

# Success of Locally Devised Continuous Positive Pressure Ventilation (CPAP) alone or in combination with Surfactant Therapy in the Management of Respiratory Distress Syndrome in Preterm Neonates

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## Abstract

**Objective:** To study the effect of implementing locally devised CPAP alone or in combination with INSURE protocol (Intubation, Surfactant, Extubation) in preterm neonates with respiratory distress syndrome in a tertiary care hospital.

**Methods:** The study was conducted from August 2012 to August 2014 in Neonatal Intensive Care Unit (NICU) of Liaquat National Hospital, Karachi. Total 113 neonates were enrolled in the study. They were grouped in two categories on the basis of severity of respiratory distress syndrome (RDS). Infants with clinical evidence of respiratory distress and radiological evidence of patchy reticulogranular pattern were given a trial of bubble CPAP alone. Neonates with severe RDS were given INSURE protocol along with bubble CPAP. The intervention was considered to be successful if respiratory distress improved and the baby could be successfully weaned off from CPAP.

**Results:** In this study 113 neonates were enrolled. Fifty neonates were initially managed with bubble CPAP alone out of which 29 (58%) improved. Neonates with severe RDS were 63 and received bubble CPAP along with INSURE protocol out of which 45 (71.4%) improved.

**Conclusion:** Locally devised Bubble CPAP along with selective surfactant therapy is a safe and effective intervention in the management of respiratory distress syndrome in preterm. It decreases the need for mechanical ventilation and its subsequent complication.

**Keywords:** Bubble CPAP; INSURE protocol, and respiratory distress

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## Introduction

Each year around 15 million premature babies are born globally. Respiratory distress is a common complication of prematurity and results in high morbidity and mortality<sup>1</sup>. The standard management of Respiratory Distress Syndrome (RDS) is oxygen, Continuous Positive Airway Pressure (CPAP), surfactant and mechanical ventilation<sup>2</sup>. One of the approaches in the management of RDS is very low

birth weight infants is to intubate, administer intratracheal surfactant and extubate the infant and begin CPAP<sup>3</sup>. The European Consensus guideline states that CPAP is a safe alternative to routine intubation, surfactant and mechanical ventilation in spontaneously breathing preterm neonates<sup>4</sup>.

When surfactant is indicated, its administration via INSURE protocol (intubation, surfactant replacement and extubation to CPAP), which was first described by Verder et al.<sup>5</sup>, remarkably reduces the need for mechanical ventilation from 85% to 41% in preterm neonate<sup>5</sup>. CPAP inflates the collapsed alveoli, reduces intrapulmonary shunting and apneas, and promotes the release of native surfactant<sup>6,7</sup>. It

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reduces the need for intubation, mechanical ventilation and Bronchopulmonary Dysplasia (BPD)<sup>8,9</sup>.

CPAP can be provided by either using expensive commercial CPAP or by low-cost, locally engineered CPAP. It can be set up in the local unit with fraction of cost of a commercial system.

This is being successfully used in both developed and developing countries. Commercially available CPAP machines are costly and many resources constrained countries cannot afford them. The locally devised bubble CPAP (BCPAP) system requires components that are readily available and less expensive<sup>7</sup>. Research has been done and effectiveness of locally adapted Bubble CPAP has been well documented<sup>7-9</sup>.

In our part of world, due to low socioeconomic status survival of premature neonates is in jeopardy, with the advent of locally devised BCPAP which is cost effective and easy to use, chances of survival of preterm babies will be increased.

The objective of this study was to observe the effect of implementing locally devised CPAP with selective surfactant administration via INSURE protocol (intubation, surfactant, extubation) in preterms with respiratory distress syndrome.

## Patients and Methods

This cross sectional study was conducted in NICU of Liaquat national Hospital, Karachi, which is a tertiary care center. A total of 113 neonates were included with gestational age between 28 to 36 weeks, and admitted from August 2012 to August 2014 in NICU with respiratory distress/Hyaline membrane disease were included in the study. Neonates were registered via a structured Performa after informed consent from parents or guardians.

The inclusion criteria for both groups was based on clinical finding of respiratory distress, i.e. respiratory rate >60/min and use of accessory muscles of respiration, with requirement of supplemental oxygen to maintain pulse oximeter saturation over 85%, supported by radiological evidence.

They were grouped in two categories on the basis of severity of RDS. Infants with clinical evidence of respiratory distress and patchy reticulogranular pattern were initially given a trial of bubble CPAP alone. Neonates with severe RDS (complete white out lung fields with indistinguishable cardiac borders) were given INSURE protocol along with bubble CPAP. Exclusion criteria included all neonates born with extremely low birth weight less than 1 kg and born less than 28 weeks of gestation.

The CPAP system used in our study consisted of a walled piped oxygen source, delivery tubes, bi-nasal prongs and CPAP generator. The CPAP generator is a cylindrical, transparent bottle filled to predetermined level with normal saline and acetic acid. It has an inspiratory limb, the interface and the expiratory limb.

One end of the inspiratory limb connects the humidified oxygen source (wall piped oxygen) through the interface (Nasal Prongs) to the baby. The expiratory limb of the circuit is immersed in CPAP generator. The depth of the immersion in centimeters below the water surface corresponds to the desired CPAP in cm H<sub>2</sub>O usually between 5-8 cm of H<sub>2</sub>O. The tube is carefully secured with an adhesive plaster to ensure that the length immersed in water remains constant<sup>10</sup>. This provides positive pressure at the end of expiration to prevent collapse of alveoli. Acetic acid is added into the saline to prevent pseudomonas contamination. Fig. 1. shows the sketch diagram of BCPAP.

Neonates were started on Bubble CPAP with bi-nasal prongs after instillation of surfactant via INSURE protocol. Positive end expiratory pressure (PEEP) was started at 5 cm of H<sub>2</sub>O and was adjusted to minimize chest retractions. FiO<sub>2</sub> was adjusted to maintain SpO<sub>2</sub> between 88% and 94%. Flow was titrated to the minimum to produce continuous bubbling in the chamber. If FiO<sub>2</sub> requirement was 94%, then surfactant was repeated every 6 to 12 hourly, with a maximum of three doses.

The criteria for success of BCPAP alone or in combination with surfactant therapy was considered successful if respiratory distress improved i.e. respiratory rate <60/min, O<sub>2</sub> Saturations of >90% on FiO<sub>2</sub> < 30% and PEEP < 5cm of water with improvement in chest X-ray.

Infant variables evaluated include birth weight, gestational age, gender, FiO<sub>2</sub> requirement, re-administration of surfactant and need for mechanical ventilation. The other clinical data recorded, were complications i.e. Patent Ductus Arteriosus, pneumothorax, apnea, intraventricular haemorrhage, sepsis and nasal damage. Data was entered and analyzed using SPSS 17.0. Mean and standard deviation computed for quantitative variables including birth weight & gestational age. Data stratified according to gestational age and birth weight to look for any confounding variable on the outcome.

## **Result**

Total 113 neonates were enrolled in the study. Mean gestational age was 31.77 ± 2.7 weeks and mean birth weight was 1780 ± 524 Thirty five neonates had very low birth weight, (Table 1).

Total 50 neonates received BCPAP alone according to criteria described earlier. neonates successfully improved on BCPAP were 29 (58%) while 21 (42%) infants failed to show improvement on BCPAP alone. Other 63 neonates fulfilling the criteria for severe RDS received BCPAP with INSURE protocol. Of those 45 (71.4%) neonates responded to this protocol and were subsequently weaned off from BCPAP with complete resolution of RDS Fig. 1 & 2.

Unfortunately, 18 (28.6%) neonates failed to improve via this protocol and required subsequent mechanical ventilation. Factors that were associated with failure included Sepsis (58.3%), Patent Ductus Arteriosus (16.6%), Intra Ventricular Haemorrhage (8.3%), Apnea (8.3%) and Pneumothorax (8.3%), (Table 2).

## **Discussion**

Locally devised bubble CPAP has been shown to be effective in the management of RDS. This study evaluates the efficacy of locally devised Bubble CPAP alone or in combination with surfactant in the management of respiratory distress syndrome in preterm neonate. It was found that by implementing selective surfactant administration via INSURE technique followed by locally devised CPAP, the need for mechanical ventilation may be effectively reduced.

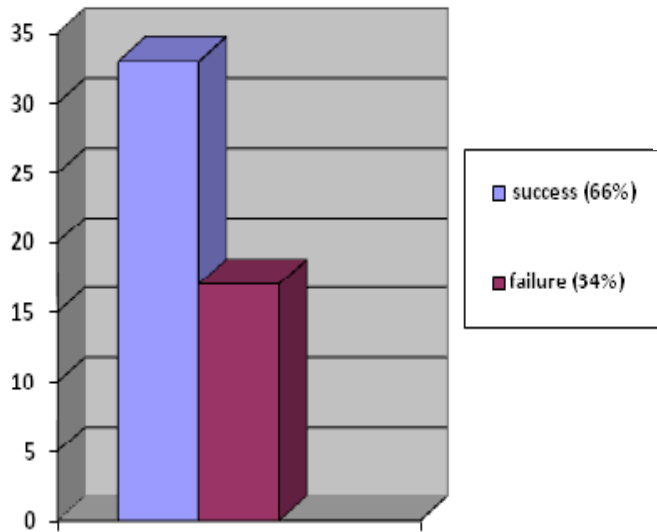
Early CPAP is the first line of treatment for very low-birth-weight infants and many infants can be successfully managed without Mechanical Ventilation (MV)<sup>7,9,10</sup>. Jonsson et al.<sup>11</sup> showed that of infants receiving early CPAP treatment, 34% later required MV, while in our study it was 28%, highlighting the efficacy of CPAP. In other uncontrolled studies comparing INSURE with ventilation, CPAP failure rates ranged from 14-40 %.

In the study by Koti et al.<sup>12</sup>, commercially manufactured CPAP was used with a failure rate of 25%. While we used a low cost, locally devised CPAP which effectively reduced the need for MV. In a study conducted in Malawi using locally devised CPAP, RDS was successfully treated in 65% of neonates, highlighting the utility of low-cost locally devised CPAP in low resource setting<sup>1</sup>. Similarly study conducted by Chan et al<sup>13</sup>. in which primarily Very Low Birth Weight (VLBW) and Extremely Low Birth Weight (ELBW) neonates were enrolled had higher success rate compared to our study. These differences are mainly due to the improved level of medical care provided, with lesser incidence of septicemia. In our study, septicemia was a major factor resulting in CPAP failure, accounting for 14/21 cases (58.3%). This could be due to catering of unbooked deliveries and patients referred from other hospitals, with more chances of neonatal sepsis<sup>14</sup>.

It is recommended that treatment with surfactant should be initiated as soon as possible after birth; repeat dosing is given every 6 - 12 hours for a total of 2 - 4 doses<sup>15</sup>. In our study a total of 24

**Table 1.** Characteristics of study subject

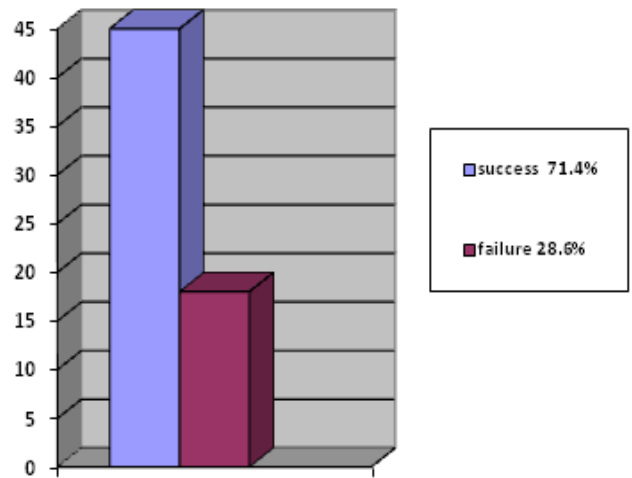
Gestational age	Frequency	Percentage
25-29 weeks	23	20.3%
29+ - 33 weeks	49	43.36%
33+ weeks	41	36.28%
<b>Weight (Kg)</b>		
>2.5	7	6.1%
LBW (2.5)	60	53.98%
VLBW (1.5 ) agea	35	30.97%
ELBW (below 1.0)	11	9.7%
<b>TOTAL</b>	<b>113</b>	<b>100%</b>



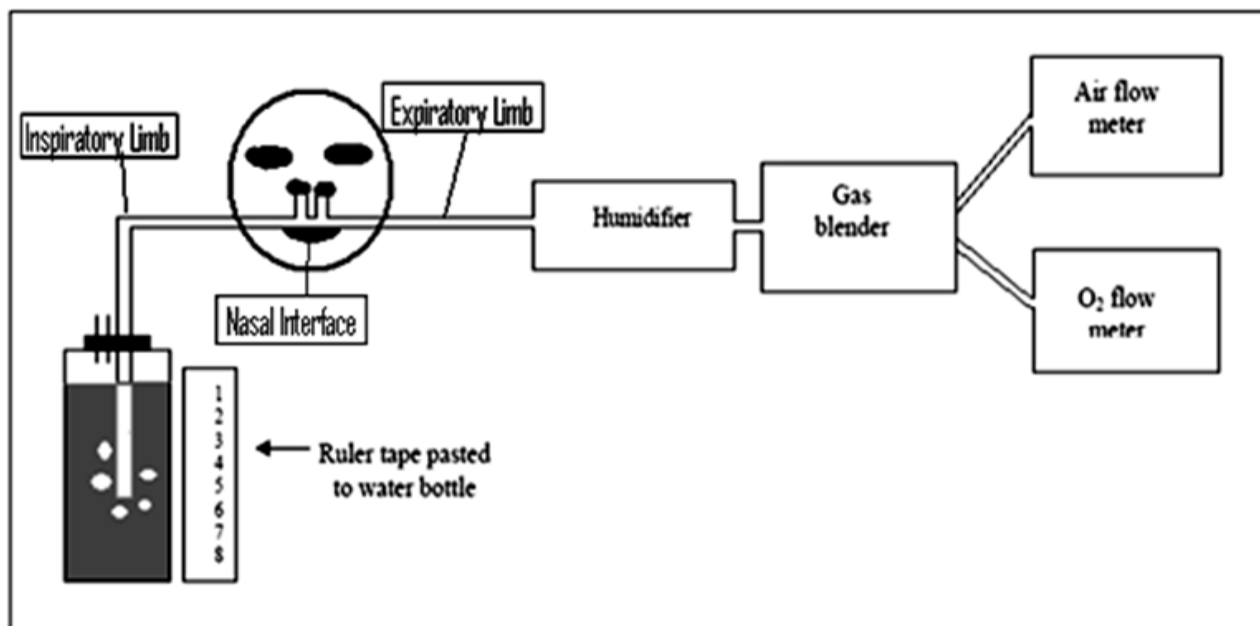
**Fig. 1.** Success rate of neonates managed on Bubble Continuous Positive Airway Pressure (BCPAP) alone

**Table 2.** Factors Associated with Failures

Sepsis	14 (58.3%)
Patent Ductus Arteriosus	4 (16.6%)
Intra Ventricular Haemorrhage	2 (8.3%)
Pneumothorax	2 (8.3%)
Apnea	2 (8.3%)



**Fig. 2-** success rate of neonates managed on BCPAP with surfactant therapy.



A Sketch Diagram Of Bubble CPAP<sup>(13)</sup>

neonates received surfactant, out of which 13 (15.4%) required a second dose and 3 (3.5%) required third dose. Our results are closer to K.Bohlin<sup>16</sup> et al. with only 17% of the infants requiring greater than one dose of surfactant. This shows the efficacy of CPAP in reducing the need for surfactant re-administration. Hence selective use of surfactant along and its judicious re-administration with CPAP could be a better intervention for managing RDS<sup>17</sup>.

Nasal cannula are recommended and used to deliver oxygen into the nose at low flow, usually with no intention of generating positive pressures in the airway. However nasal cannula, with an outer diameter of 3 mm and flows up to 2 l/min, have been reported to deliver CPAP<sup>18</sup>.

A paper published by Charanjit Kaur et al.<sup>19</sup> describe the cost effectiveness of simple BCPAP circuit and its successful use in their centre for last ten years and suggested that a single prong CPAP, using a cut down endotracheal tube, or a large bore suction tube may be used. This has shown to be as comfortable for the baby compared to the more expensive nasal prongs. This is a cheaper alternative to nasal prongs. Mouth closure is not consid-

ered essential although it can raise pharyngeal pressure.

In May 2013, European Consensus Guidelines on the Management of Neonatal Respiratory Distress Syndrome in Preterm Infants<sup>4</sup>, recommends that in spontaneously breathing babies stabilization should be done with CPAP of at least<sup>5</sup> red essential although it can raise his has shown to be as comfortable for the baby was a major factor resulting in CPAP failure, accounting face mask. The earlier CPAP is applied the greater the chance of avoiding Mechanical Ventilation, and when applied from birth CPAP reduces the need for surfactant therapy and Mechanical Ventilation.

### Conclusion

Respiratory distress syndrome, which is a potential life-threatening problem of pretermneonates, is a curable condition. In this study we observed that locally designed Bubble CPAP along with selective use of surfactant is safe and effective in the management of RDS. This management strategy can also help in reducing the economic burden of the disease.

## Conflict of Interest

The authors report no conflict of interest and have not received any funding/grant from any organization for the present study.

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