

Efficacy of Nasal Intermittent Positive Pressure Ventilation (NIPPV) in Newborn Patients With Respiratory Distress

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ABSTRACT

Objective: To determine the effectiveness of Nasal Intermittent Positive Pressure Ventilation (NIPPV) in neonates presenting with respiratory distress in terms of need and duration of mechanical ventilation.

Study Design: Prospective analytical study

Place and Duration of Study: Department of Pediatrics, Pak Emirates Military Hospital (PEMH), Rawalpindi, Pakistan, from Mar 24 to Mar 25.

Methodology: This study included 102 newborn patients who were presented with respiratory distress. All newborn patients who had respiratory distress were placed on NIPPV. Efficacy of NIPPV was determined by factors such as the final outcome of neonates, total duration of stay in the neonatal intensive care unit, need for mechanical ventilation, and development of any complications.

Results: The results of the study showed that out of a total of 102 neonates included in the study, 55(53.9%) were male and 47(46.1%) were female babies. 65(63.7%) Babies were born via LSCS while 37(36.3%) were born via SVD. Neonates born via LSCS required a longer duration on NIPV, mechanical ventilation, and had a statistically significantly longer duration of stay in NICU. Initial blood lactate >5 mmol/L was significantly associated with longer NIPPV duration, increased need for mechanical ventilation, and increased mortality rates.

Conclusion: Birth weight of babies and lactate level at birth were significantly associated with morbidity and mortality in neonates treated with NIPPV.

Keywords: Mechanical Ventilation, Nasal Intermittent Positive Pressure Ventilation, Neonates.

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INTRODUCTION

Respiratory distress is the common experienced complication in neonates born via LSCS. An effective respiratory support strategy is crucially needed for these neonates to prevent such complications. Gregory and colleagues in 1971 laid down the foundation of the first successful application of continuous positive airway pressure via an endotracheal tube.¹ Although Mechanical ventilation showed significant improvement in survival of preterm neonates with respiratory distress, multiple cases of bronchopulmonary dysplasia were also reported after prolonged ventilation, causing long term respiratory and neurological complications, which revived interest in finding alternative non-invasive ventilation methods.² Further studies suggested a link between BPD and various neurodevelopmental disorders, including cerebral palsy, movement disorders, and

sensory impairments.³

Different modes being used in NIV include: nasal cannula or head box oxygen therapy, heated humidified high-flow nasal cannula oxygenation, nasal continuous positive airway pressure (CPAP), nasal intermittent positive pressure ventilation (NIPPV), nasal bilevel positive airway pressure (BiPAP), and nasal high-frequency oscillatory ventilation (NHFOV).⁴ NIPPV's benefits extend beyond CPAP, enhancing respiratory drive, increasing mean airway pressure, and triggering Head's paradoxical reflex. Synchronization with an infant's breathing efforts can be achieved through various techniques, including pneumatic capsule, flow-triggered pneumotachograph, or pressure-triggered systems.⁵

Research indicates that Non-Synchronized Nasal Intermittent Positive Pressure ventilation (nsNIPPV) is more effective than HFNC in treating RDS.⁶ Additional research has highlighted sNIPPV's effectiveness as compared to nsNIPPV in reducing

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apneic events, desaturations, and bradycardia in neonates with apneas.⁷ A comprehensive network meta-analysis has also confirmed sNIPPV's superiority over alternative respiratory support modes.⁸ If NIPPV proved to be effective in our study, it would give confidence to pediatricians in treating neonates with respiratory distress with this mode of treatment. This mode of treatment is less costly and requires less expertise and monitoring than mechanical ventilation.

METHODOLOGY

This prospective analytical study was carried out in the Neonatal Intensive Care Unit (NICU) of PEMH Rawalpindi, from Mar 2024 to Mar 2025. The ethical review for the study was obtained from the institutional ethical review board (ERC No. A/28/ERC/04/2024). A non-probability convenience sampling technique was used. The prevalence of respiratory distress in neonates was estimated to be 4.6 - 8%.⁹ Keeping in view the above study, a prevalence of 7% was selected for this study. With a confidence interval of 95% and a margin of error of 5%, the sample size came out to be 101. A sample size of 102 Patients was selected.

Inclusion Criteria: All newborn patients were included in this study who were presented with respiratory distress manifested in the form of increased respiratory rate (> 60) or those with Signs of respiratory distress (Subcostal recessions, Moaning, Grunting, Nasal flaring) or neonates with decreased SPO2 levels ($< 90\%$ on room air).

Exclusion Criteria: Neonates with Congenital anomalies, Syndromic patients, Patients with Congenital heart diseases, and Patients whose parents did not consent for inclusion in the study were excluded from this study.

Confounding variables were addressed by using strict inclusion and exclusion criteria. The study population was stratified based on known risk factors, including birth weight, mode of delivery, and initial blood lactate levels—factors known to influence both disease severity and therapeutic outcomes. Data were analyzed separately within these stratified groups to observe potential variations in outcomes. Although multivariate regression analysis was not performed due to sample size constraints, stratification helped to reduce the influence of confounding variables on study outcomes.

Informed consent was obtained from parents or legal guardians. Patient confidentiality and privacy

were strictly maintained. Data were collected in the form of a pre-formed questionnaire. The questionnaire consisted of demographic data and clinical Data. Demographic data included Birth weight, Gestational age, Mode of delivery, gender, and Age at presentation in the NICU. Clinical Data included examination of neonates with respiratory distress, baseline investigations, capillary gases, Blood lactate levels, and measurement of the primary and secondary outcomes mentioned.

All Patients were placed on NIPPV along with specific treatment depending on the patient's condition and disease specification. The primary outcome of this study was the effectiveness of NIPPV, measured by the need for escalation to mechanical ventilation.

The secondary outcomes included: Duration of NIPPV therapy; duration of stay on Mechanical ventilation. Total length of NICU stay. Development of complications (e.g., pulmonary hemorrhage, pneumothorax, systemic complications). Mortality.

The collected data were analyzed in statistical package for the Social Sciences (SPSS) version 26 for statistical analysis. The data were stratified on the basis of birth weight, mode of delivery, gender, and serum lactate levels. Cross-tabulation of these variables was done with no days on NIPPV, no days on mechanical ventilation, need for mechanical ventilation, development of complications, development of apnea, stay in NICU, and mortality. To see whether these variables affect each other significantly or not, the Chi-square test was used. A p -value less than or equal to 0.05 was taken to be statistically significant. Independent variables were birth weight, gestational age and mode of delivery, and dependent variables were effectiveness of NIPPV measured in the form of need for escalation to mechanical ventilation, Duration of NIPPV therapy, total duration of NICU stay, development of complications (pulmonary hemorrhage, pneumothorax, systemic complications), and outcome (mortality).

RESULTS

This study included a total of 102 neonates, out of which 55(53.9%) were male, and 47(46.1%) were female. 65(63.7%) Babies were born via LSCS while 37(36.3%) were born via SVD. The neonates were divided into three groups based on birth weight: > 2500 g, 1500–2500 g, and < 1500 g. Out of 102 Patients, 23(22.5%) were having Birth weight of > 2500 ,

64(62.7%) were having Birth weight 2500-1500 and 15(14.7%) were having Birth weight of 1500-1000. Out of total 23 Patients having Birth weight >2500, 11(47.8%) patients required NIPPV for <3 days, 11(47.8%) Patients required NIPPV for 3-7 days and 1(4.3%) patients required NIPPV for >7 days. Cross-tabulation of birth weight with different variables is

DISCUSSION

In this cross-sectional analytic study, 102 neonates with respiratory distress who were managed with NIPPV were included. The majority showed marked improvement on NIPPV without requiring mechanical ventilation. Neonates with birth weights >2500 g and normal lactate levels at presentation (<3

Table-I: Association of Birth Weight with NIPPV-Associated Dependent Outcome Variables (n=102)

Clinical Factor		Birth Weight (n=%)			Total (n=%)	p-value
		>2500 g 23 (22.5%)	2500- 1500 g 64 (62.7%)	1500-1000 g 15 (14.8%)	102 (100%)	
No. of Days on NIPPV	< 3 days	11 (10.8%)	22 (21.6%)	10 (9.8%)	43 (42.2%)	0.059
	3-7 days	11 (10.8%)	31 (30.5%)	2 (1.9%)	44 (43.1%)	
	7 days	1 (0.9%)	11 (10.8%)	3 (2.9%)	15 (14.6%)	
Need for Mechanical Ventilation after NIPPV	Required after NIPPV	1 (1.0%)	2 (2.0%)	1 (1.0%)	4 (3.9%)	< 0.001
	Not required after NIPPV	22 (21.5%)	62 (60.8%)	8 (7.8%)	92 (90.2%)	
	Went on Mechanical Ventilation before NIPPV Use	0 (0%)	0 (0%)	6 (5.8%)	6 (5.8%)	
No. of Days on Mechanical Ventilation	NA	22 (21.6%)	61 (59.8%)	8 (7.8%)	91 (89.2%)	< 0.001
	3-7 days	1 (0.9%)	3 (2.9%)	0 (0%)	4 (3.9%)	
	>7 days	0 (0%)	0 (0%)	7 (6.8%)	7 (6.8%)	
Development of Complications	NA	23 (22.5%)	62 (60.8%)	6 (5.8%)	91 (89.3%)	< 0.001
	Pulmonary Haemorrhage	0 (0%)	1 (0.9%)	3 (2.9%)	4 (3.9%)	
	Pneumothorax	0 (0%)	1 (0.9%)	2 (1.9%)	3 (2.9%)	
	Systemic Complications	0 (0%)	0 (0%)	4 (4%)	4 (3.9%)	
Development of Apnoea	Yes	0 (0%)	8 (7.8%)	3 (2.9%)	11 (10.8%)	0.116
	No	23 (22.5%)	56 (54.8%)	12 (11.8%)	91 (89.2%)	
Stay in days at NICU	<3	0 (0%)	8 (7.8%)	3 (2.9%)	19 (18.6%)	<0.001
	3-7	23 (22.5%)	56 (54.8%)	12 (11.8%)	52 (50.9%)	
	7-14	0 (0%)	8 (7.8%)	3 (2.9%)	26 (25.5%)	
	14-21	23 (22.5%)	56 (54.8%)	12 (11.8%)	5 (4.9%)	
Final Outcome	Discharge	23 (22.5%)	64 (62.7%)	10 (9.8%)	97 (95.1%)	<0.001
	Death	0 (0%)	0 (0%)	5 (5%)	5 (4.9%)	

*NIPPV - Nasal Intermittent Positive Pressure Ventilation, NICU - Neonatal Intensive Care Unit

given in Table-I.

Out of 65 patients born via LSCS, 24(36.9%) patients required NIPPV for <3 days, 29(44.6%) required NIPPV for 3-7 days and 12(18.4%) patients required NIPPV for >7 days. 6(9.2%) patients were directly intubated due to severe respiratory distress. Out of 37 patients born via SVD, 19(51.3%) patients required NIPPV for <3 days, 15(40.5%) required NIPPV for 3-7 days and 3(8.1%) patients required NIPPV for >7 days. Only 1(2.7%) patient required mechanical ventilation after NIPPV for 3 days; he was extubated successfully after 3 days and placed on NIPPV and then weaned off NIPPV within 3 days, while 36(97.2%) recovered with NIPPV. Cross-tabulation of mode of delivery with different variables is given in Table-II.

Neonates were divided into 3 main groups based on blood lactate levels. 24(23.5%) neonates out of a total of 102 patients had blood lactate levels <3; 50(49%) neonates had blood lactate levels between 3-5; and 28(27.4%) neonates had blood lactate levels >5. Cross-tabulation of serum lactate level with different variables is given in Table-II

mmol/L) had shorter NIPPV duration, fewer complications, shorter NICU stay, and no mortality. In contrast, neonates with birth weights <1500 g and elevated lactate levels (>5 mmol/L) were more likely to require mechanical ventilation, had longer NICU stay, higher complication rates, and all mortalities were observed in this group. Furthermore, neonates born via cesarean section had longer NIPPV duration and higher complication rates compared to those born via spontaneous vaginal delivery (SVD).

Respiratory distress has a significant role in causing neonatal mortality and morbidity, especially affecting preterm neonates born via caesarean section.¹⁰ This study highlights the importance of Nasal intermittent positive pressure ventilation (NIPPV) in neonates suffering from respiratory distress. This study reinforced the role of NIPPV in reducing the need for mechanical ventilation and hospital stay, preventing complications, and improving overall outcomes in neonates with respiratory distress. Neonates weighing >2500 g required NIPPV for a shorter duration; 100% recovered on NIPPV without transitioning to mechanical ventilation, with a 0% mortality rate. In

Positive Pressure Ventilation

Table-II: Association of Mode of Delivery with NIPPV-Associated Dependent Outcome Variables (n=102)

Clinical Factor		Mode of delivery (n=%)		Total (n=%)	p-Value
		LSCS 65 (63.7%)	SVD 37 (36.3%)	102 (100%)	
No. of Days on NIPPV	< 3 days	24 (23.5%)	19 (18.7%)	43 (42.2%)	0.226
	3-7 days	29 (28.4%)	15 (14.7%)	44 (43.1%)	
	7 days	12 (11.8%)	3 (2.9%)	15 (14.7%)	
Need for Mechanical ventilation after NIPPV.	Required after NIPPV	2 (1.9%)	2 (1.9%)	4 (3.9%)	0.145
	Not required after NIPPV	57 (55.9%)	35 (34.3%)	92 (90.2%)	
	Went on Mechanical Ventilation before NIPPV Use	6 (5.9%)	0 (0%)	6 (5.9%)	
No. of Days on Mechanical Ventilation	NA	56 (54.9%)	35 (34.3%)	91 (89.2%)	0.105
	3-7 days	2 (1.9%)	2 (1.9%)	4 (3.9%)	
	>7 days	7 (6.8%)	0	7 (6.8%)	
Development of Complications	NA	54 (52.9%)	37 (36.3%)	91 (89.3%)	0.071
	Pulmonary Haemorrhage	4 (3.9%)	0 (0%)	4 (3.9%)	
	Pneumothorax	3 (2.9%)	0 (0%)	3 (2.9%)	
	Systemic Complications	4 (3.9%)	0 (0%)	4 (3.9%)	
Development of Apnoea	Yes	7 (6.9%)	4 (3.9%)	11 (10.7%)	0.995
	No	58 (56.8%)	33 (32.3%)	91 (89.3%)	
Days stayed in NICU	<3	9 (8.8%)	10 (9.8%)	19 (18.6%)	0.028
	3-7	30 (29.4%)	22 (21.6%)	52 (50.9%)	
	7-14	21 (20.6%)	5 (4.9%)	26 (25.6%)	
	14-21	5 (4.9%)	0 (0%)	5 (4.9%)	
Final Outcome	Discharge	60 (58.8%)	37 (36.3%)	97 (95.1%)	0.210
	Death	5 (4.9%)	0 (0%)	5 (4.9%)	

*NIPPV - Nasal Intermittent Positive Pressure Ventilation, NICU - Neonatal Intensive Care Unit, LSCS - Lower Segment Cesarean Section, SVD - Spontaneous Vaginal Delivery, NA - Not Applicable

Table-III: Association of Blood Lactate Levels with NIPPV-associated Dependent Outcome Variables (n= 102)

Clinical Factor		Blood Lactate Levels at Presentation (n =%)			Total (n =%)	p-value
		<3 24 (23.5%)	3-5 50 (49%)	>5 28 (27.4%)	102 (100%)	
No. of Days on NIPPV	< 3 days	16 (15.6%)	18 (17.6%)	9 (8.8%)	43 (42.2%)	0.041
	3-7 days	8 (7.8%)	23 (22.5%)	13 (12.7%)	44 (43.1%)	
	7 days	0 (0%)	9 (8.8%)	6 (5.8%)	15 (14.6%)	
Need for Mechanical ventilation after NIPPV	Required after NIPPV	1 (0.9%)	1 (0.9%)	2 (1.9%)	4 (3.9%)	< 0.001
	Not required after NIPPV	23 (22.5%)	49 (48%)	20 (19.6%)	92 (90.2%)	
	Went on Mechanical Ventilation before NIPPV Use	0 (0%)	0 (0%)	6 (5.8%)	6 (5.8%)	
No. of Days on Mechanical Ventilation	NA	23 (22.5%)	48 (47.0%)	20 (19.6%)	91 (89.2%)	< 0.001
	3-7 days	1 (0.9%)	2 (1.9%)	1 (0.9%)	4 (3.9%)	
	>7 days	0 (0%)	0 (0%)	7 (6.8%)	7 (6.8%)	
Development of Complications	NA	24 (23.5%)	48 (47.0%)	19 (18.6%)	91 (89.3%)	0.003
	Pulmonary Haemorrhage	0 (0%)	0 (0%)	4 (3.9%)	4 (3.9%)	
	Pneumothorax	0 (0%)	1 (0.9%)	2 (1.9%)	3 (2.9%)	
	Systemic Complications	0 (0%)	1 (0.9%)	3 (2.9%)	4 (3.9%)	
Development of Apnoea	Yes	1 (0.9%)	4 (3.9%)	6 (5.8%)	11 (10.8%)	0.091
	No	23 (22.5%)	46 (45.1%)	22 (21.5%)	91 (89.2%)	
Stay in days at NICU	<3	9 (8.8%)	8 (7.8%)	2 (1.9%)	19 (18.6%)	<0.001
	3-7	12 (11.7%)	30 (29.4%)	10 (9.8%)	52 (50.9%)	
	7-14	3 (2.9%)	12 (11.7%)	11 (10.7%)	26 (25.6%)	
	14-21	0 (0%)	0 (0%)	5 (4.9%)	5 (4.9%)	
Final Outcome	Discharge	24 (23.5%)	50 (49.0%)	23 (22.5%)	97 (95.0%)	0.005
	Death	0 (0%)	0 (0%)	5 (4.9%)	5 (4.9%)	

*NIPPV - Nasal Intermittent Positive Pressure Ventilation, NICU - Neonatal Intensive Care Unit

contrast, neonates weighing 1500-1000 g required NIPPV for a longer duration, had persistent respiratory distress, ultimately landing on mechanical ventilation, having higher rates of pulmonary and systemic complications. A study conducted by Manley et al., showed similar results, showing better outcomes on NIPPV in neonates with higher birth weights.¹⁰ Similarly, another study conducted by Dumpa et al., supported our study results that neonates having extremely low birth weights suffer from systemic and pulmonary complications, prolonged ventilation, and higher mortality rates.¹¹

Our study showed that most neonates requiring NIPPV for their respiratory distress showed significant improvement without any transition to mechanical ventilation and fewer complications, highlighting the efficacy of NIPPV as a primary respiratory support, especially in neonates with birth weights of 1500-2500 g. Similar results were found in a study conducted by Lemyre *et al.*,⁵ and Barrington *et al.*,¹² which showed that early use of NIPPV significantly reduced the need for mechanical ventilation as compared to use of CPAP. Similarly, a study conducted by Ramaswamy *et al.*,⁶ demonstrated that NIPPV had better outcomes in neonates with

respiratory distress as compared to CPAP and high-flow nasal cannula (HFNC) in both initial management and post-extubation as well. These results were also supported by studies conducted by Sai *et al.*,¹³ and Tang *et al.*¹⁴

Those neonates whose blood lactate levels were elevated had increased need for mechanical ventilation, longer NICU stay, and higher rates of complications and mortality. All 5 mortalities in our study had blood lactate levels of >5 . Specifically, all five deaths in the study were among neonates with lactate levels >5 mmol/L. Similar to our study, Fernandez *et al.*, also described a correlation between serum lactate level and neonatal mortality. In their study, lactate levels more than 4.2 mmol/L were associated with higher neonatal mortality and morbidity.¹⁵ Chaudhry *et al.*, in their study, also observed high mortality among neonates with high lactate levels. All neonates with lactate levels more than 5.68 ± 1.22 did not survive. In our study too, all 5 neonates who died had a lactate level more than 5 mmol/L.¹⁶ Labastida *et al.*, also noted increased mortality and morbidity in neonates with lactate levels of more than 4 mmol/L.¹⁷

Our study found that neonates born via caesarean section suffered from higher complication rates, prolonged use of NIPPV, and need for mechanical ventilation as compared to those neonates born via SVD. All mortalities occurred in the LSCS group. These findings showed that cesarean delivery is a risk factor for transient tachypnea of the newborn (TTN) and other respiratory complications due to delayed lung fluid clearance.¹⁸

Our study showed no significant association between gender and NIPPV duration, complications, overall outcome, and mortality having findings similar to study by conducted by Lemyre *et al.*⁵ While some studies support an increased risk of respiratory complications in males due to delayed lung maturity in male neonates, our data did not reveal any significant difference in outcomes between male and female neonates.

LIMITATION OF STUDY

Our study is limited due to its small sample size, lack of long-term neurodevelopmental outcomes, and lack of comparisons between other respiratory support therapies. Larger multicenter studies with long-term follow-up are recommended.

CONCLUSION

Based on our findings, NIPPV proved to be highly effective in primary respiratory support therapy for

neonates, especially in those neonates who were born via SVD, whose birth weight was >1500 g, and blood lactate was normal. It significantly reduced the requirement for mechanical ventilation, reduced NICU stay, reduced complications, and overall mortality rate. For neonates weighing <1500 g, other respiratory therapies must be considered, including early intubation; however, it warrants further research.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SN & AK: Data acquisition, data analysis, critical review, approval of the final version to be published.

SAS & AR: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AM & SA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Positive Pressure Ventilation

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