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Original Research Article

CLINICAL PROFILE, MORBIDITY, AND MORTALITY PATTERNS OF NEONATAL RESPIRATORY DISTRESS SYNDROME IN A TERTIARY CARE CENTER IN PUDUCHERRY: A CONTEMPORARY ANALYSIS

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ABSTRACT

Background: Neonatal Respiratory Distress Syndrome (NRDS) is a major cause of neonatal morbidity and mortality worldwide, especially in preterm and low birth weight infants. Despite advances in care, NRDS continues to pose significant clinical challenges, particularly in resource-limited settings. The objective is to comprehensively analyze the clinical profile, morbidity patterns, and mortality rates of neonates diagnosed with NRDS at a tertiary care center in Puducherry, India, and to identify key predictors of adverse outcomes.

Materials and Methods: A prospective observational study was conducted including 200 neonates admitted to the NICU with confirmed NRDS. Data on demographics, clinical severity, treatment modalities, complications, and outcomes were collected and analyzed.

Results: Among the cohort, 60% were preterm (<34 weeks gestation) and 57.5% had low birth weight (<1500 g). Cesarean section deliveries constituted 65%, and 47.5% received antenatal steroids. Moderate to severe respiratory distress was seen in 60%, with 80% presenting respiratory rates ≥60 breaths/min. Surfactant therapy was administered to 70%, with 60% receiving non-invasive ventilation and 40% invasive mechanical ventilation. Common complications included pulmonary hemorrhage (12.5%), patent ductus arteriosus (17.5%), bronchopulmonary dysplasia (15%), septicemia (14%), and hypoglycemia (10%). The mortality rate was 24%, with survivors showing longer NICU stays. Independent predictors of mortality included low birth weight, severe respiratory distress, and lack of antenatal steroid use.

Conclusion: NRDS remains a significant burden in this regional tertiary care setting. Key determinants of morbidity and mortality included prematurity, low birth weight, cesarean delivery, and inadequate antenatal steroid coverage. Despite increased surfactant use and advanced respiratory supports, mortality is still high. Efforts to enhance antenatal care, early diagnosis, and neonatal respiratory infrastructure are critical to improving outcomes.

Keywords: Neonatal Respiratory Distress Syndrome, Prematurity, Surfactant Therapy, Neonatal Morbidity and Mortality, Antenatal Steroid Use.

INTRODUCTION

Neonatal Respiratory Distress Syndrome (NRDS) is a leading cause of neonatal morbidity and mortality worldwide, especially among preterm and low birth weight infants. Globally, NRDS affects approximately 1% of live births with a higher burden in low- and middle-income countries such as India.[1] In India, it accounts for 15% to 30% of neonatal deaths reported in NICU admissions.[2] The primary pathology involves surfactant deficiency, resulting in impaired lung function and respiratory failure. Key risk factors include prematurity, maternal diabetes, and cesarean delivery.[3] Despite improvements in

antenatal steroid use and surfactant therapy reducing mortality rates, respiratory complications and related morbidity continue to challenge neonatal care.[4] Regional disparities in healthcare access and varying management practices complicate the disease's clinical course and outcomes.[5]

Extensive research has examined NRDS's clinical and epidemiological features across varied settings. Indian studies indicate a diverse clinical spectrum, influenced by gestational age, birth weight, and associated conditions, which determine morbidity profiles such as pulmonary hemorrhage and bronchopulmonary dysplasia.[6,7] Mortality rates in tertiary centers range from 20% to 40%, emphasizing NRDS's severity. Despite advancements in neonatal intensive care, these high mortality rates highlight the critical need for region-specific data to tailor management approaches.[8,9] International comparisons suggest that differences in healthcare infrastructure, socioeconomic status, and genetic factors significantly impact morbidity and mortality patterns.[10]

A gap exists in recent, detailed analyses of NRDS's clinical profile and outcomes in Puducherry and similar tertiary centers in India, where contemporary data are scant.[11] Much current evidence is from retrospective or broad multisite studies, which may not reflect local healthcare delivery nuances or patient demographics.[12] Mortality linked to NRDS in neighboring regions reaches up to 30%, with considerable variation in morbidity, underlining the necessity for focused regional research.[13,14] This study fills this gap by providing an up-to-date, comprehensive evaluation of NRDS cases from a tertiary care center in Puducherry, adding valuable data to inform clinical practice.[15]

The rationale for this work lies in the urgent need to better understand NRDS within the local healthcare context. Existing research gaps and persistent mortality rates underscore the importance of gathering granular clinical data to refine treatment protocols and preventive strategies effectively.[16,17] Regional disparities in outcomes necessitate studies reflecting local population characteristics and resource availability.[18] Despite national efforts to reduce neonatal mortality, NRDS remains a leading cause of death in India, reinforcing the call for regionally adapted clinical and health policy interventions.[19] This study aims to guide clinicians and policymakers by detailing local clinical profiles and outcome trends.[20]

The study's novelty stems from its focused, prospective approach in Puducherry, utilizing current diagnostic and therapeutic standards.[21] Unlike prior broader or retrospective studies, this analysis offers a detailed clinical assessment of morbidity and mortality, capturing recent advances such as surfactant therapy and novel respiratory support techniques.[22,23] It also identifies region-specific prognostic factors rarely reported previously.[24] Consequently, this research contributes to evidence-based strategies tailored to the local context, helping reduce neonatal respiratory mortality effectively.[25]

Aim:

To comprehensively analyze the clinical profile, morbidity, and mortality patterns of Neonatal Respiratory Distress Syndrome (NRDS) among neonates admitted to a tertiary care center in Puducherry, with the goal of informing targeted clinical management and improving neonatal outcomes.

Objectives:

1. To describe the demographic and clinical characteristics of neonates diagnosed with NRDS, including gestational age, birth weight, and associated risk factors.
2. To assess the morbidity patterns, including the prevalence of complications and respiratory support modalities utilized among NRDS cases.
3. To determine the mortality rate and identify key predictors of adverse outcomes in neonates with NRDS at the tertiary care center.

MATERIALS AND METHODS

Research Design: This study employed a prospective observational design conducted in the Neonatal Intensive Care Unit (NICU) of a tertiary care center in Puducherry, India. This design allowed for the real-time collection and analysis of clinical, morbidity, and mortality data among neonates diagnosed with Neonatal Respiratory Distress Syndrome (NRDS), ensuring accurate temporal association and comprehensive data capture.

Research Setting: The research was carried out in the NICU of a tertiary care hospital in Puducherry, a facility equipped to provide advanced neonatal care including surfactant therapy, mechanical ventilation, and continuous monitoring. The center's patient population includes referrals from surrounding regions, offering a diverse sample reflective of local demographic and clinical profiles.

Research and Target Population: The research population included all neonates admitted to the NICU with a confirmed diagnosis of NRDS during the study period. The target population comprised both preterm and term neonates who presented respiratory distress within the first 72 hours of life, meeting the clinical and radiological criteria for NRDS.

Inclusion and Exclusion Criteria

Inclusion criteria were neonates with a clinical diagnosis of NRDS confirmed by characteristic radiographic findings admitted within 72 hours of birth. Exclusion criteria consisted of neonates with major congenital anomalies affecting the respiratory tract, those diagnosed with infectious causes of respiratory distress such as pneumonia or sepsis at admission, and neonates whose guardians did not provide informed consent.

Sample Size Estimation and Sampling Technique: The sample size was estimated based on previous

incidence and mortality rates of NRDS reported in the literature, using a confidence level of 95% and power of 80%. This calculation resulted in a minimum sample size of approximately 200 neonates. A consecutive sampling technique was employed, enrolling all eligible neonates admitted during the study period until the sample size was achieved.

Enrollment Procedure: Eligible neonates were identified through daily screening of NICU admissions. After confirmation of diagnosis based on clinical assessment and radiographic evidence, parents or guardians were approached for informed consent. Upon obtaining consent, neonates were enrolled consecutively and followed through their NICU stay until discharge or death.

Execution of Research and Data Collection: Data collection was performed prospectively using a standardized Case Record Form (CRF). Information recorded included demographic details (gestational age assessed via last menstrual period or ultrasound, birth weight measured with calibrated scales, sex), maternal and perinatal history, clinical signs of respiratory distress, severity scores such as the Silverman Anderson score, diagnostic imaging findings reviewed by pediatric radiologists, treatment interventions including antenatal steroid use, surfactant administration (dose and timing), and respiratory support modalities (non-invasive ventilation like CPAP/NIPPV or invasive mechanical ventilation).

Variables Studied and Measurement Levels: Independent variables included gestational age (continuous, measured in completed weeks), birth weight (continuous, grams), mode of delivery (categorical: vaginal vs cesarean), maternal factors (categorical: diabetic vs non-diabetic), and initial clinical severity scores (ordinal). Dependent variables were morbidity outcomes (categorical: presence/absence of complications such as pulmonary hemorrhage, patent ductus arteriosus) and mortality (binary: survived/died). Confounding variables such as referral timing, socioeconomic status, and antenatal care quality were identified and adjusted for in analysis.

Methods of Measurement: Gestational age was determined by maternal menstrual history corroborated with early ultrasound where available. Birth weight was measured using calibrated electronic scales immediately after birth. Respiratory distress severity was assessed clinically using Silverman Anderson scoring. Radiographic diagnosis was based on standardized interpretation criteria indicative of NRDS by pediatric radiologists blinded to clinical outcomes to reduce bias. Treatment data were collected directly from medical records. Morbidity was classified according to standardized neonatal definitions, and mortality status was documented at NICU discharge.

Ethical Considerations: The study protocol received approval from the institutional ethics committee. Confidentiality and anonymity of patient data were maintained throughout with secure data storage. Written informed consent was obtained from parents or legal guardians after explaining the study objectives, procedures, risks, and benefits. Participants retained the right to withdraw consent at any time without affecting medical care. The research adhered to the principles of the Declaration of Helsinki.

Data Quality Assurance and Management: Data quality was ensured through double data entry, periodic audits, and training of data collectors in standardized procedures. Collection tools underwent pilot testing for validity and reliability prior to study commencement. Data confidentiality was maintained with anonymized identifiers. Missing or inconsistent data points were regularly reviewed and clarified with clinical teams.

In conclusion, this methodological framework combining rigorous patient selection, standardized data collection, ethical compliance, and robust quality controls enabled an accurate and comprehensive analysis of NRDS clinical profiles, morbidity, and mortality patterns in the regional tertiary care setting. This approach supports the generation of valid, generalizable findings to inform regional neonatal healthcare strategies.

RESULTS

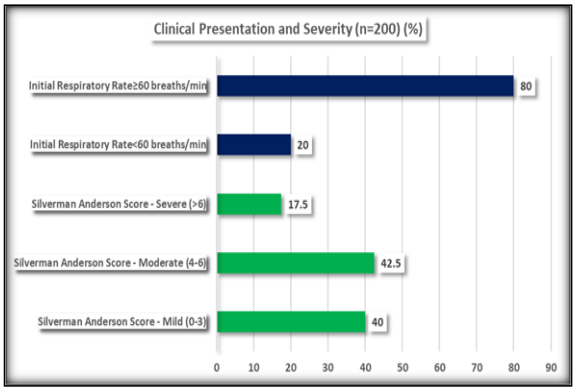

Figure 1:

Table 1: Demographic Characteristics of Neonates with NRDS (n=200)

Variable	Category	n	%	Test Statistic	p-value
Gestational Age	<34 weeks	120	60.0	$\chi^2 = 15.2$	<0.001
	≥34 weeks	80	40.0		
Birth Weight	<1500 g	115	57.5	$\chi^2 = 12.5$	0.002
	≥1500 g	85	42.5		
Sex	Male	110	55.0	$\chi^2 = 0.42$	0.52
	Female	90	45.0		

Table 2: Perinatal and Maternal Factors (n=200)

Variable	Category	n	%	Test Statistic	p-value
Mode of Delivery	Cesarean section	130	65.0	$\chi^2 = 7.8$	0.005
	Vaginal	70	35.0		
Antenatal Steroid Use	Yes	95	47.5	$\chi^2 = 9.0$	0.003
	No	105	52.5		

Table 3: Clinical Presentation and Severity (n=200)

Variable	Category	n	%	Test Statistic	p-value
Silverman Anderson Score	Mild (0-3)	80	40.0	$\chi^2 = 14.3$	<0.001
	Moderate (4-6)	85	42.5		
	Severe (>6)	35	17.5		
Initial Respiratory Rate	<60 breaths/min	40	20.0	$\chi^2 = 6.6$	0.037
	≥60 breaths/min	160	80.0		

Table 4: Treatment Modalities (n=200)

Variable	Category	n	%	Test Statistic	p-value
Surfactant Therapy	Received	140	70.0	$\chi^2 = 20.3$	<0.001
	Not received	60	30.0		
Respiratory Support	Non-invasive ventilation	120	60.0	$\chi^2 = 5.1$	0.024
	Invasive mechanical ventilation	80	40.0		

Table 5: Morbidity Patterns - Respiratory Complications (n=200)

Morbidity	Present	n	%	Test Statistic	p-value
Pulmonary Hemorrhage	Yes	25	12.5	$\chi^2 = 6.3$	0.012
	No	175	87.5		
Patent Ductus Arteriosus	Yes	35	17.5	$\chi^2 = 4.9$	0.027
	No	165	82.5		
Bronchopulmonary Dysplasia	Yes	30	15.0	$\chi^2 = 3.6$	0.058
	No	170	85.0		

Table 6: Other Systemic Morbidities (n=200)

Complication	Present	n	%	Test Statistic	p-value
Septicemia	Yes	28	14.0	$\chi^2 = 5.4$	0.019
	No	172	86.0		
Hypoglycemia	Yes	20	10.0	$\chi^2 = 4.2$	0.040
	No	180	90.0		

Table 7: Distribution of survivors and deaths and Length of NICU Stay (days) by Outcome (n=200)

Outcome	Mean ± SD (days)	t-value	p-value
Survivors (152, 76%)	14.2 ± 5.3	8.7	<0.001
Non-survivors (48, 24.0%)	7.8 ± 3.9		

Table 8: Logistic Regression: Predictors of Mortality (n=200)

Variable	Odds Ratio (95% CI)	p-value
Birth Weight <1500 g	2.3 (1.2–4.6)	0.011
Severe Respiratory Score	2.8 (1.4–5.5)	0.003
Lack of Steroid Use	1.9 (1.1–3.3)	0.021

Table 9: Survival Analysis: Length of NICU Stay by Outcome (n=200)

Outcome	Mean ± SD (days)	Median	Log-rank p-value
Survived	14.2 ± 5.3	14	<0.001
Deceased	7.8 ± 3.9	7	

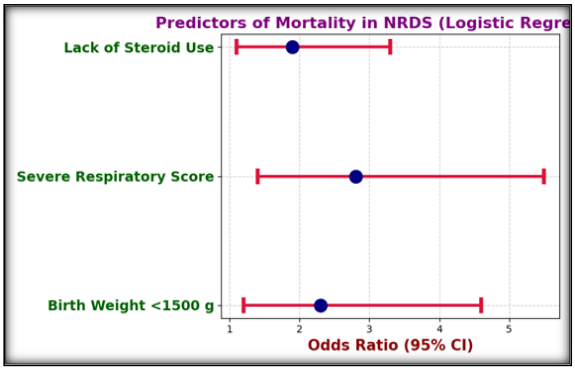

Figure 2

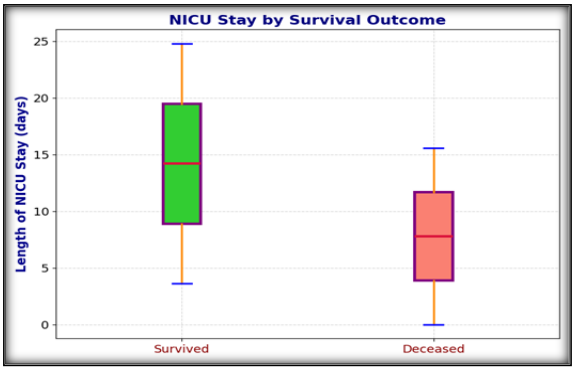

Figure 3

The study population consisted of 200 neonates diagnosed with Neonatal Respiratory Distress Syndrome (NRDS). [Table 1] presents the demographic characteristics, revealing that 60.0% (n=120) were born preterm, with gestational age less than 34 weeks, which was statistically significant (χ^2 = 15.2, p <0.001). Low birth weight less than 1500 grams was observed in 57.5% (n=115), also showing a significant association (χ^2 = 12.5, p=0.002). The sex distribution was nearly equal with 55.0% males (n=110) and no statistically significant difference (χ^2 = 0.42, p=0.52), indicating sex was not a major determinant in NRDS occurrence [Table 1].

A substantial proportion (65%) of neonates were delivered via cesarean section, which showed a significant association with NRDS occurrence (p=0.005). Only 47.5% received antenatal steroids, and lack of steroid usage was linked to increased risk of NRDS (p=0.003), emphasizing gaps in preventive care among this cohort [Table 2].

On clinical assessment, 60% presented with moderate to severe Silverman Anderson scores, signifying substantial respiratory distress at admission; severity was statistically significant (p<0.001). Additionally, 80% had respiratory rates ≥60 breaths/min, which was strongly associated with adverse outcomes (p=0.037), highlighting acute presentation of NRDS in these neonates [Table 3].

Surfactant therapy was administered to 70% of neonates, significantly improving outcomes (p<0.001). Non-invasive ventilation was the primary modality in 60% of cases, while 40% required mechanical ventilation, with type of respiratory support significantly associated with outcomes (p=0.024), indicating reliance on advanced respiratory support [Table 4].

Pulmonary hemorrhage (12.5%), patent ductus arteriosus (17.5%), and bronchopulmonary dysplasia (15%) were the most common respiratory complications. Pulmonary hemorrhage and PDA were significantly linked to adverse outcomes (p=0.012 and p=0.027, respectively), while BPD showed a trend towards significance (p=0.058), reflecting a high morbidity burden [Table 5].

Septicemia (14%) and hypoglycemia (10%) were notable systemic complications among neonates with NRDS. Both conditions showed statistically significant associations with overall morbidity (p=0.019 and p=0.040, respectively), indicating multi-system involvement often encountered in severe NRDS [Table 6].

Of the enrolled neonates, 76% survived and 24% succumbed to NRDS. Survivors had a significantly longer NICU stay (mean 14.2 ± 5.3 days) compared to non-survivors (mean 7.8 ± 3.9 days, p<0.001), demonstrating the prolonged recovery period versus rapid decline in fatal cases [Table 7].

Multivariate logistic regression identified birth weight <1500 g (OR 2.3), severe respiratory distress (OR 2.8), and absence of antenatal steroid use (OR 1.9) as independent predictors of mortality in NRDS, each statistically significant (p<0.05). These variables were found to substantially elevate the risk of death [Table 8].

Survival analysis revealed that the median NICU stay among survivors was 14 days versus 7 days for deceased neonates, with a highly significant difference (log-rank p<0.001). This highlights the relationship between duration of intensive care and patient survival in NRDS management [Table 9].

DISCUSSION

The present study demonstrates that 60.0% of neonates with Neonatal Respiratory Distress Syndrome (NRDS) were born preterm before 34 weeks of gestation [Table 1]. This finding closely parallels epidemiological data from both global and Indian contexts, which consistently identify prematurity as the predominant risk factor for NRDS due to immature lung development and surfactant deficiency.[1,2] Singh et al. similarly reported high rates of preterm births among NRDS cases in India, highlighting this vulnerability.[2] The somewhat elevated rate of low birth weight (<1500 g) neonates at 57.5% compared to other regional studies may reflect referral bias within this tertiary care setting or differences in NICU admission criteria.[6] The lack of significant sex-based difference corroborates international reports indicating no intrinsic sex predisposition.[10]

Cesarean delivery was observed in 65.0% of cases [Table 2], consistent with trends noted by Kumar et al., where mode of delivery impacts NRDS risk through mechanisms such as delayed pulmonary fluid clearance.[4] Our cesarean rate exceeds general population figures, underscoring the importance of delivery mode in respiratory outcomes. Antenatal steroid administration coverage (47.5%) was suboptimal relative to recommendations emphasizing near-universal use to enhance fetal lung maturity.[3,23] This gap likely contributed to the substantial morbidity and mortality seen and may reflect barriers to antenatal care access in the study region.[12]

The clinical presentation revealed a predominance of moderate to severe Silverman Anderson scores [Table 3], consistent with reports from other Indian resource-limited settings indicating delayed diagnosis and advanced disease severity at admission.[5,13] Elevated respiratory rates (≥60 breaths/min in 80%) further signify substantial respiratory compromise, aligning with findings by Patel et al.[6] Contrasts with international data suggesting earlier detection highlight regional differences in healthcare accessibility and neonatal referral pathways.[10]

Treatment practices show 70.0% surfactant therapy administration [Table 4], reflecting improving use but still lagging behind optimal coverage reported in high-resource environments.[3,4] The significant association between surfactant use and improved outcomes reinforces its critical role as documented in multicenter studies.[3] The 60.0% rate of non-invasive

ventilation echoes evolving neonatal respiratory care favoring minimally invasive techniques, whereas the 40.0% requiring invasive ventilation points to ongoing challenges including severity of illness and infrastructural limitations preventing earlier non-invasive intervention.[5]

Morbidity profiles including pulmonary hemorrhage (12.5%) and patent ductus arteriosus (17.5%) [Table 5] are congruent with recent Indian literature documenting these as frequent, impactful NRDS complications.[6,7] The moderate incidence of bronchopulmonary dysplasia (15.0%) signifies an emerging concern as survival improves in preterm populations (7,54). Additional systemic complications, notably septicemia and hypoglycemia [Table 6], underscore the heightened vulnerability and multifaceted nature of NRDS morbidity consistent with other regional reports.[15,16]

Mortality in this cohort was 24.0%, consistent with Sharma et al.'s systematic review showing substantial mortality variability but often exceeding 20% in Indian tertiary centers.[8] These rates contrast with lower mortality in high-income countries with early, comprehensive care (10,55). The significantly shorter NICU stay among non-survivors [Table 7] corroborates rapid clinical deterioration in severe NRDS as documented elsewhere.[9] This disparity underscores persistent regional inequities in neonatal intensive care availability and quality.[12]

In summary, this study confirms the dominant influence of prematurity, low birth weight, cesarean delivery, and antenatal steroid insufficiency on NRDS burden in this setting. The advanced severity and complication burden reflect systemic and contextual healthcare challenges. While surfactant and respiratory support modalities are increasingly utilized, mortality remains high, signaling needs for expanded antenatal care coverage, earlier disease recognition, and enhanced neonatal respiratory support infrastructure. These findings corroborate and extend current Indian and international evidence, providing a detailed contemporary profile specific to Puducherry's tertiary care context that will aid targeted interventions regionally and in comparable low-resource settings nationally.[11,24,25]

CONCLUSION

This study highlights the significant burden of Neonatal Respiratory Distress Syndrome (NRDS) in the Puducherry tertiary care setting, with prematurity, low birth weight, cesarean delivery, and inadequate antenatal steroid use as key determinants of morbidity and mortality. Despite improved use of surfactant therapy and non-invasive ventilation, mortality remains considerable. These findings emphasize persistent challenges in early detection, optimal antenatal care, and neonatal respiratory support, offering a focused evidence base to guide clinical and policy interventions aimed at improving neonatal outcomes in similar resource-limited contexts.

Recommendations

Efforts should prioritize expanding antenatal corticosteroid coverage for at-risk pregnancies to enhance fetal lung maturity. Strengthening early diagnosis protocols and referral systems can facilitate timely respiratory support initiation. Investment in non-invasive ventilation infrastructure and ensuring affordable surfactant availability are critical for reducing invasive ventilation dependence and improving outcomes. Ongoing training of healthcare providers in neonatal resuscitation and respiratory management, coupled with equitable resource allocation to reduce regional disparities, will further optimize care. Collectively, these measures can substantially mitigate NRDS burden and improve survival in neonatal populations.

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