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ORIGINAL ARTICLE

Use of Bubble CPAP in Preterm Neonates with Respiratory Distress at a Tertiary Care Hospital

Muhammad Naveed Khani, Hira Waseem, Muhammad Ashfaq, Bader-U-Nisa, Aijaz Ahmed
National Institute of Child Health Karachi, Pakistan.
Correspondence to: Dr. Hira Waseem, Email: drqureshi87@yahoo.com, ORCiD: 0000-0002-1550-4987

ABSTRACT

Objective: To determine the outcome of Bubble Continuous Positive Airway Pressure (bCPAP) Therapy use in preterm neonates with respiratory distress admitted in large public sector children hospital.

Methods: This prospective observational study was conducted at National Institute of Child Health (NICH) from March 2016 to February 2017. All preterm neonates with respiratory distress diagnosed within 24 hours treated with bCPAP were consecutively included. Respiratory distress was defined on the basis of presence of any of the three following symptoms (i) tachypnea (ii) chest indrawing (iii) grunting (iv) nasal flaring (v) hypoxemia. Outcome was measured in terms of survival, median for duration to achieve 21% O_2, apnea, hyperemia of nose, abdominal distention, median for hospital stay, and median weight gain.

Results: Of 70 preterm neonates, the median birth weight was 2700 (2300 – 3000) gm, duration to achieve 21% O2 was 3 (2 – 72) hours, and hospital stay was 8 (6–10) days. The complications of bubble CPAP showed that abdominal distension was found higher followed by hyperemia of nose and apnea i.e., 18 (25.7%), 17 (24.3%), and 4 (5.7%) respectively. Survival was found significantly associated with birth weight (p-value 0.049) and in neonates with no complications (p-value <0.001). Whereas apnea was found significantly higher in female preterm neonates (p-value 0.017), low birth weight (p-value 0.012) and in neonate who reported no survival (p-value <0.001).

Conclusion: The administration of bCPAP is an effective modality for managing respiratory illness in preterm Neonates due to fewer complications and shorter hospital stay.

Keywords: Bubble CPAP, Preterm Neonates, Respiratory Distress.

INTRODUCTION

Respiratory distress in preterm neonates is a serious complication of neonatal diseases and a major cause of morbidity and mortality around the globe.[1,2] However, early recognition, identification of risk factors, and prompt intervention can bring down neonatal deaths caused due to respiratory distress.[3]

During diseased states, ongoing inflammatory cascade causes airway collapse, thereby adversely affecting gas exchange. In order to maintain patency of smaller airways and allowing effective gaseous exchange, positive airway pressure is required, which can be achieved through different methods.[3,4] Bubble Continuous Positive Airway Pressure (bCPAP) therapy is a gentle and effective tool and can be used for this purpose.[5,6] Recently, cost-effective bCPAP has been developed for poor resource setups.[5] It has been proved through several studies that improvised bCPAP is effective and economical method of respiratory support.[7] It is reported in literature that preterm neonates had approximately 71% chance of more survival compared to controls.[8]

Studies on this novel low cost bCPAP system are scarce and the present study is designed to assess the outcome of this novel device. Pakistan is a poor resource country and most of the public hospitals do not have required number of ventilators and most patients cannot afford private hospitals expenses. Therefore, if this novel modality shows satisfactory outcomes, then the same will be utilized in future in such patients.

METHODS

This prospective observational study was conducted among neonates admitted at National Institute of Child Health (NICH), Karachi, Pakistan from March 2016 to February 2017. Ethical approval was obtained from the Institutional ethical review committee of NICH prior conducting of the study (IERB #: 11/2014).

All preterm neonates with respiratory distress

diagnosed within 24 hours of admission in neonatal intensive care unit, having gestational age of >37 weeks, weighing 1500 gms or more irrespective of gender were consecutively included. Preterm neonates with cyanotic heart disease, cleft palate, diaphragmatic hernia, severe birth asphyxia, patent ductus arteriosus, and trachea-oesophageal fistula were excluded.

Respiratory distress was defined on the basis of presence of any of the three following symptoms (i) tachypnea (ii) chest indrawing (iii) grunting (iv) nasal flaring (v) hypoxemia. Patients were treated with bCPAP which delivers a pressurized air through bi-nasal prongs, which are attached by a hat using elastic bands. Sucking of airways was done twice to clear mucus. Sterile nasal saline drops were instilled four hourly to prevent mucosal dryness. Oxygen was administered through concentrator by flow regulator from 4-6 L/min. Preterm neonates were followed for 4 weeks and final outcome was measured in terms of survival, median duration to achieve 21% O_2, apnea, hyperemia of nose, abdominal distention, and median hospital stay.

Data entry and analysis were done using a statistical package for social sciences (SPSS) version 20.0. Median and inter quartile range were computed for quantitative variables like, age, low birth weight, hospital stay (days), and duration to achieve 21% O_2 (hours) while frequency and percentages were computed for categorical variables like, gender, complications of bubble CPAP (apnea, hyperemia of nose, abdominal distension), and survival. Inferential statistics were explored using Chi-square/Fisher exact test for comparison of demographic characteristics and complications of bubble CPAP with respect to survival. Mann-Whitney U test for median difference of duration to achieve 21% O^2 and hospital stay with respect to demographic characteristics and complications of bubble CPAP. Survival curve was made to see the relation of survived neonates with respect to hospital stay, duration to achieve 21% O_2, and low birth weight. The p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Of total 70 preterm neonates, the median age was 8 (6 – 12) days. There were 42 (60%) males and 28 (40%) females.

The median birth weight was 2700 (2300 – 3000) gm, duration to achieve 21% O2 was 3 (2–72) hours, and hospital stay was 8 (6–10) days. The complications of bCPAP showed that abdominal distension was found higher followed by hyperemia of nose and apnea i.e., 18 (25.7%), 17 (24.3%), and 4 (5.7%) respectively.

The survival was observed in 59 (84.3%) of the preterm neonates. The rate of survived preterm neonates was found significantly higher in normal birth weight 36 (92.3%) as compared to low birth weight 23 (74.2%) (p-value 0.049). Similarly, survival was found significantly higher in preterm neonates who had no complications 44 (100.0%) as compared to preterm neonates who had complications 15 (57.7%) (p-value <0.001). However, an insignificant association of survived preterm neonates was found with age (p-value 0.903), gender (p-value 0.328), hospital stay (p-value 0.999), duration to achieve 21% O_2 (p-value 0.081), and hyperemia of nose (p-value 0.999). (Table 1)

The median duration to achieve 21% O_2 was insignificantly higher in preterm neonates who had apnea 4 (2.5-72) as compared to those who did not have apnea 3 (2-72) (p-value 0.349). Similarly, median duration to achieve 21% O_2 was insignificantly higher in preterm neonates with abdominal distention 6 (3-78) as compared to preterm neonates without abdominal distention 3 (2-72). The median hospital stay was significantly higher in those preterm neonates who had apnea as compared to those who did not have apnea, i.e., 10 (5-12) days vs. 8 (6-9) days (p-value 0.050). (Table 2)

Apnea was found significantly higher in female preterm neonates (p-value 0.017), low birth weight (p-value 0.012), and had no survival (p-value <0.0010). Similarly, abdominal distention was found significantly higher in preterm neonates with no survival 11 (100.0%) as compared to preterm neonates who survived 7 (11.9%) (p-value <0.001). (Table 3)

The survival functions for low weight (< 2700 gm) and normal weight (≥ 2700gm) with hospital stay both groups had highest surviving probabilities at day 5 and lowest survival probabilities at hospital stay greater than 15 days. (Figure 1)

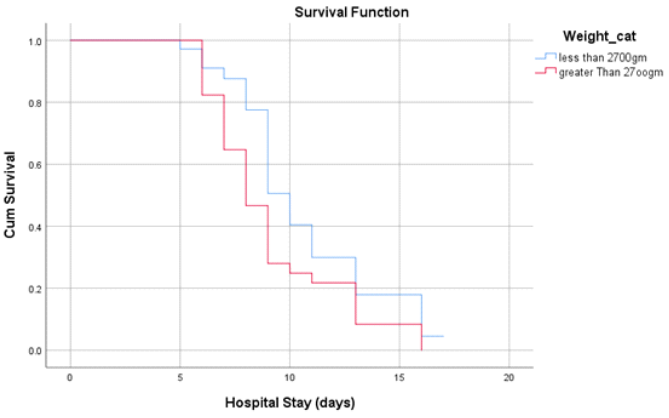

Figure 1: Survival function for low weigh (tyes and no) and hospital stay

Table 1: Comparison of demographic characteristics and complications of bubble CPAP with respect to survival (n=70)

	Total	Survival		p-value
		Yes (n=59)	No (n=11)	
Age				
≤ 8 days	37	31 (83.8)	6 (16.2)	0.903^
>8 days	33	28 (84.8)	5 (15.2)	
Gender				
Male	42	37 (88.1)	5 (45.5)	0.328~
Female	28	22 (78.6)	6 (21.4)	
Low birth weight				
Yes	31	23 (74.2)	8 (25.8)	0.049*~
No	39	36 (92.3)	3 (7.7)	
Duration to achieve 21% O2 (hours)				
≤ 3 hours	36	33 (91.7)	3 (8.3)	0.081^
> 3 hours	34	26 (76.5)	8 (23.5)	
Hospital Stay (days)				
≤ 8 days	46	39 (84.8)	7 (15.2)	0.999~
>8 days	24	20 (83.3)	4 (16.7)	
Complications				
Yes	26	15 (57.7)	11 (42.3)	<0.001*~
No	44	44 (100.0)	0 (0.0)	

^Chi-square/~Fisher exact test applied, *p-value ≤ 0.05 considered significant

Table 2: Median difference of duration to achieve 21% O^2 and hospital stay with respect to demographic characteristics and complications of bubble CPAP (n=70)

	Total	Duration to achieve 21% O^2 (hours)		Hospital Stay (days)	
		Median (IQR)	p-value	Median (IQR)	p-value
Age					
≤ 8 days	37	3 (2 – 72)	0.956	8.0 (6 – 10)	0.487
>8 days	33	3 (2 – 72)		7.0 (6 – 10)	
Gender					
Male	42	3 (2 – 72)	0.842	7.0 (5 – 9.25)	0.158
Female	28	4 (2 – 72)		8.0 (6.25 – 12)	
Low birth weight					
Yes	31	3 (2 – 72)	0.956	8.0 (5 – 12)	0.195
No	39	3.5 (2 – 72)		7.0 (6 – 8)	
Complications					
Apnea					
Yes	17	4 (2.5 – 72)	0.349	10 (5 – 12)	0.050*
No	53	3 (2 – 72)		8.0 (6 – 9)	
Hyperemia of nose					
Yes	4	15.5 (4 – 60)	0.471	8.50 (5.5 – 11.5)	0.971
No	66	3 (2 – 72)		8.0 (6 – 10)	
Abdominal distension					
Yes	18	6 (3 – 78)	0.093	8.50 (5 – 12)	0.913
No	52	3 (2 – 72)		8.0 (6 – 9)	

Mann-Whitney U Test applied, *p-value ≤ 0.05 considered significant

Table 3: Comparison of demographic characteristics and survival with respect to complications of bubble CPAP (n=70)

	Total	Apnea			Hyperemia of nose			Abdominal distension		
		Yes	No	p-value	Yes	No	p-value	Yes	No	p-value
		(n=17)	(n=53)		(n=4)	(n=66)		(n=18)	(n=52)	
Age										
≤ 8 days	37	9 (24.3)	28 (75.7)	0.994^	3 (8.1)	34 (91.9)	0.616~	10 (27.0)	27 (73.0)	0.790^
>8 days	33	8 (24.2)	25 (75.8)		1 (3.0)	32 (97.0)		8 (24.2)	25 (75.8)	
Gender										
Male	42	6 (14.3)	36 (85.7)	0.017*	4 (9.5)	38 (90.5)	0.144~	10 (23.8)	32 (76.2)	0.655^
Female	28	11 (39.3)	17 (60.7)		0 (0.0)	28 (100.0)		8 (28.6)	20 (71.4)	
Low birth weight										
Yes	31	12 (38.7)	19 (61.3)	0.012*^	1 (3.2)	30 (96.8)	0.620~	11 (35.5)	20 (64.5)	0.095^
No	39	5 (12.8)	34 (87.2)		3 (7.7)	36 (92.3)		7 (17.9)	32 (82.1)	
Survival										
No	11	10 (90.9)	1 (9.1)	<0.001~*	1 (9.1)	10 (90.9)	0.508~	11 (100)	0 (0.0)	<0.001~*
Yes	59	7 (11.9)	52 (88.1)		3 (5.1)	56 (94.9)		7 (11.9)	52 (88.1)	

^Chi-square/~Fisher exact test applied, *p-value ≤ 0.05 considered significant

DISCUSSION

Continuous positive airway pressure is an important treatment modality for 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.[9] bCPAP is one of the low-cost nasal CPAP delivering systems, with underwater seal.[10]

Globally, there has been a trend toward use of CPAP in the management of RDS in the newborn with well documented benefits.[11] Different devices can be used to deliver CPAP; these include the conventional ventilators, variable-flow infant CPAP and the bubble CPAP.[9,12] With the improvised bubble CPAP used, studies have reported high success rate in developed countries achieved on CPAP.[13]

According to the current study findings, the median duration to achieve 21% O^2 was insignificantly higher in preterm neonates who had apnea as compared to those who did not have apnea. Similarly, median duration to achieve 21% O^2 was insignificantly higher in preterm neonates with abdominal distention as compared to preterm neonates without abdominal distention. A study demonstrated immediate clinical improvement in oxygen saturation using customized bCPAP.[14]

As per current study findings, the rate of survived preterm neonates was found significantly higher in normal birth weight as compared to low birth weight. Similar findings were observed in previous studies as well.[8,15-17]

Another study found that bCPAP could decrease the rates of extubating failure for premature infants with respiratory distress syndrome.[18] One of the studies demonstrated that bCPAP could improve oxygenation. It is worth noting that bCPAP decrease the duration of hospital stay significantly compared with the other forms of CPAP with no difference in the duration of CPAP (hr). This interesting finding may support the effectiveness of bCPAP.[19] In the current study, the probability of survival was 80% when hospital stay was around 7.5 days while survival probability was going to decrease and near to zero when hospital stay was greater than 15 days.

As far as complications of bCPAP are concerned, the current study showed that the complications of bubble CPAP showed that abdominal distension was found higher followed by hyperemia of nose and apnea. In another study 15 of 17 neonates showed slight nasal septum irritation after 1 day of bCPAP. Redness of the nasal septum was mostly seen, and dark discoloration was only observed in 2 neonates. Quality of nursing care was found to be the main factor involved.[20,21]

The positive results obtained in this study demonstrates that simple interventions can go a long way in reducing neonatal mortality rate; this can be cascaded

down to other doctors and health care providers that care for these neonates through training and retraining of these personnel. This should include training on the assembly and use of bCPAP with anticipatory management of the complications that these delicate preterm are prone to. This would further reduce morbidity and mortality from RDS. It is however also important to continue research into how to improve the effectiveness and ensure safety of this improvised bCPAP to ensure that these babies benefit optimally from it and prevent or reduce complications.

The small sample size of this study does limit its applicability. A multicenter trial is needed to further confirm these findings. Instead, the decision to treat with bCPAP was based on availability of a bCPAP device. However, since allocation of CPAP to eligible subjects was based on device availability actual enrollment was dependent on available equipment and staffing resources.

The positive results demonstrate that simple interventions can reduce neonatal mortality rate, by teaching and training health care providers. Familiarizing individuals with the equipment and managing complications should be implemented as initial treatment modality. It will further decline morbidity and mortality from respiratory distress. Further research is however important in improving efficacy and ensuring safety of this modality, so that maximum benefits can be delivered to the patients.

CONCLUSION

The findings of this study showed better outcome of bCPAP in the management of the preterm neonates. It can be safely stated that administration of bCPAP is an effective modality for managing respiratory illness in preterm neonates due to fewer complications and shorter hospital stay.

ETHICAL APPROVAL: This study was approved by Institutional Ethical Review Board, National Institute of Child Health Karachi, Pakistan (IERB #: 11/2014).

AUTHORS' CONTRIBUTION: MNK & BN: Manuscript writing, literature search and critical review.
HW: Conceived the idea and discussion and literature review.
MA: Data analysis and discussion.
AA: Data collection, results and literature review.
Approved final version of the manuscript.

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