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ORIGINAL ARTICLE

Study of Clinical Profile and Outcome of Neonates on Bubble Continuous Positive Airway Pressure Support vs Heated Humidified High Flow Nasal Cannula Support for Respiratory Distress in a Tertiary Care Hospital

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Abstract

Background: A major clinical problem, neonatal respiratory distress requires immediate action to enhance results. Neonates experiencing respiratory distress are frequently managed with non-invasive respiratory assistance, that includes Continuous Positive Airway Pressure (CPAP) and Heated Humidified High Flow Nasal Cannula (HHHFNC), especially in preterm neonates. CPAP is widely used to maintain airway pressure and prevent atelectasis, while HHHFNC delivers high-flow oxygen therapy with humidification, aiming to reduce the work of breathing. However, there is ongoing debate about relative effectiveness of these interventions. Comparing CPAP and HHHFNC in neonates up to 28 days old requiring non-invasive respiratory support (NIRS) is objective of current research for assessing effects on failure rates, survival, mortality, and duration of respiratory support. **Aim**: This study aims to study the clinical Profile and outcome of Neonates on Bubble Continuous Positive Airway Pressure Support Vs Heated Humidified High Flow Nasal Cannula Support for Respiratory Distress**. Discussion:** Comparing CPAP and HHHFNC in neonates up to 28 days old requiring NIRS is objective of current research to assess effects on failure rates, survival, mortality, and duration of respiratory support. **Conclusion**: In conclusion, current research results underscore distinct advantages and limitations of CPAP and HHHFNC in neonatal care. CPAP demonstrates efficiency and consistency, particularly for preterm and LBW neonates requiring intensive respiratory support. Conversely, HHHFNC offers suitability for term neonates, although with greater variability in clinical outcomes.

Keywords: Nasal Intermittent Positive Pressure Ventilation, Heated Humidified High-Flow Nasal Cannula, Respiratory distress syndrome, Continuous Positive Airway Pressure

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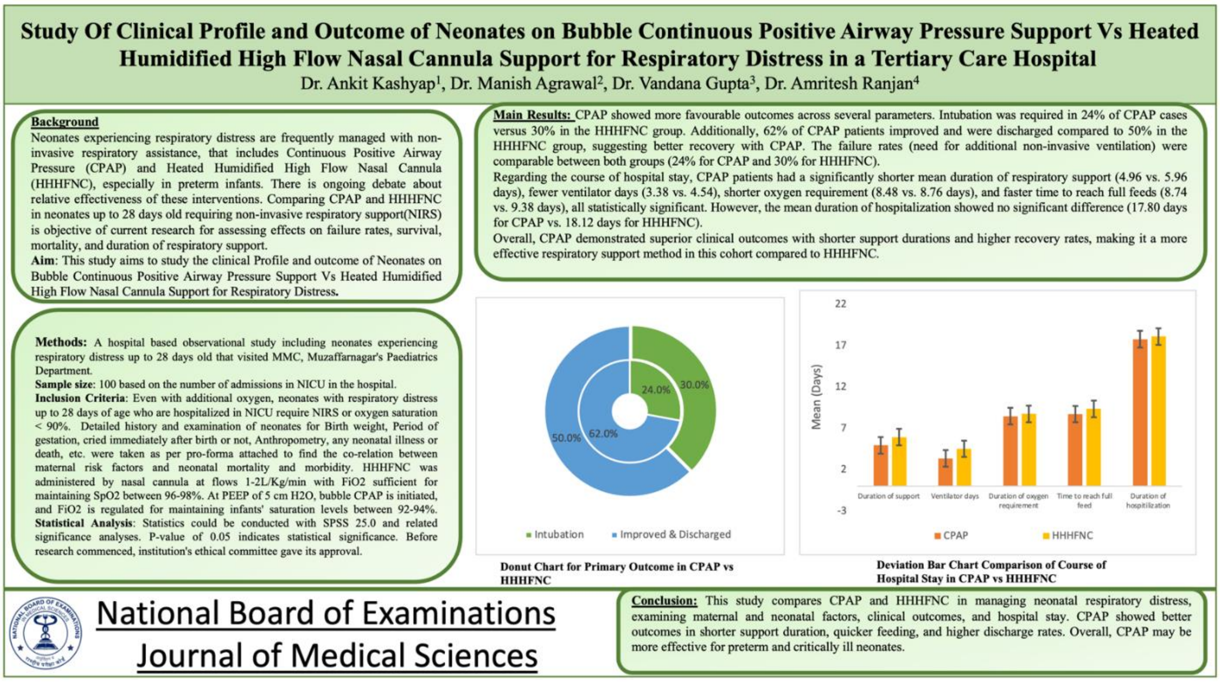
Graphical Abstract



Abbreviations

- APGAR – Appearance, Pulse, Grimace, Activity, Respiration
- ARDS – Acute respiratory distress syndrome
- BPD – Bronchopulmonary Dysplasia
- FiO_2 – Fraction of Inspired Oxygen
- FRC – Functional Residual Capacity
- GA – Gestational" "Age
- HHHFNC – Heated Humidified High-Flow Nasal Cannula
- IPP – Inspiratory Positive Pressure
- MAS – Meconium Aspiration Syndrome
- NICU – Neonatal Intensive Care Unit
- NIPPV – Nasal Intermittent Positive Pressure Ventilation
- PaO_2 – Partial Pressure of Oxygen
- CPAP – Continuous Positive Airway Pressure
- PEEP – Positive End-Expiratory Pressure
- PPHN – Persistent Pulmonary Hypertension of the Newborn
- RDS – Respiratory distress syndrome
- TTN – Transient Tachypnea of the" Newborn

Introduction

The most common problem in newborn globally is **respiratory distress**, affecting 3-7% of live births. It presents as increased work of breathing (WOB), tachypnoea, grunting, and chest retractions. Typical symptoms that indicate respiratory distress in neonates include subcostal and intercostal retractions, tachypnoea, "grunting, cyanosis, lethargy, and refusal of feed. A healthy newborn's respiratory rate ranges from 40-60 breaths per minute [1,2].

Mortality and morbidity can be decreased in cases of respiratory distress by providing adequate and prompt resuscitation, oxygen supplementation, maintaining an ideal temperature, prompt referral and providing optimal ventilatory support." Assisted ventilation is an essential method for management of respiratory distress in neonates. It is an acute, short term intervention that wholly or partially supports the physical process of respiration until the newborn develops the ability to breathe unassisted.

Respiratory distress in neonates has diverse causes, classified by system. **Airway** issues include choanal atresia, micrognathia, Pierre Robin sequence, laryngomalacia, and tracheoesophageal fistula. **Pulmonary** causes include RDS, TTN, MAS, pneumonia, pneumothorax, PPHN, and pulmonary haemorrhage. **Cardiovascular** factors involve congenital heart disease, tamponade, effusion, and failure. **Thoracic** conditions like diaphragmatic hernia and chest wall deformities can impair breathing. **Neuromuscular** causes include HIE, cerebral anomalies, meningitis, haemorrhage, and medication effects. Other causes include sepsis, metabolic abnormalities, and acidosis. Prompt identification of the underlying etiology is essential for targeted management and to improve neonatal outcomes.

Conservative care, breathing support, and surfactant therapy are subsequently employed for ideal "management. Major interventions include:

1. Antenatal corticosteroids.
2. Respiratory support.
3. Exogenous surfactant.
4. Supportive care, that includes nutritional support, antibiotic therapy, fluid and electrolyte management, thermoregulation etc.

In neonates with gestational age of 28–34 weeks, 2 doses of betamethasone 12 mg 24 hrs apart or 4 doses of dexamethasone 6mg 12hrs intervals reduce the incidence of RDS, intraventricular hemorrhage, and mortality [6-7]. Several research projects, including RCTs and systematic reviews that examined impacts of HHHFNC and CPAP, have produced contradictory results in recent years. While certain investigations revealed that HHHFNC had higher failure rate than CPAP, others indicated that HHHFNC was just as effective as CPAP [3-11].

Methodology

Study Design

Hospital-based observational study.

Place of study

Paediatrics Department, Muzaffarnagar Medical College and Hospital.

Study population

Neonates experiencing respiratory distress up to 28 days old that visited MMC, Muzaffarnagar's Paediatrics Department.

Duration of study

18 months (1 year for data collection and 6 months for data analysis).

Sample size

100 based on the number of admissions in NICU in the hospital.

Sampling technique

For the initial 28 days of life, samples are taken from every neonate, whether they are inborn or born, suffering from RDS requires non-invasive respiratory support.

Inclusion Criteria

Even with additional oxygen, neonates with respiratory distress up to 28 days of age who are hospitalized in NICU require NIRS or oxygen saturation < 90%.

Exclusion Criteria

1) Age group for more than 28 days of life. 2) Neonates with significant congenital anomalies or cardiac anomalies. 3) Neonates with unstable cardiovascular status or requiring invasive ventilation on the day of admission. 4) Neonates with prolonged refractory seizures.

Study Procedure

Detailed history and examination of neonates for Birth weight, Period of gestation, cried immediately after birth or not, Anthropometry, any neonatal illness or death, etc. were taken as per pro-forma attached to find the co-relation between maternal risk factors and neonatal mortality and morbidity. Newborns' respiratory distress has been evaluated by Downe's and Silverman-Anderson scoring systems. Clinical respiratory distress is indicated by Downe's score of >4, and imminent respiratory failure is indicated by score of >7. Clinical respiratory distress is indicated by Silverman-Anderson score of >4, and impending respiratory failure is indicated by a score of >8. Scoring systems have been employed for determining extent of respiratory distress. Date and time of applying Bubble CPAP or HHHFNC are noted, and neonates are evaluated every 4 hours thereafter. HHHFNC was administered by nasal cannula at flows 1-2L/Kg/min with FiO2 sufficient for maintaining SpO2 between 96-98%. At PEEP of 5 cm H2O, bubble CPAP is initiated, and FiO2 is regulated for maintaining neonates' saturation levels between 92-94%. Clinical monitoring is conducted by pulse oximetry, X-rays, and ABGs for determining requirements for any changes in settings. Notes have been maintained on duration of therapy and the time required to wean off.

Statistical Analysis

Statistics could be conducted with SPSS 25.0 and related significance analyses. P-value of 0.05 indicates statistical significance.

Ethical clearance

Research didn’t include any experimentation. Patient's attendant has been informed of process in detail and provided informed consent. Direct or indirect commercial benefits hadn't been provided to anyone, including investigation subject. Before research commenced, institution's ethical committee gave its approval. Statistical analysis has been conducted with SPSS 25.0 software and a relevant statistical significance test. Statistically significant P-value is 0.05.

Results

Current research investigates and compares the clinical profiles and outcomes of neonates managed with two respiratory support modalities: CPAP and HHHFNC. A total of 200 neonates were studied, with 100 cases in each group. Maternal comorbidities were distributed similarly in both groups, with Meconium-Stained Liquor (MSL) being the most common, followed by leaking per vaginum (PV) and pregnancy-induced hypertension (PIH). Statistical analysis revealed no significant difference in distribution of maternal comorbidities in CPAP and HHHFNC groups (p=0.892), suggesting that maternal health factors did not strongly influence the choice of respiratory support.

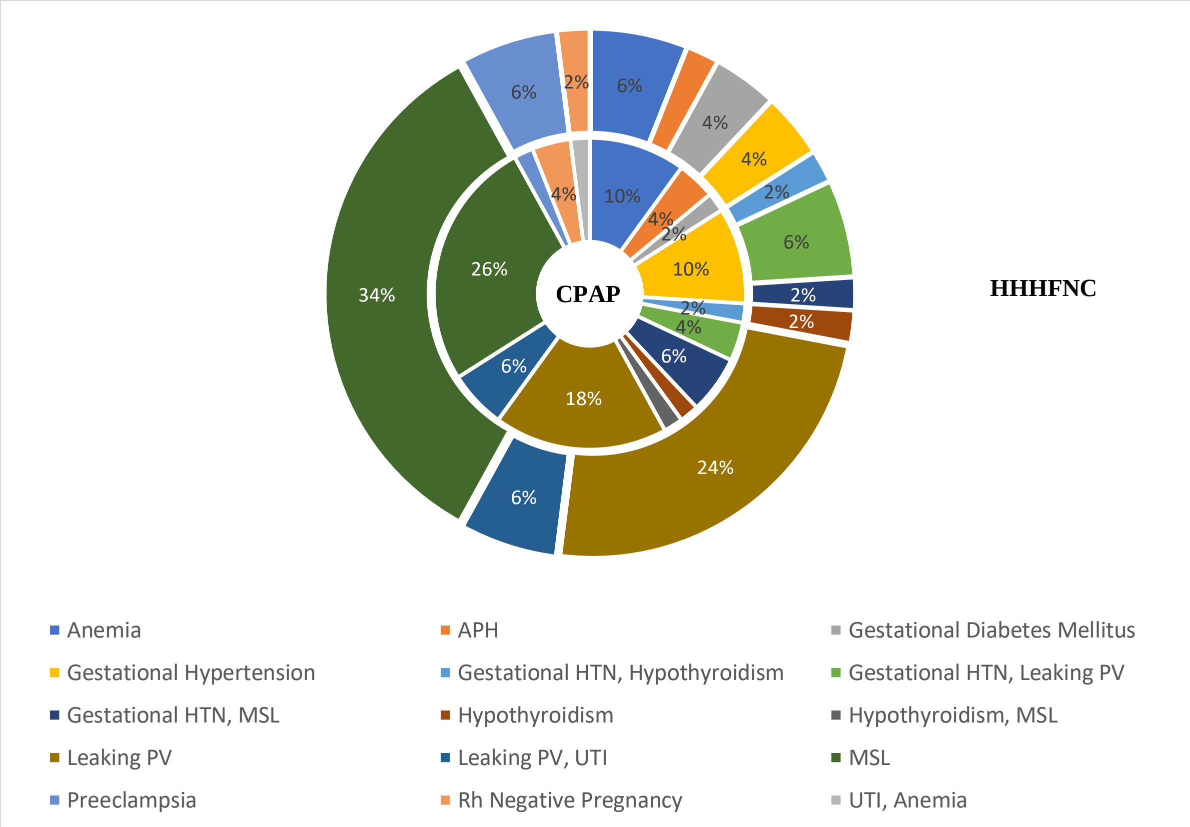


Figure 1. Donut Chart showing Comparison of Maternal Comorbidities in CPAP vs HHHFNC

However, the mode of delivery showed a significant difference. Lower segment cesarean section (LSCS) was far more frequent in HHHFNC group (96%) compared with CPAP group (62%), with statistically significant p-value of 0.001. This may reflect a trend where neonates delivered via cesarean section are more likely to receive HHHFNC, possibly due to milder respiratory distress.

Gender distribution was similar between the groups, indicating no gender-based preference or indication for either modality. In contrast, gestational age and birth weight showed highly significant differences. A higher proportion of preterm and low birth weight (LBW) neonates were managed with CPAP, while term and normal birth weight babies were more often treated with HHHFNC (p=0.001 for both).

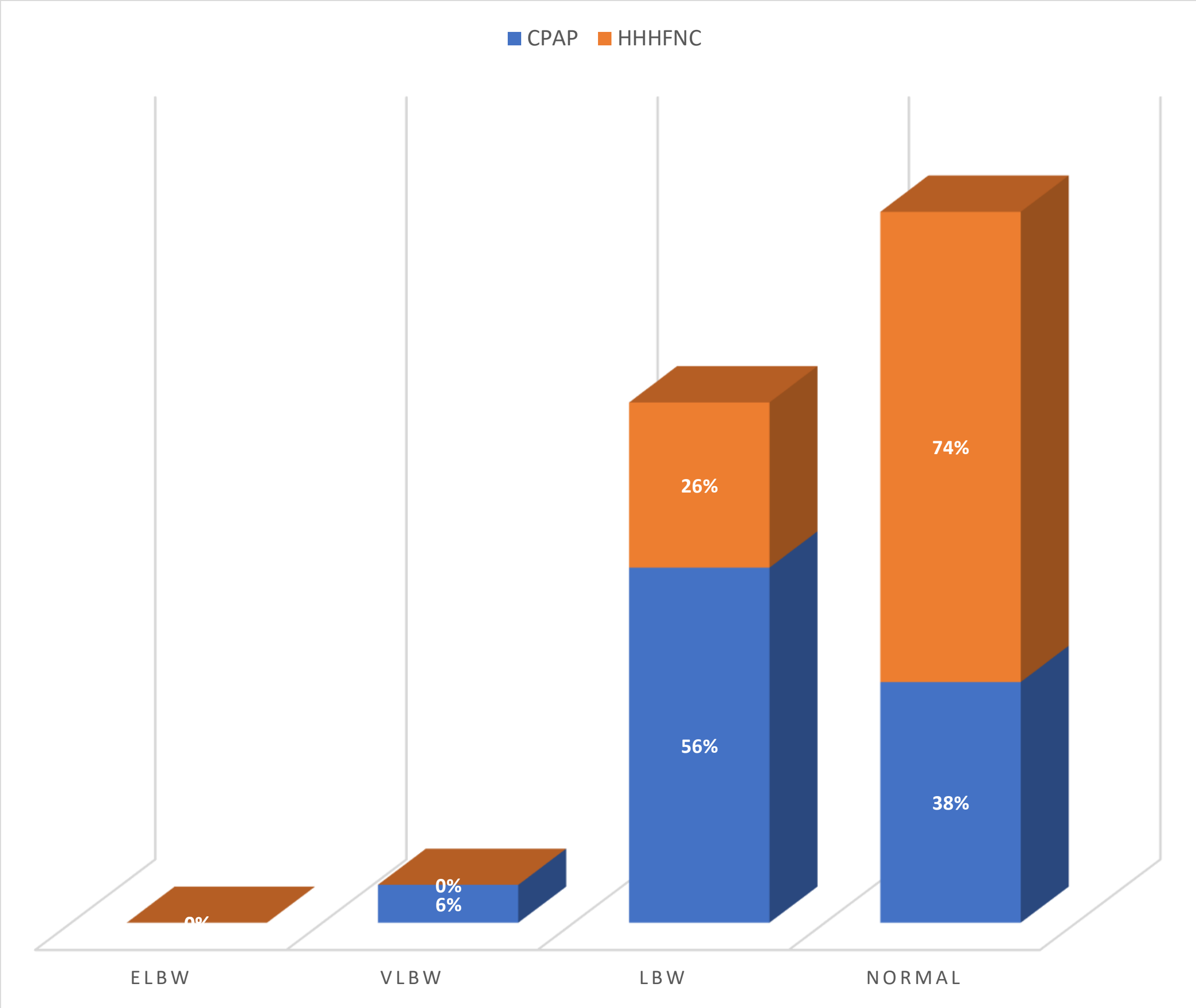


Figure 2. 3D BAR CHART Comparison of Birth Weight of Baby in CPAP vs HHHFNC

Similarly, small for gestational age (SGA) neonates were more commonly managed with CPAP, whereas appropriate for gestational age (AGA) babies have been more likely to receive HHHFNC (p=0.028). These results highlight that CPAP is preferred for more vulnerable neonates with higher clinical needs. Results indicate statistically significant difference in gestational duration across groups (p=0.001). Preterm neonates were predominantly treated with CPAP (72%), whereas term neonates were more likely to receive HHHFNC (74%). Post-term neonates were rare in both groups, though slightly more received CPAP (10%) compared to HHHFNC (4%).

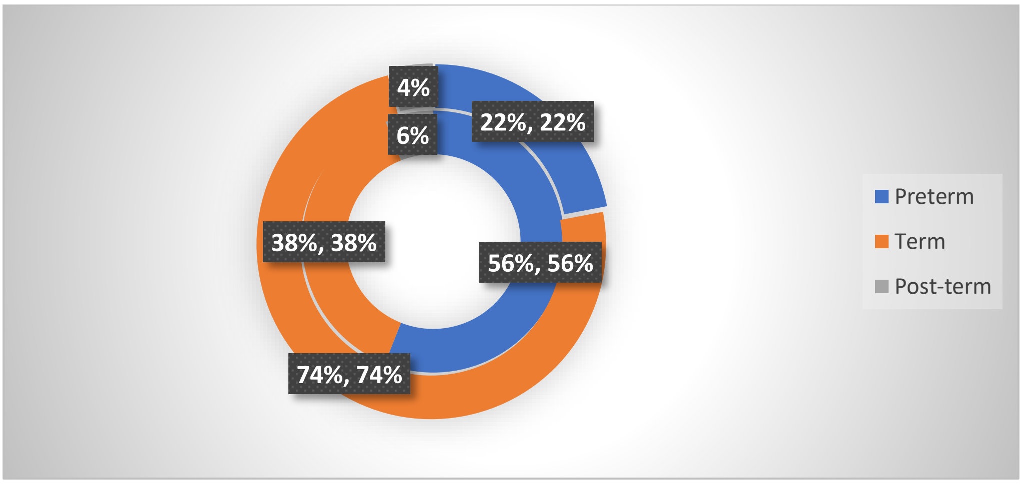


Figure 3. Donut chart Comparing Gestational Age of Baby in CPAP vs HHHFNC

Regarding the causes of respiratory distress, both groups primarily included neonates diagnosed with Meconium Aspiration Syndrome (MAS) and congenital pneumonia, often associated with neonatal sepsis. While the precise cause of distress varied slightly, there was no significant difference in underlying diagnoses that guided the choice of CPAP or HHHFNC.

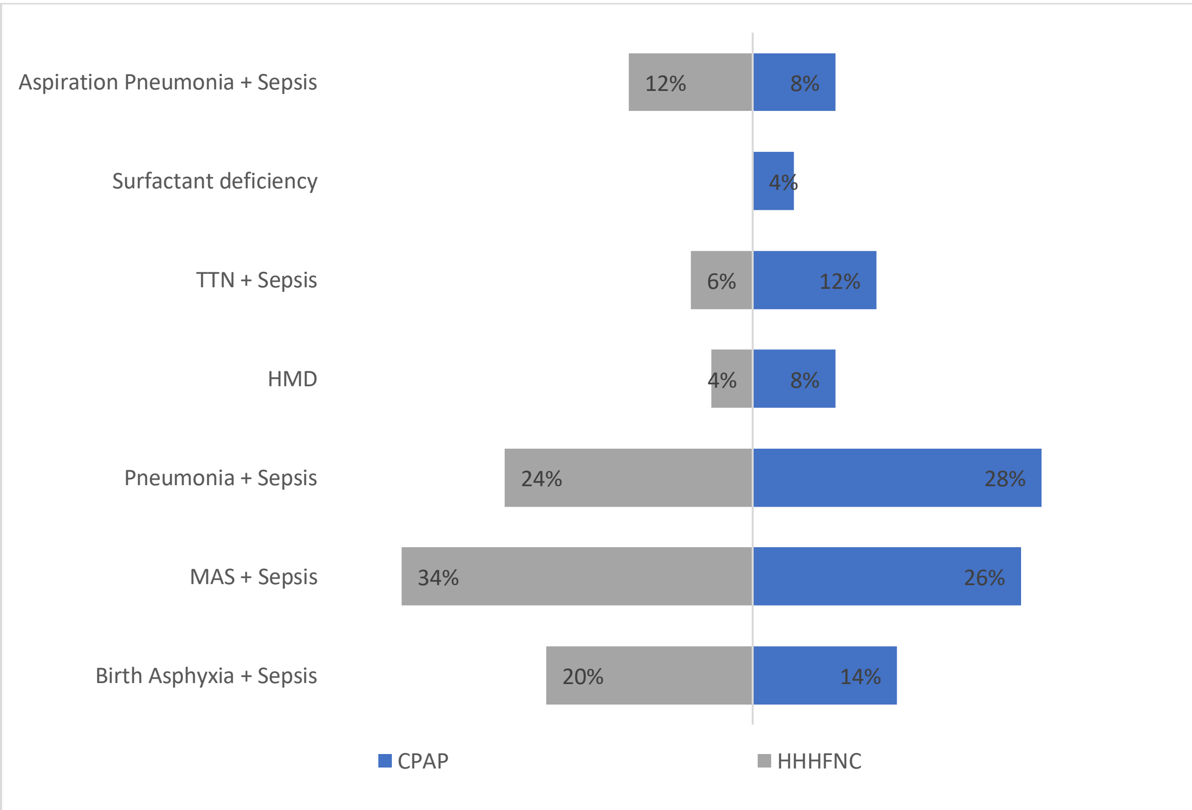


Figure 4. Bi directional chart comparing causes of respiratory distress in neonates on CPAP vs HHHFNC

Socio-economic status, evaluated using Modified Kuppuswamy Classification, showed no significant correlation with the selection of respiratory support modality (p=0.165), indicating that clinical condition rather than economic background influenced treatment decisions.

Assessment of respiratory distress using Silverman-Anderson and Downe's scores at admission revealed that neonates treated with CPAP generally presented with more severe respiratory distress compared to those in the HHHFNC group. Over time, both groups showed significant clinical improvement in scores, but the initial severity was higher in the CPAP group.

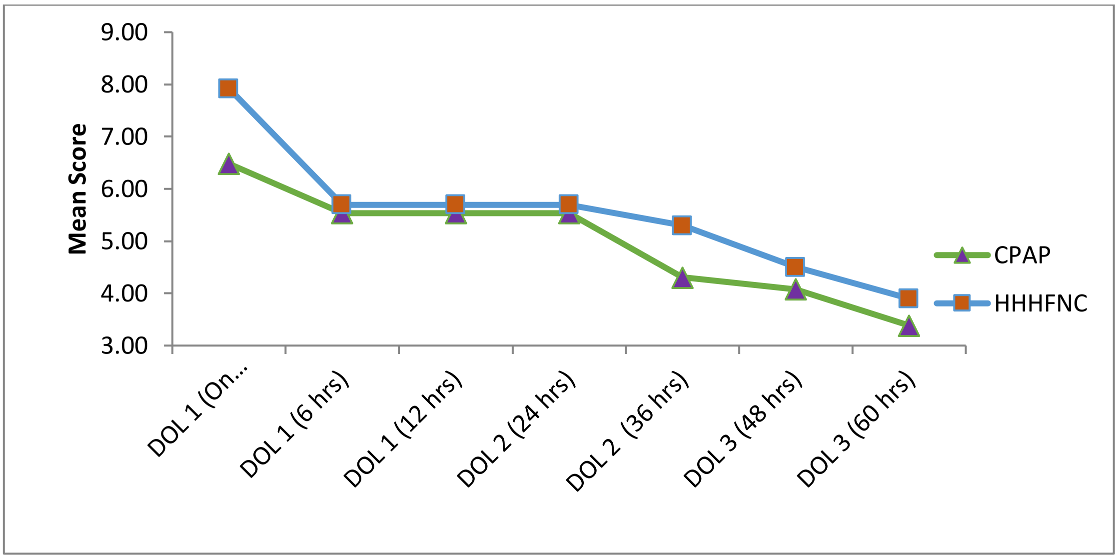


Figure 5. Line graph Comparison of Silverman Anderson's Scoring in CPAP vs HHHFNC

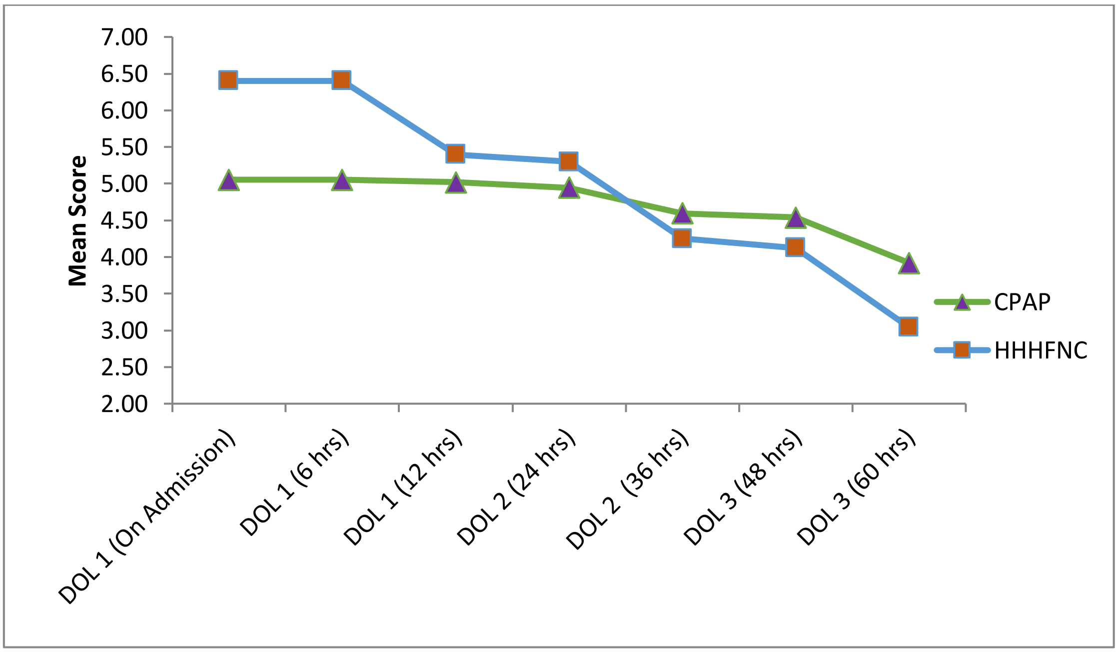


Figure 6. line graph Comparison of Downe's Scoring in CPAP vs HHHFNC

CPAP showed more favourable outcomes across several parameters. Intubation was required in 24% of CPAP cases versus 30% in the HHHFNC group. Additionally, 62% of CPAP patients improved and were discharged compared to 50% in the HHHFNC group, suggesting better recovery with CPAP. The failure rates (need for additional non-invasive ventilation) were comparable between both groups (24% for CPAP and 30% for HHHFNC).

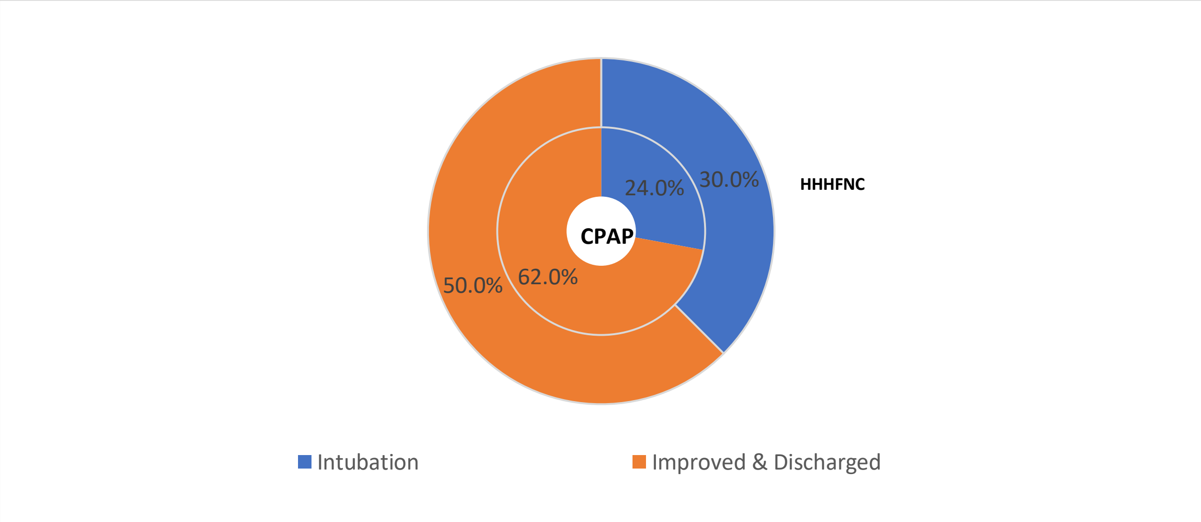


Figure 7. Donut Chart for Primary Outcome in CPAP vs HHHFNC

Regarding the course of hospital stay, CPAP patients had a significantly shorter mean duration of respiratory support (4.96 vs. 5.96 days), fewer ventilator days (3.38 vs. 4.54), shorter oxygen requirement (8.48 vs. 8.76 days), and faster time to reach full feeds (8.74 vs. 9.38 days), all statistically significant. However, the mean duration of hospitalization showed no significant difference (17.80 days for CPAP vs. 18.12 days for HHHFNC).

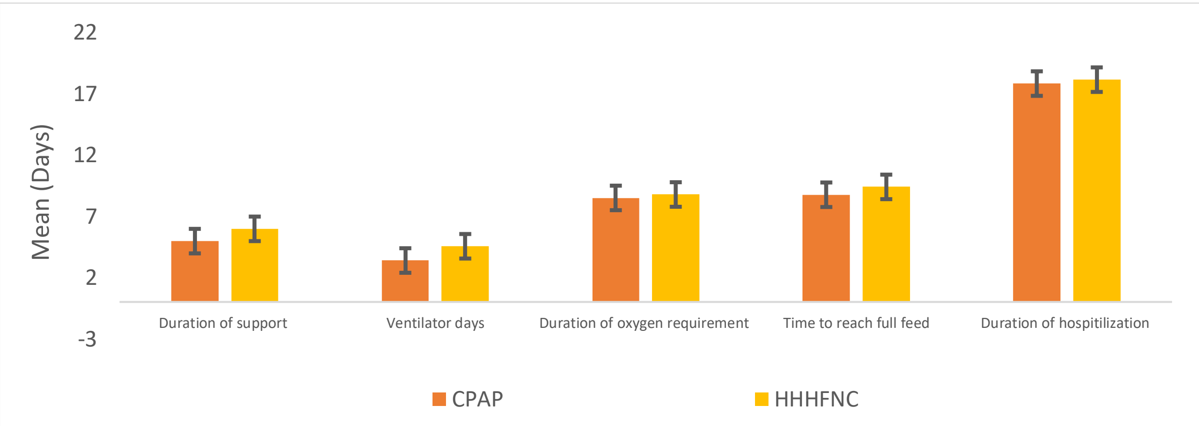


Figure 8. Deviation Bar Chart Comparison of Course of Hospital Stay in CPAP vs HHHFNC

Overall, CPAP demonstrated superior clinical outcomes with shorter support durations and higher recovery rates, making it a more effective respiratory support method in this cohort compared to HHHFNC.

Conclusion

This study compares CPAP and HHHFNC in managing neonatal respiratory distress, examining maternal and neonatal factors, clinical outcomes, and hospital stay. Maternal comorbidities showed no significant influence on treatment choice, while mode of delivery did, with HHHFNC linked to caesarean births and CPAP to vaginal deliveries. CPAP was used more in preterm and low birth weight neonates, while HHHFNC was favoured for term neonates. Both modalities had similar intubation and treatment failure rates, but CPAP showed better outcomes in shorter support duration, quicker feeding, and higher discharge rates. Overall, CPAP may be more effective for preterm and critically ill neonates.

Limitations and Future Scope

Generalizability is restricted by research's single-centre design and small sample size. Selection and exclusion criteria may introduce bias, focusing only on certain neonates. Lack of post-discharge follow-up prevents assessment of long-term outcomes. Additionally, reliance on limited statistical methods may overlook complex clinical interactions.

To increase neonatal respiratory support systems efficacy, future research should focus on improving treatment protocols and assessing long-term results. This work provides a foundation for improving clinical decision-making and advancing the quality of neonatal care.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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