

Risk Factors, Clinical Profile and Outcome of Respiratory Distress in Neonates Admitted to a Neonatal Intensive Care Unit: A Hospital-Based Observational Study

Nirma Bishnoi¹, Hemant Jain², Sushil Gupta³, Sapna Dhakar⁴

¹ Junior Resident, Department of Pediatrics, Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India

² Professor, Department of Pediatrics, Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India

³ Associate Professor and Head, Department of Neonatology, Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India

⁴ Junior Resident, Department of Pediatrics, Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India

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Corresponding Author: Dr. Nirma Bishnoi

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Abstract:

Background: Respiratory distress is one of the commonest emergencies in the neonatal period and a major cause of admission to neonatal intensive care units (NICU). This study evaluated the risk factors, clinical profile, etiological spectrum and outcome of respiratory distress in inborn neonates admitted to a tertiary care NICU.

Methods: A hospital-based descriptive observational study was conducted in the NICU of a tertiary care teaching hospital in Udaipur, Rajasthan, over 18 months. Eighty-five consecutive inborn neonates with respiratory distress were enrolled. Severity was graded using the Silverman–Anderson score for preterm and the Downes score for term neonates. Perinatal risk factors, etiology, respiratory support, duration of stay and mortality were recorded. Associations were tested using the chi-square test, with $p < 0.05$ considered significant.

Results: Preterm neonates constituted 63.5% of the cohort, and 63.0% weighed below 2.5 kg. Respiratory distress syndrome (RDS) was the commonest etiology (47.1%), occurring predominantly in preterm neonates (36/40), followed by transient tachypnoea of the newborn (31.8%), mostly in term neonates. Moderate distress was the commonest severity grade (43.5%). Caesarean delivery (90.7% vs 58.1%; $p < 0.01$), maternal hypertension and gestational diabetes were more frequent among preterm deliveries. Continuous positive airway pressure was the commonest support (60/85), and invasive ventilation was required almost exclusively by preterm neonates with RDS. RDS was associated with the longest respiratory support (7.65 ± 5.54 days) and hospital stay (17.30 ± 1.07 days). Overall mortality was 4.7%, confined to preterm neonates with RDS.

Conclusion: Respiratory distress in this NICU cohort was driven mainly by prematurity and RDS, with low birth weight, caesarean delivery and maternal morbidity as important associated factors. Mortality was low and confined to preterm RDS, underscoring the value of antenatal optimisation, early non-invasive support and timely referral.

Keywords: Neonatal Respiratory Distress; Respiratory Distress Syndrome; Preterm; Neonatal Intensive Care Unit; Silverman Score; Downes Score.

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Introduction

Respiratory distress is one of the most common emergencies encountered in the neonatal period and remains a major cause of neonatal morbidity and mortality worldwide. It arises when a newborn is unable to maintain adequate ventilation and gas exchange after birth, producing tachypnoea, chest retractions, nasal flaring, grunting and cyanosis.[1] Successful transition to extrauterine life requires

rapid clearance of fetal lung fluid, establishment of functional residual capacity and a fall in pulmonary vascular resistance; disruption of any of these processes can precipitate respiratory compromise.[2]

The etiology is diverse and includes respiratory distress syndrome (RDS), transient tachypnoea of

the newborn (TTNB), meconium aspiration syndrome (MAS), pneumonia and pneumothorax, as well as extrapulmonary causes.[3] RDS in particular remains a leading contributor to early neonatal death, especially in preterm and low-resource settings, where access to surfactant, oxygen and ventilatory support may be limited.[4][5]

Advances in perinatal care—antenatal corticosteroids for women at risk of preterm birth, early non-invasive respiratory support and surfactant replacement—have substantially improved outcomes, and contemporary consensus guidelines emphasise a structured approach to the preterm infant with RDS.[6][7] Continuous positive airway pressure, in particular, reduces the need for mechanical ventilation and mortality in preterm infants with respiratory distress.[8]

Despite these advances, respiratory distress continues to account for a large share of NICU admissions, and its risk factors, clinical profile and outcomes vary with local case-mix and referral patterns. Characterising this spectrum in a given setting is important for anticipating support needs and directing preventive effort. The present study was therefore undertaken to evaluate the risk factors, clinical profile, etiological spectrum and outcome of respiratory distress in inborn neonates admitted to the NICU of a tertiary care teaching hospital.

Methods

Design and Setting: This hospital-based descriptive observational study was conducted in the Neonatal Intensive Care Unit, Department of Pediatrics, Geetanjali Medical College and Hospital, Udaipur, Rajasthan, over an 18-month period after ethical clearance. Written informed consent was obtained from a parent or guardian of each neonate before enrolment.

Participants and Sampling: All consecutive inborn neonates who developed respiratory distress during the study period were enrolled. Outborn neonates and those whose parents declined consent were excluded. The sample size was calculated using the formula $N = (Z_{1-\alpha/2} + Z_{1-\beta})^2 P(1-P)/E^2$, taking an expected prevalence (P) of 8%, 95% confidence ($Z_{1-\alpha/2} = 1.96$), 80% power ($Z_{1-\beta} = 0.8413$) and

absolute error (E) of 10%, giving a minimum of 58; a total of 85 eligible neonates were enrolled and analysed.

Instruments and Data Collection: Clinical and demographic details of all neonates were recorded on a pre-structured proforma. Weight was measured on an electronic scale and maturity assessed using the New Ballard Score. Severity of respiratory distress was graded using the Downes score in term neonates (respiratory rate, chest indrawing, grunting, air entry and cyanosis; total 0–10, categorised as ≤ 3 mild, 4–5 moderate, ≥ 6 severe) and the Silverman–Anderson score in preterm neonates (upper- and lower-chest retraction, xiphoid retraction, nasal flaring and grunting; total 0–10, categorised as 0–3 mild, 4–6 moderate, > 6 severe).

Complete blood count, C-reactive protein, blood culture and chest radiography were performed, and neonates were managed according to the unit protocol. Oxygen was delivered by nasal prongs or continuous positive airway pressure (CPAP), and mechanical ventilation and surfactant were used when indicated. All neonates were examined daily until discharge or death, and mortality and duration of hospital stay were documented.

Data Analysis: Data were entered in Microsoft Excel and analysed using SPSS version 20. Continuous variables were summarised as mean $\pm$ standard deviation and categorical variables as frequencies and percentages. Associations between categorical variables were tested using the chi-square test, with a p-value < 0.05 considered statistically significant.

Results

Demographic and Perinatal Profile: Eighty-five inborn neonates with respiratory distress were enrolled. Preterm neonates constituted nearly two-thirds of the cohort (54; 63.5%) and term neonates 36.5% (Table 1). Birth weight was strongly related to gestational age ($p < 0.01$); among preterm neonates the majority (57.4%) weighed 1.5–2.5 kg and 25.9% weighed 1–1.5 kg, whereas most term neonates (67.7%) weighed above 2.5 kg and none below 1.5 kg. Overall, low birth weight (< 2.5 kg) was present in about two-thirds of the cohort.

Table 1: Distribution of birth weight by gestational age (N = 85).

Birth weight	Preterm n (%)	Term n (%)
<1 kg	3 (5.6)	0 (0)
1–1.5 kg	14 (25.9)	0 (0)
1.5–2.5 kg	31 (57.4)	10 (32.3)
>2.5 kg	6 (11.1)	21 (67.7)
Total	54 (100)	31 (100)

Note: $p < 0.01$ (chi-square test).

Mode of delivery differed significantly by gestational age ($p < 0.01$): caesarean section accounted for 90.7% of preterm and 58.1% of term

deliveries, reflecting the high-risk nature of preterm pregnancies. Oxytocin was administered in 41.9% of term versus 9.3% of preterm deliveries ($p = 0.01$),

consistent with more frequent induction or augmentation at term.

Maternal risk factors and obstetric history:

Maternal risk factors were more frequent among preterm deliveries (Table 2). No identifiable maternal risk factor was present in 38 mothers (14 preterm, 24 term). Hypertension was the commonest

maternal condition (17 cases; 25.9% of preterm vs 9.7% of term), followed by gestational diabetes mellitus (13 cases; 20.4% vs 6.5%). Premature rupture of membranes, oligohydramnios and other conditions occurred less frequently. Obstetric history showed a near-equal split of primigravida (48.2%) and multigravida (51.8%) mothers, with multiparous women predominating (71.8%).

Table 2: Distribution of maternal risk factors by gestational age (N = 85).

Maternal risk factor	Preterm n (%)	Term n (%)	Total
None	14 (25.9)	24 (77.4)	38
Hypertension	14 (25.9)	3 (9.7)	17
Gestational diabetes	11 (20.4)	2 (6.5)	13
PROM	4 (7.4)	1 (3.2)	5
Oligohydramnios	4 (7.4)	0 (0)	4
Others	7 (13.0)	1 (3.2)	8

Note: PROM = premature rupture of membranes.

Etiology and severity of respiratory distress:

Respiratory distress syndrome (RDS) was the commonest etiology, accounting for 40 of 85 neonates (47.1%), and occurred predominantly in preterm neonates (36/40; 90.0%). Transient tachypnoea of the newborn (TTNB) was next (27; 31.8%), mostly in term neonates (18/27), followed

by meconium aspiration syndrome (8.2%), pneumothorax (7.1%) and pneumonia (5.9%) (Table 3, Figures 1 and 2). By severity, moderate distress was commonest (37; 43.5%), followed by mild (28; 32.9%) and severe (20; 23.5%); severe distress was more frequent among preterm (27.8%) than term (16.1%) neonates (Figure 3).

Table 3: Etiology of respiratory distress by gestational age (N = 85).

Etiology	Preterm n (%)	Term n (%)	Total n (%)
RDS	36 (66.7)	4 (12.9)	40 (47.1)
TTNB	9 (16.7)	18 (58.1)	27 (31.8)
MAS	2 (3.7)	5 (16.1)	7 (8.2)
Pneumothorax	4 (7.4)	2 (6.5)	6 (7.1)
Pneumonia	3 (5.6)	2 (6.5)	5 (5.9)
Total	54 (100)	31 (100)	85 (100)

Note: RDS = respiratory distress syndrome; TTNB = transient tachypnoea of the newborn; MAS = meconium aspiration syndrome.

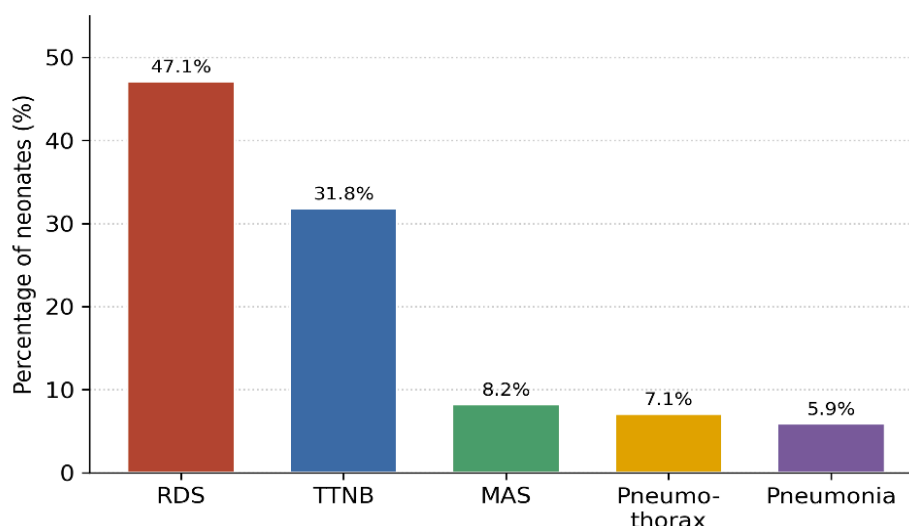


Figure 1: Distribution of etiology of respiratory distress (N = 85).

Note: RDS was the commonest etiology overall.

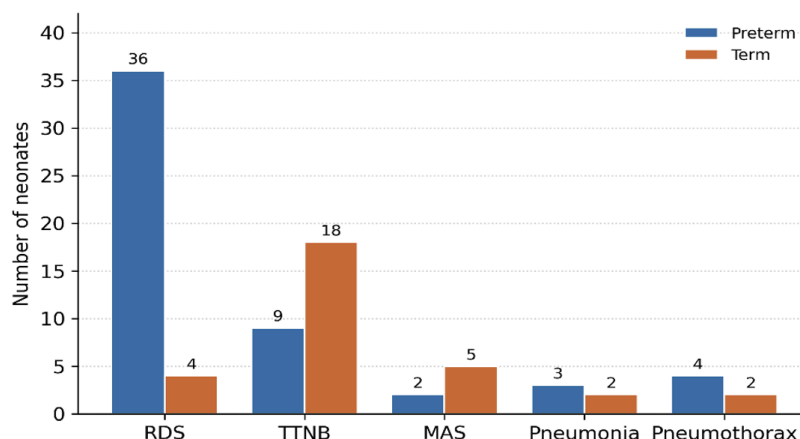


Figure 2: Etiology of respiratory distress by gestational age.

Note: RDS predominated among preterm and TTNB among term neonates.

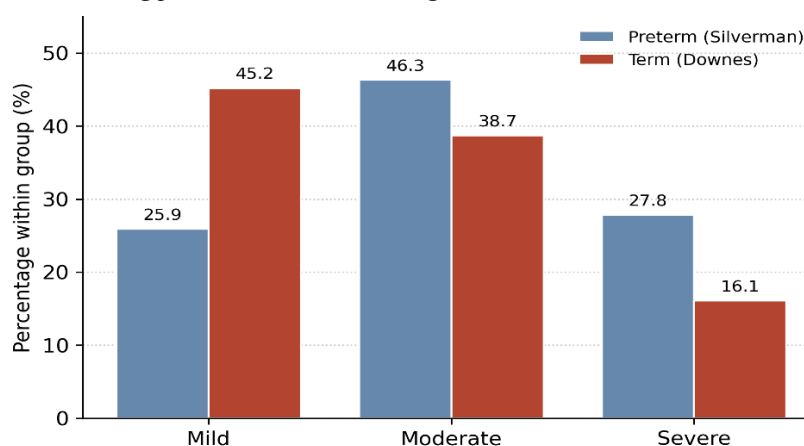


Figure 3: Severity of respiratory distress by gestational age.

Note: Severity graded by Silverman–Anderson score (preterm) and Downes score (term).

APGAR scores: Neonates with RDS had the highest proportion of low 1-minute APGAR scores (<7), seen in 26 of 40 (65.0%), whereas most neonates with TTNB, MAS, pneumonia and pneumothorax had scores ≥ 7 . A marked improvement was observed by 5 minutes: 90.0% of RDS neonates achieved an APGAR ≥ 7 , and all neonates with TTNB, pneumonia and pneumothorax scored ≥ 7 , indicating good response to resuscitation across etiologies.

Respiratory Support and Outcome: Non-invasive support was used in 75 neonates and invasive ventilation in 10, the latter almost exclusively in preterm neonates with RDS. CPAP was the commonest modality (60/85), used more often in preterm neonates, while high-flow nasal cannula was used more in term neonates and mechanical ventilation predominantly in preterm neonates; the association between gestational age and type of support was significant ($\chi^2 = 10.7$, $p = 0.01$) (Table 4). Surfactant was administered exclusively to neonates with RDS (9 cases, mostly preterm).

Table 4: Type of respiratory support by gestational age (N = 85).

Support	Preterm n (%)	Term n (%)	Total
CPAP	42 (70.0)	18 (30.0)	60
HFNC	6 (37.5)	10 (62.5)	16
MV	6 (85.7)	1 (14.3)	7
Nasal prongs	0 (0)	2 (100)	2

Note: $\chi^2 = 10.7$, $p = 0.01$; CPAP = continuous positive airway pressure; HFNC = high-flow nasal cannula; MV = mechanical ventilation.

The duration of respiratory support and hospital stay varied by etiology (Table 5). RDS required the longest respiratory support (7.65 ± 5.54 days) and the longest hospital stay (17.30 ± 1.07 days),

followed by pneumothorax and MAS, while TTNB and pneumonia needed the shortest. Across all etiologies, preterm neonates required longer support and stay than term neonates. Overall mortality was

4.7% (4/85), occurring exclusively among preterm neonates with RDS; no deaths occurred in the other etiological groups.

Table 5: Mean duration of respiratory support and hospital stay by etiology (days).

Etiology	Respiratory support	Hospital stay
RDS	7.65 ± 5.54	17.30 ± 1.07
TTNB	2.52 ± 1.28	3.56 ± 1.84
MAS	3.43 ± 1.90	7.29 ± 3.49
Pneumonia	2.00 ± 0.71	4.93 ± 1.45
Pneumothorax	5.50 ± 2.88	11.67 ± 8.65

Note: Values are mean ± SD.

Discussion

In this cohort of 85 inborn neonates with respiratory distress, prematurity and respiratory distress syndrome dominated the clinical picture, with low birth weight, caesarean delivery and maternal morbidity as important associated factors. Non-invasive support sufficed for most neonates, and mortality was low and confined to preterm neonates with RDS. These findings characterise the burden and outcome of neonatal respiratory distress in a tertiary care setting.

The predominance of preterm and low-birth-weight neonates is consistent with the recognised epidemiology of neonatal respiratory morbidity, in which structural and functional lung immaturity and surfactant deficiency render preterm infants highly susceptible.[9] The male predominance frequently reported in such cohorts is thought to reflect relatively delayed pulmonary maturation in males, although experimental data suggest the disadvantage relates more to physiological adaptation at birth than to gross differences in lung structure.[10]

The strong association between caesarean delivery and preterm birth in this study likely reflects the high-risk nature of these pregnancies rather than the procedure itself; nonetheless, caesarean delivery, particularly without labour, is an established risk factor for neonatal respiratory distress. A case-control study of term neonates identified elective caesarean section and male sex as independent predictors of RDS,[11] a pattern echoed by the higher frequency of caesarean delivery among the preterm neonates here. Maternal hypertension and gestational diabetes were the commonest maternal conditions; maternal hyperglycaemia is recognised to impair surfactant maturation, and surfactant deficiency remains the central mechanism of RDS for which replacement therapy has markedly reduced air leaks and mortality.[12]

The etiological spectrum—RDS commonest overall and in preterm neonates, TTNB predominant in term neonates, and MAS largely confined to term infants—mirrors the established pathophysiology of each condition. TTNB reflects delayed clearance of fetal lung fluid and is the commonest cause of distress in term newborns,[13] whereas MAS results

from airway obstruction, inflammation and surfactant inactivation, often with abnormal radiographic findings.[14][15]

The management pattern observed—CPAP as the commonest modality, invasive ventilation and surfactant largely restricted to preterm RDS, and low overall mortality—reflects the effectiveness of a graded respiratory-support strategy. Surfactant replacement, administered here only to neonates with RDS, is well established to reduce air leaks and mortality, with animal-derived preparations broadly comparable in efficacy,[16] and its restriction to preterm RDS, together with confinement of mortality to that group, is consistent with contemporary practice. The low mortality also underscores the value of antenatal optimisation, early non-invasive support and timely intervention.

Limitations: This was a single-centre study of inborn neonates over a limited period, so the findings may not be generalisable to outborn neonates or other settings. The descriptive design did not establish independent causal relationships between individual risk factors and respiratory distress, and microbiological confirmation and longer-term follow-up were not undertaken. Larger multicentre studies with multivariate analysis are needed to confirm these associations.

Conclusion

Respiratory distress in this NICU cohort was driven mainly by prematurity and respiratory distress syndrome, with low birth weight, caesarean delivery and maternal morbidity as important associated factors. Respiratory distress syndrome carried the longest respiratory support and hospital stay, and mortality—though low at 4.7%—was confined to preterm neonates with RDS. These findings emphasise the importance of preventing preterm birth through better antenatal care, judicious use of antenatal corticosteroids, early non-invasive respiratory support and timely referral of high-risk pregnancies to reduce the burden of neonatal respiratory distress.

Declarations

Ethics Approval and Consent: The study was approved by the institutional ethics committee.

Written informed consent was obtained from a parent or guardian of each participating neonate.

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