (N=52) neonates with respiratory distress who were admitted at the NICU and received Bubble CPAP were taken for the study. After obtaining written informed consent from the parent/guardian, relevant information was recorded in predesigned proforma which includes particulars of the patient such as age on admission, sex, birth weight, and gestational age. Then antenatal, natal and postnatal history consisting of ANC, place and mode of delivery, home trial resuscitation at birth and on admission, H/O convulsion and apnoea were noted. The examination findings such as weight, length, OFC, heart rate, respiratory rate, temperature, CRT, consciousness status, pallor, jaundice, cyanosis, dehydration, chest retraction, tone, and primitive reflexes were also noted. Those who failed Bubble CPAP were identified and their outcome was noted. Factors responsible for failure were also noted. Ethical clearance was taken from the ethical review committee, Bangladesh Institute of Child Health.

Data analysis:

The study coordinators performed random checks to verify data collection processes. Completed data forms were reviewed, edited, and processed for computer data entry. 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. The data analysis was performed using Statistical Package for the Social Sciences (SPSS) Version 23.0. The significance level of 0.05 was considered for all tests.

Inclusion criteria:

- Both term and preterm neonates.
- Neonates presented with respiratory distress having two or more findings listed below
  - ✓ Respiratory rate >70/min
  - ✓ Grunting respiration
  - ✓ Cyanosis
  - ✓ Moderate or severe intercostals, supraclavicular, suprasternal retractions
  - ✓ Oxygen saturation in pulse oxymeter <85%.

Exclusion criteria:

- Type II respiratory failure
- Neonates who needed intubation at birth.
- Neonates with congenital heart disease.
- Neonates with structural malformation of lungs and GI tract causing respiratory distress at birth.

RESULTS

Among the study patients (N=52), most of the neonates (46.1%) belonged to age ≤24 hours. The mean age was found 43.3±43.1 hours with a range from 2 to 204 hours. Thirty neonates (57.7%) were male and around two-fifth of the neonates (42.3%) were female. It was observed that around three-fifth of the neonates (66.7%) had birth weight ≥ 2500 gm and seven (13.5%) had <1499 gm. It was observed that the majority of the patients (59.6%) belonged

to gestational age between 37-41 wks, followed by thirteen (25.0%) between 33-36 wks and eight (15.3%) between 28-32 wks of gestation. Most of the mothers (57.7%) underwent lower uterine segment cesarean section. Thirty-eight neonates (73.1%) needed resuscitation at birth (**Table I)**.

Table I: Distribution of the study patients by Characteristics (N=52)

Characteristics	(N,%)
Age in hours	
≤24	24,46.1%
25-48	11,21.1%
49-72	7,13.5%
>72	10,19.2%
Sex	
Male	30,57.7%
Female	22,42.3%
Birth weight (gm)	
<1499	7,13.5%
1500-2499	11,21.1%
≥2500	34,65.4%
Gestational Age	
28-32 wks	8,15.3%
33-36 wks	13,25.0%
37-41 wks	31,59.6%
Mode of delivery	
NVD	22,42.3%
LUCS	30,57.7%
Resuscitation at birth	
Yes	38,73.1%
No	14,26.9%

It was observed that forty-nine patients (94.2%) had chest retraction followed by forty-one (78.8%) had tachypnoea, about half (52.0%) had cyanosis, twenty-five (48.0%) had H/O apnoea and twenty (38.4%) had pallor (**Table II**).

Table II: Distribution of the study patients according to clinical features (N=52)

Clinical Features	(N,%)
H/O convulsion	13,25.0%
H/O apnea	25,48.0%
Pallor	20,38.4%
Jaundice	18,34.6%
Dehydration	7,13.5%
Cyanosis	27,52.0%
Tachypnea	41,78.8%
Chest retraction	49,94.2%

Of the neonates with respiratory distress who needed Bubble CPAP support, nine (17.3%) had RDS, nine (17.3%) had PNA, seven (13.5%) had pneumonia, seven (13.5%) had PPHN, five had (9.6%) sepsis, and six (12.0%) had congenital pneumonia (**Table III**).

Table III: Distribution of the study patients according to diagnosis (N=52)

Diagnosis	(N,%)
RDS	9,17.3%
PNA	9,17.3%
PPHN	7,13.5%
MAS	4,7.7%
TTN	3,5.7%
Cong. Pneumonia	6,12.0%
Pneumonia	7,13.5%
Sepsis	5,9.6%
Laryngomalacia	2,4%

The majority of patients (38.5%) were put into Bubble CPAP within ≤12 hours, nineteen (36.5%) were within >12-24 hours, and one-fourth (25.0%) were within >24-48 hours of admission. Sixteen patients had (30.8%) 49-72 hours of starting age of Bubble CPAP, followed by

twelve (23.0%) had ≤ 24 hours, thirteen (25.0%) had 25-48 hours and eleven (21.2%) had >72 hours. According to this study, most of the patients' (30.8%) Bubble CPAP was started within 49-72 hours of age. Almost half of the patients (50.0%) needed 25-48 hours of Bubble CPAP support, seven (13.4%) needed ≤24 hours and nineteen (36.5%) needed >48 hours. (**Table IV**).

Table IV: Distribution of the study patients according to Bubble CPAP(N=52)

Time from admission to Bubble CPAP(hours)	(N,%)
≤12	20,38.5%
>12-24	19,36.5%
>24-48	13,25.0%
>48	0,0.0%
Starting age of Bubble CPAP(hours)	
≤ 24	12,23.0%
25-48	13,25.0%
49-72	16,30.8%
>72	11,21.2%
Duration of Bubble CPAP(hours)	
≤ 24	7,13.4%
25-48	26,50.0%
>48	19,36.5%

More than three-fourths of the patients (78.8%) were found successfully weaned and one-fifth of the patients (21.2%) failed (**Table V**).

Table V: Distribution of the study patients according to outcome of Bubble CPAP(N=52)

Outcome of Bubble CPAP	(N,%)
Weaned	41,78.8%
Failure	11,21.2%

Out of forty-one (n=41) weaned cases, eight patients (19.5%) had PNA, seven (17.0%) had RDS, six (14.6%) had pneumonia, five (12.2%) had cong. pneumonia. Out of eleven (n=11) failed cases, three (27.3%) had PPHN, and three (27.3%) had sepsis. PPHN and sepsis were statistically significant ($p<0.05$) when compared to the outcome of Bubble CPAP. So, PPHN and sepsis have an association with Bubble CPAP failure (**Table VI**).

Table VI: **Association between outcome of Bubble CPAP with diagnosis (N=52)**

Diagnosis	Weaned (n=41)	Failure (n=11)	*p-value*
RDS	7,17.0%	1,9.1%	0.43^{ns}
PNA	8,19.5%	1, 9.1%	0.06^{ns}
PPHN	4,9.7%	3,27.3%	0.04^{s}
MAS	3,7.3%	1,9.1%	0.61^{ns}
TTN	3,7.3%	0,0.0%	0.44^{ns}
Cong. Pneumonia	5,12.2%	1,9.1%	0.60^{ns}
Pneumonia	6,14.6%	1,9.1%	0.006^{s}
Sepsis	2,4.9%	3,27.3%	0.22^{ns}
Laryngomalacia	3,7.3%	0,0.0%	0.29^{ns}

Out of eleven (n=11) failure cases who were put into mechanical ventilation, eight cases (72.7%) died and three (27.3%) cases survived and got discharge. All (100.0%) patients survived and got discharge in the weaned group. The difference was statistically significant ($p<0.05$) between the two groups. That means the patients who failed in Bubble CPAP, died more in outcome (**Table VII).**

Table VII: Distribution of the study patients according to outcome of Bubble CPAP with Final outcome (N=52)

Final outcome	Weaned (n=41)	Failure (n=11)	p-value
Discharge	41,100.0%	3,27.3%	0.001^{s}
Death	0,0.0%	8,72.7%	

DISCUSSION

Bubble CPAP is a non-invasive ventilation approach for newborns with respiratory distress syndrome. Bubble CPAP supports delivering continuous positive airway pressure which helps newborns to maintain lung volumes during expiration [14]. In this present analysis, it was observed that the majority of the patients (46.1%) belonged to age ≤24 hours. The mean age was found 43.3±43.1 hours with a range from 2 to 204 hours. A similar observation was carried out in Los Angeles and reported that the mean age of enrolled infants was 1.35±0.60 days [15]. This current study depicted that thirty neonates (57.7%) were male and around two-fifth of the neonates (42.3%) was female. A similar result was found in different studies. A study observed that 66% were males and 34% were female [16]. Another similar observation also found that (57.9%) were males and (42.1%) were female [15]. A study conducted in Pakistan also found that male to female ratio was 1.6:1[17]. In our study, it was observed that around

three-fifth of the neonates (66.7%) had birth weight ≥ 2500 gm. A relevant study observed that the mean weight was 1.76±0.37 kg [15]. A related article also found that almost half of the patients were very low birth weight [16]. A contradictory study found that 96% of the population was very low birth weight babies weighing less than 1500gm [18]. Another study observed that 53% of the population was very low birth weight babies weighing less than 1500 g [10]. In this series, it was observed that most of the mothers (57.7%) underwent LUCS and twenty-two (42.3%) belonged to the normal delivery group. Another study found 30(17.6%) patients belonged to the LUCS group and (82.4%) belonged to the NVD group [16]. A related study also described that (54.7%) patients in the success group and (57.1%) in failed CPAP group were delivered by LUCS. The difference was not statistically significant (p>0.05) between the two groups [19]. It was observed that most of the patients (73.1%) needed resuscitation at birth. So, a neonate who needed resuscitation at birth has more chance of developing respiratory distress afterwards found in the present study. Another related observation found 16(9.4%) needed resuscitation [16].

In this study it was observed that (94.2%) patients had chest retraction followed by 41 (78.8%) had tachypnoea, (52.0%) had cyanosis, (48.0%) had H/O apnoea and (38.4%) had pallor. A related study demonstrated in India observed (14.3%) patients experienced apnea in the success group and (28.6%) in the failure of the CPAP group [20]. According to this study, the most common diseases for starting Bubble CPAP in the neonate with respiratory distress are RDS, PNA, PPHN, pneumonia, congenital pneumonia, MAS, TTN, sepsis and laryngomalacia. A related study found that the most common disease for starting Bubble CPAP was RDS (80%) followed by pneumonia (17%), TTNB (0%) and MAS (2%) [10]. Another relevant article had a subcostal recession and (66.9%) had typical X-ray findings of RDS [15]. Another author found that the most common disease for starting Bubble CPAP was RDS (n = 32) followed by pneumonia (n = 8), TTNB (n = 6) and Apnoea (n =4) [18]. Most of the patients were admitted within 12 hours from admission in this present study. According to this study, most of the patients (30.8%) Bubble CPAP was started within 49-72 hours of age. Sixteen patients had (30.8%) 49-72 hours of starting age of Bubble CPAP, followed by twelve (23.0%) had ≤ 24 hours, thirteen (25.0%) had 25-48 hours and eleven (21.2%) had >72 hours. Another analysis showed the median age of starting CPAP was 2(0.3-6) hours of life [19]. According to this study, most of the patients (30.8%) Bubble CPAP was started within 49-72 hours of age. Almost half of the patients (50.0%) needed 25-48 hours of Bubble CPAP support, seven (13.4%) needed ≤24 hours and nineteen (36.5%) needed >48 hours. A related article showed that the median duration of CPAP was 26 hours (range 6 -144 h) [16]. Another outcome showed the median duration of CPAP was 36 hours (range 7-120 h) [19]. In this study, it was observed that more than three-fourths of the patients (78.8%) were found successfully weaned and one-fifth of the patients (21.2%) failed These 23 patients were put into mechanical ventilators out of which 3 were survived and got discharge and 8 died finally. Of the patients who were weaned successfully, among them

100% survived and got discharged. Another related article suggested that overall, (63.6%) preterm infants were successfully weaned off from Bubble CPAP [15]. Some authors observed (69.4%) patients were found successfully weaned and (30.6%) were failed [16]. The overall survival rate of the study population was 94% depicted by another author [18]. A relevant article found that there were 51 patients who were put on Bubble CPAP out of which 60% were weaned successfully while other were intubated and was considered in the failure group [10]. Another study observed that (66.67%) newborns survived and weaned successfully from CPAP and (33.33%) failed to wean successfully from CPAP and put into mechanical ventilation [19]. The current study shows, out of 41 weaned cases, (19.5%) patients had PNA, (17.0%) had RDS, (14.6%) had pneumonia, and (12.2%) had cong. pneumonia. The difference was statistically significant ($p<0.05$) between the two groups [15]. Another finding suggested that RDS on the chest x-ray was an important predictor of Bubble CPAP failure [21].

In the current study, it was observed that, out of 11 failure cases that were put into mechanical ventilation, (72.7%) cases died and (27.3%) cases survived and got discharge. All (100.0%) patients survived and got discharge in the weaned group. The difference was statistically significant ($p<0.05$) between the two groups. That means among the patients who failed in bubble CPAP, died in the outcome. Another article showed that (2.4%) patient died in weaned group and 5(35.7%) in the failed group. The difference was statistically significant ($p<0.05$) between the two groups [20]. A related article also observed (4.7%) patients died in weaned group and (76.19%) in the failed group. The difference was statistically significant ($p<0.05$) between the two groups [19].

CONCLUSION

This current study concluded that Bubble CPAP is an effective way of improving the oxygenation of neonates with respiratory distress due to numerous reasons. The common causes of respiratory distress were RDS, PNA, MAS, PPHN, TTN, Sepsis, congenital pneumonia, pneumonia and Laryngomalacia. Among these, sepsis and PPHN has significant relation with Bubble CPAP failure. Most of the patients were weaned. Patients, who failed in Bubble CPAP, died more in the final results.

RECOMMENDATIONS

This was a small-scale study done at a single center over a brief period of time. A large scale, multi-center study over long duration will give a complete picture to fulfill the objective of this study.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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