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**Original Research Article**

# Bubble continuous positive airway pressure therapy for neonatal respiratory distress at birth in level III newborn unit in Chengalpattu Medical College Hospital: a prospective observational study

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## ABSTRACT

**Background:** Bubble continuous positive airway pressure (bCPAP), a non-invasive respiratory device provides continuous pressure that helps recruitment of more alveoli, increases the lungs, functional residual capacity and decreases the work of breathing in newborns admitted with respiratory distress. Bubble continuous positive airway pressure (bCPAP) is the most important respiratory support in different types of respiratory conditions in level III. In this observational study, author reported this research using bCPAP therapy as the primary respiratory support in level III unit in tertiary care centre in Chengalpattu, Tamil Nadu, India. Despite reporting their indications, duration of use and adverse effects we tried to search for further improvement in other areas of CPAP therapy in level III newborn unit.
**Methods:** This prospective observational study included 250 babies delivered in obstetric unit and admitted with respiratory distress within 6 hours of birth at level III care. They were treated according to level III newborn unit protocol. Those data were collected and entered in the proforma. Newborns were followed up till discharge.
**Results:** A total of 250 babies satisfying the inclusion criteria delivered in Chengalpattu Medical College Hospital, Tamil Nadu, India (mean gestational age 36±2 weeks, mean birth weight 2.5±1.2 kg were included. All newborns were given bCPAP as the primary support. The most common underlying cause of respiratory distress was transient tachypnea of newborn (44%), followed by respiratory distress syndrome (24%) and prolonged respiratory transition (18%). The therapy success rate was 86%. Only 35 newborns failed to respond to CPAP. The most common adverse effect was eye puffiness (19%).
**Conclusions:** Bubble continuous positive airway pressure (b CPAP) therapy use is being well established in level III unit for various respiratory conditions with minimal failure and adverse effects. Its use in extreme preterms and initiation after 6 hours is controversial.

**Keywords:** CPAP therapy, Neonatal unit, Respiratory distress

## INTRODUCTION

Bubble continuous positive airway pressure (bCPAP), a noninvasive respiratory support used to manage newborn babies with respiratory distress, was first reported in 1971 to help smooth transition of preterm neonates.[1,2] Bubble continuous positive airway pressure (bCPAP) is considered as less invasive respiratory support than conventional ventilation.[3] Bubble continuous positive airway pressure (bCPAP) provides continuous pressure

that helps recruitment of more alveoli, increases the lungs, functional residual capacity and decreases the work of breathing in newborns admitted with respiratory distress.[4] Moreover, bCPAP is very inexpensive and easy to use, it's the method of choice for delivering CPAP to distressed neonates in developing countries.[5-7] Bubble continuous positive airway pressure bCPAP can be used to manage various respiratory conditions in newborn including respiratory distress syndrome (RDS), transient tachypnea of newborn (TTN), meconium aspiration, congenital pneumonia and apnea.[8] It can be also used in post extubated newborns to decrease the incidence of reintubation.[9]

The level III unit in Chengalpattu Medical College, Tamil Nadu, India is 15 bedded, provides good service and care to sick newborns with trained NICU nurses and experienced pediatrician with expert neonatologist. This service is extended now to manage extreme preterms with less than 1000 gms in ELBW ward with good KMC care.[10]

Eventhough, authors are providing care to sick newborn for more than 20 years, authors have experienced in managing the distressed newborns who need respiratory support with bCPAP and conventional ventilation for the past few years. In this study, authors shared their observation of babies admitted with respiratory distress, need support for various indications, duration of stay, their improvement after therapy, etc.

## METHODS

This prospective observational study was conducted to include 250 babies admitted with respiratory distress in a 15 bedded level III unit in Chengalpattu Hospital, Tamil Nadu, India where 900 deliveries occur per month. This study was conducted between January 2018 to June 2018.

All procedures performed in this study were in accordance with ethical standards of Chengalpattu hospital, Tamil Nadu, India. Newborns with respiratory distress at birth started bCPAP within 6 hours of admission were included.

Newborns needed CPAP after 6 hours of birth, post extubation support, newborns with congenital anomaly were excluded. Those newborns were given treatment according to the unit protocol and followed up till discharge or changed to conventional ventilation.

The now available CPAP devices was manufactured by Fanem and Phoenix. The oxygen and air sources are piped oxygen and air then mixed to give the desired Fio2.

The mixed oxygen is humidified and delivered at a flow rate of 6 l/min and pressure of 5 cm $H_2O$. During the study, the interfaces used were nasal cannula and newborn nasal prongs.

Respiratory distress is defined as the presence of one or more of the signs which was tachypnea with a respiratory rate >60 breaths/min, grunting, retractions, flaring of ala nasi, cyanosis and or apnea.[11] TTN is defined as the presence of mild respiratory distress that occurs primarily in term and late preterm infants within 2 hours of birth that resolves within 72 hrs.[12]

Prolonged respiratory transition (PRT) is defined as presence of respiratory distress signs at birth that usually improves with the use of CPAP therapy within 6 hours of birth.[13] RDS is the presence of respiratory distress signs within first 6 hours of birth especially in preterms with radiologic findings that persists for more than 2-3 days.[14] Failure of CPAP therapy is defined as need for endotracheal intubation due to the persistence of severe respiratory distress signs and need for a high oxygen concentration (>40%) despite CPAP therapy with a pressure of 5 cm of $H_2O$.[15]

CPAP therapy is decided by the pediatrician but applied by NICU nurses. Weaning depends on the resolution of respiratory distress signs and when $FIO_2$ reaches 21-30%, pressure lowered down to 4 cm of $H_2O$. In the delivery room, CPAP was provided using a T piece resuscitator with a pressure of 5 cm of $H_2O$ until transfer to the neonatal unit attached to a pressurized 100% oxygen cylinder. After transferred to level III nasal CPAP was applied by bedside nurse and newborn was placed in a neutral thermal environment and connected to a multichannel monitor.

Vital signs and distress signs were assessed and documented hourly. The newborn was screened for risk factors for sepsis and other perinatal morbidity through detailed history and examination. If symptoms were resolved within 6 hours, feeding was started and transferred back to mother side.

Newborn were investigated with chest X-ray if distress persisted for >6 hours. Surfactant therapy was provided according to Insure protocol after CPAP failure. Empirical antibiotic treatment was reserved for sick newborn after routine septic workup has done.

## RESULTS

In this study, a total of 250 babies were included who received bCPAP as the primary respiratory support. Their mean gestational age was 36±2 weeks. Mean birth weight was 2.5±1.2 kg. There is a male preponderance (72%) in this study. Of these newborns 190 babies (76%) were born with caesarean section. 36% of the babies needed positive pressure ventilation during resuscitation.

Newborns born to maternal diabetes and PIH mother contributes to 18% and 20% respectively. The babies detailed demographic characteristics are shown in Table 1.

**Table 1: Demographic characteristics of neonates with respiratory distress treated with CPAP.**

| Characteristics | No. (%) |
|---|---|
| Mean gestational age | 36±2 weeks |
| Term | 48 (19.2%) |
| Late preterm | 125 (50%) |
| Preterm | 77 (30.8%) |
| Birth weight (mean) | 2.5±1.2 kg |
| Male gender | 182 (72.8%) |
| Twin gestation | 38 (15.2%) |
| Cesarean section | 190 (76%) |
| First minute apgar | 7 |
| Fifth minute apgar | 9 |
| **Resuscitation details** | |
| Positive pressure ventilation | 90 (36%) |
| Chest compression | 6 (2.4%) |
| Maternal diabetes | 45 (18%) |
| Maternal hypertension | 50 (20%) |
| Prolonged rupture of membranes | 74 (29.6%) |

**Table 2: Respiratory distress signs and underlying lung pathology of neonates treated with CPAP.**

| Respiratory distress signs | No. % |
|---|---|
| Tachypnea | 225 (90%) |
| Grunting | 180 (72%) |
| Apnea | 8 (3.2%) |
| Cyanosis | 26 (10.4%) |
| Retraction | 150 (60%) |
| **Underlying pathology** | |
| Prolonged respiratory transition | 47 (18.8%) |
| Transient tachypnea of newborn | 110 (44%) |
| Respiratory distress syndrome | 60 (24%) |
| Congenital pneumonia | 15 (6%) |
| Meconium aspiration syndrome | 18 (7.2%) |

Tachypnea was the most common presenting sign of respiratory distress (90%), followed by grunting (72%), retractions (60%), cyanosis (10%) and the least is apnea. The most common underlying cause of respiratory distress was transient tachypnea of newborn (44%), followed by respiratory distress syndrome (24%) and prolonged respiratory transition (18%) (Table 2). Respiratory distress started at birth in 140 babies (56%), within 2 hours in 60 babies (24%) and 2 to 6 hours in 50 babies (20%). Most of the babies required CPAP for 6-48 hours.

Feeding initiated while on CPAP was around 72% of babies. The duration of requirement of CPAP to newborn was more in case of meconium aspiration syndrome (48±24 hours) and less in case of prolonged respiratory transition (5±1.5 hours). The CPAP failure rate was 14% (Table 3). The most common complication of CPAP therapy was eye puffiness (19%), followed by nasal septum injury (14%) and abdominal distension (10%) (Table 4).

**Table 3: Characteristics of CPAP therapy in neonates with respiratory distress.**

| Characteristics | No. (%) |
|---|---|
| **Starting age of CPAP therapy** | |
| At birth | 140 (56%) |
| <2 hours | 60 (24%) |
| 2-6 hours | 50 (20%) |
| **$FIO_2$ required at initiation** | |
| <40% | 202 (80%) |
| >40% | 48 (20%) |
| Feeding while on CPAP | 180 (72%) |
| **CPAP therapy duration** | |
| <6 hours | 93 (37%) |
| 6 hours-2 days | 105 (42%) |
| 2-14 days | 40 (16%) |
| 14 days-2 months | 12 (4.8%) |
| **CPAP therapy duration according to diagnosis** | |
| Prolonged respiratory transition | 5±1.5 hours |
| Transient tachypnea of newborn | 16±3 hours |
| Respiratory distress syndrome | 24 hours±5 days |
| Meconium aspiration syndrome | 48 hours±24 hours |
| Failed CPAP | 35 (14%) |
| Surfactant therapy | 25 (10%) |
| Length of hospital stay | 10±2 days |

**Table 4: Complications of CPAP therapy in neonates.**

| Complications | No. (%) |
|---|---|
| Nasal septum injury | 35 (14%) |
| Eye puffiness | 48 (19%) |
| Abdominal distension | 25 (10%) |
| pneumothorax | 0 |

**Table 5: Comparison between neonatal clinical characteristics according to diagnosis.**

| Clinical characteristics | Prolonged respiratory transition | Transient tachypnea of newborn | Respiratory distress syndrome |
|---|---|---|---|
| Mean gestational age | 37±1.5 | 36±1.7 | 34±2.5 |
| Birth weight (mean) | 2.6±400 | 2.9±500 | 2.2±800 |
| Male gender | 30/47 (63%) | 88/110 (80%) | 46/60 (76%) |
| Cesarean section | 38/47 (80%) | 92/110 (83%) | 42/60 (70%) |
| CPA duration | 5±1.5 hours | 16±3 hours | 24 hours±5 days |

## DISCUSSION

This prospective observational study included 250 babies delivered over a period of 6 months in a tertiary care centre in Chengalpattu who required bCPAP as the primary respiratory support. Level III unit is supporting the babies with CPAP device for more than 10 years, especially preterms, extreme low birth weight babies with apnea and post extubational support. This study was conducted to share author's experience in using CPAP therapy and identify further requirements.

In this study, the included newborns were mostly preterm <36 weeks (80%) and term 20%. Among these 30% are less than 34 weeks. The included newborns who need resuscitation were around 38%. The success rate of CPAP therapy was high 86% with only 35 newborns failing CPAP and requiring intubation and 25 babies required surfactant therapy.

Respiratory distress causes for CPAP therapy are variable, but similar to previous studies TTN was the most common cause (44%). Prolonged respiratory transition is one of the features of postnatal delayed adaptation.[16,17] The main pathology is delayed absorption of fetal lung fluid.[18] This process might get delayed in babies born by caesarean section.[19] Providing continuous pressure via nasal bCPAP will stabilize the alveoli, prevent their collapse and help stabilize surfactant at alveolar surfaces and further improves functional residual capacity.[20] Eighteen percent of the babies fall in this category. Most (80%) delivered via caesarean section. They were relatively mature with mean gestational age of 37±1.5 weeks vs 36±1.7 and 34±2.5 weeks for those with TTN and RDS, respectively. The average duration of CPAP therapy for PRT was 5 hours±1.5 hours. None of these infants require $FIO_2$ >40% (Table 5).

TTN is also a relatively benign respiratory morbidity characterized by mild respiratory symptoms that usually resolves within few days.[21,22] It is the most common respiratory morbidity in term and late preterm infants especially after caesarean section.[23] The underlying pathology for TTN is the same as PRT. The mean gestational age for TTN was 36±1.7 weeks with birth weight 2.9±500 gms. 83% delivered via caesarean section.[24] The average length of therapy was 16±3 hours.

Respiratory distress syndrome is primarily a disease of prematurity, due to surfactant deficiency.[25] Without appropriate support affected newborns will develop acidosis and hypoxemia which will further harm the lung epithelium.[26,27] CPAP helps splints the airways of premature babies and decrease the rate of apnea.[28] RDS the second most cause of distress affects premature infants with mean gestational age of 34±2.5 weeks, with birth weight of 2.2±800 gms. Most 70% delivered via caesarean section. The average length of CPAP therapy was much longer than those in TTN and PRT (24 hours±5 days).[29]

Studies from other developing countries included fewer number of cohorts, but similar demographic characteristics, causation, CPAP therapy duration etc. were documented. There are other challenges arise in preterm babies who need CPAP for longer duration. Feeding, developmental stimulation, kangaroo mother care while on CPAP are other challenges, author have to improve in future.[30] Avoiding nasal injury and eyelid puffiness due to tight fitting of interface needs further expertise.[31] CPAP weaning initiated by our NICU nurses reflects their experience in newborn care.

## CONCLUSION

Present study showed that neonatal CPAP therapy is being well established in the tertiary care centre with success rate of 86%. Eventhough, its usefulness in extreme preterms is well known, the low rate of use of CPAP in these newborns due to various reasons and for long duration need further research.

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