Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/15513
DOI URL: http://dx.doi.org/10.21474/IJAR01/15513

*RESEARCH ARTICLE*

# CORRELATION BETWEEN INITIAL PRESSURE AND DURATION ON BUBBLE CPAP IN NEONATES WITH RESPIRATORY DISTRESS ADMITTED IN NEONATAL INTENSIVE CARE UNIT IN A TERTIARY CARE CENTRE

**Dr. Rubini M.S[1], Dr. Senthil Kumar K.[2], Dr. Suresh Chelliah[3] and Dr. Senguttuvan[4]**

1. Senior Resident, Velammal Medical College and Research Institute, Madurai.
2. Consultant Neonatologist, Department of Pediatrics, KMC hospitals, Trichy.
3. Head of the department, Department of Pediatrics, KMC hospitals, Trichy.
4. Senior Consultant, Department of Pediatrics, KMC Hospitals, Trichy.

## Manuscript Info

***Manuscript History***
Received: 15 August 2022
Final Accepted: 18 September 2022
Published: October 2022

## Abstract

**Background:** Continuous Positive airway pressure (CPAP) is a non-invasive form of respiratory support, which is safe and effective in neonates with respiratory distress. The purpose of this study is to predict the length of stay on bubble CPAP in neonates by correlating the initial pressure and duration on it with respect to gestational age, birth weight and respiratory distress scores.

**Objective:** To correlate the initial pressure and duration on bubble CPAP in neonates with respiratory distress thereby predicting the length of stay on it and analyzing the factors responsible for bubble CPAP failure.

**Materials and Methods:** A prospective longitudinal study was conducted over a period of 2 years in neonates with respiratory distress requiring bubble CPAP. Applying Pearsoncoefficient, the initial pressure and duration on bubble CPAP was correlated with respect to different variables. The statistical analysis was performed using SPSS (Version 20.0). P value of <0.05 was considered as statistically significant.

**Results:** Out of 246 neonates enrolled, 211(85.77%) neonates were successfully treated with bubble CPAP, with mean birth weight of 1.66 kg and mean duration of stay on bubble CPAP was 32.64 hours. Applying Pearson co- efficient on initial pressure and duration on bubble CPAP there was negative correlation, which was statistically significant. 35(14.23%) failed bubble CPAP. The predictors of failure were prematurity (51.43%), birth asphyxia (8.6%), age at initiation of bubble CPAP, sepsis (8.57%), Downes score and Silverman Anderson score of more than 6. Other maternal and neonatal variables did not influence the need of mechanical ventilation. **Conclusion**: The duration of stay on bubble CPAP and the initial pressure set are negatively correlated that is, higher the initial pressure there is significant reduction in duration on bubble CPAP thereby the length of stay can be predicted by initial pressure set.



**Corresponding Author:- Dr. Rubini M.S**
Address:- Senior Resident, Velammal Medical College and Research Institute, Madurai.

……..

## Introduction:-

Respiratory distress syndrome,a disease typical in preterm neonates that is caused by insufficient pulmonary alveolar surfactant, whichis major cause of morbidity and mortality. Prolonged respiratory distress leads to hypoxemia, hypercarbia and acidosis which in turn leads to pulmonary vasoconstriction and persistence of fetal circulation with right to left shunting, thereby aggravating hypoxemia leading to multisystem organ dysfunction. The incidence of respiratory distress syndrome is inversely related to gestational age. For example, neonates born at 28 to 32 weeks, RDS occurs in upto 50%[1]. Surfactant replacement therapy, either as rescue or prophylactic treatment was established as an effective and safe therapy for immaturity related surfactant deficiency and it lowers the risk of chronic lung disease and improves survival with Broncho Pulmonary Dysplasia[2,3.]

Continuous positive airway pressure (CPAP),which is a non-invasive form of respiratory support has been introduced in aim of avoiding the use of invasive ventilation in infants with respiratory failure[4-7].Mechanical ventilation is often life saving, but it is associated with complications like ventilator induced lung injury and nosocomial pneumonia. Endotracheal tubes are uncomfortable and are often associated with airway injury[8]. This can be reduced by the use of CPAP, whichwas introduced in 1971 by George Gregory to stabilize lung volume in neonates with respiratory distress syndrome. CPAP is a non-invasive continuous distending airway pressure that is helpful in spontaneously breathing neonates as it increases the functional residual capacity of lung resulting in better gas exchange[9].Bubble CPAP is found to be safe, cost effective, requires less training and has less complications compared to ventilator derived CPAP in premature infants. But not all preterm respond well to CPAP[10]. Careful monitoring is required to minimize the pulmonary toxicity and consequences of hypoxemia. The sooner the initiation of CPAP, better the success in infants with RDS. The severity of respiratory distress is assessed by Downes score, which can be applied to any gestational age and Silverman Anderson score, which is more suited for preterm neonates with hyaline membrane disease[11]. Increasing $FiO_2$ requirement to maintain saturation in term and preterm neonates is a sensitive indicator for assessing severity and need for mechanical ventilation and surfactant therapy.

In neonatology, early prediction of neonatal mortality and length of stay on B-CPAP helps in decision-making [12]. Parents also have a strong interest in knowing the anticipated date of discharge of their neonate. Although the other authors have cautioned against making predictions about length of stay based on predictor variables alone, the physician caring newborn needs to answer questions after baby's birth in order to counsel the parents regarding length of stay in CPAP. Also there are very few studies relating the pressure with duration on bubble CPAP. This study is conducted to analyze the correlation between initial pressure and duration on B-CPAP in newborn with respiratory distress thereby predicting the length of stay and to analyze the factors responsible for B-CPAP failure.

## Materials and Methods:-

This prospective longitudinal observational study was conducted in neonatal intensive care unit of a tertiary care hospital for a period of 2 years. 246 neonates admitted with respiratory distress in neonatal intensive care unit requiring B-CPAP were included and those with congenital anomalies were excluded from the study. Statistical analysis was performed using SPSS (Version 20.0). Correlation between two variables was analyzed by applying Pearson coefficient. P value <0.05 will be considered as statistically significant.A study proforma was filled separately for each neonate, which included various maternal and neonatal variables that affects their duration of stay on B-CPAP. The neonates on B-CPAP were followed up and the duration of stay on it was correlated with initial pressure in those who succeeded B-CPAP therapy .The variables responsible for the B-CPAP failure were analyzed in neonates who required mechanical ventilation.

## Results:-

246 neonates fulfilling the inclusion criteria were enrolled in this study. 153(62.2%) were male, 112(45.53%) were low birth weight neonates, 80(32.5%) were small for gestation age. Maternal morbidity was found in 39.02% of study population. 95.1% were delivered through caesarian section. 211(85.77%) neonates were successfully treated with bubble CPAP, with mean birth weight was 1.66 kg and mean duration of stay on bubble CPAP was 32.64 hours. Applying Pearson co- efficient on initial pressure and duration on bubble CPAP with respect to gestational age, birth weight and respiratory distress score there was negative correlation, which was statistically significant. With respect to Downes score recorded at the time of initiation of bubble CPAP, higher initial pressure during the start of bubble CPAP resulted in minimum duration of stay on it (negative correlation). 35(14.23%) neonates failed

bubble CPAP. The predictors of failure were age at initiation of bubble CPAP, prematurity (51.43%), birth asphyxia (8.6%),sepsis (8.57%), Downes score and Silverman Anderson score of more than 6. 85.7% of neonates who failed B-CPAP required surfactant therapy.

## Discussion:-

Correlation between initial pressure and duration on B-CPAP with respect to variables like gestation age, birth weight, severity of respiratory distress were analyzed thereby the approximate length of stay on B-CPAP was predicted. Similar prospective study was conducted correlating the predictor variables affecting the duration on B-CPAP and analyzing the length of stayon B-CPAP [13].

In our study, incidence of RDS requiring B-CPAP was higher with moderate preterm (n=147) and very preterm (n=63) neonates than term neonates. This represents that RDS is inversely proportional to gestational age[12]. Sanghvi A et alshowed that rate of RDS was 89% in very preterm, 70% in moderate preterm and nil in full term neonates[14]

Most of the newborn included were male (62.20%) in our study. The study conducted by Sanghvi A et al(59.6%) and Al-Iawama M et al (64%) also mentioned that maximum population required B-CPAP was male[14, 15]. But another descriptive study discussed that success of B-CPAP was independent of gender of the newborn[16].

The mean birth weight in our study was 1.66 kg. In a study by Arora V et al, mean birth weight was found to be 1290 ± 404 grams. Bubble CPAP requirement was high in low (45.53%) and very low (32.93%) birth weight neonates and only 10.5% ELBW neonates were started on B-CPAP[7]. This means that ELBW neonates needed more advanced intervention than B-CPAP for respiratory distress. In our study 56.91% and 32.52% were AGA and SGA neonates respectively and only 10.57% were LGA neonates that required B-CPAP. This indicates that smaller neonates benefited from B-CPAP [14].

In a epidemiological survey conducted by Lui L[17], risk factors for RDS was mentioned to be birth asphyxia (33.1%), multiple birth (19.7 %), gestational hypertension (17.8%), gestational diabetes (1.6%), premature rupture(13.7%) and Sanghvi et al mentioned LSCS delivery (28%), perinatal asphyxia (14%), maternal diabetes (5.2%), multiple birth (3.5%) as riskfactors for RDS. In our study, the risk factors of RDS were found to be LSCS delivery (95.1%), maternal morbidity (39%), birth asphyxia (4.5%), multiple birth(16.7%). Among the maternal morbidities, gestational diabetes was found to be higher 16.3%(n=40). Almost all neonates who required bubble CPAP for respiratory distress was started on antibiotics (n=246) where as inotropes were required in 85.37% (n = 210) among the included population. In our study, there is no significant association between the antenatal steroids and B-CPAP requirement as 36.18 % did not know about the antenatal steroid status, among them 31.42% failed B-CPAP.Sanghvi et al commented that 14.3% of neonates who did not receive antenatal steroids expired and the presence of sepsis carried an increased risk of mortality and poor outcome (75%). However in preterm neonates who received both antenatal steroids and postnatal surfactant were found to have significant reduction in mortality and severity of respiratory distress when compared with subgroup that received neither steroids nor surfactant or antenatal steroids only or surfactant only [18-20].

Interestingly, only 12.2% (n=30) of them required surfactant in this study. Similarly in a prospective study conducted in Georgia,only 10% received surfactant[13]. This indicates that B-CPAP is an alternative method of decreasing respiratory distress by increasing oxygenation as it increases FRC. It can also be noted that the neonates that appear to be failing B-CPAP may receive the surfactant as another attempt to keep him/her off the mechanical ventilator. In a case control study conducted by Boo NY et al, the higher failure rates was attributed to inadequate usage of antenatal steroids and lesser use of surfactant [21].

In our study, the overall mean duration on B-CPAP was found to be 32.64 hours and overall mean initial pressure in B-CPAP success and failure group was 4.4 and 4.8 cm of $H_2O$ respectively. The mean duration on B-CPAP in the studies conducted by Stoeri AL and Koti J et al was 125 hours (5 days) and 23.5 hours respectively.

With the results obtained by statistical analysis, it is concluded that there is a negative correlation between the initial pressure and duration on B-CPAP with respect to gestational age, birth weight and respiratory distress scores. This means with higher initial pressure, the duration of stay on B-CPAP decreases. On analysing the study with respect to gestational age, term neonates had moderate negative correlation while moderate preterm and very preterm neonates had low negative correlation between initial pressure and duration on B-CPAP, which was statistically significant

($p<0.05$). Thus premature infants require longer duration of stay on B-CPAP than term and with the inverse relationship between initial pressure and duration on B-CPAP (negative correlation).

In the present study, term neonates had average initial pressure of 4.7 cm of $H_2O$ to achieve mean duration of stay on B-CPAP of approximately 27 hours whereas mean initial pressure of moderate preterm and very preterm was found to be 4.4 cm of H2O and mean duration was found to be approximately 33 and 32 hours respectively. With respect to birth weight, the results showed moderate negative correlation in SGA neonates whereas low negative correlation was in AGA and LGA neonates ($p<0.05$). It is noted that AGA neonates required B-CPAP for lesser duration when compared to SGA and LGA neonates. Similarly, with respect to DS, the score of 5 ($p<0.05$) has high negative correlation and scores of 3,4,6 ($p<0.05$) has moderate negative correlation between initial pressure and duration of stay on B-CPAP whereas score of 7 had only negligible correlation with respect to initial pressure and duration on B-CPAP. The result infers that with increase in DS, the duration on B-CPAP increases and mean initial pressure also increases. For the DS of 3, the mean initial pressure and mean duration was found to be 3.7 cm of H2O and 21.09 hours respectively and for the DS of 4 and 5 the mean initial pressure was found to be approximately 4.4 and 4.5 cm of H2O and mean duration was found to be 31.37 and 32.29 hours respectively. Mean duration for the DS of 6 was found to be 50.70 hours with mean initial pressure of approximately 4.8 cm of $H_2O$.

As sophisticated biochemical tests like lecithin/sphingomyelin ratio are not routinely available, diagnosis of RDS and pressure (PEEP) to be set during the initiation of B-CPAP can be primarily made based on clinical presentation and its severity by using clinical scores like Downes score for all neonates irrespective of gestational age. In a systematic review authors discussed that PEEP is a factor that impacts the length of weaning[8]. Analysis of our study shows initial pressure (PEEP) highly affects the length of stay on B-CPAP. It is concluded that higher PEEP reduced the duration on B-CPAP with respect to respiratory distress score, as there is negative correlation between them.

Out of 246 neonates, 35 neonates (14.23%) failed B-CPAP. Risk factor for sepsis was high in B-CPAP failure group (8.6%). Regarding antenatal steroids and B-CPAP failure, our study did not show any difference. With respect to DS, maximum neonates who failed B-CPAP had DS of ≥6 (62.9%) and SAS of ≥6 (90%). In a prospective study, 25% had CPAP failure and the variables associated with failure of CPAP were no exposure to antenatal steroids, grade 3-4 RDS on chest x-ray, PDA, Sepsis, SAS ≥ 7 at admission [14]. In a retrospective study conducted by Ammari et al, the failure rate of B-CPAP was 24% in babies <1250 grams and 50% in babies <750 grams [22].

## Conclusion:-

Earlier initiation of bubble CPAP in neonates with respiratory distress syndrome is safe and effective in reducing the duration of stay on it and the need of mechanical ventilation. The duration of stay on bubble CPAP and the initial pressure set are negatively correlated. Higher initial pressure reduced the duration on bubble CPAP with respect to gestational age, birth weight and respiratory distress score. Premature infants require longer duration of stay on bubble CPAP than term neonates. Birth weight of neonates appropriate for gestational age had lesser duration on bubble CPAP when compared to small and large for gestational age neonates. Thus, along with gestational age, birth weight, age at initiation of bubble CPAP and severity of respiratory distress, the pressure that is set during the initiation of bubble CPAP significantly affects the duration of stay on it. Nearly 14.2 % failed B-CPAP and risk factors for failure on B-CPAP are prematurity, sepsis, Downes score of ≥ 6, Silverman Anderson score of ≥6 and delay in initiation of B-CPAP in RDS neonates. Antenatal steroids and postnatal surfactant therapy independently and additively reduce mortality and severity of RDS. Further research is needed to relate the pressure and duration on B-CPAP to provide the clinicians with comprehensive knowledge on neonates suffering from respiratory distress with aim of reducing the length of stay on B-CPAP with care, that is safe and effective.

## References:-

1. Lemons JA, Bauer CR, Oh W, Korones SB, Papile LA, Stoll BJ, Verter J, Temprosa M, Wright LL, Ehrenkranz RA, Fanaroff AA. Very low birth weight outcomes of the National Institute of Child health and human development neonatal research network, January 1995 through December 1996. Pediatrics. 2001 Jan 1;107(1):e1.
2. Soll RF. Synthetic surfactant for respiratory distress syndrome in preterm infants (Cochrane Review). The Cochrane Library. 2004(4).
3. Rodriguez RJ, Martin RJ. Exogenous surfactant therapy in newborns. Respiratory care clinics of North America. 1999 Dec;5(4):595-616.

4. Avery ME, Tooley WH, Keller JB, Hurd SS, Bryan MH, Cotton RB, Epstein MF, Fitzhardinge PM, Hansen CB, Hansen TN, Hodson WA. Is chronic lung disease in low birth weight infants preventable? A survey of eight centers. Pediatrics. 1987 Jan 1;79(1):26-30.
5. Narendran V, Donovan EF, Hoath SB, Akinbi HT, Steichen JJ, Jobe AH. Early bubble CPAP and outcomes in ELBW preterm infants. Journal of perinatology. 2003 Apr;23(3):195.
6. Verder H, Bohlin K, Kamper J, Lindwall R, Jonsson B. Nasal CPAP and surfactant for treatment of respiratory distress syndrome and prevention of bronchopulmonary dysplasia. Actapaediatrica. 2009 Sep;98(9):1400-8.
7. Arora V, Gediya SG, Jain R. Outcome of premature babies with RDS using bubble CPAP. International Journal of Contemporary Pediatrics. 2017 May;4(3):939.
8. Newth CJ, Venkataraman S, Willson DF, Meert KL, Harrison R, Dean JM, Pollack M, Zimmerman J, Anand KJ, Carcillo JA, Nicholson CE. Weaning and extubation readiness in pediatric patients. Pediatric critical care medicine: a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies. 2009 Jan;10(1):1.
9. Wung JT, Koons AH, Driscoll Jr JM, James LS. Changing incidence of bronchopulmonary dysplasia. The Journal of pediatrics. 1979 Nov 1;95(5):845-7.
10. Whitaker K. Assessment of the neonatal and pediatric patient. Comprehensive perinatal & pediatric respiratory care. 3rd ed. New York: Delmar. 2001
11. Mathai SS, Raju U, Kanitkar M. Management of respiratory distress in the newborn. Medical journal, Armed Forces India. 2007 Jul;63(3):269.
12. Zernikow B, Holtmannspötter K, Michel E, Hornschuh F, Groote K, Hennecke KH. Predicting length-of-stay in preterm neonates. European journal of pediatrics. 1999 Jan 1;158(1):59-62.
13. Stoeri AL. Correlational study for predictor variables affecting duration on bubble CPAP
14. Sanghvi A, Rasania M. Study of respiratory distress syndrome in newborn with special reference to the role of bubble CPAP in its management. International Journal of Contemporary Pediatrics. 2017 Jul;4(4):1334-9
15. Al-lawama M, Alkhatib H, Wakileh Z, Elqaisi R, AlMassad G, Badran E, Hartman T. Bubble CPAP therapy for neonatal respiratory distress in level III neonatal unit in Amman, Jordan: a prospective observational study. International journal of general medicine. 2019;12:25.
16. Parasuramappa H, Belavadi G. A descriptive study on the use of bubble CPAP in a level 2 neonatal intensive care unit in Bangalore, India. Sri Lanka Journal of Child Health. 2017 Sep 5;46(3):211-7.
17. Lui L. Epidemiological survey of neonatal respiratory distress syndrome in part of northwest regions in China. 2015;53(5):341-7.
18. Jobe AH, Mitchell BR, Gunkel JH. Beneficial effects of the combined use of prenatal corticosteroids and postnatal surfactant on preterm infants. American journal of obstetrics and gynecology. 1993 Feb 1;168(2):508-13.
19. Kari MA, Eronen M, Virtanen M, Hallman M, Teramo K, Koivisto M, Ikonen RS. Prenatal dexamethasone treatment in conjunction with rescue therapy of human surfactant:a randomized placebo-controlled multicenter study. Pediatrics. 1994 May 1;93(5):730-6.
20. White A, Marcucci G, Andrews E, Edwards K, Long W. Antenatal steroids and neonatal outcomes in controlled clinical trials of surfactant replacement. American Journal of Obstetrics &Gynecology. 1995 Jul 1;173(1):286-90.
21. Boo NY, Zuraidah AL, Lim NL, Zulfiqar MA. Brief report. Predictors of failure of nasal continuous positive airway pressure in treatment of preterm infants with respiratory distress syndrome. Journal of tropical pediatrics. 2000 Jun 1;46(3):172-5.
22. Ammari A, Suri M, Milisavljevic V, Sahni R, Bateman D. Variables associated with the early failure of nasal CPAP in very low birth weight infants. J Pediatr.2005 Sep;147:341-7.