

Bubble CPAP - A Primary Respiratory Support for Respiratory Distress Syndrome in Newborns

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Manuscript received: November 8, 2006; Review completed: December 26, 2006; Accepted: June 19, 2008.

In preterm infants with respiratory distress syndrome (RDS), the application of continuous positive airway pressure (CPAP) is associated with benefits in terms of reduced respiratory failure and reduced mortality. We conducted this prospective study to evaluate the effectiveness of bubble-CPAP as primary mode of respiratory support. Bubble CPAP was found to be safe and effective means of treating mild and moderate grade RDS, it was also observed to be more successful in babies born to mothers who had received antenatal steroids.

Keywords: Bubble-continuous positive airway pressure (bCPAP), Newborn, Management, Respiratory distress syndrome.

Published online: 2009 Jan 1. pii-S001960610600626-2

Continuous positive airway pressure (CPAP) is an important treatment modality for respiratory distress syndrome (RDS) in neonates. It can be applied via a face mask, nasopharyngeal tube, or nasal prongs, using a conventional ventilator, bubble circuit or a CPAP driver.

Bubble CPAP (bCPAP) is one of the low cost nasal CPAP delivering systems, with underwater seal. CPAP delivered by underwater seal causes vibration of the chest due to gas flow under water; and these vibrations simulate waveforms produced by high frequency ventilation. Lee, *et al.*(1) demonstrated the superiority of bubble CPAP as compared to ventilator derived CPAP in premature infants. Bubble CPAP is also a less expensive method of respiratory support, most suitable to neonatal units with limited resources in developing countries(2). We evaluated the effectiveness of bubble CPAP as a simple and non-invasive option in a developing country.

METHODS

This prospective observational study was conducted

at Neonatal ICU, MS Ramaiah Medical College and Teaching Hospital. 50 babies requiring respiratory support for RDS were included in this study.

Indication for CPAP included (i) $\text{FiO}_2 > 0.4$ to maintain $\text{PaO}_2 \geq 60$ mmHg associated with $\text{pH} < 7.25$; and (ii) $\text{PaCO}_2 > 50$ mmHg; and Downes score ≥ 4 . Mechanical ventilation was considered for failure of CPAP *i.e.*, in babies with worsening clinical symptoms of RDS, or those with $\text{PaO}_2 < 50$ mmHg or $\text{PaCO}_2 > 60$ mmHg with $\text{FiO}_2 > 0.6$ and MAP of 8.

Based on radiological findings, severity of RDS(4) was graded as mild, moderate or severe. Babies with respiratory distress secondary to asphyxia, meconium aspiration, sepsis, necrotising enterocolitis and congenital anomalies, were excluded.

The Fisher and Paykel Bubble CPAP involves a source of gas flow (6-8L/min), an air oxygen blender, humidifier, and respiratory circuit. The expiratory end of which is inserted in a bottle of water. CPAP level delivered is equivalent to the distance that the distal end of expiratory tubing is underwater.

Data were analyzed using Chi-square test for comparison of proportions and Student 't' test to compare means between two groups. *P* value <0.05 was considered as significant.

RESULTS

Bubble CPAP proved to be effective in 40 (80%) out of total 50 babies; 10 babies required positive pressure ventilation. Their details are summarized in **Table I**. The mean (SD) age at admission was 3.6 (3.7) hours (range 1-28 h), and at initiation of treatment was 5.5 (3.9) h. The mean duration of treatment in 'success' group was 30.8±8.6h (range, 18-70 h).

Effectiveness of bubble CPAP was judged using Downes score(5). Out of 16 babies who had Downes score 4 at initiation of BCPAP, after 6 hour, 12 (75%) babies had a score of <4 and 4 (25%) babies had a score of >6, which was found to be statistically significant. 31 babies had a score of 5 before initiation of BCPAP and after 6 hrs 25 (80%) had improved to a score of 4 or less and 6 (20%) had a score of more than 6 (*P* <0.05). Three babies had a score of 6 initially, and all of them improved by 6 hrs. Thus, there was a marked improvement in Downes score following bubble CPAP therapy in newborns with RDS. FiO₂ requirement also reduced significantly and there was an increase in PaO₂ levels in babies who responded to bubble CPAP therapy.

Surfactant was used only in the neonates who failed bubble CPAP and required ventilation. A total of 5 infants had PDA (2 in failure group and 3 in success group). None of the babies developed pneumothorax. The success rate of BCPAP in mild (*n*=6, 12%), moderate (*n*=29, 59%) and severe (*n*=15, 30%) RDS was 100%, 93.1% and 46.6% respectively.

DISCUSSION

Role of CPAP in preterm and low birthweight infants is well documented(6-9). In our study, statistically significant success was observed in preterms born between 32-34 weeks and in infants with birthweight between 1000-1500g. Our observations were similar to other reports of effectiveness of nasal CPAP. In this study, outcome of bCPAP did not vary between genders. Sandri, *et al.*(10) have shown higher need for respiratory assistance in male infants with RDS.

Bubble CPAP was effective in treating mild and moderate grade RDS whereas, in a study conducted by Boo, *et al.*(3), moderate RDS was one of the predictors of failure of CPAP. We also found statistically significant improvement in Downes score after application of Bubble CPAP. The success in our study in managing moderate RDS may be related to early initiation of BCPAP at a Downes score of 4. Further larger trials may help to confirm this observation.

TABLE I PATIENT CHARACTERISTICS AND RESPONSE TO BUBBLE CPAP THERAPY

Parameters	Success (n=40)	Failure (n=10)	Total (n=50)	<i>P</i> value
Gender				
Male	26 (78.8%)	7 (21.2%)	33 (66%)	0.76
Female	14 (82.4%)	3 (17.6%)	17 (34%)	
Gestational age (wks)				
28-31	7 (77.8%)	2 (22.2%)	9 (18%)	<0.001
32-34	31 (81.5%)	7 (18.5%)	38 (76%)	
35-37	2 (66.6%)	1 (33.4%)	3 (6%)	
Birthweight (g)				
<999	3 (75%)	1 (25%)	4 (8%)	<0.001
1000-1500	27 (81.8%)	6 (18.2%)	33 (66%)	
1501-2000	10 (77%)	3 (23%)	13 (26%)	
Antenatal steroids				
Received	26 (92.8%)	2 (7.2%)	28 (56%)	<0.001
Not received	14 (63.6%)	8 (36.4%)	22 (44%)	

WHAT THIS STUDY ADDS?

- Bubble CPAP is a simple and effective means of primary respiratory support for management of mild and moderate grade RDS.

Establishing a NICU with mechanical ventilation would require high level of expertise and trained personnel, which is far from reality in many of the peripheral and district hospitals in developing countries. Lanieta, *et al.*(2) have successfully demonstrated the usefulness of bCPAP in a developing country, and have also reported the cost effectiveness with use of Bubble CPAP(2). Pieper, *et al.*(11) have shown the importance of CPAP in the absence of neonatal intensive care and also the improved outcome in neonates treated with CPAP prior to transfer to a tertiary unit. Bubble CPAP, thus, may be considered as a primary mode of respiratory support in resource poor settings.

ACKNOWLEDGMENT

Director Professor David Tudehope; Deputy Director Dr Peter Gray, Andrew Shearman, Respiratory scientist, and the nursing staff of Division of Neonatology, Mater Mothers Hospital, Brisbane Australia for their guidance and technical support.

Contributors: PSU conceptualised, designed, analysed and is the guarantor for study. FK Collected and analysed data. PSU and FK were involved in preparation of manuscript. PPM provided suggestions for preparation of manuscript.

Funding: None.

Competing interests: None stated.

REFERENCES

1. Lee US, Dunn MS, Fenwick M, Shenan AT. A comparison of underwater bubble continuous positive airway pressure with ventilator derived CPAP in preterm neonates ready for extubation. *Biol Neonate* 1998; 73: 69-75.
2. Lanieta K, Joseph K, Josaia D, Samantha C, Trevor D. An evaluation of bubble-CPAP in a neonatal unit in a developing country: effective respiratory support that can be applied by nurses. *J Trop Pediatr* 2006; 52: 249-253.
3. Boo NY, Zuraidah AL, Lim NL, Zulfiqar MA. Predictors of failure of nasal continuous positive airway pressure in treatment of preterm infants with respiratory distress syndrome. *J Trop Pediatr* 2000; 46: 172-175.
4. Carlos JS. Diagnostic imaging. In: Martin RJ, Fanaroff AA, Michele CW, editors. *Neonatal-Perinatal Medicine: Diseases of the Fetus and Infant*. 8th ed. Philadelphia: Mosby Elsevier Publishers; 2006. p. 713-714.
5. Downes JJ, Vidyasagar D, Marrow GM, Boggs TR. Respiratory distress in newborn infants, new clinical scoring system with acid base and blood gas correlation. *Clin Pediatr* 1970; 9: 325-330.
6. Subramaniam P, Henderson-Smart DJ, Davis PG. Prophylactic nasal continuous positive airways pressure for preventing morbidity and mortality in very preterm infants. *Cochrane Database System Rev* 2005; 3: CD001243.
7. De Klerk AM, De Klerk RK. Nasal continuous positive airway pressure and outcomes of preterm infants. *J Paediatr Child Health* 2001; 37: 161-167.
8. Ho JJ, Subramaniam P, Henderson-Smart DJ, Davis PG. Continuous distending pressure for respiratory distress syndrome in preterm infants. *Cochrane Database System Rev* 2002; 2: CD002271.
9. Narendran V, Donovan EF, Hoath SB, Akinbi HT, Steichen JJ, Jobe AH. Early bubble CPAP and outcomes in ELBW preterm infants. *J Perinatol* 2003; 23: 195-199.
10. Sandri F, Ancora G, Lanzoni A, Tagliabue P, Colnaghi M, Ventura M. Prophylactic nasal continuous positive airways pressure in newborns of 28-31 weeks gestation: multicentre randomised controlled clinical trial. *Arch Dis Child Fetal Neonatal Ed* 2004; 89: F394-398.
11. Pieper CH, Smith J, Maree D, Pohl FC. Is nCPAP of value in extreme preterms with no access to neonatal intensive care? *J Trop Pediatr* 2003; 49: 148-152.