

Evaluating the diagnostic value of emergency portable ultrasound in the diagnosis of pneumonia

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Abstract

Introduction: Pneumonia is a severe and common infectious disease that is associated with a high rate of morbidity and mortality. Lung ultrasound has recently become a common device in emergency rooms, and it is a quick and easy way to diagnose pneumonia. The aim of this study was to see how effective emergency bedside ultrasound is at diagnosing pneumonia.

Materials and Methods: In the years 2017-2018, 146 patients over the age of 18 were referred to the emergency department of Kowsar Hospital in Sanandaj and this study is based on that. Many of the patients had portable ultrasound and radiography. A sonologist took ultrasound photos in the presence of an emergency medicine specialist and an emergency medicine nurse. CT scans were used as a gold standard to compare the outcomes of chest radiographs and portable ultrasounds in these patients. In the diagnosis of pneumonia, the sensitivity, precision, positive and negative predictive value of ultrasound versus radiography is measured.

Results: A total of 146 patients, with an average age of 64.2 years, were studied in this study. Fever was present in 65 percent of patients, sputum was present in 63 percent of patients, pathologic auscultation was present in 58.9% of patients, the cough was present in 52.7 percent of patients, and shortness of breath was present in 52.1 percent of patients. The ultrasound test's sensitivity, specificity, positive predictive value, and negative predictive value were 44.4 percent, 100 percent, 100 percent, and 0 percent, respectively, while the radiographic test's sensitivity, specificity, positive predictive value, and negative predictive value were 25.92 percent, 100 percent, 100 percent, and 0 percent, respectively.

Conclusion: Because of its availability and effectiveness, ultrasound may be a successful alternative to chest radiography and chest CT scan in the diagnosis of pneumonia, according to the results of this report.

Keywords: Pneumonia; Emergency; Diagnostic value; Ultrasound; Radiography.

INTRODUCTION

Pneumonia is a widespread and dangerous infectious disease that is often misdiagnosed and treated. Antibiotic therapy must be administered correctly and promptly (1). Pneumonia is an acute infection of the lung parenchyma with acute symptoms that is confirmed by acute infiltration in the chest X-ray or by finding changes in sound in the patient's physical examination, and the diagnosis is made in a patient who is not hospitalized or has not been hospitalized for the past 14 days (1-3). Cough, sputum cough, dyspnea, fever, and pleuritic pain are all symptoms of the disease. Because of its high prevalence, mortality, and serious complications, community-acquired pneumonia (CAP) is particularly critical in the elderly (4). This pneumonia has a prevalence of around 12 cases per 1000 people and is the most common at both ends of the age spectrum (1). According to WHO figures from the year 2000, approximately 4 million deaths were caused by acute respiratory infections worldwide, with acute pneumonia accounting for 90% of these deaths. 1.9 million of these deaths occurred in children under the age of five (5). Because of the underlying hunger, the majority of these figures pertain to developed countries (6). On the other hand, acute respiratory infection, particularly pneumonia, accounts for about 20 percent of all child deaths, so that for every 1,000 live births in developing countries, 12 to 20 children are dying due to pneumonia before the age of 5 (7).

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Abnormal radiographic results normally take several weeks to months to improve relative to the patient's clinical findings, so healing to a normal lung takes 4 to 6 weeks. However, if a child has had pneumonia for three months and has an irregular chest X-ray, further investigation is needed, so delayed chest X-ray is not recommended for regular follow-up of children with acute pneumonia (8, 9).

The most popular imaging method used to diagnose pneumonia is chest radiography. While radiography can be done on a patient's bed without causing them to move, just a few images can provide enough detail. As a result, it is not uncommon for misdiagnoses to occur (12-12).

However, the most common procedure for diagnosing pneumonia is a chest x-ray. This method has poor sensitivity and accuracy, and it cannot be used during pregnancy or is associated with risk (14-16). The use of sleeping x-rays, on the other hand, does not provide useful details in patients admitted to intensive care units or in hospitalized patients who are unable to stand upright due to poor quality. The use of a CT scan (3-5) is the gold standard for definitive diagnosis. In addition, x-ray disapproval of pneumonia raises antibiotic use and its complications. Owing to the thymus shadow and the components of the thoracic cavity, one of the graphical problems in neonates is the non-differentiation of lung tissue from other tissues, which can result in no diagnosis of remission or loss of the middle lobe pneumonia. According to research, chest ultrasound is an alternative available approach today (13-15).

Due to the importance of correct and rapid diagnosis of pneumonia in patients, and the failure of CT scan and CXR in all patients, as well as in cases of unstable patients, ultrasound may be a very useful tool. Ultrasound is, therefore, less expensive than CT scans and CXR, and it is free of radiation and risks. It can be used in remote areas, war zones, and natural disasters (15-17).

Given the above, our aim in this study was to compare the diagnostic accuracy of traditional radiography and ultrasound for the diagnosis of pneumonia in order to substitute less aggressive modalities and avoid imposing procedures with complications on patients, as well as to perform bedside modalities. Ultrasound can be used instead of radiography if the results are satisfactory.

MATERIALS AND METHODS

The current study is a diagnostic value determination study on 146 patients over the age of 18 who were referred to the emergency department of Kowsar Hospital in Sanandaj in 2017-2018. Many of the patients had portable ultrasound and radiography. A sonologist took ultrasound photos in the presence of an emergency medicine specialist and an emergency medicine resident.

All patients with a clinical suspicion of pneumonia who met the inclusion requirements of fever, tachypnea, respiratory distress, cough, and a drop in O₂ saturation had a chest ultrasound performed by an emergency medicine resident prior to radiography and were tested for pneumonia diagnostic criteria. The ultrasonography system used was a Siemens model gm-6703a-2600 Japanese ultrasonography system from 2004.

The patient's history and clinical assessment (cough, sputum, fever, pathologic findings in auscultation) were also examined in addition to sonography. The thorax was divided into three sections for ultrasound: anterior (para-sternal line to anterior axillary line), lateral (between anterior and posterior axillary line), and posterior (between anterior and posterior axillary line) (from posterior axillary line to paravertebral line). The convex probe was used to conduct ultrasound in the intercostal space parallel to each rib. The location of the patients for ultrasound was supine for the anterior part, lateral decubitus for the lateral part, and prone for the posterior part. Hypochoic areas of various sizes and shapes, air bronchograms, fluid bronchograms, B-lines (comet-tail artifacts), intraconsolidar vascular design, and pleural effusion were among the findings in pneumonia. Any of these results indicated that the symptomatic individuals had pneumonia.

CT scans were used as a gold standard to compare the outcomes of chest X-rays and ultrasound findings in these patients. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) statistical indices were measured, and the region under the ROC curve was recorded. To equate the ultrasound and radiography results with the CT scan results, each of the indices was recalculated (Gold Standard). SPSS 20 was used to analyze the data.

RESULTS

In this report, 146 patients with an average age of 64.2 years were examined, with 76 (52.1%) of them being female. Fever was present in 65 percent of the patients, sputum was present in 63 percent of the patients, pathologic auscultation was present in 58.9% of the patients, the cough was present in 52.7 percent of the patients, and dyspnea was present in 52.1 percent of the patients (Table 1). The ultrasound test's sensitivity, specificity, positive predictive value, and negative predictive value were 44.4 percent, 100 percent, 100 percent, and 0 percent, respectively (Table 2), while the radiographic test's sensitivity, specificity, positive predictive value, and negative predictive value were 25.92 percent, 100 percent, 100 percent, and 0 percent, respectively (Table 3). The findings also revealed that the ultrasound ROC test's sensitivity, accuracy, positive predictive value, and negative predictive value, as well as the region under the curve, were 91.27 percent, 0%, 95.83 percent, 0%, and 91.3 percent, respectively (Table 4).

Variable	Frequency	Percentage	Total
Gender	Male	70	47.9
	Female	76	52.1
Respiratory Distress	Yes	2	1.4
	No	143	99.3
Tachpnea	Yes	3	2.1
	No	142	99.3
Fever	Yes	50	34.2
	No	95	65.1
Dyspnea	Yes	69	47.3
	No	76	52.1
Cough	Yes	77	52.7
	No	68	46.6
Sputum	Yes	53	36.3
	No	92	63
Low Saturation	Yes	1	0.7
	No	144	98.6
Pathologic Auscultation	Yes	60	14.1
	No	86	58.9

Table 1. Frequency of the demographic variables and signs and symptoms suspicious to pneumonia in the studied patients

Diagnostic method CT scan ultrasound	Positive percentage	Negative percentage	Total
Positive	12	0	12
Negative	15	0	15
Sensitivity	44.4		
Specificity	100		
Positive Predictive Value	100		
Negative Predictive Value	0		

Table 2. Frequency of findings of CT scan and ultrasound in the diagnosis of pneumonia

Diagnostic method CT scan	Positive percentage	Negative percentage	Total
radiography			
Positive	7	0	7
Negative	20	0	20
Sensitivity	25.9		
Specificity	100		
Positive Predictive Value	100		
Negative Predictive Value	0		

Table 3. Frequency of findings of CT scan and radiography in the diagnosis of pneumonia

Diagnostic method ultrasound	Positive percentage	Negative percentage	Total
radiography			
Positive	115	0	122
Negative	11	0	11
Sensitivity	91.2		
Specificity	0		
Positive Predictive Value	95.8		
Negative Predictive Value	0		

Table 4. Frequency of findings of ultrasound and radiography in the diagnosis of pneumonia

DISCUSSION

A total of 146 patients, with an average age of 64.20 years, were studied in this study. Fever was present in 65 percent of patients, sputum was present in 63 percent of patients, pathologic auscultation was present in 58.9% of patients, the cough was present in 52.7 percent of patients, and dyspnea was present in 52.1 percent of patients. The most common symptoms in the study by Mohammadi Fard and Ebrahimpzadeh (18) were fever (96%), cough (89.5%), sputum (84%), and irregular auscultation in clinical examination, which included reduced or completely absent sounds, fine and coarse crackle, and wheezing in 88 percent of cases. The most common symptoms of pneumonia, according to Diehr et al., were cough (92 percent), fever (91 percent), sputum (78 percent), and pleuritic pain (41 percent) (19). Fever was the most common symptom of pneumonia at the time of admission in studies conducted in the United States, Spain, and Brazil (20–22). The findings of this study were consistent with those of other research, indicating that fever was the most frequent symptom of infection.

Accounting for more than ultrasound test’s sensitivity, specificity, positive predictive value, and negative predictive value were 44.4 percent, 100 percent, 100 percent, and 0 percent, respectively, while the radiographic test’s sensitivity, specificity, positive predictive value, and negative predictive value were 25.92 percent, 100 percent, 100 percent, and 0 percent, respectively. Sensitivity, accuracy, positive predictive value, negative predictive value, and area under the curve for sonography tests were 91.27 percent, 0%, 95.83 percent, 0%, and 91.3 percent, respectively, according to the findings. The sensitivity of sonography was significantly higher than that of radiography in the study of Amatya et al., but the specificity of sonography and radiography were comparable at 61 percent and 50 percent, respectively. Sonography and radiography had a positive predictive value of 85 percent and 78 percent, respectively, and a negative predictive value of 73 percent and 43 percent, respectively. Sonography’s positive and negative probability ratios were 2.34 and 0.15, respectively, while radiography’s were 1.45 and 0.55 (23). Long et al. indicated that ultrasound had an overall sensitivity of 88 percent and a specificity of 86 percent in a meta-analysis review, and the accuracy of ultrasound testing using the ROC curve level was 0.95. (24). Ye et al, recorded 95 percent overall sensitivity and 91 percent specificity in their analysis (15). Sonography had a sensitivity of 94 percent, while radiography had a sensitivity of 78 percent, according to Liu et al. They also discovered that when the gold standard measure is a

CT scan, ultrasound sensitivity is higher (99 percent vs. 61 percent) (26). Furthermore, the positive likelihood ratio, negative likelihood ratio, and ultrasound AUC in the study by Chavez et al. were 16.8 (95 percent CI: 7.7-37), 0.07 (95 percent CI: 0.05-0.10), and 0.98 (95 percent CI: 0.98 - 0.99), respectively (26). Pereda and colleagues Ultrasound sensitivity, accuracy, and positive and negative probability ratios were 96 percent (95 percent CI: 94-97 percent), 93 percent (95 percent CI: 90-96 percent), 15.3 percent (95 percent CI: 6.6-35.3), and 0.06 percent (95 percent CI: 0.03-0.11), respectively (27). Ultrasound was found to be more sensitive than radiography in the diagnosis of pneumonia in several studies (29-32).

CONCLUSION

The results of this study showed that ultrasound is very effective in the diagnosis of pneumonia and that it can be a successful alternative to chest radiography and chest CT scan because of its availability and feasibility.

Conflict of Interest: There are no conflicts of interest declared by the writers.

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