

2023

A Guide to Point of Care Ultrasound Examination of Acute Decompensated Heart Failure

Michael Dong, MD

Thomas Jefferson University, michael.dong@jefferson.edu

Rebecca Davis, MD

Thomas Jefferson University, rebecca.davis@jefferson.edu

Jonathan Foster, MD

Thomas Jefferson University, jonathan.foster@jefferson.edu

Jillian Cooper, MD

Thomas Jefferson University, jillian.cooper@jefferson.edu

Frances Mae West, MD

Thomas Jefferson University, frances.west@jefferson.edu

Follow this and additional works at: <https://jdc.jefferson.edu/tmf>

 Part of the [Internal Medicine Commons](#)

[Let us know how access to this document benefits you](#)

Recommended Citation

Dong, MD, Michael; Davis, MD, Rebecca; Foster, MD, Jonathan; Cooper, MD, Jillian; and West, MD, Frances Mae (2023) "A Guide to Point of Care Ultrasound Examination of Acute Decompensated Heart Failure," *The Medicine Forum*: Vol. 24, Article 13.

DOI: <https://doi.org/10.29046/TMF.024.1.012>

Available at: <https://jdc.jefferson.edu/tmf/vol24/iss1/13>

This Article is brought to you for free and open access by the Jefferson Digital Commons. The Jefferson Digital Commons is a service of Thomas Jefferson University's [Center for Teaching and Learning \(CTL\)](#). The Commons is a showcase for Jefferson books and journals, peer-reviewed scholarly publications, unique historical collections from the University archives, and teaching tools. The Jefferson Digital Commons allows researchers and interested readers anywhere in the world to learn about and keep up to date with Jefferson scholarship. This article has been accepted for inclusion in *The Medicine Forum* by an authorized administrator of the Jefferson Digital Commons. For more information, please contact: JeffersonDigitalCommons@jefferson.edu.

ULTRASOUND EDUCATION

A Guide to Point of Care Ultrasound Examination of Acute Decompensated Heart Failure

Michael Dong, MD¹, Rebecca Davis, MD¹, Jonathan Foster, MD¹, Jillian Cooper, MD¹, Frances Mae West, MD^{1,2}

1. Department of Internal Medicine, Thomas Jefferson University Hospital, Philadelphia, PA
2. Division of Pulmonary, Allergy, and Critical Care, Department of Medicine, Thomas Jefferson University, Philadelphia, PA

LEARNING OBJECTIVES

1. Learn the technique for cardiac ultrasound.
2. Identify and interpret the cardiac ultrasound findings consistent with left heart systolic failure.
3. Recognize early-point septal separation (EPSS) and Kimura's cardiopulmonary limited ultrasound evaluation (CLUE) as techniques for assessing reduced left heart ejection fraction.

INTRODUCTION

A patient presents with dyspnea on exertion, orthopnea, and lower extremity edema. They have a prior history of coronary artery disease and reported episodes of chest pain three months ago. They did not seek medical evaluation at the time and have had no chest pain recently. In this setting, there is a high clinical suspicion of heart failure with concern for ischemic heart disease. The gold standard for diagnosis of heart failure is a formal transthoracic echocardiogram. Bedside point of care ultrasound (POCUS) is a tool that can provide essential information without delay in diagnosis.

A study by Razi et al. in 2011 investigated whether internal medicine residents with limited training (20 practice studies) could use POCUS to identify systolic heart failure with handheld ultrasound machines. They identified heart failure with reduced EF < 40% with a sensitivity and specificity of 94%.¹ At their institution, obtaining results from a formal echocardiogram took 22 hours on average.

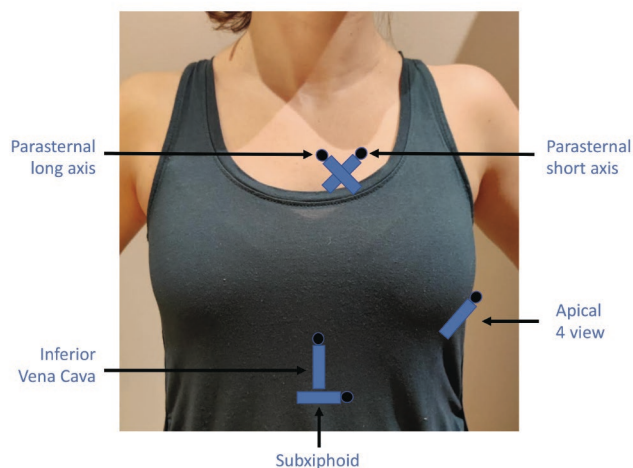
It is important to recognize the limited scope of cardiac POCUS. The goal of cardiac POCUS is to answer key clinical questions, and ideally, questions that can be simplified into binary outcomes. For example, is the left heart larger than the right heart? Is there a pericardial effusion present? Is the right heart dilated? Does the

E-point septal separation (EPSS) suggest a reduced left heart ejection fraction?²

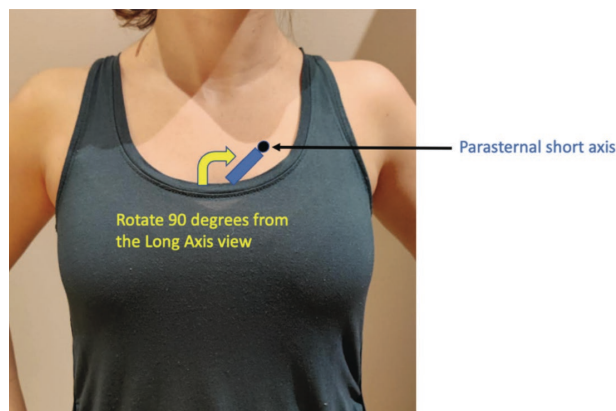
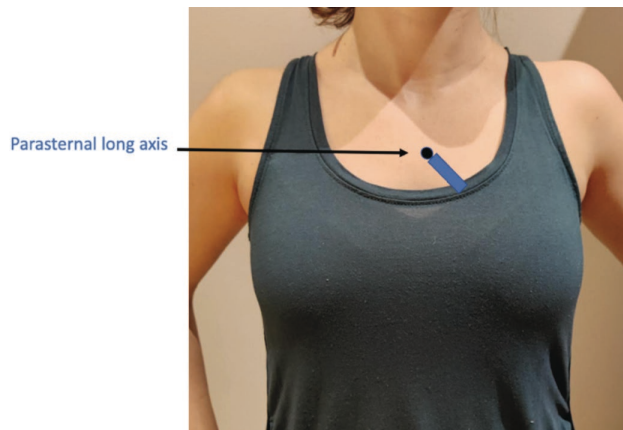
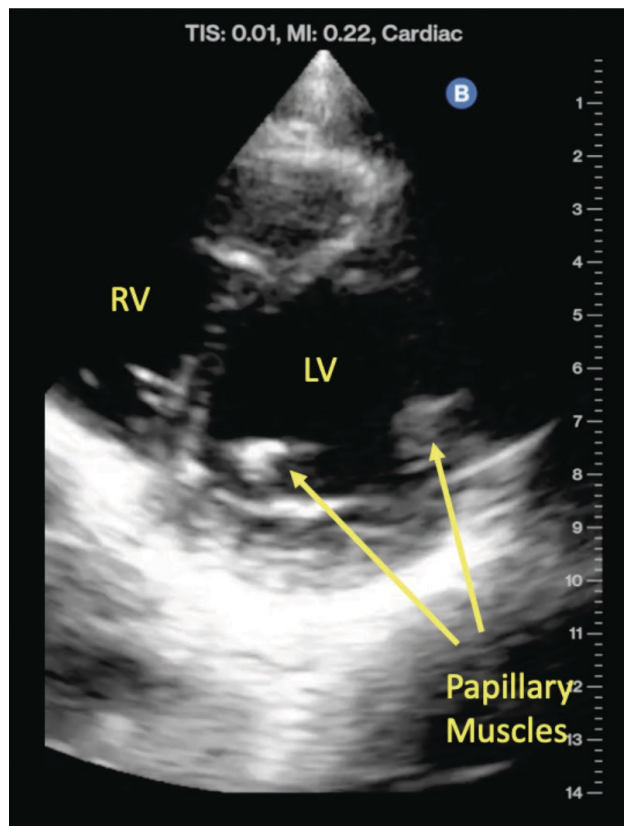
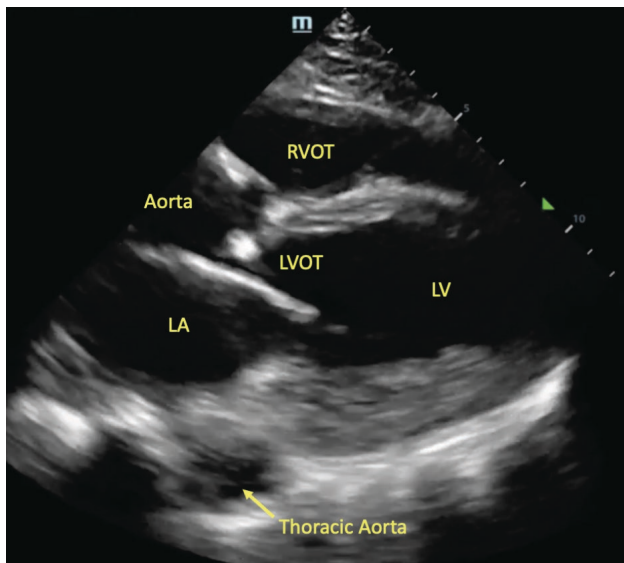
Using the previous example, an internal medicine resident with limited training would not be able to make a determination of valvular dysfunction, segmental wall motion abnormalities, estimation of pulmonary artery systolic pressures, and nuanced evaluation of ejection fraction. However, many valuable clinical findings can be made with cardiac POCUS, and validated techniques such as EPSS and the CLUE protocol are effective at assessing for reduced left heart ejection fraction.

TECHNIQUE

The Cardiac POCUS includes four views plus an IVC exam.

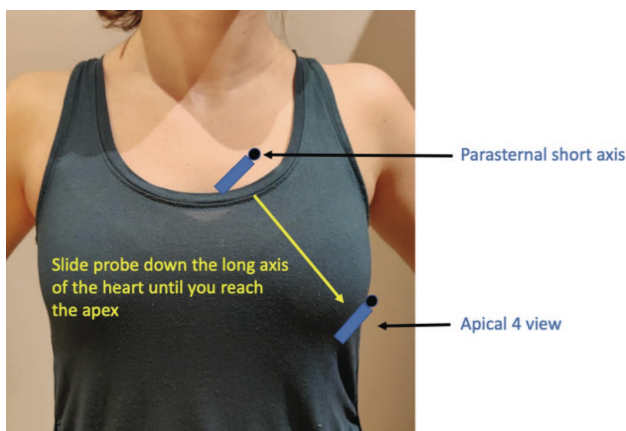
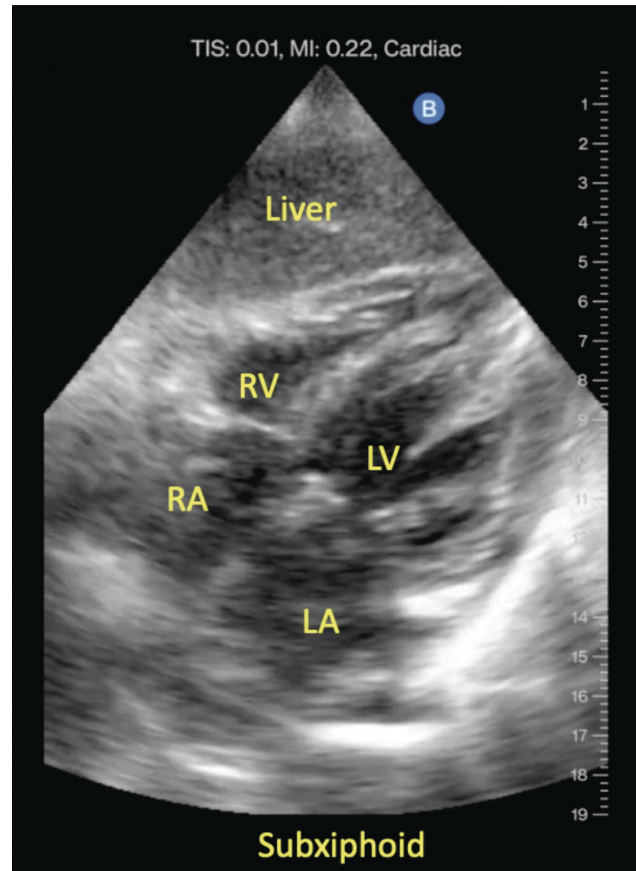
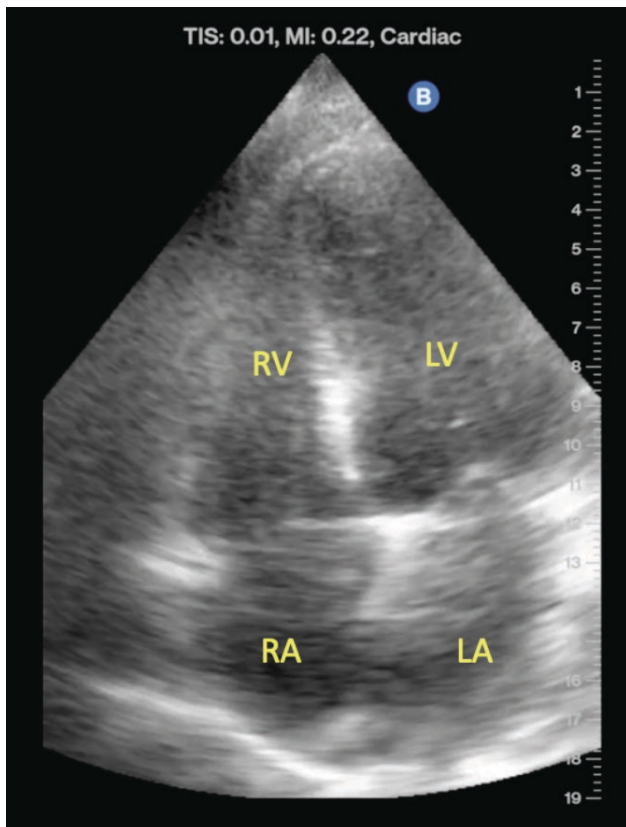


1. The parasternal long axis (PLAX) is obtained at the second intercostal to the left of the sternum, with the probe indicator directed at the patient's right shoulder.
 - a. The most anterior chamber is the right ventricle (RV) and right ventricular outflow tract (RVOT).
 - b. Deep to the RV is the left ventricle (LV). The left ventricular outflow tract (LVOT) leads to the aortic valve and aorta. The left atrium (LA) and mitral valve lead into the left ventricle.
 - c. The deepest structure identified is the thoracic aorta.
 - d. TIP: set your depth to the thoracic aorta.
 - e. TIP: the RVOT, aorta, and left atrium should be 1:1:1 in size. If one of those structures is significantly different, it may suggest that you are off-axis or that there is abnormal pathology.
2. The parasternal short axis (PSAX) is obtained at the same position as the PLAX but with a 90-degree rotation of the probe indicator towards the patient's left shoulder.
 - a. The ideal view will be at the level of the papillary muscles. The papillary muscles should be equal in size, which indicates that you are on the appropriate axis.

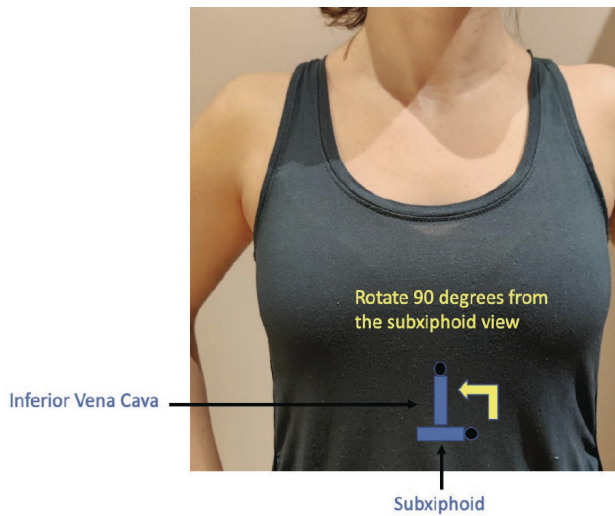
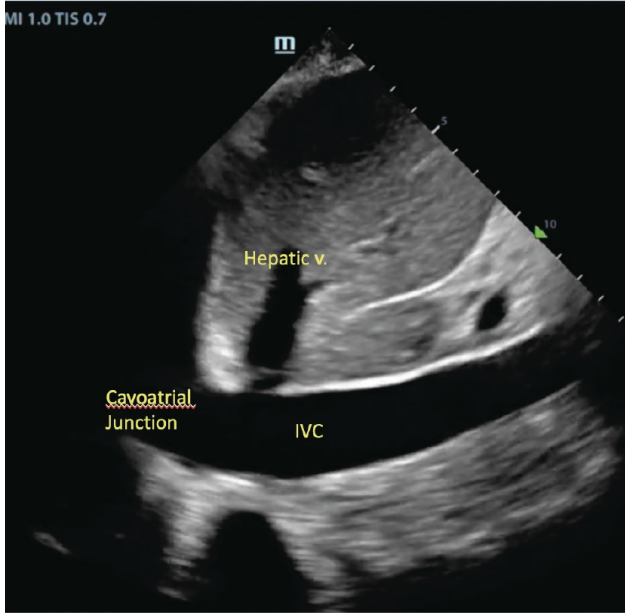


3. The apical 4-chamber (A4C) is obtained at the apex of the heart with the indicator pointed in the same axis as the PSAX.
 - a. After obtaining the PSAX, slide the probe down the length of the heart, and when you reach the apex, tilt the probe so that it is pointing up the long axis of the heart.
 - b. A 5-chamber view can be obtained by fanning your probe and capturing the aortic valve and LV outflow tract.

4. The subxiphoid view (SXI) is obtained by imaging from under the sternum with the probe held horizontally and the probe indicator directed to the patient's left.

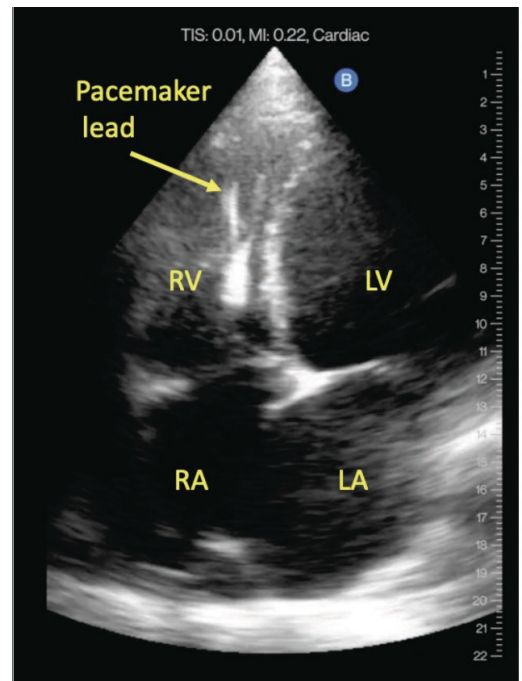
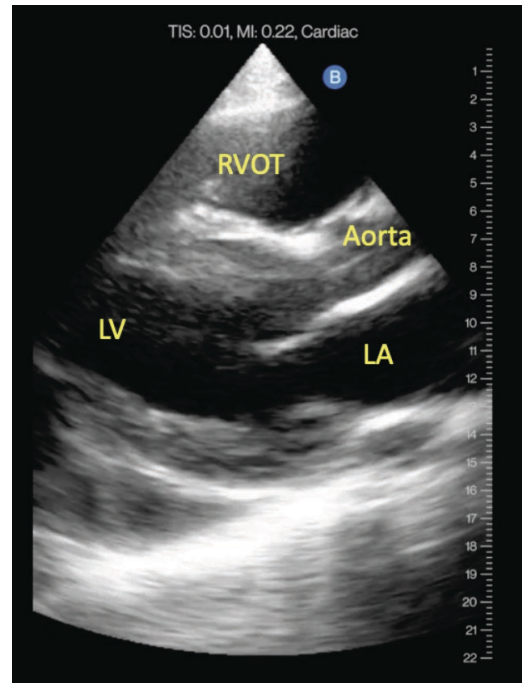


- The Inferior vena cava (IVC) view is obtained by first identifying the right atrium on the subxiphoid view, then rotating the probe 90 degrees so that the probe indicator is directed caudally.



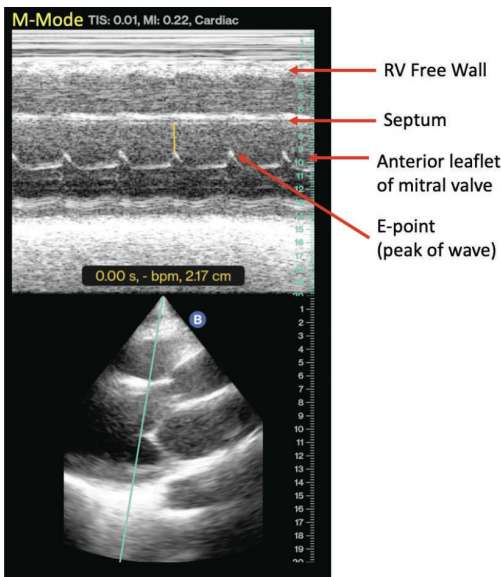
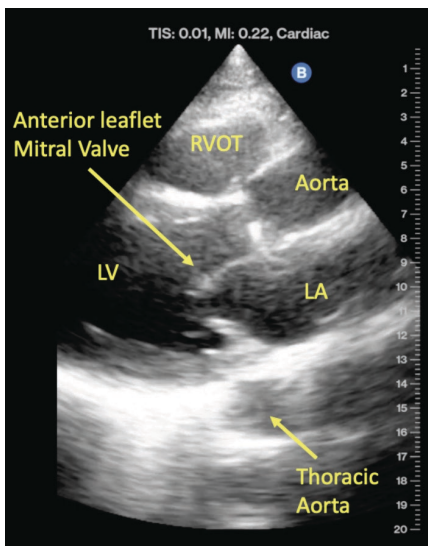
Findings Consistent with Acute Decompensated Left Heart Failure

- Left heart ventricular dilation in multiple views and with decreased fractional shortening of the left ventricular walls. A symmetric reduction in the volume of the ventricle of 30% is associated with an ejection fraction of at least 50%.³

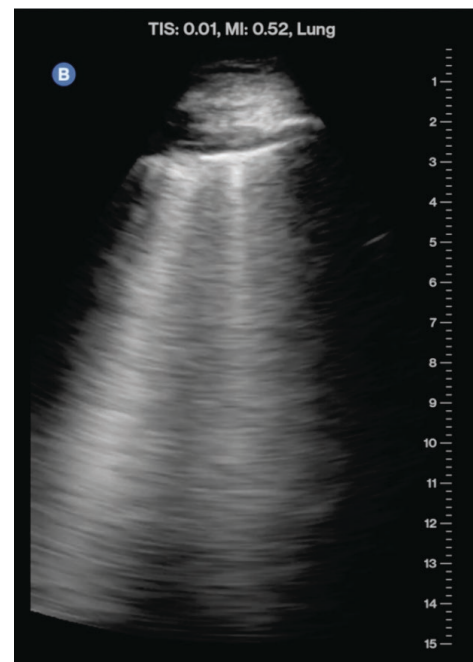
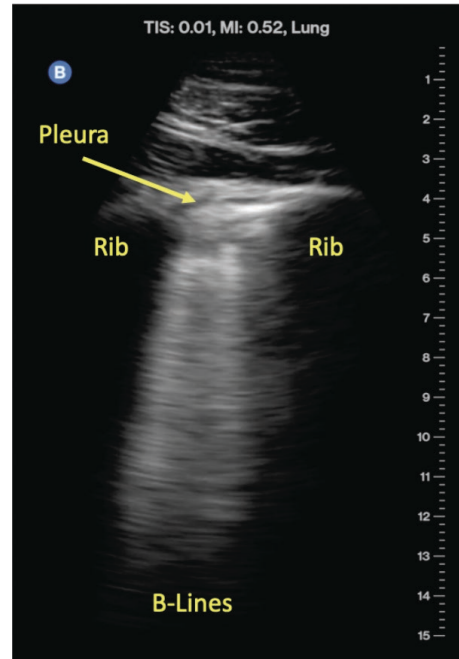


2. Measurement of the Early-point septal separation.

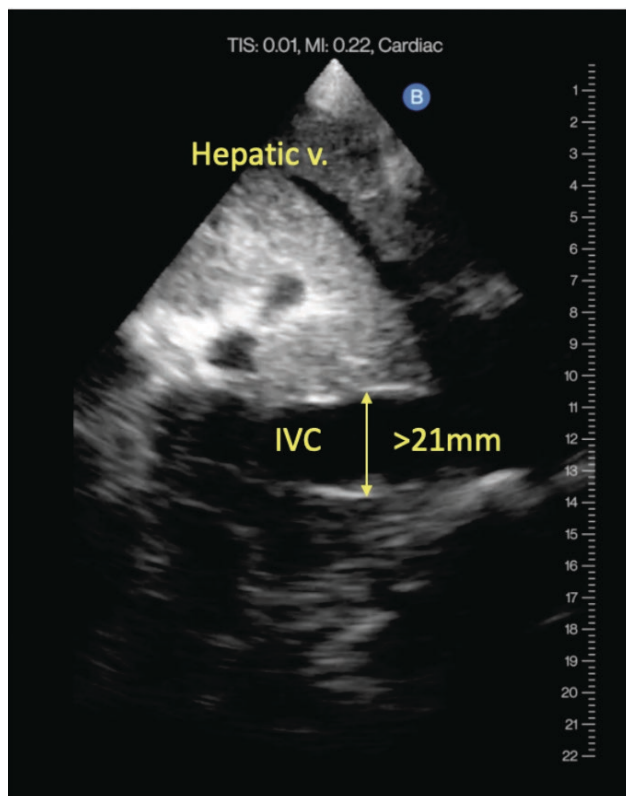
Early-Point septal separation (EPSS) is an objective method of estimating left ventricular ejection fraction. Visualization of the mitral valve is optimized in the parasternal long axis. M-mode is centered on the anterior leaflet of the mitral valve as it moves toward the interventricular septum. A few cardiac cycles are measured, then freeze the frame and use the calipers to measure the EPSS. The EPSS is calculated as the distance between the endpoint of the mitral valve leaflet motion and the septum. If the anterior leaflet of the mitral valve moves within 1 Dong Ultrasound Cardiac fig 8 0.7cm of the septal wall, the patient's EF is assumed to be greater than 55%. A distance greater than 1.0cm is consistent with a reduced EF.⁴



3. Bilateral B-lines are consistent with pulmonary edema. In the Cardiopulmonary Limited Ultrasound Evaluation (CLUE) protocol for reduced left ventricular ejection fraction, only the bilateral apical lungs are assessed.⁵



4. A Plethoric IVC: Dilated IVC > 21mm with less than a 50% decrease on inspiration.



Pitfalls and Pearls

1. One view is no view! LV function cannot be estimated in a single view; multiple views are needed for a proper assessment.
2. Positioning is important. Off-axis views of the PLAX or poor visualization of the mitral valve will also lead to inaccurate EPSS. If the parasternal views are obscured by air, ask the patient to exhale and hold. If you have difficulty finding a window for the apical four-chamber, try asking the patient to lie on their left side, which brings the heart closer to the chest wall.
3. EPSS is inaccurate in certain conditions. For example, patients with mitral valve stenosis due to poor movement of the anterior leaflet, even if the ventricular function is normal. In aortic regurgitation, there is also poor anterior mitral valve leaflet motion, thus underestimating the EPSS. In Takotsubo's cardiomyopathy, there could be severe apical dilation, but the EPSS is normal, thus greatly overestimating the ejection fraction.

4. Kimura et al. in 2011 created the CLUE protocol, which combines four views to predict if there is a reduced left heart ejection fraction. Using only the parasternal LV long-axis, subcostal IVC, and two apical lung views, the protocol assesses LV dysfunction, LA enlargement, IVC plethora, and B-lines in the lung apices. When evaluating LV ejection fraction < 40%, the CLUE protocol had a sensitivity of 69%, specificity of 91%, and accuracy of 89%.⁵

Acknowledgments:

The ultrasound images were acquired by Dr. Saati, Dr. Cooper, Dr. Foster, and Dr. Dong.

REFERENCES

1. Razi R, Estrada JR, Doll J, Spencer KT. Bedside hand-carried ultrasound by internal medicine residents versus traditional clinical assessment for the identification of systolic dysfunction in patients admitted with decompensated heart failure. *J Am Soc Echocardiogr.* 2011;24(12):1319-1324. doi:10.1016/j.echo.2011.07.013.
2. McKaigney CJ, Krantz MJ, La Rocque CL, Hurst ND, Buchanan MS, Kendall JL. E-point septal separation: a bedside tool for emergency physician assessment of left ventricular ejection fraction. *Am J Emerg Med.* 2014;32(6):493-497. doi:10.1016/j.ajem.2014.01.045.
3. Quinones MA, Pickering E, Alexander JK. Percentage of shortening of the echocardiographic left ventricular dimension. Its use in determining ejection fraction and stroke volume. *Chest.* 1978;74(1):59-65. doi:10.1378/chest.74.1.59.
4. D'Cruz IA, Lalmalani GG, Sambasivan V, Cohen HC, Glick G. The superiority of mitral E point-ventricular septum separation to other echocardiographic indicators of left ventricular performance. *Clin Cardiol.* 1979;2(2):140-145. doi:10.1002/clc.4960020210.
5. Kimura BJ, Yogo N, O'Connell CW, Phan JN, Showalter BK, Wolfson T. Cardiopulmonary limited ultrasound examination for "quick-look" bedside application. *Am J Cardiol.* 2011;108(4):586-590. doi:10.1016/j.amjcard.2011.03.091.