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Case Report

BEE FIRST: A standardized point-of-care ultrasound approach to a patient with dyspnea☆,☆,☆

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ABSTRACT

Dyspnea is a common complaint in patients who present to the emergency department and can be due to numerous etiologies. This case report details a 90-year-old female with a history significant for hypertension, hyperlipidemia, and new diagnosis of ovarian malignancy whose symptoms increased over the past three days. Point-of-care Ultrasonography showed multiple B-lines, a plethoric IVC without respiratory variation, a markedly low EF and a lack of RV dilation. There was also no evidence of effusion which led the emergency medicine team to the diagnosis of acute decompensated heart failure. This quick diagnosis was possible due to using the standardized POCUS approach guided by the *BEE FIRST* algorithm. BEE FIRST can help physicians remember: B-lines are indicative of interstitial thickening, Effusion such as pericardial or pleural should be checked for, Ejection Fraction is useful in assessing for heart failure, IVC/Infection/Infarct correlates with central venous pressure, and can be used to assess volume status, check for enlargement, evidence of pneumonia, subpleural consolidation "shred sign", hepatization of lung, and/or pulmonary infarction related to pulmonary embolism, Right Heart Strain can indicate pulmonary embolism or pulmonary hypertension, Sliding Lung can assess for pneumothorax and pleural

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characteristics, and lastly, Thrombosis/Tumor can assess for myxoma and interrogation of lower extremities for deep vein thrombosis can aid in dyspnea differentiation. In this report, we demonstrate how the framework BEE FIRST offers a standardized stepwise approach to the utilization of POCUS in a patient with acute dyspnea in the ED setting.

Introduction

Undifferentiated dyspnea is a common emergency department (ED) presentation. One study in Boston, MA, demonstrated that 23% of all admitted ED patients reported dyspnea in the past 24 hours, and 11% reported dyspnea within 12 hours after admission [1]. The most common causes of dyspnea in the ED have been reported as decompensated heart failure, COPD, pneumonia, pulmonary embolism, and asthma [2]. The COVID-19 pandemic has added to the list of respiratory complaints to be considered in a differential diagnosis. Currently, X-rays, CT scans, laboratory studies, and physical examinations are the most utilized methods of differentiating causes of dyspnea. X-rays and physical examinations are often insufficient, and CT scans have limitations in application due to cost and the exposure to radiation [3]. Most of the above listed diagnostic strategies have an additional significant limiting factor: the time to completion. Increased time to diagnosis may adversely affect both clinical outcomes and the patient's ultimate disposition.

Point- of- care ultrasound (POCUS) has been shown to be accurate in diagnosing a variety of etiologies including acute decompensated heart failure, pneumonia, pneumothorax, pulmonary thromboembolism, pleural/pericardial effusion, and empyema [3]. Previous studies have shown that POCUS is a diagnostically accurate and efficient method to differentiate causes of dyspnea in ED patients [2,4–6]. We present a case demonstrating the use of BEE FIRST, a POCUS ultrasound standardized step wise approach that can be used to differentiate the cause of dyspnea in the ED utilizing lung, cardiac, and IVC views.

Case

A 90-year-old female with a history significant for hypertension, hyperlipidemia, and new diagnosis of ovarian malignancy presented to the ED with gradually increasing shortness of breath over three days duration, which improved with sitting up and worsened on exertion. The patient denied any cardiac history or chest pain but acknowledged some chills. Upon presentation, the patient was noted to be hypoxic with severe respiratory distress. On physical examination the patient had blood pressure 101/47, pulse 93, respiratory rate 32, temperature 97.3, and Sp02 95%. She also had decreased breath sounds and accessory muscle use. She had an elevated white blood cell count, predominantly neutrophils, elevated troponins, markedly elevated NT-ProBNP and severe acidosis).

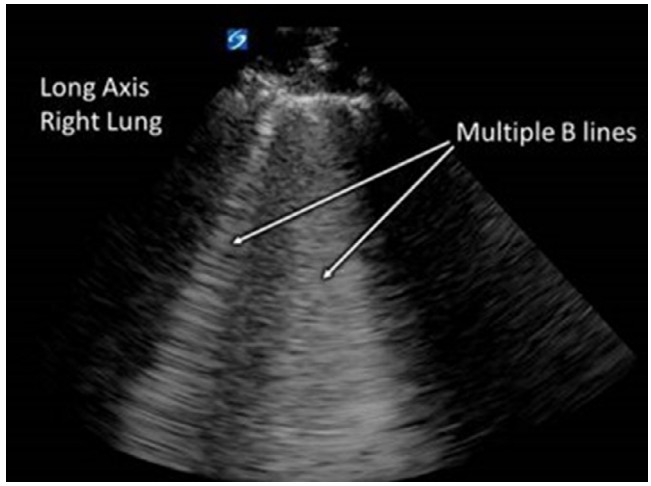

Fig. 1 – Long axis lung showing multiple B lines.

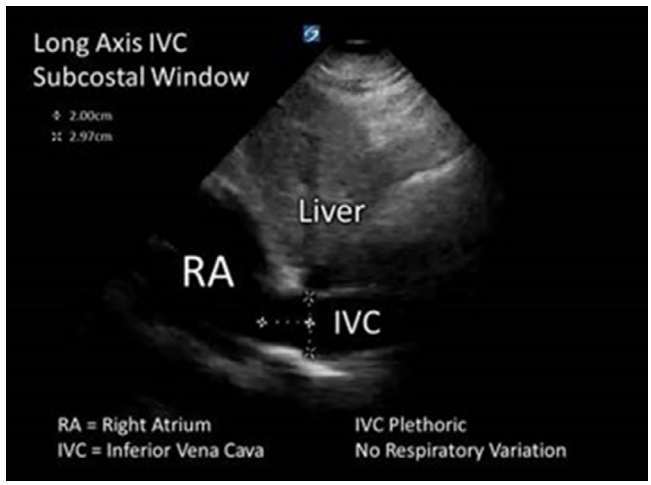

Fig 2 – Long Axis Inferior Vena Cava from a subcostal window showing Right Atrium, Liver. IVC is plethoric. No respiratory variation seen.

The initial electrocardiogram and physical examination did not significantly narrow the differential diagnosis.

Using a systematic BEE FIRST approach to their POCUS, the provider found the presence of multiple B-lines (Fig. 1), a plethoric IVC without respiratory variation (Fig. 2), and a markedly low EF and a lack of RV dilation (Fig. 3). There was no evidence of effusion (Fig. 3), infection/infarction, or intracardiac mass (thrombosis/tumor). These findings were all

Table 1 – BEE FIRST POCUS Approach.

	Pathology	Probe	Positioning
B-lines	Indicative of interstitial thickening seen in inflammation, pulmonary edema, or pulmonary fibrosis for example	Linear Transducer or Phased Array	Placed in each lung field anteriorly and posteriorly with indicator to head
Effusion	Pericardial (Tamponade?) or pleural effusions	Phased Array	Parasternal long (PLAX) or Subxiphoid view
Ejection **F**raction	Cardiac ejection fraction is useful in assessing for heart failure. Assess Anterior Mitral Leaflet excursion, wall shortening/ thickening and left ventricular size change	Phased Array	Parasternal long axis
IVC	Correlates with CVP, assess volume status, enlargement also seen in tamponade/CHF/ R heart strain	Phased Array	Subxiphoid with indicator to head
Infection	Evidence of pneumonia, subpleural consolidation “shred sign”, hepatization of lung	Phased Array	Placed in each lung field anteriorly and posteriorly with indicator to head
Infarct	Pulmonary infarction related to pulmonary embolism	Phased Array	
Right Heart Strain	Can indicate pulmonary embolism/ pulmonary hypertension	Phased Array	Parasternal long axis
Sliding lung	Assess for pneumothorax, pleural characteristics	Linear Transducer	Placed in each lung field anteriorly and posteriorly with indicator to head. 2D or M- Mode utilized
Thrombosis*	*Interrogation of lower extremities for deep vein thrombosis can also aid in dyspnea differentiation.	Linear Transducer	Probe placed along femoral and popliteal vasculature, indicator to patient’s right.
Tumor	Assess for myxoma, embolism etc.	Phased array	PLAX

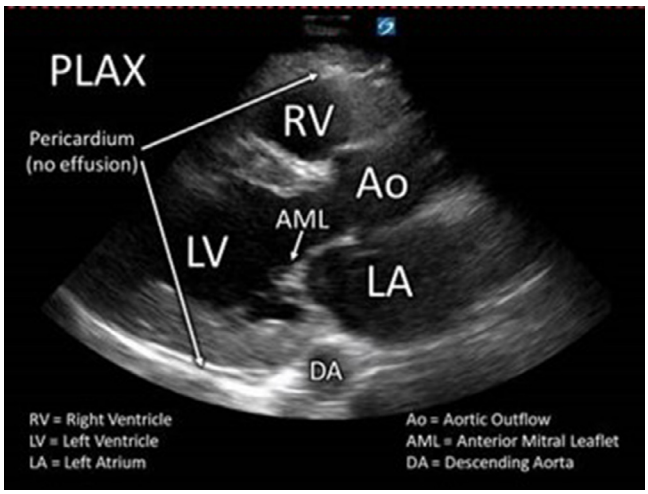

Fig. 3 – PLAX showing right and left ventricles, left atrium, aortic outflow, anterior mitral leaflet, descending aorta. No RV dilation was seen. EF was abnormally low. No effusion seen.

consistent with a diagnosis of acute decompensated heart failure. Due to utilizing POCUS and the BEE FIRST algorithm, the diagnosis and initiation of therapy for acute decompensated congestive heart failure within 10 minutes of presentation to the ED hastened the patient’s stabilization and admission to the ICU.

Discussion

Patients that present to the ED in respiratory distress have high mortality, ranging up to 71.4% in patients with massive pulmonary embolism [7]. This presentation requires prompt diagnosis and treatment, as delay can be deadly. A complicating factor is that these patients often are too short of breath to provide a detailed history of present illness. The use of POCUS allows for a substantial amount of information to be determined rapidly. By utilizing the BEE FIRST algorithm (Table 1) as a directed, stepwise approach; the physician in the case was able to initiate treatment prior to the return of lab results and even before imaging had been performed. Each of these different POCUS procedures collectively aid in the diagnosis of the undifferentiated dyspneic patient. At each stage, findings inconsistent with the working diagnosis should prompt a re-evaluation of the etiology of the dyspnea.

The absence of right heart strain was also key in this case as the patient was at high risk for pulmonary embolism and was too unstable to be transported to CT scan. Delay in treatment for this patient could have been deadly.

There are practical limitations to this diagnostic strategy, there are body habitus challenges and patient’s respiratory distress can limit image quality and the ability to interpret

results. Rigorous research utilizing the BEE FIRST approach to managing patients with dyspnea have not been performed. However, authors believe BEE FIRST is a reliable, repeatable method to aid clinicians in the initial evaluation of patients presenting with undifferentiated dyspnea. (for further illustration of the technique, see video, Appendix 1) While the algorithm is not exhaustive, it does quickly identify the major culprits that require timely care. It is important to interpret these ultrasound findings in the context of the patient that is being evaluated. It can also be used to assist in the education of clinicians with limited experience in critical care POCUS applications. Consistent with other application learning curves, authors recommend 25 quality reviewed exams in the BEE FIRST application to establish operator skill level for performance in this bedside approach. There are other diagnostic techniques that provide a more comprehensive evaluation, but a benefit of the BEE FIRST strategy is the rapidity in performance and the teachability it has to educate a large number of clinicians.

Conclusion

The BEE FIRST algorithm is a mnemonic for a standardized POCUS approach which lends itself as a memory tool for a physician actively involved in lifesaving care. This approach allows for prompt diagnosis and streamlines treatment for patients such as our case, who are in undifferentiated respiratory distress that present acutely in the ED setting.

Author contributions

All authors provided substantial contributions to manuscript content. All authors gave final approval of the version of the article to be published., The authors have no outside support information, conflicts or financial interest to disclose, and this work has not been presented elsewhere.

Appendix 1 BEE FIRST in Dyspnea Educational Video

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2022.01.004.

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