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Outcome of the Use of Nasal Continuous Positive Airway Pressure for Neonate with Respiratory Distress in a Provincial Hospital in Vietnam

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ABSTRACT

Background: *Respiratory distress (RD) is a common syndrome in the neonatal period, especially occurring in the first few days after birth. Nasal continuous positive airway pressure (NCPAP) is a method of supporting infants with RD who are still able to breathe spontaneously by maintaining a continuous positive pressure throughout the breathing cycle.*

Aims: *This study aims to evaluate the final outcomes and risk factors affecting the outcomes of NCPAP for neonate with respiratory distress.*

Patients and Methods: *The study design was a prospective descriptive study. Neonates under 28 days of age with RD requiring NCPAP ventilation were included in the study. NCPAP outcomes were evaluated at 1 hour, 6 hours, 12 hours, 24 hours, and 48 hours after NCPAP ventilation.*

Results: *The study was conducted on 105 neonates with RD treated with NCPAP at Bac Ninh Obstetrics and Pediatrics Hospital from January to June 2025. Of these, 62 (59%) were boys. There were 44 (41.9%) neonates had a gestational age from 32 to 37 weeks, 32 (30.5%) from 28 to 32 weeks and 10(9.5%) under 28 weeks. Neonates with birth weight 1500-2500g were 46(43.8%) and there were only 4(3.8%) neonates with birth weight under 1000g. Vaginal delivery was more common than cesarean section, with rate of 59% and 41% respectively. Most children had moderate respiratory distress, accounting for 74.3%. The general success rate of NCPAP were 72.5%, while the remaining 27.6% neonates failed with NCPAP had to be switched to invasive mechanical ventilation. The failure rate of NCPAP for premature born before 32 weeks was 54.5%, higher than for premature born at 32 weeks or more (8.2%) (OR = 12.5; 95% CI=4.2-37.1; p<0.001). Neonates with birth weight < 1500g had a NCPAP failure rate of 48.8%, higher than neonates with birth weight ≥ 1500g (11.3%) with OR=7.2; 95%CI=2.4-21.6; p<0.001. Neonates with Apgar score < 7 had a NCPAP failure rate of 56.0%, higher than neonates with Apgar score ≥ 7 (16.3%) with OR = 6.2; 95%CI=2.0-19.3; p<0.001. Neonates with severe RD (Silverman score > 5) had a NCPAP failure rate of 54.1%, higher than infants with Silverman scores 3-5 (9.9%) with OR=10.1; 95%CI= 3.4 – 30.0; p<0.001. Neonates delivered by cesarean section had a NCPAP failure rate of 60.0%, higher than vaginal delivery neonates (15.3%) with OR=3.8; 95%CI=1.5-9.7; p<0.001.*

Conclusion: *The general success rate of NCPAP in neonates with RD after 48 hours were 72.5%. Neonates who failed NCPAP (27.6%) had to be switched to invasive mechanical ventilation. Risk factors that increase the failure rate of NCPAP are gestational age under 32 weeks, birth weight < 1500g, Apgar score < 7 after birth, severe RD with Silverman score > 5 and cesarean section.*

Keywords

Neonate, Respiratory distress, NCPAP, Risk factors.

Introduction

Respiratory distress (RD) is a common syndrome in the neonatal period, especially occurring in the first few days after birth [1,2]. The most common cause of respiratory distress in premature infants is transient surfactant deficiency leading to hyaline membrane disease. Meanwhile, common causes of respiratory distress in full-term infants include transient tachypnea in newborns, pneumonia,

meconium aspiration, perinatal asphyxia leading to persistent pulmonary hypertension in newborns, pneumothorax, spontaneous or secondary, etc [3-5].

Continuous positive airway pressure (CPAP) is an effective intervention for respiratory distress in neonates and is widely used worldwide. Nasal CPAP is a method of supporting infants with RD who are still able to breathe spontaneously by maintaining a continuous positive pressure throughout the breathing cycle [6-8]. Nasal CPAP can be used in newborns with RD due to various reasons like perinatal asphyxia, respiratory distress syndrome, transient tachypnea of the infant, meconium aspiration syndrome, pneumonia, and post extubation after mechanical ventilation [9]. Prophylactic nasal CPAP in very preterm infants reduces the incidence of bronchopulmonary dysplasia [10,11].

Based on the general principle of NCPAP, it is administered either through conventional bubble CPAP or through CPAP generator machines like infant flow drivers [3,12]. Nasal CPAP improves blood oxygenation, reduces carbon dioxide, reducing work of breathing and preventing lung collapse. It results in better recruitment of alveoli thus increasing the functional residual capacity, tidal volume, lung compliance and improve pulmonary ventilation and perfusion [6,13].

Compared with invasive mechanical ventilation, NCPAP also helps reduce the risk of infection, is easier to operate and care for, and is less expensive. It significantly reduces the incidence of bronchopulmonary dysplasia, ventilator-associated pneumonia and avoids intubation complications [12,14].

Nasal CPAP has been applied to neonates with respiratory distress for many years at Bac Ninh Province Obstetrics and Pediatrics Hospital, Vietnam. This study aims to evaluate the final outcomes and risk factors affecting the outcomes of NCPAP for neonate with respiratory distress

Patients and Methods

Selection Criteria

- All neonates ≤ 28 days old with respiratory failure indicated for NCPAP ventilation.
- The severity of respiratory failure was assessed according to the Silverman index: 3-5 points for moderate respiratory failure and above 5 points for severe respiratory failure.
- Time: from January 2025 to June 2025.
- Study Design: Prospective descriptive study.
- Assessment time points were 1 hour, 6 hours, 12 hours, 24 hours, and 48 hours after NCPAP ventilation.
- Evaluation of NCPAP ventilation results

Assessment was conducted at two levels: success and failure as follow:

- **Success criteria:** Stable neonatal condition (newborn alert, pinkish, no chest retraction, normal respiratory rate, SpO_2 92-96%; blood gases (if available): PaO2 60-80mmHg; PaO_2 40-45mmHg, pH 7.3-7.4) after weaning from NCPAP for at least 48 hours without requiring any other respiratory support besides oxygen therapy.
- **Failure criteria:** Endotracheal intubation and mechanical ventilation required at any time while using NCPAP; resumption of NCPAP within 48 hours of stopping NCPAP; apnea or episodes of apnea; SaO_2 < 90% or PaO_2 < 60mmHg with pressure of 10cm H_2O and FiO_2 80-100%; PaO_2 > 55mmHg. Or complications such as pneumothorax.
- **Data analysis:** Data analyzed using SPSS 20.0 software.

Results

The study was conducted on 105 neonates with respiratory distress syndrome treated with continuous positive airway pressure (NCPAP) via nasal cannula at Bac Ninh Obstetrics and Pediatrics Hospital from January to June 2025. Of these, 62 (59%) were boys and 43 (41%) were girls. The male/female ratio was 1/1.43. Most (97.1%) of the infants admitted were under 10 days old, with only 3 (2.9%) infants over 10 days old.

Table 1: Baseline characteristics of study participants.

Characteristics		*Number (%)*
Gestational age	< 28 weeks	10 (9.5)
	28 - < 32 weeks	32 (30.5)
	32 - < 37 weeks	44 (41.9)
	≥ 37 weeks	19 (18.1)
Birth weight	< 1000 g	4 (3.8)
	1000 - < 1500 g	33 (31.4)
	1500 - < 2500 g	46 (43.8)
	≥ 2500 g	22 (21.0)
Mode of delivery	Vaginal delivery	62 (59.0)
	Cesareansection	43 (41.0)
Respiratory Distress	Silverman ≥ 5	27 (25.7)
	Silverman: 3-5	78 (74.3)

Among the 105 children participating in the study, there were 44 (41.9%) neonates had a gestational age from 32 to 37 weeks, 32 (30.5%) from 28 to 32 weeks and 10(9.5%) under 28 weeks. Neonates with birth weight 1500-2500g were 46(43.8%) and there were only 4(3.8%) neonates with birth weight under 1000g. Vaginal delivery was more common than cesarean section, with percentages of 59% and 41% respectively. Most children had moderate respiratory distress, accounting for 74.3% (Table 1).

Signs of respiratory distress in the study infants improved significantly over time after NCPAP treatment. The percentage of neonates with SpO_2 < 92% decreased to 81.0% (85/105) after 1 hour, to 33.3% (35/105) after 6 hours, to 14.3% (15/105) after 12 hours, to 7.6% (8/105) after 24 hours, and to only 4.9% (5/102) after 48 hours. Cyanosis also decreased similarly after 1 hour to 85.7% (90/105) and to 4.9% (5/102) after 48 hours. Chest retraction decreased after 1 hour to 90.5% (95/105) and to 7.8% (8/102) after 48 hours (Figure 1). The general success rate of NCPAP were 72.5%, while the remaining 27.6% neonates failed with NCPAP had to be switched to invasive mechanical ventilation (Figure 2).

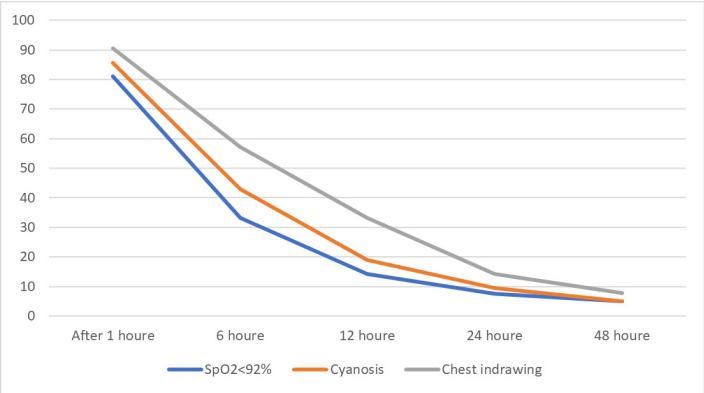

Figure 1: Clinical outcomes at different time points after initiating NCPAP ventilation.

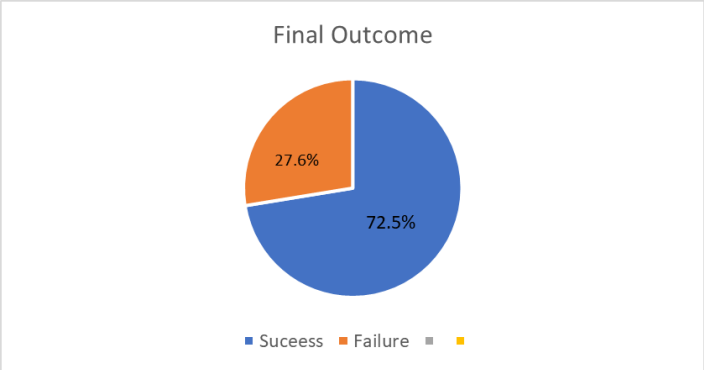

Figure 2: Final Outcome of NCPAP for newborns with respiratory distress syndrome.

Discussion

This study included 105 neonates, of those, 62 (59%) were male, 44 (41.9%) had gestational ages between 32 and under 37 weeks, 40% were born prematurely before 32 weeks. Of the 90 newborns with respiratory distress requiring CPAP treatment in West Nepal, 53.3% were premature, 44.4% were full-term, and the remainder were post-term [9]. The proportion of infants weighing between 1500-2500g was 43.8%, while the proportion of infants weighing under 1000g was 4%. Asress FG et al. found that among 60 infants, 43.3% were male, and the majority (60%) had gestational ages under 37 weeks, and 70% of infants weighed less than 2.5kg [6].

The study have shown that NCPAP significantly improved respiratory distress symptoms within the first 48 hours. SpO_2 decreased from 81.0% at 1 hour to 33.3% at 6 hours, further decreasing to 14.3% at 12 hours, 7.6% at 24 hours, and only 4.9% at 48 hours. Cyanosis also decreased similarly from 85.7% to 4.9% at 48 hours. Chest indrawing decreased from 90.5% to 7.8% at 48 hours. These figures demonstrate that NCPAP is an effective respiratory support method, leading to rapid improvement in the child's respiratory status. Ho JJ et al. also concluded that in preterm infants with respiratory distress, the application of CPAP is associated with reduced respiratory failure, use of mechanical [15].

Bano T et al. found that nCPAP was effective in 73% of neonates, with arterial pCO_2 decreasing from 48.2 to 39.5 mmHg ($p<0.001$, 95% CI: 6.4–10.9) and oxygen saturation increasing from 84% to 97% ($p<0.001$, 95% CI: 11.8–14.2) [16]. The results of a study by Boix H et al. showed that the overall failure rate of non-invasive ventilation (NIV) in neonates within the first 72 hours was 27/173 (15.6%). Among these, the failure rate was 14.6% in the CPAP group and 17.1% in the NIPPV group [17]. A study in Pakistan showed that 52 out of 60 (86.7%) infants successfully received nCPAP ventilation, while only 8 (13.3%) infants required mechanical ventilation [3].

The success rate of 72.4% is quite high compared to other reports, possibly because the neonates selected for this study had a higher proportion of mild to moderate respiratory distress. Abdallah Y et al. used CPAP on 174 neonates with acute respiratory distress

Table 2: Risk factors associated with NCPAP outcomes.

Risk Factors	Failure		Success		OR (95% CI) p
	n	%	*n*	%	
Gestational age < 32 weeks ≥ 32 weeks	24 5	54.5 8.2	20 56	45.5 91.8	12.5 (4.2 – 37.1) < 0.001
Birth weight < 1500 g ≥ 1500 g	21 8	48.8 11.3	22 54	51.2 88.7	7.2 (2.4 – 21.6) < 0.001
APGAR score at 5min < 7 ≥ 7	14 15	56.0 16.3	11 64	44.0 83.7	6.2 (2.0 – 19.3) < 0.001
Silverman >5 3-5	20 9	54.1 9.9	17 68	45.9 90.1	10.1 (3.4 – 30.0) < 0.001
Cesarean section Vaginal delivery	18 11	60.0 15.3	12 60	40.0 84.7	3.8 (1.5 – 9.7) < 0.001

The failure rate of NCPAP for premature born before 32 weeks was 54.5%, higher than for premature born at 32 weeks or more (8.2%) (OR = 12.5; 95% CI=4.2-37.1; $p<0.001$). Neonates with birth weight < 1500g had a NCPAP failure rate of 48.8%, higher than neonates with birth weight ≥ 1500g (11.3%) with OR = 7.2; 95%CI=2.4-21.6; $p<0.001$. Neonates with Apgar score < 7 had a NCPAP failure rate of 56.0%, higher than neonates with Apgar score ≥ 7 (16.3%) with OR = 6.2; 95%CI=2.0-19.3; $p<0.001$. Neonates with severe RD (Silverman score > 5) had a NCPAP failure rate of 54.1%, higher than infants with Silverman scores 3-5 (9.9%) with OR=10.1; 95%CI= 3.4 – 30.0; $p<0.001$. Neonates delivered by cesarean section had a NCPAP failure rate of 60.0%, higher than vaginal delivery neonates (15.3%) with OR=3.8; 95%CI=1.5-9.7; $p<0.001$ (Table 2).

syndrome (RDS) and found an overall failure rate of 37.4% and among those weighing ≤ 1200g, it was 44.1%. Most failure occurred within the first 24 h [1].

This study included 10 (9.5%) extremely preterm neonates (< 28 weeks) with immature lungs, lower surfactant levels, and weaker respiratory muscles compared to other infants. Therefore, these neonates were at higher risk of complications such as nasal ulcers, hypothermia, and infections. This also reduced the success rate of NCPAP. This study included 25 (23.7%) infants with Apgar scores < 7. These neonates often had complications such as cerebral hemorrhage, necrotizing enterocolitis, and chronic lung disease, which could affect the success rate of NCPAP.

Wu WW et al. studied 817 preterm infants born before 32 weeks who received non-invasive ventilation and found 139 cases of failure (17.0%). The failure group had lower gestational age, birth weight, and 1-minute and 5-minute Apgar scores compared to the successful group (P<0.05) [18].

The severity of respiratory distress was assessed using the Silverman score. In this study, neonates with a Silverman score > 5 had a higher NCPAP failure rate of 54.1% compared to neonates with a Silverman score between 3-5 (9.9%) with [OR=10.1; 95%CI: (3.4 – 30.0); p<0.001]. Chen IL et al. also found that gestational age, birth weight, APGAR scores at 1 and 5 minutes and the degree of respiratory distress were all correlated with successful NCPAP weaning. [19].

The method of delivery also affects the outcome of NCPAP. In this study, neonates born by cesarean section had a higher nCPAP failure rate of 60.0% compared to neonates born vaginally (15.3%) with [OR = 3.8; 95% CI: (1.5 -9.7); p < 0.001]. However, Nath A et al. found that the failure rate of non-invasive ventilation was 67.5% in the vaginal delivery group, higher than in the lower cesarean section group (P = 0.003) [20].

Conclusion

The general success rate of NCPAP in neonates with RD after 48 hours were 72.5%. Neonates who failed NCPAP (27.6%) had to be switched to invasive mechanical ventilation. Risk factors that increase the failure rate of NCPAP are gestational age under 32 weeks, birth weight <1500g, Apgar score <7 after birth, severe RD with Silverman score >5 and cesarean section.

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