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OUTCOME OF BUBBLE CONTINUOUS POSITIVE AIRWAY PRESSURE IN PRETERM NEONATES WITH RESPIRATORY DISTRESS SYNDROME: A CROSS SECTIONAL STUDY
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OUTCOME OF BUBBLE CONTINUOUS POSITIVE AIRWAY PRESSURE IN PRETERM NEONATES WITH RESPIRATORY DISTRESS SYNDROME: A CROSS SECTIONAL STUDY

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ABSTRACT

Background: **Bubble Continuous Positive Airway Pressure (BCPAP) is reported to be a safer alternative compared to mechanical ventilation in preterm neonates with respiratory distress syndrome (RDS). The objective of this study was to assess the effects of BCPAP on premature neonates with RDS.**

Methodology: **This was an analytic cross-sectional study done over 7 months involving preterm neonates with RDS admitted at the AIC Kijabe Hospital New Born Unit. The duration of BCPAP support, duration of oxygen therapy and oxygen requirements at 36 weeks gestational age (GA), the GA of the infants when full enteral feeds were tolerated, and the complications of BCPAP were documented. Data was analyzed with SPSS version 17.0.**

Results: **Sixty-one preterm neonates were recruited in the study, 54.1% male and 45.9% female. The median duration of BCPAP treatment was 5 days (IQR 3-7 days), and this was significantly associated with birth weight (p=0.044). The median duration of oxygen therapy was 6 days (IQR 4-17 days) and this was significantly associated with GA (p=0.003). Twenty percent of the neonates required oxygen administration at 36 weeks. The median age of full enteral feeds was 18 days (IQR 12- 25 days). There were no major complications of BCPAP (pneumothorax, CPAP belly and nasal trauma). The mortality rate of preterm neonates treated with BCPAP was 13.1%.**

Conclusion **BCPAP exhibited a favorable safety profile, with no major complications reported. It is a safe mode of respiratory support for preterm neonates with RDS and should be readily available in all newborn units.**

INTRODUCTION

Premature birth is defined as birth occurring at less than 37 completed weeks or 259 days of gestation[1]. It is a major determinant of neonatal mortality and morbidity and has long term adverse consequences on health[2, 3]. Preterm birth rates have been reported to range from 5%-7% in the developed countries but may be significantly higher in the developing countries[4]. Preterm infants are particularly predisposed to RDS due to deficiency of pulmonary surfactant[5]. The risk in turn depends on the maternal health status, mode of delivery and infant comorbidities[4,5].

The management of RDS in preterm infants is based on various modalities of respiratory support[6]. Mechanical ventilation has been the mainstay for treatment of RDS in our setting. It is however associated with the risk of chronic lung disease (CLD) and adverse pulmonary and neurodevelopmental outcomes[7,8]. Exogenous surfactant has been shown to significantly reduce the mortality and morbidity associated with RDS, but its prohibitive cost limits its use in our setting[9]. CPAP assists in expansion of the lungs, prevents alveolar collapse, reduces protein leak and conserves surfactant. This maintains positive pressure in the airways during spontaneous breathing hence increasing functional residual capacity and improving oxygenation in infants with RDS. Bubble CPAP produces pressure oscillations of up to 4cm of water, which improves gas exchange and protects against lung injury making it more effective than ventilator CPAP[10]. The aim of this study was therefore to investigate the outcomes of premature infants with RDS treated with Bubble CPAP at the AIC Kijabe hospital and to evaluate the sustainability of this intervention in other resource-constrained health facilities.

MATERIALS AND METHODS

This was an analytical cross-sectional study which recruited 61 preterm infants who were admitted at the New Born Unit, AIC Kijabe Hospital after ethical approval from KNH-UoN Ethics and Research Committee and the Research Ethical Committee of the AIC Kijabe Hospital and informed consent from parents. The neonates were classified based on birth weight as low birth weight (LBW [<2500g])[11], very LBW (<1500g)[12] and extremely LBW (<1000g)[13] and were recruited in a study lasting a 7-month period.

RDS was diagnosed by the clinical findings of a preterm with progressive respiratory distress that was indicated by increased work of breathing and increased oxygen requirements, tachypnea, nasal flaring, grunting, cyanosis and intercostal and subcostal retractions. Eligible babies, who had persistent respiratory distress but were able to breathe spontaneously, were started on Bubble CPAP with bi-nasal Hudson prongs. Positive End Expiratory Pressure (PEEP) was started at 5cm of water and adjusted to maintain SpO_2between 87% and 95%. The flow was titrated to the minimum to produce continuous bubbling in the bubble chamber. Bubble CPAP was considered successful if the respiratory distress improved and the neonate could be successfully weaned off from Bubble CPAP. The criteria for weaning was absence of respiratory distress clinically i.e. minimal or no chest retractions and respiratory rate between 30 and 60 breaths per minute; SpO_2>90% on FIO_2< 30 %, and PEEP < 5cm of water; free from apnea for 24 hours and the capacity to tolerate gentle nasopharyngeal suctioning without increasing FIO_2 requirements with CPAP removed. Those who did not meet the above criteria were transferred on to mechanical ventilation.

The duration of BCPAP support in days, duration of oxygen therapy, oxygen requirements at 36 weeks GA, GA of the infants when full enteral feeds were tolerated, the complications of BCPAP, maternal health status during pregnancy and at the time of delivery, mode of delivery of the baby, APGAR score at birth and outcome of the patient (death or discharged alive) were documented. Data was analyzed using SPSS version 17.0. Statistical comparisons were made using Chi square tests and Multivariate logistic regression [$p<0.05$].

RESULTS

There were 33 (54.1%) male and 28 (45.9%) female newborns of ages ranging from 1-14 days with the median age being 1 day (Table 1). BCPAP was initiated during the first day of life for 91.8% of the preterms. The average birth weight of the participating newborns was 1425g (SD ±461) and the average admission weight was 1422g (SD ±460). The average gestational age of the newborns was 30.8 weeks (SD ± 2.7) and all the neonates were less than 36 weeks gestational age. The median APGAR score at birth (1 minute) was 8 (IQR 4–9) and this score increased to 9 at 5 minutes (IQR5-10) and to 10 at 10 minutes (IQR6 – 10).

Table 1

Demographic characteristics of preterm infants admitted with RDS

Characteristic	**Frequency (%)**
Number of participants	61 (100.0)
Males N (%)	33 (54.1)
Females N (%)	28 (45.9)
Age at initiation of BCPAP	
First day of life N (%)	56 (91.8)
First week (2-6 days) N (%)	2 (3.3)
7-14 days N (%)	3 (4.9)
Very low birth weight N (%)	
LBW < 2500 g	23 (37.7)
VLBW < 1500 g	26 (42.6)
ELBW < 1000 g	12 (19.7)
APGAR SCORE	Median (IQR)
1 minute	8(4–9)
5 minutes	9 (5-10)
10 minutes	10 (6 – 10)

The length of hospital stay ranged from 26 to 36 days for the premature newborns with a median length of stay of 28 days. Forty-seven (77%) of all deliveries in this study were conducted at Kijabe AIC hospital (Table 2). Nine (14.8%) newborns were delivered in other hospitals and 5(8.2%) were born at home. Most (53.3%) of the deliveries were spontaneous vertex deliveries and antenatal steroids were administered in 13 (21.3%) out of the 61 cases. Surfactant administration was reported in 10 (14.8%) cases.

Table 2

Neonates with RDS managed with BCPAP at Kijabe Hospital

Birth details	Frequency
Place of birth N (%)	
AIC Kijabe Hospital	47 (77.0)
Other hospital	9 (14.8)
Home	5 (8.2)
Mode of delivery N (%)	
Cesarean section	28 (46.6)
Spontaneous vertex delivery	32 (53.3)
Antenatal steroids N (%)	
None	34 (55.7)
Complete	13 (21.3)
Partial	2 (3.3)
Not known	12 (19.7)
Surfactant administered N (%)	
Yes	10 (16.4)
No	42 (68.9)
Not known	9 (14.8)

RDS was the primary diagnosis in all the 61 infants recruited in the study. However, 22 (36.1%) newborns were diagnosed with at least one comorbid neonatal illness. Neonatal jaundice and neonatal sepsis were the most common comorbid illnesses occurring in 23% and 16.4% of the newborns respectively, followed by congenital malformations in 2 (3.3%), congenital heart disease (1.6%) and Patent Ductus Arteriosus (1.6%) both diagnosed on echocardiography. The mortality rate among the preterms treated with Bubble CPAP during the study was 13.1%. Neonatal death was significantly associated with birth weight [p=0.044]. The characteristics of pre-terms who died during hospital stay are presented in table 3.

Table 3

Characteristics of neonatal deaths among admissions treated with bubble CPAP

Factor	N (% survived)	N (% died)	RR (95% CI) P value
Female N =28	23(82.1)	5 (17.9)	1.96 (0.51-7.5)0.45
Male N = 33	30 (90.9)	3 (9.1)	1.00
Very low birth weight LBW< 2500 g N=23	21 (95.5)	1 (4.5)	0.1(0.001-0.81) 0.007
VLBW< 1500 g N=26	24 (92.3)	2 (7.7)	0.12(0.01-0.96) 0.012
ELBW< 1000 g N=12	7 (58.3)	5 (41.7)	1.00
Place of birth Kijabe AIC N = 47	41 (87.2)	6 (12.8)	0.57(0.14-2.40) 0.64
Other hospital N = 9	7 (77.8)	2 (22.2)	1.00
Home N = 5	5(100)	0	

The median duration of Bubble CPAP treatment was 5 days (IQR 3-7 days) and it had a statistically significant association with birth weight [p=0.044]. It was longer among very low birth weight preterms compared to preterms weighing > 1750 g (Table 4).

Table 2

Characteristics of preterm babies and median duration of bubble CPAP therapy

Variables	**Duration of CPAP therapy greater than median duration (5 days)**		**Chi square**	**P value**
	Yes	No		
Sex				
Male	11(36.7%)	19(63.3%)	1.65	0.27
Female	13(54.2%)	11(45.8%)		
Surfactant administered				
Yes	2(25%)	6(75%)	-	0.43*
No	20(47.6%)	22(52.4%)		
Birth place				
Kijabe AIC	21(48.8%)	22(51.2%)	-	0.29*
Other hospital	3(37.5%)	5(62.5%)		
Home	0(0%)	2(100%)		
Antenatal steroids				
Yes	5(33.3%)	10(66.7%)	0.70	0.54
No	17(45.9%)	20(54.1%)		
Birth weight				
VLBW<2500gms	6(26.1%)	17(73.1%)	-	0.044*
LBW<1500gms	10(38.5%)	16(61.5%)		
ELBW<1000gms	10(83.3%)	2(16.7%)		
Mode of delivery				
SVD	14(50%)	14(50%)	0.73	0.43
CS	10(38.5%)	16(61.5%)		

**Fishers exact test – cells with inadequate numbers required for chi squared test*

Data on the number of days on oxygen was available for 51 (83.6%) out of the 61 preterm neonates. The average duration of oxygen therapy among participating preterms was 14.2 days (SD ±18.9) and the median duration of oxygen therapy was 6 days (IQR 4-17). Out of the 50 newborns delivered before 36 weeks GA, 10 (20%) required oxygen administration at 36 weeks. All 61 newborn babies on bubble CPAP were monitored for development of pneumothorax, CPAP belly or nasal trauma. None of the major complications of bubble CPAP were reported during the study. The outcome of age at full enteral feeding was available for 33 (54.1%) of the newborn babies in the study. The median age at full enteral feeds was 18 days (IQR 12-25 days).

DISCUSSION

In this study, 86.9% of the preterms who were treated with Bubble CPAP survived to discharge which compares favorably with reports of effective Bubble CPAP found by Prashanth Urs[14] who reported 80% effective Bubble CPAP and Bassinouy et al a 61 % success rate among the 50 and 44 newborns studied in India respectively. The outcome did

not vary between gender in contrast to findings by Sandri et al (2010)[15]in which there was a high need for respiratory assistance in male preterms. Another significant finding was that 91.8% of preterms had Bubble CPAP initiated on the first day of life hence there was no delay in the institution of respiratory support.

The mortality rate in preterm babies treated with Bubble CPAP was 13.1%. With regard to gender, gestational age, birth weight and place of birth, none of these factors showed a statistically significant association with death. De Klerk and De Klerk[16] found a significant reduction in the incidence of death or CLD at 28 days of 16% vs 3% where Bubble CPAP was used as the mode of respiratory support.

In this study, the median duration of oxygen therapy was 6 days (IQR 4-17 days). De Klerk and De Klerk (2001)[16] found a two-fold decrease in the number of days on oxygen and a median duration of 2 days (IQR of 1-3 days). The two populations of neonates studied are comparable as theirs were VLBW of 1000-1499gms, similar to the population in this study.

The non-respiratory outcome of age at full enteral feeding was in this study at a median of 18 days (IQR 12-25 days). De Klerk[16] reported similar results in that infants reached full enteral feeds faster and there was no change in days to regain birth weight. This suggests that abdominal distention and or increased work of breathing and caloric expenditure, both potential adverse effects of CPAP did not adversely affect the infants in the study. The preterms in this study were monitored for development of pneumothorax, CPAP belly or nasal trauma. None of these complications was reported. This is similar to what Chan and Chan[17] reported in that no infant had injury or trauma to the nose, and no significant air leak was encountered in the study period.

The mortality rate for neonates on BCPAP in this study was 13.1% which depicts significantly improved outcome relative to similar studies in developing countries which have reported higher mortality rates. A study in Zimbabwe reported 46% overall mortality among 234 neonates with an odds ratio for death of 12 if babies required mechanical ventilation compared to those who received conventional CPAP[18]. This study was conducted in a setting in which resources in terms of expert care and equipment were severely restricted. It is possible to conclude that Bubble CPAP is a feasible alternative to mechanical ventilation even in resource-restricted settings due to its high safety profile and effectiveness.

CONCLUSION

Bubble CPAP was not associated with any complications during the study period specifically pneumothorax, CPAP belly and nasal trauma. It is a safe and effective mode of respiratory support for preterm neonates with RDS and should be available at all levels of care that admit and manage neonates.

Study Limitation

While acknowledging the limitation of a small sample size, the study highlights BCPAP as an effective respiratory support mode for preterm neonates. However, caution should be exercised in generalizing the results to the entire population.

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