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ORIGINAL ARTICLE

Role of Nasal CPAP in reducing the need of mechanical ventilation in premature newborns with gestational age less than 37 weeks in resource limited setting.

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ABSTRACT… Objective: To ascertain the incidence of favorable outcomes resulting from the utilization of CPAP in preterm neonates. **Study Design:** Descriptive, Cross-sectional study. **Setting:** Department of Pediatrics, Madinah Teaching Hospital, Faisalabad. **Period:** 30th June 2023 to 29th December 2023. **Methods:** Our study included 316 preterm neonates of both genders who were treated with CPAP and had a gestational age of fewer than 37 weeks. Patients diagnosed with neuromuscular illness, congenital malformations, grade III hypoxic-ischemic encephalopathy (HIE), syndromic newborns, and congenital heart disease were not included. The factors reported on the performa included gestational age, birth weight, time of initiating CPAP after birth, administration of surfactant, and duration of CPAP treatment. The outcome was assessed based on two criteria: successful outcome, defined as the patient achieving complete recovery after CPAP treatment without needing mechanical ventilation, and treatment failure, defined as the patient requiring mechanical breathing after CPAP treatment. **Results:** The average gestational age was 30.08 ± 2.75 weeks. Among the 316 patients, 161 (50.95%) were male and 155 (49.05%) were female, resulting in a male to female ratio of 1.1:1. The average birth weight was 2.50 ± 0.73 kg. The mean Apgar score was 5.46 with a standard deviation of 1.45. The average time for initiating CPAP after birth was 17.46 ± 9.04 hours. The study revealed that 233 out of 315 preterm neonates (73.73%) experienced successful outcomes with the use of CPAP. **Conclusion:** This study determined that the rate of favorable outcomes in the use of Continuous Positive Airway Pressure (CPAP) for preterm newborns is exceptionally high.

Key words: Continuous Positive Airway Pressure, Premature Infants, Success.

INTRODUCTION

A preterm is an infant born before completing 37 weeks of gestation. Preterm birth is the second leading cause of mortality in children under the age of 5. In 2010, over 15 million infants were born prematurely, accounting for 11.1% of all live births globally.[1] The prevalence of preterm births varied from 5% in Europe to 18% in Africa. Approximately 60% of premature infants are delivered in south Asia and sub-Saharan Africa, resulting in over 1 million deaths annually due to prematurity.[1,2]

Approximately 10% of neonates are born prematurely, resulting in a global total of nearly 15 million preterm births each year. The user's text is.[2] Prematurity can lead to several issues in neonates. Respiratory distress syndrome is a frequently encountered condition that often arises in premature infants. Additional frequent problems associated with prematurity include bronchopulmonary dysplasia, intraventricular hemorrhage, necrotizing enterocolitis[3], and retinopathy of prematurity. The number is 3. RDS, which stands for respiratory distress syndrome, contributes to 28% of neonatal fatalities globally. Birth asphyxia, which refers to a lack of oxygen after birth, accounts for 23% of neonatal deaths. Infections are responsible for 36% of neonatal deaths. Together, these three factors make up more than 87% of all neonatal deaths worldwide. RDS, or hyaline membrane disease, is a condition where the lungs fail to achieve the necessary functional residual capacity (FRC) and have a tendency to collapse (atelectasis) due to a lack of surfactant.[4]

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Prior to delivery, the placenta fulfills three primary functions for the fetus: supplying all necessary nutrients for growth, removing waste materials produced by the fetus, and producing hormones that facilitate fetal development. Except for four specific electrolytes, the maternal circulation has a greater amount of substrate, such as blood glucose, compared to the fetal circulation.[5] Furthermore, the placenta has metabolic activity and utilizes glucose. The placenta facilitates the passage of waste products from fetal metabolism, such as heat, urea, bilirubin, and carbon dioxide, to the mother's excretory organs, including the liver, lungs, kidneys, and skin, for elimination.[6]

CPAP is now advised as the primary respiratory support for preterm infants who are breathing on their own. This is because the availability of experienced workers and the higher likelihood of problems make the use of mechanical ventilation less feasible. Continuous positive airway pressure (CPAP) is the administration of positive pressure to the lungs during the whole breathing process. Currently, it has emerged as a crucial therapeutic approach for managing respiratory distress syndrome (RDS) and other well-known problems associated with premature birth, such as apnea of prematurity and newborn pneumonia.[7] Based on the study findings, 71.1% of patients achieved successful treatment using nasal CPAP alone, while 28.9% of patients needed mechanical ventilation after CPAP was unsuccessful.[6]

Pakistan in Asia experiences a rising prevalence of preterm births, with an approximate annual count of 748,100. Pakistan is ranked fourth, following India, China, and Nigeria.[7] The mortality rate of neonates in underdeveloped nations such as Pakistan is significantly elevated as a result of respiratory complications. The majority of newborn mortality worldwide, around two-thirds, are concentrated in ten nations, primarily in Asia.[8] Pakistan is third on this list, with a total of 298,000 neonatal deaths occurring annually and a mortality rate of 49 per 1000 live births. Pakistan contributes to 7% of the total newborn mortality worldwide.

Given its cost-effectiveness, little invasiveness, ease of application, and the ease with which staff can be taught in its use, the routine implementation of CPAP can be beneficial in mitigating the five morbidities and death rates related with preterm in poor nations such as ours. CPAP can be administered nasally using either infant flow drivers or simple bubble CPAP. In our country, it is uncommon to use CPAP. Furthermore, there are few studies conducted on CPAP in Pakistan. The published studies primarily concentrate on nasal CPAP with infant flow drivers, and there is limited data on basic bubble CPAP. The purpose of this study is to assess how preterm neonates respond to bubble CPAP, a form of respiratory assistance, in settings with limited resources.[9]

OBJECTIVES & OPERATIONAL DEFINITION

The aim of the study was to ascertain the rate at which continuous positive airway pressure (CPAP) is effective in achieving positive outcomes in preterm newborns.

Operational Definitions

Preterm Infant

Preterm infants are defined as babies born before 37 weeks of gestation, calculated from the first day of the mother's last menstrual cycle.

Nasal CPAP (Simple Bubble CPAP)

A device that delivers continuous positive pressure throughout the breathing cycle via a nasal cannula, allowing for adjustable pressure and FiO2 levels as needed.

Successfully Treated Case

A preterm infant, who had continuous positive airway pressure (CPAP) treatment for respiratory distress syndrome (RDS), was effectively transitioned off CPAP without the need for mechanical ventilation and was discharged home.

Treatment Failure

The need for mechanical breathing after CPAP is determined based on 48 specific criteria:

- pCO2 above 60 mm Hg and /or pH < 7.20
- O2 requirement $> 60\%$ at CPAP pressure of 6 cm H2O

- Three or more apnoeic episodes / hour requiring stimulation or one apnoeic episode requiring bag and mask ventilation. 6 49

METHODS

This Descriptive, case series study was conducted at NICU, Department of Pediatrics, Madinah Teaching Hospital, Faisalabad from 30th June 2020 to 29th December 2020.

Sample Size

The sample size is 316. Using the following formula for frequency in a population, the sample size is determined. Nine Sample size n = [DEFF*Np(1-p)]/ [(d2 /Z2 1-α/2*(N-1)+p*(1-p)] In which location Population size (for finite population correction factor or fpc)(N): 1,000,000 Hypothesized percentage of patients who were successfully treated with CPAP (p): 71.1% +/-5 6 50 Confidence limits expressed as a percentage of 100 (absolute +/- %) (d): 5% Design effect (for cluster surveys-DEFF): 1 Confidence level = 95%

The Sample Technique used was Non-probability, consecutive sampling.

Sample Selection

a. Inclusion Criteria: a. Premature infants of both genders with a gestational age of less than 37 weeks who were given CPAP were included. b. Criteria for Exclusion: a. Congenital malformations b. Neuromuscular disease c. HIE Grade III d. Syndromic infants e. Congenital heart disease.

Data Collection Procedure

After receiving sanction from the Hospital Ethical Committee (TuF/UMDC/DME/32/33 Dated: 13/4/23), this investigation was implemented at the NICU department of Madinah Teaching Hospital Faisalabad. After obtaining informed consent from parents, 316 patients who met the inclusion criteria and required CPAP were selected. Data were collected in accordance with the pre-designed questionnaire that is appended herewith. The performa recorded the following variables: gestational age, birth weight, time of 51 starting CPAP after delivery, surfactant given or not, and the duration of CPAP required for treatment. The patient's successful outcome, which is a complete recovery without the need for mechanical ventilation following CPAP treatment, and treatment failure, which necessitates mechanical ventilation following CPAP treatment, were monitored.

Data Analysis Procedure

The data analysis commences by undertaking the necessary steps to prepare and validate the collected data. The data collection was structured according to the required format for the statistical analysis software. The verified data was inputted into SPSS version 22. Excluded were data that were incomplete and inconsistent.

Gestational age was used to compute the mean and standard deviation. Gender, birth weight, APGAR score, condition at delivery, surfactant administration, time of initiating CPAP after birth, and CPAP success were all analyzed and expressed as frequencies and percentages. The estimated frequencies are next utilized to assess the Test of Independencies between the two variables. These variables might be any of the variables in the dataset, along with the corresponding outcome of the case. The number is 52.

RESULTS

The average gestational age was 30.08 ± 2.75 weeks, as shown in Table-I. Among the 316 patients, 161 (50.95%) were male and 155 (49.05%) were female, resulting in a male to female ratio of 1.1:1 (Figure IV). The average birth weight was 2.50 ± 0.73 kg, as shown in Table-II.

The mean Apgar score was 5.46 ± 1.45, as shown in Table-III. The distribution of patients based on their condition at birth and the usage of surfactant is presented in Table-IV and V, respectively. The average time for initiating CPAP after birth was 17.46 ± 9.04 hours, as shown in Table-VI.

The study revealed that 233 out of 315 preterm neonates (73.73%) experienced successful outcomes with the use of CPAP, as depicted in Figure V. The Table-VII demonstrates the stratification of CPAP success based on gestational age, whereas Table-VIII presents the stratification based on gender. Table-IX and X display the categorization of the effectiveness of CPAP based on birth weight and Apgar score, respectively. The Table-XI displays the stratification of CPAP success based on the condition at birth, while Table-XII shows the stratification based on surfactant use. The table labeled-XIII illustrates the correlation between the timing of CPAP initiation after birth and the level of success achieved. 53 Table-I presents the distribution of patients based on their gestational age, with a total of 316 patients included in the analysis. Gestational age (in weeks) Number of patients as a percentage The numbers are 32, 63, and 19.94. The mean ± standard deviation is 30.08 ± 2.75 weeks. Figure IV displays the distribution of patients based on their gender, with a total of 316 individuals. The value is 161, which represents 50.95%. The value is 155, which represents 49.05%. Gender: Male, Female Age: 55 Table-II presents the distribution of patients categorized by birth weight, with a total of 316 individuals. Weight at birth (in kilograms) The percentage of patients with a count of 1 or less is 1.90%. The data can be categorized as follows: for values between 1 and 1.5, there are 30 occurrences with an average of 9.49; for values between 1.5 and 2.5, there are 77 occurrences with an average of 24.37; and for values greater than 2.5, there are 203 occurrences with an average of 64.24.

GA (Weeks)	No. of Patients	%age
<28	15	4.75
28-32	238	75.32
>32	63	19.94

Table-I. Distribution of patients according to gestational age (n=316).
• Mean ± SD = 30.08 ± 2.75 weeks

Birth Weight (Kg)	No. of Patients	%age
≤1	06	1.90
1-1.5	30	9.49
>1.5-2.5	77	24.37
>2.5	203	64.24

Table-II. Distribution of patients according to birth weight (n=316).

Apgar Score	No. of Patients	%age
≤5	168	53.16
>5	148	46.84
Mean ± SD	5.46 ± 1.45	

Table-III. Distribution of patients according to Apgar score (n=316).

Condition at Birth	No. of Patients	%age
Cried spontaneously	120	37.97
Needed resuscitation	196	62.03

Table-IV. Distribution of patients according to condition at birth (n=316).

Surfactant Use	No. of Patients	%age
Yes	243	76.90
No	73	23.10

Table-V. Distribution of patients according to surfactant use (n=316).

Time of Starting CPAP After Birth (Hours)	No. of Patients	%age
Within 1 hour	43	13.61
1-24 hours	195	61.71
>24 hours	78	24.68

Table-VI. Distribution of patients according to time of starting CPAP after birth (n=316).

GA (Weeks)	Success of CPAP		P-Value
	Yes	No	
<28	14	01	0.062
28-32	178	60	
>32	41	22	

Table-VII. Stratification of success of CPAP with respect to gestational age.

Gender	Success of CPAP		P-Value
	Yes	No	
Male	127	34	0.034
Female	106	49	

Table-VIII. Stratification of success of CPAP with respect to gender.

Birth Weight (Kg)	Success of CPAP		P-Value
	Yes	No	
≤1	06	00	0.421
1-1.5	22	08	
>1.5-2.5	59	18	
>2.5	146	57	

Table-IX. Stratification of success of CPAP with respect to birth weight.

Apgar Score	Success of CPAP		P-Value
	Yes	No	
≤5	122	46	0.631
>5	111	37	

Table-X. Stratification of success of CPAP with respect to Apgar score.

Condition	Success of CPAP		P-Value
	Yes	No	
Cried spontaneously	89	31	0.891
Needed resuscitation	144	52	

Table-XI. Stratification of success of CPAP with respect to condition at birth.

Surfactant Use	Success of CPAP		P-Value
	Yes	No	
Yes	180	63	0.802
No	53	20	

Table-XII. Stratification of success of CPAP with respect to surfactant use.

Time of Starting CPAP After Birth (Hours)	Success of CPAP		P-Value
	Yes	No	
Within 1 hour	38	05	0.0001
1-24 hours	122	73	
>24 hours	73	05	

Table-XIII. Stratification of success of CPAP with respect to time of starting CPAP after birth.

DISCUSSION

The most effective method for managing the respiratory needs of premature infants in the early stages is still a subject of debate. The numbers 74 and 75. The findings from randomized controlled trials (RCTs), both when analyzed individually (76-78) and collectively (79,80), indicate that the commencement of nasal continuous positive airway pressure (CPAP) is at least equivalent, if not superior, to early intubation and exogenous surfactant therapy.[10] Based on recent studies, the American Academy of Pediatrics now recommends considering the use of CPAP as a viable alternative to intubation, even for babies born at very early stages of pregnancy. The number is 81.

An issue with using CPAP universally for preterm newborns is that individuals with severe respiratory distress syndrome (RDS) may not receive sufficient support from CPAP. As a result, they may eventually need to be intubated and receive exogenous surfactant at a suboptimal time.[29] After reviewing the randomized controlled trial (RCT) evidence, the statement from the American Academy of Pediatrics found that using early continuous positive airway pressure (CPAP) alone for management does not result in a higher risk of negative outcomes, even if treatment with surfactant is delayed or not administered.[30] The number is 81.[23] However, none of the randomized controlled trials (RCTs) analyzed outcomes separately for infants who were successful or unsuccessful in their initial continuous positive airway pressure (CPAP) treatment.[11] Evidence from multiple hospital-based cohort studies strongly indicates that the main cause of CPAP failure is untreated surfactant deficiency.[22] This failure is linked to negative outcomes, such as a higher risk of mortality, as well as various health issues including air leak, bronchopulmonary dysplasia (BPD), and intraventricular hemorrhage (IVH).[21] The range is from 82 to 87.

Previous research on CPAP failure have focused on small groups of newborns treated at only one or two medical facilities. The range of numbers is 82 to 87. Analysis of the impact of initial CPAP assistance and CPAP failure in large neonatal databases has been hindered by the challenge of accurately determining the specific sequence of respiratory management in early life based on the available data. Eighty-eight The purpose of this study was to ascertain the rate at which preterm neonates experience favorable outcomes when using CPAP.[12] The study revealed that 233 out of 315 preterm neonates (73.73%) experienced successful outcomes with the use of CPAP. A study found that 71.1% of patients were effectively treated with nasal CPAP alone, but 28.9% of patients needed mechanical ventilation when CPAP was unsuccessful.[24] This study demonstrates the strong effectiveness of early CPAP, which aligns with the findings of earlier studies involving infants of the same gestational age as our study population. The failure rates reported in these studies were 20.6% (Rocha et al89) and 34% (De Jaegere et al90).[13]

Nevertheless, the great efficacy of early CPAP treatment should be approached with a degree of caution. A specific proportion of preterm newborns inevitably necessitates intubation in the delivery room. This study specifically targeted newborns who underwent noninvasive ventilation.[14] According to a national assessment of 987 preterm newborns with RDS91, conducted in Polish centers, kids born before 30 weeks make up a minority (approximately 38%) of all infants. Out of the 573 children who were 30 weeks old, 333 (58%) failed CPAP treatment.[25] A research conducted in Blantyre, Malawi, demonstrated that newborns with severe respiratory distress who were treated with low-cost bNCPAP had a survival rate of 71%, but those who received normal nasal oxygen therapy had a survival rate of 44%.[15] In general, 65.5% of very low birth weight (VLBW) neonates who were treated with bNCPAP therapy lived until they were discharged, while only 15.4% of the control group survived.[26]

Furthermore, bNCPAP had a noteworthy positive impact on infants suffering from both respiratory distress syndrome (RDS) and sepsis.[16] 97 A study was conducted in Nicaragua to assess the effects of low-cost bNCPAP on mortality and rates of mechanical ventilation. The results showed a noteworthy decrease in mortality (from 40% to 23%) and a reduction in the need for mechanical ventilation (from 72% to 39%). Nevertheless, there was a noticeable rise in the average length of stay in the Neonatal Intensive Care Unit (NICU) from 14.6 days in 2006 to 17.5 days in 2008.[17] Additionally, the percentage of newborns who received sole treatment with bubble nasal continuous positive airway pressure (bNCPAP) increased from 27% to 61%. 98 Similarly, the implementation of affordable bNCPAP at a tertiary hospital NICU in Eastern Uganda led to a significant decrease of 44% in mortality rates of very low birth weight (VLBW) infants with respiratory distress syndrome (RDS) (odds ratio 0.56, 95% confidence interval 0.36–0.86).99.[27]

The efficacy and treatment outcomes of a low-cost bNCPAP system were compared to those of oxygen therapy in a recent randomised controlled trial (RCT) that involved preterm neonates at a tertiary hospital in Northern Tanzania.[18] Neonates were initiated on bNCPAP if the Silverman-Andersen Respiratory Severity Score was ≥6, and weaning off bNCPAP was evaluated when the score was ≤3 for a minimum of 6 hours.[28] The survival rate of neonates who received bNCPAP was higher than that of those who received oxygen therapy (77.3% vs. 47.8%),[19] despite the fact that the difference were not statistically significant. 100 73.

CONCLUSION

The study determined that the rate of favorable outcomes from the use of Continuous Positive Airway Pressure (CPAP) in preterm infants is exceedingly high.[20] We strongly advocate for the routine use of Continuous Positive Airway Pressure (CPAP) as a respiratory support in our practice to enhance the survival rate of preterm newborns. The number is 74. 1. Kliegman R, Behrman, Schor, Stanton, Joseph. (Source)

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Syrah Liaquat:** Result interpretation.
2	**Rashid Nawaz:** Data collection.
3	**Rabia Tahir:** Data collection.
4	**Faizaan Asghar:** Drafting.
5	**Sadida Bhawal:** Revision.
6	**Imran Sarwar:** Proof read.