Bubble-CPAP in Neonatal Unit of TUTH

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Abstract

Introduction: Nasal Continuous Positive Airway Pressure (CPAP) in newborn babies with respiratory distress reduces requirement for mechanical ventilation thereby decreasing referral to higher centre. In our neonatal unit prior to the use of this intervention, morbidity and mortality associated with respiratory distress was significant which has decreased after we started CPAP in Kartik 2065 (October 2008) including a decrease in referrals to higher centre for ventilator support.The objective of this study was to evaluate the outcome of bubbling CPAP in newborn babies who had respiratory distress. **Methods:** Observational study done in neonatal unit of TUTH over a period of 3 months i.e from Kartik to Poush 2065 B.S (mid of October to mid of January,2008) **Results:** 127 neonates were admitted, of whom 15 babies with respiratory distress (11.8% of total admissions) received CPAP. 11 babies improved, while 4 babies died. Among those attending follow up (8 babies) none had any features of chronic lung disease. **Conclusion:** In resource poor settings where level II neonatal care is already exists; CPAP can be easily applied for newborn babies with respiratory distress with promising results and it helps to decrease neonatal morbidity and mortality.

Key words: CPAP, neonatal mortality, respitatory Distress.

Introduction

With an increase in deliveries by 38% over the past 10 years in the Tribhuvan University Teaching hospital (TUTH), there is also an increasing trend of preterm births from 25% to 42%. In the year 2007-2008, of the total 3992 live births 382(9.6%) were preterm. In the same year we had a neonatal mortality rate of 6.3% out of which 37% accounted for conditions associated with prematurity. In another study on the outcome of low birth weight babies at TUTH, respiratory distress of prematurity accounted for 40% of the mortality[1]. Just before Continuous Positive Airway pressure (CPAP) was started in the neonatal unit, from Magh 2064 to Asoj 2065, of 372 admitted babies, 104 (28%) were preterms. Of these preterm babies, 49 babies (47%) developed respiratory distress of prematurity, among which 10 babies died and 15 babies were referred to higher centres for ventilatory support. Referral to other facilities for ventilator support has its constraints. There are only few NICUs in the country including government and private institutions with provision for only a handful of babies needing ventilator support. Many a times babies needing advanced respiratory support at TUTH have had to wait for availability of ventilator support and some have even succumbed to death during this time. There are studies which have demonstrated that application of nasal continuous positive airway pressure (CPAP) to babies with respiratory distress can reduce transfer to tertiary care and the need for mechanical ventilation[2]. There are also encouraging reports from India with survival of 100% among babies weighing more than 1.5 Kg who received CPAP[3].

At TUTH we were able to start nasal CPAP in our unit from Kartik 2065 with the help of visiting colleagues from Brooklyn Hospital, New York. The outcome was very encouraging and we would like to share our

experience as this can be easily applied in a neonatal nursery where level II service already exists.

Methodology

Before starting nasal CPAP in the unit, faculty, pediatric residents and nursing staffs were briefed about the device, its indications, assembling of the tubes and sterilization of the circuit. We used two corrugated tubes; one blue and another white and a Hudson prong (Fig. 1).

Steps for setting up the CPAP circuit

1. Connect the air and oxygen tubing from compressor and oxygen cylinder respectively. (The white tube was connected with the central oxygen source through the Y-tube so as to facilitate admixture with compressed air). Set the oxygen flow using flow meter (usually at 5-8 L/min)
2. Set up the inspiratory limb (white tubing):
   a. From the flow meter to the humidifier and,
   b. From the humidifier to the patient end (e.g. nasal cannula).

Oxygen was humidified and warmed by having it pass through heated water in the bottle (humidifier).

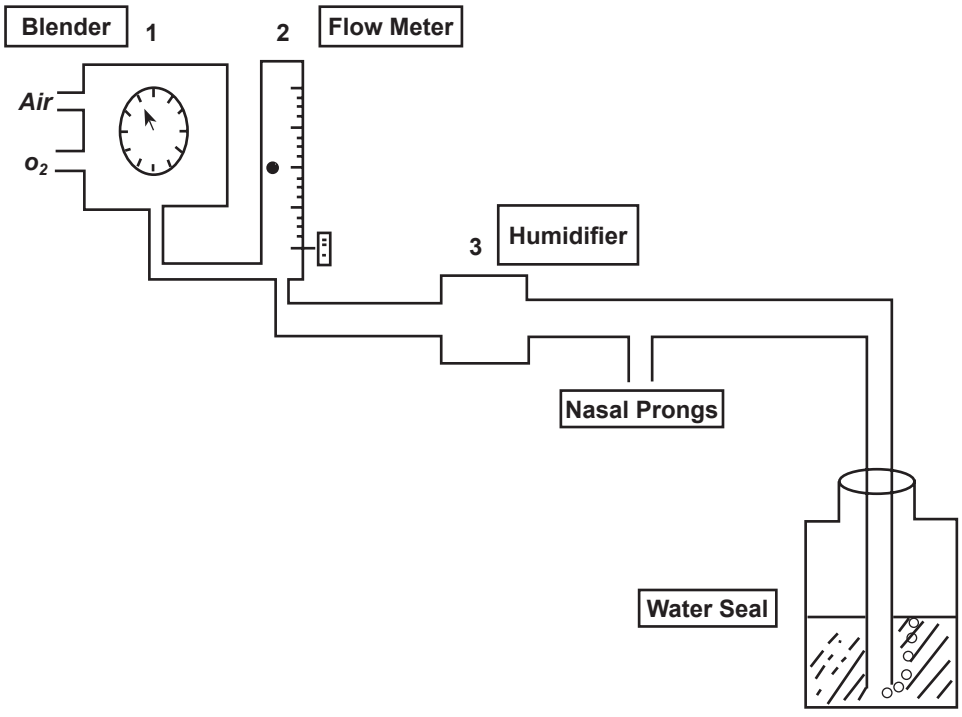
3. Set up the expiratory limb (blue tubing) - from the patient end to a chamber filled with sterile water. Immerse it under the water up to the required depth (which is determined by the intended pressure; e.g. to deliver 5 cm H_20, immerse up to 5 cm mark in the tube).

The starting oxygen flow was kept at 5-10 litres/ minute and starting positive airway pressure was kept at 5 to 7 cm of H_2O.

The indication for initiating CPAP was mainly clinical and included any baby with the following:

- Presence of increased work of breathing as indicated by an increase in respiratory rate of > 30% of normal, substernal and suprasternal retractions, grunting, and nasal flaring.
- Presence of pale or cyanotic skin color and agitation.
- Not maintaining saturation (SpO_2 measured with a pulse oximeter) despite high flow oxygen given via headbox.

CPAP was gradually discontinued after improvement of the above mentioned clinical parameters. Vitals including respiratory rate, heart rate, blood pressure, SpO_2 were monitored every two hours while babies were receiving CPAP. Nursing care regarding position change and suctioning was continued and water in the bottle was heated and changed every 4 to 6 hours.



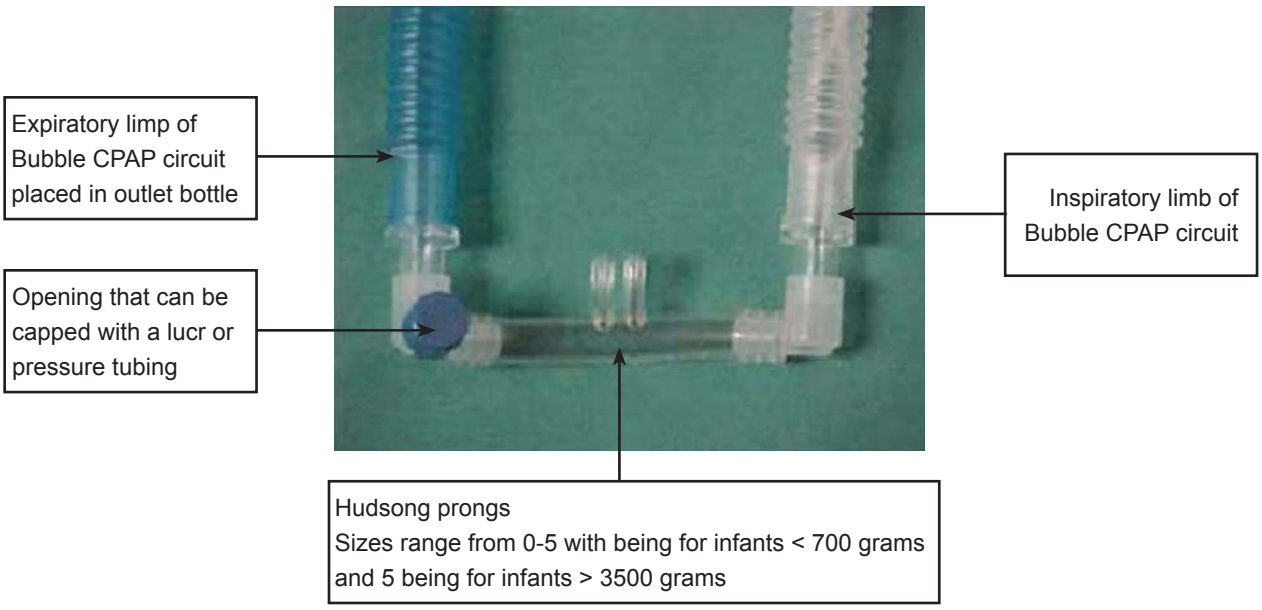


Fig. 1: Schematic Diagrams and Tubing with Hudson Prong.

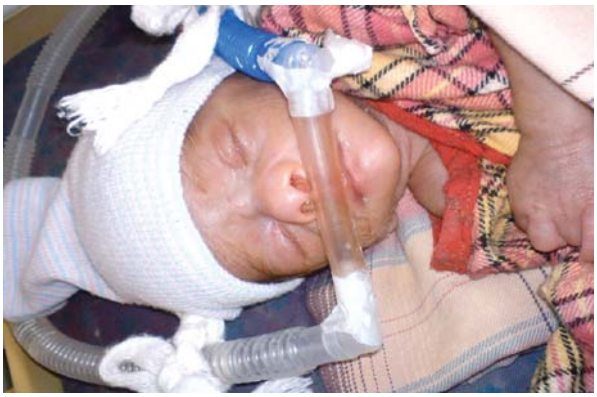


Fig. 2: Showing a baby getting CPAP.

Results

Over a period of three months (Kartik to Poush 2065), 127 neonates were admitted to the neonatal unit of which 15 babies (11.8% of total admissions) received CPAP. There were 9 male and 6 female neonates and their average weight was 1720± 588grams. All babies with the exception of one were born preterm. The most frequent (12 babies) indication for CPAP was respiratory distress of prematurity followed by three with a diagnosis of congenital pneumonia.

CPAP started at the earliest age was at an hour of life and was continued for a maximum of seven days (168 hours) duration.

Regarding the outcome, among the twelve babies with respiratory distress of prematurity eight improved and discharged and four babies died. All the babies with congenital pneumonia improved and were discharged. Table 1 shows the characteristics of babies kept on CPAP in more detail. One baby weighing 800 gms and born at 28 weeks developed a pneumothorax on the 3rd day of life. The pneumothorax was drained but this baby then developed recurrent apnea and died as we were unable to refer him for ventilatory support as this was not available at the referral hospital. Three babies died due to severe sepsis while on CPAP. All babies on discharge are advised to attend the high risk clinic for follow up. Among the 8 babies who did attend regularly, none had any signs of chronic lung disease till 6 months of age. Two babies (both born at 28 weeks of gestation) developed retinopathy of prematurity.

Discussion

CPAP is an application of positive pressure to the airway of a spontaneously breathing infant through out the respiratory cycle. The first clinical use of CPAP was reported by Gregory in 1971 in preterm babies with respiratory distress syndrome through an endotracheal tube. Later Kattwinkel reported successful use of nasal prongs to provide CPAP in these infants[4].

In the 1980s, use of CPAP decreased because of the advent of newer modes of ventilation and the perceived complications of CPAP. Following this there have been studies proving that with CPAP there is lower incidence of chronic lung disease (CLD) with insignificant complications and therefore there is a resurgence of interest in this modality of non invasive ventilation over the past 15 years.

Table 1: Characteristics, duration and outcome of the babies who received CPAP

Serial number	Gestational age	Birth Weight (Grams)	Initiated (hours of life)	Discontinued (hours of life) with outcome
1.	28wks	1100	1	144 - improved
2.	28wks	1500	1	168 - improved
3.	28wks	1100	1	Died at 42 hours of life*
4.	28wks	800	2	Died at 91 hours of life #
5.	29wks	1400	2	69 - improved
6.	30wks	1200	3	Died at 8 days of life *
7.	32wks	1800	17	Died at 8 days of life*
8.	33wks	2250	14	93 – improved
9.	34wks	2500	2	72 – improved
10.	34wks	1900	1	2 – improved
11.	34wks	1800	16	72 – improved
12.	34wks	1350	2	22 – improved
13.	34wks	1800	14	96 – improved
14.	36wks	2700	2	68 – improved
15.	37wks	2600	2	120 – improved

**: severe sepsis/disseminated intravascular coagulopathy*
#: recurrent apnea

The bubbling CPAP is a form of oscillatory pressure delivery in which mechanical vibrations are transmitted to the chest secondary to non-uniform flow of gas bubbles across the downstream of a water seal[5] and this system results in waveforms similar to those produced by high-frequency ventilation when recorded by a transducer attached to the infant's airway. The chest vibrations produced contribute to gas exchange by facilitated diffusion[6].

The system we have used is a simple, low-cost device and does not require highly trained personnel[7]. The circuit used in our unit is quite similar to that used by Charanjit Kaur et al in neonatal unit of St Stephens Hospital, India[8]. We used the circuit with corrugated tubes and Y-tube made of an old unused stethoscope. In most of the babies we started CPAP within 4 hours of life. There are several studies that have demonstrated that early initiation of CPAP decreased the need for mechanical ventilation in up to 50% of cases[9]. A large prospective study in Poland including 1299 newborn in 57 centres in Poland showed that tracheal intubation was avoided in 78% of the babies who were electively treated with CPAP[10]. In another study in Australia, CPAP was compared with oxygen administered by hood in infants greater than 30 weeks gestation with respiratory distress and they concluded that only 23% in nCPAP group and 40% in oxygen group required transfer to a regional tertiary care hospital[2]. From our unit, 93% (14 babies) did not require a transfer for ventilatory support with the exception of one who developed recurrent apnea but later died for the reason already explained earlier.

Since there is no evidence for any additional benefit with prophylactic CPAP; prophylactic CPAP is not recommended at present and therefore this was not practiced in our unit as well[11]. Regarding the outcome of CPAP, studies have shown lower mortality and morbidity rate in infants with birth weights greater than 1500 g who were placed on CPAP compared to those initially supported with mechanical ventilation[12]. We have not compared outcome prior to the arrival of CPAP in the neonatal unit and also we are reporting outcome after CPAP in only a small number of babies and therefore unable to compare with studies done elsewhere. Pneumothrax (<5%) during CPAP is a reported complication which usually results from the underlying disease process rather than positive pressure alone. In our unit also an 800gm baby developed pneumothorax which required intervention. Chronic lung disease (CLD) was almost non-existent where bubble CPAP was started either in the delivery room or within 3 hours after birth. This study has shown that the initiation of mechanical ventilation was associated with increased risk of CLD with odd ratio of 13.4, 9.6 and 6.3 when the mechanical ventilation was started on day 1, days 1 to 3, and day's 4 to 7 respectively[13]. Similar study done by Howard J. Birenbaum et al also showed that there was a significant reduction in the incidence of CLD in infants with birth weights of <1500 g with avoidance of intubation and early use of nCPAP therapy[14]. Among the 66% babies who survived and are attending follow up in our high risk clinic we have not found evidence of chronic lung disease in any of them.

Conclusion

In conclusion, bubble CPAP can be easily applied to newborn babies in a Level II nursery with respiratory distress using a simple device and help to avert the need for referral to higher centres for ventilatory support.

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