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Integration of lung ultrasound in the diagnostic reasoning in acute dyspneic patients: A prospective randomized study

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ABSTRACT

Introduction: Misdiagnosis in acute dyspneic patients (ADP) has consequences on their outcome. Lung ultrasound (LUS) is an accurate tool to improve diagnostic performance. The main goal of this study was to assess the determinants of increased diagnostic accuracy using LUS.
Materials: Multicentre, prospective, randomized study including emergency physicians and critical care physicians treating ADP on a daily basis. Each participant received three difficult clinical cases of ADP: one with only clinical data (OCD), one with only LUS data (OLD), and one with both. Ultrasound video loops of A, B and C profiles were associated with the cases. Which physician received what data for which clinical case was randomized. Physicians assessed the diagnostic probability from 0 to 10 for each possible diagnosis. The number of uncertain diagnoses (NUD) was the number of diagnoses with a diagnostic probability between 3 and 7, inclusive.
Results: Seventy-six physicians responded to the study cases (228 clinical cases resolved). Among the respondents, 28 (37%) were female, 64 (84%) were EPs, and the mean age was 37±8 years. The mean NUDs, respectively, when physicians had OCD, OLD, and both were 2.9±1.8, 2.2±1.7, 2.2±1.8 ($p = 0.02$). Ultrasound data and ultrasound frequency of use were the only variables related to the NUD. Higher frequency of ultrasound use by physicians decreased the number of uncertain diagnoses in difficult clinical cases with ultrasound data (OLD or associated with clinical data).
Conclusion: LUS decreases the NUD in ADP. The ultrasound frequency of use decreased the NUD in ADP clinical cases with LUS data.

1. Introduction

Point of Care Ultrasound (POCUS) is a clinical tool [1] used in emergency medicine [2-4]. Lung ultrasound is a POCUS application characterized by very good accuracy and far better than radiology [5-9] or auscultation [9]. A POCUS diagnostic evaluation, mainly based on a lung ultrasound (LUS) of patients admitted for acute dyspnea, is concordant with complete diagnostic care and is much faster [10].

According to the American College of Emergency Physicians (ACEP), the first three steps of emergency ultrasound competency are the recognition of indications and contraindications, image acquisition, and image interpretation [11]. The last step must be able to integrate POCUS into individual patient care plans and management [11]. To achieve this, physicians must know the accuracy of the ultrasound technique used. As an accurate POCUS technique, LUS should be easily integrated by physicians into their clinical reasoning. However, physicians also reason with other clinical arguments, e.g., past and recent medical history and clinical signs. The decision weight of LUS in diagnostic reasoning is probably different according to each physician. A mechanism of POCUS-added value is a reduction of the number of possible diagnoses [12] and an improvement of diagnostic probability [13]. The improvement of diagnostic probability reduces the number of uncertain diagnoses (NUD). The certainty level is important to allow the decision to treat.

We hypothesized that the decision weight of LUS in diagnostic reasoning is different according to the ultrasound frequency of use and

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Table 1
Available data according to group

	Clinical Case 1 Acute cardiogenic pulmonary edema	Clinical Case 2 Pneumonia	Clinical Case 3 Chronic obstructive pulmonary disease
Group 1	Clinical data and ultrasound	Ultrasound only	Clinical data only
Group 2	Clinical data only	Clinical data and ultrasound	Ultrasound only
Group 3	Ultrasound only	Clinical data only	Clinical data and ultrasound

the physician's medical experience. The primary aim of our study was to identify the determinants of increasing diagnostic accuracy due to lung ultrasound in complicated clinical cases of acute dyspnea.

2. Materials and methods

2.1. Materials

This multicentre, prospective, randomized study was conducted from May 2016 to July 2016. All participants consented to the study. Physicians included were Emergency Physicians (EP) and Critical Care Physicians (CCP). To participate in the study, all physicians had to provide care for patients with acute dyspnea on a daily basis, had formal pulmonary ultrasound training, and practice regularly. Physicians were contacted by email. We proposed to enrol doctors through three professional networks: the Winfocus France group, the "*Comité Urgence*" of the "*Société Francaise d'Anesthésie et Réanimation*" (*SFAR*), and emergency physicians (EP) of the south-east of France hospitals.

Four experts (3 EP, 1 CCP) defined three clinical cases scenario of acute dyspnea that were considered as difficult. Clinical case 1 involved a 45-year-old patient with unknown alcoholic heart disease admitted for acute dyspnea during a transition to atrial fibrillation secondary to cutaneous sepsis. Clinical case 2 described acute dyspnea in a male octogenarian with a past medical history of chronic bronchitis and chronic heart failure. Clinical case 3 described acute dyspnea in a female octogenarian known with chronic obstructive pulmonary disease (COPD) and chronic heart failure. The clinical data included a history of present illness, pertinent past medical history, and all clinical examination data. Four LUS videos were associated with each of the three clinical cases (right base, right apex, left base, and left apex). These videos were made in three patients just after a CT scan performed by a LUS expert. The videos of clinical case 1 were those of acute cardiogenic pulmonary edema (ACPE, bilateral B profile), case 2 videos showed left base pneumonia (posterolateral alveolar and pleural syndrome: PLAPS), and clinical case 3 videos were bilateral A profile with lung sliding. These ultrasounds exams were all performed with a pocket-sized ultrasound system (V-Scan Dual Probe©, GE Healthcare, Milwaukee, Wisconsin, USA). Once consenting to participation in the study, the physicians were randomized into three groups, one for each clinical case (Table 1).

2.2. Aims

The main objective of this study was to identify the determinants of increasing diagnostic accuracy due to LUS. The primary endpoint was the number of considered uncertain diagnoses. There was a maximum of eight possible diagnoses: ACPE, infectious pneumonia, COPD exacerbation, pneumothorax, neoplastic acute dyspnea, acute asthma exacerbation, pulmonary embolism, and metabolic acute dyspnea. Physicians had to evaluate the diagnostic probability from 0 (unlikely definitely not diagnosis) to 10 (definite diagnosis) for each. The number of diagnoses considered possible was the number of diagnoses with a value different from 0. The NUD was the number of possible diagnoses with a value between 3 and 7, inclusive. Our hypothesis was the NUD would be lower with ultrasound data but influenced by ultrasound frequency of use. The secondary aims were to verify that LUS reduces the number of possible diagnoses in acute dyspnea clinical cases and to find if these possible diagnoses are influenced by ultrasound frequency of use or the physician's medical experience.

2.3. Collected data

Data collected on each respondent included their age, gender, clinical experience, specialty (emergency or critical care), main activity (emergency medicine or critical care), LUS training during their initial training, and their frequency of use of ultrasound. Each of the eight possible diagnoses had to be scored according to an assessed diagnostic probability from 0 to 10. Only complete responses were included in the study.

2.4. Statistical analysis

Quantitative data are expressed as mean ± standard deviation (SD) or median with 25th and 75th percentiles ([25th percentile–75th percentile]) according to the variable distribution. Qualitative variables are expressed as frequency with percentage. Comparison of quantitative variables among the different groups was performed by an overall analysis of variance (ANOVA). When conditions of validity of this test (normal distribution, equality of variances) were not verified,

Table 2
Respondents' characteristics
SD: Standard Deviation

		All respondents $n = 76$	Group 1 $n = 25$	Group 2 $n = 22$	Group 3 $n = 29$	p
Age (years) Mean ± SD or Median [Q25; Q75]		37 ± 8	34 [30; 38]	36 [33; 45]	33 [31; 39]	0.37
Gender: female n (%)		28 (37%)	13 (46%)	7 (25%)	8 (29%)	0.15
Clinical experience (year) Mean ± SD or Median [Q25; Q75]		8 ± 7	6 [2; 9]	7 [4; 15]	3 [2; 10]	0.35
Speciality: emergency n (%)		64 (84%)	22 (34%)	17 (27%)	25 (39%)	0.56
Principal activity: emergency n (%)		67 (88%)	23 (34%)	19 (29%)	25 (37%)	0.76
Initial ultrasound training n (%)		40 (53%)	15 (37%)	10 (26%)	15 (37%)	0.60
Ultrasound frequency use n (%)	<1/week	21 (47%)	9 (43%)	5 (24%)	7 (33%)	0.52
	Between once a week and once a month	36 (28%)	11 (31%)	9 (25%)	16 (44%)	
	Everyday	19 (25%)	5 (26%)	8 (42%)	6 32%)	

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