"CAROL DAVILA" UNIVERSITY OF MEDICINE AND PHARMACY, BUCHAREST

DOCTORAL SCHOOL

MEDICINE

NEONATAL LUNG ULTRASOUND VS. CHEST X-RAY IN NEWBORNS WITH PULMONARY CONDITIONS

SUMMARY OF THE DOCTORAL THESIS

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Introduction

Over the past decade, lung ultrasound (LUS) has become a vital tool for diagnosing respiratory pathologies in newborns, particularly in neonatal intensive care units (NICUs). Compared to conventional radiography, LUS offers significant advantages, such as the absence of ionizing radiation and the ability to deliver real-time results. This study focuses on the role of lung ultrasound in diagnosing and monitoring key neonatal pathologies, with an emphasis on its contributions to advancing this imaging technique.

Lung ultrasound has established itself as an indispensable method for identifying and managing respiratory conditions in neonates, offering several advantages over chest radiography, which was traditionally considered the gold standard. Recent studies demonstrate that LUS achieves sensitivity and specificity comparable to radiography in detecting common neonatal respiratory conditions, including respiratory distress syndrome (RDS), transient tachypnea of the newborn (TTN), neonatal pneumonia, meconium aspiration syndrome, and pneumothorax. A key benefit of LUS is its ability to avoid ionizing radiation exposure, which is especially important for vulnerable neonates in intensive care units.

Moreover, LUS allows dynamic bedside monitoring and supports rapid, accurate interventions in critical cases, while being cost-effective. As a result, this technique shows great potential to become a standard imaging modality in neonatal care.

One particularly important application of lung ultrasound is its use in determining the optimal timing for surfactant therapy in newborns with respiratory distress syndrome. Research has shown that LUS scoring systems can effectively predict the need for surfactant, enabling timely interventions and reducing the likelihood of complications. It also facilitates ongoing monitoring of responses to surfactant administration and CPAP ventilation.

LUS has proven invaluable in the rapid assessment of unstable neonates, aiding clinical decision-making without the delays associated with transport or additional resource requirements.

Currently, this non-invasive method has become revolutionary in neonatal intensive care units, improving the management of respiratory conditions and reducing the use of invasive and risky procedures. Its role is expected to grow continuously as technology and protocol implementation advance.

1. Hypothesis and General Objectives

This study is based on the following hypotheses:

a) Evaluating the relationship between the severity of respiratory distress syndrome (RDS) and gestational age in newborns to determine whether prematurity influences the need for and type of therapeutic interventions.

b) Determining the correlation between Apgar scores at 1 and 5 minutes and the severity of respiratory conditions to assess whether lower scores are associated with an increased risk of respiratory complications.

c) Analyzing the utility of the lung ultrasound score (LUS) in risk stratification and guiding therapeutic interventions, such as surfactant administration or mechanical ventilation.

d) Investigating the impact of surfactant administration on the clinical outcomes of newborns with respiratory syndromes to evaluate treatment efficacy based on disease severity.

e) Comparing the effectiveness of lung ultrasound and chest radiography in monitoring and assessing neonatal respiratory pathologies to establish the advantages and limitations of each imaging modality.

f) Determining the incidence and types of respiratory support required (mechanical ventilation, CPAP, oxygen therapy) based on the severity of the respiratory syndrome and LUS results.

g) Assessing the effects of maternal pathologies, such as pregnancy-induced hypertension or prenatal infections, on the therapeutic needs of newborns.

h) Identifying risk factors associated with prolonged hospitalization in newborns with respiratory conditions to optimize management and resource utilization in the NICU.

i) Analyzing the correlation between antenatal corticosteroid use and the need for respiratory interventions at birth to determine the efficacy of corticosteroid therapy in reducing the severity of respiratory syndromes.

j) Examining the influence of sex and other demographic variables on the severity and progression of respiratory syndromes to identify clinical differences between subgroups.

Research Objectives

The primary objective of this research is to emphasize the importance of imaging methods, such as neonatal lung ultrasound and chest radiography, in diagnosing respiratory conditions in newborns—a complex and frequent pathology in NICUs, especially among premature infants.

Respiratory distress syndrome is one of the leading causes of neonatal morbidity and mortality, influenced by factors such as gestational age, maternal pathologies, and perinatal interventions.

In this context, the study aims to investigate both clinical and imaging characteristics associated with respiratory conditions and the efficacy of therapeutic interventions. Assessing diagnostic and monitoring methods, such as lung ultrasound and chest radiography, is essential for improving the management of these patients.

The general objectives of this thesis aim to address critical questions regarding the identification, monitoring, and appropriate treatment of newborns with respiratory syndromes, considering both maternal variables and specific patient characteristics.

Newborns were assessed immediately after birth, within the first 10 minutes of life, and subsequently admitted to the NICU, where they underwent continuous monitoring. Clinical and laboratory analyses were collected dynamically, and lung ultrasounds and chest radiographs were performed to evaluate and adjust treatment based on respiratory evolution.

The general objectives of this research are outlined as follows:

a) Evaluating the relationship between the severity of respiratory distress syndrome, gestational age, Apgar scores at 1 and 5 minutes, and the need for therapeutic interventions.

b) Analyzing the utility of the lung ultrasound score (LUS) in risk stratification and guiding therapeutic interventions.

c) Investigating the impact of surfactant administration and various respiratory support methods on the clinical progression of patients.

d) Comparing the effectiveness of lung ultrasound and chest radiography in monitoring and assessing neonatal respiratory pathologies.

2. General Methodology of the Research

This study is a prospective observational study. Its prospective nature is defined by the inclusion of patients based on data collected about the mother from clinical observation sheets and information about the newborns obtained through clinical and paraclinical evaluations in the NICU of the Elias University Emergency Hospital, Bucharest.

The study was conducted over two years (2022–2023) and included a total of 82 newborns with gestational ages ranging from 31 to 41 weeks, admitted to the NICU immediately after birth. These infants presented with respiratory distress syndrome, diagnosed based on clinical and paraclinical investigations.

The database included the following maternal variables: antenatal corticosteroid administration, mode of delivery, and risk factors. Neonatal variables included: gestational age, sex, birth weight, Apgar scores at 1 and 5 minutes, coloration, presence of respiratory symptoms within the first 24 hours of life, NICU admission requirements, need for supplemental oxygen (via headbox), respiratory support/mechanical ventilation, parenteral nutrition, inotropic support, antibiotic therapy, surfactant administration, pulmonary radiographic findings, pulmonary ultrasound findings, lung ultrasound scores, and length of hospital stay.

The data were subsequently analyzed to establish the relationship between lung ultrasound scores, diagnosis severity, surfactant administration, and respiratory parameter management. Newborns were categorized based on their diagnosed respiratory pathology: respiratory distress syndrome, transient tachypnea of the newborn, meconium aspiration syndrome, pneumothorax, and pneumonia.

Upon admission, according to the NICU protocol, arterial blood gas analyses and chest radiography were performed. Lung ultrasound and LUS calculation were subsequently carried out. Surfactant was administered based on European consensus guidelines (early rescue therapy if FiO_2 > 0.3 at CPAP pressure of at least 6 cm H_2O).

Inclusion criteria:

- Newborns with gestational ages between 31 and 41 weeks.
- Presence of respiratory distress syndrome at birth.
- Admission to the NICU immediately after birth.

Exclusion criteria:

- Major congenital heart diseases.
- Significant chromosomal abnormalities or congenital malformations.
- Inborn errors of metabolism.
- Untreated severe maternal infections during pregnancy.

Most newborns received surfactant through the INSURE method (intubate-surfactant-extubate), followed by non-invasive respiratory support (e.g., CPAP). Lung ultrasound was performed and interpreted by a clinician experienced in ultrasonography.

Statistical Analysis

All collected information was centralized in a database created with Microsoft Excel, and statistical analysis was performed using IBM SPSS Statistics 28.0 (IBM Corporation, USA, 2021).

Continuous variables with normal distribution, confirmed by the Shapiro-Wilk test ($p < 0.05$), are expressed as mean ± standard deviation, while non-normally distributed variables are expressed as median (mode). Numeric or ordinal variables are presented as counts.

The independent t-test was used to compare data regardless of distribution, as the groups consisted of more than 20 patients. A p-value of < 0.05 was considered statistically significant. For non-normally distributed variables, the Mann-Whitney U test with Yates correction was used. Variance equality was evaluated using Levene's test, and if the p-value for Levene's test was < 0.05, unequal variance t-values were reported.

For categorical variables, Pearson's Chi-square test was applied to determine statistically significant differences ($p < 0.05$) between expected and observed frequencies in the two groups.

All statistical data were reported following the latest recommendations of the American Psychological Association (APA) at the time of writing.

Ethical Considerations

The study was conducted with the approval of the ethics committee of the Elias University Emergency Hospital. All mothers provided informed consent before including their newborns in the study, in compliance with ethical norms for medical research. Consent was obtained after detailed explanations of the study's objectives and procedures.

3. Results

The study conducted is a prospective observational study. Its prospective nature is defined by the inclusion criteria for patients, which involved collecting data about the mothers from clinical observation records, while information about the newborns was gathered through clinical and paraclinical evaluations in the Neonatal Intensive Care Unit (NICU) of the Elias University Emergency Hospital in Bucharest.

The study was conducted over two years (2022–2023) and included a total of 82 newborns with gestational ages ranging from 31 to 41 weeks. These infants were admitted to the NICU immediately after birth and diagnosed with respiratory distress syndrome based on clinical and paraclinical investigations.

The numerical variables included in the study (gestational age, birth weight, Apgar score at 1 minute, and Apgar score at 5 minutes) were analyzed based on gender. The first step of the analysis involved determining the normality of the distribution of these variables according to the patient's gender. Since the patient cohort consisted of fewer than 100 individuals, the Shapiro-Wilk test was deemed appropriate for this analysis. (Table 4.1.)

Table 4.1.: Results of the Shapiro-Wilk Test by Gender

Variables	**Gender**	**Statistic**	**Df**	**P**
Gestational Age	Male	0.930	53	0.004
	Female	0.931	29	0.060
Birth Weight	Male	0.969	53	0.190
	Female	0.977	29	0.764
Apgar Score at 1 minute	Male	0.766	53	<0.001
	Female	0.631	29	<0.001
Apgar Score at 5 minute	Male	0.809	53	<0.001
	Female	0.770	29	<0.001

As observed, the values for gestational age, Apgar score at 1 minute, and Apgar score at 5 minutes did not follow a normal distribution based on gender ($p > 0.05$ for both groups studied). Consequently, statistical analysis for these variables was conducted using the non-parametric Mann-Whitney U test.

Regarding respiratory pathology at birth, out of the total of 82 newborns included in the study, most presented with moderate respiratory distress syndrome (RDS) (n=17), followed by moderate transient neonatal tachypnea (TTN) (n=16). Fourteen patients had severe RDS. Twelve patients had meconium aspiration syndrome (MAS). Seven patients had mild RDS. Six patients were diagnosed with congenital pneumonia. Four patients each had severe TTN and mild TTN, respectively, and only two patients were diagnosed with pneumothorax. (Figure 4.1.)

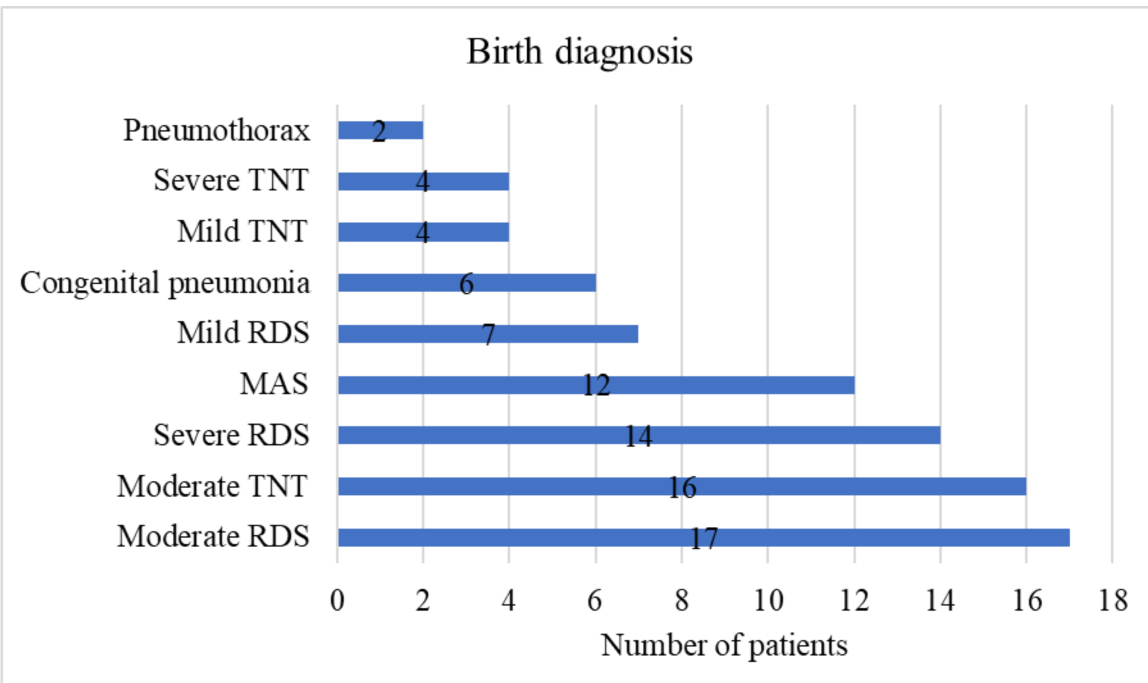

Figure 4.1.: Graphical representation of the diagnosis at birth.

The average LUS score in the cohort was 8.80 ± 2.57, with a minimum score of 2 and a maximum score of 14 (Figure 4.2).

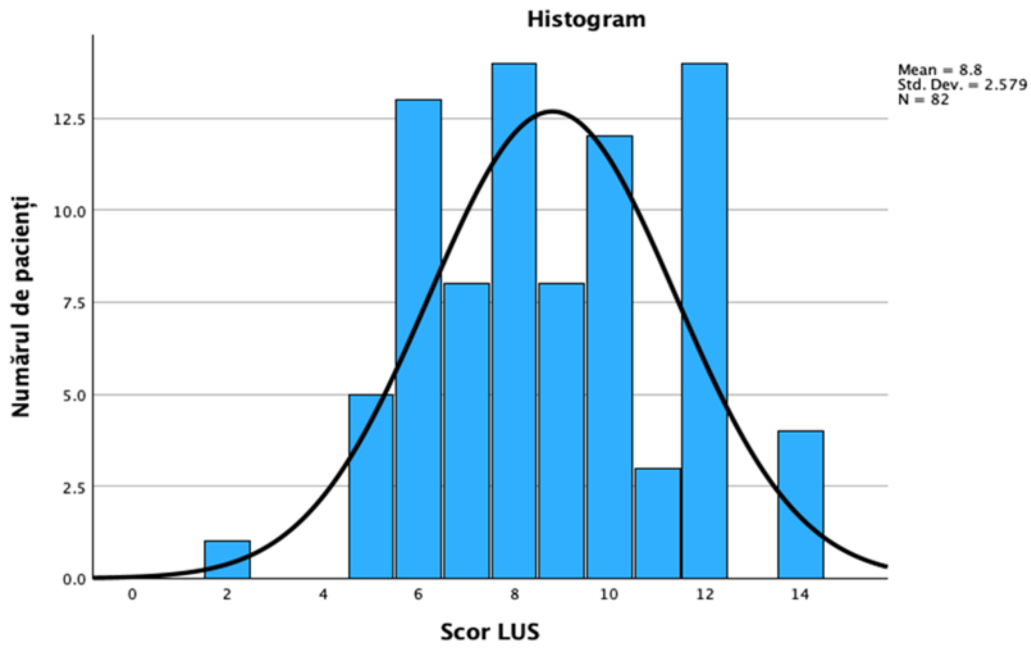

Figure 4.2.: Distribution and average LUS score in the sample

The average LUS scores, in descending order, were as follows: pneumonia (9.83 ± 1.16), RDS (9.71 ± 2.68), pneumothorax (9.00 ± 1.41), TTN (7.79 ± 2.51), and MAS (7.42 ± 1.73). A one-way ANOVA test was conducted to determine if the LUS score differed by diagnosed disease. The cohort was diagnosed with 5 diseases, and the mean scores according to diagnosis are presented in Figure 3. The ANOVA test showed statistically significant differences between the types of diagnosed diseases in the group ($F(4, 77) = 3.62$, $p = 0.009$) . Additionally, significant differences were observed between groups, specifically between patients with TTN and patients with RDS ($p = 0.027$), and between patients with RDS and patients with MAS ($p = 0.043$). (Figure 4.3.)

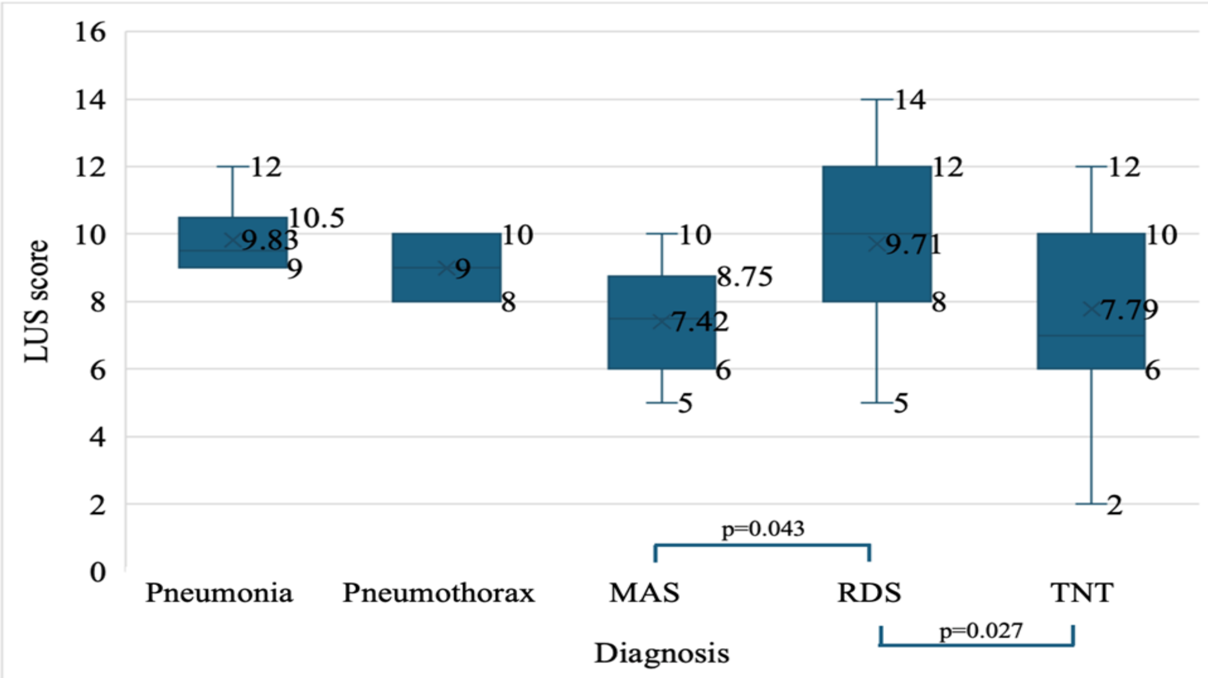

Figure 4.3.: Average LUS score by pathology

Significant differences were found in patients who received surfactant treatment ($\chi^2(2) = 10.071$, $p = 0.007$). Specifically, no patients with mild respiratory functional syndrome received surfactant, 7 children with moderate syndrome received it, and 11 with severe syndrome received it. (Figure4.4.)

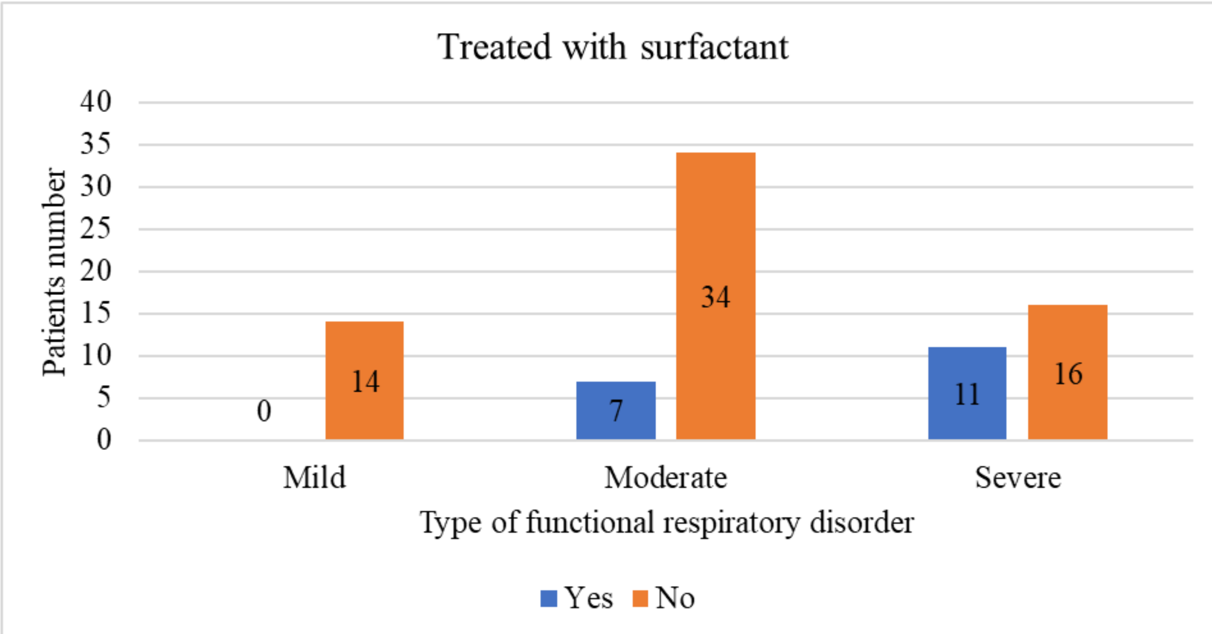

Figure 4.4.: Sample distribution by type of respiratory syndrome and surfactant administration

Further analysis was conducted to determine if there were statistically significant differences between two groups of patients – those who received surfactant (n = 18) and those who did not (n = 64) – regarding gestational age, birth weight, Apgar score at 1 minute, and Apgar score at 5 minutes. The first step was to determine if these numerical variables were normally distributed in the two patient groups using the Shapiro-Wilk test. Only birth weight was normally distributed in both patient groups ($p > 0.05$). Therefore, the non-parametric Mann-Whitney test was conducted to analyze the existence of statistically significant differences between the two groups concerning gestational age, Apgar score at 1 minute, and Apgar score at 5 minutes. To compare if there were significant differences in birth weight, the independent t-test was used. (Table 4.2.)

Table 4.2.: Shapiro-Wilk test results by surfactant administration

Variable	Surfactant adminstration	Statistic	Df	P
Gestational age	Yes	0.862	18	0.013
	No	0.937	64	0.003
Birth weight	Yes	0.970	18	0.803
	No	0.970	64	0.124
Apgar Score at 1 minute	Yes	0.613	18	<0.001
	No	0.723	64	<0.001
Apgar Score at 5 minutes	Yes	0.775	18	<0.001
	No	0.772	64	<0.001

Gestational age was significantly different between the two groups of patients (those who received surfactant, n=18, and those who did not receive surfactant, n=64) with U=348.00, Z=-2.575, p=0.010. Similarly, the Apgar score at 1 minute was significantly different (U=352.00, Z=-2.866, p=0.004), as was the Apgar score at 5 minutes (U=334.00, Z=-3.056, p=0.002).(Figure 4.5.)

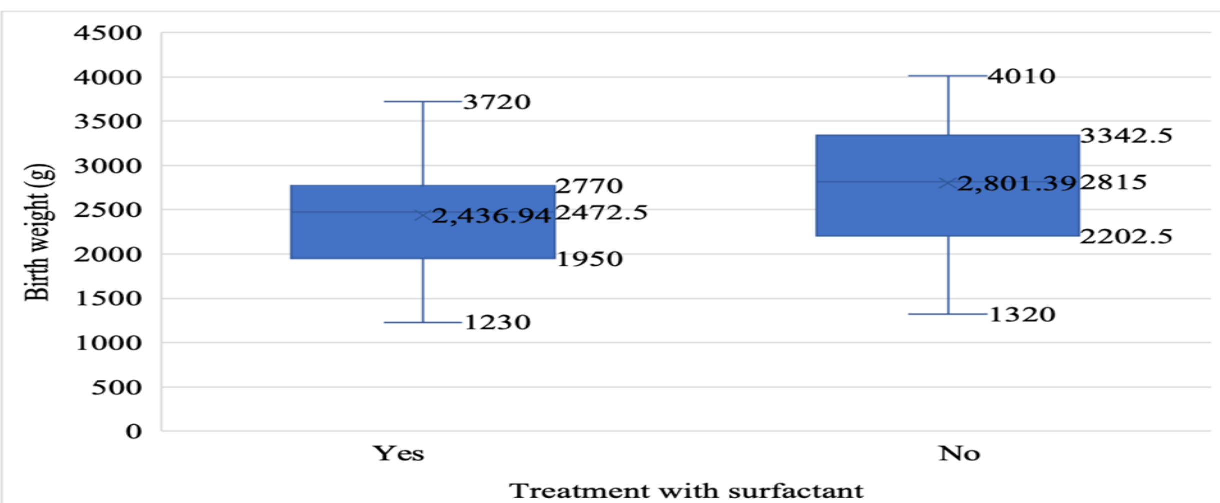

Figure 4.5.: Average birth weight based on surfactant administration

Additionally, the majority of newborns who required respiratory support via CPAP did not receive surfactant (n=31). These data are comparable to the patients who required CPAP therapy and also received surfactant (n=14). Thus, the differences were statistically significant ($\chi^2(1) = 4.884$, $p = 0.027$).(Figure 4.6.)

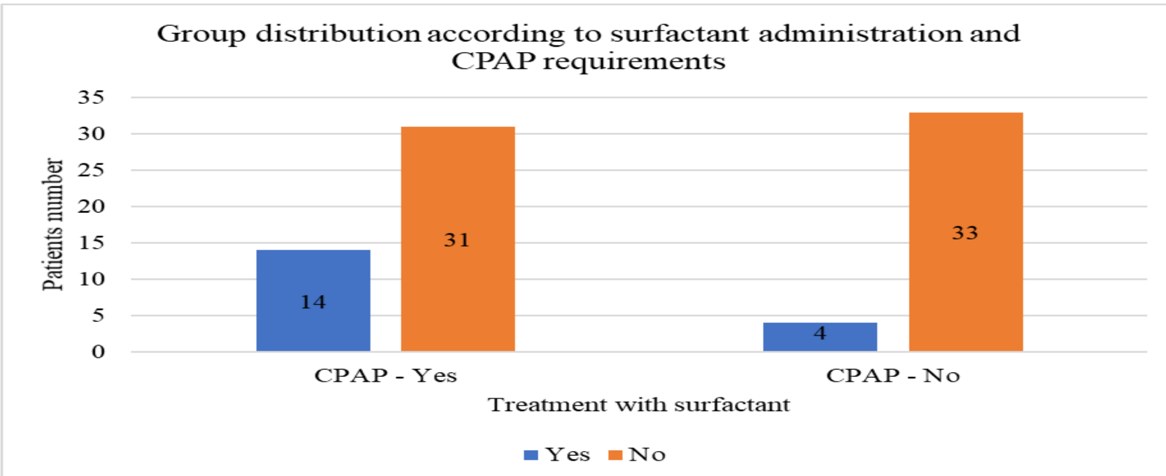

Figure 4.6.: Sample distribution by CPAP requirement and surfactant administration

Further analyzing the number of pulmonary ultrasounds and X-rays performed on the newborns included in the study, we found the following aspects: 36 newborns did not undergo any pulmonary X-rays, 37 underwent a single pulmonary X-ray during hospitalization, 6 newborns had 2 X-rays, and only 3 underwent 3 pulmonary X-rays during hospitalization (Figure 4.7.). Most newborns underwent 2 pulmonary X-rays (n=25), and 22 underwent 3 pulmonary X-rays. Only 3 newborns in the study underwent 6 or 7 pulmonary ultrasounds (Figure 4.8.).

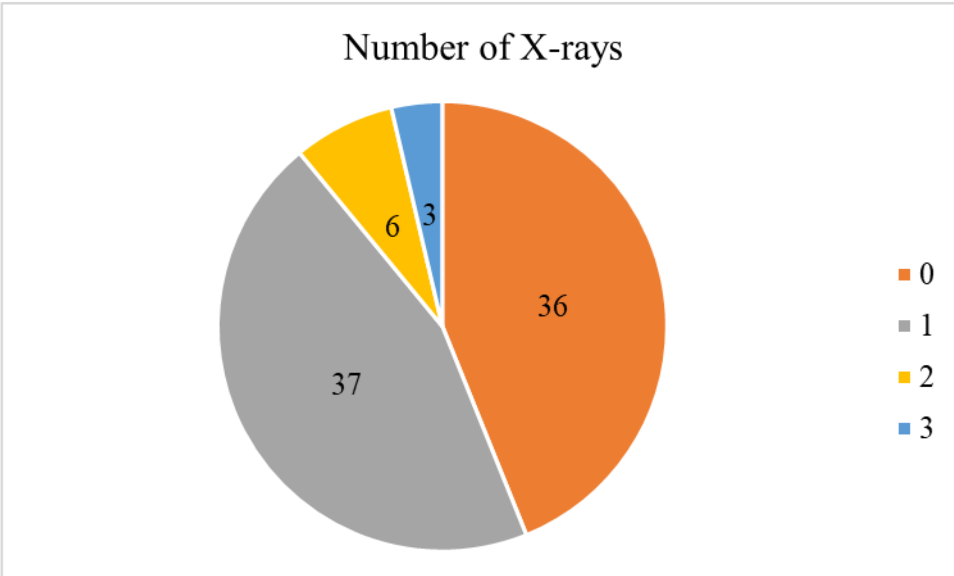

Figure 4.7.: Sample distribution by the number of chest X-rays performed

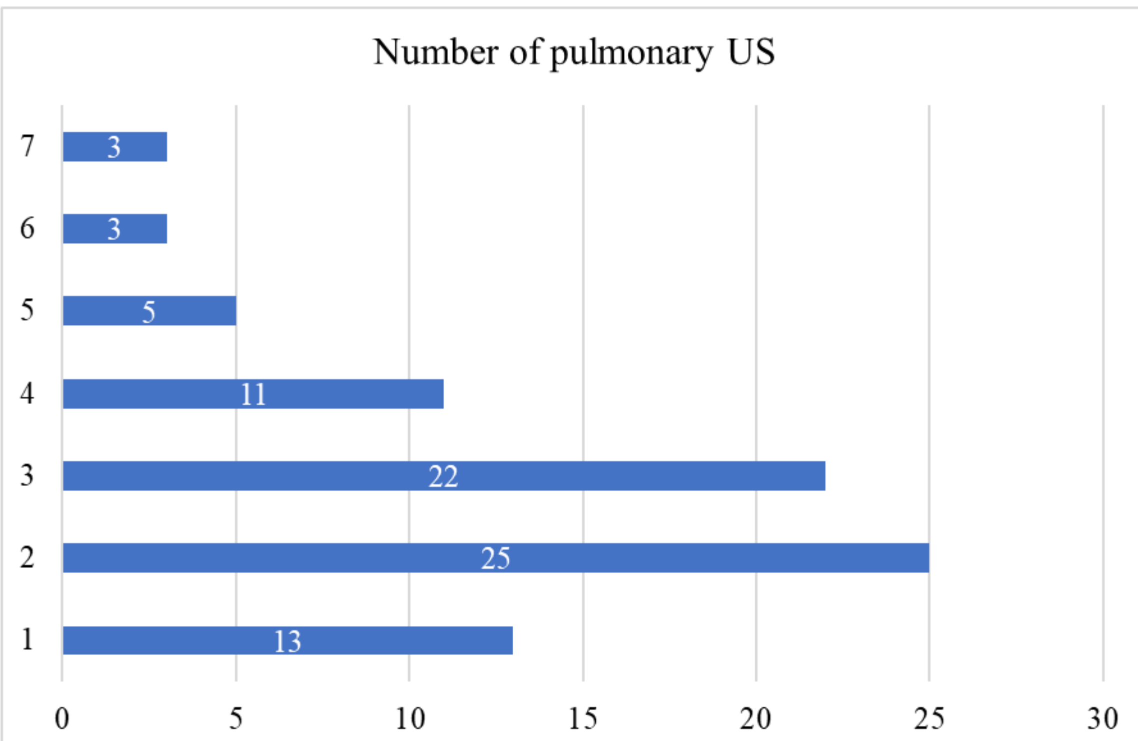

Figure 4.8.: Sample distribution by the number of lung ultrasounds performed

Number of Ultrasounds in Preterm and Term Newborns

The data has been represented as Mean±S.D. of number of ultrasounds performed per group of patients (term and premature newborns). The mean number of ultrasounds performed in term newborns was 2.15±0.98 (n=27 patients), which was significantly lower than the number of ultrasounds performed in the premature newborns group (n=55), of 3.25±1.57 (t(80)=3.33, p<0.001) (Figure 4.9.)(Table 4.3.).

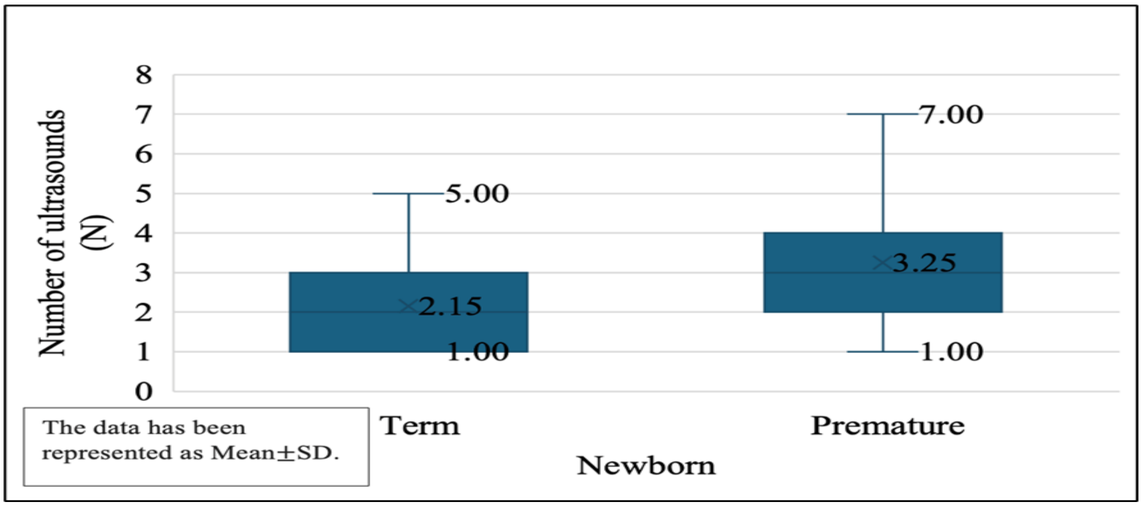

Figure 4.9.: Boxplots of number of ultrasounds performed in term and premature newborns.

Table 4.3.: Number of Ultrasounds in preterm and term newborns.

Number of Ultrasounds	PREMATURE	TERM
Minimum	1	1
Quartile 1	2	1.5
Median	3	2
Quartile 3	4	3
Maximum	7	5

The data has been represented as number of patients.

Number of X-rays in Preterm and Term Newborns

The data has been represented as Mean±S.D. of number of chest X-rays performed per group of patients (term and premature newborns). The mean number of chest X-rays performed in the term newborns was 0.33±0.55 (n=27 patients), which was significantly lower than the number of ultrasounds performed in the premature newborns group (n=55), of 0.89±0.78 (t(80)=3.30, $p<0.001$) (Figure 4.10.)(Table 4.4.).

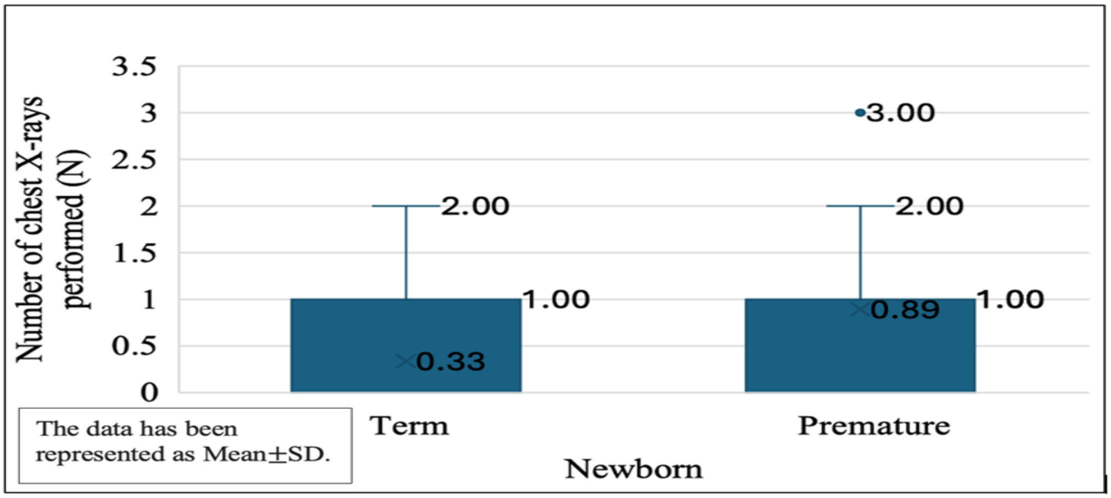

Figure 4.10.: Boxplots of numbers of X-rays performed in term and premature newborns

Table 4.4.: Number of X-ray in preterm and term newborns.

Table 2: Number of X-rays in preterm and term newborns.

Number X-rays	PREMATURE	TERM
Minimum	0	0
Quartile 1	0	0
Median	1	0
Quartile 3	1	1
Maximum	3	2

The data has been represented as number of patients = N.

The average number of days spent in the hospital by each newborn was 10.74 ± 7.17 days. (Figure 4.11.)

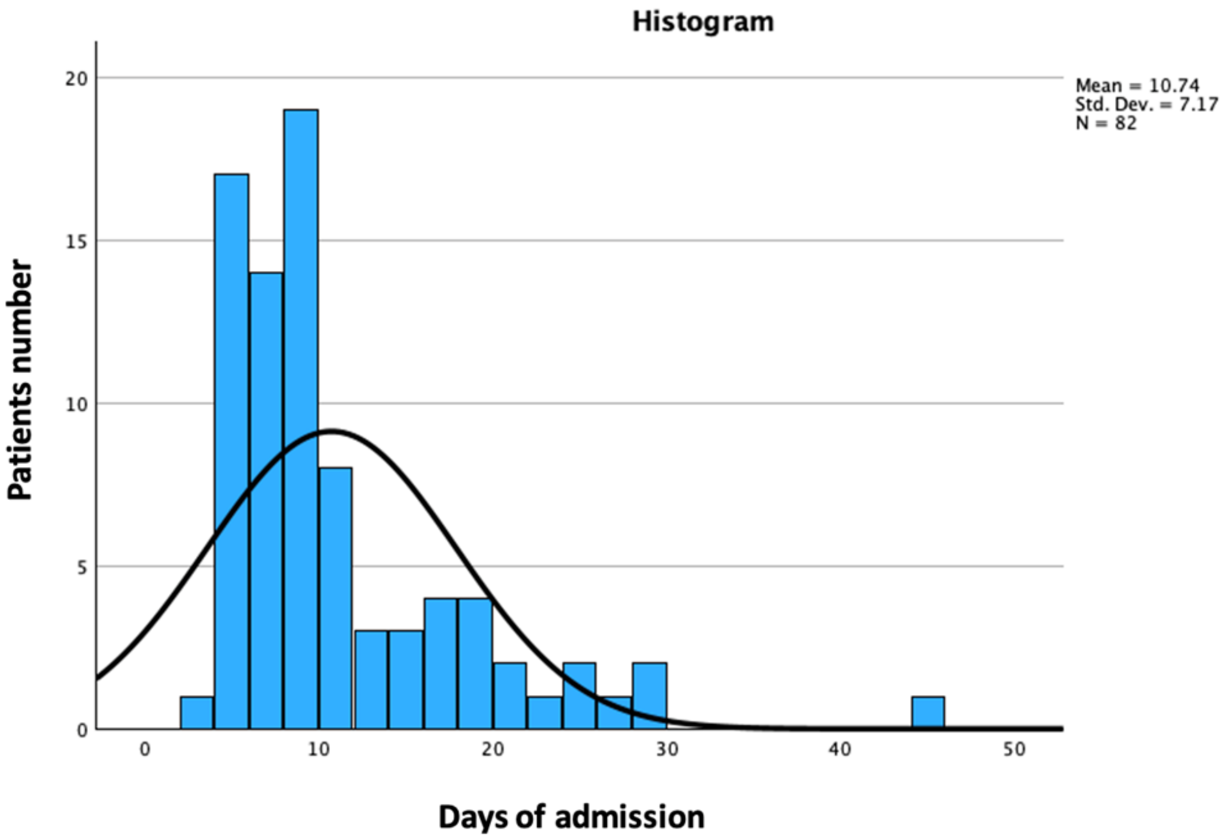

Figure 4.11.: Average number of hospitalization days in the sample

4. Conclusions and Personal Contributions

In this doctoral thesis, I highlighted the advantages of lung ultrasound (LUS) in the rapid and accurate diagnosis of neonatal respiratory pathologies, emphasizing its positive impact on adapting clinical management and reducing radiation exposure.

Additionally, I contributed to the development of standardized guidelines for the use of lung ultrasound in the diagnosis and monitoring of respiratory conditions in newborns. These protocols include diagnostic methods, disease severity assessment, and monitoring treatment efficacy, designed to support the optimal application of the lung ultrasound score.

I demonstrated that lung ultrasound can provide reliable and rapid diagnoses, reducing the need for X-rays and minimizing the risks associated with radiation exposure. This aspect paves the way for a shift in the diagnostic approach to neonatal respiratory conditions.

From the detailed analysis of clinical cases included in this study, we conclude that lung ultrasound has shown high efficiency in diagnosing RDS by identifying characteristic air bronchograms and extensive consolidations. Ultrasound scores directly correlated with disease severity and the need for assisted ventilation. Ultrasound enabled the rapid identification of areas of pulmonary consolidation and pleural effusions, facilitating the prompt initiation of antibiotic treatment in cases of neonatal pneumonia. The ultrasound technique demonstrated superior sensitivity compared to chest X-rays in detecting pneumothorax, reducing the time to therapeutic intervention in pneumothorax cases.

Real-time monitoring of responses to surfactant administration and mechanical ventilation allowed for rapid treatment adjustments, thereby optimizing clinical outcomes.

However, the need for adequate training of medical personnel and the variability in image interpretation remain significant challenges that can influence diagnostic accuracy.

Future Perspectives

Standardizing the use of lung ultrasound in all NICUs:

It is necessary to develop and implement uniform protocols for the use of lung ultrasound in all neonatal intensive care units. These protocols should be adapted to the various experience levels of medical personnel and include continuous training programs to ensure the correct and effective application of the method.

Integrating lung ultrasound into medical practice guidelines:

By including LUS in national and international guidelines for the diagnosis and management of neonatal respiratory pathologies, ultrasound could become a standard evaluation method. This integration would standardize and improve the quality of neonatal care, providing access to a safe and effective technology.

Establishing lung ultrasound as the primary diagnostic method:

As research continues to confirm the accuracy and benefits of LUS, it could entirely replace chest X-rays in diagnosing neonatal respiratory conditions. The advantages of ultrasound, including the absence of radiation, the possibility of dynamic monitoring, and accessibility, position it as the reference method in neonatal practice.

Expanding the use of ultrasound scoring:

The broader use of ultrasound scores will enable more precise quantification of the severity of respiratory conditions and detailed monitoring of treatment responses. These tools could be integrated into clinical protocols to guide therapeutic interventions.

Implementing continuous training programs for neonatologists:

Developing standardized educational courses that include advanced lung ultrasound techniques is essential. These programs will support neonatologists in effectively using ultrasound, thereby improving patient care and reducing disparities in the application of this method.

By adopting lung ultrasound as a core method in neonatal intensive care units, significant improvements in care quality and patient outcomes can be achieved. This imaging technique has the potential to become the gold standard in diagnosing neonatal respiratory pathologies due to its reliability, safety, and accessibility, radically transforming the current approach to neonatal care.

Selective bibliography

1. Han S, Mallampalli RK. The Role of Surfactant in Lung Disease and Host Defense against Pulmonary Infections. Ann Am Thorac Soc. 2015 May;12(5):765-74. doi: 10.1513/AnnalsATS.201411-507FR. PMID: 25742123; PMCID: PMC4418337.
2. Sweet DG, Carnielli VP, Greisen G, Hallman M, Klebermass-Schrehof K, Ozek E, Te Pas A, Plavka R, Roehr CC, Saugstad OD, Simeoni U, Speer CP, Vento M, Visser GHA, Halliday HL. European Consensus Guidelines on the Management of Respiratory Distress Syndrome: 2022 Update. Neonatology. 2023;120(1):3-23. doi: 10.1159/000528914. Epub 2023 Feb 15. PMID: 36863329; PMCID: PMC10064400.
3. Mark C. Liszewski, Edward Y. Lee, Neonatal Lung Disorders: Pattern Recognition Approach to Diagnosis, Volume 210, Issue 5, https://doi.org/10.2214/AJR.17.19231.
4. Corsini I, Rodriguez-Fanjul J, Raimondi F, Boni L, Berardi A, Aldecoa-Bilbao V, Alonso-Ojembarrena A, Ancora G, Aversa S, Beghini R, Meseguer NB, Capasso L, Chesi F, Ciarcià M, Concheiro A, Corvaglia L, Ficial B, Filippi L, Carballal JF, Fusco M, Gatto S, Ginovart G, Gregorio-Hernández R, Lista G, Sánchez-Luna M, Martini S, Massenzi L, Miselli F, Mercadante D, Mosca F, Palacio MT, Perri A, Piano F, Prieto MP, Fernandez LR, Risso FM, Savoia M, Staffler A, Vento G, Dani C. Lung UltrasouNd Guided surfactant therapy in preterm infants: an international multicenter randomized control trial (LUNG study). Trials. 2023 Nov 4;24(1):706. doi: 10.1186/s13063-023-07745-8. PMID: 37925512; PMCID: PMC10625281.
5. Nguyen J. Call for point-of-care ultrasound training regimens in neonatal-perinatal medicine. J Pediatr. 2017;185:254. https://doi.org/ 10.1016/j.jpeds.2017.02.029
6. Liang HY, Liang XW, Chen ZY, Tan XH, Yang HH, Liao JY, Cai K, Yu JS. Ultrasound in neonatal lung disease. Quant Imaging Med Surg. 2018 Jun;8(5):535-546. doi: 10.21037/qims.2018.06.01. PMID: 30050788; PMCID: PMC6037955.
7. Sweet DG, Carnielli VP, Greisen G, Hallman M, Klebermass-Schrehof K, Ozek E, Te Pas A, Plavka R, Roehr CC, Saugstad OD, Simeoni U, Speer CP, Vento M, Visser GHA, Halliday HL. European Consensus Guidelines on the Management of Respiratory Distress Syndrome: 2022 Update. Neonatology. 2023;120(1):3-23. doi: 10.1159/000528914. Epub 2023 Feb 15. PMID: 36863329; PMCID: PMC10064400.

8. Raimondi F, Yousef N, Rodriguez Fanjul J, de Luca D, Corsini I, Shankar-Aguilera S, Dani C, di Guardo V, Lama S, Mosca F, Migliaro F, Sodano A, Vallone G, Capasso L (2019) A multicenter lung ultrasound study on transient tachypnea of the neonate. Neonatology 115:263–268

9. Ruoss JL, Bazacliu C, Cacho N, De Luca D. Lung Ultrasound in the Neonatal Intensive Care Unit: Does It Impact Clinical Care? Children (Basel). 2021 Nov 29;8(12):1098. doi: 10.3390/children8121098. PMID: 34943297; PMCID: PMC8700415.

10. Application of ultrasonography in neonatal lung disease: An updated review. Jin Wang,Hongjuan Wei, Hui Chen, Ke Wan, Ruifeng Mao, Peng Xiao, Xin Chang. Front. Pediatr., 25 October 2022, Sec. Pediatric Pulmonology, Volume 10 – 2022.

11. Kurepa, D., Zaghloul, N., Watkins, L. *et al.* Neonatal lung ultrasound exam guidelines. *J Perinatol* 38, 11–22 (2018). https://doi.org/10.1038/jp.2017.140

List of scientific publications

1. Popa A E, Popescu S D, Tecuci A, et al. (August 03, 2024) Lung Ultrasound and Ultrasound Score: A Useful Tool in Neonatal Intensive Care Units for the Diagnosis and Therapeutic Management of Newborns With Respiratory Pathology. Cureus 16(8): e66064. doi:10.7759/cureus.66064, IF= 1.1, (Capitolul 2, pag.70, 71, 74, 88, 91, 92)
   Link: https://www.cureus.com/articles/278427-lung-ultrasound-and-ultrasound-score-a-useful-tool-in-neonatal-intensive-care-units-for-the-diagnosis-and-therapeutic-management-of-newborns-with-respiratory-pathology

2. Popa A E, Popescu S D, Tecuci A, et al. (September 20, 2024) Current Trends in the Imaging Diagnosis of Neonatal Respiratory Distress Syndrome (NRDS): Chest X-ray Versus Lung Ultrasound. Cureus 16(9): e69787. doi:10.7759/cureus.69787, (Capitolul 1, pag. 4-34)
   Link: https://www.cureus.com/articles/296778-current-trends-in-the-imaging-diagnosis-of-neonatal-respiratory-distress-syndrome-nrds-chest-x-ray-versus-lung-ultrasound

3. Popa, A. E., Cinteza, E. E., Popescu, S. D., Tecuci, A., Vladareanu, S., & Carol, ". (2024). Maedica-a Journal of Clinical Medicine Radiological and Ultrasound Findings in Neonatal Respiratory Pathology: Perspectives in Diagnosis. Maedica A Journal of Clinical Medicine, 19(4). https://doi.org/10.26574/maedica.2024.19.4.718, (Capitolul 2, pag 83-86, 89-90)
   Link: https://www.maedica.ro/articles/2024/4/2024_19(22)_No4_pg718-725.pdf