Research Article

Lung ultrasound versus chest radiograph in the diagnosis of pneumonia in ICU patients

Ibrahim A. Yousef, Ahmed Hassanein and Ahmed G. Ali Shahat
Department of Anesthesia, El-Minia Faculty of Medicine

Abstract
Introduction: Lung ultrasounds have shown a growing interest during the last few years in the diagnosis of pleural effusions, pneumothorax. It is radiation free, can be performed at the bedside in a few minutes, and can be interpreted in real time for multiple diagnoses. The results are so encouraging that in some units, chest x-rays have been replaced by lung ultrasounds in the follow-up of the patients. **Aim of the work:** to compare Lung Ultrasound Versus Chest x-ray as regard diagnostic efficacy of pneumonia cases in Intensive Care Unit (ICU) and time saving between both modalities. **Patients and Methods:** A total of 72 patients of either sex, age between 18 to 70 years with clinically suspected Pneumonia. We used The machine Sonosite M turbo ultrasound system, (1-5MHz) micro convex probe and (13-6 MHz) linear probe as well as a Portable X-ray machine. **Results: W**e found that LUS was superior to conventional CXR in diagnosing pneumonia patients. In addition, we found that LUS was more efficient than CXR in diagnosis of pneumonia in hemodynamically unstable patients. Regarding the duration of imaging, CXR was more time consuming as compared with LUS. Considering that early antibiotic administration in pneumonia patients is associated with better outcomes especially concerning morbidity and mortality, the importance of finding a less time consuming modality for the diagnosis is outstanding. **Conclusion**: **We concluded that** bedside lung ultrasound demonstrated better results than chest X-ray for the early diagnosis of pneumonia.
Keywords: Lung ultrasounds, pleural effusions, pneumothorax

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Introduction
Pneumonia is the leading cause of mortality related to infectious disease in Western countries, and on major cause of severe sepsis and septic shock.[1] However the diagnosis of pneumonia is often difficult in the emergency setting, as clinical, biological, and imaging sign are not specific**.**

Lung ultrasounds have shown a growing interest during the last few years in the diagnosis of pleural effusions, pneumothorax. It is radiation free, can be performed at the bedside in a few minutes, and can be interpreted in real time for multiple diagnoses. The results are so encoura-ging that in some units, chest x-rays have been replaced by lung ultrasounds in the follow-up of the patients. Because of the bedside use of the ultrasound units, result can be immediately available preventing any delay in the diagnosis process. Moreover, its realization could allow a substantial time-saving for the establishment of the diagnosis and consequently reduce the length of stay at the ICU[2].

Aim of the work
The aim of this study is to compare Lung Ultrasound Versus Chest x-ray as regard diagnostic efficacy of pneumonia cases in Intensive Care Unit (ICU) and time saving between both modalities**.**

Patients and Methods
After ethical committee approval and written informed consent was obtained from all patients, this study was carried patients with clinical suspecion of pneumonia who were collected from those admitted at Surgical intensive care unit, Minya university hospital during the period from March 2018 to November 2018.

A total of 72 patients of either sex, age between 18 to 70 years with clinically suspected Pneumonia. Suspicion was raised clinically (fever 38.0°C, cough, purulent expectoration, dyspnea) and on the basis of typical auscultation findings (rales or bronchial breath sounds) if the patient was not intubated and fever, change in the colour or amount of secretions, auscultatory findings as well as drop of oxygen saturation below 92% if intubated.

We used The machine Sonosite M turbo ultrasound system, (1-5MHz) micro convex probe and (13-6 MHz) linear probe as well as a Portable X-ray machine.

All Patients were subjected to radiological examination using chest ultrasound and chest x-ray on to surgical ICU.

Each patient underwent a comprehensive TUS assessment including anterior and postero lateral aspects of the chest wall. Patients were investigated in supine if intubated, or in a sitting position with raising their arms above head to widen the intercostal space if not intubated.

Lung ultrasonography was performed in six specific points called **the BLUE points** three on each hemithorax with the transducer orientated either perpendicular or transverse to the chest wall.
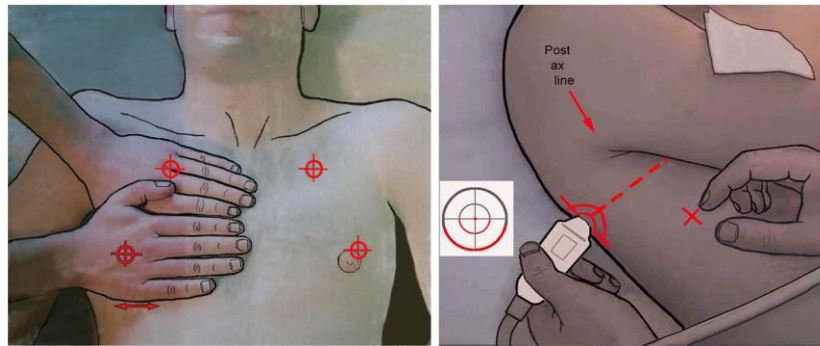

Figure (1) showing the BLUE points on the left panel, PLAP point on the right panel (black arrow) and phrenic point (cross mark) [3]

The following Sonographic profiles were interpreted as pneumonia:
B′- profile: B profile with abolished lung sliding.
A/B - profile: anterior predominant B+ lines at one side, predominant A lines at the other.
C- Profile: anterior alveolar consolidation(s)
PLAPS: posterior-lateral alveolar consolidation and/or pleural effusion syndrome.

Ultrasonography chest examination was done using real time (B) mode, motion mode (M).

Duration of imaging (time/minutes) were calculated from start of study to appearance of findings and compared between all patients.

Results
Table (1): Baseline characteristics of the study participants, n = 72

Characteristic	Mean ± SD/No. (%)
Age, year	48 ± 15
Male sex	47 (65.3 %)
Female sex	25 (34.7 %)

Among the 72 cases enrolled, a total of 21 cases of pneumonia were detected using CXR, whereas LUS identified 61 cases; 44 lesions detected by LUS were not detected by CXR. CXR detected 4 cases that were not detected by LUS. Only 7 cases could not be detected by both modalities.

Table (2): demonstrates Ultra-sonographic & X-ray findings in **the studied groups using mcnemar test.**

LUS +ve CXR -ve	LUS –ve CXR +ve	LUS +ve CXR +ve	LUS –ve CXR -ve	P – value
44 (61.1%)	4 (5.6%)	17 (23.6%)	7 (9.7%)	**< 0.001***

Table (3): demonstrates Ultra-sonographic & X-ray findings in **the studied groups.**

Total No	No detected by LUS	No detected by CXR	P - value
72	61 / 72	21 / 72	< 0.001*

As regard duration of imaging there is significant rise in values between ultrasonography and chest x-ray p-value <0.05.

Duration of Imaging

- Duration of LUS: 12 Minutes
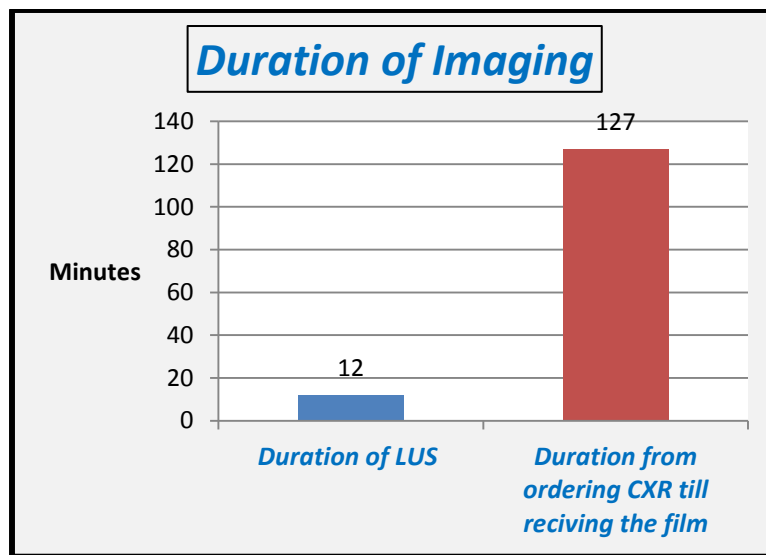- Duration from ordering CXR till reciving the film: 127 Minutes

Figure (2): duration of imaging

Discussion

Several studies in high-income countries have shown ultrasound to be a reliable tool to diagnose pneumonia with a higher sensitivity and specificity than chest X-ray. Ultrasound is a safe, inexpensive, noninvasive, readily available imaging modality that can complement physical examination and clinical evaluation in cases of Acute respiratory failure . The main advantage of bedside TUS is its immediate application to the diagnosis of thoracic disorders. Other advantages include delaying or even avoiding the need for patient transportation to the radiology suite, radiation exposure and guiding life-saving therapies in extreme emergency**.**

This results are in agreement with Amatya et al., (2018), who studied the Diagnostic use of lung

ultrasound compared to chest radiograph for suspected pneumonia in a resource-limited setting on 62 patients in the emergency department with suspected pneumonia and evaluated them with bedside lung ultrasound, single posterioranterior chest radiograph, and computed tomography (CT). Using CT as the gold standard, they compared the sensitivity of lung ultrasound to chest X-ray for the diagnosis of pneumonia using McNemar's test for paired samples. Diagnostic characteristics for each test were calculated. They found that 44(71%) were diagnosed with pneumonia by CT. Lung ultrasound demonstrated a sensitivity of 91% compared to chest X-ray which had a sensitivity of 73% (p = 0.01). They also calculated the specificity of lung ultrasound and chest X-ray and found it 61 and 50% respectively.

Our results were comparable with Bourcier et al., (2014) who compared lung ultrasound and chest x-ray for the diagnosis of pneumonia in the ED. They analyzed 144 adult patients. The ultrasound examination was performed by one of five trained emergency physicians, and a chest radiograph interpreted by a radiologist. The primary end point was the diagnosis of hospital discharge. They found a sensitivity of 0.95 for the ultrasound examination against 0.6 for radiography (P < 0.05). The negative predictive value was 0.67 against 0.25 for radiography (P < 0.05).

In consistence with our results, Iorio et al., (2018) who studied LUS findings undetected by chest x-ray in children with CAP by reviewing the medical records of patients admitted to the pediatric ward from January 2014 to December 2016 and they selected only cases discharged with a diagnosis of CAP who had performed lung ultrasound (LUS) and CR within 24 h of each other. All radiologic and sonographic images of the selected cases were examined blindly by a senior radiologist and a skilled sonographer. They found that of the 47 cases of pneumonia, 28 lung lesions spotted by LUS were undetected by CR. They concluded that LUS should be considered the first line imaging tool for CAP.

In contrast to our study, Ambroggio et al., (2016) who studied children aged 3 months to 18 years with a CXR and LUS with or without a clinical diagnosis of pneumonia. Four pediatric radiologists blinded to clinical information reported findings for the CXR and LUS images. The interrater reliability (IRR) was estimated for 50 LUS and CXR images. The main outcome was the finding from CT ordered clinically or the probability of the CT finding for patients clinically requiring CT. Two radiologists reviewed CT scans to determine an overall finding. Latent class analysis was used to evaluate the sensitivity and specificity for findings for LUS and CXR compared with CT. Their results showed that Of the 132 patients in the cohort, 36(27%) had CT performed for a clinical reason. Pneumonia was clinically documented in 47 patients (36%). The IRR for lung consolidation was 0.55 (95% CI, 0.40-0.70) for LUS and 0.36 (95% CI, 0.21-0.51) for CXR. The sensitivity for detecting consolidation, interstitial disease, and pleural effusion was statistically similar for LUS and CXR compared with CT; however, specificity was higher for CXR. The negative predictive value was similar for CXR and LUS.

Regarding the time consumed from the start of the procedure till reaching a diagnosis: Lung ultrasound was able to be performed and interpreted rapidly at the bedside. In this setting, given that chest X-ray took an average of nearly 2h to be performed, bedside lung ultrasound can provide a quicker diagnosis with timely and appropriate therapy. Amatya, Rupp et al., (2018) reported similar findings.

The main limitation of this study is the small number of patients enrolled; however, statistical analysis shows significant results, especially concerning the asymmetry of McNemar test, favorable to lung US. It is not possible to infer conclusive data on sensitivity and specificity of bedside lung US in the diagnosis of pneumonia from this study as, because of ethical reasons, we did not perform CT (considered as the gold standard) in all patients. Finally, it is important to

say that the lung US operator was not blind concerning clinical presentation of patients.

Recommendations
Based on the current study,
1- LUS is recommended as an effective diagnostic technique for pneumonia promote early managment after confirmation of the diagnosis.
2- Furthur studies probably are required on larger sample size to confirm our results especially regarding diagnostic value of LUS in pneumonia with hypovolemia.

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