Section: Paediatrics

Original Research Article

ASSESSING THE OUTCOME OF CPAP ON PRETERM BABIES WITH RESPIRATORY DISTRESS SYNDROME ATTENDING THE PEDIATRICS UNIT IN A TERTIARY CARE CENTER

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ABSTRACT

Background: Globally, approximately 15 million preterm infants are born each year, with over one million dying shortly after birth, primarily due to respiratory complications. The rate of preterm births varies between 5% to 18% across 184 countries. In India, out of the 27 million births annually, 3.5 million are preterm.
Materials and Methods: This hospital-based observational prospective study was conducted over months, from 01/02/24 to 31/01/2025. It included neonates diagnosed with respiratory distress syndrome (RDS) who were admitted to the Neonatal Intensive Care Unit (NICU) at Department of Paediatrics Great Eastern Medical School and Hospital Ragolu, Srikakulam
Results: Out of the 150 preterm neonates included in the study, 35 (23.4%) were born between 28-31 weeks of gestation, 25 (30%) between 32-34 weeks, and 70 (46.6%) between 35-37 weeks. Regarding birth weight, more than half (72%) of the neonates had a birth weight of less than 2,000 grams, while 28% had a birth weight greater than 2,000 grams. The average birth weight was 1792.69 grams. CPAP treatment resulted in a successful outcome for 126 (84%) of the neonates.
Conclusion: The use of CPAP, along with timely administration of surfactant and antenatal steroids, significantly improves survival rates among preterm neonates with respiratory distress syndrome.
Keywords: Preterm Neonates, Respiratory Distress Syndrome (RDS), Continuous Positive Airway Pressure (CPAP), Birth Weight, Survival Rate .

INTRODUCTION

Respiratory Distress Syndrome (RDS) is a leading cause of neonatal mortality among preterm infants. The overall incidence of RDS is approximately 10-15 per 1,000 live births, with preterm infants being particularly vulnerable about 10-15% of preterm babies are affected by this condition.[1] RDS primarily occurs due to inadequate pulmonary surfactant production, which is crucial for reducing surface tension in the lungs and facilitating efficient gas exchange. In the absence of sufficient surfactant, alveolar collapse and impaired lung function result in epithelial injury, pulmonary edema, and further disruption of surfactant activity, leading to the characteristic clinical manifestations of RDS.[2]
Globally, around 15 million preterm infants are born each year, and over one million of these infants die within the first month of life, with respiratory complications being the leading cause of death. Preterm birth rates vary significantly across countries, ranging from 5% to 18%, with high neonatal mortality rates in low- and middle-income countries.[3] In India, for example, approximately 27 million babies are born annually, and about 3.5 million of these are premature.
The primary risk factor for developing RDS is prematurity, with additional contributing factors such as perinatal asphyxia, prolonged labor, maternal diabetes, and the lack of antenatal steroid administration. Antenatal steroids are known to accelerate lung maturity in the fetus, thereby reducing the risk of RDS.
Management of RDS includes non-invasive respiratory support, with Continuous Positive Airway Pressure (CPAP) being a cornerstone of therapy.[4]

CPAP involves delivering continuous positive pressure to the airways of a spontaneously breathing infant throughout the respiratory cycle. This method helps to maintain alveolar patency, prevents further lung collapse, and reduces the need for more invasive ventilation methods, which can carry higher risks and complications.

Bubble CPAP is a particular form of CPAP that has gained popularity due to its cost-effectiveness, simplicity of use, and low complication rates. It is a non-invasive and user-friendly technique that does not require specialized training to operate. Additionally, it is associated with fewer risks compared to more invasive mechanical ventilation. Despite these advantages, not all preterm infants with RDS respond adequately to CPAP.[5] Some may require more intensive interventions, such as surfactant replacement therapy or mechanical ventilation.

However, there is a need for further research on the safety, effectiveness, and long-term outcomes of CPAP, especially bubble CPAP, to better understand which infants are most likely to benefit from this therapy. While the benefits of CPAP in terms of reducing respiratory failure and mortality in preterm infants are well established, ongoing studies are necessary to optimize its use and refine patient selection criteria.[6]

In summary, CPAP remains an important and effective non-invasive treatment for managing RDS in preterm infants, but more evidence is needed to guide its use and improve neonatal outcomes across diverse clinical settings.

MATERIALS AND METHODS

Study Type: Prospective Observational study

Study Area: Department of Paediatrics, Great Eastern Medical School and Hospital Ragolu, Srikakulam

Study Period: 01/02/24 to 31/01/2025

Methodology: The neonates who are diagnosed with Respiratory distress syndrome and admitted between the period 01/02/24 to31/01/2025 in Neonatal Intensive care unit in Department of Paediatrics Great Eastern Medical School and Hospital Ragolu, Srikakulam

Inclusion Criteria:

The study included neonates with a gestational age between 28 and 36 weeks (inclusive) who were diagnosed with Respiratory Distress Syndrome (RDS). These infants were selected based on their gestational age and the presence of RDS, which is a common condition in preterm infants due to surfactant deficiency and immature lung development.

Exclusion Criteria:

1. Neonates with a gestational age less than 28 weeks or greater than or equal to 37 weeks.
2. Neonates with respiratory distress caused by conditions other than RDS, such as birth asphyxia, congenital pneumonia, sepsis, or congenital anomalies (e.g., cleft lip, cleft palate, tracheoesophageal fistula, or other congenital respiratory tract anomalies) were excluded.
3. Parents or guardians who did not provide informed consent for participation in the study, or who chose not to have their child participate, were excluded.

Ethical considerations: Prior to initiating the study, approval was obtained from the institutional ethics committee

This ensured that the study adhered to ethical guidelines for research involving neonates and their families.

Statistical Analysis: The data were analyzed using SPSS version 22, widely used statistical software. Appropriate statistical methods were applied to evaluate the results. Descriptive statistics, such as percentages and mean values, were calculated to summarize the characteristics of the study population. The p-value was calculated to assess the statistical significance of the findings. The results were carefully analyzed to draw conclusions.

RESULTS

Out of the total 150 preterm neonates in the study, 35 neonates (23.4%) were born at a gestational age between 28 and 31 weeks, 25 neonates (30%) were in the 32-34 weeks gestational age group, and the largest group, 70 neonates (46.6%), was born at a gestational age between 35 and 37 weeks. The majority of the study population fell into the 32-34 weeks (30%) and 35-37 weeks (46.6%) gestational age groups. The mean gestational age of the entire cohort was 35.4 weeks.

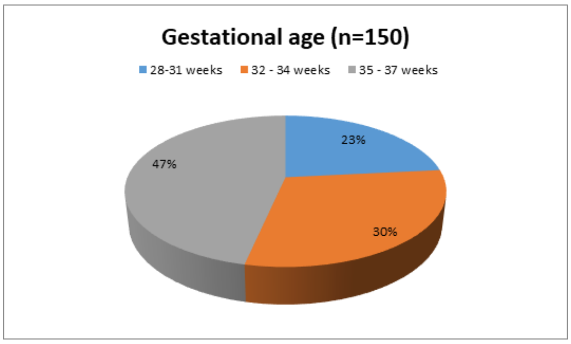

Figure 1: Age distribution of neonates.

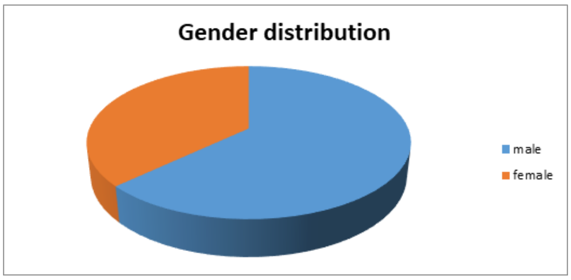

Figure 2

In this study, 63% of the neonates were male, while 37% were female, indicating a higher proportion of male infants. The male-to-female ratio was 1.4:0.8.

Table 1: Birth weights of the neonates.

Birth Weight	Number	Percentage
≤ 1000gms	12	8
1001 – 1500gms	56	37.4
1501 – 2000gms	40	26.6
>2000gms	42	28
Total	150	100

In this study, 72% of the neonates (n = 108) had a birth weight of less than 2,000 grams, while the remaining 28% (n = 42) had a birth weight greater than 2,000 grams. The mean birth weight of the neonates was 1792.69 grams.

Table 2: Demographic and etiological variables of study neonates.

Variable	Mean or total percentage (n=150)
Birth weight (gm) (mean)	1896.78
Gestational age in weeks (mean ± SD)	35.4 wks
Age at CPAP (Hrs) (mean ± SD)	14.86
Duration of CPAP (Hrs) (mean ± SD)	54.55
Cesarean Delivery	86
Sepsis	26
Surfactant	24
Antenatal steroid	8

In this study, 57.3% of the neonates were delivered via caesarean section, while 43.7% were delivered through normal vaginal delivery. Sepsis was observed in 17.3% of the neonates, followed by surfactant deficiency in 16%. Additionally, 5.3% of the mothers received antenatal steroids.

Table 3: Showing CPAP outcome with Gestational age among the study neonates

Gestational Age	CPAP outcome				P < 0.05
	Success		Failure		
	No	%	No	%	
28 – 31 weeks	21	17.6	12	40	0.0176
32 – 34 weeks	37	30.8	11	36.6	
35 – 37 weeks	62	51.6	7	23.4	
Total	120	100	30	100	

CPAP success was highest among neonates with a gestational age of 35-37 weeks (51.6%), followed by those in the 32-34 weeks group (30.8%) and 28-31 weeks group (17.6%). Conversely, CPAP failure was most common in neonates with a gestational age of 28-31 weeks (40%), followed by those in the 32-34 weeks group (36.6%). The data showed a clear trend of increasing CPAP success rates with advancing gestational age, and this correlation was statistically significant (p = 0.0176).

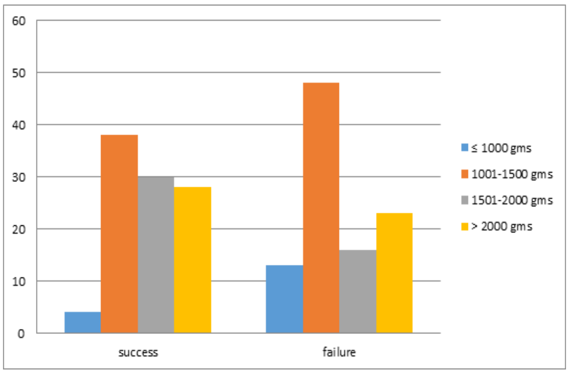

Figure 3: Showing CPAP outcome with Birth weight.

CPAP success was highest among neonates with a birth weight of 1,001–1,500 grams (38%), followed by those with a birth weight of 1,501–2,000 grams (30%) and greater than 2,000 grams (28%). CPAP was least effective in neonates with a birth weight of 1,000 grams or less (4%). In terms of CPAP failure, it was most common in neonates with a birth weight of 1,001–1,500 grams (48%), followed by those with a birth weight greater than 2,000 grams (23%). No statistically significant association was found between CPAP success or failure and the neonates' birth weight.

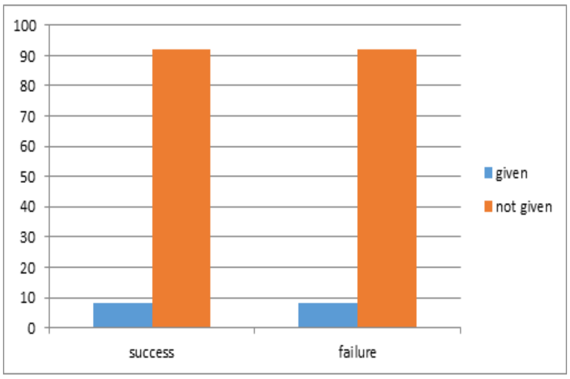

Figure 4

Among the neonates who received antenatal steroids, CPAP success was observed in 5.3%, while CPAP failure was also noted in 5.3%. A total of 8 neonates (5.3%) in the study received antenatal steroids. The p value is 0.9087 and is statistically not significant.

Table 4: Showing CPAP outcome with mode of delivery

Mode of delivery	CPAP outcome				P < 0.05
	Success		Failure		
	No	%	No	%	
NVD	46	38.4	18	60	0.0339
LSCS	74	61.6	12	40	
Total	120	100	30	100	

CPAP success was highest among babies delivered by caesarean section (LSCS), with a success rate of 61.6%, compared to 38.4% in those born via normal vaginal delivery. This difference was found to be statistically significant (p = 0.0339).

Table 5: CPAP outcome and Silverman Anderson score

Silverman Anderson score	CPAP outcome				P < 0.05
	Success		Failure		
	No	%	No	%	
3 – 4	18	15	4	13.4	
5 – 6	80	66.7	16	53.3	
7 – 9	22	18.3	10	33.3	
Total	120	100	30	100	

The CPAP success rate varied with the Silverman Anderson score at admission. For neonates with a score of 3-4, the success rate was 15%, while for those with a score of 5-6, the success rate increased to 66.7%. However, for neonates with a Silverman Anderson score of 7 or higher, the CPAP success rate was only 18.3%.

Table 6: Surfactant and CPAP outcome

Use of Surfactant	CPAP Outcome				P < 0.05
	Success		Failure		
	No	%	No	%	
Yes	18	15	4	13.4	0.865
No	102	85	26	86.6	
Total	120	100	30	100	

Of the total surfactant administered cases CPAP success is among (15%) than CPAP failure (13.4%). Surfactant was given to 20 (14.66%) neonates only.

Table 7: CPAP initiation time (age in hours) and outcome status

Age (hrs) at CPAP starting	CPAP Outcome				P < 0.05
	Success		Failure		
	No	%	No	%	
<24 hours	92	76.7	16	53.3	0.0073
>24 hours	28	23.3	14	46.7	
Total	120	100	30	100	

CPAP success was highest when it was initiated within 24 hours of birth, with a success rate of 76.7%, compared to 23.3% when CPAP was started after 24 hours. This difference was found to be statistically significant (p = 0.0073).

Table 8: Complication observed among the neonates

Complication	Number	Percentage
Sepsis	32	21.3
Nasal trauma	24	16
IVH	1	0.6
Pneumothorax	4	2.6
Shock	5	3.3
PVL	3	2

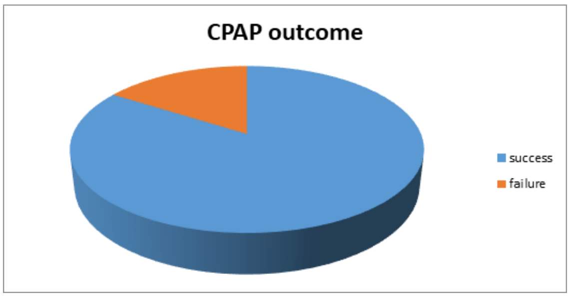

Figure 5

The most common complication observed was sepsis, affecting 21.3% of the neonates, followed by nasal trauma in 16% of cases. Shock was seen in only five neonates.
The majority of the subjects, 126 neonates (84%), had a successful outcome with CPAP in this study.

DISCUSSION

This study included 150 preterm neonates, who were admitted between and among these neonates, 126 infants (84%) were successfully weaned off CPAP, a success rate that is comparable to those reported in studies by Prashanth URS et al. (80%) and J. Koti et al. (75%). The findings in the current study suggest a high rate of CPAP success, which is consistent with previous literature.
Notably, CPAP success was found to be statistically significant in neonates whose mothers had received antenatal steroids in both the studies by Prashanth et al,[8] and Koti et al,[7] In these studies, neonates born to mothers who received antenatal steroids had higher success rates with CPAP. However, in contrast, no significant association was observed between the use of antenatal steroids and CPAP success in the studies by Ajay Sethi et al,[9] (p-value = 0.148) and Shamil et al,[10] (p-value = 0.148). In the present study, the percentage of neonates who received antenatal steroids was 5.3%, which is considerably lower than the percentages reported in the aforementioned studies. This relatively low usage of antenatal steroids could explain some of the variation in CPAP outcomes across studies.
The mean age at initiation of CPAP in this study was found to be 14.86 hours after birth, which was significantly later than in Prashanth et al., where CPAP was initiated at 5.5 hours. Research, including findings from a Cochrane systematic review, has consistently shown that early initiation of CPAP (within the first few hours of life) is associated with better outcomes, particularly a reduced need for invasive ventilation. In the present study, CPAP success was significantly higher in neonates where CPAP was started within 24 hours of birth (p-value = 0.0073), a result that aligns with the findings of Shamil A et al. (p-value = 0.024). This highlights the importance of early intervention in improving CPAP outcomes.[11]

In terms of surfactant administration, 18 neonates (15%) in this study received surfactant, which is similar to the rates observed in other studies, such as Ajay Sethi et al. (41.4%) and Sunil B et al. (16.9%). The relatively low use of surfactant in this study could be reflective of regional practices or the inclusion criteria used to determine its necessity.
The failure rate of CPAP in this study ranged from 25-50%, which is consistent with findings from various other studies on CPAP. The primary causes of CPAP failure in this study were identified as low gestational age, a Silverman Anderson score of 7 or higher, delayed initiation of CPAP (after 24 hours), lack of antenatal steroid use in many cases, as well as the presence of sepsis and nasal trauma. These factors were found to contribute significantly to the need for more intensive respiratory support and CPAP failure.
In summary, while the present study demonstrated high CPAP success rates, it also reinforced the importance of early initiation of CPAP and the use of antenatal steroids for improving outcomes. The relatively low percentage of antenatal steroid use and delayed initiation of CPAP may have contributed to the challenges faced in some cases, underscoring the need for further research and improvement in preterm birth management strategies. Additionally, factors such as gestational age, the severity of respiratory distress (as indicated by the Silverman score), and complications like sepsis and nasal trauma were key determinants of CPAP success or failure in this cohort.

CONCLUSION

The successful management of Respiratory Distress Syndrome (RDS) in preterm infants is primarily influenced by three key factors: antenatal steroid administration, the initiation of CPAP within 24 hours of birth, and the use of surfactant therapy. These interventions help improve lung maturity, stabilize respiratory function, and enhance oxygenation in preterm neonates. However, complications such as sepsis and nasal trauma remain common in neonates receiving CPAP support. To minimize these risks, it is crucial to implement strict aseptic techniques to prevent infection and ensure proper handling of CPAP equipment by the healthcare team. Proper training and careful management of both the neonate and the respiratory support tools can significantly reduce the occurrence of these complications and improve treatment outcomes.

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