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Early Lung Ultrasound Score and Its Correlation with Respiratory Distress in Very Preterm Newborns: A Prospective Study

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ABSTRACT

Respiratory distress syndrome (RDS) remains a major challenge in managing very preterm newborns. Early detection and intervention are crucial to improving outcomes in this vulnerable population. This study investigates the correlation between early lung ultrasound (LUS) scores and the severity of respiratory distress in a cohort of very preterm infants (<32 weeks gestational age) admitted to a Level 3 NICU at Mahatma Gandhi Hospital, Jaipur. We prospectively enrolled 78 preterm neonates between September 2023 and June 2024 and evaluated their LUS scores within the first 24 hours of life. The study's findings support the use of LUS as a predictive tool for RDS severity, demonstrating significant correlations between LUS scores and the need for respiratory support, duration of NICU stay, and overall clinical outcomes. These results suggest that LUS could be integrated into routine neonatal care to guide early therapeutic interventions.

INTRODUCTION

Respiratory distress syndrome (RDS) is a leading cause of morbidity and mortality in preterm infants, particularly those born before 32 weeks of gestation . The immature lungs of these infants, characterized by a deficiency of surfactant, predispose them to RDS, which can lead to significant complications if not promptly diagnosed and treated . Traditional diagnostic methods, such as chest radiography, though effective, expose neonates to ionizing radiation, raising concerns about their safety, especially with repeated exposures .

Lung ultrasound (LUS) has recently emerged as a promising, non-invasive diagnostic tool for evaluating neonatal lung pathology. LUS offers several advantages, including real-time imaging, the absence of ionizing radiation, and the ability to perform bedside evaluations . Studies have shown that LUS can accurately detect lung abnormalities in neonates, such as pleural line abnormalities, B-lines, and consolidation, which are indicative of RDS (1). Moreover, LUS has been suggested as a potential tool for assessing the severity of RDS and guiding treatment decisions (2) .

Given the growing evidence supporting the utility of LUS in neonatal care, this study aims to evaluate the correlation between early LUS scores and the severity of respiratory distress in a cohort of very preterm infants. We hypothesized that higher LUS scores within the first 24 hours of life would be associated with more severe respiratory distress, requiring increased levels of respiratory support and resulting in longer NICU stays.

METHODS

Study Design

This prospective observational study was conducted at the Level 3 Neonatal Intensive Care Unit (NICU) of Mahatma Gandhi Hospital, Jaipur, from September 2023 to June 2024. The study was approved by the Institutional Ethics Committee, and informed consent was obtained from the parents or guardians of all participants.

Study Population

The study population comprised 78 very preterm infants with a gestational age of less than 32 weeks, admitted to the NICU within the first 24 hours of life. Inclusion criteria included preterm infants with a gestational age of less than 32 weeks, who were admitted to the NICU within 24 hours of birth, and whose parents provided informed consent. Exclusion criteria were the presence of major congenital anomalies or incomplete data.

Lung Ultrasound Protocol

Lung ultrasound was performed within the first 24 hours of life using a high-frequency linear probe. The LUS examination covered six regions of the lung bilaterally—anterior, lateral, and posterior regions. Each region was scored based on the presence of A-lines, B-lines, consolidation, and pleural line abnormalities. A standardised LUS scoring system was used to ensure consistency in assessments across all patients .

Score was given as follows

Score 0: Only A-lines (normal aeration).

Score 1: B-pattern (presence of 3 or more well-spaced B-lines).

Score 2: Severe B-pattern (crowded and coalescent B-lines with or without sub pleural consolidations).

Score 3: Extensive consolidations.

Assessment of Respiratory Distress

The severity of respiratory distress was classified based on clinical and radiological findings, including the need for respiratory support (continuous positive airway pressure (CPAP), mechanical ventilation) and surfactant therapy. The correlation between LUS scores and respiratory outcomes, such as the duration of respiratory support and NICU stay, was analyzed.

Data Collection and Statistical Analysis

Data were collected on gestational age, birth weight, Apgar scores, LUS scores, and respiratory outcomes. Statistical analysis was conducted using SPSS software, with Pearson's correlation coefficient used to assess the correlation between LUS scores and the severity of respiratory distress. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Demographics and Clinical Characteristics

The study included 78 preterm infants with a mean gestational age of 29.5 ± 1.2 weeks and a mean birth weight of 1250 ± 230 grams. Of these, 42 (53.8%) were male, and 36 (46.2%) were female. The mean Apgar scores at 1 and 5 minutes were 6.5 ± 1.3 and 7.8 ± 1.0, respectively. Forty neonates (51.3%) required CPAP, while 20 (25.6%) required mechanical

ventilation. Surfactant therapy was administered to 32 (41.0%) infants. The average length of NICU stay was 28.5 ± 7.2 days (Table 1).

Table 1: Demographics and Clinical Characteristics of Study Population

Variable	Mean ± SD / n (%)
Gestational Age (weeks)	29.5 ± 1.2
Birth Weight (grams)	1250 ± 230
Gender	
- Male	42 (53.8%)
- Female	36 (46.2%)
Apgar Score at 1 minute	6.5 ± 1.3
Apgar Score at 5 minutes	7.8 ± 1.0
Need for CPAP	40 (51.3%)
Need for Mechanical Ventilation	20 (25.6%)
Surfactant Therapy	32 (41.0%)
Length of NICU Stay (days)	28.5 ± 7.2

Lung Ultrasound Findings

The mean LUS score across the study population was 12.3 ± 4.5. Infants with higher LUS scores were more likely to require mechanical ventilation and had longer NICU stays (Table 2). Specifically, infants with LUS scores greater than 14 had a significantly higher risk of severe respiratory distress, necessitating more intensive respiratory support.

Table 2: Lung Ultrasound Scores and Respiratory Outcomes

Lung Ultrasound Score	Mean ± SD	n (%)
Total LUS Score	12.3 ± 4.5	
- LUS Score < 10	8.7 ± 1.2	25 (32.1%)
- LUS Score 10-14	12.2 ± 1.4	28 (35.9%)
- LUS Score > 14	16.5 ± 1.8	25 (32.1%)
Need for CPAP		40 (51.3%)
Need for Mechanical Ventilation		20 (25.6%)
Surfactant Therapy		32 (41.0%)

Correlation Analysis

A significant positive correlation was observed between LUS scores and the need for respiratory support. Infants with LUS scores greater than 14 were significantly more likely to require mechanical ventilation ($p < 0.01$), while those with LUS scores between 10 and 14 were more likely to need CPAP (Table 3). Moreover, LUS scores were positively correlated with the length of NICU stay, with higher scores associated with longer hospitalisations (Table 4).

Table 3: Correlation Between LUS Scores and Respiratory Support Requirements

LUS Score	CPAP Required (n=40)	Mechanical Ventilation Required (n=20)	p-value
< 10	10 (25%)	2 (5%)	< 0.05
10-14	18 (45%)	8 (20%)	< 0.05
> 14	12 (30%)	10 (25%)	< 0.01

Table 4: Correlation Between LUS Scores and Length of NICU Stay

LUS Score	Length of NICU Stay (days)	p-value
< 10	20.2 ± 5.4	< 0.05
10-14	28.1 ± 6.3	< 0.05
> 14	35.4 ± 8.2	< 0.01

DISCUSSION

The findings of this study underscore the potential of early lung ultrasound (LUS) as a reliable and non-invasive tool for predicting the severity of respiratory distress syndrome (RDS) in very preterm newborns. Our results are consistent with those of previous studies, which have highlighted the utility of LUS in neonatal intensive care units (NICUs) for assessing lung pathology and guiding clinical management .

Lung ultrasound can play important role in timely intervention to improve outcomes in critically ill neonates (3). It can emerge as significant to in diagnosis and management of respiratory infections including pneumonias and meconium aspiration syndrome (4,5). Very few indian studies have been conducted to evaluate the role of ling ultrasound in Indian nurseries .

The significant correlation between LUS scores and the need for respiratory support observed in our study suggests that LUS can play a crucial role in stratifying risk and informing treatment decisions in very preterm infants. Specifically, infants with higher LUS scores (>14) were more likely to require mechanical ventilation, indicating more severe respiratory distress. This finding aligns with previous research, such as the studies by Raimondi et al. (2020) and Brat et al. (2015), which also reported a strong association between higher LUS scores and the severity of RDS (6).

One of the key strengths of LUS is its ability to provide real-time, bedside assessments without exposing neonates to ionizing radiation. This is particularly important in the neonatal population, where repeated exposure to radiation can have long-term consequences. The safety and feasibility of LUS in NICUs have been well-documented, as seen in studies by Singh et al. (2021) and others, who have advocated for its broader adoption in clinical practice, especially in resource-limited settings (7,8)

Our study also demonstrated a positive correlation between LUS scores and the length of NICU stay, with higher LUS scores associated with longer hospitalisations. This suggests that LUS not only serves as a diagnostic tool for assessing the severity of RDS but also has prognostic value in predicting the overall course and duration of NICU care. Similar findings have been reported by Tissot et al. (2022), who observed that higher LUS scores were linked to prolonged NICU stays and more complex clinical courses (9,10).

However, the study's limitations must be acknowledged. The single-center design may limit the generalisability of our findings, and the relatively small sample size, while sufficient for detecting significant correlations, warrants cautious interpretation of the results. Future research should aim to validate these findings in larger, multicenter studies, which would also help to refine the LUS scoring system and establish more precise cutoffs for clinical decision-making.

Another limitation is the potential for inter observer variability in LUS interpretation, a well-known challenge in ultrasound-based studies. Although we used a standardized LUS protocol and ensured that all scans were performed by trained neonatologists, interobserver agreement remains a concern. Studies have highlighted the importance of training and certification programs to minimize variability and improve the reliability of LUS assessments (11, 12).

Despite these limitations, our study contributes valuable evidence supporting the integration of LUS into routine neonatal care. The ability to quickly and accurately assess lung pathology at the bedside allows for earlier identification of infants at risk for severe RDS and facilitates timely interventions, potentially improving outcomes (13, 14). The non-invasive nature of LUS, combined with its diagnostic and prognostic capabilities, makes it an attractive alternative to traditional imaging modalities.

CONCLUSION

early lung ultrasound is a valuable tool in assessing the severity of respiratory distress in very preterm newborns. Our study demonstrates significant correlations between LUS scores and respiratory outcomes, including the need for respiratory support and the duration of NICU stay. These findings suggest that LUS can enhance neonatal care by providing critical information that informs early and targeted therapeutic interventions. Further research, particularly multicenter studies with larger cohorts, is needed to validate these findings and optimize the use of LUS in neonatal care.

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