Zagazig University Medical Journal
www.zumj.journals.ekb.eg
https://doi.org/10.21608/zumj.2024.314423.3533 Volume 31, Issue 1, January. 2025
Manuscript id: ZUMJ-2408-3533
Doi: 10.21608/zumj.2024.314423.3533
ORIGINAL ARTICLE

Lung Ultrasound Scoring System in Mechanically Ventilated Children

Nehad Ahmed Karam[1], Sameh Saber Bayoumi Ahmed[2], Asmaa Gamal Abbas Khotaby[1*], Sahbaa Fehr Mohamed Hafez [1]
[1] Pediatrics Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt
[2] Radiology Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt

***Corresponding author:**
Asmaa Gamal Abbas Khotaby
Email:
asmaajamalabbas@gmail.com,

Submit Date: 26-08-2024
Revise Date: 25-09-2024
Accept Date: 30-09-2024

ABSTRACT

Background: Lung ultrasound is an increasingly used tool for monitoring pulmonary lesions or improving the diagnosis of pneumonia in critically ill children.

Aim: This study aimed to examine the relationship between the pulmonary ultrasound scoring system and clinical metrics in order to follow up with patients with acute respiratory failure, assess treatment response, and predict weaning.

Methods: This prospective cohort study included 52 children on mechanical ventilation who were admitted to the pediatric intensive care unit (PICU) at our institute. The Pediatric Risk of Mortality scores (PRISM III) were calculated within 24 hours of PICU admission. Pulmonary Ultrasound examinations were performed at 3 time points during a patient's ICU stay: as soon as possible after intubation, 48 hours after the initial examination, and after extubation.

Results: Duration of intubation ranged from 3 to 11 days with a median (IQR) of 5 (2.25), while the duration of ICU stays ranged from 3 to 13 days with a median (IQR) of 6 (4) and duration of hospital stay ranged from 4 to 33 days with median (IQR) of 10(10.25). As regards outcome; (59.6%) of the patients died, while (40.4%) of the patients were discharged from ICU. There was a highly statistically significant positive correlation between the first total US score and the duration of ICU stay and ventilation days (p-value<0.001). Also, ROC curve analysis was used to differentiate discharged from dead patients by using the second US score at cut point 12; it showed a sensitivity of (93.55%) and a specificity of (76.19%) with an AUC of (0.940).

Conclusion: The pulmonary ultrasound scoring system is a good prognostic tool in children with acute respiratory failure, predicting mortality and assessment of treatment response, and predicting mortality and treatment response assessment.

Keywords: Pulmonary Ultrasound, Lung Ultrasound, Respiratory failure

INTRODUCTION

Chest physicians are becoming more interested in transthoracic ultrasonography. Modern ultrasound equipment is portable, lightweight, affordable, and easy to use, making it ideal for both bedside examinations of critically sick patients and outpatient settings. In the near future, ultrasound will be a useful and crucial tool for pulmonologists **[1].**

The use of lung ultrasound (LUS) has grown in both adult and pediatric populations because it quickly assesses a number of lung and pleural illnesses. Many benefits of the approach, including its affordability, speed, absence of ionizing radiation, bedside accessibility, and repeatability, have contributed to its adoption **[2].**

According to Rodriguez, **[3]** LUS has a well-established role in directing interventional procedures, such as thoracocentesis and biopsy, and it has been demonstrated to improve outcomes by lowering complications (such as pneumothorax).

In order to reduce the use of chest radiography, which is linked to the negative effects of radiation exposure (particularly in pediatric patients), many practitioners have argued for the routine use of lung US in the ICU **[4].** Due to children's small thoracic diameters and the lack of ionizing radiation required to provide diagnostic imaging results, LUS has a specific role in pediatrics, including enhanced visualization of abnormalities in the thorax **[5]**.

LUS is a method that pediatricians are increasingly using, particularly in emergency rooms, to assess patient response to physiotherapy and medication (e.g., diuretics) **[6].**

Pulmonary ultrasonography (PUA) can quantify extravascular lung water, which can predict outcome in critically ill patients. Scoring systems are correlated with mortality in patients with acute respiratory distress syndrome (ARDS), on hemodialysis, and with congestive heart failure (CHF) **[7].**

It has been shown that a new lung ultrasonography score has predictive value following heart surgery; it can forecast the duration of mechanical ventilation and the length of stay in the pediatric intensive care unit (PICU) **[8].** The aim of this study is to examine the relationship between the pulmonary ultrasound scoring system and clinical metrics to follow up with patients of acute respiratory failure, assess treatment response, and predict weaning.

METHODS

After our Local Ethics Committee approved the protocol (IRB# 11174-8-10-2023), this study was carried out in the pediatric intensive care unit (PICU) from June 2023 to December 2023, the pediatric department at our institute. Fifty-two kids were put on mechanical ventilation as a result. Parents' or guardians' written informed consent was acquired for research participants. The World Medical Association's code of ethics for human research, the Helsinki Declaration, was followed throughout the entire study procedure.

The Inclusion Criteria were all intubated children aged between 1 and 14 who were admitted to our institute's PICU.

Children with persistent lung disease, such as cystic fibrosis or bronchopulmonary dysplasia, patients unable to change positions safely due to significant hemodynamic instability, patients deemed unsuitable for lung ultrasonography due to severe chest cage deformities or subcutaneous emphysema, and patients with less than twenty-four hours on mechanical ventilation were excluded from the study.

A comprehensive history-taking procedure, a comprehensive clinical examination, and laboratory investigations (CBC, ESR, liver and kidney function tests, and electrolytes: Na, Ca, Mg, K, and Phosphorus) were performed on each patient. Chest radiograph. Vital signs, oxygen saturation, blood gas analysis, serial Glasco coma scale, and fluid input and output evaluation. Within 24 hours of PICU admission, the Pediatric Risk of Mortality scores (PRISM III) were computed. The PRISM III scoring system's 14 parameters were evaluated in order to provide a precise mortality risk assessment **[9].**

During a patient's stay in the intensive care unit, pulmonary ultrasound tests were conducted three times: as soon as the patient was intubated, 48 hours after the initial evaluation, and after extubation.

Technique of Ultrasound chest examination:

Alpinion Color Doppler Ul ultrasound was used to do a transthoracic ultrasound. A smal with transducer is us; with increasing age, the size of the thoracic cavity increases, and non-visualization of the deeper lung fields becomes a concern, and a convex or micro-convex (5-MHz) probe is used. Before beginning the examination, the patient's chest CT scan and x-ray should be reviewed in order to place them correctly for a chest ultrasonographic examination. This will serve as a guide for the region of interest and the patient's ideal placement **[1]**

The development of lung US scanning technology requires examining similar regions in each hemithorax. The anterior, lateral, and posterior parts of the hemithorax are roughly separated by the midclavicular line and the anterior and posterior axillary lines.

The lungThe lung is divided into anterior, lateral, and posterior segments by three lines: the (MC), midclavicular line, anterior axillary line (AAX), and posterior axillary line (PAX). The anterior lung lies between the parasternal line and anterior axillary line and is roughly divided along the nipple line into upper and lower zones. The lateral lung lies between the anterior axillary line and the posterior axillary line. The posterior lung lies posterior to the PAX **[10].**

To classify the findings, an image had to be frozen, and anomalies had to be counted. The track ball can be used to measure still images created using the freeze function**[11].**

What area of the scanned image is shown on the monitor at a certain magnification is defined by the depth function, which is a digital zoom. A vertical axis is used to display the scale. The maximum depth at which high-frequency scanning is carried out is about 3-5 cm. Ideally, the depth should be changed so that the area of interest completely fills the digital screen **[11].**

To optimize the contrast between tissues, alter the gain, which measures the amplification of the echoes and controls the image's brightness **[11].**

To perform a complete lung ultrasound scan (LUS), every hemithorax must be evaluated in the anterior, lateral, and posterior lung zones. Additionally, every lung field must be investigated in both the transverse and longitudinal orientations; neglecting to do so may result in missing abnormalities **[12].**

Scoring system:

Score 0 indicated that the A-lines were predominant, with scattered (<3) B-lines. Score 1 indicated that multiple non-fused B-lines. Score 2 indicated that dense, partially fused B-lines. Score 3 indicated that completely fused B-lines **[13]** (figure 1).

A (normal aeration): lung sliding/lung pulse with A lines or less than two B lines for intercostal space; **B1 (moderate loss of lung aeration):** multiple spaced B-lines, more or equal than 3 for each space; **B2 (severe loss of lung aeration):** multiple coalescent B lines with or without subpleural consolidations; **B3 or C (consolidation):** the presence of a tissue pattern with or without air bronchograms where N = 0, B1 = 1, B2 = 2, B3 = 3 [14]. The chest was divided into nine zones.

Total lung score (TLS) was the summation of all points across the nine lung zones (possible range = 0–36). The total B score represented the sum of only the B-line points (B1, B2, B3) (range = 0–27) The total anterior score included points from zones 1, 2, 6, and 7 and total posterior score from zones 3, 4, 5, 8, and 9, as shown in figure and 7, and total posterior score from zones 3, 4, 5, 8, and 9, as shown in Figure 1. If there was effusion, each zone got one extra point. Each zone could score up to four points, as shown in Figure 2 **[15]**.

LUS score was directly obtained and reported by the observers for each zone in a dedicated case report form.

STATISTICAL ANALYSIS

IBM SPSS 23.0 for Windows, a database software tool, was used to code, input, and analyze the gathered data (SPSS Inc., Chicago, IL, USA). The averages and standard deviations, median and range, were used to summarize numerical data. The summary of categorical data was provided by percentages and figures. When comparing categorical data, the Fisher's exact test or the Chi-square test were used. An established significance threshold of $P \leq 0.05$ was set.

RESULTS

This prospective cohort study involved 52 mechanically ventilated children Their ages ranged from 1 to 14 years with mean ± SD of 5.77 ± 3.29. Most of the patients (65.4%) were males, while (34.6%) were females. The most frequent diagnosis detected was bronchopneumonia, which was detected among (34.6%) of the patients, followed by pneumonia which was detected among (30.8%), acute kidney injury among (9.6%), post-arrest and congestive heart failure among (7.7%); septic shock among (5.8%), while the least frequent diagnosis detected was pleural effusion which was detected among (3.8%) of the patients (table 2). total lung ultrasound score in parenchymal diseases ranged from 8-28, which was higher than that of non-parenchymal diseases, ranged from 8-28, which was higher than that of non-parenchymal diseases, which ranged from 10-25, as regarded in Table 3. Post- extubation score showed a significant reduction than second US score in survived a significant reduction than second US score in surviving patients (table 4). Table 5 showed that there was a statistically significant positive correlation between the first US score with duration of ventilation, ICU stay, hospital stay, and mortality rate (P <0.05). There was a statistically significant reduction in the US score among the surviving group, as shown in Table 6.

We determined a cutoff point of 12 for predicting outcome, with a sensitivity of (93.55%), specificity of (76.19%) and AUC of (0.940) as shown in Figure 7.

Table 1: Demographic data among studied patient

Variables	**All patients (n=52)**
Age *(years)* Mean ± SD Range	 5.77 ± 3.29 (1 – 14)
Sex *(N.%)* Male Female	 34 (65.4%) 18 (34.6%)

Table 2: Diagnosis (etiology) among the studied patient

Variables *(N. %)*	**All patients(n=52)**
Bronchopneumonia	18 (34.6%)
Pneumonia	16 (30.8%)
Acute kidney injury	5 (9.6%)
Congestive heart failure	4 (7.7%)
Post arrest	4 (7.7%)
Septic shock	3 (5.8%)
Pleural effusion	2 (3.8%)

Table 3: Comparison between Parenchymal and Non-parenchymal diseases

Variables	**Non-parenchymal (n=15)**	**Parenchymal (n=37)**	**P Value**
Anterior score *Median (IQR)* *Range*	 6 (3.5) (3 – 15)	 9 (4) (4 – 18)	 0.42
Posterior score *Median (IQR)* *Range*	 8 (3) (4 – 10)	 6 (3) (3 – 12)	 0.67
Total score *Median (IQR)* *Range*	 14 (6) (10 – 25)	 16 (6) (8 – 28)	 0.82

Mann-Whittney U test, Non-significant: $P > 0.05$, Significant: $P \leq 0.05$* **IQR: Inter-quartile range

Table 4: Second and post extubation US score among studied patient

Variables	**All patients (n=52)**
Second US score *Median (IQR)* *Range*	 12 (6.75) (3 – 28)
Post extubation score *Median (IQR)* *Range*	 8 (8) (1 – 17)

IQR: Inter-quartile range**, US:** Ultrasound

Table 5: Correlation of First US score with mortality rate and hospitalization characteristics

Variable	First US score	
	r	***P***
Duration of ventilation	0.368	**0.002**
Duration of ICU stay	0.233	**0.001**
Duration of hospital stay	0.385	**0.04**
Mortality rate	**0.322**	**0.02**

Spearman rank correlation test, Non-significant: P >0.05, Significant: P ≤0.05* **ICU: Intensive care unit

Table 6: First, second and post extubation US score according to diagnosis

Variables Median (IQR)	**First US score**	**Second US score**	**Post extubation US score**	**P Value**	**Post HOC**
Acute Kidney Injury	15 (6)	13 (6)	15 (0)	0.21	P1=0.73 P2=0.11 P3=0.19
Septic shock	17 (3.5)	10 (3)	12 (3.5)	0.15	P1=0.06 P2=0.16 P3=0.44
Post arrest	12 (1.5)	7.5 (5)	6 (7)	0.31	P1=0.19 P2=0.33 P3=0.68
Pleural effusion	28 (0)	22 (6)	3 (0)	0.16	P1=0.29 P2=**0.04** P3=0.07
Pneumonia	17 (5.75)	14.5 (8.25)	8 (7)	**0.007**	P1=**0.002** P2<**0.001** P3=0.27
Bronchopneumonia	15 (7.25)	13 (4.5)	6 (1.5)	**0.04**	P1=**0.007** P2=**0.003** P3=0.49
Congestive Heart Failure	13 (7)	12 (3)	6 (3)	0.09	P1=0.52 P2=**0.02** P3=0.05

*P value comparison between the three groups, Non-significant: P >0.05,
Significant: P ≤0.05
-P1=comparison between First & Second US score
-P2=comparison between First & Post extubation US score
-P3=comparison between Second & Post extubation US score

There was a statistically significant reduction of the US score among a statistically significant reduction in the US score among the surviving group.

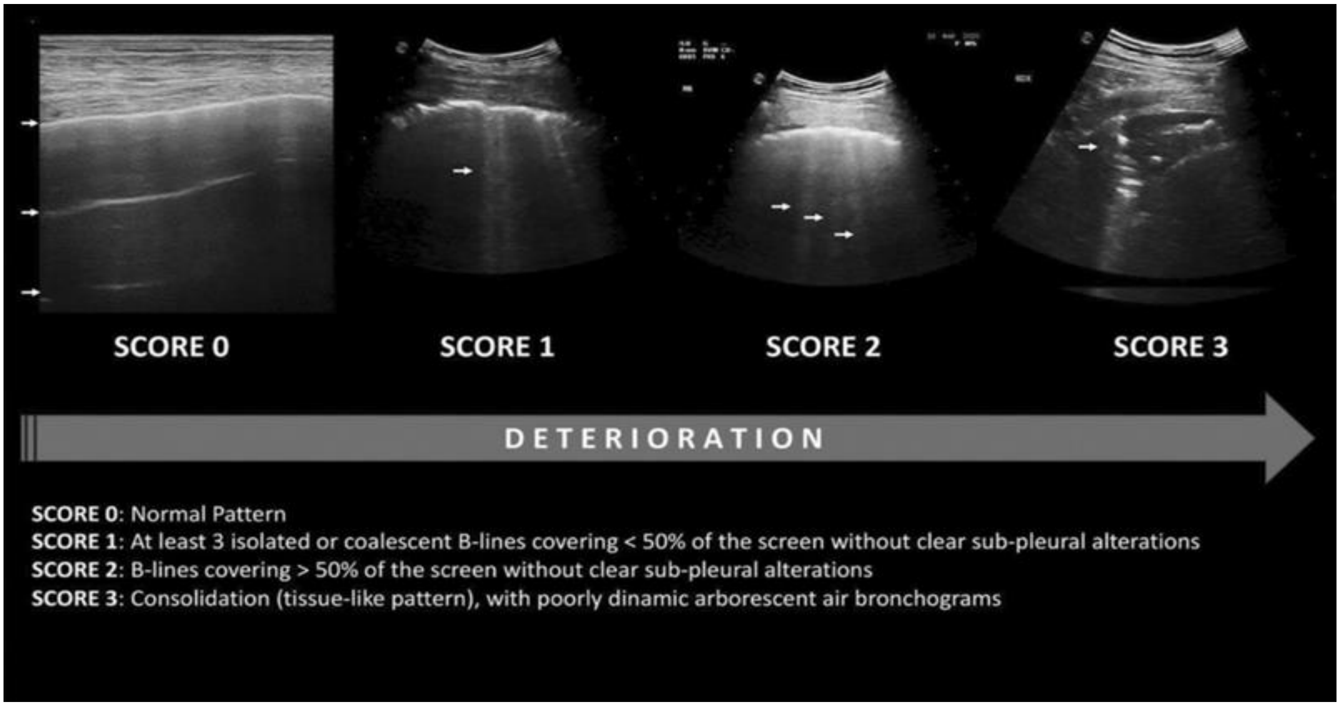

Figure 1: lung ultrasound score **[13].**

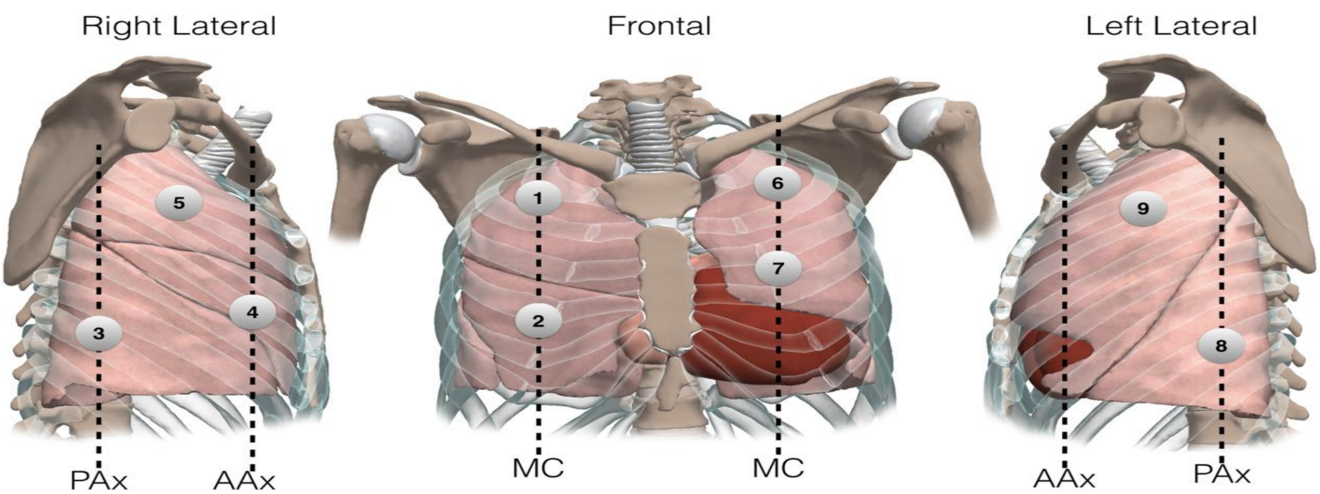

Figure 2: Locations and numbering of the examination zones**[15].**

Abbreviations: AAx, anterior axillary line; MC, midclavicular line; PAx, posterior axillary line**.**

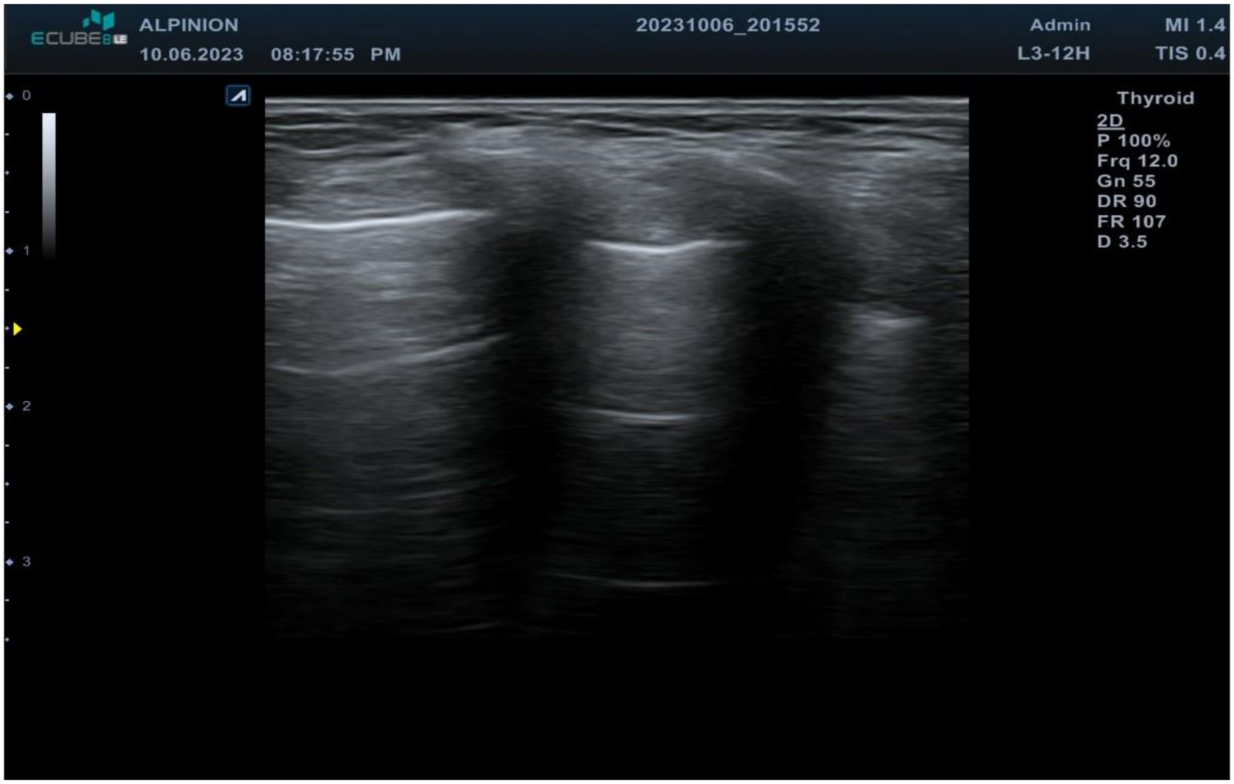

Figure 3: Lung ultrasound showing the pleural line and the artifact A-lines.

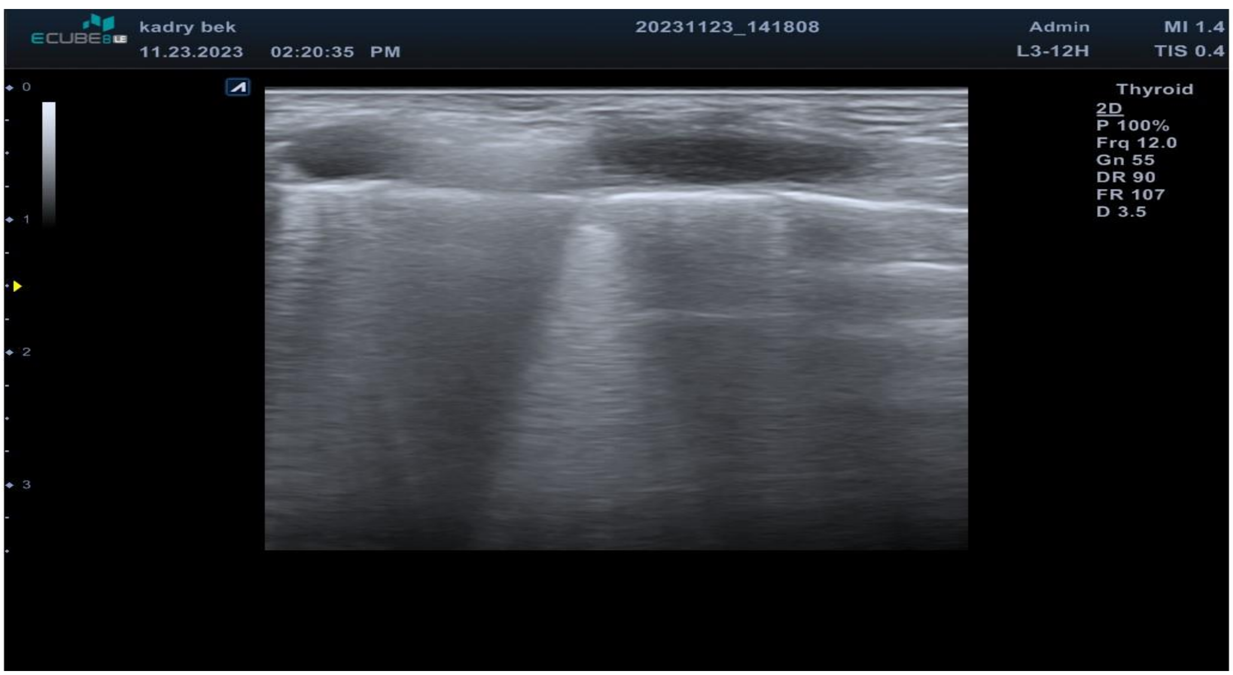

Figure 4: Lung ultrasound showing the pleural line and the artifact B-lines.

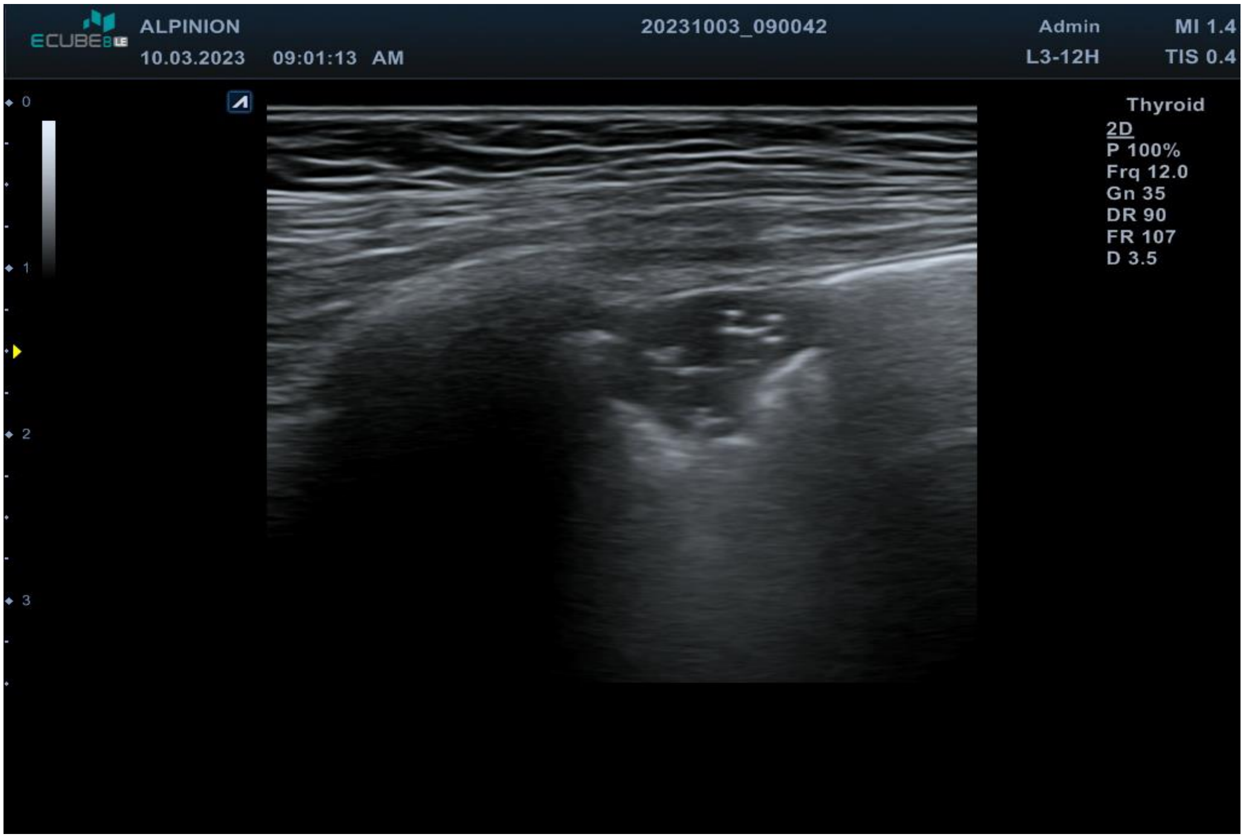

Figure 5: lung ultrasound showing consolidation

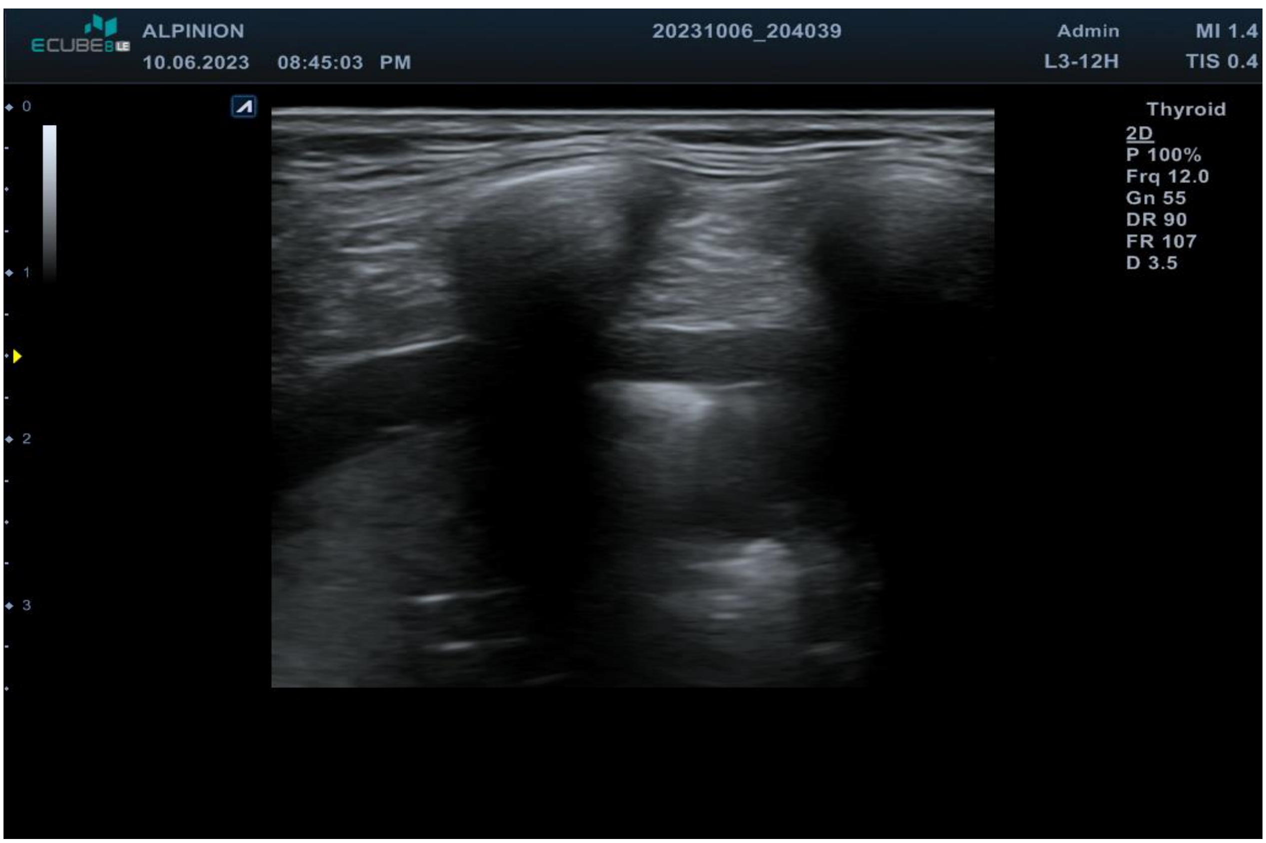

Figure 6: lung ultrasound showing pleural effusion

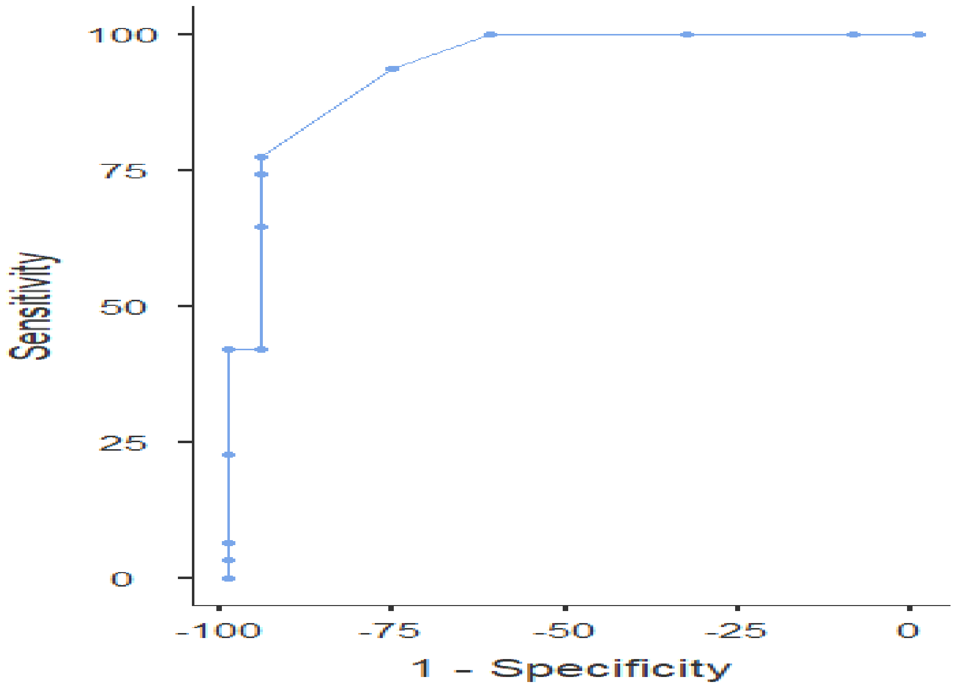

Figure 7: ROC curve analysis of second US score in differentiating discharged from dead patients

DISCUSSION

Lung ultrasound is an increasingly used tool for monitoring pulmonary lesions or improving the diagnosis of pneumonia in critically ill children **[16]**. LUS may also be more sensitive and specific than CXR to identify pulmonary fluid overload **[17]**.

The use of the LUS score in respiratory-distressed patients as a screening and diagnostic tool may improve the currently high number of undiagnosed respiratory-distressed patients in clinical practice and increase the use of appropriate treatment in these patients **[18]**.

The current study showed that the most common cause of admission in PICU was respiratory, as bronchopneumonia represented (34.6%), followed by pneumonia, as bronchopneumonia represented (34.6%), followed by pneumonia, represented (30.8%). Pleural effusion represented which represents (30.8%), and pleural effusion represented (3.8%) of the patients.

Another study by **Giorno et al. [19]** comprised 103 patients, with respiratory conditions accounting for 84% of PICU admissions and various reasons for 16%.

According to our findings, lung ultrasonography detected pleural line modifications. These modifications can include irregularities, fragmentations, thickness, subpleural abnormalities, and the uneven distribution of the B-lines.

First lung ultrasonography scores in our study varied from 8 to 28, with a median of 15. While in research, **Zhang et al. [20].** The first score had a median of 23 and ranged from 20 to 30. Due to the inclusion of both parenchymal and nonparenchymal disorders in our analysis, the wide range of scores, whereas the study of **Zhang et al. [20]** comprised only parenchymal illnesses.

The second US score (after 48 hours) in this study had a median value of 12, ranging from 3 to 28, and we observed a progressive decline in the second score among the discharged group.

The post-extubation score had a median of 8 and ranged from 1 to 17. Among patients who survived, the post-extubation score showed a considerable decline in value. Our results aligned with the observation of **Zhang et al. [20],** who reported the post-extubation score, which varied from 10 to 15 with a median of 12, and the second score, which varied from 26 to 28 with a median of 27, confirming that there was a considerable decline in the post-extubation score among survivors.

The present investigation demonstrated a statistically significant decrease in the US score for patients suffering from pneumonia and bronchopneumonia. Specifically, the median initial

US score for patients with pneumonia was 17 and decreased to 8 following extubation, whereas the median initial US score for patients with bronchopneumonia was 15 and decreased to 6 following extubation agreed with our findings **[20]**.

Another study by **Eltomey** revealed that patients who were able to wean themselves off of MV had far lower scores than those who were unable to do so **[21]**.

Since the lung ultrasonography score strongly corresponded with the histological injury score and with various inflammatory indicators, this decrease in score was caused by breathing support and appropriate treatment **[22].**

The overall lung score for parenchymal diseases in the current study was 16, which was higher than the score for non-parenchymal diseases, which was 14. Li et al. published a similar discovery, finding a statistically significant positive connection between pneumonia and the overall lung score of parenchymal disorders **[23]**.

Because the B-pattern on lung ultrasonography is closely linked to diffuse parenchymal lung illness, our study's findings clearly show the presence of changes in the lung parenchyma.

The total lung score of parenchymal and non-parenchymal disorders did not differ statistically significantly, according to the current study. **Tierney et al. [15]** also reported the same findings.

The length of intubation varied from 3 to 11 days, with a median of 5, according to the current study, whereas the length of ICU hospitalization varied from 3 to 13 days, with a median of 6. Conversely **Zhang, et al. [20],** discovered that the length of the ICU hospitalization varied from 12 to 34 days, with a median of 15, and the duration of intubation varied from 6 to 18 days, with a median of 12.

This study found that the first US score and the length of ventilation, ICU stay, and hospital stay were significantly positively correlated. Tierney et al. et al. et al. [15] corroborated the study's findings**.**

Abushady et al. discovered that patients who had the LUSs guide discovered that patients who had the LUSs-guided recruitment maneuver had a significant reduction in lung inflammation and a reduction in the length of time they required invasive ventilation **[24]**.

According to the current study, a strong positive statistical link exists between the initial total US score and the mortality rate, with the death rate rising as the score rises. Lung disorders cause lesions on ultrasonography known as consolidations or artifacts and a partial or complete lack of aeration. Pleural lines (on the lung surface) and subpleural lesions frequently accompany artifacts.

Similarly, **Wang** discovered that, in comparison to survivors, non-survivors had a higher LUS score at admission **[25]**. Furthermore, patients with ARDS who had a high LUS score at admission had a higher probability of dying in the hospital. Furthermore, **Tierney et al. [15]** found that the total lung score was strongly linked to mortality.

According to this study, 40.4% of patients were released from the PICU, and 59.6% of patients passed away. As you are studying **Wang** 33.6% of their patients died during hospitalization **[25]**. In another study conducted by **Zhang et al [20],** of the 29 patients, 69% of the youngsters survived, while 31% of them passed away.

The results of the present investigation revealed no statistically significant relationship between the age or gender of the patients under research and their outcome, which is consistent with the findings of **Aygün et al [26].**

This study demonstrated that the second score US could differentiate between died and discharged patients with a cutoff point of 12, as demonstrated by ROC curve analysis, with a sensitivity of 93.55%, specificity of 76.19%, and area under curve of 0.940 (Figure 7).

Another research by **Pere et al. [27]** reported that a cut point ≥24 with 100% sensitivity, 69.2% specificity, and an area under the receiver operating characteristic curve of 0.85 for predicting a worse prognosis.

Huang et al. found that cutoff point of 20.5 with a sensitivity of 88.1% and specificity of 83.1%, according to an analysis of the ROC curve. It has an AUC of 0.91**[28]**.

Also, **Li et al.** determined cutoff point 19, which has an 84% sensitivity and 89% specificity in death prediction **[23]**.

This study has not been done at our institute before. From this study, we can follow up on pulmonary conditions, making many everyday decisions easier for clinicians and enabling a higher quality of treatment and faster recovery of children.

This study has several Limitations: Our study included only children on mechanical ventilation, and All the LUS techniques were performed by experienced radiologists with standard LUS training. Many cases were lost during follow-up, and the sample size decreased.

CONCLUSION

The strength of this study is the presentation of the LUS score was the first noninvasive, objective parameter developed for pediatric lung diseases. This score can be utilized for the quantification of parenchymal lung lesions and for further monitoring of disease outcomes; it can also predict weaning. The pulmonary ultrasound scoring system is a useful prognostic tool. The initial total US score was significantly positively correlated with days of ventilation, length of hospital stay, length of ICU stay, and mortality.

Conflict of interest: The authors declare no conflict of interest.

Financial Disclosures: This study was not supported by any source of funding.

Sources of funding: No specific grant was obtained for this research from governmental, private, or nonprofit funding organizations.

REFERENCES

1- Lichtenstein DA. Current misconceptions in lung ultrasound: a short guide for experts. Chest. 2019 Jul 1; 156(1):21-5.

2- Elia l , Raffaella N. Silvia Bloise Domenico Paolo La Regina Diagnostic. (2021); 11(4).652.

3- Rodriguez LD, Yepes AF, Birchenall JC, Mercado DM, Pinilla RI. Real-time ultrasound-guided thoracentesis in the intensive care unit: prevalence of mechanical complications. Ultrasound J. 2020 Dec;12:1-8.

4- Mojoli F, Bouhemad B, Mongodi S, Lichtenstein D. Lung ultrasound for critically ill patients. Am J Respir Crit Care Med. 2019 Mar 15;199(6):701-14.

5- Berce V, Tomazin M, Gorenjak M, Berce T, Lovrenčič B. The usefulness of lung ultrasound for the aetiological diagnosis of community-acquired pneumonia in children. Sci Rep. 2019; 29;9(1):17957.

6- Hasan T, Bonetti S, Gioachin A, Bulgarelli A, Bartolacelli Y, Ragni L et al. Lung ultrasound compared with bedside chest radiography in a paediatric cardiac intensive care unit. Acta Paediatr. 2021 Apr;110(4):1335-40.

7- Fuller BM, Ferguson IT, Mohr NM, Drewry AM, Palmer C, Wessman BT et al. Lung-protective ventilation initiated in the emergency department (LOV-ED): a quasi-experimental, before-after trial. Ann Emerg Med. 2017; 1;70(3):406-18.

8- Cantinotti M, Marchese P, Giordano R, Franchi E, Assanta N, Jani V et al. Overview of lung ultrasound in pediatric cardiology. Diagnostics. 2022 Mar 21;12(3):763.

9- Mirza S, Malik L, Ahmed J, Malik F, Sadiq H, Ali S et al. Accuracy of pediatric risk of mortality (PRISM) III score in predicting mortality outcomes in a pediatric intensive care unit in Karachi. Cureus. 2020 Mar;12(3).

10- Bhalla D, Naranje P, Jana M, Bhalla AS. Pediatric lung ultrasonography: Current perspectives. Pediatr Radiol. 2022 Sep;52(10):2038-50.

11- Baribeau Y, Sharkey A, Chaudhary O, Krumm S, Fatima H, Mahmood F et al. Handheld point-of-care ultrasound probes: the new generation of POCUS. J Cardiothorac Vasc Anesth. 2020 Nov 1;34(11):3139-45.

12- Milliner BH, Tsung JW. Lung consolidation locations for optimal lung ultrasound scanning in diagnosing pediatric pneumonia. J Ultrasound Med. 2017 Nov;36(11):2325-8.

13-Dell'Aquila P, Raimondo P, Racanelli V, De Luca P, De Matteis S, Pistone A et al. Integrated lung ultrasound score for early clinical decision-making in patients with COVID-19: results and implications. Ultrasound J. 2022 Jun 1;14(1):21.

14- Costamagna A, Steinberg I, Pivetta E, Arina P, Veglia S, Brazzi L et al. Clinical performance of lung ultrasound in predicting time-dependent changes in lung aeration in ARDS patients. J Clin Monit Comput. 2023 Apr;37(2):473-80.

15- Tierney JF, Stewart LA, Ghersi D, Burdett S, Sydes MR. Practical methods for incorporating summary time-to-event data into meta-analysis. Trials. 2007 Dec;8:1-6.

16- Buonsenso D, De Rose C. Implementation of lung ultrasound in low- to middle-income countries: a new challenge global health? Eur J Pediatr. 2022; 181(1):1–8.

17- Schapka E, Gee J, Cyrus JW, Goldstein G, Greenfield K, Marinello M, et al. Lung ultrasound versus chest x-ray for the detection of fluid overload in critically ill children: a systematic review. J Pediatr Intensive Care. 2021;11(3):177–82.

18- Bellani G, Pham T, Laffey JG. Missed or delayed diagnosis of ARDS: a common and serious problem. *Intensive Care Med.* 2020;46:1180–1183.

19- Giorno EP, Foronda FK, De Paulis M, Ghosn DS, Couto TB, Sa FV et al. Point-of-care lung ultrasound score for predicting escalated care in children with respiratory distress. Am J Emerg Med. 2023 Jun 1;68:112-8.

20- Zhang W, Zhao G, Li L, Zhao P. Prophylactic administration of corticosteroids for preventing postoperative complications related to tracheal intubation: a systematic review and meta-analysis of 18 randomized controlled trials. Clin Drug Investig. 2016 Apr;36:255-65.

21- Eltomey MA, Shehata AH, Nassar MA, Elmashad AE. Can lung ultrasound assist in the decision of

weaning mechanically ventilated neonates?. J Egypt Radioly Nuclear Med. 2019 Dec;50:1-7.
22- Elsayed YN, Hinton M, Graham R, Dakshinamurti S. Lung ultrasound predicts histological lung injury in a neonatal model of acute respiratory distress syndrome. Pediatr Pulmonol. 2020 Nov;55(11):2913-23.
23- Li L, Yang Q, Guan J, Liu Z, Han J, Chao Y et al. The value of lung ultrasound score on evaluating clinical severity and prognosis in patients with acute respiratory distress syndrome. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue. 2015 Jul 1;27(7):579-84.
24- Abushady NM, Awad HA, Kamel DR, Fouda EM, Ahmed NT, Dawoud MO. Role of lung ultrasound in the assessment of recruitment maneuvers in ventilated preterm neonates with respiratory distress syndrome and its correlation with tracheal IL-6 levels: A randomized controlled trial. J Neonatal Perinatal Med. 2021 Jan 1; 14(3):369-74.
25- Wang D, Qi Y. Lung ultrasound score and in-hospital mortality of adults with acute respiratory distress syndrome: a meta-analysis. BMC Pulmonary Med. 2024 Jan 29;24(1):62.
26- Aygün F, Durak C, Varol F, Çokuğraş H, Camaoğlu Y, Çam H. Evaluation of complete blood count parameters for diagnosis in children with sepsis in the pediatric intensive care unit. Cocuk Enfeksiyon Dergisi. 2020 Jun 1;14(2):E55-62.
27- Trias-Sabria P, Molina-Molina M, Aso S, Argudo MH, Diez-Ferrer M, Sabater J. et al. Lung ultrasound score to predict outcomes in COVID-19. Respiratory Care. 2021; 66 (8) 1263-70.
28- Huang C, Zhang S, Ha X, Cui Y, Zhang H. The value of lung ultrasound score in neonatal respiratory distress syndrome: a prospective diagnostic cohort study. Front Med. 2024 Feb 8;11:1357944.

Citation

Karam, N., Bayoumi Ahmed, S., Abbas Khotaby, A., Mohamed Hafez, S. Lung Ultrasound Scoring System in Mechanically Ventilated Children. *Zagazig University Medical Journal*, 2024; (415-426): -. doi: 10.21608/zumj.2024.314423.3533