Sarcouncil Journal of Medical Series

ISSN(Online): 2945-3550

Volume- 04| Issue- 05| 2025

Research Article **Received:** 02-05-2025 | **Accepted:** 20-05-2025 | **Published:** 28-05-2025

Assessment of Correlation between Transthoracic Lung Ultrasound in Community-Acquired Pneumonia and CURB-65 Score

Dr. Noor Razzak Abdulhussain[1], Dr. Hadeel Sabah Mansoor Hermiz[2], and Dr. Mohaimen Abdulridah Mahdi[3]

[1]M.B.Ch.B., C.A.B.E.M, Emergency Medicine Specialist, Fellow of the Arab Board of Emergency Medicine, Iraqi Ministry of Health, Baghdad Al-Karkh Health Directorate, Al-Yarmouk Teaching Hospital, Emergency Department, Baghdad, Iraq.

[2]M.B.Ch.B., E.M.J.F.S. \ (Emergency Medicine), Iraqi Ministry of Health, Al-Russafa Health Department, Al-Sheck Zaid General Hospital, Baghdad, Iraq.

[3]M.B.Ch.B., Mustansiriya College of Medicine, Emergency Medicine Specialist, Jordanian Medical Council, Iraqi Ministry of Health, Al-Russafa Health Department, Al-Sheck Zaid General Hospital, Baghdad, Iraq

Abstract: Objective: Today, lung ultrasound provides an important bedside tool in the emergency department evaluation of CAP. During this study, a wireless ultrasound probe and mobile phone real-time scanning were used to evaluate the correlation between lung ultrasound findings in CAP and CURB-65 scores in trying to identify an ultrasound finding correlating with a higher CURB-65 score. Method: Fifty patients were enrolled in the study. The CURB-65 score and each lung ultrasound finding were correlated using math lab R 2018 programming language; variables were correlated by the Pearson correlation method, also calculating the P-value. Results: Hepatization or tissue-like appearance of the lung (with/out) air bronchogram on sonography showed a high correlation (0.66) with a CURB-65 score of ≥3, and this correlation was highly statistically significant (P=0.002). Conclusion: Lung ultrasound by a wireless probe is simple and easy as well as reliable enough to serve as a guide in the disposition of CAP patients. Hence, sonographic hepatization of the lung in patients with CAP correlates with higher CURB-65 scores and could thus be used to direct the disposition of the patient.

Keywords:. Transthoracic Lung Ultrasound, Pneumonia and CURB-65, CAP

INTRODUCTION

BACKGROUND

Community-acquired pneumonia is one of the most commonly faced infectious diseases and a major cause of death, morbidity, and admission into hospitals worldwide (Baer, S.L. *et al*. 2019; Darden, D.B. *et al*. 2020).

The diagnosis of pneumonia depends upon a clinical presentation, investigations, and chest imaging (Mohammed, H.A. *et al*. 2018).

Whereas in the previous days, CXR and CT scan were being used as a common diagnostic modality, now, they are not routinely recommended (Chavez, M.A. *et al*., 2014). Lung ultrasound, especially combined with the CURB-65 score for assessing pneumonia severity, has therefore been increasingly recognized as a useful tool for diagnosing community-acquired pneumonia (CAP). It has been reported that LUS has a high sensitivity and specificity in diagnosing CAP and can thus be used confidently as an alternative diagnostic method that surpasses chest x-rays (Elsayed, M.Z. *et al*., 2022; Gupta, A. *et al*., 2023; Dhawan, J. *et al*., 2022).

There are no clear-cut guidelines for hospital admission; however, a scoring system can be used as support for hospitalization decisions. The CURB-65 scheme is widely used, applying five simple criteria to identify those at low risk of adverse events.

- **C**onfusion,
- **U**remia (blood urea >20 mg/dl),
- **R**espiratory rate greater than 30 breaths/min,
- **B**lood pressure less than 90 systolic or less than 60 mmHg diastolic, &
- **A**ge 65 years old or older.

The risk of 30-day mortality increases with more of these factors:

- 0.7 % with zero factors
- 9.2% with two factors
- 75% with five factors

Patients with zero or one score can receive outpatient care; those with two should be admitted, and ICU admission should be considered for three or more factors {Ahmed, A, 2024; Uguen, J. *et al.*, 2023}.

IMPORTANCE

Studies suggest that LUS can enhance the predictive accuracy of CURB-65 by providing real-time assessments of lung conditions, thus aiding in timely clinical decisions (Elsayed, M.Z. *et al*., 2022; Ahmed, A. *et al*., 2024).

Key Ultrasound Signs of Pneumonia are:

***Corresponding Author:** Dr. Noor Razzak Abdulhussain

DOI- https://doi.org/ 10.5281/zenodo.15530301

- **Consolidation**, or hepatization of the lung, maybe the hallmark sign observed in many studies, with sensitivity rates reaching up to 100% in cases of ventilator-associated pneumonia (Uguen, J. *et al*., 2023).
- **B-Lines:** Indicating interstitial edema and are frequently associated with pneumonia, showing high sensitivity (95.3%) and specificity (85.4%) (Lahin, R.E. *et al*., 2022).
- **Dynamic Air Bronchograms:** This sign reflects the presence of fluid in the alveoli, enhancing the diagnosis of pneumonia (Uguen, J. *et al*., 2023).
- **Pleural Effusion:** The presence of fluid in the pleural space can also be detected, further supporting the diagnosis (Shea, D.E. *et al*., 2023).
- **Subpleural hypoechoic area and shredded pleura**

Goals: Assessment of correlation between transthoracic lung ultrasound in community-acquired pneumonia and the CURB-65 SCORE

METHOD

This is a cross-sectional study conducted in the AL Yarmouk Teaching Hospital/Emergency Department over a period of 1 year, 2022.

Selection of participants: patients present to the emergency department from the Triage with clinical features Suggestive of pneumonia, like fever, cough, Malaise, and shortness of breath, were included in the study.

Exclusion criteria were:

- Age less than 16 years old.
- Patient was referred directly to the outpatient medical unit by the Triage doctor.
- Patients with a history of Lung mass or malignancy, history of TB, chronic Interstitial lung disease, chronic obstructive lung disease, asthma, and patients with a history of congestive heart Failure.
- Recent admission to the hospital within 72 hours.

Interventions

For all patients, detailed clinical history was recorded, and systematic physical examination was done, vital signs were recorded, &laboratory investigations were conducted accordingly. All patients had a chest X-ray, and In some occasion's thoracic computed tomography (CT) scan was done. Also, all patients had a bedside Lung ultrasound that was done by an emergency medicine specialist trained with the use of Lung ultrasound using a portable pocket held 3.5 MHz convex probe that works wireless with the image being transferred Via Wi-Fi To mobile image, and the result was recorded, the lung was divided into five zones on each chest side using the parasternal, anterior axillary, posterior axillary and horizontal line that pass through the nipples.

The following findings were recorded:

- Focal Kerley B lines and /or focal pleural thickening.
- Hypoechoic area with shredded pleura.
- Tissue-like appearance consolidation or hepatization of the lung, indicating trans-lobar consolidation.
- Air bronchogram.
- Pleural effusion.
- Diffused Kerley B line pattern.
- Multilobe involvement.

For patients with diffused Kerley B lines, a bedside echocardiography and inferior vena cava (IVC) dynamic changes were scanned, looking for poor cardiac contractility and a plethora of IVC.

Patients were scored using the CURB-65 scoring system to guide their admission.

In our hospital, patients with a score of 3 require admission to the medical word or monitored bed, and patients with a score of 4 or 5 require the intensive care unit.

Then, the ultrasound findings were correlated with the CURB-65 score in an attempt to find an ultrasound finding that correlates with higher scores.

Measurements

A Correlation between the CURB-65 score & each lung ultrasound finding was done using MATLAB R 2018 programming language, variables were correlated by the Pearson correlation method, and the P-value was also calculated.

Outcomes and Analysis:

One hundred fifty patients were diagnosed with community-acquired pneumonia, aged > 16 years, with a mean age of 71 years.

Males accounted for 60% of patients, as females accounted for the rest 40%.

Regarding CURB-65 scoring,13% had a CURB-65 score of 0 or 1, 27% had a score of 2, 40% had a score of 3, while scores 4 and 5 together accounted for 20 % of patients (Table 1).

RESULTS

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Patients' Disposition According to Their Score is as Follows

In 40% of cases, i.e., with scores 0, 1 & 2, outpatients were treated with later follow-up. Another 40% burned a score of 3, so they got admitted to medical wards with monitoring facilities for treatment. For 20% of patients, i.e., those who scored 4 and 5, endotracheal intubation and mechanical ventilation were necessary, followed by admission to the respiratory intensive care unit (RCU). (Table 1)

Table 1: Score of Patients' Disposition

CURB-65 score	percentage %	Disposition
0 and 1	13	Discharged with follow-up
2	27	Discharged with follow-up
3	40	Admission to a monitored bed
4 and 5	40	RCU admission

Table 2: Findings of Transthoracic sonographic

Sonographic finding:	Overall percentage %
Focal Kerley B lines and /or focal pleural thickening.	47
Subpleural hypoechoic area with shredded pleura.	20
Tissue-like appearance consolidation or hepatization of the lung, indicating trans-lobar consolidation.	73
Air bronchogram.	67
Pleural effusion.	60
Diffused Kerley B line pattern	33
Multilobe involvement.	27

Correlation between Sonography Findings and Total CURB-65 Score:

On sonography, hepatization or the lung's tissue-like appearance has a strong connection (0.66) with the CURB-65 score (P-value 0.008).

There is a significant connection (0.60) between the air bronchogram and the CURB_65 score (P-value 0.018).

Shred sign has a non-significant P-value (0.079) but a moderately negative correlation (-0.47) with the CURB_65 score.

The CURB-65 65 score did not significantly correlate with other sonographic data. (Table 3)

Table 3: Correlation between Sonography Findings and Total CURB-65

Sonographic findings	Correlation with CURB-65 score	P-value
Focal Kerley B lines and /or focal pleural thickening.	-0.33	0.24
Subpleural hypoechoic area with shredded pleura.	-0.48	0.072
Hepatization of the lung	0.66	0.008
Air bronchogram	0.60	0.018
Pleural effusion.	0.38	0.17
Diffused Kerley B line pattern.	0.08	0.018

Correlation between Sonographic Findings in Pneumonia and the CURB-65 Score of≥ 3:

Hepatization or tissue-like appearance of the lung on sonography shows a large correlation (0.74) with the CURB-65 score of ≥3 (P-value 0.002).

Correlation between Different Sonographic Findings and CURB-65 Score Variables:

Respiratory rate > 30 (P-value 0.029) and patient age ≥ 65 years (P-value 0.001) were significantly correlated (0.56) with hepatization or tissue-like appearance of the lung.

A significant connection (0.56) was found between pleural effusion and patient age over 65 (P-value 0.032).

A significant (0.56) connection was found between the air bronchogram and both urea levels exceeding 20 mg/dl (P-value 0.032) and patients age over 65 years (P-value 0.032).

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There was no significant link between the CURB-65 score variables and other sonographic observations (Table 4).

Table 4: Correlation between Different Sonographic Findings and CURB-65

Variables	Correlation	P-value
Hepatization of the lung VS. CURB-65 score ≥3	0.74	0.002
Hepatization vs. RR	0.56	0.029
Hepatization vs. age >65 years	0.65	0.001
Hepatization vs. air bronchogram	0.53	0.040
Pleural effusion vs. age >65 year	0.56	0.032
Pleural effusion vs. Shred sign or subpleural hypoechoic lesion	-0.70	0.003
Air bronchogram vs. urea >19 mg/dl	0.56	0.032
Air bronchogram vs. age >65 years	0.55	0.032
Note: Variables that did not show significant correlations between each other were neglected		

DISCUSSION

This study looked at the relationships between the CURB-65 score and lung sonographic findings in 50 patients who were diagnosed with community-acquired pneumonia in the emergency room. Only 13% of patients had a score of 0 or 1, which was significantly lower than that of Qi Guo, *et al*., {2011}, where 58.2% of patients had a CURB-65 score of 0 and 32.7% had a score of 1. Patients with a score of 3 or higher comprise 60% of patients, whereas Mohammed, H. *et al*., {2018} only had 40% of patients with a score of 3 or higher. This is because our ED's triage protocols transfer the majority of stable, well-appearance patients to the outpatient consultation unit in an effort to reduce ED overcrowding, and those patients were not included in our study.

The most frequent sonographic finding in 73% of patients was tissue-like appearance consolidation or hepatization of the lung, while 67% of patients had an air bronchogram.

These findings closely matched those of D'Amato, *et al*., {2017}, who found tissue consolidation in 73% of their patients.

60% of the patients in the study had pleural effusions of some degree, which is significantly greater than the 30.4% of patients who had pleural effusions found by D'Amato, *et al*., {2017}.

Correlation between Sonography Findings and CURB-65 Score:

Hepatization or tissue-like appearance of the lung on sonography shows a large correlation (0.66) with the CURB_65 score, and this was statically significant (P-value 0.008), and patients were more tachypneic and older in age due to its significant correlation with respiratory rate of 30 or above and age above 65 years. (P-value 0.029, 0.001, respectively.)

Air bronchogram shows a large correlation (0.60) with the CURB_65 score (P-value 0.018).

Shred sign shows a moderate negative correlation (-0.47) with the CURB_65 score, but this result was not statically significant (P-value 0.079).

Other sonographic findings did not show any correlation with the CURB-65 65 score.

Correlation between Sonographic Findings in Pneumonia and the CURB-65 score of≥ 3:

Hepatization or tissue-like appearance of the lung +/_ air bronchogram on sonography shows a large correlation (0.66) with a CURB_65 score of ≥3, and that correlation was highly significant statically (P-value 0.002); this brings out the question "can hepatization of the lung on sonography in CAP patients be considered as a criterion to admit the patient to the hospital?

On the other hand, "Can the absence of hepatization of the lung on sonography support the decision to discharge the patient for outpatient treatment?"

Another study, Rennis, K.D. *et al*., {2017} studied the correlation with other pneumonia score, which is the pneumonia severity index PSI, and found only a small correlation (0.35) with PSI score, were as Mohammed, H. *et al*., showed a statistically significant relation between the extent of consolidation on lung sonography and CURB _65 score (P-value <0.001).

A limitation in this study was the small sample volume; to some extent, this is due to the exclusion of patients with a history of Lung mass or malignancy, history of TB, chronic Interstitial lung

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disease, chronic obstructive lung disease, asthma, and patients with a history of congestive heart failure from our study.

Also, the most stable, well-appearing patients were shifted to the consultation unit and were also excluded. So, future study with a larger sample, maybe from multiple hospitals, is indeed recommended.

The long list of exclusion criteria aimed to decrease the false positive results of lung sonography due to other lung pathology; also, the examination of lung sonography is done by the same emergency medicine specialist so that to overcome operator-dependent variation.

Using a wireless probe with your own phone scanning makes it easier to move around the patient faster, and there is no need to manage cables. Also, it makes it easier to share scanning photos to colleagues of colleagues by different phone applications.

CONCLUSION

Lung ultrasound using a wireless probe is a simple, easy, and reliable tool that can be used to guide the disposition of patients with CAP.

Hepatization of the lung or consolidation on lung sonography in patients with CAP correlates with a higher CURB-65 score and may be used to guide the disposition of the patient.

ABBREVIATIONS

CT: computed tomography
CXR: chest x-ray
CAP: community-acquired pneumonia
RCU: Respiratory Care Unit
RR: respiratory rate

DEDICATION

To my dear parents,
My wonderful husband,
My precious daughters.
Noor

ACKNOWLEDGMENT

I would like to express my great thanks and gratitude to my dear sister, Dr. Reem Razzak Abdul Hussain, for her precious help.

Also, I would like to thank all my colleagues at Al Yarmouk Teaching Hospital for their help &support.

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Source of support: Nil;
Conflict of interest: Nil.

Cite this article as:
Abdulhussain, N.R., Hermiz, H.S.M. and Mahdi, M.A. "Assessment of Correlation between Transthoracic Lung Ultrasound in Community-Acquired Pneumonia and CURB-65 Score." *Sarcouncil Journal of Medical Series* 4.5 (2025): pp 16-21.

Publisher: SARC Publisher