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RESEARCH ARTICLE
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TO COMPARE THE INCIDENCE OF COMPLICATIONS IN NEWBORN VENTILATED WITH NIPPV (VS) CONVENTIONAL VENTILATION WITH RDS

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Abstract

Background: Respiratory distress syndrome (RDS) is a leading cause of neonatal morbidity and mortality, especially in preterm infants. Mechanical ventilation is often required but carries significant risks. **Objective:** To compare the incidence of complications in neonates with RDS managed with NIPPV versus those receiving conventional mechanical ventilation.

Methods:

Study Design and Setting: This comparative observational study was conducted in the Neonatal Intensive Care Unit (NICU) of **PNS Shifa Hospital, Karachi**, from **15th May 2025 to 14th August 2025**.

Sample Size and Sampling: A total of 185 neonates with a diagnosis of respiratory distress syndrome (RDS) were included using non-probability consecutive sampling.

Results: The incidence of BPD, pneumothorax, and VAP was significantly lower in the NIPPV group (9.8%, 3.3%, and 2.2%, respectively) compared to the conventional group (22.6%, 11.8%, and 16.1%, respectively). Nasal trauma was noted only in the NIPPV group (8.7%). Gastrointestinal distension was more common in the NIPPV group (13.0%) than in the conventional group (5.4%), though not statistically significant. The NIPPV group had shorter durations of ventilation (38.6 ± 12.4 hrs vs. 72.1 ± 18.7 hrs, $p < 0.001$) and NICU stay (10.2 ± 3.6 days vs. 13.7 ± 4.9 days, $p < 0.001$). Mortality rates did not differ significantly between groups.

Conclusion: NIPPV is associated with fewer serious complications and improved short-term clinical outcomes compared to conventional ventilation in neonates with RDS. While minor complications such as nasal trauma and gastrointestinal distension were more frequent with NIPPV, these were manageable.

Introduction

Respiratory distress syndrome (RDS) is one of the most common causes of morbidity and mortality in preterm neonates, primarily due to surfactant deficiency and immature lungs. Effective respiratory support is crucial in managing RDS to maintain adequate oxygenation and minimize lung injury [1]. Traditionally, invasive mechanical ventilation (IMV) has been the mainstay for moderate to severe cases; however, it is associated with significant complications such as ventilator-associated pneumonia (VAP), bronchopulmonary dysplasia (BPD), volutrauma, and long-term neurodevelopmental impairments [2]. In recent years, non-invasive positive pressure ventilation (NIPPV) has emerged as a promising alternative to conventional mechanical ventilation (CMV). NIPPV offers the advantage of reducing the need for endotracheal intubation while providing better alveolar recruitment and gas exchange compared to nasal continuous positive airway pressure (nCPAP) [3]. By avoiding the risks associated with invasive intubation, NIPPV may decrease the incidence of complications such as BPD, air leak syndromes, and nosocomial infections. Additionally, studies suggest that NIPPV may be associated with shorter duration of oxygen therapy and hospital stay [4].

Traditionally, conventional mechanical ventilation via endotracheal intubation has been employed to manage severe RDS. Although conventional ventilation is effective in providing adequate oxygenation and ventilation, it carries significant risks, including barotrauma, volutrauma, oxygen toxicity, and infection [5]. These complications contribute to the development of bronchopulmonary dysplasia, a chronic lung disease that has long-term implications on pulmonary and neurodevelopmental outcomes. Other adverse effects associated with invasive ventilation include ventilator-associated pneumonia, upper airway injury, subglottic stenosis, and increased length of hospital stay [6]. Considering such issues, paradigm shift towards non-invasive ventilation strategies has occurred in neonatal intensive care units. An example of such modality includes non-invasive positive pressure ventilation (NIPPV) in which positive pressure breaths are given without an endotracheal tube by the use of nasal prongs or a mask [7]. The use of NIPPV has the advantage of merging the effect of continuous positive airway pressure and intermittent application of positive pressure breath which ensures a better alveolar ventilation and therefore a reduction in the work of breathing than continuous positive airway pressure [8].

A number of studies indicated that NIPPV can lead to the reduction of the extubation failure rate and/or limited necessity of reintubation in premature infants with RDS. It has also been linked with reduced chances of ventilator induced lung injury, since it does not cause uncontrolled airway instrumentation, but it may allow greater physiologic ventilator mechanics [9]. Nonetheless, NIPPV application will need special equipment, training of the staff members, and careful supervision to avoid complication of injury on nasal traumas, gastric distension, and air leak syndromes [10]. Although NIPPV is being used more and more, its clinical superiority over conventional ventilation in the neonatal RDS remains a debated issue.

There are signs in some randomized controlled trials and meta-analyses that showed a decrease in the extent of bronchopulmonary dysplasia and reintubation with early initiation of NIPPV, but others do not show significant variations in significant clinical results [10]. In addition to this, difference in interfaces, setting on ventilators, and patient selection criteria also results in inconsistent results in different healthcare facilities. These problems are even accentuated in developing nations and resource poor settings [11]. There is a shortage of access to highly effective non-invasive ventilation technology, trained staff and standardised practice in many neonatal intensive care units [12].

Objective

To compare the incidence of complications in neonates with RDS managed with NIPPV versus those receiving conventional mechanical ventilation.

Methodology

Study Design and Setting:

This comparative observational study was conducted in the Neonatal Intensive Care Unit (NICU) of **PNS Shifa Hospital, Karachi**, from **15th May 2025 to 14th August 2025**.

Sample Size and Sampling:

A total of 185 neonates with a diagnosis of respiratory distress syndrome (RDS) were included using non-probability consecutive sampling.

Inclusion Criteria

- Neonates diagnosed with respiratory distress syndrome based on clinical and radiological finding
- Gestational age between 28 and 35 weeks
- Neonates requiring either non-invasive positive pressure ventilation (NIPPV) or conventional mechanical ventilation as per clinical judgment
- Parental or guardian consent obtained

Exclusion Criteria

- Neonates with major congenital anomalies
- Neonates with confirmed sepsis or perinatal asphyxia at the time of admission
- Neonates who required both modes of ventilation sequentially
- Incomplete medical records or early transfer/discharge before 48 hours of ventilation

Data Collection

Data were collected prospectively using a structured proforma. Patients were divided into two groups based on the mode of ventilation: Group A (NIPPV) and Group B (Conventional Ventilation). Baseline demographic details such as gestational age, birth weight, and Apgar scores were recorded. Clinical outcomes and complications during the hospital stay were monitored, including incidence of bronchopulmonary dysplasia, pneumothorax, ventilator-associated pneumonia, nasal trauma, gastrointestinal distension, duration of ventilation, and mortality. Data were collected from bedside monitoring charts, nursing records, and physician documentation.

Statistical Analysis

Data were entered and analyzed using SPSS version 25.0. Quantitative variables such as gestational age and birth weight were expressed as mean ± standard deviation, while categorical variables such as incidence of complications were presented as frequencies and percentages. The chi-square test was applied to assess differences in the incidence of complications between the two groups. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 185 neonates diagnosed with respiratory distress syndrome were included in the study. Mean gestational age was 33.9 ± 2.1 weeks in the NIPPV group and 33.7 ± 2.3 weeks in the conventional group ($p = 0.48$). Mean birth weights were also comparable (1.86 ± 0.42 kg vs. 1.78 ± 0.46 kg; $p = 0.23$). Male distribution (56.5% vs. 52.7%) and low Apgar scores at 5 minutes (<7) (13.0% vs. 16.1%) were not significantly different ($p > 0.05$), indicating well-matched groups.

Table 1: Baseline Characteristics of Study Participants (n = 185)

Variable	NIPPV Group (n = 92)	Conventional Group (n = 93)	p-value
Mean Gestational Age (weeks)	33.9 ± 2.1	33.7 ± 2.3	0.48
Mean Birth Weight (kg)	1.86 ± 0.42	1.78 ± 0.46	0.23
Male Gender (%)	52 (56.5%)	49 (52.7%)	0.61
Apgar Score at 5 min <7	12 (13.0%)	15 (16.1%)	0.54

NIPPV significantly reduced the risk of complications compared to conventional ventilation. Bronchopulmonary dysplasia occurred in only 9.8% of NIPPV patients vs. 22.6% in the conventional group (p = 0.01), while pneumothorax was reported in 3.3% vs. 11.8% (p = 0.03). Ventilator-associated pneumonia was dramatically lower in the NIPPV group (2.2% vs. 16.1%; $p < 0.001$). However, nasal trauma occurred only in the NIPPV group (8.7%; p = 0.004). Gastrointestinal distension was more common in NIPPV (13.0% vs. 5.4%), but not statistically significant (p = 0.06). Mortality rates were not significantly different (4.3% vs. 8.6%; p = 0.24).

Table 2: Incidence of Complications in Both Groups

Complication	NIPPV Group (n = 92)	Conventional Group (n = 93)	p-value
Bronchopulmonary Dysplasia	9 (9.8%)	21 (22.6%)	0.01
Pneumothorax	3 (3.3%)	11 (11.8%)	0.03
Ventilator-Associated Pneumonia	2 (2.2%)	15 (16.1%)	<0.001
Nasal Trauma	8 (8.7%)	0 (0%)	0.004
Gastrointestinal Distension	12 (13.0%)	5 (5.4%)	0.06
Mortality	4 (4.3%)	8 (8.6%)	0.24

Ventilation and hospitalization metrics strongly favored the NIPPV group. The mean duration of ventilation was significantly shorter in the NIPPV group (38.6 ± 12.4 hours) compared to the conventional group (72.1 ± 18.7 hours; $p < 0.001$). NICU stay was also reduced (10.2 ± 3.6 vs. 13.7 ± 4.9 days; $p < 0.001$), as was the duration of oxygen therapy (5.4 ± 2.1 vs. 8.6 ± 3.2 days; $p < 0.001$).

Table 3: Duration of Ventilation and Hospital Stay

Parameter	NIPPV Group (n = 92)	Conventional Group (n = 93)	p-value
Mean Duration of Ventilation (hrs)	38.6 ± 12.4	72.1 ± 18.7	<0.001
Mean NICU Stay (days)	10.2 ± 3.6	13.7 ± 4.9	<0.001
Duration of Oxygen Therapy (days)	5.4 ± 2.1	8.6 ± 3.2	<0.001

Overall clinical outcomes favored the NIPPV group. Successful weaning was achieved in 87.0% of NIPPV cases compared to 69.9% in the conventional group (p = 0.006). Reintubation was significantly less frequent in the NIPPV group (7.6% vs. 17.2%; p = 0.045). Discharge rates were slightly higher in the NIPPV group (92.4% vs. 86.0%), though not statistically significant (p = 0.18). Mortality remained low and comparable in both groups (4.3% vs. 8.6%; p = 0.24), reinforcing the safety and efficacy of NIPPV.

Table 4: Overall Clinical Outcomes

Outcome	NIPPV Group (n = 92)	Conventional Group (n = 93)	p-value
Successful Weaning (%)	80 (87.0%)	65 (69.9%)	0.006
Reintubation Required (%)	7 (7.6%)	16 (17.2%)	0.045
Discharged Home (%)	85 (92.4%)	80 (86.0%)	0.18
Mortality (%)	4 (4.3%)	8 (8.6%)	0.24

Discussion

This study aimed to compare the incidence of complications in neonates diagnosed with respiratory distress syndrome who were managed with either non-invasive positive pressure ventilation (NIPPV) or conventional mechanical ventilation. The findings revealed that NIPPV was associated with a significantly lower incidence of major complications such as bronchopulmonary dysplasia (BPD), pneumothorax, and ventilator-associated pneumonia (VAP), when compared to conventional ventilation. The incidence of BPD in the NIPPV group was 9.8%, which was considerably lower than the 22.6% observed in the conventional group. This aligns with previous studies that suggest NIPPV,

by avoiding direct tracheal instrumentation and delivering gentler ventilatory support, reduces lung injury and preserves alveolar structure [13]. Several trials have reported similar protective effects of early NIPPV in preterm infants, reinforcing the role of non-invasive strategies in mitigating the risks of chronic lung disease. Pneumothorax, a serious complication often associated with high ventilatory pressures and volume trauma, occurred more frequently in the conventionally ventilated group (11.8% vs. 3.3%). This may be due to the higher peak inspiratory pressures and lack of synchrony between patient effort and ventilator cycles in conventional ventilation. NIPPV, by contrast, offers better pressure control and may reduce overdistension of immature alveoli [14]. This observation is in line with the fact that introduction of endotracheal tube in bypassing the upper airway predisposes the recipient to nosocomial infections, especially those with weak immune systems of which neonates are the leading victims due to their extended stay in the NICUs [15]. Interestingly, nasal trauma was a problem that was specific to the NIPPV group (8.7 %) as it is already identified as a shortcoming of this modality. Amazing mismatch and nasal interfaces, as well as extended operations without rotation or guarding, may result in skin breakdown and columellar necrosis [16]. Howbeit, this is a complication that is largely controllable, however, this points to the fact that steady nursing care and interface choices are vital to enacting NIPPV. Gastrointestinal distension rate rates were also higher in the NIPPV group, but not significantly (13.0% vs. 5.4%) [17]. The behavior can be explained by the fact that the side effect of positive pressure through nasal interfaces is known as aerophagia [18]. Nonetheless, the cohort did not encounter necrotizing enterocolitis in any of the infants in the two groups, which implies that the complication did not cause severe outcomes in it. The difference between the groups in the percentage of mortality was not significant however, the NIPPV group was moving towards the higher survival rate [19]. In sum, this trial reinforces the body of evidences that lean towards accepting the application of non-invasive ventilation strategies especially NIPPV in the treatment of neonatal RDS [20]. The risk of severe pulmonary complications and reduced NICU length of stay provide a solid case in support of the integration of NIPPV into the normal practice of respiratory support of newborn children. Nevertheless, the danger of the nasal injury and gastrointestinal distension cannot be overstressed and is the subject of prophylaxis measures. There are some limitations in the study. It is observational in design, and, therefore, competes with possibility of selection bias and confounding variables. Also, it has not applied long term neuro developmental follow up which is crucial in determining the overall effects of each strategy of ventilation.

Conclusion

It is concluded that non-invasive positive pressure ventilation (NIPPV) is associated with a significantly lower incidence of major complications, including bronchopulmonary dysplasia, pneumothorax, and ventilator-associated pneumonia compared to conventional mechanical ventilation in neonates with respiratory distress syndrome. Additionally, the NIPPV group experienced shorter durations of ventilation, oxygen therapy, and NICU stay, suggesting a more favorable clinical course. While nasal trauma and mild gastrointestinal distension were observed more frequently with NIPPV, these complications were non-life-threatening and manageable. Although no statistically significant difference in mortality was found, the trend favored better outcomes with NIPPV.

References

1. Esmaeilnia T, Nayeri F, Taheritafti R, Shariat M, Moghimpour-Bijani F. Comparison of Complications and Efficacy of NIPPV and Nasal CPAP in Preterm Infants With RDS. Iran J Pediatr. 2016 Mar 5;26(2):e2352. doi: 10.5812/ijp.2352. PMID: 27307960; PMCID: PMC4904342.
2. Tang S, Zhao J, Shen J, Hu Z, Shi Y. Nasal intermittent positive pressure ventilation versus nasal continuous positive airway pressure in neonates: A systematic review and meta-analysis. Indian Ped J. 2013;50(4):371–6. doi: 10.1007/s13312-013-0122-0

3. Skariah TA, Lewis LE. Early Nasal Intermittent Positive Pressure Ventilation (NIPPV) versus Nasal Continuous Positive Airway Pressure (NCPAP) for Respiratory Distress Syndrome (RDS) in Infants of 28-36 weeks gestational age: a Randomized Controlled Trial. Iranian Journal of Neonatology. 2019 Jun: 10(2). DOI: 10.22038/ijn.2018.32566.1454
4. Farhat AS, Mohammadzadeh A, Mamuri GA, Saeidi R, Noorizadeh S. Comparison of Nasal Non-invasive Ventilation Methods in Preterm Neonates with Respiratory Distress Syndrome. Iranian Journal of Neonatology. 2018 Dec: 9(4). DOI: 10.22038/ijn.2018.24544.1313
5. Chawanpaiboon S, Vogel JP, Moller AB, Lumbiganon P, Petzold M, Hogan D, et al. Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. Lancet Glob Health. 2019;7(1):e37–46. doi:10.1016/S2214-109X(18)30451-0
6. Perin J, Mulick A, Yeung D, Villavicencio F, Lopez G, Strong KL, et al. Global, regional, and national causes of under-5 mortality in 2000-19: an updated systematic analysis with implications for the sustainable development goals. Lancet Child Adolesc Health. 2022;6(2):106–15. doi:10.1016/S2352-4642(21)00311-4
7. Dyer J. Neonatal respiratory distress syndrome: tackling a worldwide problem. P T. 2019;44(1):12–4. PMID:30675087
8. Homan TD, Nayak RP. Short- and long-term complications of bronchopulmonary dysplasia. Respir Care. 2021;66(10):1618–29. doi:10.4187/respcare.08401
9. Courtney SE, Durand DJ, Asselin JM, Hudak ML, Aschner JL, Shoemaker CT, et al. High-frequency oscillatory ventilation versus conventional mechanical ventilation for very-low-birth-weight infants. N Engl J Med. 2002;347(9):643–52. doi:10.1056/NEJMoa012750
10. Klingenberg C, Wheeler KI, McCallion N, Morley CJ, Davis PG. Volume-targeted versus pressure-limited ventilation in neonates. Cochrane Database Syst Rev. 2017;10(10):CD003666. doi:10.1002/14651858.CD003666.pub4
11. Drevhammar T, Berg N, Nilsson K, Jonsson B, Prahl Wittberg L. Flows and function of the infant flow neonatal continuous positive airway pressure device investigated with computational fluid dynamics. *Acta Paediatr*. (2021) 110(3):811–7. doi: 10.1111/apa.15502
12. Prakash R, De Paoli AG, Davis PG, Oddie SJ, McGuire W. Bubble devices versus other pressure sources for nasal continuous positive airway pressure in preterm infants. *Cochrane Database Syst Rev*. (2023) 3(3):CD015130. doi: 10.1002/14651858.CD015130
13. Bharadwaj SK, Alonazi A, Banfield L, Dutta S, Mukerji A. Bubble versus other continuous positive airway pressure forms: a systematic review and meta-analysis. *Arch Dis Child Fetal Neonatal Ed*. (2020) 105(5):526–31. doi: 10.1136/archdischild-2019-318165
14. Bordessoule A, Moreira A, Civitillo CF, Combescure C, Polito A, Rimensberger PC. Comparison of inspiratory effort with three variable-flow nasal continuous positive airway pressure devices in preterm infants: a cross-over study. *Arch Dis Child Fetal Neonatal Ed*. (2021) 106(4):404–7. doi: 10.1136/archdischild-2020-320531
15. Prakash R, De Paoli AG, Oddie SJ, Davis PG, McGuire W. Masks versus prongs as interfaces for nasal continuous positive airway pressure in preterm infants. *Cochrane Database Syst Rev*. (2022) 11(11):CD015129. doi: 10.1002/14651858.CD015129
16. Cresi, F., Chiale, F., Maggiora, E. *et al.* Short-term effects of synchronized vs. non-synchronized NIPPV in preterm infants: study protocol for an unmasked randomized crossover trial. *Trials* **22**, 392 (2021). https://doi.org/10.1186/s13063-021-05351-0
17. Handoka NM, Azzam M, Gobarah A. Predictors of early synchronized non-invasive ventilation failure for infants < 32 weeks of gestational age with respiratory distress syndrome. Arch Med Sci AMS. 2019;15(3):680–7.
18. Lemyre B, Laughon M, Bose C, Davis PG. Early nasal intermittent positive pressure ventilation (NIPPV) versus early nasal continuous positive airway pressure (NCPAP) for preterm infants. Cochrane Database Syst Rev. 2016;12:CD005384.

19. Ferguson KN, Roberts CT, Manley BJ, Davis PG. Interventions to improve rates of successful extubation in preterm infants: a systematic review and meta-analysis. JAMA Pediatr. 2017;171(2):165.
20. Sweet DG, Carnielli V, Greisen G, Hallman M, Ozek E, Te Pas A, et al. European Consensus Guidelines on the Management of Respiratory Distress Syndrome - 2019 Update. Neonatology. 2019;115(4):432–50.