Pulmonary Ultrasound Scoring System for Intubated Critically Ill Patients and Its Association with Clinical Metrics and Mortality

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ABSTRACT
Background: Preliminary research has shown that pulmonary ultrasonography (PU) has become a vital tool for quickly diagnosing the cause of acute respiratory failure (ARF), as well as monitoring therapy progress in critically sick patients. The aim of the present study is to examine the relationship between the PU grading system and clinical metrics to identify the etiology of ARF with assessment of treatment response. **Patients and methods:** A prospective cohort study of 50 ARF patients was recruited from Benha University Hospital's respiratory, general, and coronary critical care units. PU examinations were performed at 3 time points during a patient's ICU stay at intubation, 48 hours after intubation and after extubation. **Results:** The research comprised 28 men and 22 women. The average age of participants was 58 years old. COVID-19 was the most common diagnosis (46%). Average intubation was 6.42 days, with a P/F ratio of 172.14 and average length of stay in the ICU 10.06 days. The average length of stay in the hospital was 12.6 days, with death rate 68%. Mean first US score was 18.1 and second US score 17.54. The first total US score had a substantial positive association with mortality rate. The initial total US score had also a substantial positive link with the length of ICU stay and ventilation days ($p<0.001$), whereas the P/F ratio had a negative correlation with the total lung score ($p<0.001$). **Conclusion:** First-to-total US score had positive connection with mortality, length of hospital stay, length of ICU stays, ventilation days, and negative connection with P/F ratio.
Keywords: Cohort study, acute respiratory failure, ICU, pulmonary ultrasound, U/S scoring system.

INTRODUCTION
Chest doctors' interest in transthoracic ultrasonography has grown in recent years. If you're looking for a gadget that is easy to use in outpatient and hospital environments, an ultrasound is an excellent choice. The pulmonologist will soon find ultrasound (US) to be a useful and vital tool [(1)].

Critically sick individuals may benefit greatly from ultrasonography. Use at the bedside is possible because of the device's mobility and safety, allowing for quick, thorough information on internal organs and circulatory systems. The installation of central venous catheters, as well as pleural and intra-abdominal fluid measurement and safe drainage, are both made possible by the use of ultrasonography [(2)].

It has only lately been possible to perform thoracocentesis, paracentesis, and central venous cannulation under the guidance of ultrasound with the advent of new portable, battery-powered, affordable, and hand-carried ultrasound instruments. Rapid diagnosis of acute respiratory failure (ARF), tracking treatment progress, and clarifying nonspecific chest radiograph (CXR) abnormalities among critically ill patients have made pulmonary ultrasound (PU) an essential diagnostic tool. PU has better test characteristics than the clinical examination and CXR. Rapid diagnosis relies on acquisition, interpretation and integration of PU results in a single moment in time [(2)]. The importance of monitoring changes in PU over time cannot be overstated when it comes to validating a diagnosis and making therapy adjustments. To fulfil the requirement for consistency, PU scoring models have been established and have been demonstrated to correlate with different measures in certain patient groups [(2)].

The aim of this work was to examine the relationship between the PU grading system and clinical metrics to identify the etiology of ARF with assessment of treatment response.

PATIENTS AND METHODS
This prospective cohort study included 50 patients that were admitted at respiratory ICU, general ICU and coronary care unit at Benha University Hospital in the period between June 2021 and December 2021.

All patients in the study were subjected to the following:
History taking, physical examination, full laboratory investigations (CBC, ESR, liver and kidney function tests), chest x-ray and pulmonary ultrasound examinations were performed at 3 time points during a patient's ICU stay: 1) As soon as possible after intubation; 2) 48 hours after the initial examination; 3) at extubation.

The chest was divided into 9 zones based on a modification of previously established protocols to approximate lobar anatomy of the lung and reflect the clinical workflow in intubated patients as follow: (1) Right upper lung lobe anterior aspect at midclavicular Line (MCL). (2) Right middle lung lobe anterior aspect at MCL. (3) Right lower lung lobe lateral aspect at posterior axillary Line (PAL). (4) Right middle lung lobe lateral aspect at anterior axillary line (AAL). (5) Right upper lung lobe lateral aspect between AAL and PAL. (6) Left upper lung lobe anterior aspect at MCL. (7) Lingula anterior aspect at MCL. (8) Left lower lung lobe lateral aspect

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at PAL. (9) Left upper lung lobe lateral aspect between AAL and PAL.

Sonographic interpretation was as follow:

A = lung sliding, presence of A-lines, and lack of B-lines or consolidation. B1 = 1 to 3 B-lines present per intercostal space. B2 = quantity of B-lines between B1 and B3. B3 = confluent B-lines occupying >50% of an intercostal space.

Inclusion Criteria: Intubated patient with acute respiratory failure with: Acute respiratory distress syndrome (ARDS) or on hemodialysis or dyspnea and or chest pain or congestive heart failure.

Patients with following criteria were excluded: Patients were intubated solely for airway protection with history of pleurodesis and patients with history of pneumonectomy, or video-assisted thoracoscopic surgery.

Transthoracic ultrasonography:

Description of device: Transthoracic US was done using Philips Hd5 Color Doppler Ultrasound Machine, (Tokyo, Japan), with Philips C5-2 Curved Array Probe was used with frequency 5 MHz.

Technique:

Proper explanation of the procedure to the conscious patient and taking written consent, patient position: Supine (ventral images), right lateral position (lateral images) &left lateral position (lateral images). The probe was cleaned with a disposable anti-microbial wipe. The skin was cleaned and water-based transducing gel was used to improve the interface.

Scanning techniques that were used in Transthoracic ultrasound: (A) Subcostal: The liver served as an acoustic window for the transducer. (B) Intercostal: The transducer was oriented parallel to the ribs.

Interpretation of the Sonographic images:

Ultrasound images were displayed on a grey scale. The strongest echo appeared white while it appeared black when no sound wave is reflected from the organs. Depending on the reflected wave amplitude, the following terms are used to define echogenicity: (A) Anechoic: when no sound wave was reflected and the image appeared black as in pleural effusion. (B) Isoechoic: when the echoes were of comparable amplitude with the surrounding tissue as with kidneys, liver or spleen. (C) Hyperechoic: when echoes were stronger than the surrounding tissue as in diaphragm.

Scoring system [(3)]:

An individual lung zone received: 0 points for an A classification, 1 point for a B1, 2 points for a B2, and 3 points for any of the following: B3, consolidation, atelectasis, or small consolidations. Each zone received an additional point if effusion was present.

The maximum score per zone was 4 points:

(1) Isolated atelectasis without other parenchymal abnormalities existing received 1 point.
(2) Total lung score (TLS) is the summation of all points across the 9 lung zones.
(3) Total B score represented the sum of only the B-line points (B1, B2, B3).
(4) Total atelectasis/ consolidation score is the sum of points assigned for atelectasis and consolidation classifications across zones.

Total anterior score included points from zones 1, 2, 6, 7 and total posterior score from zones 3, 5, 8, 9. Each zone was classified as follows: A = lung sliding, presence of A-lines, and lack of B-lines or consolidation. B1 = 1 to 3 B-lines present per intercostal space. B2 = quantity of B-lines between B1 and B3. B3 = confluent B-lines occupying >50% of an intercostal space.

Ethical consent:

An approval of the study was obtained from Benha University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as numbers and relative percentages. Chi square test (χ^2) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value $\leq$0.05 was considered significant.

RESULT

The demographic data of 50 patients were assessed in this study showed that mean age for the studied group was 58.34 (SD: 15.13) years. Of 50 patients, 28 (56%) were males and 22 (44%) females.

Laboratory finding of the studied patients revealed that 58% of the patients had increased TLC with mean of 15.32 (SD: 2.632). Only 48% of patients had increased urea level with mean of 64.5 (SD: 14.32) and ranged from 23 to 250. Only 44% of patients had increased creatinine level with mean of 2.35 (SD: 0.34) mg/dl and ranged from 0.7 to 9mg/dl **(Table 1).**

Table (1) Laboratory finding of the studied patients

Variables		Numbers and Percentages (n= 50)
TLC Mean ± SD **(15.32 ±2.632) x 10^3**	**Normal** (No., %)	21 (42%)
	Increased (No., %)	29 (58%)
ESR(mm/h) Mean ± SD **(55.9 ±11.83)**	**Normal** (No., %)	0 (0%)
	Increased (No., %)	50 (100%)
Urea (mg/dl) Mean ± SD **(64.5 ±14.32)**	**Normal** (No., %)	26 (52%)
	Increased (No., %)	24 (48%)
Creatinine (mg/dl) Mean ±SD **(2.35 ± 0.34)**	**Normal** (No., %)	28 (56%)
	Increased (No., %)	22 (44%)

Diagnosis (etiology) among the studied patients show that majority of patients (46%) had COVID-19 **(Table 2).**

Table (2): Diagnosis (etiology) among the studied patients.

Variable		No. (%)
Diagnosis	**AKI**	6 (12%)
	Septic shock	4 (8%)
	Post cardiac arrest	3 (6%)
	Pneumonia	5 (10%)
	Bronchopneumonia	3 (6%)
	COVID-19	23 (46%)
	Congestive heart failure	4 (8%)
	Alveolar hemorrhage	2 (4%)

The mean p/f ratio of studied patients was 172.14 (SD: 37.38), mean of days of intubation 6.42 (SD: 1.32) & mean ICU stay was 10.06 (SD: 3.12). Regarding hospital stay, the mean was 12.6 (SD: 2.32), with 68% mortality rate **(Table 3).**

Table (3): Po2/Fio2 ratio, days of intubation, days of ICU stay, days of hospital stay and outcome among studied patients.

Variable		Numbers and Percentages (n = 50)
P/F ratio	Mean ±SD / (Range)	172.14 ± 37.38 / (60-340)
Days of intubation	Mean ±SD / (Range)	6.42 ± 1.32 / (3 – 13)
Days of ICU stay	Mean ±SD / (Range)	10.06 ± 3.12 / (3 – 25)
Days of hospital stay	Mean ±SD / (Range)	12.6 ± 2.32 / (3 - 50)
Outcome	**Discharged**	16 (32%)
	Died	34 (68%)

P/F ratio: pao2/fio2 ratio, **ICU**: intensive care unit.

Lung score by clinical grouping during first time shows no statistically significant difference between parenchymal and non-parenchymal diseases **(Table 4).**

Table (4): Various lung score by clinical grouping during first time

Clinical group	Total lung score	Anterior score	Posterior score
Non parenchymal disease (14)	17.92±4.10	8±1.59	10±2.92
Parenchymal disease (36)	18.16±3.85	9.83±2.31	8.25±1.32
P-value	0.902	0.092	0.118

In the current study, the mean first US total score among the studied patients was 18.1 (SD: 3.15) and ranged from 7 to 28, the second US score (after 48h) was 17.54 (SD: 4.51) and ranged from 3 to 28. Regarding outcome, 68% of patients were died **(Table 5).**

Table (5): First and second US score and outcome among studied patients.

Variable			Numbers and Percentages (n = 50)
First US score	**Anterior**	Mean ±SD / (Range)	9.32 ± 2.46 / (4 - 18)
	Posterior	Mean ±SD / (Range)	8.8 ± 1.48 / (2 – 16)
	Total	Mean ±SD / (Range)	18.1±3.15 / (7 – 28)
Second US score (after 48 h)		Mean ±SD / (Range)	17.54 ± 4.51 / (3 – 28)
US score after extubation (n=16)		Mean ±SD / (Range)	8.44 ± 1.98 / (1 – 20)
Outcome	**Discharged**	No. (%)	16 (32%)
	Died	No. (%)	34 (68%)

US: ultrasound.

This study shows no statistical significant difference in US score in first and second measurement in different diagnosis ($p > 0.05$) **(Table 6).**

Table (6) Comparison between 1st and 2nd total score in different causes of acute respiratory failure among studied patients

Variable	First total US score	Second total US score	P value
	Mean ±SD	Mean ±SD	
AKI (n=6)	21±5.53	16.5±3.31	0.24
Septic shock (n=4)	18.5±4.23	19.5±4.44	0.70
Post cardiac arrest (n=3)	12.67±3.13	11±2.03	0.42
Pneumonia (n=5)	15.57±3.40	17 ± 4.83	0.26
Bronchopneumonia (n=3)	15±3.62	14.33±4.14	0.91
COVID-19 (n=22)	18.52±4.63	18.78±3.72	0.54
Congestive heart failure (n=4)	19.25±3.4	17.25±4.48	0.90
Alveolar hemorrhage (n=2)	22±0	22±0	-

Also in the current study, there was significant difference between First and at extubation US score among patients with AKI, with no significant difference in US score in first and at extubation measurement in COVID-19, pneumonia, bronchopneumonia, congestive heart failure and post-cardiac arrest ($p > 0.05$) **(Table 7).**

Table (7): First and extubation US score among survived patients.

Diagnosis	First total us score	Us score at extubation	P-value
AKI	21 ± 5.32	12.66 ± 5	0.0308
COVID-19	11.66 ± 2.81	7 ± 1.81	0.312
Pneumonia	13	6	-
Bronchopneumonia	7	1	-
Congestive heart failure	18	7	-
Post cardiac arrest	8	3	-

Pneumonia, bronchopneumonia, congestive heart failure and post cardiac arrest were just one case for each one. **AKI:** acute kidney injury.

Table (8): Correlation between first total lung ultrasound score, mortality rate, ICU stay, ventilation days, hospital stay and P/F ratio.

Variable / Total lung score	Correlation coefficient (r_{pb})	P-value
Mortality rate	0.335	**0.017**
Median ICU stay	0.133	**<0.001**
Median ventilation days	0.306	**<0.001**
Median total hospital stay	0.302	**<0.001**
P/F ratio	-0.384	**<0.001**

P/F ratio: pao2/fio2 ratio, **ICU**: intensive care unit.

DISCUSSION

Patients in critical condition can benefit from PU because it can quickly identify the cause of ARF, track treatment progress, and help clarify nonspecific CXR abnormalities. When used in conjunction with cardiac and vascular ultrasound, it can enhance the understanding of etiology and may reduce the need for CXR or chest CT according to **Tierney *et al.*** **[(3)]**.

In critically sick patients, ARF is the most prevalent organ failure. Mechanical ventilation (MV) is required for 40–65 percent of ICU patients. As a clinical condition, ARF may point to a number of different illnesses that manifest suddenly. ARF patients with acute lung injury (ALI) or ARDS are the only ones included in most studies looking at the epidemiology of ARF or the use of MV. This is based on **Linko *et al.*** **[(4)]**.

For the sake of consistency, PU scoring models have been established to satisfy this requirement and have been shown to correlate with different measures in certain patient groups. With regard to ARDS, on hemodialysis and with congestive heart failure, scoring methods may be used to predict mortality, and PU can be used to measure extravascular lung water, which can be used to predict outcome **[(3)]**.

Aim of the present study was to determine the cause of ARF and the effectiveness of therapy, this research examined the relationship between the PU grading system and clinical metrics.

The age of the participants in this research ranged from 18 to 83 years old, with a mean value of 58.34 (SD: 15.13). There were 28 men and 22 women participants. In similar cohort study the median age was 62.5. **Manzano *et al.*** found that in the age ranges of 15 to 29, 30 to 44, 45-59, 60-74, and more than 74, the incidence of ARDS per 100 000 individuals per year ranged from 4.6 to 13.6, 21.6 to 51, and 73.9 instances. The total mortality rate at the hospital was 66% **[(5)]**.

This can be explained by the fact of chest wall compliance gradually declines with age, which may be due to structural changes in the rib cage, whereas functional residual capacity and residual volume both rise. Ventilatory obstruction is more common at lower flow rates. Diaphragmatic mass and strength decline with age, as do physiological cardiovascular alterations such as decreased myocyte number, intrinsic contractility, coronary flow reserve, and ventricular compliance, as well as ß-adrenoceptor-mediated inotropy regulation **[(6)]**.

Patients with acute respiratory failure had a mean TLC value of 15.32 (SD: 2.632) in the present research, which is related to the fact that many patients had infections (35 cases: 5 pneumonias, 3 bronchopneumonias, 23 COVID-19, and 4 septic shocks).

Kim ***et al.*** provided confirmation for our findings, revealing a 6.8% incidence of sepsis-induced ARDS [(7)].

One explanation for this is that acute respiratory distress syndrome is an extremely variable condition that is defined by the presence of abnormalities in the cell membranes of the alveoli and the capillaries of the lungs. Direct lung damage (such as pneumonia and gastric aspiration) and indirect lung injury (such as non-pulmonary sepsis and trauma) are the two main types of lung injury, however it may be difficult to tell the difference in certain circumstances (e.g., pneumonia sepsis). An assault to the lung epithelium causes direct lung injury, while inflammatory mediators damage the endothelium throughout the body, causing indirect lung damage [(7)].

Serum urea and creatinine levels were found to be increased in 48% of patients with ARF, with a mean of 64.54 (SD: 6.45) for urea and 2.35 (SD: 0.34) for creatinine.

In a study done by **Panitchote and his colleagues** 357 of 634 ARDS patients who satisfied the study criteria had AKI following the beginning of ARDS (68.3%) [(8)].

This can be explained by the presence of so many possible triggers for AKI in patients with ARDS that can occur as due to high intrathoracic pressures as a result of ventilator interaction with poorly compliant lungs; subsequent gas exchange abnormalities resulting in hypoxemia, hypercapnia, and systemic acidosis could influence renal vascular resistance altering renal perfusion pressures, causing AKI. The continued production of inflammatory cytokines duo to ventilator-induced lung injury (VILI) further impairs kidney function through hemodynamic and neurohormonal abnormalities [(8)].

This research found that the leading cause of ARF in the study group investigated was (COVID-19 in 46 % of studied patients AKI in 44 % and pneumonia in 5 %).

Vincent ***et al.*** found that of the 991 patients who were admitted to the ICU without ARF, 352 developed ARF during the ICU stay. The risk factors for the development of ARF in the ICU were infection, altered neurologic status, and older age. The risk factors for death were MOF, history of hematologic malignancy, chronic renal failure or liver cirrhosis, presence of circulatory shock at ICU admission, presence of infection, and older age [(9)].

Li and his colleagues proved that the invasion of SARS-CoV2 is partially responsible for the ARF of patients with COVID-19 [(10)].

Grieco and his colleagues also found that around 5% of COVID-19 patients required ICU admission due to ARDS, with a mortality rate ranging between 30 and 60%. Invasive mechanical ventilation is required in most of the patients to treat gas exchange abnormality and represents the corner stone of supportive therapy [(11)].

This can be explained by COVID-19 tracheobronchitis, characterized by mononuclear inflammation, epithelial shedding and submucosal congestion, may be to blame for this. Eighty-five percent of patients had diffuse alveolar damage (DAD) in the acute, organising, or both stages. Pleural effusion, edema and fibrin deposits in alveoli, type II pneumocyte hyperplasia and increased alveolar infiltrates were all detected in the study of **Martines** ***et al.*** Atypical pneumocytes and squamous metaplasia, as well as a few multinucleated cells, were seen. [(12)]

About 172.14 (SD: 37.38) was the average Pao2/Fio2 ratio found in the individuals examined in this research, with ranges ranging from 60 to 340, this study included a wide range of intubation durations, ranging from 3-13 days on average. The median length of stay in the intensive care unit was 10.06 days, ranging from 3 to 25 days. There was a mean of 12.6 (SD: 2.32) days spent in the hospital, with a range of 3 days to 50 days. 68 % of the patients died.

Matthay and his colleagues found that severe arterial hypoxemia (PaO2/FiO2< 100) and a greater proportion of the pulmonary dead space fraction (p >0.60) are related with increased mortality, as are shock, liver failure, acute renal damage and age over 60 years [(13)].

Another study included 176 patients in the research, only 22 of them spent more than 14 days in the hospital ICU, mortality was not higher in patients with prolonged stays (40.9% vs 25.3% respectively, p-value 0.12), but hospital mortality was higher in patients with prolonged stays (63.6 % vs 33.8 %, p-value 0.01) and one-year follow-up mortality was higher in patients with prolonged stays (68.2 % vs 41.2 %, p value 0.02). One-year mortality rates for the two groups were almost identical (87.5 % versus 90.6 %, p-value 0.57) [(14)].

In our study, there was no statistical significant difference between the total lung score of parenchymal and non-parenchymal disorders were found.

According to **Tierney** ***et al.*,** the total lung score of parenchymal disorders such as pneumonia had a substantial positive relationship with the total lung score [(3)].

Among the patients in this research, the mean first US total score varied from 7 to 28. The second US score (after 48 hours) was 17.54 (SD: 4.51) and ranged from 3 to 28. The mean US after extubation was 8.44 (SD: 1.98) and ranged from 1 to 20. 68% of the patients died as a result of their treatment.

ARDS patients had the greatest mean Lung Score and COPD/asthma patients had the lowest mean Lung Score, according to **Tierney** ***et al.*** who found that the total Lung Score for baseline tests varied from 0 to 31 points. Posterior lung scores contributed a greater proportion to the TLS than anterior lung scores in all diagnostic groups except ARDS [(3)].

Also **Zhao's** study endpoint was ICU mortality, and the 21 patients were separated into two groups:

those who survived (8 patients, or 38.1 %) and those who did not (13 patients, 61.9%). In addition to anticipated body weight, a score for sequential organ failure evaluation, a lung injury score, and PaO2/FiO2, there were significant positive linear correlations between LUS and extra vascular lung water (EVLW). A repeated-measures analysis of variance revealed significant differences in LUSs between the non-survivor and survivor groups (F = 77.6, p-value 0.01). On various days, no significant variations existed between the two groups. LUS and EVLW had areas under their receiver operating characteristic curves of 0.846 (p-value 0.01) and 0.918 (p-value 0.01) [(2)].

Lung ultrasonography was performed on 21 patients hospitalized to the intensive care unit of Fu Xing Hospital following diagnosis. Lung ultrasound (LUS) and extra vascular lung water index (EVLWI) scores were correlated. Lung ultrasonography was studied for its predictive clinical significance in ARDS patients. The 12 areas approach was used to perform the chest ultrasounds. Lung aeration was used to calculate the overall lung ultrasonography score [(2)].

While no significant difference in US scores was found for distinct diagnoses (p-value >0.05), a higher ultrasound score was found to be related with (COVID19, congestive heart failure, and AKI), all with mean values of 18.52 (SD: 4.63), 19.25 (SD: 3.4), and 21 (SD: 5.32) respectively.

A meta-analysis of 1075 patients from seven studies **Picano *et al.*** found that B-lines are useful for distinguishing acute heart failure syndrome from non-cardiac causes of acute dyspnea in the emergency room, with high sensitivity and excellent specificity[(14)]. In a recent multicenter trial, which included 1005 patients from seven Italian centers, researchers found that the LUS-based technique was more accurate than initial clinical evaluation, chest X-ray, and natriuretic peptide testing [(15)].

In another study a total of 22 with confirmed COVID-19 by RT-PCR assay and hospitalized patients underwent Lung US. Interlobular septa thickness or cloudiness that did not cover the underlying bronchial structures or pulmonary, with bilateral distribution, was the cause of all (100%) of the B lines patterns seen on US and subpleural consolidation (27.3%). Only one out of every 4,500 cases had an A-and-B-line pattern on the US assessment. CT imaging revealed bilateral ground-glass opacities (GGO) and consolidations in these individuals [(16)].

in the current study, there was significant difference between first and extubation US score among patients with AKI (p-value 0.03), while there was no statistical significance in US score in first and at extubation measurement in COVID19 (p-value >0.05).

This might be due to the effect of treatment of AKI especially dialysis in decreasing extra vascular lung water as **Mallamaci and his colleagues** supported our study by chest US examinations in all patients (N=75). Before dialysis, about 63% of patients exhibited moderate to severe lung congestion. Lung water reduced after dialysis, but (31%) patients still had pulmonary congestion of moderate to severe degree [(17)].

Also, **Picano *et al.*** found that the appearance of B-lines corresponds to a progressive loss of air per volume of lung tissue with a corresponding increase in relative and absolute content of extra vascular lung water [(14)].

Death rates significantly correlated positively with a person's overall US score in this research (rpb = 0.333, p-value 0.017) where mortality increases with increased score and (rpb = 0.335, p-value 0.017). Also, there was highly statistically significant positive correlation between first total US score and duration of ICU stay and ventilation days (p-value <0.001). On the other hand, significant negative correlation between P/F ratio and total lung score was detected where total score decreases with increased score (rpb = -0.3843, p-value <0.001).

According to **Tierney *et al.*,** TLS linked strongly with mortality (p-value 0.03), ventilator hours (p-value 0.03), intensive care unit and hospital length of stay (p value 0.03 and 0.008 respectively), and lowering PaO2/FiO2 (P<.001) [(3)].

Also **Zhao's** study proved that**,** LUS is closely related to ARDS prognostic indices (extra vascular lung water Index and P/F) and also can predict death risk as it served as a diagnostic marker of ARDS. Early measurement of LUS is a better diagnostic and prognostic indicator of acute lung injury than late measurement [(2)]**.**

CONCLUION

The PU scoring system may be a useful tool in diagnosing the etiology of ARF, predicting mortality, and assessing therapy response since it is non-invasive and promising at the bedside for diagnostic and prognostic purposes.

First total US score had a substantial positive correlation with mortality, length of stay in the hospital, length of stay in the ICU, and days of ventilation. P/F ratio and the first total ultrasound score have a strong negative correlation.

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