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The role of critical care ultrasonography in acute respiratory distress

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***Abstract*---**Introduction: Acute Respiratory Distress and/or Failure (ARF), is a common and serious presentation of patients admitted to intensive care unit (ICU) and traditional diagnosis has a low accuracy except CT chest which may inappropriate to all patient. Bedside ultrasound (US) is now emerging as a valuable tool in dynamic assessment of lungs, heart, vessels and hemodynamic status. Aim of

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the work: Our aim in this study was to evaluate the diagnostic utility of combined cardiac and thoracic critical care ultrasonography in identifying causes of Acute Respiratory Distress and/or Failure in the early course of critical illness. Patients and method: This prospective observational study was conducted on adult patient admitted to Medical Intensive Care Unit (MICU), Department of Internal medicine, Al Hussein university hospital, Al Azhar University. All included patients underwent bedside CPUS including lung ultrasound (US) and transthoracic echocardiography plus targeted venous US by single investigator, blinded to clinical data. The US diagnosis of ARF etiology was shared with treating intensivist. Initial clinicaldiagnosis (ICD) of each patient were compared with post US clinical diagnosis. Results: A total of 50 patients were considered for analysis. Age of patients ranged from 18 to 81 years with a mean age of 51±17.9 years (standard deviation), 18 (36%) of them was male while 32 (64%) were female. Causes of RF by LUS changed or added to primary diagnosis by 84% and significant correlation in HTN group with P value 0.059. while Causes of RF by echocardiography change or add to primary diagnosis by 99% with significant change in male and AKI groups with P value 0.032 and 0.22 respectively. Overall subgroups in relation to chest causes of RF by u/s, cardiac causes of RF by Echocardiography and combined causes there are significant difference in DM, CKD, AKI groups by P value 0.022, 0.25 and 0.011 respectively. While combined LUS and echocardiography has significant change in causes of RF in CKD, AKI, D. C. L patients by P value 0.015, 0.00 and 0.011 respectively. Conclusion: We conclude that routine screening of ARF patients at admission to MICU with combined US approach is feasible and has significant diagnostic impact.

***Keywords*---**Acute respiratory failure, Combined ultrasound approach, Critical care, Impact assessment, Lung ultrasound, Transthoracic echocardiography.

Introduction

Acute Respiratory Distress and/or Failure (ARF), is a common and serious presentation of patients admitted to intensive care unit (ICU).[1,2] Which refers to a heterogeneous syndrome presenting with hypoxemia, hypercapnia, or both resulting from impaired respiratory muscle function or pulmonary dysfunction.[3] Whatever is it hypoxemic type when $SaO_2 < 90\%$ with normal $PaCO_2$ or hypercapnic ARF with $PaCO_2 > 45$ mm Hg, it may be in acute or chronic form.[3] where patient is more stable in chronic form but easily deteriorates. Acute respiratory failure occurs due to variable reasons as neuromuscular diseases, obstructive airways, alveolar affection either focal as pneumonia or diffuse as cardiogenic pulmonary edema (CPE), interstitial diseases, vascular diseases, such as pulmonary embolism, plural diseases or metabolic cause.[4]

Patients admitted to ICU with ARF are challenging in diagnosis, however that early recognition and treatment of certain cause is vital and has a major impact

on morbidity and mortality. [4] Traditional diagnosis include history, physical examination, arterial blood gas (ABG) analysis, bedside radiography, and computed tomography (CT). Physical examination has low accuracy.[5,6] while ABG analysis provides limited information about etiology of ARF.[7] Bedside chest X-rays (CXRs) has low diagnostic efficacy.[5] Although diagnostic accuracy of CT is high, CT in critically ill patients has several limitations such as risk of radiation exposure, high cost, and moving critically ill patients to scanning room can be inappropriate.

Bedside ultrasound (US) is now emerging as a valuable tool in dynamic assessment of lungs, heart, vessels and hemodynamic status. Bedside US is readily available, noninvasive, convenient, and cost effective can be repeated at will and has shown better diagnostic efficacy compared to physical examination and CXR for diagnosis of lung conditions in critically ill patients.[5,6,8] In recent, Combining transthoracic echocardiography (TTE) as a single integrated method with lung ultrasound (LUS) may has a potential role in an etiological diagnosis of ARF.[9] With limited applicability in clinical practice due to some limitations especially her in Egypt as it not used in all cases with ARF, limited knowledge to some physicians and incompatibility between different specialties. Our aim in this study was to evaluate the diagnostic utility of combined cardiac and thoracic critical care ultrasonography in identifying causes of Acute Respiratory Distress and/or Failure in the early course of critical illness.

Patient and Methods

This prospective observational study was conducted on adult patient admitted to Medical Intensive Care Unit (MICU), Department of Internal medicine, Al Hussein university hospital, Al Azhar University. We prospectively recruited adult patients admitted to Medical Intensive Care Unit (MICU) for ARF or already admitted to ICU for a different reason but later developed ARF during their hospital stay. Any patients aged ≥18 years with one of the objective criteria of ARF, including oxygen saturation by pulse oximetry (SaO_2) ≤90% in COPD patients or ≤ 94 % in non-COPD patients while breathing room air, PaO_2/FiO2 ratio of ≤200 mm Hg, respiratory rate of ≥25/minute, $PaCO_2$ of >45 mm Hg with an arterial pH <7.35, were included and Patients excluded from our study if an MICU provider declined bedside CCUS, CCUS examination was deemed to interfere with patient care, a sonographer was not available within 24 h after ABG testing.

Verbal consent obtained from either the patients or their surrogates.
Ethical considerations: *This clinical study was conducted after approval of Al-Azhar University, Faculty of Medicine research ethical committee in accordance with the Declaration of Helsinki.*

Routine Clinical Assessment For every patient include: medical history; physical examination findings; arterial blood gas analysis while breathing room air; 12-lead ECG; chest radiograph; and routine blood tests (CBC, serum createnin, urea, ALT, AST, albumin, bilirubin, Na, K) were conducted>

Cardiac and lung ultrasound: The echocardiographic examination was include left ventricular systolic function [10], left ventricular end diastolic pressure

estimation (pulsed Doppler echocardiography recorded mitral inflow and Doppler tissue imaging with the sample cursor placed in the lateral mitral annulus to record the following: E-wave velocity, A-wave velocity, Ea velocity, and E/A and E/Ea ratios),[11] any cardiac mass and pericardial evaluation (detection of pericardial effusion as either present or absent).[12]

Lung Ultrasonography will be evaluated by a single operator, who will unaware of the CT and CXR findings. eight region/zone methods were used which included scanning of anterior and lateral chest wall on both sides with patients in supine or semi recumbent position.[13,14] ten typical sonographic signs (bat sign, lung sliding, A-lines, quad sign, sinusoid sign, squad sign, tissue-like sign, B-lines, stratosphere sign, and the lung point) was elicited by lung ultrasound. Among these, eight sonographic patterns indicating essential respiratory diseases (Table 1), with an overall accuracy of 90.5% .[8]

Table 1: The eight profiles of the BLUE protocol and their clinical interpretation[8]

BLUE Protocol Profile	Profile Description	Etiology of Respiratory Failure
A-profile	*Anterior lung sliding + A-lines + free veins*	Exacerbated COPD or Severe acute asthma
B-profile	*Anterior lung sliding + lung-rockets*	Pulmonary edema
B′-profile A/B-profile C-profile A-V-PLAPS profile	*B-profile + abolished lung sliding* *Half A-profile at one lung, half B-profile at another* *Anterior lung consolidation* *A-profile + free veins + PLAPS*	Pneumonia
A-DVT profile	*A-profile + DVT*	Pulmonary embolism
A′-profile	*A-profile + abolished lung sliding (+ lung point)*	Pneumothorax

BLUE: bedside lung ultrasound in emergency; COPD: chronic obstructive pulmonary disease; PLAPS: posterolateral alveolar and/or pleural syndrome; DVT: deep venous thrombosis.

Statistical Analysis

Continuous variables were expressed as means and standard deviation (SD). In the primary analysis, comparisons between groups were performed with Pearson's chi-square asymptotic test for categorical variables, Fisher's exact test if any groups contain less than 5 cases. We Measured the Agreement by kappa methods and manamar test for correlation between groups. All the statistical tests were 2-tailed. A *P* value of < 0.05 was considered statistically significant. Data were analyzed using SPSS 23 for Windows (SPSS, Chicago, IL).

Results

Out of the 74 patients with ARF during time of study only 50 patients enrolled in the study over the time of study, due to patient's problem or unavailability of

investigator or US scan was not possible or incomplete. Five patients had multiple etiological diagnoses for ARF, and two patients had miscellaneous diagnoses (Table 2).

A total of 50 patients were considered for analysis. Age of patients ranged from 18 to 81 years with a mean age of 51±17.9 years (standard deviation), 18 (36%) of them was male while 32 (64%) were female. At the time of inclusion, the history, clinical examination and investigations were done (table 2) with primary diagnosis was taken (table 3).

Table (2): Demographic data distribution among study group

Demographic data		Total (50)
SEX	Male	18 (36%)
	Female	32 (64%)
Age (years)	Mean ±SD	51±17.9 years
	Range	18-81

Table (3): Descriptive History and relative clinical data among study group

VARIANTS		NO (%) OR Mean ±SD
DM	YES	16 (32%)
	NO	34 (68%)
HTN	YES	23 (46%)
	NO	27 (54%)
CHD	NO	46 (92.0%)
	YES	4 (8.0%)
CKD	NO	34 (68.0%)
	YES	16 (32.0%)
AKI	NO	37 (72.0%)
	YES	13 (26.0%)
CLD	NO	48 (96.0%)
	YES	2 (4.0%)
ALI	NO	48 (96.0%)
	YES	2 (4.0%)
SLE	NO	38 (76.0%)
	YES	12 (24.0%)
HB		9.0 ±2.69
PH		7.4 ± 0.081
MV	NO	36 (72.0%)
	YES	8 (16.0%)
DCL	NO	35 (70.0%)
	YES	15 (30.0%)
MORTALITY	NO	36 (72.0%)
	YES	14 (28.0%)

Primary diagnosis was taken by senior doctor at time of admission and classified in our analysis into 3 groups_ chest causes, cardiac causes and others which include metabolic causes and neurologic …_for easily analysis and overcome low

numbers in each cause group (table 4) with detailed primary causes presented in figure 1. For LUS and echocardiography scanning results were interpreted using standardized criteria for etiological diagnosis of ARF, as depicted in the methodology. Causes of RF by LUS were described in table 4 which change or add to primary diagnosis by 84% (Table 5) and significant correlation in HTN group with P value 0.059 (Table 6).

Causes of RF by echocardiography were described in table 5 with Preserved Ejection fraction by 30 (60.0%), Mid-range Ejection fraction 6 (12.0%) and Reduced Ejection fraction 14 (28.0%). With diastolic function in Pt. with Ejection fraction≥ 50% (N=30 (60%) with Indeterminate diastolic dysfunction 3 (10.0%) and Diastolic dysfunction 10 (33.3%) Grade I 10(100%). In PT. with ejection fraction > 50% n= 20 (40%)) with Diastolic dysfunction grade I no 14 (70%) Diastolic dysfunction grade II 2 (10%) and Diastolic dysfunction grade III 4(20%).
Echocardiography change or add to primary diagnosis by 99% (Table 8) with significant change in male and AKI groups with P value 0.032 and 0.22 respectively (Table 7).

Table (4): Primary diagnosis classification of causes of RF among study group

Primary diagnosis		Frequency	Percent
causes	non-cardiac or chest causes	30	60.0
	Chest causes	19	38.0
	Cardiac causes	1	2.0
	Total	50	100.0

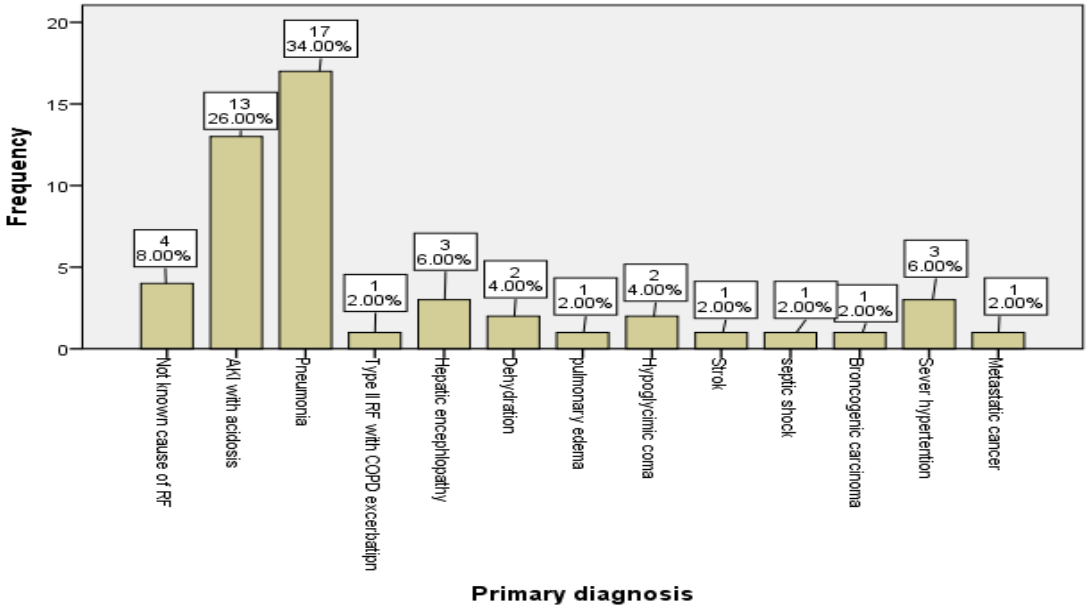

Figure (1): Primary diagnosis of causes of RF among study group

Table (5): Assessment of causes of RF by chest U/S among study group

Parameter	No	%
No chest pathology	10	20.0 %
Pleural effusion only	3	6.0 %
Pneumonic consolidation/ARDS	10 4 of them was ARDS	20.0 %
Pneumonic consolidation + pleural effusion	11 3 0F them was ARDS	22.0 %
Cardiogenic pulmonary edema	3	6.0 %
Alveolar hemorrhage	5	10.0 %
Interstitial lung disease	5	10.0 %
Interstitial lung disease + pleural effusion	3	6.0 %
Add on finding of chest mases Per all patients	4/50	8%
ARDS per all patients	7/50	14%

Table (6): Assessment of causes of RF by echocardiography among study group

Ejection fraction	Preserved Ejection fraction	30 (60.0%)			
	Mid-range Ejection fraction	6 (12.0%)			
	Reduced Ejection fraction	14 (28.0%)			
DIASTOLIC DYSFUNCTION	IN Pt. with Ejection fraction≥ 50% (N=30 (60%)	No	17 (56.7%)		
		Indeterminate	3 (10.0%)		
		Diastolic dysfunction	10 (33.3%)	Grade I	10(100%)
				Grade II	0 (0%)
				Grade III	0 (0%)
	IN PT. with ejection fraction < 50% (n= 20 (40%))	Diastolic dysfunction grade I	14 (70%)		
		Diastolic dysfunction grade II	2 (10%)		
		Diastolic dysfunction grade III	4 (20%)		

Myocarditis suspicion overall patients	4/50 (8%)
PERICARDIAL EFFUSION overall patients	12/50 (28.0%)
INFECTIVE ENDOCARDITIS overall patients	1/50 (2%)

Table (7): Different group parameters in relation to chest causes of RF by u/s, cardiac causes of RF by Echocardiography and combined causes Severally

variable		Chest causes By chest u/s		P value	Cardiac causes By echo		P value	Combined cardiac and chest causes by echo and chest u/s		
		no	yes		No	yes		mono	bipath	
sex	Male	6 33.3% 42.9%	12 66.7% 33.3%	.529	1 5.6% 8.3%	17 94.4% 44.7%	.036*	7 38.9% 26.9%	11 61.1% 45.8%	.164
	female	8 25.0% 57.1%	24 75.0% 66.7%		11 34.4% 91.7%	21 65.6% 55.3%		19 59.4% 73.1%	13 40.6% 54.2%	
DM	NO	12 35.3% 85.7%	22 64.7% 61.1%	.094	8 23.5% 66.7%	26 76.5% 68.4%	.910*	20 58.8% 76.9%	14 41.2% 58.3%	.159
	YES	2 12.5% 14.3%	14 87.5% 38.9%		4 25.0% 33.3%	12 75.0% 31.6%		6 37.5% 23.1%	10 62.5% 41.7%	
HTN	NO	11 40.7% 78.6%	16 59.3% 44.4%	.056*	6 22.2% 50.0%	21 77.8% 55.3%	.750	17 63.0% 65.4%	10 37.0% 41.7%	.093
	YES	3 13.0% 21.4%	20 87.0% 55.6%		6 26.1% 50.0%	17 73.9% 44.7%		9 39.1% 34.6%	14 60.9% 58.3%	
CHD	NO	13 28.3% 92.9%	33 71.7% 91.7%	1.00*	12 26.1% 100.0%	34 73.9% 89.5%	.560*	25 54.3% 96.2%	21 45.7% 87.5%	.340*
	YES	1 25.0% 7.1%	3 75.0% 8.3%		0 0.0% 0.0%	4 100.0% 10.5%		1 25.0% 3.8%	3 75.0% 12.5%	
CKD	NO	11 32.4% 78.6%	23 67.6% 63.9%	.501*	11 32.4% 91.7%	23 67.6% 60.5%	.074*	22 64.7% 84.6%	12 35.3% 50.0%	.015*
	YES	3 18.8% 21.4%	13 81.3% 36.1%		1 6.3% 8.3%	15 93.8% 39.5%		4 25.0% 15.4%	12 75.0% 50.0%	

AKI	NO	13 35.1% 92.9%	24 64.9% 66.7%	.078*	12 32.4% 100.0%	25 67.6% 65.8%	.022*	25 67.6% 96.2%	12 32.4% 50.0%	0.00*
	YES	1 7.7% 7.1%	12 92.3% 33.3%		0 0.0% 0.0%	13 100.0% 34.2%		1 7.7% 3.8%	12 92.3% 50.0%	
SLE	NO	9 23.7% 64.3%	29 76.3% 80.6%	.226	9 23.7% 75.0%	29 76.3% 76.3%	1.0*	18 47.4% 69.2%	20 52.6% 83.3%	.327*
	YES	5 41.7% 35.7%	7 58.3% 19.4%		3 25.0% 25.0%	9 75.0% 23.7%		8 66.7% 30.8%	4 33.3% 16.7%	
SHOCK	NO	12 29.3% 85.7%	29 70.7% 80.6%	1.0*	11 26.8% 91.7%	30 73.2% 78.9%	.425*	23 56.1% 88.5%	18 43.9% 75.0%	.281*
	YES	2 22.2% 14.3%	7 77.8% 19.4%		1 11.1% 8.3%	8 88.9% 21.1%		3 33.3% 11.5%	6 66.7% 25.0%	
D.C. L	NO	12 33.3% 85.7%	24 66.7% 66.7%	.295*	11 30.6% 91.7%	25 69.4% 65.8%	.140*	23 63.9% 88.5%	13 36.1% 54.2%	.011*
	YES	2 14.3% 14.3%	12 85.7% 33.3%		1 7.1% 8.3%	13 92.9% 34.2%		3 21.4% 11.5%	11 78.6% 45.8%	
COPD	NO	9 22.0% 64.3%	32 78.0% 88.9%	.094*	12 29.3% 100.0%	29 70.7% 76.3%	.092*	21 51.2% 80.8%	20 48.8% 83.3%	1.0*
	YES	9 22.0% 64.3%	4 44.4% 11.1%		0 0.0% 0.0%	9 100.0% 23.7%		5 55.6% 19.2%	4 44.4% 16.7%	
MV	NO	12 33.3% 85.7%	24 66.7% 80.0%	1.0*	10 27.8% 83.3%	26 72.2% 81.3%	1.0*	22 61.1% 84.6%	14 38.9% 77.8%	.697*
	YES	2 25.0% 14.3%	6 75.0% 20.0%		2 25.0% 16.7%	6 75.0% 18.8%		4 50.0% 15.4%	4 50.0% 22.2%	

Overall subgroups in relation to chest causes of RF by u/s, cardiac causes of RF by Echocardiography and combined causes there are significant difference in DM, CKD, AKI groups by P value 0.022, 0.25 and 0.011 respectively. While combined LUS and echocardiography has significant change in causes of RF in CKD, AKI, D. C. L patients by P value 0.015, 0.00 and 0.011 respectively.

Table (8): Different group parameters in relation to chest causes of RF by u/s, cardiac causes of RF by Echocardiography and combined causes

Variables		Chest causes By chest u/s	Cardiac causes By echo	Combined cardiac and chest causes by echo and chest u/s	P value *exact test
sex	Male	1 5.6% 8.3%	6 33.3% 42.9%	11 61.1% 45.8%	.064*
	female	11 34.4% 91.7%	8 25.0% 57.1%	13 40.6% 54.2%	
DM	NO	1.00 8 23.5% 66.7%	12 35.3% 85.7%	14 41.2% 58.3%	.022
	YES	4 25.0% 33.3%	2 12.5% 14.3%	10 62.5% 41.7%	
HTN	NO	6 22.2% 50.0%	11 40.7% 78.6%	10 37.0% 41.7%	0.11
	YES	6 26.1% 50.0%	3 13.0% 21.4%	14 60.9% 58.3%	
CHD	NO	12 26.1% 100.0%	13 28.3% 92.9%	21 45.7% 87.5%	0.8
	YES	0 0.0% 0.0%	1 25.0% 7.1%	3 75.0% 12.5%	
CKD	NO	11 32.4% 91.7%	11 32.4% 78.6%	12 35.3% 50.0%	0.025
	YES	1 6.3% 8.3%	3 18.8% 21.4%	12 75.0% 50.0%	
AKI	NO	12 32.4% 100.0%	13 35.1% 92.9%	12 32.4% 50.0%	0.01
	YES	0 0.0% 0.0%	1 7.7% 7.1%	12 92.3% 50.0%	
SLE	NO	9 23.7% 75.0%	9 23.7% 64.3%	20 52.6% 83.3%	0.43
	YES	3	5	4	

		25.0% 25.0%	41.7% 35.7%	33.3% 16.7%	
SHOCK	NO	11 26.8% 91.7%	12 29.3% 85.7%	18 43.9% 75.0%	0.57
	YES	1 11.1% 8.3%	2 22.2% 14.3%	6 66.7% 25.0%	
D.C. L	NO	11 30.6% 91.7%	12 33.3% 85.7%	13 36.1% 54.2%	0.34
	YES	1 7.1% 8.3%	2 14.3% 14.3%	11 78.6% 45.8%	
COPD	NO	12 29.3% 100.0%	9 22.0% 64.3%	20 48.8% 83.3%	0.62
	YES	0 0.0% 0.0%	5 55.6% 35.7%	4 44.4% 16.7%	
MV	NO	10 27.8% 83.3%	12 33.3% 85.7%	14 38.9% 77.8%	0.89
	YES	2 25.0% 16.7%	2 25.0% 14.3%	4 50.0% 22.2%	

Table (9): Assessment of Chest causes of RF by primary diagnosis in relation to chest u/s

Causes			Chest causes diagnosed by chest ultrasound		Total	McNemar Test	Measure of Agreement Kappa
			yes	No			
Primary chest causes diagnosis	yes	Count	16	3	19	0.00	16%
		% within Primary chest causes diagnosis	84.2%	15.8%	100.0%		
		% within Chest causes diagnosed by chest ultrasound	44.4%	21.4%	38.0%		
	no	Count	20	11	31		
		% within Primary	64.5%	35.5%	100.0%		

		chest causes diagnosis					
		% within Chest causes diagnosed by chest ultrasound	55.6%	78.6%	62.0%		
Total		Count	36	14	50		
		% within Primary chest causes diagnosis	72.0%	28.0%	100.0%		
		% within Chest causes diagnosed by chest ultrasound	100.0%	100.0%	100.0%		

Table (10): Assessment of Cardiac causes of RF by primary diagnosis in relation to echocardiography

Causes			cardiac causes diagnosed by echocardiography		Total	McNemar Test	Measure of Agreement Kappa
			1.00	2.00			
Primary cardiac causes diagnosis	1.00	Count	1	0	1	0.00	1%
		% within Primary cardiac causes diagnosis	100.0%	0.0%	100.0%		
		% within cardiac causes diagnosed by echocardiography	2.6%	0.0%	2.0%		
	2.00	Count	37	12	49		
		% Primary cardiac causes diagnosis	75.5%	24.5%	100.0%		
		% cardiac causes diagnosed by echocardiography	97.4%	100.0%	98.0%		
Total		Count	38	12	50		
		% within Primary cardiac causes diagnosis	76.0%	24.0%	100.0%		
		% within cardiac	100.0%	100.0%	100.0%		

	causes diagnosed by echocardiography					

Table (11): Assessment of Cardiac and chest causes of RF by primary diagnosis in relation to both echocardiography and chest U/S:

Causes			Combined cardiacand chest causes diagnosed by echocardiography and chest u/s		Total	McNemar Test	Measure of Agreement Kappa
			yes	no			
Primary cardiac and chest causes diagnosis	yes	Count	8	12	20	.572	
		% within Primary cardiac and chest causes diagnosis	40.0%	60.0%	100.0 %		
		% within Combined cardiacand chest causes diagnosed by echocardiography and chest u/s	33.3%	46.2%	40.0%		
	no	Count	16	14	30		
		% within Primary cardiac and chest causes diagnosis	53.3%	46.7%	100.0 %		
		% within Combined cardiacand chest causes diagnosed by echocardiography and chest u/s	66.7%	53.8%	60.0%		
Total		Count	24	26	50		
		% within Primary cardiac and chest causes diagnosis	48.0%	52.0%	100.0 %		
		% within Combined cardiacand chest causes diagnosed by echocardiography and chest u/s	100.0 %	100.0%	100.0 %		

Discussion

The main results of our study were significant improvement in the diagnostic accuracy of early combined lung U/S and echocardiography compared with usual care (i.e. physical examination, chest radiography, and emergency laboratory tests) for the etiological diagnosis of ARF in critically ill patient; and (ii) high incidence of change in clinician's initial diagnosis and after early CPUS in critically ill patient with ARF indicating significant impact of CPUS on management of ARF patients. In our study, among the 50 included patients with ARF, LUS and TTE test yielded change or add to primary etiological diagnosis by 84% and 99 respectively of ARF cases, whereas primary diagnosis by intensivists was correct only in 17% of ARF cases. The higher accuracy of CPUS over clinical examination and CXR is supported by results of previous studies.6,15,16

Furthermore, higher diagnostic accuracy of the early combined LUS and TTE approach was found in Pt. with *CKD, AKI, D. C. L patients groups by P value 0.015, 0.00 and 0.011 respectively* were analyzed independently. We found similar sensitivity and specificity as were described in previous studies using combined CPUS for etiological diagnosis of ARF in critical care.9,17 Our data showed that initial clinical diagnosis of ARF (made before US scan) was Changed or added to diagnosis in 82% of cases after sharing combined LUS and TTE findings with the treating intensivists.

In a prospective multicentric study in 142 ICUs in France, Belgium, and Switzerland by Zieleskiewicz et al. [18] to describe the diagnostic and therapeutic effects of POCUS performed during a 24-h period, the use of POCUS changed the diagnosis in 21% of cases, led to confirmation of a suspected diagnosis in 63% of cases, and was associated with interventions including treatment, imagery ordering, and patient triage in 69% of cases [18]. Bapi Barman et al. [19] also investigated the use of POCUS in ICU patients, Of the 108 ARF patients included in this study, etiological diagnosis of ARF was altered or modified after the CPUS in 40 (37%) patients, which included "diagnosis changed" in 18 (17%) and "diagnosis.

added" in 22 (20%) patients Several previous studies evaluated LUS and TTE in patients presented with respiratory symptoms to the emergency room (ER) or general ICUs, but up to our knowledge, none of them assessed it specifically in medical ICU (MICU) . MICU patients are a heterogeneous group presenting with either primary respiratory disease or secondary respiratory disease to other illness. They are characterized by respiratory failure, need for mechanical ventilation, severe illness, multiple system dysfunction, and multiple coexisting comorbidities [19].

This study has several limitations. First, it was a single-center observational study conducted in a tertiary MICU population. Second, low number of patients because of epidemic of COVID 19 which limit our study and double investigator confirmation. Lastly, heterogenicity of patients which may be a benefit from other point of view. Despite these limitations, our study has several advantages. Our study shows that addition of combined US approach as a supplement to clinical evaluation and improves the diagnostic accuracy and also changes diagnosis and

treatment plan in significant proportion of ARF cases in addition to assessment in different groups of patients. Feasibility was demonstrated, as investigator was able to obtain interpretable images in the majority of patients.

Conclusion

This study demonstrates that use of combined US approach (LUS AND TTE) as an initial test in ARF improves diagnostic accuracy for identification of underlying etiology and frequently changes clinical diagnosis and/or treatment. We conclude that routine screening of ARF patients at admission to ICU with combined US approach is feasible and has significant diagnostic impact

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