The Role of LUS (Lung Ultrasound Score) in the Diagnosis and Monitoring of Pneumonia

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A R T I C L E I N F O

A B S T R A C T

Pneumonia is an acute lower respiratory tract disease that affects the lung parenchyma, including the alveoli and interstitial tissue. Radiological examination is considered the gold standard in confirming the diagnosis of pneumonia. The curriculum aims to emphasize the role of ultrasound (USG) in the form of Lung Ultrasound Score (LUS) in diagnosing and monitoring pneumonia. LUS examination is simple, easy to use, cost-effective, non-invasive, and reduces radiation exposure. This tool demonstrates high sensitivity and specificity compared to chest X-rays and CT scans of the chest. However, this diagnostic tool is operator-dependent, hence requiring standardized skills and expertise among operators to diagnose pneumonia consistently.

INTRODUCTION

Pneumonia is an acute lower respiratory tract disease that affects the lung parenchyma, including alveoli and interstitial tissue. The majority of pneumonia cases are caused by viruses or bacteria. Generally, the bacteria most commonly involved in pneumonia are Streptococcus pneumoniae, Haemophilus influenzae, Staphylococcus aureus, as well as atypical pathogens such as Chlamydia and Mycoplasma (Suci, 2020).

According to data from the Ministry of Health of the Republic of Indonesia in 2022, there were reported to be 7,475,856 cases of pneumonia (Tustika et al., 2024). Based on the Global Burden of Diseases (GBD) study in 2019, respiratory tract infections including pneumonia and bronchiolitis affect 489 million people worldwide, with cases occurring at a rate of per 1,000 children under 5 years old (Annisa Sam et al., 2023). However, the impact of pneumonia on morbidity, mortality, and deaths is greater in developing countries. In Indonesia, there are 988 cases per 100,000 hospitalizations, with the majority being caused by pneumonia (Bramantono et al., 2021).

Transmission can occur through droplet spread from infected individuals when coughing, sneezing, or direct contact with the patient. Pathogenic microorganisms such as bacteria enter the lungs through the respiratory tract. Subsequently, bacteria enter the bronchioles and alveoli, leading to inflammatory reactions and the production of edema fluid in the alveoli and interstitial tissue (Hasanah et al., 2021).

Symptoms of pneumonia include chills, fever, headache, cough, sputum production, and shortness of breath (Nurvina F, 2020; Tran et al., 2023). Vulnerable populations include children under 2 years old, individuals over 65 years old, and those with health problems such as malnutrition or immunological disorders (Nurvina F, 2020).

Ultrasonography has been used as an imaging technique for over 50 years, but it is still considered limited for diagnosing and managing respiratory diseases due to the presence of air and rib structures in the chest that impede examination. Currently, lung ultrasonography has become a rapid diagnostic tool for lung abnormalities such as pulmonary edema, pleural effusion, pneumothorax, and lung consolidation (Wijaya & Atmaja, 2021).

THEORETICAL FRAMEWORK
LUS (Lung Ultrasound Score)

Lung Ultrasound Score (LUS) is an examination used to identify and monitor pneumonia by assigning an increasing score. However, it does not include parameters such as inferior vena cava (IVC) diameter and collapsibility index, diaphragmatic excursion, and the search for pleural and pericardial effusions. Lung ultrasound score (LUS), which measures the level of superficial lung disease, has been shown to predict disease outcomes and the evolution of interstitial pneumonia in critically ill patients over time (Dell'Aquila et al., 2022).

Lung ultrasonography can be used to evaluate lung function and identify patients with increased fluid content in the lungs and a decreased P/F ratio. Lung ultrasonography facilitates rapid and bedside examination by a clinician,

reinforces physical examination findings, and provides superior diagnostic accuracy compared to chest radiography in certain conditions. Lung ultrasonography offers several advantages, particularly when used to evaluate patients directly at the bedside and combined with other ultrasonography examinations (C. P. Wibowo et al., 2020).

Diagnosis and Monitoring Pneumonia

Pneumonia is a common acute respiratory infection that affects the alveoli and distal bronchial tree of the lungs. It can be caused by viruses, bacteria, fungi, or a combination thereof, leading to inflammation and fluid accumulation in the lung parenchyma. Globally, pneumonia is a leading cause of morbidity and mortality in children under 5 years of age (Annisa Sam et al., 2023).

Figure 1. Ultrasonography examination shows the pleural line (white arrow), A-line (yellow arrow), and rib (white star)

Figure 2. Ultrasonography examination shows multiple B-lines (white arrows)

Figure 3. Ultrasonography examination shows shred sign with fractal line (white arrow), lung consolidation (white star)

Figure 4. Ultrasonography examination of lung consolidation with hepatization (white star), air bronchograms (yellow arrow); pleural line (white arrow), rib (yellow star)

The causes of pneumonia-related deaths are multifactorial, including excessive inflammation, both systemic and local, in the lung organ. Other causes include acute lung injury, endothelial dysfunction in the vasculature, and coagulopathy. The diagnosis of pneumonia involves history taking, clinical symptoms, physical examination, and diagnostic tests (Natasya, 2022). Definitive diagnosis of community-acquired pneumonia (CAP) is established if a new or progressive infiltrate is present on chest X-ray along with ≥2 symptoms. These symptoms include cough, change in sputum character to purulent, body temperature >38°C, physical examination findings of consolidation signs, bronchial breath sounds and rales, and leukocytes >10,000 or <4,500 cells/μL (Aliya Julianti et al., 2023).
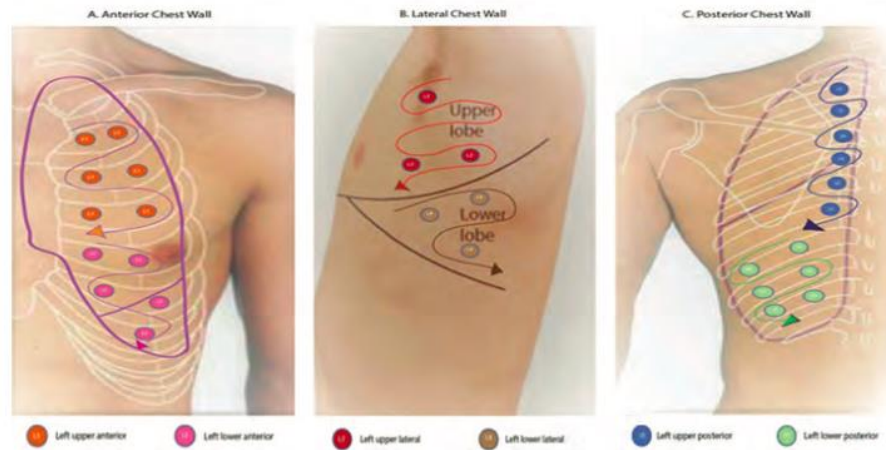
Figure 5. Lung ultrasonography scanning zone.

The technique of lung ultrasonography examination involves understanding several signs, including: First, identification of the pleural line (Figure 1, white line) and lung sliding (in ultrasonography, horizontal movement of the pleural line indicates the absence of pneumothorax). Second, A-line (Figure 1, yellow line, a horizontal line extending from the pleural line); A-lines and sliding indicate normal lungs; A-lines without sliding indicate pneumothorax. Third, the lung point indicates pneumothorax. Fourth, B-lines (Figure 2, white arrows) indicate interstitial syndrome originating from the pleura. B-lines appear as 2 or 3 lines radiating from the pleura, obliterating A-lines and extending the ultrasonography image to the end of the examination field. Fifth, consolidation is confirmed as fractal/shred sign (Figure 3, white arrow). Consolidated lung tissue appears as a subpleural hypoechoic region resembling hepatic tissue with irregular and thick edges. Sixth, pleural effusion signs include quad and sinusoid signs (quad signs consist of 4 lines representing the pleura, ribs, fluid, and lung, while sinusoid signs indicate lung breath movement with atelectasis). Both of these signs have high sensitivity and specificity for pleural effusion (Figure 4) (Wijaya & Atmaja, 2021).

Radiological examination is considered the gold standard in diagnosing pneumonia. Radiological patterns may include air bronchogram appearance (air space disease). Laboratory examinations include routine blood tests, arterial blood gas analysis, systemic inflammatory and infection biomarkers, sputum gram staining, blood and sputum cultures, and serological tests (Aliya Julianti et al., 2023).

In patients suspected by clinicians of having community-acquired pneumonia, blood tests can provide information about inflammatory conditions (i.e., leukocyte count and characteristics and CRP levels), organ damage (i.e., acute kidney injury), and disease severity. Biomarkers can assist clinicians in differentiating bacterial pneumonia from other disorders (e.g., upper respiratory tract disorders) (Natasya, 2022).

RESULT AND DISCUSSION
The Role of Lung Ultrasound Score (Lus) in the Diagnosis and Monitoring of Pneumonia

Community-acquired pneumonia (CAP) is pneumonia that occurs outside healthcare facilities or within the first 48 hours of hospitalization. Pneumonia is a disease with high mortality and treatment rates. In the United States, there are six million cases of pneumonia each year, with over one million hospitalizations and 50,000 deaths due to community-acquired pneumonia (A. Wibowo, 2023).

In daily practice, the diagnosis of pneumonia is based on history taking, physical examination, and radiology. There are various modalities to assist in diagnosing pneumonia, including laboratory and radiological examinations. Each tool has different accuracy values. Radiological examinations commonly used to confirm diagnosis in atypical clinical presentations include chest X-rays. In studies comparing the use of chest X-rays and CT scans in the Emergency Department to diagnose community-acquired pneumonia, there were 30% false positive and false negative rates on chest X-ray examinations (A. Wibowo, 2023).

The use of chest X-rays and CT scans should also be considered in critical patients, children, and pregnant women. CT scans can be used to diagnose pneumonia but have limitations such as radiation exposure, patient transfer to the examination room, and higher examination and equipment maintenance costs. Chest ultrasound examination (LUS) can overcome the limitations of chest X-rays and CT scans. LUS examination is easy, inexpensive, non-invasive, and can be performed at the patient's bedside. This examination has high accuracy in diagnosing lung abnormalities (A. Wibowo, 2023).

Lung ultrasound score (LUS) obtained from the examination of both lungs at 12 points with lung ultrasound is a useful examination to evaluate patients with ARDS and bacterial pneumonia. Lung ultrasonography is a useful method for evaluating respiratory diseases including pneumonia (Sumbul et al., 2021). A recent meta-analysis showed a sensitivity of 94.0% (95% CI 92.0 to 96.0) and specificity of 96.0% (95% CI 94.0 to 97.0) in diagnosing pneumonia in adults. Compared to previous methods, lung ultrasound has several advantages; radiation-free, can be performed at the bedside and in pregnant women, allows dynamic evaluation, improves accuracy in detecting consolidation and pleural effusion compared to chest radiography, and requires less time (Natasya, 2022).

CONCLUSIONS AND RECOMMENDATIONS

From the above description, it can be concluded that ultrasound plays a significant role in the diagnosis of Lung Ultrasound Score (LUS) in diagnosing and monitoring pneumonia. Lung ultrasound examination is simple, easy to use, inexpensive, non-invasive, and can reduce radiation exposure. This tool has high sensitivity and specificity compared to chest X-rays and CT scans, but it is operator-dependent, requiring standardization and consistent expertise among operators to diagnose pneumonia.

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