

# Point-of-Care Ultrasound (POCUS) in Evaluation of Undifferentiated Dyspnea

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**Define:** Dyspnea is the subjective feeling of distress or discomfort with breathing.

**Background:** POCUS should be used to assess a variety of diagnoses associated with dyspnea and has been found to improve the accuracy of diagnosis by 30% when POCUS is used in conjunction with standard diagnostic pathways.<sup>1,2</sup> Many protocols exist; understanding cardiopulmonary POCUS with a standardized approach to basic cardiac, pulmonary, and vascular evaluation is discussed below.\*

\*This method is meant to identify acute and life threatening etiologies in a somewhat timely manner, but does not address the complexities of patients with underlying chronic pulmonary and cardiac disease. Internists should consider how these underlying chronic conditions may change the overall acute POCUS interpretations (i.e. B-lines in ILD, reduced LVSF in CHF).

Clinical guidelines support the use of POCUS to aid with the diagnosis of heart failure, pleural effusion, pneumonia, pneumothorax, and pulmonary embolism<sup>1,2</sup> with additional evidence supporting the evaluation of a wide variety of other diagnostic dilemmas.<sup>3-5</sup> More advanced techniques may also assist in this evaluation but are outside the scope of this document.

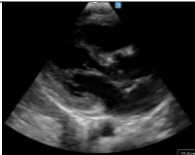
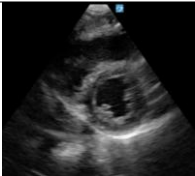
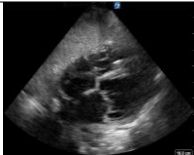
- Most common etiologies of undifferentiated dyspnea: **heart failure, pneumonia, COPD/asthma, and pulmonary embolism**
- Emergent/ acute etiologies -> "ACT ASAP": **Arrhythmia, ACS, Tamponade, Airway obstruction, Stenosis, Anaphylaxis, and Pneumothorax\*\***

\*\*All diagnoses in bold above can be ruled in or out with POCUS as a component of the evaluation. Additionally, in the absence of findings, concerns for alternative diagnoses such as anaphylaxis and airway obstruction should be prioritized.

## Components of basic cardiopulmonary POCUS evaluation:

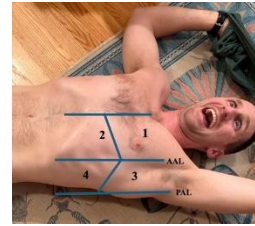
### 1) Cardiac evaluation:

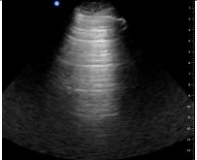
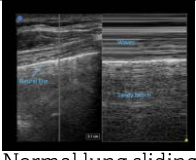
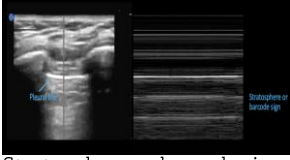
- Probe:** Phased array recommended, curvilinear optional (low frequency probes)
- Preset:** *Cardiac*
- Patient:** Supine, position patient in left lateral decubitus when possible to improve image quality

| Views          | Parasternal Long Axis (PLAX)                                                        | Parasternal Short Axis (PSAX)                                                       | Apical 4 Chamber (A4C)                                                               | Subcostal 4 Chamber (S4C)                                                             |
|----------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Probe Location | Left parasternal border, 3 <sup>rd</sup> /4 <sup>th</sup> ICS                       | Left parasternal border, 3 <sup>rd</sup> /4 <sup>th</sup> ICS                       | PMI, 4 <sup>th</sup> -6 <sup>th</sup> intercostal space, inframammary line           | Caudal to xiphoid process, liver as echogenic window                                  |
| Probe Marker   | Patient's right shoulder                                                            | Patient's left shoulder                                                             | Towards the bed, may need to rotate slightly counterclockwise (2-3 o'clock)          | Patient's left side                                                                   |
| Path           | Global LV function, LV, LA, RV chamber dilation, pericardial effusion               | Global LV function, RV pressure or volume overload (D-sign), pericardial effusion   | Global LV and RV function, chamber dilation, pericardial effusion, and tamponade     | Global LV and RV function, pericardial effusion and tamponade                         |
| Image (normal) |  |  |  |  |

## 2) Pulmonary evaluation:

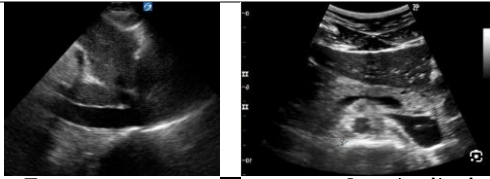
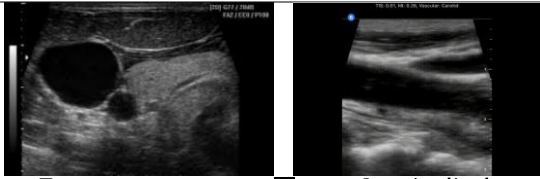
- Probe:** Linear array (high frequency) for pleural (lung sliding) evaluation; Phased array or curvilinear (low frequency) transducer can be used for both pleural and lung examination.
- Preset:** *Lung* when evaluating “artifacts” (A-lines/ B-lines); *abdominal* when evaluating for consolidation and effusion.
- Patient:** Supine or semi-recumbent (appr. 30 degrees) . Semi-recumbent can improve visualization of gravity-dependent pleural effusions and aid in individuals who cannot lie flat.



| Views          | Anterior and anterolateral zones (zones 1-3)                                                                                                                                                                                                                       |                                                                                                                                    | Posterolateral alveolar and/or pulmonary syndrome (PLAPS) point (zone 4)                                                                                 |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Probe Location | Intercostal space, cranial-caudal, pleural lining about 0.5cm below the ribs. Increase depth to at least 10-12 cm.<br><br>Use linear probe to evaluate lung sliding in greater detail. Intercostal space, cranial-caudal, Depth set at 3-6 cm depending on patient |                                                                                                                                    | Draw an imaginary line from the xiphoid process to the midaxillary line and place the probe here (around the 7-9 <sup>th</sup> rib space).               |
| Probe Marker   | Cranial                                                                                                                                                                                                                                                            |                                                                                                                                    | Cranial                                                                                                                                                  |
| Pathology      | +/- lung sliding (sensitive but not specific for PTX), +/- lung point (highly specific for PTX), B-line count, subpleural consolidation, consolidation/ effusion (see PLAPS point for more details), bilateral/ unilateral, focal/ diffuse pattern.                |                                                                                                                                    | <u>Healthy:</u> Curtain sign<br><u>Disease state:</u> Spine sign, Effusion, Consolidation/ Atelectasis, Air bronchograms: static vs. dynamic, Shred sign |
| Image (normal) | <br>A lines                                                                                                                                                                     |                                                                                                                                    | <br>Normal lung sliding (sandy beach or seashore)                     |
|                | <br>B lines                                                                                                                                                                     |                                                                                                                                    | <br>Stratosphere or barcode sign                                      |
|                |                                                                                                                                                                                                                                                                    | <br>Normal curtain sign and lack of spine sign | <br>Consolidation with air bronchograms                             |
|                |                                                                                                                                                                                                                                                                    | <br>Simple pleural effusion                    | <br>Shred sign                                                      |
|                |                                                                                                                                                                                                                                                                    | <br>Complex pleural effusion                   |                                                                                                                                                          |

### 3) Vascular evaluation

- Probe:** IVC – Phased array or Curvilinear; IJV - Linear
- Preset:** IVC – Cardiac OR abdominal; IJV – vascular
- Patient:** IVC – Patient supine, bent knees can aid with examination; IJV – Semi-recumbent at 30-45°, head and neck turned leftward slightly

| Views          | IVC                                                                                                                                                                                                                       | Internal Jugular Vein (IJV)                                                                                                                                                                                                                                                        |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Probe Location | Caudal to xiphoid process, liver as echogenic window                                                                                                                                                                      | Over right IJ and carotid. Sliding caudal to cephalad, evaluating for IJV collapse.                                                                                                                                                                                                |
| Probe Marker   | Long: Cephalad<br>Trans: Patient's left if in cardiac preset and patient's right if in abdominal preset                                                                                                                   | Long: Cephalad<br>Trans: Patient's right                                                                                                                                                                                                                                           |
| Path           | Dilated IVC (>2.1cm) and non-collapsible (<50% collapsible) estimate a CVP of >10-15 mmHg. Evaluate both longitudinal and cross sectional as one view in isolation can be difficult to interpret and fraught with errors. | Ultrasound JVP (uJVP)* >8 cm indicates RAP > 9<br><br>*uJVP: documented point of collapse measure just like standard JVP of PE +5cm. Multiple other techniques being studied. Some protocols measure distance of RA from chest wall in PLAX view given presumed inaccuracy of 5cm. |
| Image (normal) |  <p>Transverse                      Longitudinal</p>                                                                                     |  <p>Transverse                      Longitudinal</p>                                                                                                                                             |

See the chart below for discussion of various findings of common clinical conditions.

| Diagnosis                | Findings on POCUS to support clinical diagnosis of most common and most supported disease processes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                   |                                                                                                                                                                                                                                                                           |                                 |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Congestive heart failure | <b>Cardiac:</b> RV and LV dilation, atrial dilation, poor LV and RV function. Diastology is beyond the scope of this report.<br><b>Pulmonary:</b> + Lung sliding, diffuse bilateral B-lines (usually symmetrical), + bilateral pleural effusions, +/- compressive atelectasis<br><b>Vascular:</b> Dilated IVC (>2.1 cm) and non-collapsible (<50%) suggesting elevated right atrial pressure. uJVP >8 cm.                                                                                                                                                                                 |                                                                                                                   |                                                                                                                                                                                                                                                                           |                                 |
|                          | Pooled <sup>6</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | EPSS>7 mm (ED<30%) <sup>7</sup>                                                                                   | Visually "reduced" EF <sup>8</sup>                                                                                                                                                                                                                                        | >/= 3 B-lines BL <sup>9</sup>   |
|                          | PLR<br>NLR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 7.87<br>0.14                                                                                                      | 2.07<br>0                                                                                                                                                                                                                                                                 | 4.1<br>0.24<br>12.38<br>0.06    |
| Pneumonia                | <b>Cardiac:</b> "normal" (if no underlying history), could have hyperdynamic function in setting of sepsis (distributive shock)<br><b>Pulmonary:</b> + Lung sliding (in some cases of pneumonia lung sliding can be absent and further eval is necessary), focal consolidation/B-lines, unilateral pleural effusion in setting of parapneumonic effusion. Dynamic air bronchograms.<br><b>Vascular:</b> Normal or small and collapsible in sepsis for both vessels                                                                                                                        |                                                                                                                   |                                                                                                                                                                                                                                                                           |                                 |
|                          | Pooled <sup>10</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Hepatization, shred sign, air bronchograms <sup>11</sup>                                                          | Subpleural consolidations and/or focal B-lines <sup>12</sup>                                                                                                                                                                                                              |                                 |
|                          | PLR<br>NLR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 16<br>0.08                                                                                                        | 12.14<br>0.16                                                                                                                                                                                                                                                             | 15.3<br>0.09                    |
| Pneumothorax             | <b>Cardiac:</b> R heart strain (RV > 2/3 LV, D-sign in PSAX), Decreased RV function (TAPSE <1.7, Mcconells sign), tricuspid regurgitation, flat septum.<br><b>Pulmonary:</b> Lung sliding, eval for presence of lung point (the interface of normal lung and pneumothorax)<br><b>Vascular:</b> variable                                                                                                                                                                                                                                                                                   |                                                                                                                   |                                                                                                                                                                                                                                                                           |                                 |
|                          | Pooled <sup>15</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | No lung sliding and lack of comet tails <sup>16</sup>                                                             | Lung point <sup>17</sup>                                                                                                                                                                                                                                                  |                                 |
|                          | PLR<br>NLR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 44.32<br>0.18                                                                                                     | 50.5<br>0.09                                                                                                                                                                                                                                                              | Approaches infinity (Spec 100%) |
| Pulmonary embolism       | <b>Cardiac:</b> +/- evidence of R heart strain (dilated RV, poor RV function, D-sign); +/- hyperdynamic LV in case of obstructive shock<br><b>Pulmonary:</b> Most commonly normal lung sliding and A-lines; Wedge shaped sub-pleural consolidation can be seen in pulmonary infarcts; Unilateral pleural effusion possible<br><b>Vascular:</b> Variable, though evidence of elevated CVP by large (>2.1 cm), non-collapsible IVC (<50%) or uJVP >8cm is highly suggestive. DVT exam (out of scope of this document) can be performed to evaluate for the presence of lower extremity DVT. |                                                                                                                   |                                                                                                                                                                                                                                                                           |                                 |
|                          | Pooled lung ultrasound (LUS) <sup>18</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Techniques used by studies in metaanalysis: B-lines, sub-pleural lesions or consolidation, and pleural effusions. | RV dysfunction: RV enlargement (RV diameter greater than or equal to that of the left ventricle), severe RV systolic dysfunction (RV free wall hypokinesis or TAPSE < 1.0 cm), and/or interventricular septum flattening or bowing into the left ventricle. <sup>19</sup> |                                 |
|                          | PLR<br>NLR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 6.2<br>0.24                                                                                                       | 90<br>0                                                                                                                                                                                                                                                                   |                                 |

## References and recommended reading:

1. Gartlehner G, Wagner G, Affengruber L, et al. Point-of-Care Ultrasonography in Patients With Acute Dyspnea: An Evidence Report for a Clinical Practice Guideline by the American College of Physicians. *Ann Intern Med.* 2021;174(7):967-976. doi:10.7326/M20-5504
2. Qaseem A, Etzeandía-Ikobaltzeta I, Mustafa RA, Kansagara D, Fitterman N, Wilt TJ. Appropriate Use of Point-of-Care Ultrasonography in Patients With Acute Dyspnea in Emergency Department or Inpatient Settings: A Clinical Guideline From the American College of Physicians. *Ann Intern Med.* 2021;174(7):985-993. doi:10.7326/M20-7844
3. Soni NJ, Lucas BP. Diagnostic point-of-care ultrasound for hospitalists. *J Hosp Med.* 2015;10(2):120-124. doi:10.1002/jhm.2285
4. Soni NJ, Schnobrich D, Mathews BK, et al. Point-of-Care Ultrasound for Hospitalists: A Position Statement of the Society of Hospital Medicine. *J Hosp Med.* 2019;14(1):E1-E6. doi:10.12788/jhm.3079
5. Kenny JÉS, Prager R, Rola P, Haycock K, Basmaji J, Hernández G. Unifying Fluid Responsiveness and Tolerance With Physiology: A Dynamic Interpretation of the Diamond-Forrester Classification. *Crit Care Explor.* 2023;5(12):e1022. doi:10.1097/CCE.0000000000001022
6. Rahmani E, Farrokhi M, Farrokhi M, et al. Accuracy of Lung Ultrasonography for Diagnosis of Heart Failure; a Systematic Review and Meta-analysis. *Arch Acad Emerg Med.* 2025;13(1):e33. doi:10.22037/aaemj.v13i1.2555
7. 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
8. Martindale JL, Wakai A, Collins SP, et al. Diagnosing Acute Heart Failure in the Emergency Department: A Systematic Review and Meta-analysis. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2016;23(3):223-242. doi:10.1111/acem.12878
9. Al Deeb M, Barbic S, Featherstone R, Dankoff J, Barbic D. Point-of-care ultrasonography for the diagnosis of acute cardiogenic pulmonary edema in patients presenting with acute dyspnea: a systematic review and meta-analysis. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2014;21(8):843-852. doi:10.1111/acem.12435
10. Desai D, Shah AB, Dela JRC, et al. Lung Ultrasonography Accuracy for Diagnosis of Adult Pneumonia: Systematic Review and Meta-Analysis. *Adv Respir Med.* 2024;92(3):241-253. doi:10.3390/arm92030024
11. Alzahrani SA, Al-Salamah MA, Al-Madani WH, Elbarbary MA. Systematic review and meta-analysis for the use of ultrasound versus radiology in diagnosing of pneumonia. *Crit Ultrasound J.* 2017;9(1):6. doi:10.1186/s13089-017-0059-y
12. Orso D, Guglielmo N, Copetti R. Lung ultrasound in diagnosing pneumonia in the emergency department: a systematic review and meta-analysis. *Eur J Emerg Med Off J Eur Soc Emerg Med.* 2018;25(5):312-321. doi:10.1097/MEJ.0000000000000517
13. Yousefifard M, Baikpour M, Ghelichkhani P, et al. Screening Performance Characteristic of Ultrasonography and Radiography in Detection of Pleural Effusion; a Meta-Analysis. *Emergency.* 2016;4(1):1-10.
14. Yousefifard M, Baikpour M, Ghelichkhani P, et al. Screening Performance Characteristic of Ultrasonography and Radiography in Detection of Pleural Effusion; a Meta-Analysis. *Emerg Tehran Iran.* 2016;4(1):1-10.
15. Dahmarde H, Parooie F, Salarzaei M. Accuracy of Ultrasound in Diagnosis of Pneumothorax: A Comparison between Neonates and Adults—A Systematic Review and Meta-Analysis. *Can Respir J.* 2019;2019:5271982. doi:10.1155/2019/5271982
16. Alrajhi K, Woo MY, Vaillancourt C. Test characteristics of ultrasonography for the detection of pneumothorax: a systematic review and meta-analysis. *Chest.* 2012;141(3):703-708. doi:10.1378/chest.11-0131
17. Lichtenstein D, Mezière G, Biderman P, Gepner A. The “lung point”: an ultrasound sign specific to pneumothorax. *Intensive Care Med.* 2000;26(10):1434-1440. doi:10.1007/s001340000627
18. Du Y, Yang A, Wang X. Accuracy of transthoracic lung ultrasound for diagnosing pulmonary embolism: An updated systematic review and meta-analysis. *Thromb Res.* 2024;241:109112. doi:10.1016/j.thromres.2024.109112
19. Weekes AJ, Thacker G, Troha D, et al. Diagnostic Accuracy of Right Ventricular Dysfunction Markers in Normotensive Emergency Department Patients With Acute Pulmonary Embolism. *Ann Emerg Med.* 2016;68(3):277-291. doi:10.1016/j.annemergmed.2016.01.027