Does lung ultrasound help in determining the need of surfactant administration?

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ABSTRACT

Background. Fetal lung immaturity can lead to neonatal respiratory distress syndrome (RDS), a significant cause of respiratory failure and neonatal mortality in premature infants due to lack of pulmonary surfactant. Lung ultrasound may aid in deciding when to administer surfactant.

Case report. The patient was diagnosed with respiratory distress syndrome (RDS) and received timely surfactant therapy based on their FiO₂ and Lung Ultrasound Score. This led to an improved clinical status and successful extubation within 48 hours. After being discharged at 30 days, the patient showed normal development during a 7-month follow-up period.

Conclusions. A favorable outcome results from prompt and targeted lung ultrasound (LUS) interventions, specifically highlighting the efficacy of timely surfactant intervention and collaborative healthcare management in addressing RDS in neonates.

Keywords: neonatal respiratory distress syndrome, lung ultrasound, surfactant therapy, European RDS Management Guidelines, outcomes

List of abbreviations (in alphabetical order):

- ABG — arterial blood gas
- LUS — lung ultrasound
- OTI — orotracheal intubation
- PS — pulmonary surfactant
- RDS — respiratory distress syndrome

INTRODUCTION

Fetal lung immaturity results in a lack of pulmonary surfactant, which causes neonatal respiratory distress syndrome (RDS), one of the main causes of respiratory failure and neonatal death in premature infants. The introduction of exogenous pulmonary surfactant treatment has significantly improved the outcome of the disease [1,2].

The Management of RDS European Consensus Guidelines was revised in 2022. For neonates with RDS, the recommended protocol is to treat worsening RDS with surfactant when FiO₂ > 0.3 on CPAP pressure ≥ 6 cm H₂O or if lung ultrasound suggests surfactant deficiency. The same guidelines include that the rescue surfactant should be given early in the course of the disease (A1: High quality, Strong recommendation for using intervention), and the suggested protocol would be to treat worsening babies with RDS when FiO₂ > 0.30 on CPAP pressure ≥ 6 cm H₂O or if lung ultrasound suggests surfactant need (B2: Moderate quality, Weak recommendation for using intervention) [3].

The LUS score divided each lung into three regions (upper anterior, lower anterior, and lateral) and analyzing them using a linear probe. A 0 to 3 point score was assigned to each lung area, resulting in a total score ranging from 0 to 18. Specifically, the LUS score was allocated as follows: 0 characterized by the presence of only A-lines; 1 indicated the presence of three or more B-lines per lung field; 2 represented by coalescent B-lines with or without consolidations limited to the subpleural space; and 3 indicated extended consolidations. A-lines reflected pleura
due to ultrasound diffusing through an air-filled lung, while B-lines were attributed to fluid in the interstitium [4].

We describe the case of a female premature neonate, in which the lung ultrasound images supported the decision for the administration of surfactant.

CASE REPORT

A premature female was born at 30 weeks and 6 days gestation with a birth weight of 1500 grams through C-section due to high-risk pregnancy. The mother, a 35-year-old, gravida 5 parity 0, was known to have preeclampsia, and during the pregnancy, she developed preeclampsia (maximum blood pressure 179/115 mmHg). She received Dexamethasone, magnesium sulfate, and Methyldopa.

The APGAR scores of the newborn were 8 at 1 minute and 9 at 5 minutes of life. During the physical examination, the newborn was found to have rapid, labored, grunting respirations. As a result, non-invasive ventilation with NeoPuff (PIP 25 cm H₂O, PEEP 5 cm H₂O, FiO₂ 50%) was administered for 15 minutes during the initial resuscitation. The baby was then admitted to the neonatal intensive care unit (NICU) and placed on CPAP with FiO₂ 40% and PEEP 6. ABG (arterial blood gases) levels at birth and 1h of life showed respiratory acidosis with metabolic compensation (Table 1). One hour after arrival in the NICU (Neonatal Intensive Care Unit) – 45 minutes of life, we performed the lung ultrasound using the Lung Ultrasound Score (LUS) developed by Brat [4]. The score was 12, with no visible A-lines and confluent B lines that showed a uniform pattern of the white lungs with no spared areas, with lung sliding present (Figure 1).

Based on the clinical features, the diagnosis given was RDS. Using the RDS European Consensus Guidelines, it was decided to administer surfactant. First, we performed the oro-tracheal intubation and then the X-ray to verify the correct position of the endotracheal tube. The X-ray appearance has not been as suggestive of a severe form of RDS as it was in the lung ultrasound – no ground glass appearance and no air bronchogram were present (Figure 2). The decision to administer surfactant was based on the LUS, clinical features, and the FiO₂ value.

Two hours after birth, we administered 240 mg of surfactant through the endotracheal tube and repeated the arterial blood gas (ABG) and lung ultrasound (LUS) tests. The new LUS score was 8, showing the appearance of A-lines and decreased B-lines (as seen in Figure 3). The patient's overall clinical condition has improved, with signs of spontaneous breathing and chest movements. The patient was extubated after 48 hours and received non-invasive positive pressure ventilation (NIPPV) for 36 hours. She received full enteral feedings since day ten and was discharged home after 30 days of life. The results of the head ultrasound performed during the hospitalization were normal, and the neurological exam showed no abnormalities. For the next 7 months, the patient was seen for the follow-up examination, which revealed normal development for corrected age, normal neurological exam – fidgety movements present at 3 months corrected age, head control at 2 months corrected age, independent sitting at 7 months. The head circumference growth chart showed good growth according to the corrected age (Figure 4).

DISCUSSION

Administering surfactant early to infants with RDS who require assisted ventilation reduces the likelihood of acute pulmonary injury, including a decrease risk of pneumothorax and pulmonary interstitial emphysema. Additionally, early surfactant administration is associated with a lower risk of neonatal mortality and chronic lung disease compared to delaying treatment until the infants experience worsening RDS [5]. Early surfactant administration is recognized for its role in decreasing the incidence of bronchopulmonary dysplasia (BPD) and mortality [6].

LUS can lower the rate of misdiagnosis for RDS, reducing the likelihood of utilizing positive pressure support and decreasing the required pulmonary surfactant dosage [7]. The use of lung ultrasound proves efficient in anticipating the need for surfactant administration in newborns. Performing LUS within 1–3

| TABLE 1. ABG levels from birth to the point of extubation |
|-------------------|--------------------|--------------------|-------------------|--------------------|
|                   | After birth         | 45 minutes of life | 2 hours of life   | After extubation   |
|                   | (CPAP: FiO₂ 30%, PEEP 6 cm H₂O) | (after intubation and surfactant administration) | (48 hours) |
| pH                | 7.27               | 7.23               | 7.52              | 7.36               |
| pCO₂              | 48                 | 53.3               | 21.4              | 33.4               |
| Base excess       | -4.8               | -4.7               | -5.4              | -6.5               |
| HCO₃⁻             | 18.9               | 20                 | 22.6              | 20.1               |

hours after birth is advised, with a suggested cutoff of 9 [8]. Nevertheless, it is essential to consider the oxygen saturation to FiO₂ ratio [8]. Lung ultrasound is a reliable predictor for the necessity of early surfactant replacement [9,10].

The lung ultrasound scores developed by Brat, Raimondi, and Rodriguez-Fanjul demonstrate outstanding predictive capabilities for determining the requirement of surfactant replacement therapy, although with varying cutoff values. Each of the three lung ultrasound scores exhibited excellent reproducibility, both within individual observers and between different observers. Due to variations in the optimal cut-off value, it is recommended to maintain consistency by using the same score within the same medical center [11].
CONCLUSION

Despite the challenges faced, prompt and targeted medical interventions, given the implementation of surfactant therapy, resulted in a favorable outcome. The decision to administer surfactant, guided by clinical features, LUS findings, and FiO₂ values, led to a marked improvement in the patient’s respiratory status, with subsequent successful extubation after 48 hours. Over the next 7 months, follow-up examinations demonstrated normal development for corrected age, a normal neurological exam, and satisfactory head circumference growth. This success underscores the effectiveness of the healthcare team’s collaborative efforts in ensuring the patient’s positive trajectory.

FIGURE 3. LUS after intubation and surfactant administration – LUS score 8

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FIGURE 4. Head circumference growth chart

REFERENCES


