

Value of thoracic ultrasound including focused cardiac ultrasound in daily practice of outpatient chest clinic

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ABSTRACT

Background: Chest examination alone may be insufficient to declare cardiorespiratory diseases specially in its early stages and/or silent forms, also it is impractical for the CXR and cardiac consultation to be requested for every patient in the outpatient clinic, therefore involving the chest US and FoCUS (Focused Cardiac Ultra Sound) examination in the bedside practice of outpatient chest clinic may influence the clinical diagnosis and management plan.

Objective: To determine how the bedside thoracic US including FoCUS can alter the clinical diagnosis in patients who are clinically diagnosed as acute bronchitis in the outpatient chest clinic.

Subjects and methods: This study was conducted at Chest outpatient clinic, Al-Azhar University in the period between January 2024 to March 2025. 300 patients diagnosed clinically as acute bronchitis were evaluated by bedside chest ultrasound and FoCUS.

Results: A prospective cross sectional study including 300 patients clinically diagnosed as acute bronchitis and evaluated by the bedside chest US including FoCUS which was additive and/or changing in clinical diagnosis in 31 (10.3%) of the studied patients, the sonographic evidence of pneumonia was present in 17 (5.7%) patients, the interstitial lung disease ILD was suggested in 5 (1.7%) patients, the clinic-sonographic diagnosis of heart failure was present in 7 (2.3%), the findings of mitral stenosis was present in 2 (0.7%).

Conclusion: The practice of bedside chest US including FoCUS should not be restricted to the emergency rooms and ICUs but also should be extended to the outpatient clinic as it can diagnose unexpected clinical problems, guide to the next investigational step, and shorten the time to the clinical diagnosis and recovery.

Key words: Acute bronchitis, Chest US, FoCUS

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Introduction

Acute bronchitis will persist as a simple word but should not be continued as a simple diagnosis, despite the careful history and proper clinical examination that could uncover many unexpected clinical problems, but the ultrasound probe can still afford more and take its place as a second necessary handheld stethoscope [1].

The chest ultrasound evaluation recently includes the FoCUS examination which is a newly developing strategy that is intended to practice by non-echocardiographer and is designed to make the chest US examination more comprehensive, informative and even conclusive when incorporated with the bedside clinical data, which could be achieved by clinching crucial echocardiographic findings that is relatively straightforward to be learned and detected [2].

The sonographic findings like abnormal pleural line, pleural effusion, subpleural consolidation, B lines that can be easily detected in chest US and the FoCUS findings such as the qualitative rather than quantitative evaluation of cardiac contractility, mitral valve disease especially mitral stenosis and detection of pericardial effusion, all have a significant rule in the evaluation, diagnosis and overall management of many respiratory patients [3] which may encourage involving this sonographic diagnostic modality in every day practice of outpatient chest clinic.

Aim of the work

To determine how the bedside thoracic US including FoCUS can alter clinical diagnosis in patients who are clinically diagnosed as acute bronchitis in the outpatient chest clinic.

Subjects and methods

A prospective cross-sectional study was conducted from January 2024 to March 2025 at Outpatient clinics at Al-Azhar university hospitals, Cairo, Egypt. 300 patients clinically diagnosed as acute bronchitis at the outpatient clinic were randomly selected and evaluated by the bedside chest US including (FoCUS) after taking patients permissions.

All patients were subjected to the following: - Clinical history and examination; - Chest US including FoCUS.

Inclusion criteria: All patients are clinically diagnosed as only acute bronchitis and have no apparent clinical indication for further investigations.

Exclusion criteria: - Patients less than 18 years old.
- Patients with known cardiac or chronic respiratory disease. - Patients with any systemic disease other than DM and HTN.

The Ultrasound examination was done by the attending physicians at the outpatient clinics who have more than five years' experience in chest ultrasound after completing chest ultrasound training course. The ultrasound machine SonoScape-SS1 (Sono-Scape Medical Manufacturer, Shenzhen, China) has been used for the examination of patients.

- a. The examination protocol: - every hemithorax was divided into 6 zones, upper and lower anterior chest zones, upper and lower (lateral) axillary zones, interscapular and intrascapular posterior zones and the intercostals spaces were scanned with the ultrasound probe perpendicular to it.
- b. Selected probe: - the curved abdominal probe was the standard probe.
- c. Used preset: - all patients were examined in the B mode with initial setting as following: -frequency 3-5 Hz, depth average 8 cm in addition to the total gain which was changed as guided by the patient body built and to obtain the best clarity of the image.

Results

The study included 300 patients initially diagnosed with acute bronchitis who met the inclusion criteria. Their median age was 47 years (range: 19-87 years). Out of these, 61% were male and 39% were female. Additionally, 53 patients (17.7%) were smokers, 20 patients (6.7%) had hypertension, 17 patients (5.7%) had diabetes (Table 1).

Table 1. Descriptive data of the studied patients.

Variables		n=300	%
Age (years)	Median [IQR]	47 [32 – 59]	
	Min – Max	19 – 87	
Sex	Male	183	61.0
	Female	117	39.0
Smoking	Yes	53	17.7
	No	247	82.3
Comorbidities	HTN	20	6.7
	DM	17	5.7
Initial diagnosis	Acute bronchitis	300	100.0

IQR: Interquartile range.

Table 2. Sonographic findings of the patients studied with acute bronchitis.

Variables		n=300	%
B-lines	Yes	28	9.3
Pleural line	Normal	277	92.3
	Thick	5	1.7
	Irregular	17	5.7
Subpleural consolidation	Yes	17	5.7
Minimal pleural effusion	Yes	4	1.3
Cardiac contractility	Impaired	7	2.3
Septal leaflet	Elbowing	2	0.7

Sonographic findings showed B-lines in 28 patients (9.3%), thickened pleural line in 5 patients (1.7%), irregular pleural lines in 17 patients (5.7%), subpleural lung consolidation in 17 patients (5.7%), and minimal pleural effusion in 4 patients (1.3%). Focused cardiac ultrasound (FoCUS) findings indicated impaired cardiac contractility was observed in 7 patients (2.3%) and the elbowing of the septal leaflet of the mitral valve in 2 patients (0.7%) (Table 2).

The application of chest US including FoCUS examination was additive and/or changing to the initial clinical diagnosis in 31 (10.3%) of patients distributed as follow; pneumonia in 17 patients (5.7%), heart failure in 7 patients (2.3%), interstitial lung disease in 5 patients (1.7%), and mitral stenosis in 2 patients (0.7%) while 269 patients (89.7%) remain with their initial clinical diagnosis of acute bronchitis (Figure 1).

The final clinicosonographic diagnosis identified 17 patients (5.7%) with pneumonia, 7 (2.3%) with heart failure, 2 (0.7%) with mitral stenosis, 5 (1.7%) with ILD. Pneumonia (17 patients): All exhibited sonographic findings of B-lines and irregular pleural lines as well as subpleural consolidation. Heart failure (7 patients): Sonographic findings included B-lines in 6 patients (85.7%), normal pleural line in all patients, minimal pleural effusion in 4 (57.1%), and impaired cardiac contractility in 7 (100%). Mitral stenosis (2 patients): Both patients presented with elbowing of the septal leaflet. ILD (5 patients): All exhibited B-lines and thickened pleural line (Table 3).

Among 17 patients diagnosed with pneumonia, 3 (17.6%) had comorbid hypertension and 6 (35.3%) had DM. Among 7 patients diagnosed with heart failure, 5 (71.4%) had comorbid hypertension and 4 (57.1%) had DM (Table 4).

Statistical analysis

Variables were coded on an Excel program for proper extraction of data. Statistical analysis was carried out using the SPSS computer package version 26.0 (SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to determine whether the data (age) was normally distributed. For descriptive statistics, the number and percentage were used for qualitative variables, while the median and interquartile range (IQR) were used for non-normally distributed quantitative variables. Kruskal-Wallis's test was used to assess the differences in means of quantitative non-parametric statistics. A significant level was set as $P < 0.05$.

Discussion

Acute bronchitis is always a clinical diagnosis that is given to a constellation of symptoms of cough, expectoration and wheezes in some patients; it develops acutely with different symptom predominance and variable degrees of severity together with exclusion of pneumonia at the time of presentation [4]. In many times the acute bronchitis can pose a considerable risk when it occurs on top of chronic lung illness or

Table 3. Correlation between sonographic findings and clinical diagnoses.

Clinico-sonographic diagnosis	Clinicosonographic findings					
	B-lines n (%)	Pleural line n (%)	Consolidation n (%)	Pleural effusion n (%)	Cardiac contractility n (%)	Septal leaflet n (%)
Pneumonia (n=17)	17 (100)	17 (100) ¹	17 (100)			
Heart Failure (n=7)	6 (85.7)	7 (100) ²		4 (57.1)	7 (100) ⁵	
Mitral stenosis (n=2)		2 (100) ³				2 (100) ⁶
Interstitial lung disease (n=5)	5 (100)	5 (100) ⁴				

¹: All with irregular pleural lines. ²: All with normal pleural lines. ³: All with normal pleural lines. ⁴: All with thick pleural lines. ⁵: Impaired contractility. ⁶: All with elbowing of the septal leaflet.

Table 4. Relation between clinico-sonographic diagnosis and comorbidities.

Clinical diagnoses	HTN n=20 (%)	DM n=17 (%)
Pneumonia (n=17)	3 (17.6)	6 (35.3)
Heart Failure (n=7)	5 (71.4)	4 (57.1)
Mitral valve disease (n=2)	0 (0.0)	0 (0.0)
Interstitial lung disease (n=5)	0 (0.0)	0 (0.0)

be the decompensating insult of an underlying cardiorespiratory disease. The chest ultrasound including FoCUS [5] that can be performed in a few minutes by a well-trained pulmonologist can give a clue to many of such underlying diagnoses like interstitial lung disease (ILD), subtle pneumonic process with early forming GGO, tight mitral stenosis, left ventricular impairment as well as mild pleural effusion that warrant further investigations.

Through evaluation of the patients who are already clinically diagnosed as acute bronchitis, this study is intended to address the value of the chest ultrasound including FoCUS to be incorporated in the daily practice of bedside evaluation in the outpatient chest clinic.

In the current prospective cross sectional study which include 300 patients with median age of 47 years and age range of 19–87 years, 183 (61%) males and 117 (39%) females, 53 patients (17.7%) was smoker, 247 (82.3%) of patients was nonsmokers, 17(5.7%) patients were diabetic and 20 (6.7%) were HTN (Table 1); all patients were clinically diagnosed as acute bronchitis and then evaluated by thoracic US including

FoCUS examination, which result in an added and/or alternative diagnosis in 31 (10.3%) of the studied patients (Figure 1).

The sonographic findings of minimal pleural effusion was present in 4 (1.3%) patients, B lines was present in 28 patients (9.3%) associated with thick pleural line in 5 (1.7%) and irregular pleural line in 17 (5.7%) patients, the findings of impaired cardiac contractility was present in 7 (2.3%) patients and elbowing of septal mitral valve leaflet was present in 2 (0.7%) cases, subpleural consolidation was present in 17 (5.7%) patients (Table 2).

Based on the formulation of the clinicosonographic findings the lung ultrasound including FoCUS was additive and/or changing of the initial clinical diagnosis of acute bronchitis in 31 (10.3%) of the 300 studied patients who had the initial clinical diagnosis of acute bronchitis and was distributed as: pneumonic process in 17 (5.7%) patients, 5 (1.7%) patients were suggested to have an underlying ILD while clinicosonographic diagnosis of heart failure was formulated in 7 (2.3%) patients and mitral valve stenosis in 2 (0.7%) cases (Figure 1), also Shahba et al. [6] who conducting his study in fifty patients with acute respiratory distress found that the initial clinical diagnosis was changed and/or supplemented by another diagnosis in 84% of patients when the chest ultrasound was introduced to the clinical assessment, the marked difference in the number of studied population and the different clinical situation may be responsible for such wide range of percentage.

Regarding the sonographic findings in the studied patients, among 17 patients diagnosed as pneumonia

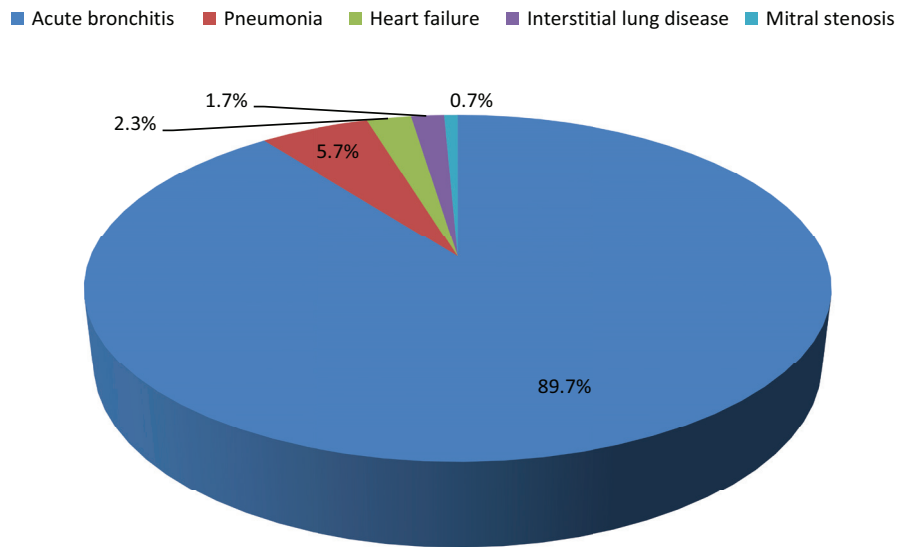


Figure 1. Different clinical diagnoses based on clinicasonographic correlation.

the focal finding of irregular pleural line associated with sub pleural consolidation and concomitant B lines was present in all of them (100%) with no pleural effusion at all. In 5 patients with ILD the only sonographic clue was in the form of B lines with thick pleural lines in all patients, while in 7 patients with heart failure the sonographic evidence of impaired cardiac contractility was present in all patients, B lines were also present in 6 (85.7 %) and minimal pleural effusion in 4 (57.1%). Finally, elbowing of the septal leaflet was present in the 2 patients with mitral valve stenosis (Table 3).

Regarding the correlation between the comorbidities and final diagnosis, among 17 patients with pneumonia 6 (35.3%) was diabetic and 3 (17.6%) was HTN, also among 7 patients with heart failure HTN was present in 5 (71.4%) and DM was present in 4 (57.1%) while no comorbidities were found in patients with either mitral valve disease or those with suspected interstitial lung disease (Table 4). Such findings may warrant special attention for those patients with DM and HTN to be particularly evaluated by chest US and FoCUS examination even when presented with acute bronchitis although further studies including larger number of patients may be needed to confirm this finding.

Many patients with pneumonia may present without physical local chest findings of the common crackles

[7] and even with normal chest x ray in the early stages of GGO where it could be easily detected by chest US specifically when subpleural in location [8].

Minimal pleural effusion may reveal no clinical findings and even normal ordinary posteroanterior CXR when at least 200 ml of pleural fluid is needed to blunt the costophrenic recess [9] while the chest ultrasound can simply detect small amounts of less than 20 ml [10,11].

Ibrahim et al. [12] found that the lung US has a sensitivity of 93.33% and specificity of 96% in diagnosis of pneumonia and pleural effusion with the additional advantage of detection of septations and loculations where it is more sensitive than chest CT [13].

The increased percentage of pneumonic patients may be attributed to the time of the study, which is concomitant with the winter when respiratory tract infection is more common, but it could also be alarming to involve chest US examination in this period.

Patients with suggested ILD were proven later to suffer ILD by the non-contrast enhanced high-resolution CT of the chest (HRCT). Such patients with an underlying chronic lung disease may experience recurrent, prolonged or a more severe form of acute bronchitis and frequently misdiagnosed as asthmatic patients and spend a long period of time and unnecessary medications to the point that the lung

functions are compromised when their underlying interstitial lung disease become evident, routine and simple chest ultrasound in such groups of frequent or prolonged bronchitis may shorten the time for diagnosis of their underlying ILD.

The usual sonographic signs of ILD include the B lines which are typically widely spaced and asymmetrically distributed all over the lung zones mostly with thick, fragmented and/or irregular pleural lines; despite appearing nonspecific but these features are still characteristic and valuable for suggestion of interstitial lung disease and endorsement of further diagnostic work up particularly in the appropriate clinical situations [14].

Govind et al. [15] found a statistically significant results among the patients studied with interstitial lung disease where the abnormal B lines were the commonest sonographic finding in 80% of the studied patients in addition to pleural line abnormalities in the form of irregularity in 78%, thickening in 56%, and impaired sliding in 44% of patients.

B lines is a well-known and one of the most frequent and studied lung sonographic signs which are defined as a hyperechoic vertical and lasery fanning lines extending from the pleural line to the bottom of the screen with masking of the normally occurring A lines, and it was found to be coalescent, diffuse, bilateral and symmetrically distributed in patients with heart failure and have a progressive relationship with increased deaeration of the lung in patients with pulmonary congestion [16].

Ali et al. [17] study showed that the B lines have a sensitivity of 90.9% and specificity of 94.8% for diagnosis of pulmonary edema particularly when detected symmetrically and in multiplicity in the anterior four lung zones, while Elke Platz et al. [18] conclude that the larger the number of B lines the higher the risk of adverse events in patients with heart failure.

When this is clinically acceptable to be applied and the heart failure can be diagnosed earlier, definitely it will have its positive consequences like changing some epidemiological data as the true incidence and prevalence of the disease in addition to the clinical advantage of early diagnosis of heart failure where more preservation of the cardiac function and in the ultra-short term reducing the ominous consequences

of a more severe and prolonged bronchitis where such severity and prolongation should not be confusingly explained by the severity of the mutant respiratory viruses or managed by the worthless changing of the antimicrobial therapy. Additionally, some patients with pulmonary congestion may develop wheezes due to the airway obstruction caused by the edematous peribronchial cuffing that may be easily misdiagnosed as bronchial asthma [19] with further diagnostic delay and patient deterioration due to an initially undiagnosed heart failure, a real clinical situation that is not infrequently encountered in the daily practice of respiratory medicine. Such long road of misdiagnosis and diagnostic delay can be greatly reduced by one moment looking for the cardiac function by the ultrasound probe that allows for the qualitative evaluation of the cardiac function as recommended by FoCUS examination strategy [20].

Furthermore, well trained pulmonologists can easily detect the finding of mitral valve disease exactly mitral stenosis [21] and particularly when severe, this FoCUS findings certainly will alter the management plan and shorten the time of recovery and decrease the patient morbidity through the immediate prescription of the appropriate medications such as diuretics and definitely the patient will be evaluated sooner by a formal echocardiography.

The striking point in this study is that it was not classically designed to compare the sensitivity and specificity of chest US with other imaging investigational modalities like chest radiograph, formal echocardiography or CT chest, but rather it was to evaluate the ability of the ultrasound probe when used by a qualified pulmonologists to declare an underlying clinically silent cardiopulmonary pathology, to alter the management pathway of the patient by clenching some patients who clinically can definitely be simply discharged as acute bronchitis but sonographically are not yet.

In some clinical situations like the minimal pleural effusion, some cases of pneumonia and earlier or previously unknown impairment of the cardiac function when the stethoscope cannot be informative but the ultrasound probe can do, hence it could be sufficient for the ultrasound probe to be involved in the daily practice of outpatient chest clinic as a complementary

second handheld stethoscope that can see the clinical finding while the ordinary stethoscope can hear it.

Up to this time, the CXR is not obligatory for the diagnosis of acute bronchitis and even impractical [22] but this is not necessarily applied to the noninvasive, non-radiating and time saving look by the US probe.

Finally, in addition to the common belief that CXR is complementary to chest examination, it may be the time to announce that the chest ultrasound probe should be the second stethoscope, although at this point of time it may be difficult to recommend the addition of the US probe to the routine bedside chest evaluation which seems in its necessity to look like observing the expectorated sputum - even if it is not performed by many physicians-, but sooner it would be a firm particularly for some patients with risk factors like diabetes and hypertension and those with systemic rheumatological diseases as well as those with alarming history of a more prolonged and frequent chest illness.

Conclusion

The practice of bedside chest US including FoCUS should not be restricted to the emergency rooms and ICUs but also should be extended to the outpatient clinic as it can diagnose unexpected clinical problems, guide to the next investigational step, and shorten the time to the clinical diagnosis and recovery.

Limitations: This study did not define certain patients population who may be at greater risk of subtle underlying cardiorespiratory disease to be specifically evaluated by chest ultrasound and FoCUS, therefore further studies are needed to define certain patient groups who merit such examination to avoid the cumbersome practice of sonographic evaluation of all respiratory patients.

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