Editorial

How to Perform an Echocardiographic Assessment of a Non-Valvular Patient with Dyspnea of Cardiac Etiology

Como eu Faço Avaliação Ecocardiográfica do Paciente não Valvopata com Dispneia de Origem Cardíaca

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Introduction

Echocardiography provides essential information on the heart's anatomy, function, and hemodynamics. Thus, it becomes an essential tool when establishing the differential diagnosis of patients with dyspnea of cardiac and noncardiac etiologies.[1] Dyspnea is a significantly common symptom present in up to 25% of patients,[2] and rapid assessment and targeted treatment are required in managing dyspnea as it is associated with increased mortality.[2]

During the echocardiographic assessment of a patient with dyspnea, the following four essential elements should be considered: systolic and diastolic functions and anatomy and hemodynamics of the valve and pericardium.[3] The present study aimed to determine the etiologies of cardiac dyspnea in patients without valvular or pericardial heart disease. Concepts and algorithms used to assess dyspnea of cardiac etiology by echocardiography and lung ultrasonography (USG) will be briefly analyzed[1,3-6] (Video 1).

Thus, to provide a didactic presentation, the essential learning points are divided into the following two major items: addressing dyspnea in elective patients with heart failure with preserved ejection fraction (HFpEF) and heart failure with reduced ejection fraction (HFrEF) and addressing dyspnea in patients requiring urgent and emergent care.

Addressing dyspnea in elective patients

Patients with heart failure with preserved ejection fraction HFpEF symptoms are significantly similar to those of HFrEF (Video 2). Currently, more than 50% of hospitalizations due to heart failure (HF) are caused by HFpEF.[5] Thus, the use of a systematic diagnostic method improves daily clinical practice and minimizes clinical errors when managing elective patients with dyspnea[7] (Figure 1).

The ejection fraction must be preserved in HFpEF, and the suggested cutoff point is 53% using the biplane method.[8] The first step is to assess the signs and symptoms of HF, clinical data that characterize the patients' phenotype (obesity, hypertension, diabetes mellitus, age, atrial fibrillation, lung disease, and kidney disease), and recent atrial natriuretic peptide values, if available.[3-5] These data can be added to the report, as suggested in Figure 2.

The information described is essential to establish HFpEP[3-5] probability scores and to determine the main phenotypes (i.e., pulmonary hypertension, right ventricular dysfunction, left atrial [LA] dysfunction, obesity, ischemia, hypertrophic or infiltrative cardiomyopathy) and the recommended type of examination.[3-5]

The essential echocardiographic parameters are LA volume index, left ventricular (LV) mass index, relative LV wall thickness, tricuspid regurgitation velocity, presence of increased filling pressure by conventional and tissue mitral Doppler echocardiography (mean E/e', septal and lateral e'), and LV longitudinal strain with a cutoff point of 16% (absolute value).[5]

To improve the initial therapy and follow-up of patients with high probability of HFpEF (Figure 1), lung USG is performed to determine the presence and level of pulmonary congestion using a simple assessment protocol of six to eight bilateral quadrants and to confirm the predominance of B lines,[6-9] which have significant clinical relevance and can be described in the report (Figure 2). It is also important to assess the diameter and collapsibility of the inferior vena cava to determine the right atrial pressure and, therefore, the patient's fluid status.[1-8] The integration of congestion and blood pressure improves the use of diuretics, consequently improving the patient's congestion and increasing renal function due to low systolic volume.

Keywords

Echocardiography; Dyspnea; Diagnosis.

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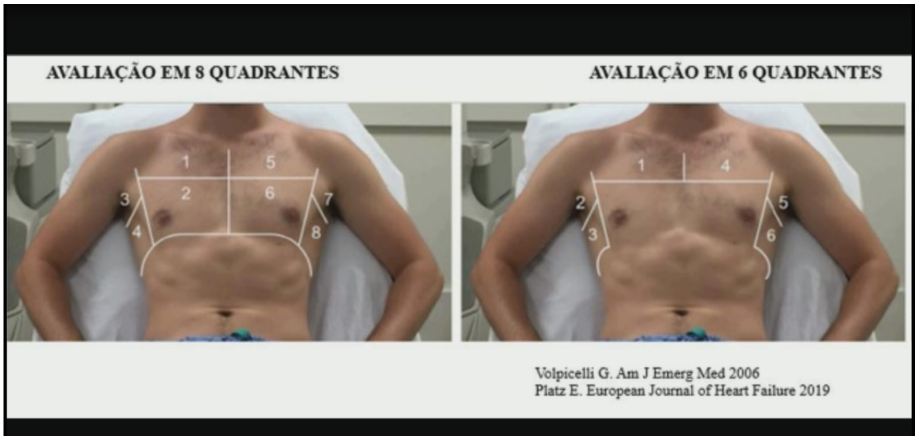
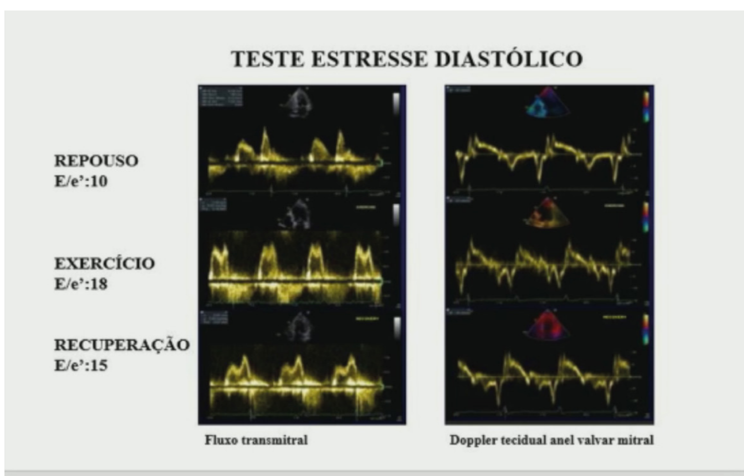
Editorial



USG: ultrasonography; EVLW: extravascular lung water.

Video 1 – *Lung ultrasonography.*



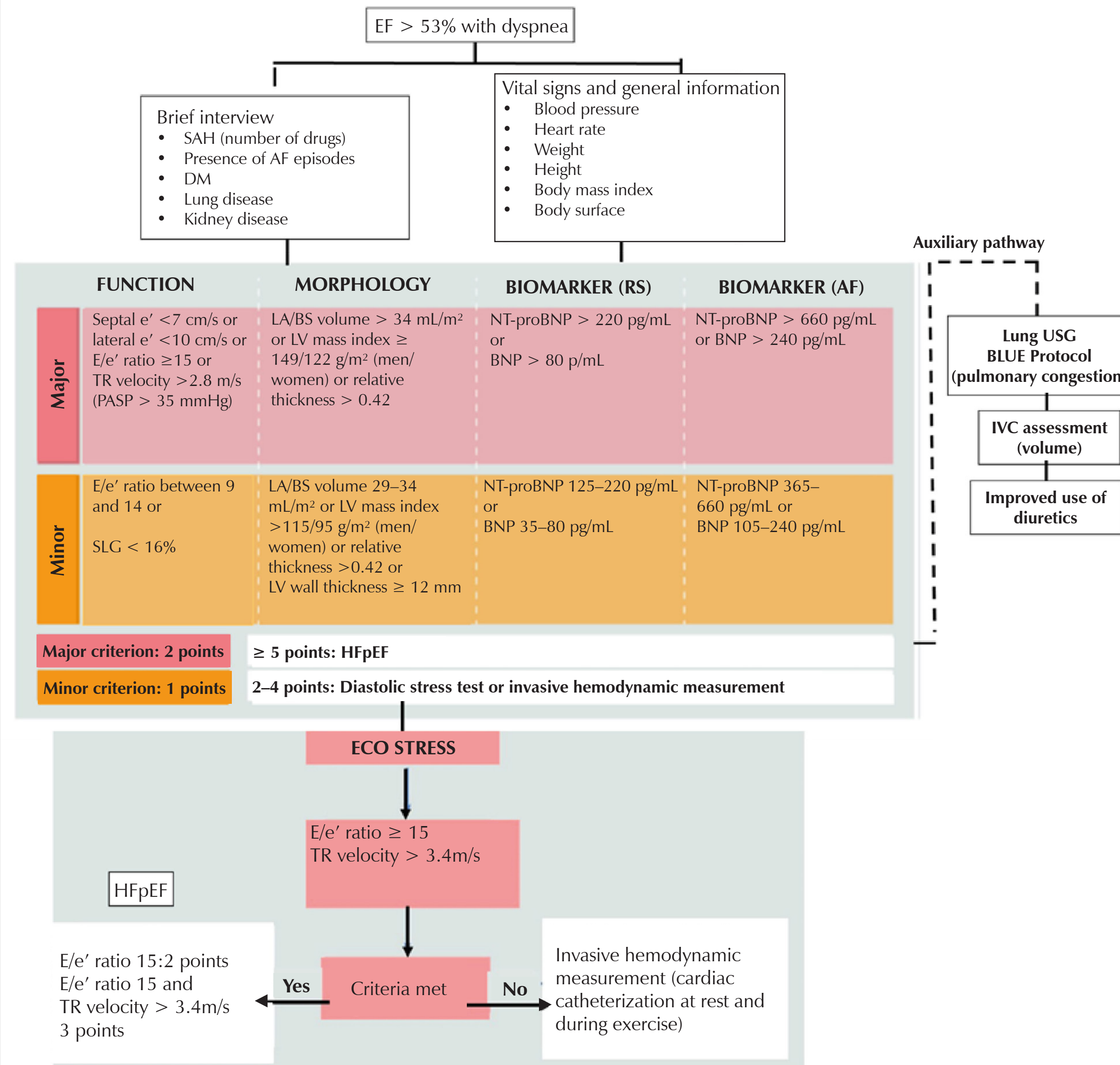
HFpEF: heart failure with preserved ejection fraction; BP: blood pressure; HR: heart rate; BMI: body mass index; LV: left ventricle; IVS: interventricular septum; PW: posterior wall; LVEF: left ventricular ejection fraction; SLG: global longitudinal strain; TR Vmax: maximum velocity of tricuspid regurgitation; TR: tricuspid regurgitation; PASP: pulmonary artery systolic pressure; LVOT: left ventricular outflow tract; MHR: maximum heart rate; MR: mitral regurgitation; USG: ultrasonography.

Video 2 – *Addressing dyspnea in elective patients with heart failure with preserved ejection fraction.*

In case the resting echocardiography and the score suggested in Figure 1 are not conclusive for HFpEF,[5] an echocardiography during exercise should be recommended in the report to assess diastolic pressure. The standard instrument of choice for diastolic stress echocardiography is the cycle ergometer with an initial load of 12 to 25 W and increases of 10 to 25 W per stage, which can last from 3 to 5 minutes up to 100 to 110 beats per minute. At each stage, Doppler echocardiography to assess mitral and tissue inflow and tricuspid regurgitation velocity should be performed until the preceding wave fusion is achieved.[5,10,11] Result interpretation is provided in detail in the algorithm presented in Figure 1.

Patients with heart failure with reduced ejection fraction

One of the challenges of assessing dyspnea in this group of patients is the appropriate determination of the grade of diastolic dysfunction to estimate the filling pressures to improve the treatment and determine the prognosis of patients with HFrEF (Video 3 and Figure 3).[12] Lung USG is performed to assess the amount of pulmonary extravascular fluid as an adjunct to recommend hospitalization and control at hospital discharge and outpatient follow-up and to determine patients' prognosis due to its direct association with mortality and cardiovascular events.[6,13]



EF: ejection fraction; SAH: systemic arterial hypertension; DM: diabetes mellitus; TR: tricuspid regurgitation; PASP: pulmonary artery systolic pressure; LA: left atrium; BS: body surface; LV: left ventricle; NT-proBNP: N-terminal fragment of type B natriuretic peptide; BNT: type B natriuretic peptide; SLG: global longitudinal strain; USG: ultrasonography; BLUE: bedside lung ultrasound in emergency. Source: Adapted from Pieske et al.[5]

Figure 1 – *Heart failure assessment algorithm with signs and symptoms of heart failure with preserved ejection fraction on stress echocardiography.*

Assessing dyspnea in patients requiring urgent and emergent care: lung ultrasound associated with point-of-care echocardiography

Point-of-care echocardiography has a fundamental role in establishing a rapid diagnosis and treatment decision in dyspneic patients requiring urgent and emergent care and should be performed together with lung USG (Video 4).[6,13] Thus, with the combination of these two methods, cardiac and noncardiac etiologies of dyspnea are significantly distinguished with greater accuracy than a physical examination alone[6,13] and the presence of pulmonary congestion is determined. Essential echocardiographic data should focus on rapid cardiac morphofunctional assessment without detailed measurements; however, the ejection fraction should be properly estimated.[14] The predominant presence of B lines on lung USG[13] shows a significant amount of extravascular lung water, and a differential

Vital and Anthropometric Signs

BP = _ HR = _ Weight = _ Height = _ Body Surface: _m² BMI = ___ kg/m² Age=years
Pace:

Numerical parameters
LV: cavity and wall diameter, mass, indexed mass, relative thickness, ejection fraction by biplane
RV: basal and mean diameter; shortening fraction, TAPSE, S velocity of the tricuspid ring
Left atrium: Indexed volume (biplane)
Right atrium: volume by biplane
Aorta: root, ascending and arch diameter
Mitral valve Doppler: E velocity, A velocity, septal and lateral mitral tissue Doppler velocity
Calculation of the mean E/e' ratios
Peak pressure of tricuspid regurgitation in cm/s
Assessment of the right atrium pressure through the inferior vena cava
Calculation of systolic pulmonary artery pressure

Descriptive Analysis

Left ventricle
Left ventricle with cavity dimensions and wall thickness (normal/enlarged)
Global and segmental systolic functions are preserved. Global longitudinal strain of __ (absolute value)
The integrated analysis of clinical parameters, two-dimensional image, and conventional and tissue mitral Doppler is compatible with diastolic dysfunction grade __ (I/II/III) with an E/e' ratio of _ (_ possibly increased in filling pressures)
Examination under continuous electrocardiographic monitoring

Right Ventricle
Global and segmental systolic functions are preserved
Normal cavity dimensions and wall thickness

Left Atrium
Normal dimensions/Increased grade (light/moderate/severe)

Right Atrium
Normal dimensions

Aorta
Aortic root, ascending aorta, and aortic arch with normal diameters

Pulmonary artery
Normal dimensions

Heart Valves
Mitral valve (anatomical description) Spectral Doppler analysis and Color flow mapping show normal flow/insufficiency
Aortic valve (anatomical description) Spectral Doppler analysis and Color flow mapping show normal flow/insufficiency
Tricuspid valve (anatomical description) Spectral Doppler analysis and Color flow mapping show normal flow/insufficiency
Pulmonary valve (anatomical description) Spectral Doppler analysis and Color flow mapping show normal flow/insufficiency

Intracavitary septa
Intact atrial and ventricular septa

Pericardium
Normal without effusion

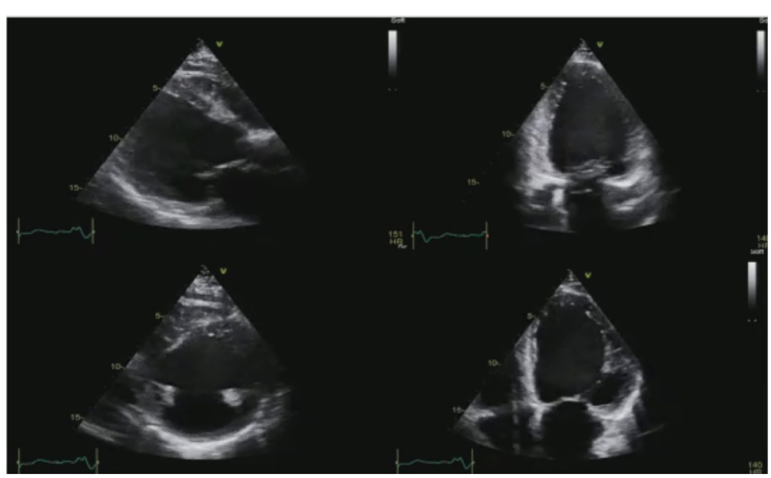
Lung USG
Lung USG to assess lung congestion (protocol model can be 4–8 quadrants)
Description of the presence of B lines
Conclusion on possible congestion

Diagnostic impression
Use of the proposed algorithm for diagnostic probability of HF with preserved ejection fraction by Pieske et al. (Eur. H J 2019; p. 3297-3317) doi: 10.1093/eurhartj/ehz641)
- BNP result (yes/no)
- Major criteria: ___
- Minor criteria: ___
- Final score:
1 = low probability
2–4 = intermediate probability of HFpEF, diastolic stress suggested
5 = high probability of HFpEF
The most likely phenotype associated with diastolic HF is ___.

Conclusions
Diastolic LV dysfunction grade _ (_ increased perfusion pressures by integrated analysis)
LV systolic function preserved (biplane EF and global longitudinal strain)
RV systolic function preserved (global longitudinal strain in pulmonary hypertension phenotype and RV dysfunction)
Lung USG to assess pulmonary congestion: (pulmonary congestion conclusion)
Pulmonary hypertension of medium probability (associated with diastolic dysfunction)
Obs. 1: The quantification requirements used in this report are based on the new quantification recommendations of the American Society of Echocardiography, published in January 2015 (Lang, R. JASE 2015; 28: 1-39)
Obs. 2: The requirements for diastolic function classification are based on the new recommendations of the American/European Society of Echocardiography, published in 2016 (Nagueh SF et al. JASE 2016; 29: 277-314)

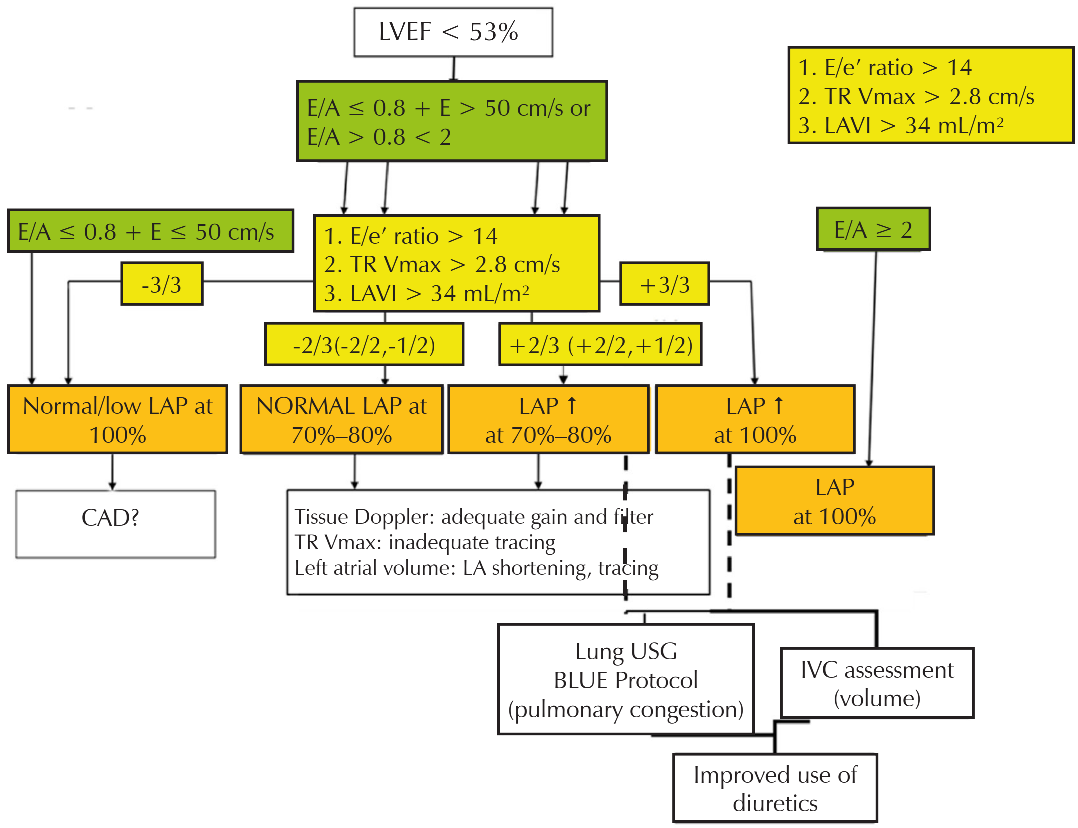
BP: blood pressure; HR: heart rate; BMI: body mass index; LV: left ventricle; RV: right ventricle; USG: ultrasonography; HFpEF: heart failure with preserved ejection fraction; EF: ejection fraction.

Figure 2 – *Suggested report model for heart failure with preserved ejection fraction integrating lung ultrasound and probability score.*



HFrEF: heart failure with reduced ejection fraction; HR: heart rate; BMI: body mass index; LVEDD: left ventricular end-diastolic diameter; LV: left ventricle; IVS: interventricular septum, PP: posterior wall; LVEF: left ventricular ejection fraction; SLG: global longitudinal strain; TR Vmax: maximum velocity of tricuspid regurgitation; TR: tricuspid regurgitation; IVC: inferior vena cava; PASP: pulmonary artery systolic pressure; USG: ultrasonography.

Video 3 – *Addressing dyspnea in elective patients with heart failure with reduced ejection fraction.*



LVEF: left ventricular ejection fraction; Vmax: maximum velocity; LAVI: left atrial volume index; LAP: left atrial pressure; CAD: coronary artery disease; TR: tricuspid regurgitation; LA: left atrium; USG: ultrasonography; BLUE: bedside lung ultrasound in emergency; IVC: inferior vena cava.
Source: Adapted from Nagueh et al.[12]

Figure 3 – *Algorithm for assessing heart failure with reduced ejection fraction evaluating filling pressures, congestion, and blood volume.*

Addressing dyspnea in patients requiring urgent and emergent care. BP: blood pressure; HR: heart rate; RR: respiratory rate; SatO2: oxygen saturation; VM: vesicular murmur; CR: crepitant rales; 2S RHR: regular heart rate in two stages; ECG: electrocardiogram; RBBB: right bundle branch block; RV: right ventricle; PASP: pulmonary artery systolic pressure; MPAP: mean pulmonary artery pressure; PADP: pulmonary artery diastolic pressure; DH: diagnostic hypothesis.

Video 4 – *Addressing dyspnea in patients requiring urgent and emergent care.*

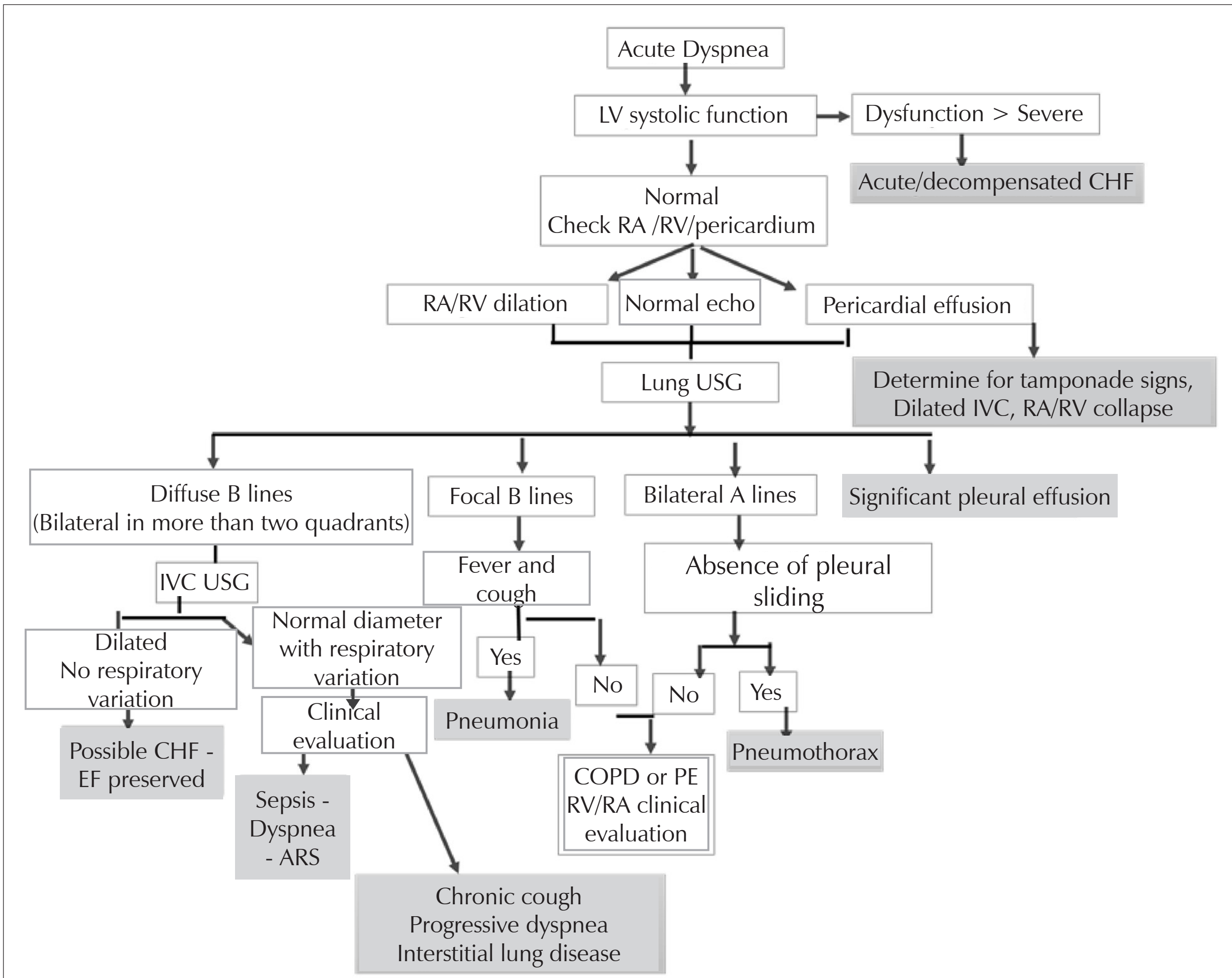
diagnosis of interstitial lung disease should be established. Figure 4 shows the recommended algorithm adapted from Guttikonda et al.[15] to better understand the assessment sequence. The diagnostic agreement and final diagnosis at hospital discharge with the use of this algorithm was 88% (kappa = 0.805).

Conclusion

Echocardiography is often requested to assess dyspnea of cardiac or noncardiac etiology. Lung ultrasound is a quick and easy technique that can be combined with echocardiography. Some sequences of processes and videos have been proposed for an efficient and accurate differentiation of dyspnea to improve the daily clinical practice for patients with dyspnea of cardiac etiology.

Conflict of interest

The authors have declared that they have no conflict of interest.



LV: left ventricle; RA: right atrium; RV: right ventricle; CHF: congestive heart failure; USG: ultrasonography; IVC: inferior vena cava; EF: ejection fraction; ARS: acute respiratory syndrome; COPD: chronic obstructive pulmonary disease; PE: pulmonary embolism
Source: Adapted from Guttikonda et al.[15]

Figure 4 – *Acute dyspnea algorithm. Combination between echocardiography and lung ultrasound.*

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