Acute respiratory distress syndrome or pneumonia? 
The role of lung ultrasound

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ABSTRACT

Background. Neonatal Acute Respiratory Distress Syndrome (ARDS), although recognized for almost 34 years, is still difficult to define. An attempt was made to include this pathology in a set of criteria (The Montreux definition) that allows early diagnosis and appropriate therapeutic measures.

Case report. We present one case of neonatal ARDS that was diagnosed using the Montreux definition. Two out of the five criteria were discovered while performing seriated lung ultrasounds. A term newborn (GA=39W6D) developed respiratory failure at 15 minutes after birth: rapid, labored, grunting respirations, suprasternal and substernal retractions. The suspected diagnosis was ARDS because all 5 criteria were met. The infant was transferred to the NICU where CPAP treatment and antibiotic prophylaxis were initiated. Lung ultrasounds were performed, showing congenital pneumonia as the primary acute respiratory condition so the antibiotics were changed. In the second day of life the patient was sedated and received mechanical ventilation support followed by 3 doses of surfactant. The patient’s status slowly improved and he was extubated after 56 hours. The lung ultrasounds began to show a normal pattern; blood cultures were negative, and CRP was decreasing. The patient was discharged at 8 days of life.

Conclusions. When faced with a term newborn with respiratory distress it is important to consider ARDS as a possible diagnosis if all the criteria are met.

Keywords: ARDS, surfactant administration, Montreux definition, lung ultrasound

INTRODUCTION

The absence of a formal definition for Acute Respiratory Distress Syndrome (ARDS) in neonates, despite the established recognition of ARDS in later life, highlights a critical gap in understanding and addressing respiratory distress in the perinatal period [1].

Literature highlights a notable deficiency in definitive data and comprehensive studies specifically addressing the peculiarities and treatment options for neonatal Acute Respiratory Distress Syndrome (ARDS). The complexity of ARDS is underscored by its diverse etiology and the range of underlying diseases contributing to its manifestation. This emphasizes the importance of recognizing gestational age-specific causes and tailoring therapeutic interventions accordingly [2,3].

List of abbreviations (in alphabetical order):

ARDS        −  acute respiratory distress syndrome
CPAP        −  continuous positive airway pressure
C-RP        −  C-reactive protein
D            −  days
FiO₂         −  fraction of inspired oxygen
GA           −  gestational age
MAP          −  mean airway pressure
NICU         −  neonatal intensive care unit
PaO₂         −  partial pressure of oxygen in the arterial blood
W            −  weeks

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The issuance of the Montreux definition for neonatal ARDS through expert consensus and literature review, endorsed by the European Society of Neonatal Intensive Care and the European Society for Pediatric Research, signifies a crucial advancement in precision medicine for newborn infants [1]. This specific definition not only aligns with established ARDS definitions in other age groups but also considers the unique characteristics of neonates and the intricacies of neonatal critical care. The adoption of the Montreux definition is expected to contribute significantly to improved accuracy in diagnosing neonatal ARDS, facilitating targeted and effective treatment strategies [1,4].

The 5 criteria present in the Montreux definition are:

- Acute onset (in the first hour of life)
- Exclusion of other diagnosis (RDS, TTN, congenital anomalies)
- Lung imaging (pulmonary ultrasound) shows diffuse, bilateral, and irregular opacities (with no other explanation)
- Absence of congenital heart disease that would explain the edema
- Oxygenation index: mild, moderate, or severe oxygenation deficit [1].

**CASE REPORT**

This case report describes the clinical course of a male infant born at 39 weeks and 6 days gestational age, weighting 3570g, delivered via cesarean section, and initially presenting with signs of respiratory distress. It is essential to emphasize that the mother consistently attended all prenatal care appointments and had no relevant history of illnesses.

Within the first 15 minutes after birth, the infant exhibited labored breathing, grunting respirations, suprasternal and substernal retractions, and abundant oropharyngeal secretions. He has been placed in a neutral thermal environment with free flow oxygen and received saline and glucose i.v. Despite initial interventions, the infant’s oxygen saturation declined to 88%, prompting CPAP initiation.

Serial ultrasounds revealed a persistent white lung appearance (multiple, confluent B lines, the absence of A lines), diffuse subpleural opacities, leading to a presumed diagnosis of congenital pneumonia as the underlying condition (Figure 1).

A chest X-ray was conducted, but it did not provide adequate information to determine whether intubation was necessary (Figure 2).

An echocardiography was performed to exclude a congenital heart disease that would otherwise explain the edema, and the results were normal. Antibiotic prophylaxis with ampicillin and gentamicin was initiated (after obtaining blood culture samples) but proved insufficient, prompting a regimen change to meropenem and vancomycin due to patient’s progressive decline and elevated CRP levels (19.57mg/L).

The initial blood tests revealed neutrophilia (19.34*10^3) with lymphopenia(2.52*10^3).

As the infant’s status deteriorated (CPAP failure: grunting respirations and oxygen desaturations are persistent) orotracheal intubation and mechanical ventilation, accompanied by sedation with fentanyl, became necessary and were performed. The oxygenation deficit was calculated using the following parameters: FiO₂ (40%), MAP (9 cm H₂O) and PaO₂ (78
mmHg) giving an oxygenation index of 6.3 (suggestive for mild ARDS). Surfactant administration (360mg/4.5ml) via endotracheal tube was performed, gradually improving the infant’s status. Follow-up lung ultrasounds depicted the emergence of A lines, scarce B lines and decreasing opacities (Figures 3, 4).

Following the Montreux definition of neonatal ARDS, the infant meets all 5 criteria described by the Neonatal ARDS Project [1] (Table 1). The course of treatment was established according to the clinical signs but also considering the beforementioned set of criteria.

The infant was extubated 56 hours later, with normal looking pulmonary ultrasound. With infant’s status gradually improving he was discharged at 8 days of life.

### DISCUSSIONS

Lung ultrasound has an important role in assessing the severity of neonatal ARDS, respectively in predicting the need of mechanical ventilation. This aspect is particularly relevant in neonatal care, where early identification of infants at risk for respiratory complications is essential for optimizing treatment strategies and resource allocation [5].

#### TABLE 1. The 5 criteria of the Montreux definition applied on the current case

<table>
<thead>
<tr>
<th>Criteria</th>
<th>The Montreux definition</th>
<th>Current case</th>
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<tbody>
<tr>
<td>Time frame</td>
<td>Acute onset (ie, within one week) from a known or suspected clinical insult</td>
<td>15 minutes of life</td>
</tr>
<tr>
<td>Exclusion criteria</td>
<td>RDS, TTN, or congenital anomalies as a primary current acute respiratory condition</td>
<td>RDS, TTN, congenital anomalies excluded using ultrasonography and clinical examination</td>
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<tr>
<td>Lung imaging</td>
<td>Diffuse, bilateral, and irregular opacities or infiltrates, or complete opacification of the lungs, which are not fully explained by local effusions, atelectasis, RDS, TTN, or congenital anomalies</td>
<td>Bilateral opacities, “white lung” aspect on ultrasonography</td>
</tr>
<tr>
<td>Origin of edema</td>
<td>Absence of congenital heart disease explaining the oedema (this includes ductus arteriosus with pulmonary overflow if no acute pulmonary hemorrhage exists). Echocardiography is needed to verify the origin of oedema</td>
<td>Normal echocardiography -&gt; exclusion of congenital heart disease</td>
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<tr>
<td>Oxygenation index</td>
<td>Mild ARDS: 4≤O&lt;8</td>
<td>=6.3 (mild ARDS)</td>
</tr>
<tr>
<td></td>
<td>Moderate ARDS: 8≤O&lt;16</td>
<td></td>
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<tr>
<td></td>
<td>Severe ARDS: O≥16</td>
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In the 7th day of life, neutrophils (3.54*10³) and lymphocytes (11.85*10³) have returned within normal limits, while the red blood cell series with age-appropriate morphology has remained consistent throughout the entire hospitalization period.

CRP values (2.72 mg/L) were normal and the blood cultures were negative at 7 days (final result).
Given its lack of side effects and unrestricted use, lung ultrasound emerges as a valuable bedside tool to complement radiography in critically ill newborns [6,7]. Three out of the five criteria used for diagnosing neonatal ARDS could be easily evaluated via ultrasound examination but at the same time it does not diminish the importance of radiography images.

Additional investigation into the diagnostic precision of lung ultrasound is essential before lung ultrasound can supplant chest radiography as the imaging element of the established reference standard [7].

Although ARDS is mainly discovered in late preterm infants, term infants with respiratory distress should not be excluded from an ARDS diagnosis [8].

In term and late preterm infants with well-developed surfactant machinery, infection-related respiratory failure may manifest as secondary surfactant dysfunction. Certain components of surfactant exhibit a negative feedback mechanism by down-regulating their own breakdown. Consequently, research has explored the use of exogenous surfactant in infants with infection-related respiratory failure (IRRF) to hinder secondary dysfunction and reinstate surfactant activity [9].

CONCLUSIONS

When faced with a term newborn with respiratory distress, it is important to consider ARDS a possible diagnosis if all the criteria are met. At the same time, the diagnosis of pneumonia should also be discussed, as the clinical and imaging criteria align. However, the concomitant presence of both ARDS and pneumonia is possible, as these pathologies do not mutually exclude each other. Early identification and management of either pathology could result in a better prognosis for the patient.

Lung ultrasound has played an irreplaceable role in performing repeated non-invasive evaluation of the infant's status.

The administration of surfactant enhances survival rates in infants experiencing ARDS and may provide an earlier weaning off mechanical ventilation.

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REFERENCES


