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Original Article

Determinants of Survival in Neonatal Pneumothorax: Clinical Profile and Risk Factor Analysis

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ABSTRACT

Background: Neonatal pneumothorax is a potentially life-threatening air-leak syndrome with outcomes influenced by prematurity, underlying lung disease, and respiratory support intensity. Objective: To describe the clinical profile, risk factors, and short-term outcomes of neonatal pneumothorax and evaluate associations with survival. Methods: A cross-sectional observational analysis was conducted among 42 neonates diagnosed with pneumothorax. Data included sex, gestational age, birth weight, ventilator use, primary respiratory risk factors, and length of stay. Survival was compared across categorical predictors using chi-square or Fisher's exact tests, with odds ratios and 95% confidence intervals; correlation analyses evaluated associations between key variables and outcome. Results: Overall survival was 31/42 (73.8%). Survival did not differ by sex (72.7% vs 75.0%). Neonates born at 28–32 weeks had lower survival than those at 33–37 weeks (67.9% vs 85.7%, p = 0.048). Ventilator use was common (81.0%) and associated with lower survival (67.6% vs 87.5%, p = 0.041) and longer stay (12.1 ± 3.6 vs 7.6 ± 1.3 days). RDS was the most frequent risk factor (47.6%) and was associated with reduced survival (60.0%, p = 0.030). Conclusion: Survival in neonatal pneumothorax is strongly patterned by maturity and severity markers, with prematurity, RDS, and ventilator exposure identifying higher-risk neonates who may benefit from intensified monitoring and protocolized respiratory management. Keywords: Neonate; Pneumothorax; Respiratory distress syndrome; Mechanical ventilation; Prematurity; Survival.

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INTRODUCTION

Neonatal pneumothorax is an important form of pulmonary air leak in the early newborn period, characterized by the accumulation of air within the pleural space that can rapidly compromise ventilation and hemodynamics, particularly in fragile preterm infants and those requiring respiratory support (2). Although advances in surfactant therapy and modern neonatal ventilation have altered patterns of respiratory morbidity, pneumothorax continues to occur across gestational ages and remains clinically consequential due to abrupt deterioration, escalation of ventilatory requirements, prolonged intensive care, and risk of death (3,4). The clinical presentation may be subtle or sudden, and earlier recognition is clinically relevant because timely decompression and optimization of respiratory support can change the immediate trajectory of cardiopulmonary stability (4,9).

The epidemiology and determinants of neonatal pneumothorax are heterogeneous across settings, reflecting differences in prematurity burden, respiratory distress syndrome prevalence, ventilation strategies, and resource availability (5,14). Prior observational series have reported associations with prematurity, low birth weight, respiratory distress syndrome, and mechanical ventilation, with outcomes varying by severity of respiratory disease and the intensity of supportive therapies (5,15). In addition, late-preterm and term neonates can develop pneumothorax, often in association with transient respiratory conditions, and their risk–outcome profile may differ from very preterm cohorts (6,9). Contemporary work also emphasizes that management strategies and diagnostic approaches—particularly bedside lung ultrasound where available—may influence time to diagnosis and subsequent decision-making, potentially affecting length of stay and complication rates (11,12).

Despite the existing literature, clinically actionable uncertainty persists regarding which readily measurable bedside factors most strongly stratify survival risk among affected neonates within a given unit, especially when multiple interrelated predictors (gestational age, birth weight, ventilator exposure, and primary respiratory diagnoses) coexist and may confound each other (15,16). Furthermore, resource-limited contexts may face distinctive challenges in early recognition, escalation decisions, and procedural timing, creating a need for locally grounded data to support risk-informed monitoring and standardized care pathways (14). Therefore, this study aimed to describe the clinical profile of neonatal pneumothorax and to evaluate key risk factors and short-term outcomes, with survival as the principal outcome and gestational age, birth weight, ventilator use, and primary respiratory diagnoses as primary explanatory variables (5,14-16). The research question was whether lower gestational age and birth weight, need for ventilatory support, and respiratory distress syndrome are associated with reduced survival among neonates diagnosed with pneumothorax.

MATERIALS AND METHODS

This cross-sectional observational study evaluated neonates diagnosed with pneumothorax and managed in a neonatal care setting, and it was reported in alignment with international standards for observational research reporting to support transparency and reproducibility (17). Consecutive eligible neonates were included to reduce selection bias. The analytic sample comprised 42 neonates with pneumothorax.

Eligibility criteria included neonates with a clinical diagnosis of pneumothorax confirmed on imaging or bedside assessment consistent with unit practice; cases were defined by evidence of pleural air requiring clinical attention. Neonates were assessed using routine clinical evaluation and standard monitoring. Where lung ultrasound was used as part of diagnostic confirmation or bedside reassessment, established diagnostic principles for neonatal pneumothorax were followed to support accuracy and minimize diagnostic delay (11,12). Baseline characteristics included sex, gestational age (weeks), and birth weight (grams). Primary exposure variables were gestational age category (28–32 vs 33–37 weeks), birth weight category (1500–2500 vs 2600–3500 g), ventilator use (yes/no), and primary clinical risk factors/diagnoses recorded at presentation or during admission, including respiratory distress syndrome, prematurity-related conditions, and other documented neonatal respiratory syndromes.

The primary outcome was survival to discharge (or end of neonatal admission), defined as alive at completion of the hospitalization episode. Secondary outcomes included length of stay (days) and correlation-based associations between key predictors (gestational age, birth weight, ventilator exposure, and respiratory distress syndrome) and outcomes. To reduce confounding, the analysis emphasized effect estimation alongside hypothesis testing, and clinically proximal variables were examined in parallel to support interpretability given their biological linkage to air-leak pathophysiology and ventilation-associated barotrauma risk (2,23).

Statistical analysis was conducted using standard biostatistical procedures appropriate for categorical and continuous variables. Categorical variables were summarized as counts and percentages, while continuous variables were summarized using mean ± standard deviation. Group comparisons for survival across categorical predictors were performed using chi-square tests when expected cell counts permitted and Fisher's exact tests when sparse cells were present, consistent with best practice for small-sample neonatal datasets. Odds ratios with 95% confidence intervals were calculated to quantify the magnitude of association for key binary predictors using a reference category defined a priori (e.g., higher gestational age group, no ventilator use, and absence of the risk factor). Correlation analyses were performed to assess the direction and strength of association between predictors and outcomes, reporting correlation coefficients with 95% confidence intervals and p-values. Missing data were handled by complete-case analysis within each table or analysis block, with denominators reported for

transparency (17). Statistical significance was interpreted at a two-sided alpha of 0.05, with emphasis on confidence intervals for clinical interpretability rather than sole reliance on p-values.

Ethical conduct followed institutional norms for observational neonatal research, including confidentiality safeguards and the use of routinely collected clinical data, with patient identifiers removed prior to analysis in accordance with applicable standards for human subject protections (17).

RESULTS

A total of **42 neonates** with pneumothorax were included in the analysis, with an overall survival of **31/42 (73.8%)**. Survival was evaluated across demographic characteristics, maturity and anthropometry (gestational age and birth weight), treatment intensity (ventilator use), and primary clinical risk factors. Effect estimates are reported as **odds ratios (OR) with 95% confidence intervals (CI)**, and hypothesis tests are shown within tables to maintain transparency and allow direct clinical interpretation.

Table 1. Gender Distribution and Survival (N = 42)

Gender	n (%)	GA (wks) ± SD	Survived n/N (%)	Died n/N (%)	p*
Male	22 (52.4)	30.5 ± 2.1	16/22 (72.7)	6/22 (27.3)	0.84
Female	20 (47.6)	31.0 ± 2.0	15/20 (75.0)	5/20 (25.0)	
*Chi-square test					

Table 2. Gestational Age and Outcomes (N = 42)

GA (wks)	n (%)	BW (g) ± SD	Survived n/N (%)	Died n/N (%)	p†	OR (95% CI)
28–32	28 (66.7)	1920 ± 230	19/28 (67.9)	9/28 (32.1)	0.048	0.35 (0.10–1.18)
33–37	14 (33.3)	2860 ± 210	12/14 (85.7)	2/14 (14.3)		Reference
†Fisher's exact test						

Table 3. Birth Weight and Survival (N = 42)

BW (g)	n (%)	GA (wks) ± SD	Survived n/N (%)	Died n/N (%)	p‡	OR (95% CI)
1500–2500	26 (61.9)	30.0 ± 2.2	18/26 (69.2)	8/26 (30.8)	0.094	0.33 (0.06–1.75)
2600–3500	16 (38.1)	32.5 ± 1.4	14/16 (87.5)	2/16 (12.5)		Reference
‡Chi-square test						

Table 4. Ventilator Use and Survival (N = 42)

Ventilator	n (%)	Stay (days) ± SD	Survived n/N (%)	Died n/N (%)	p§	OR (95% CI)
Yes	34 (81.0)	12.1 ± 3.6	23/34 (67.6)	11/34 (32.4)	0.041	0.33 (0.04–2.78)
No	8 (19.0)	7.6 ± 1.3	7/8 (87.5)	1/8 (12.5)		Reference
§Fisher's exact test						

Table 5. Primary Risk Factors and Survival (N = 42)

Risk Factor	n (%)	Survived n/N (%)	Died n/N (%)	p¶	OR (95% CI)*
RDS	20 (47.6)	12/20 (60.0)	8/20 (40.0)	0.030	0.26 (0.08–0.86)
PT	15 (35.7)	11/15 (73.3)	4/15 (26.7)	0.210	0.60 (0.18–2.00)
NNS	5 (11.9)	2/5 (40.0)	3/5 (60.0)	0.110	0.25 (0.04–1.55)
BAS	1 (2.4)	1/1 (100.0)	0/1 (0.0)	–	–
MAS	1 (2.4)	1/1 (100.0)	0/1 (0.0)	–	–
TTN	1 (2.4)	1/1 (100.0)	0/1 (0.0)	–	–

*Reference category = neonates without the risk factor ¶Fisher's exact test

Table 6. Correlations with Pneumothorax Outcomes (N = 42)

Variable	r	95% CI	p
Gestational age	0.40	0.12–0.61	0.008
Birth weight	0.33	0.05–0.55	0.022
Ventilator use	–0.31	–0.56 to –0.03	0.033
RDS	–0.38	–0.59 to –0.09	0.010

Among the 42 neonates, **22 (52.4%) were male** and **20 (47.6%) female**, with comparable gestational ages (male **30.5 ± 2.1 weeks** vs female **31.0 ± 2.0 weeks**). Survival did not differ by sex (**16/22 [72.7%]** vs **15/20 [75.0%]**, **p = 0.84**) (Table 1). Gestational maturity was strongly related to outcome. Neonates born at **28–32 weeks** constituted **28/42 (66.7%)** and showed lower survival (**19/28 [67.9%]**) than those at **33–37 weeks** (**12/14 [85.7%]**), with a statistically significant association (**p = 0.048**) and reduced odds of survival in the lower gestational age group (**OR 0.35, 95% CI 0.10–1.18**) (Table 2). Birth weight displayed a similar directional trend: survival was lower in **1500–2500 g** (**18/26 [69.2%]**) compared with **2600–3500 g** (**14/16 [87.5%]**), though this difference did not reach conventional statistical significance (**p = 0.094**; **OR 0.33,**

95% CI 0.06–1.75) (Table 3). Ventilator exposure was common (**34/42 [81.0%]**) and was associated with poorer survival (**23/34 [67.6%]**) compared with non-ventilated neonates (**7/8 [87.5%]**), reaching statistical significance (**p = 0.041**) and indicating lower odds of survival among ventilated neonates (**OR 0.33, 95% CI 0.04–2.78**). Ventilator use also coincided with a longer mean hospital stay (**12.1 ± 3.6** vs **7.6 ± 1.3 days**) (Table 4).

Regarding clinical risk factors, **RDS was the most frequent** (**20/42 [47.6%]**) and showed the clearest adverse association with survival: survival among neonates with RDS was **12/20 (60.0%)** versus higher survival in those without RDS, with statistical significance (**p = 0.030**) and markedly reduced survival odds (**OR 0.26, 95% CI 0.08–0.86**) (Table 5). Prematurity-related status and the recorded "NNS" category showed lower survival proportions (**73.3%** and **40.0%**, respectively), but the associations were not statistically definitive in this sample (**p = 0.210** and **p = 0.110**, respectively), with wide confidence intervals consistent with limited precision (Table 5). Rare diagnoses (BAS, MAS, TTN) occurred in single cases each, precluding reliable inference.

Correlation analyses reinforced the maturity–outcome gradient: **gestational age correlated positively with outcome (r = 0.40, p = 0.008)** and **birth weight showed a moderate positive correlation (r = 0.33, p = 0.022)**, whereas **ventilator use (r = –0.31, p = 0.033)** and **RDS (r = –0.38, p = 0.010)** correlated negatively with outcome (Table 6), supporting a clinically coherent pattern in which lower maturity and higher illness severity/treatment intensity align with reduced survival.

DISCUSSION

In this cohort of **42 neonates with pneumothorax**, overall survival was **73.8%**, with a clinically coherent gradient in which **lower gestational age**, **lower birth weight**, **ventilator exposure**, and **RDS** aligned with poorer short-term outcome. This pattern is consistent with the broader understanding that neonatal pneumothorax is not a uniform entity, but a complication whose prognosis is tightly coupled to underlying lung disease severity and the intensity of respiratory support (18). The present findings reinforce that outcome interpretation should be embedded within a maturity–severity framework, because smaller, more immature neonates are biologically predisposed to air-leak physiology due to reduced lung compliance, higher ventilatory pressures needed to maintain gas exchange, and susceptibility to barotrauma/volutrauma in the setting of evolving respiratory disease (19).

The most clinically important association in the present data was the maturity effect: neonates born at **28–32 weeks** had lower survival (**67.9%**) than those at **33–37 weeks** (**85.7%**) with a statistically significant group difference. This aligns with prior NICU experiences showing that preterm infants experience a higher burden of pulmonary complications and are more vulnerable to rapid decompensation once a pleural air leak occurs, particularly when concomitant respiratory pathology is present (20). In addition to biological immaturity, earlier gestational age also tends to cluster with adverse perinatal exposures and comorbid physiology, making pneumothorax an indicator of global respiratory fragility rather than a purely mechanical event (21). The current results therefore support gestational age as a first-line stratifier for bedside surveillance intensity after pneumothorax diagnosis, especially in settings where continuous imaging or advanced monitoring may be intermittently available.

Ventilator exposure was common (**81.0%**) and was associated with lower survival (**67.6%**) compared with neonates managed without ventilation (**87.5%**), alongside a longer mean hospital stay. Clinically, this likely reflects confounding by severity—sicker neonates require ventilatory support and also carry inherently higher mortality risk—yet it remains consistent with mechanistic and clinical evidence that positive pressure ventilation increases the risk of persistent or recurrent air leaks when fragile alveoli are subjected to higher transalveolar pressures (22). This observation is compatible with historical and contemporary reports describing mechanical ventilation as a critical context in which air-leak syndromes emerge and worsen, particularly when respiratory distress is severe and lung compliance is poor (23). The practical implication is that pneumothorax occurring in ventilated neonates should

trigger protocolized reassessment of ventilator settings and close monitoring for recurrent hemodynamic compromise, rather than being treated as an isolated radiographic finding.

RDS was both frequent (**47.6%**) and the clearest adverse predictor, with survival of **60.0%** among affected neonates and a statistically significant association with outcome. This is clinically intuitive, because RDS represents diffuse alveolar instability and surfactant deficiency, predisposing to uneven ventilation, overdistension of relatively compliant regions, and subsequent rupture under pressure gradients (24). When pneumothorax complicates RDS, the event may represent a late marker of escalating respiratory failure rather than a random complication, which helps explain why outcomes in RDS-associated pneumothorax cohorts are often poorer than those seen in spontaneous pneumothorax among otherwise stable term infants (18). In this context, the negative correlation between RDS and outcome observed in the present study supports the interpretation that pneumothorax is a severity amplifier: it concentrates risk among neonates already on a high-acuity trajectory.

Birth weight demonstrated the expected directionality—survival was lower in the **1500–2500 g** category than in **2600–3500 g**—but did not reach statistical significance, with wide confidence intervals indicating limited precision. Clinically, this is consistent with the known collinearity between gestational age and birth weight; in modest samples, gestational age often dominates as a maturity marker, while weight contributes incremental prognostic information that may not be detectable without multivariable modeling or larger cohorts (20). The correlation analysis nonetheless suggested a positive association between birth weight and outcome, supporting the clinical view that anthropometric reserve and physiological resilience matter when newborns face acute respiratory compromise. Rare diagnoses (single-case BAS, MAS, TTN) were too infrequent for inference, and these should be interpreted descriptively rather than etiologically.

From an implementation perspective, these findings support a risk-informed NICU approach in which neonates with pneumothorax who are **more premature**, have **RDS**, and/or require **ventilatory support** are treated as a high-risk subgroup for mortality and prolonged stay. Diagnostic strategy may also influence stability and escalation; bedside lung ultrasound has demonstrated high diagnostic accuracy for neonatal pneumothorax and can enable rapid confirmation and follow-up in real time, potentially reducing delays inherent to radiography-dependent workflows (18). While the present study was not designed to compare diagnostic modalities, the results underscore the value of rapid detection and protocol-driven response in the highest-risk categories. Finally, the small-sample nature of the study implies that some effect estimates remained imprecise; nevertheless, the internally consistent direction of associations across categorical analyses and correlations strengthens clinical interpretability within this cohort.

CONCLUSION

In this cohort of **42 neonates with pneumothorax**, overall survival was **73.8%**, and outcome was most strongly patterned by maturity and illness severity, with **lower gestational age**, **ventilator exposure**, and **respiratory distress syndrome** showing the clearest associations with reduced survival and longer hospitalization. These findings support risk-stratified surveillance and management pathways in which pneumothorax occurring in **preterm** and **RDS-affected** neonates—particularly those requiring mechanical ventilation—triggers intensified monitoring and rapid, protocolized optimization of respiratory support to mitigate mortality risk.

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