

**Original Research Article**  
**The Use of CPAP For Respiratory Distress Syndrome in Preterm Infants**

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**Abstract**

**Objectives:** To study the immediate outcome of preterm infants with respiratory distress syndrome (RDS) on CPAP and identify factors associated with its failure.

**Study design:** Prospective analytical study.

**Subjects:** preterm infants (gestation 28 to 34 weeks) admitted to the NICU of index medical college with respiratory distress and chest X-ray suggestive of RDS.

**Intervention:** CPAP with bi-nasal prongs. Primary outcome: CPAP failures-infants requiring ventilation in the first one week.

**Results:** 60 neonates were enrolled in the study. 15 (25%) babies failed CPAP. The predictors of failure were; no or only partial exposure to antenatal steroids, HMD/congenital pneumonia on the chest X-ray, patent ductus arteriosus, sepsis/pneumonia and Downe's score >7 or FiO<sub>2</sub>>50% after 20-25 minutes of CPAP. Other maternal and neonatal variables did not influence the need for ventilation, Rates of mortality and duration of oxygen requirement was significantly higher in babies who failed CPAP. Only two infants developed pneumothorax. No baby had chronic lung disease.

**Conclusion:** CPAP failures (mechanical ventilation) occurs in Infants with no or partial exposure to antenatal steroids, HMD/congenital pneumonia in chest X-ray, patent ductus arteriosus, sepsis/pneumonia and those with higher FiO<sub>2</sub> requirement after initial stabilization on CPAP. CPAP is safe for preterm infants with RDS.

**Key words:** CPAP, CPAP failure, Management. Prematurity, Respiratory distress syndrome, downe's score.

**Study Design:** Observational Study.

**1. INTRODUCTION**

Continuous positive airway pressure (CPAP) re-expands the collapsed alveoli and reduces work of breathing and improve the respiratory pattern(1) when applied to premature infants with Respiratory distress syndrome (RDS). When CPAP used appropriately, is most cost effective, less intensive, requires less training and has lower risk of complications(2). However, Atelecto-trauma (repeated opening and collapse of the alveoli), biotrauma (intubation of the airway) and volutrauma (overstretching of the alveoli), the key determinants of ventilator induced lung injury are minimal or absent in gentler modes of ventilation such as nasal CPAP(3). Not all preterm infants with RDS respond to CPAP(4). We conducted this prospective analytical study to evaluate the short term outcome of preterm

infants (gestation 28 to 34 weeks) with RDS on CPAP, and to study the risk factors associated with failure of CPAP.

## 2. METHODS

The study was conducted at a level III neonatal unit between Jan 2021 to Oct 2021.

**Inclusion criteria-** All consecutively born preterm infants with gestation between 28 to 34 weeks, admitted to the neonatal intensive care unit with respiratory distress and chest X-ray suggestive of respiratory distress syndrome (RDS) were included.

**Exclusion criteria-** 1. Babies requiring intubation at birth and those. 2. major malformation eg diaphragmatic hernia /TEF . 3. If patient attender refuses to undergo treatment. Eligible babies were started on CPAP with bi-nasal prongs in index medical college indore. PEEP was started at 5 cm of water and adjusted to minimize chest retractions. FiO<sub>2</sub> was adjusted to maintain SpO<sub>2</sub> between 87% and 95%. Flow was titrated to the minimum to produce continuous bubbling in the bubble chamber. Surfactant was administered by INSURE technique (Intubate, Surfactant and extubate after 3 to 5 minutes of intermittent positive pressure ventilation). Surfactant was given for babies with moderate or severe RDS on the chest X-ray and or FiO<sub>2</sub> requirement >30%.

CPAP was considered to be successful if the respiratory distress improved and the baby could be successfully weaned off from CPAP. The criteria for weaning was absence of respiratory distress (minimal or no retractions and respiratory rate between 30 and 60 per minute) and, SpO<sub>2</sub>>90% on FiO<sub>2</sub><30% and PEEP <5 cm of water. Infants were diagnosed to have failed CPAP and were started on mechanical ventilation when they: (a) remained hypoxic, i.e. SpO<sub>2</sub><87% despite FiO<sub>2</sub>>70% and PEEP>7cm of water; (b) had severe retractions on PEEP >7cm of water; (c) had prolonged (>20 seconds) or recurrent apneas (>2 episodes within 24 hours associated with bradycardia) requiring bag and mask ventilation; and, (d) had severe metabolic acidosis or shock requiring inotropic support (dopamine and or dobutamine) >15µg/kg/min. Infants failing CPAP in the first 1 week of life were considered to be CPAP failures.

Data collection of maternal variables included multiple births, pregnancy induced hypertension, premature rupture of membrane, cesarean section and antenatal steroids. Gestational age was calculated based on mothers last menstrual period and or early pregnancy ultrasound scan or New Ballard score. Newborn variables evaluated included birth weight, gestational age, presence of IUGR (weight <10th on Lubchenko percentile). Apgar score at 1 minute, delivery room management (oxygen, bag and mask), X-ray chest, arterial blood gas, FiO<sub>2</sub> requirement and Downe's score at 15 to 20 minutes of starting CPAP. Based on radiological findings, the severity of RDS was graded as mild (mild granularity of lungs), moderate (generalized granularity of lungs with air bronchogram with preserved cardiac borders) and severe (white out lungs with loss of cardiac borders). The other clinical data recorded are patent ductus arteriosus (PDA) (clinical and Echo proven), pneumothorax, culture positive sepsis, pneumonia, necrotizing enterocolitis (NEC) (modified Bells criteria), chronic lung disease (oxygen requirement at 36 weeks PMA), germinal matrix - intraventricular hemorrhage (IVH), periventricular leucomalacia (PVL) (neurosonogram before day 7, at discharge and at 40 weeks PMA), retinopathy of prematurity (ROP) of any grade, duration of hospital stay among the survivors, and mortality.

The study assessed the following outcomes: CPAP failure, mortality, incidence of pneumothorax, IVH, PVL, shock, duration of hospital stay and predictors of CPAP failure.

Variables distributed normally are represented as mean  $\pm$  SD and the others as medians (range). P value  $<0.05$  was considered to be significant.

### 3. RESULTS

We take 60 neonates of gestational age 28 week to 34 weeks.

OUTCOME	CPAP Success N=45(75%)	CPAP failures N=15(25%)
Pneumothorax	3(4.7)	0
Apnea	8(14.3)	4(28.6)
IVH/PVH	0	2(14)
Shock	0	2(14)
Hospital stay (days)	12+ <sub>-</sub> 7.5	16.8+ <sub>-</sub> 8
Mortality	1(2.5)	5(35.7)

(range 1 hr to 15 hrs of life). The median duration of CPAP was 23.5 hours (range 2 -144 h). In infants surviving till discharge, the median duration of oxygen requirement was 102 (range 13-504 h) and median duration of hospital stay was 11 days (range 3-37 days). No baby had chronic lung disease. fifteen (25%) babies failed CPAP. Of the 15 infants, in 4 (7%) ventilation was started after an initial recovery from CPAP. Seven (11%) babies died during the hospital stay. The variables associated with failure of CPAP were: no or only partial exposure to antenatalsteroids, HMD/congenital pneumonia on the chest X-ray , patent ductusarteriosus, sepsis/pneumonia and Downe's score  $>7$  or  $FiO_2 \geq 50\%$  after 20 to 25 minutes of CPAP . Mortality was higher in the babies who required ventilation. In infants surviving till discharge, duration of hospital stay was longer in babies who failed CPAP

### 4. DISCUSSION

This is one of the few prospective studies on the role of CPAP for RDS in preterm neonates(gestation 28 to 34 weeks). In our study 25% of babies started on CPAP required ventilation. No baby required oxygen for more than 28 days. Only threebabies had pneumothorax but all three babies were stabilized on CPAP and required neither ventilation nor chest tube drainage. No exposure to antenatal steroids, severe RDS as suggested by white out X-ray, presence of PDA, sepsis/pneumonia, higher  $FiO_2$  and persisting distress after stabilization on CPAP, are the early predictors of CPAP failure.

In a retrospective study by **Ammari, et al.(5)** the failure rate of Bubble CPAP was 24% in babies'  $\geq 1250g$  and 50% in babies  $\leq 750g$ . None of the babies with gestation  $>30$  weeks failed CPAP. In their study nearly 65% of the babies were ELBW and 85.5% of babies had gestation less than 30 weeks as against 17.9% and 39.3% respectively in our study. The main difference between our study and that by Ammari, et al.(5) are, (a) ours is a unit which is doing Bubble CPAP for RDS for 6 months before the onset of the study, (b) we used Fisher and Paykel nasal prongs while it was Hudson prongs in their study, (c) definition of CPAP failure included  $FiO_2 >70\%$  and PEEP  $>7cm$  for the first 7 days of life as against  $FiO_2 >60\%$  for the first 72 hours of life. No PEEP criteria were set in their study. These major differences might explain the differences in failure rates in the two studies. Since most events in the early neonatal period are reflections of the care and support in the first couple of days, we choose 7 days as the cut off for CPAP failures(6).

In other uncontrolled studies and in the studies comparing INSURE with ventilation, CPAP failure rate ranged from 14% to 40% (4). The difference may be attributed to birthweight and gestation of infants enrolled, type of nasal interface, the CPAP device, age of starting CPAP, and use of antenatal steroids and surfactant. In the study by **Ammari, et al. (5)**, the predictors of CPAP failure were (i) need for positive pressure ventilation at birth; (ii) alveolar to arterial oxygen difference (A-a DO<sub>2</sub>) > 180 mm of Hg on the first blood gas; and (iii) severe RDS on the initial chest X-ray. Similar to their study, parameters of severe lung disease such as white out chest X-ray, higher FiO<sub>2</sub> requirement and higher Downe's score were associated with CPAP failure in our study (7).

In a case-control study by **(6)**, of the 97 preterm babies (gestation < 37 weeks) with RDS on ventilator CPAP or Bubble CPAP, 38% failed CPAP and required ventilator support. Babies were given ventilator support for hypoxia (SpO<sub>2</sub> < 90%) on FiO<sub>2</sub> > 90%. Only 34% of the infants in their study received antenatal steroids and the authors did not report the usage of surfactant in their study. Similar to our study and that by Ammari, et al. (5) severe RDS on the chest X-ray was an important predictor of CPAP failure. Pneumothorax and septicemia was higher in the CPAP failures. Although septicemia predicted CPAP failure in our study too, pneumothorax was seen in 2 babies in the success group. The higher failure rates in the study may be attributed to inadequate usage of antenatal steroids and may be due to lesser use of surfactant.

We conclude that CPAP for RDS in moderately preterm babies is safe and associated with lesser lung injury (no CLD or prolonged oxygen requirement). Nearly 25% of these infants fail CPAP and the predictors for failure are no exposure to antenatal steroids, severe RDS, presence of PDA or sepsis, persisting FiO<sub>2</sub> > 50% or persisting distress even after stabilization on CPAP (8).

## 5. CONCLUSION

CPAP failures (mechanical ventilation) occurs in Infants with no or partial exposure to antenatal steroids, HMD/congenital pneumonia in chest X-ray, patent ductus arteriosus, sepsis/pneumonia and those with higher FiO<sub>2</sub> requirement after initial stabilization on CPAP. CPAP is safe for preterm infants with RDS.

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