

Efficacy of Bubble CPAP in Managing Respiratory Distress in Neonatal Intensive Care Unit

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Abstract

Objective: To determine the efficacy of BCPAP (bubble continuous positive airway pressure) in management of neonates presenting with respiratory distress.

Material and Method: This is a Descriptive Case series conducted in Neonatal Intensive Care Unit, Punjab Rangers Teaching Hospital, Lahore, over 6 months from 3rd August, 2022 to 3rd February, 2023. 60 neonates of both gender, received within 2 hours of delivery and symptoms of respiratory distress syndrome (as per operational definition). BCPAP (Bubble continuous positive airway pressure) was initiated at 5cm H₂O to maintain pulse oximeter saturations above 90% in babies weighing over 1.5kg. Neonates were monitored for 48 hours, and Silverman Anderson Retraction Scores were assessed before and after this period. Efficacy, defined as a 3-point or greater reduction in the Silverman Anderson Retraction Score after 48 hours, was evaluated.

Results: 35 % (n=21) were male whereas 65% (n=39) were females. This study found that percentage of efficacy was 88.3% of BCPAP in management of neonates presenting with respiratory distress.

Conclusion: BCPAP has proven to be the choice of primary respiratory support in neonates with Respiratory Distress Syndrome due to its efficacy and cost-effectiveness in a limited resource setting.

Keyword: Bubble CPAP, Neonate Respiratory Distress, RDS, Supplemental Oxygen

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Introduction

In global perspective, approximately 2.5 million neonates die out of the 140 million live births.

Respiratory Distress syndrome remains one of the most frequent cause of mortality in the neonatal period. The manifestation of this syndrome is a usually a consequence of decreased surfactant synthesis and produces symptoms of tachypnoea, increased work of breathing with retraction of suprasternal, intercostal and subcostal areas,

cyanosis, grunting, stridor and poor feeding. Worsening condition without intervention lead to ventilation-perfusion mismatch, atelectasis and type 1 and type 2 respiratory failure.^{1,2} These symptoms start at birth and deteriorate over next 2-3 days.

The rate of neonatal mortality is significantly elevated in low and middle-income nations compared to high-income countries. In 2019, the infant mortality rate in United States due to respiratory distress syndrome (RDS) was reported to be 11.5 per 100,000 live births. However, in a study in Ethiopia the total incidence of neonatal mortality was 59.87 per 1000 neonates-days observations and in 2019, sub-Saharan Africa and Southern Asia comprised of 80% of global neonatal fatalities.^{1,3} 75% of these deaths occur in the first week, and nearly one million newborns passing away within 24 hours. Respiratory issues are the primary cause of neonatal intensive care

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unit (NICU) admissions, responsible for about 25% of NICU deaths.⁴ Gender-based research suggests a higher risk of distress in males, as reported by Aynalem et. al.⁵

Continuous Positive Airway Pressure (CPAP) is vital in managing neonatal respiratory distress. Nasal CPAP, commonly used in NICUs, offers numerous benefits. Effective CPAP administration requires close coordination among physicians, nurses, and families. CPAP is increasingly accessible in developing countries due to cost-effective devices. It can be given through variable flow, high flow nasal cannulas, or bubble CPAP (bCPAP), which involves generating bubbles using a water column. The mixed oxygen is delivered at 6-7L/min flow and 5-6cm H₂O pressure.⁶ The intranasal bubble CPAP delivery system is cost-effective, aiding in maintaining open airways and supporting respiratory function, particularly in premature neonates experiencing signs of respiratory distress. Using this method, gas passes through the nasal device, and pressure is established in the circuit by submerging the CPAP circuit's distal end in a predetermined depth of water. This action produces bubbles and induces pressure fluctuations within the circuit. The simplicity and cost-effectiveness of this CPAP method makes it preferable in limited-resource settings. Kinshella et al . reports that the price of stand-alone CPAP unit cost 100 to 1000 times higher than equipment used in this case.⁷

Studies in Nepal emphasize the early benefits of bubble CPAP within 24 hours of birth.⁸ Multiple studies from low-income countries show CPAP's survival advantages over oxygen alone in preterm and VLBW neonates.⁹⁻¹³ This novel bubble CPAP system has been designed in such a way to administer pressurized and humidified gases in the absence of need of manual power, compressed air or electricity without compromising on quality and accessibility.¹⁴

Pakistan faces significant neonatal mortality challenges, primarily due to respiratory distress. As a third-world country, we require straightforward and efficient approaches to enhance neonatal care provided in hospitals. Various studies in Pakistan report varying efficacy rates of bubble CPAP, with survival rates ranging from 71% to 93.3%.¹³

This study aims to assess bubble continuous positive airway pressure's efficacy in managing neonatal

respiratory distress, offering evidence tailored to the local population. The focus is on BCPAP, which has proven to be a more cost-effective option in a low-income setting compared to CPAP generated by driver devices or ventilators, which include expensive accessories replacement. This will enhance regional guidelines for neonatal respiratory distress management, improving our understanding of this critical issue.

Materials and Methods

This study is a Descriptive Case series conducted in Neonatal Intensive Care Unit, Neonatal Intensive Care Unit, Punjab Rangers Teaching Hospital, Lahore, over 6 months from 3rd August, 2022 to 3rd February, 2023. The sample size of 60 neonates is calculated, using the WHO calculator, with 95% confidence interval, 7% margin of error and percentage of efficacy i.e. 93.3% with BCPAP in neonates with respiratory distress.¹³ The sampling technique is non-probability, consecutive sampling. The study included neonates of both gender, received within 2 hours of delivery and symptoms of respiratory distress syndrome (as per operational definition). The patients excluded from the study were those with birth weight <1.5 kg, very preterm (<33 weeks of gestation) congenital anomalies like Tetralogy of Fallot's, Cleft lip and palate, congenital diaphragmatic hernia, choanal atresia and neonates with severe cardiovascular instability (on clinical examination).

The study enrolled 60 eligible infants from the Neonatology Department's emergency unit, with parental informed consent obtained. Demographic data, including baby name, age at admission, gestational age at birth, birth weight, and Apgar score, were meticulously recorded. BCPAP was initiated at 5cm H₂O to maintain pulse oximeter saturations above 90% in babies weighing over 1.5kg. This method involved creating bubbles by immersing the end of a respiratory circuit, facilitating exhalation against a water column. Neonates were monitored for 48 hours, and Silverman Anderson Retraction Scores were assessed before and after this period. Efficacy, defined as a 3-point or greater reduction in the Silverman Anderson Retraction Score after 48 hours, was evaluated. Data collection employed a standardized proforma, and subsequent analysis was performed using SPSS Statistics. Quantitative data, such as age at presentation, birth weight, gestational age at birth, Apgar score, and Silverman Anderson Retraction Scores before and

after treatment, were expressed as mean and standard deviation. Qualitative data, including gender, efficacy, and mode of delivery, were presented as frequency and percentage

Stratified analysis was conducted by gestational age, gender, and birth weight, with a chi-square test applied for significance (p-value set for analysis).

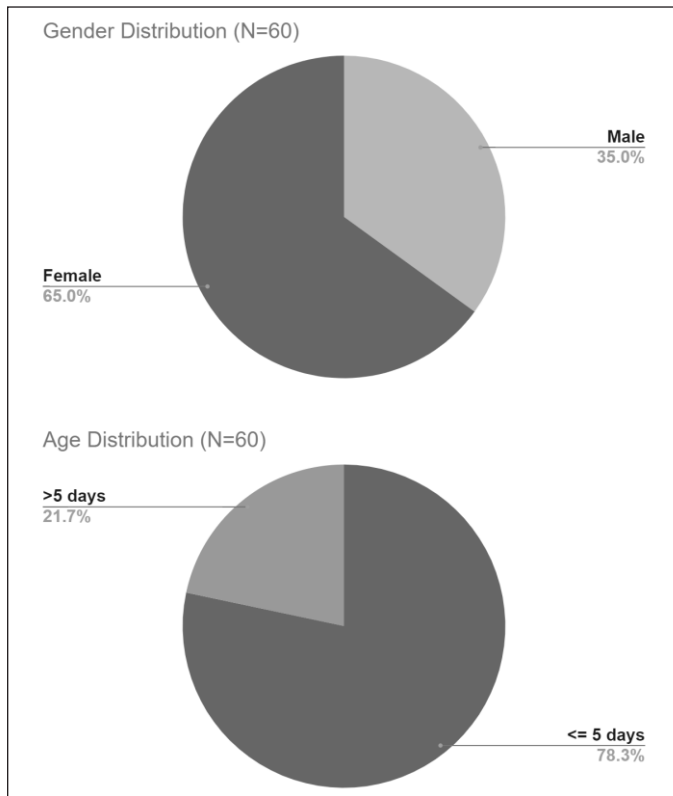


Fig No. 1: Age and Gender Distribution

Results

After 60 patients fulfilling inclusion and exclusion criteria will be selected to determine the efficacy of BCPAP in management of neonates presenting with

Table 1: Distribution of efficacy (N= 60)

	Frequency	Percent
Yes	53	88.3
No	7	11.7
Total	60	100.0

Table 2: Silverman Anderson Retraction Scores before and after BCPAP (N=60)

Variable	Mean±SD
SARS (Before)	7.41±1.3
SARS(After)	3.15±0.60

Table 3: Stratification of efficacy with respect to gender using chi-square test N= 60

		Efficacy		Total	P-value	
		Yes	No			
Gender	Male	Count	17	4	21	0.191
		% within Gender	81.0%	19.0%	100.0%	
Gender	Female	Count	36	3	39	0.191
		% within Gender	92.3%	7.7%	100.0%	
Total		Count	53	7	60	0.191
		% within Gender	88.3%	11.7%	100.0%	

respiratory distress. Age distribution of the patients was done, it shows that out of 60 patients, 78.3% (n=47) were in age group of <= 5 days and 21.7% (n=13) were in age group of >5 days and mean age was calculated as was 3.88±1.94 days. (Fig No. 1) Gender distribution of the patients was done, it showed that 35 % (n=21) were male whereas 65% (n=39) were females. (Fig-1) This study found that percentage of efficacy was 88.3% of BCPAP in management of neonates presenting with respiratory distress. (Table No. 1) The Silverman Anderson retraction Score calculated after initiating BCPAP in the patients was less than by almost 60% (Table No. 2)

Discussion

Neonatal respiratory distress syndrome (RDS) is a common issue in newborns, especially preterm infants. It remains a leading cause of morbidity and mortality among these infants.¹⁵ In this study of 60 patients, 78.3% were in the <= 5 days age group, with a mean age of 3.88±1.94 days. Gender distribution showed 35% males and 65% females. The study found that BCPAP was effective in 88.3% of neonates with respiratory distress.¹⁵

Neonatal respiratory distress is characterized by increased work of breathing, including nasal flaring, tachypnea, chest retractions, or grunting. Tachypnea is defined as a respiratory rate exceeding 60 breaths per minute, often seen in various respiratory, cardiovascular, metabolic, or systemic diseases. Neonatal chest walls, composed primarily of cartilage, are more pliable, predisposing them to decreased functional residual capacity and atelectasis. Decreased lung compliance, as seen in TTN, RDS, pneumonia, or pulmonary edema, results in marked tachypnea.¹⁶⁻²⁰

RDS affects preterm infants more than term infants. The incidence is inversely related to gestational age, and more severe in smaller and more premature

neonates.¹⁵ In the United States, RDS affects about 24,000 infants annually, primarily preterm ones. It is the most frequent complication seen in prematurity and can lead to significant morbidity and mortality in very low birth weight infants. Risk factors of RDS include, low birth weight, prematurity, male gender, white race, late preterm delivery, perinatal hypoxia, maternal diabetes, and ischemia, and delivery in the without labor.²¹

RDS, historically known as hyaline membrane disease, involves the eosinophilic membrane lining distal airspaces. The ruddy appearance of lung tissue from infants suffering from RDS is similar in to hepatic tissue. The components of hyaline membrane include cellular debris, fibrin, leukocytes and red blood cells. Microscopic examination shows pulmonary tissue with areas of atelectasis and dilated alveoli.¹⁵

Bubble CPAP is the preferred mode of delivering CPAP in resource-poor setting due to its simple set-up and efficacy. This proved to be so in this study with 88.3% efficacy in reducing symptoms of respiratory distress in neonates compared to nasal oxygen. Earlier initiation of b-CPAP in RDS, especially in preterm infants, is recommended for faster stabilization and avoidance of downward spiraling of alveolar instability, lung collapse and fall in functional residual capacity which leads to hypoxemia and respiratory failure.²²

Conclusion

In current study, we determined the efficacy of bubble continuous positive airway pressure in management of neonates presenting with respiratory distress, where the percentage of efficacy was 88.3% of bubble continuous positive airway pressure. B-CPAP is highly successful in improvement of condition neonates and very low rate of mortality after B-CPAP. This study will help us to improve our knowledge and current guidelines for management of neonates with respiratory distress.

Conflict of interest: *None*

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Authors Contribution

MAK: Conceptualization of Project

HA: Data Collection

AQ: Literature Search

SN: Statistical Analysis

MA: Drafting, Revision

MJ: Writing of Manuscript