Developing a POCUS curricular session for longitudinal clerkship medical students in Cape Breton, Nova Scotia.

A medical education tool

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Abstract

a. Background: Ultrasonography is becoming a necessary skill in a variety of medical settings and medical students would benefit from its addition to the undergraduate medical education curriculum. The aim of this study was to develop a point-of-care ultrasound (POCUS) curricular session for longitudinal integrated clerkship (LIC) students in Nova Scotia, Canada.

b. Methods: A needs assessment and literature review were completed to identify objectives for the curricular session. Four students from Dalhousie University completing their LIC in Cape Breton, Nova Scotia were included in the study. A pre- and post-session questionnaire was distributed to learners to gauge the utility of the curricular session.

c. Results: The needs assessment and literature review identified a need for hand-on exposure to cardiac and lung POCUS in addition to conducting E-FAST exams. There was a 33 % increase in correct responses in the post-session questionnaire compared to the pre-session questionnaire and all students reported that their skills in ultrasound had slightly or greatly improved after the session.

d. Interpretation: This was an effective curricular session for LIC learners. Incorporating an ultrasound curriculum for LIC learners would benefit their future practice and this model could be used in other centres where with LIC learners. While this study has a small sample size, there may be benefit to

conducting a larger study, expanding this curricular session to LIC sites across Nova Scotia and other maritime provinces.

Introduction

Ultrasound (US) is a valuable clinical tool and point-of-care ultrasound (POCUS) has become an essential bedside tool in a variety of medical specialties. It is for this reason that many medical schools are incorporating US into their undergraduate medical education (UGME). The objective of this study was to develop a POCUS curricular session for longitudinal integrated clerkship (LIC) students in Cape Breton, Nova Scotia.

Background

POCUS is an essential clinical tool for many general and specialized practitioners. Its use both for procedural guidance and for diagnostic clarification continues to expand in a variety of medical settings. A review by Moore and Copel listed 22 specialties that routinely use US in their clinical practice, a number which is only anticipated to grow as US technology continues to improve.(1) Specialties that routinely apply US include anesthesia, cardiology and obstetric however, rural family practice and emergency medicine are areas where its use is expanding rapidly.(2,3) In a time when there is a shortage of rural physicians, US is a valuable skill for the rural physician but barriers exist in enabling rural physicians to receive adequate training.(4) It is for this reason that incorporating US early into the medical school curriculum may aid future rural physicians in gaining

competency. Particularly, in a program such as LIC where learners complete their clerkship rotations at smaller centres that naturally appeal to the aspiring rural physician. (5)

Many medical schools in Canada and internationally have developed their own US curriculum in both UGME and residency programs. In 2014, half of Canadian medical schools had a UGME US curriculum and a more recent survey of medical schools in the US showed that 57% of respondent schools had an approved POCUS curriculum.(6,7) Its incorporation into UGME curriculums included POCUS for teaching anatomy, for diagnostic clarification and identifying pathology and its utility for procedural guidance.(8–14)

Dalhousie University, situated on the East Coast of Canada, has medical school campuses in Halifax, Nova Scotia and St. John, New Brunswick. Like many of the medical schools across the country, they have developed an integrated US UGME curriculum. Much of this curriculum is in pre-clerkship and exposure to US in clerkship varies. Many of Dalhousie's clerks participate in regional clerkship streams outside of their main campuses and while there are opportunities for didactic in-person skills sessions, it is limited when compared to their medical student counterparts in the larger centres. Despite this, these integrated, regional clerkship streams offer clerks a unique opportunity to have longitudinal exposure to patients throughout the 3rd year of their medical training and personalize their clerkship experiences to best suit their learning goals. One of the challenges of LIC

streams is ensuring all learners get access to the same didactic and hands-on teaching sessions that learners in bigger centres may access.

LIC students at Cape Breton Regional Hospital in Sydney, Nova Scotia would have had access to all pre-clerkship US sessions offered by Dalhousie Medical School but in clerkship, much of the US exposure would be dependent on clinical encounters. Developing a hands-on POCUS session that reinforces existing learning objectives, teaches new skills and provides some hands-on experience would facilitate cyclical learning for Dalhousie medical students and further build confidence in their US skills.

Methodology

Given the self-directed nature of LIC learning, it was integral that the needs and priorities of Cape Breton's LIC students were considered in developing their POCUS curriculum. For this reason, a needs assessment was performed prior to developing the session curriculum. The needs assessment consisted of 2 parts: a review of the existing Dalhousie UGME curriculum and a pre-session survey to identify the needs of learners. Surveys were anonymous and sent out to learners approximately 8 weeks prior to the session. As part of the needs assessment, potential barriers and facilitators in session development were identified.

In addition to the needs assessment a literature review was completed to identify implementation strategies used in developing a POCUS curriculum at other schools in Canada. The search was later expanded to North America to ensure all papers including Canadian medical schools were included. Educational Resource

Information Centre (ERIC) and Ovid MedLine® databases were searched for relevant literature (See Appendix A). The search was limited to articles published since 2013. The search was rerun on December 18, 2024 to ensure all relevant articles were included. One reviewer reviewed all articles. Abstract screening was completed first followed by full text screening.

Following the needs assessment and literature review the session objectives were identified and a lesson plan was developed. An anonymous pre-session comprehension questionnaire was sent to learners two weeks prior to the session and an anonymous post session comprehension questionnaire and feedback survey was completed by learners immediately following the session. The answers to both questionnaires and slideshow were shared with learners following completion of the post-session questionnaire by all learners. The questionnaires were structured to cover all objectives and while the clinical cases remained the same, US clips were changed to create different questions with different answers to prevent content variance between the questionnaires.

Results

Results of the needs assessment

The survey sent to learners can be reviewed in Appendix B. There are currently four LIC students in Cape Breton. While the survey had both multiple choice and short answer questions, the results are provided as a summary to protect that anonymity of learners. 75% of learners felt they did not have adequate exposure to US in their medical education thus far to fulfill their learning needs

(50% “slightly inadequate”, 25% “definitely inadequate”). They also identified a need for the session to be scheduled prior to their procedural skills examination at the end of February. LIC students unanimously agreed that they wanted their session to prioritize hands-on scanning time. Prior to the session, learners identified that they had some confidence in identifying abdominal anatomy with US and performing a focused assessment with sonography in trauma (FAST) exam (Table 1). All learners felt they needed additional exposure to identifying pleural effusion, pneumothorax and performing cardiac views under US (Table 1).

What POCUS skills do you feel confident in either from clinical exposure or pre-clerkship and curricular sessions? (select all that apply)
Abdominal RUQ* structures – 3
Abdominal LUQ** structures – 2
Structures of the pelvis (suprapubic view) – 3
Identifying pericardial tamponade (FAST) – 1
Identifying abdominal free fluid (FAST) – 2
Which POCUS skills do you feel would benefit your clinical practice to have more training in? (select all that apply)
Abdominal RUQ structures – 2
Abdominal LUQ structures – 3
Structures of the pelvis (suprapubic view) – 3
Identifying pericardial tamponade (FAST) – 2
Identifying abdominal free fluid (FAST) – 3
Identifying pleural effusion – 4
Identifying pneumothorax – 4
Signs of congestive heart failure – 3
Retinal detachment – 2
Ultrasound guided peripheral IV – 3
Cellulitis/abscess – 2
Performing cardiac views – 4
Identifying vascular structures (inguinal, head and neck) – 2
Are there any skills in particular you want to learn? (select all that apply)
FAST exam – 3
Lung ultrasound (pneumothorax and pleural effusions) – 3
Congestive heart failure – 3
Cellulitis/Abscess identification – 1
POCUS of eye for retinal detachment – 1
Cardiac ultrasound – 2
Other: “MSK tendon rupture/tendonitis” – 1

*Table 1. Needs assessment featured questions and response breakdown. Answers that were not selected by any learners were not included in the table (refer to appendix B for complete questions options). *RUQ - Right upper quadrant ** LUQ - left upper quadrant*

Dalhousie's US curriculum in 2023-2024 consisted of pre-session videos as well as six in-person sessions, four of which took place in pre-clerkship and two took place in clerkship. The videos and the objectives of the in-person sessions were reviewed and compared with the results of the literature review to identify key objectives for the session.

Results of the literature review

A total of 240 studies were identified in the literature review. 1 duplicate was removed and 168 studies screened irrelevant in abstract screening. 71 studies progressed to full text screening and 11 studies were included and reviewed. The primary aim of reviewing these papers was to identify relevant content or strategies to incorporate in the US session.

Eight studies were identified which looked at UGME POCUS curriculums in Canada.(15–22) Ma et al. proposed objectives for a national UGME US curriculum based on expert consensus and identified 85 objectives that Canadian medical schools should include as their UGME Pocus curriculum.(21) These recommendations were considered when developing objectives for the Cape Breton LIC session. Two studies in the United States identified "near-peer" and "peer-assisted" US sessions as valuable for their clinical learning.(10,23) Ma et al. also identified peer teaching as an acceptable method of curriculum delivery.(21) This was relevant as access to qualified instructors was identified as a barrier to developing US curriculums in California and was also a barrier in providing this session.(24)

Development of the POCUS curriculum session

Through the pre-session survey, the following priorities were identified which were congruent with objectives in Dalhousie curriculum and Ma et al.'s UGME curriculum recommendations (21): lung US with a focus on identifying pneumothorax and pleural effusion, additional practice time for FAST scans (which had been previously taught) and cardiac POCUS (Table 2). While these objectives were covered elsewhere in Dalhousie's curriculum, limited exposure meant that learners felt they needed additional practice time in these areas and that the session would remain relevant to their upcoming procedural exam. The session was scheduled to be a 2-hour session with 2 parts: Lung US with additional time for individuals to perform a FAST exam and receive real-time feedback, and an introduction to cardiac POCUS.

LIC POCUS session objectives
1. Time for practicing the hands-on skills 2. Gain familiarity with the US machine, selecting the transducer, mode, depth and gain. 3. Know how to do an E-FAST exam with time to practice the integrated exam. a. Orienting and selecting the probe. b. Problem solving difficult views such as using more gel, ensuring probe is positioned correctly, having the patient bend their knees or take a deep breath. c. Gain familiarity with a negative or normal E-FAST exam. d. Be able to interpret exam findings as well as recognize limitations (e.g. false negatives and false positives). 4. Gain familiarity with lung US including a. Orienting and selecting the probe b. Identifying normal findings such as A-lines, pleural sliding and curtain sign c. Know how to diagnose pleural effusion and pneumothorax on ultrasound and how to identify and interpret B-lines. d. Use M mode to further differentiate between pneumothorax and normal lung. 5. Become more comfortable finding the 4 main cardiac ultrasound views: Parasternal Long Axis, Parasternal short axis, apical 4 chamber and subxiphoid (subcostal). a. Use strategies to optimize view such has having the patient control their breathing, getting the patient in left-lateral decubitus or having them bend there knees, using more gel, making small, discrete adjustment when performing cardiac ultrasound to optimize view.

Table 2. LIC POCUS Session objectives

b. Gain familiarity with cardiac anatomy on ultrasound.
c. Recognize the utility and limitations of cardiac POCUS.

6. Be able to identify the IVC on subxiphoid view and comment on its diameter and compressibility.
    a. Students will understand the value and limitations of this in the patient presenting in shock and in the patient presenting with possible congestive heart failure recognizing that IVC ultrasound is only useful in conjunction with clinical history and examination.

The POCUS session took place on February 4, 2025. The session required two untrained volunteers for learners to practice scanning and took place at Cape Breton Regional's simulation lab. Learners were paired and shared an US machine between both of them. A powerpoint presentation was also provided and the slides can be found in appendix E. The instructor was a senior family medicine resident with a strong interest in emergency medicine and US. While she was not a qualified US instructor, examination components were reviewed with a content expert.

Results of comprehension questionnaires and learner feedback:

A copy of both pre-session questionnaire and post-session questionnaire for comprehension can be found in Appendix C. LIC learners got an average of 58.3% on the pre-session questionnaire and an average of 91.7% on the post-session comprehension questionnaire (Table 3). Sessional feedback was generally positive with all learners feeling the session improved their skills in lung US, cardiac US and FAST exams (Table 3). All learners felt the session should be provided for LIC students in future years and when asked for feedback, a learner suggested involving the emergency room attending physicians at a future session to have additional qualified instructors.

Results of Pre-Session Questionnaire	
Pneumothorax	25% correct
Identifying B-lines (normal exam)	25% correct
Identification of abdominal free fluid (positive right upper quadrant)	100% correct
Cardiac anatomy parasternal long axis (identifying the left ventricle)	75% correct
Identification of pericardial tamponade (normal)	25% correct
Identification of pleura effusion (abnormal right upper quadrant)	100% correct
Average score:	**58.3%**
Results of the Post-Session Questionnaire	
Pneumothorax (abnormal exam)	100% correct
Identifying B-lines (abnormal exam)	100% correct
Identification of abdominal free fluid (normal left upper quadrant)	100% correct
Cardiac anatomy apical 4 chamber (identifying the left atrium)	50% correct
Identification of pericardial tamponade (abnormal)	100% correct
Identification of pleura effusion (abnormal left upper quadrant)	100% correct
Average score:	**91.7%**
Since completing this session, my skills in lung ultrasound are...	75% greatly improved, 25% slightly improved
Since completing this session, my skills in cardiac ultrasound are...	75% greatly improved, 25% slightly improved
Since completing this session, my ability to complete and interpret the E-FAST exam is...	50% greatly improved, 50% slightly improved
Do you think this session should be hosted for the LIC students next year?	100% responded "yes"

Table 3. Results of the pre and post-session comprehension questionnaires.

Discussion

In reviewing the results of learner feedback from the POCUS curricular session, the session appears to have met its objectives and has improved LIC learner knowledge of POCUS. The performance of learners was greatly improved from prior to the session though analysis on significance was not completed due to

the small sample size. Given the positive feedback of learners, it is likely the session met the learning priorities identified by LIC students.

Future sessions could incorporate trained preceptors working with each learner pair to provide even more expertise in the curriculum session, however, in a setting of limited resources having a resident or near-peer teach this session remained an effective way to deliver curriculum. This session could be incorporated into other Dalhousie LIC sites to further the learning of LICs and other sites across Nova Scotia and New Brunswick.

Some study limitations include the relatively small sample size of the LIC learner group. While this provided excellent hands-on experience for learners and there was a clear improvement in test scores, survey results may lack generalizability to other medical student populations due to the sample size. Additionally, if this methodology were applied to a larger centre, there would be a need for additional instructors and equipment to provide adequate scanning time for each learner which may pose a challenge in some centres. Lastly, due to the relatively short timeline following the session, a 3-month follow-up post session comprehension survey could not be completed but would have provided value to assess the retention of learned skills. Yamamoto et al. found that echocardiography skills significantly declined 1 month following a 2-hour echocardiography session. However, Steinmetz et al. found that first year medical students who participated in 6 teaching sessions had long-term retention of their

US skills. (22) The content of the LIC curricular session was building on existing Dalhousie curriculum which may improve long-term retention of learned skills.

Conclusion

In summary, developing a POCUS curriculum specific to LIC learners is valuable given their connection to rural medicine and limited access to didactic session provided at larger centres. Our model of session development was effective and improved LIC learner US skills thus expanding this curriculum session to other Dalhousie LIC sites and potentially other medical schools with LIC learners would be beneficial. Further research would look at implementing this curriculum session at all LIC sites across Dalhousie University and assess long-term retention of skills.

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Appendix A: Search Strategies

Database 1: Educational resources information centre (ERIC) search:

Medical student Medical school clinical clerkships Medical learner Undergraduate medical education *AND* Ultrasound POCUS Point of care ultrasound *AND* North America Canada *(((medical student) OR (medical school clinical clerkships) OR (medical learner) OR (undergraduate medical education)) AND (ultrasound OR POCUS OR (Point of care ultrasound) AND (North america) OR 'canada'))*	557 results
Limited to January 1, 2023 – January 1, 2025 *(((medical student) OR (medical school clinical clerkships) OR (medical learner) OR (undergraduate medical education)) AND (ultrasound OR POCUS OR (Point of care ultrasound) AND (North america) OR 'canada')) AND pd(20130101-20250101)*	175 results
Limited to peer reviewed studies *(((medical student) OR (medical school clinical clerkships) OR (medical learner) OR (undergraduate medical education)) AND (ultrasound OR POCUS OR (Point of care ultrasound) AND (North america) OR 'canada')) AND (pd(20130101-20250101) AND PEER(yes))*	164 results

Database 2: Ovid MedLine® ALL

Ultrasound.mp. Exp ultrasonography POCUS.mp. Point of care ultraso*.mp. AND	1013 results

Students Medical students Premedical students Clinical clerkship Education, medical, undergraduate Medical student*.mp. Clinical clerk*.mp.	
Limited to North America	103 results
Limited to January 1, 2013 to January 1, 2025	77 results

Appendix B: Needs assessment pre-session survey

Please complete this 7-question quiz for your upcoming POCUS session.

1. *How useful was your pre-clerkship exposure to ultrasound?*
   - Very useful
   - Somewhat useful
   - Neutral
   - Somewhat not useful
   - Not useful at all

2. *Rate your exposure to POCUS in clerkship thus far. "My clinical exposure to POCUS is...."*

   - Above and beyond my personal learning objectives (i.e. I don't need anymore POCUS exposure)
   - Adequate to fulfill my personal learning objectives.
   - Slightly inadequate to fulfill my personal learning objectives.
   - Definitely inadequate to fulfill my personal learning objectives.
   - I don't remember
   - Other: _____

3. *What POCUS skills do you feel confident in either from clinical exposure or pre-clerkship and curricular sessions? Check all that apply.*

   - Identifying structures in the right upper quadrant of the abdomen
   - Identifying structures in the left upper quadrant of the abdomen
   - Identifying structures of the pelvis (suprapubic view)
   - Identifying pericardial tamponade on subxiphoid view (FAST)
   - Looking for free fluid in the abdomen (FAST)
   - Identifying pleural effusion
   - Identifying Pneumothorax
   - Signs of congestive heart failure on POCUS
   - Scanning the eye for retinal detachment
   - Ultrasound guided peripheral IV
   - Identifying cellulitis/abscess with ultrasound
   - Performing pericardial views (apical 4 chamber and/or parasternal long axis view)
   - Identifying vascular structures in the head and neck and inguinal regions.
   - Other: _____

4. *Which POCUS skills do you feel would benefit your clinical practice to have more training in? Check all that apply.*

    - o Identifying structures in the right upper quadrant of the abdomen
    - o Identifying structures in the left upper quadrant of the abdomen
    - o Identifying structures of the pelvis (suprapubic view)
    - o Identifying pericardial tamponade on subxiphoid view (FAST)
    - o Looking for free fluid in the abdomen (FAST)
    - o Identifying pleural effusion
    - o Identifying Pneumothorax
    - o Signs of congestive heart failure on POCUS
    - o Scanning the eye for retinal detachment
    - o Ultrasound guided peripheral IV
    - o Identifying cellulitis/abscess with ultrasound
    - o Performing pericardial views (apical 4 chamber and/or parasternal long axis view)
    - o Identifying vascular structures in the head and neck and inguinal regions.
    - o Other: _____

5. *What type of format would you prefer your in-person session to be?*

    - o Primarily scanning/hands on time with a small amount of lecture.
    - o Half lecture, half scanning time to review POCUS fundamentals.
    - o Mostly lecture based to learn more about POCUS and POCUS applications.

6. *Are there any skills in particular you want to learn? (I can't promise we can facilitate all of these sessions but I just want to get an idea of what interests you). Check all that apply.*

    - o FAST exam
    - o Lung ultrasound (pneumothorax and pleural effusions)
    - o Congestive heart failure
    - o Cellulitis/Abscess identification
    - o POCUS of eye for retinal detachment
    - o Cardiac ultrasound
    - o Other: _____

7. *Do you have any other questions or comments regarding previous POCUS learning experiences or objectives for this session to make it most useful to you?*

_____

_____.

Appendix C: Pre-session comprehension questionnaire

Disclaimer: image descriptions were added for the benefit of the reader, however were not included in the questionnaire.

1. A 27 year-old female presents with shortness of breath and chest pain following a car accident. You scan her right anterior chest using POCUS and see the following image:

Figure 1[1]

This shows:

- Normal lung sliding, negative for intrapleural pathology
- **Pneumothorax**
- Pleural effusion, likely hemothorax
- Other:

2. A 75 year-old male presents with shortness of breath with a known history of congestive heart failure and COPD. On examination of his lungs with ultrasound you see this diffusely:

[1] Video screenshot of a pneumothorax on ultrasound from Life in the Fast Lane: Pneumothorax case 1. Accessed December 1, 2024 from https://litfl.com/pneumothorax-case-1/.

Figure 2[2]

In this clinical context...

- **Lungs are dry (COPDE exacerbation or other pathology)**
- Lungs are wet (CHF exacerbation)
- Other:

3. A patient is in a car accident, on assessment of the RUQ you identify this:

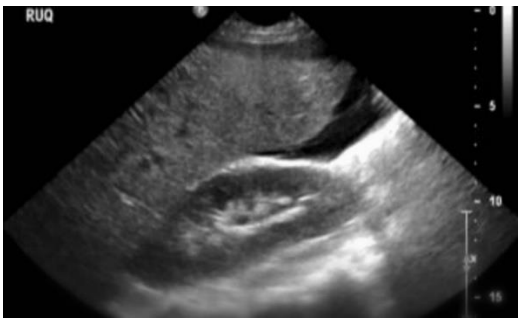


Figure 3[3]

This suggests...

- **Intra-abdominal free fluid (this patient needs the OR).**
- This is a normal RUQ exam.
- Other:

4. Parasternal long axis view of the heart.

[2] Video capture of normal lung sliding from POCUS 101: Lung Ultrasound Made Easy: a Step-by-step guide. Accessed December 1, 2024 from https://www.pocus101.com/lung-ultrasound-made-easy-step-by-step-guide/.
[3] Video screenshot of free fluid in the hepatorenal space from UltrasoundIdiots.com. Accessed December 1, 2024 from https://www.ultrasoundidiots.com/trauma.

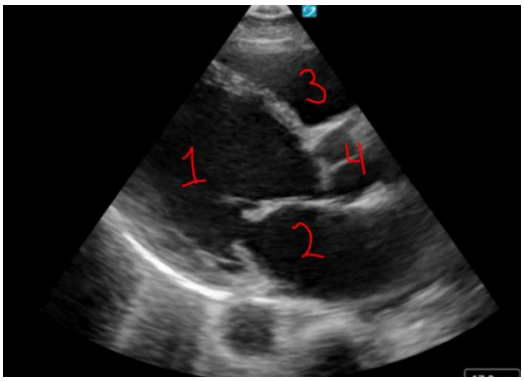


Figure 4[4]

Identify the left ventricle:

- **1**
- 2
- 3
- 4

5. A 68 year-old male presents to the ER. Vitals signs are temp 36.6^{O}C, HR 140, BP 82/45, O2 sats 95% on RA, RR 28. You expertly identify that this patient is likely in shock and use POCUS during your exam. Subxiphoid view reveals the following image:

Figure 5[5]

This suggests:

[4] Cardiac ultrasound image from POCUS 101. Cardiac Ultrasound Made Easy: Step-by-Step guide. Accessed December 1, 2024 from https://www.pocus101.com/cardiac-ultrasound-echocardiography-made-easy-step-by-step-guide/.

[5] Video screenshot of subxiphoid view of the heart from BC PoCUS eFAST. Accessed from https://www.bcpocus.ca/organscans/efast/.

- The left ventricular ejection fraction is severely reduced suggesting cardiogenic shock.
- There is a dilated right ventricle suggesting right heart strain and likely PE.
- **This is a normal subxiphoid view suggesting another source for shock (distributive, hypovolemic, hemorrhagic).**
- This is a pericardial effusion suggesting pericardial tamponade.
- Other:

6. A 76 year-old female presents to cheticamp hospital at 00:30 in the morning with worsening shortness of breath that is worse when lying down. Unfortunately you don't have X ray overnight but thankfully you are skilled at POCUS. You scan the base of her lungs and this is what you see:

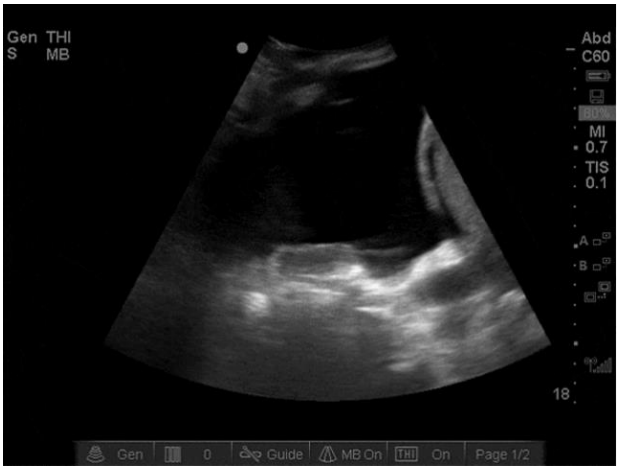


Figure 6[6]

This scan is...

- Normal, look for other cause of shortness of breath.
- **Abnormal, pleural effusion is present.**
- Abnormal, there is a consolidation in the right lower lobe.
- Other:

[6] Video screenshot of a right pleural effusion on ultrasound accessed from BC PoCUS Pleural Effusion. Accessed from https://www.bcpocus.ca/organscans/pleural-effusion/.

Appendix D: Post-session comprehension questionnaire and feedback survey

Disclaimer: image descriptions were added for the benefit of the reader, however were not included in the questionnaire.

1. A 27 year-old female presents with shortness of breath and chest pain following a car accident. You scan her right anterior chest using POCUS and see the following image:

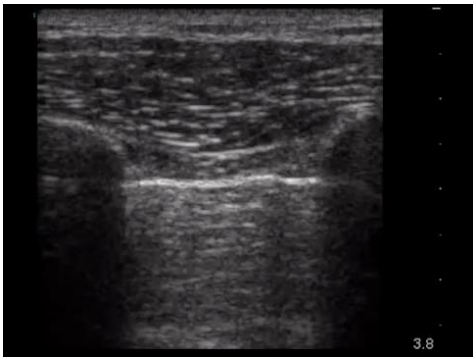


Figure 7[7]

This shows…

- **Normal lung sliding, negative for intrapleural pathology**
- Pneumothorax
- Pleural effusion, likely hemothorax
- Other:

2. A 75 year-old male presents with shortness of breath with a known history of congestive heart failure and COPD. On examination of his lungs with ultrasound you see this diffusely:

[7] Video screenshot of normal pleural sliding from BC PoCUS Pneumothorax. Accessed from: https://www.bcpocus.ca/organscans/pneumothorax/.

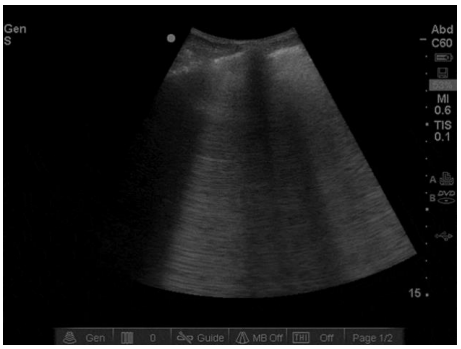


Figure 8[8]

In this clinical context…

- Lungs are dry (COPDE exacerbation or other pathology)
- **Lungs are wet (CHF exacerbation)**
- Other:

3. A patient is in a car accident, on assessment of the RUQ you identify this:

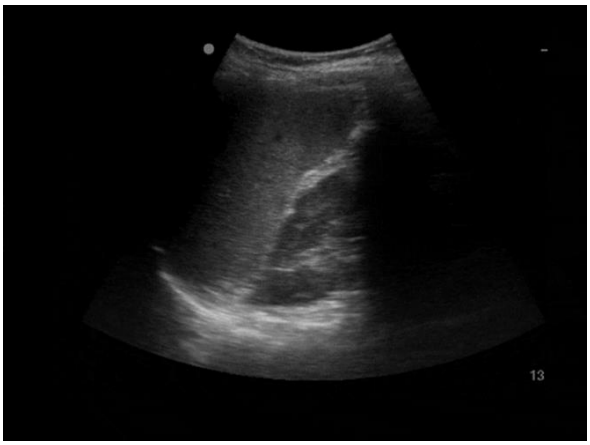


Figure 9[9]

This suggests…

- Intra-abdominal free fluid (this patient needs the OR).
- **This is a normal LUQ exam.**
- Other:

4. Apical 4 chamber view of the heart.

[8] Video screenshot of B-lines from BC PoCUS Pulmonary Edema. Accessed from https://www.bcpocus.ca/organscans/pulmonary-edema/.
[9] Videos screenshot of a normal left upper quadrant exam from BC PoCUS. Accessed from https://www.bcpocus.ca/organscans/efast/.

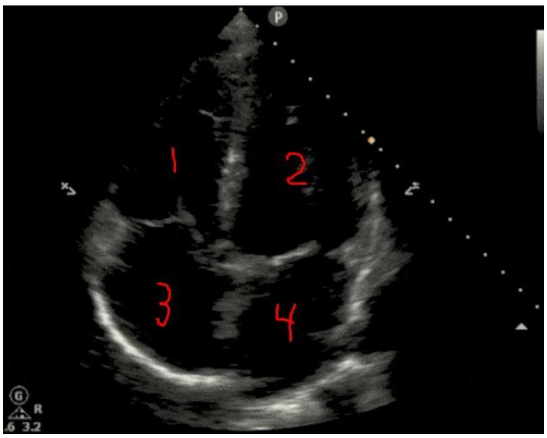


Figure 10[10]

Identify the left atrium:

- 1
- 2
- 3
- **4**

5. A 68 year-old male presents to the ER. Vitals signs are temp 36.6^{O}C, HR 140, BP 82/45, O2 sats 95% on RA, RR 28. You expertly identify that this patient is likely in shock and use POCUS during your exam. Subxiphoid view reveals the following image:

Figure 11[11]

This suggests:

- The left ventricular ejection fraction is severely reduced suggesting cardiogenic shock.

[10] Image from POCUS 101 Cardiac Ultrasound Made Easy: Step-by-Step guide. Accessed from https://www.pocus101.com/cardiac-ultrasound-echocardiography-made-easy-step-by-step-guide/.
[11] Image of subxiphoid view of the heart from BC PoCUS eFAST. Accessed from https://www.bcpocus.ca/organscans/efast/.

- There is a dilated right ventricle suggesting right heart strain and likely PE.
- This is a normal subxiphoid view suggesting another source for shock (distributive, hypovolemic, hemorrhagic).
- **This is a pericardial effusion suggesting pericardial tamponade.**
- Other:

6. A 76 year-old female presents to Neil's Harbour ED at 00:30 in the morning with worsening shortness of breath that is worse when lying down. Unfortunately, you don't have Xray overnight but thankfully you are skilled at POCUS. You scan the base of her left chest and this is what you see:

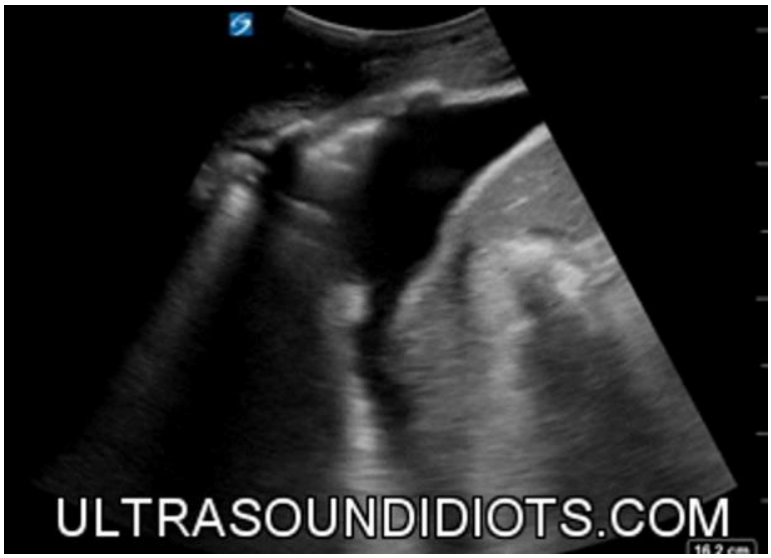


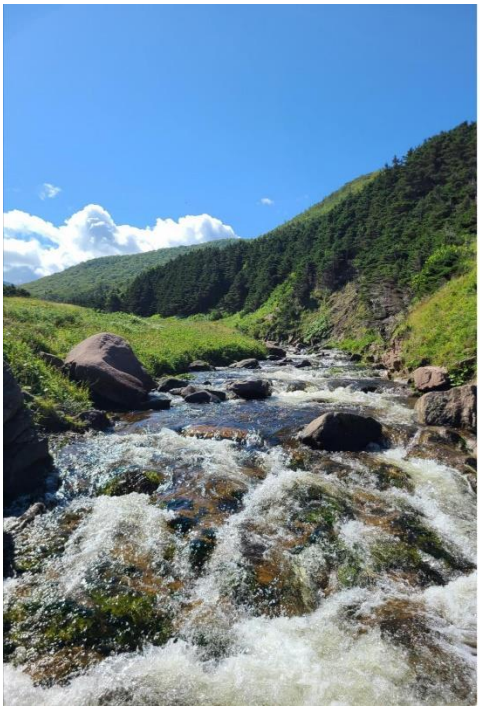
Figure 12[12]

This scan is...

- Normal, look for other cause of shortness of breath.
- **Abnormal, pleural effusion is present.**
- Abnormal, there is a consolidation in the right lower lobe.
- Other:

[12] Video screenshot of a left pleural effusion on ultrasound. Accessed from https://www.ultrasoundidiots.com/trauma

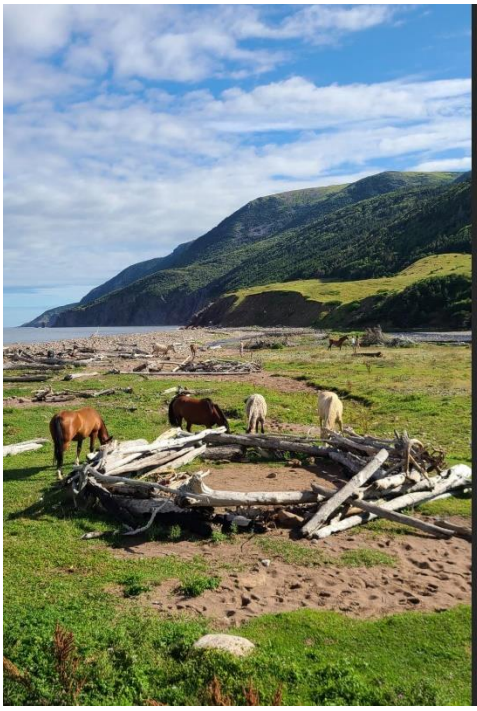
Appendix E: Slide Deck



POCUS for Dummies

BY GILLIAN FORSTER

Dalhousie family medicine PGY 2



Objectives: chosen by you!

1. Time for practicing the hands-on skills
2. Know how to identify pneumothorax and pleural effusion on lung ultrasound and interpret these results.
3. Know how to perform the 4 main cardiac ultrasound views: Parasternal Long Axis, Parasternal short axis, apical 4 chamber and subxiphoid (subcostal)
    1. Know how to correctly orient the probe and strategies to optimize views.
    2. Know how to identify pericardial tamponade and begin to interpret global cardiac function (e.g. identifying right heart strain).
4. Identify the IVC on subxiphoid view and B-lines on lung US as tools in examining the patient with congestive heart failure.
5. Become comfortable with completing the E-FAST exam in its entirety.

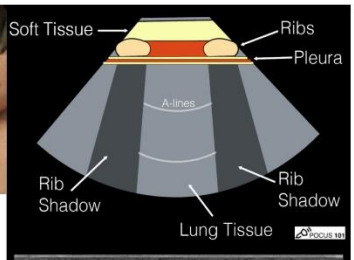
Disclaimers

- I'm not an expert (just a hobbyist).
- I wish I was being paid by a large company to be here.

Intro to Lung Ultrasound

- Can be used to identify pleural effusion, pneumothorax, and airspace disease.
- Airspace disease can include congestive heart failure, ARDS, pneumonia, etc.
- Terms to know:
  - A-lines – parallel to pleura (horizontal) and found in normal lung.
  - B-lines – perpendicular to pleura and seen when there is too much fluid in the air space (CHF/ARDS etc.)
  - Batwing sign – used to landmark the pleura. Refers to the shadow of two ribs looking like batwings.

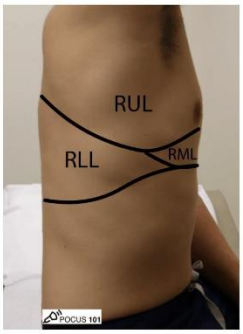
Pneumothorax

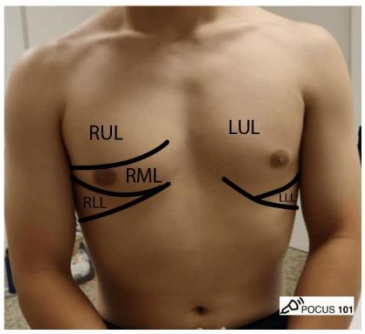


- In order to rule in or out a pneumothorax you must be able to confidently identify normal pleura.
- Easiest to identify with the **linear probe** but often **curvilinear probe** is used as part of the e-fast.
- Position: Place probe with the indicator facing toward the patient's head, identify a space between 2 ribs - **batwing sign**. In the E-FAST the most sensitive space to check is the 2nd intercostal space at the midclavicular line however, ideally you want to examine 3 rib spaces.
- Pleura appears as a white line that moves as the patient breaths like **"ants on a log"**. This is the visceral and parietal pleura sliding against each other.

POCUS 101 Lung Ultrasound Made Easy: Step-By-Step Guide

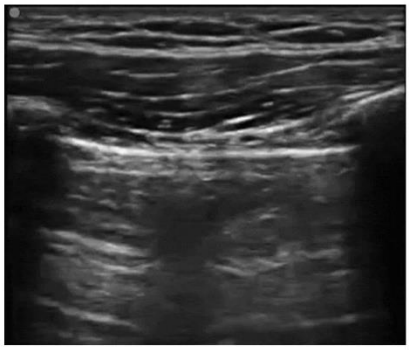
Lung Zones: External Anatomy

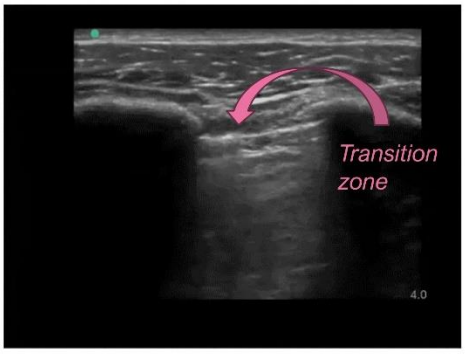




Normal exam

Abnormal exams



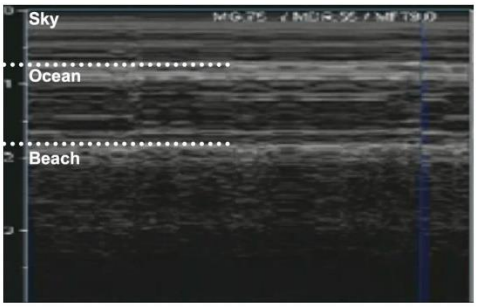


Possible false positives would be if the patient isn't breathing, the pleura won't move, anatomical transition zones at diaphragm and heart, visceral/parietal pleura adhered (scar tissue).

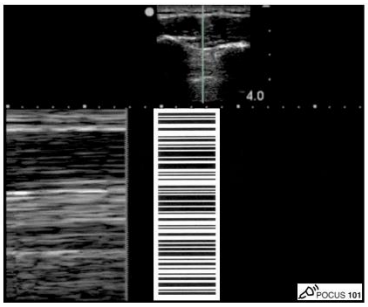
Images from POCUS 101

M-Mode

"BEACH SIGN" – GOOD, NORMAL LUNG SLIDING



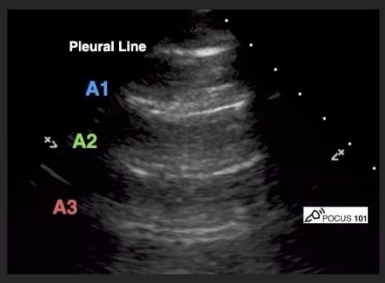
"BARCODE SIGN" – BAD, NO LUNG SLIDING



Images from POCUS 101

B-Lines

- Suggest airspace disease.
- Diffuse B lines that are symmetrical in both lungs are gravity dependent can be a sign of CHF
- B-lines located only in 1 area of a lung may be more suggestive of pneumonia.
- Probe: Whatever your comfortable with, just make sure adequate depth is using linear probe.



Images from POCUS 101

Pleural effusions

- Probe: curvilinear or cardiac probe (need adequate depth to assess effusion.
- Position: Patient is typically supine but could also do sitting up. Scan the midaxillary line down to diaphragm. Typically gravity causes fluid to collect in the most dependent areas (posterior, inferior) however a loculated effusion may not. To rule out pleural effusion, scan all lung areas.
- E-FAST Position: In trauma context, trying to rule out hemothorax, scan 1-2 rib spaces above RUQ/LUQ to view lung windows above diaphragm.
- Normal exam: Curtain sign lung expansion causing diaphragm to go in and out of view with breaths (remember you can't see through air)
- Abnormal exam: You can see hypoechoic fluid where lung should be and/or spine sign. You make also see atelectatic lung floating in the fluid.

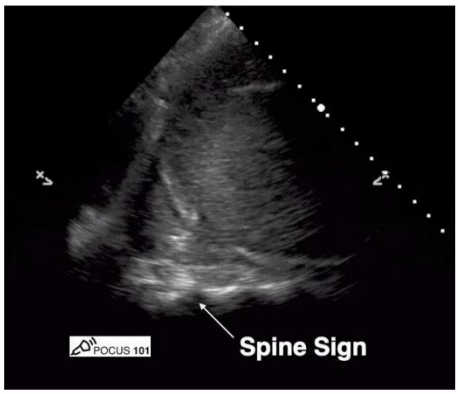
Image from BC POCUS

Normal

CURTAIN SIGN

Image from POCUS 101

Abnormal – Spine sign



Seeing the spine go above the diaphragm is considered pathologic and positive for hemothorax.

Images from POCUS 101

The FAST Exam

Focused abdominal sonography in trauma.

1. RUQ view (Hepatorenal potential space i.e. Morrison's pouch)

2. Subxiphoid view (rule out pericardial tamponade)

2. LUQ view (Splenorenal potential space)

3. Suprapubic view (retrovesicular or retrouterine space/pouch of Douglas) – Longitudinal and transverse views

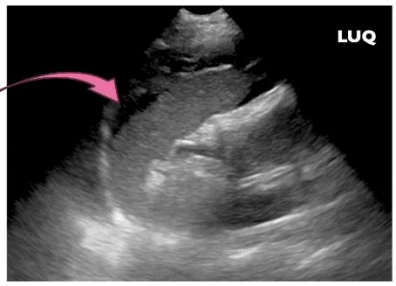
The FAST exam – POSITIVE Findings

RUQ View

Free fluid at the caudal tip of liver + morrisons pouch + suprahepatic!

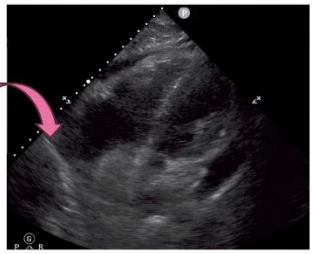
LUQ View

Free fluid in the perisplenic space!



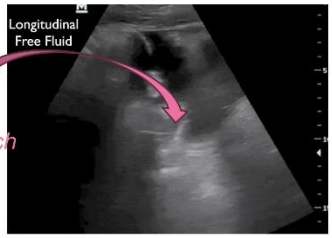
Subxiphoid view

Pericardial effusion!



Suprapubic View

Free fluid in the rectovesicular pouch (longitudinal view)



Images from POCUS 101

False negatives ?

- A normal FAST is more sensitive for intra-abdominal FF than a CT scan, however a CT scan may still be useful, e.g. bowel perforation/fractures, intra hepatic/splenic hemorrhage.
- In a patient where no CT is done, serial FAST scans should be completed to ensure no bleeding.

False positives ?

- Free fluid in the abdomen isn't always blood – e.g. ascites can mimic it.
- Cardiac tamponade – pericardiac effusion doesn't always cause tamponade. Tamponade is a form of obstructive shock, therefor the patient much be in shock to have tamponade. Beware the **anterior fat pad.** This can look like a pericardial effusion but is more hyperechoic (ie. more grey than free fluid) and does not extend to the posterior aspect of the patient.

The Extended FAST Exam (E-Fast)

Extended Focused Assessment with Sonography in Trauma

FAST Exam:

1. RUQ view
2. LUQ view
3. Subxiphoid view
4. Suprapubic review

E- FAST Exam:

1. RUQ view
2. LUQ view
3. Subxiphoid view
4. Suprapubic view
5. RUQ view – for pleural effusion
6. LUQ view – for pleural effusion
7. R anterior chest – for PTX
8. L anterior chest – for PTX

Cardiac POCUS

- Remember, I'm not a cardiologist, my goal is to get you guys to do these views correctly, not help you calculate the EF. Thanks POCUS 101 for all of the amazing pictures and teaching!
- Indicator located on the **right** side of the screen which is the opposite of all other ultrasound modes.
- The chambers of the heart are hypoechoic (because they are filled with fluid), the pericardium is hyperechoic.
- Acronyms for the different views:
  - Parasternal long axis – PSLA
  - Parasternal short axis – PSSA
  - Apical 4 chamber – A4C

Parasternal long axis view

Probe indicator: toward patient's **right** shoulder.

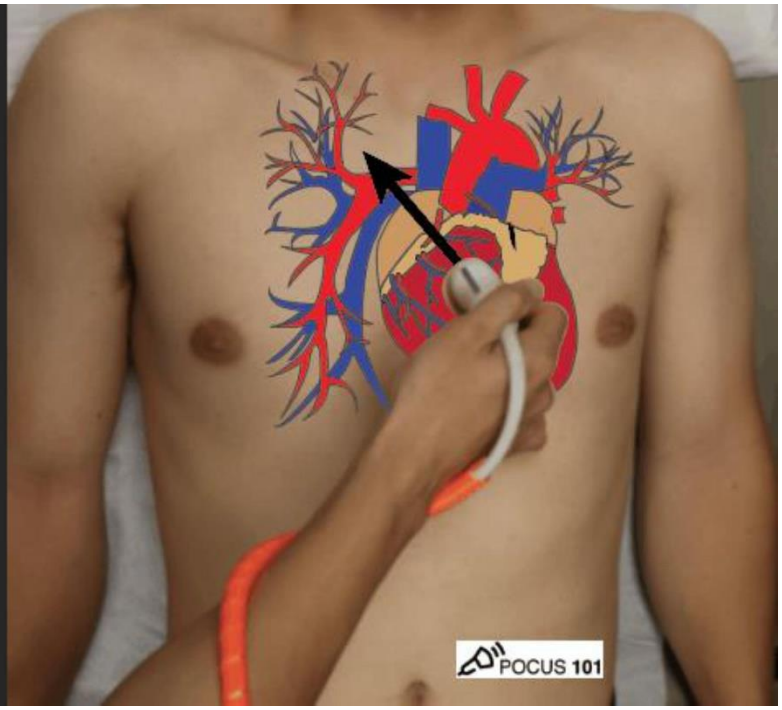
Position: 4th intercostal space in line with the nipple on men. Patient can be supine or LLD if difficulty visualizing.

Remember the 3 Ls: *"for parasternal **long** axis view, the **left** ventricle is on the **left** side of the screen." - POCUS 101*

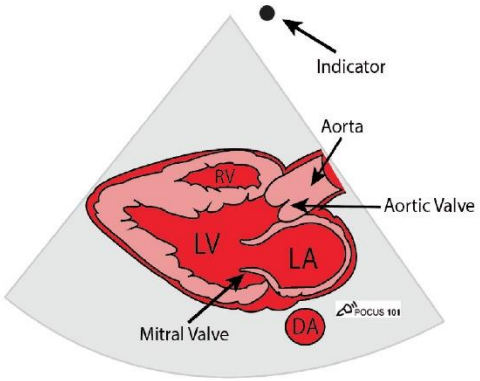
Depth: should be able to see the descending aorta.

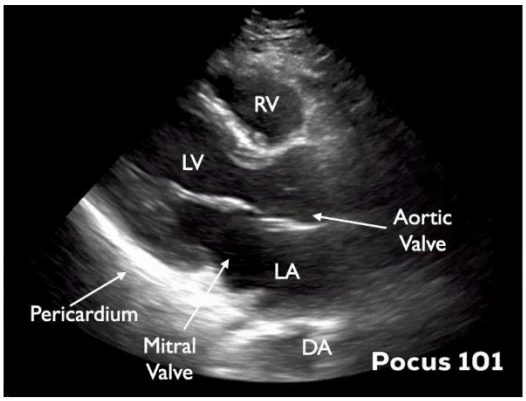
Gain: should be able to the chambers of the heart.

Most useful for visualizing the LV outflow tract and aortic valve + mitral valve.



Parasternal Long Axis view





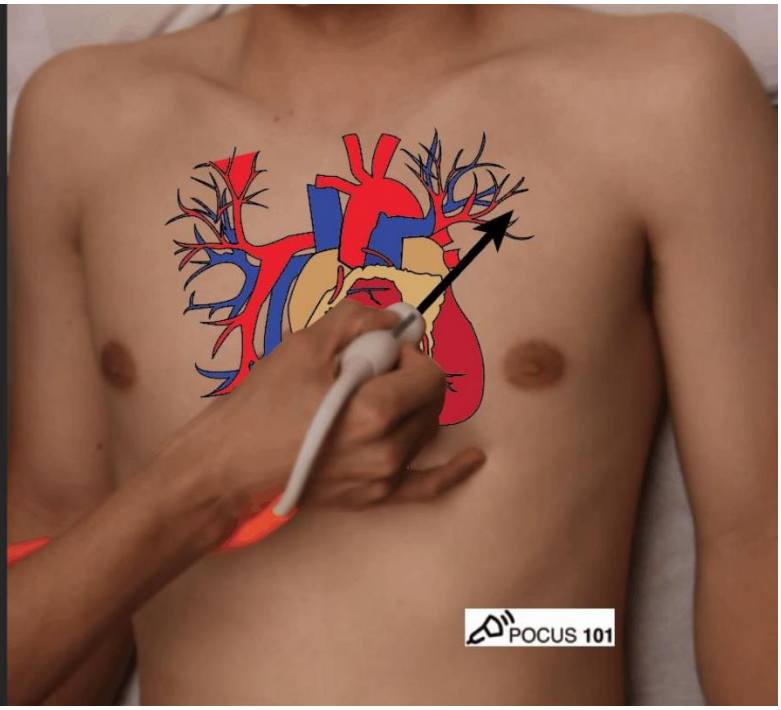
Parasternal short axis view

Probe indicator: toward patient's **left** shoulder. → rotate the probe 90°

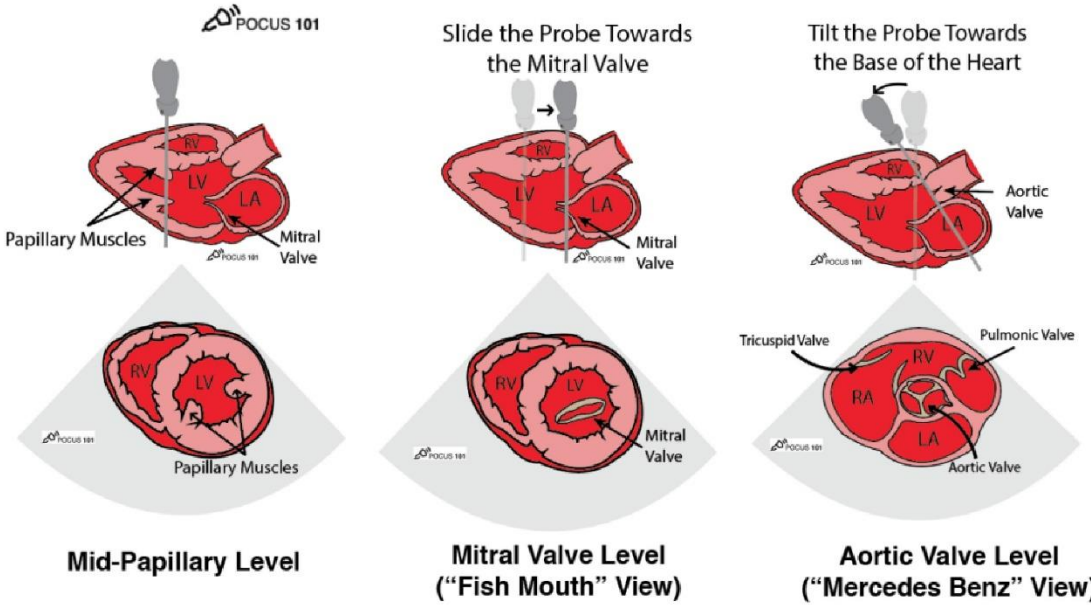
Position: 4th intercostal space in line with the nipple on men. Patient can be supine or LLD if difficulty visualizing.

Depth & Gain: same as PSLA.

3 main levels: mid-papillary, Mitral valve and aortic valve levels.

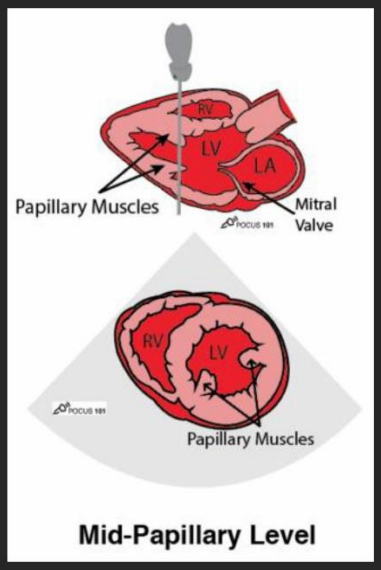


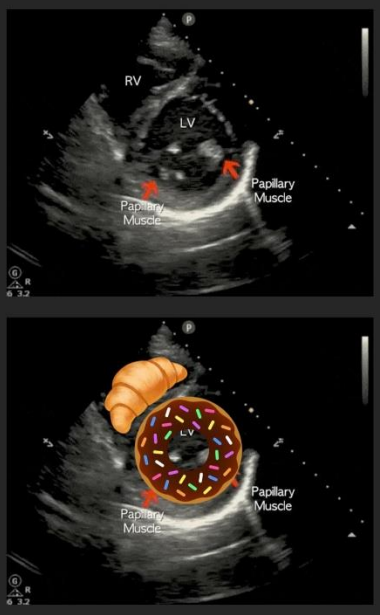
PARASTERNAL SHORT AXIS VIEWS



Mid-Papillary Level

- Ejection fraction
- Right ventricular function (and dysfunction)
- Regional wall motion abnormalities of the LV (such as in an MI).
- Remember the croissant (RV) and the donut (LV)!

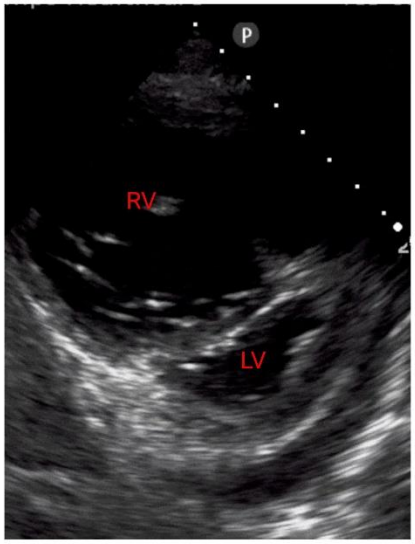




Images from POCUS 101

D-Sign – Identifying right heart strain

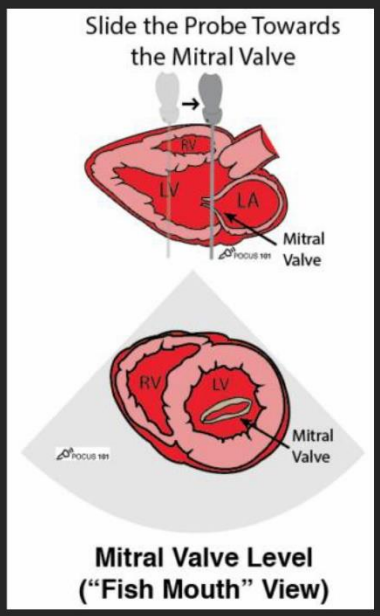
- Right heart strain can be seen in massive/submassive pulmonary embolism.
- There are multiple POCUS findings suggestive of PE but one of the most common ones is “D sign”.
- The LV is a D-shaped structure with a large RV seen.

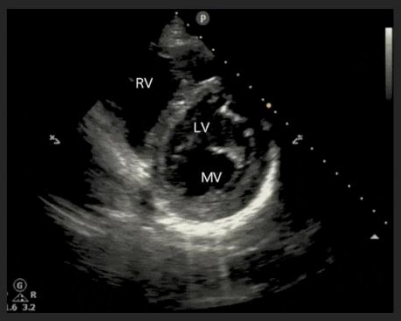


Images from POCUS 101

Mitral Valve Level

- **Fish mouth view**
- Typically, you must slide the transducer toward the sternum, staying in the same rib space.
- Visualize the anterior and posterior leaflets of the mitral valve.

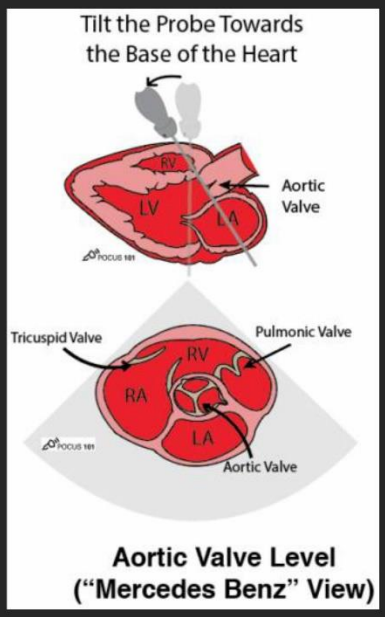


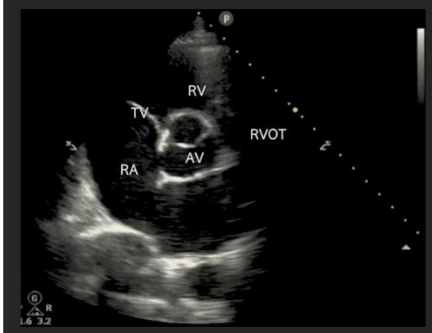


Images from POCUS 101

Aortic valve level

- **Mercedes Benz view**
- Fan the probe toward the base of the heart (upward) until you can see the aortic valve.
- This view is complicated: specialists can use this view to evaluate the aortic valve for stenosis/bicuspid valve, tricuspid regurge and pulmonary pressures.

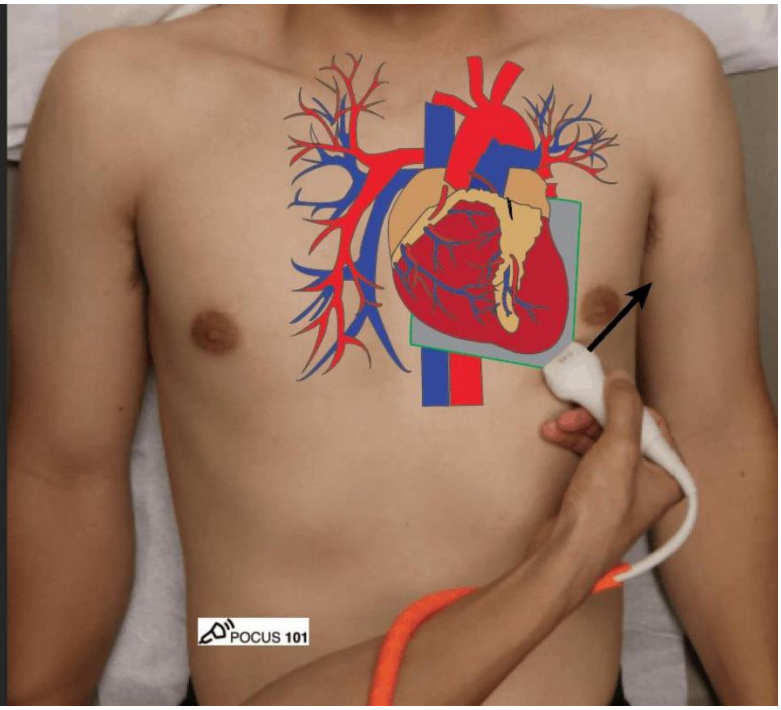




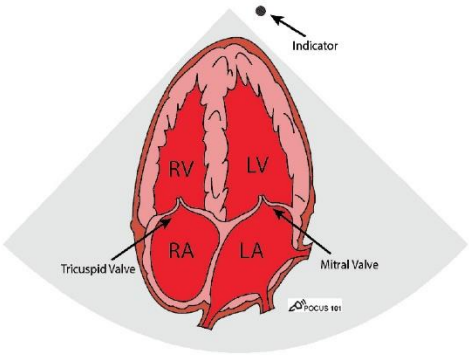
Images from POCUS 101

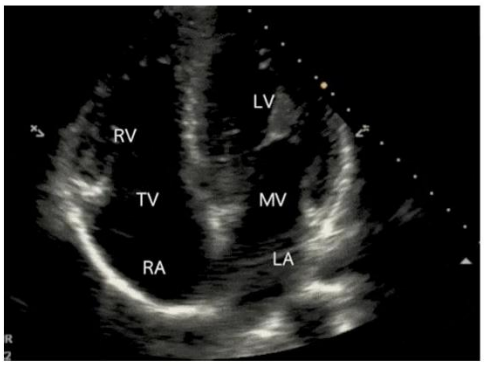
Apical 4 chamber view

- Probe indicator: Towards the patient's left shoulder
- Position: on the apex of heart (PMI) with the probe handle tilted toward the patient's foot. Usually easier in LLD.
- Purpose: evaluation of diastolic dysfunction, valvular regurgitation, cardiac output and more!
- Depth: usually needs to be increased to visualize the 4 chambers.



Apical 4 chamber view

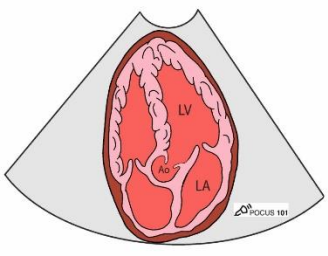


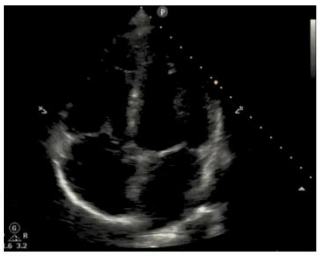


Images from POCUS 101

Having problems?

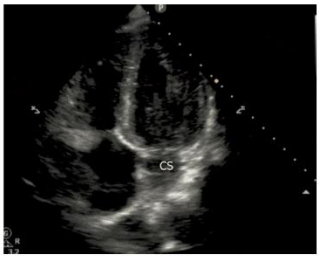
- **Apical 5 chamber view**
  - Includes the LV outflow tract





Tilt the probe handle toward the patient's head a *tiny* bit.

- **Coronary sinus view**
  - Coronary sinus visualized and can mimic and atrial septal defect.

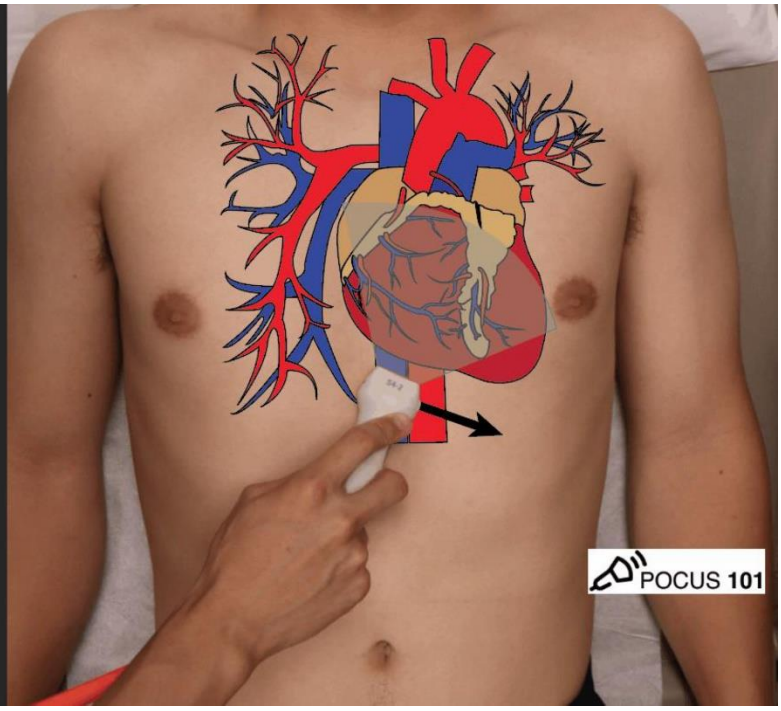


Tilt the probe handle toward the patient's feet a *tiny* bit.

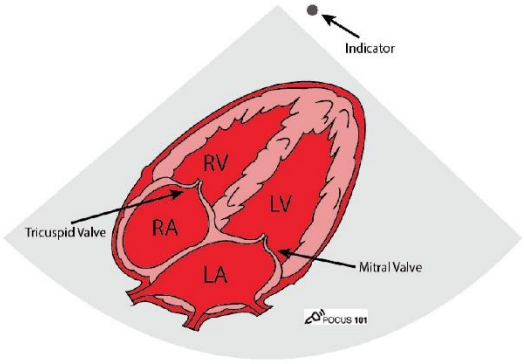
Images from POCUS 101

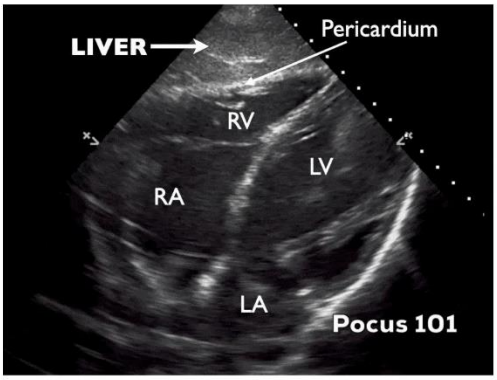
Subxiphoid (subcostal) view

- Probe indicator: to patients **left**. However, in a FAST scan, probe indicator will likely be to patient's right.
- Position: under the subcostal arch. Remember, the heart is sometimes more medial than you think.
- Grip the probe from above so you can get it parallel with the patient's skin.
- Getting the patient to bend their knees can help relax the abdominal muscles.
- Helpful in FAST and in COPD patients.



Subxiphoid view

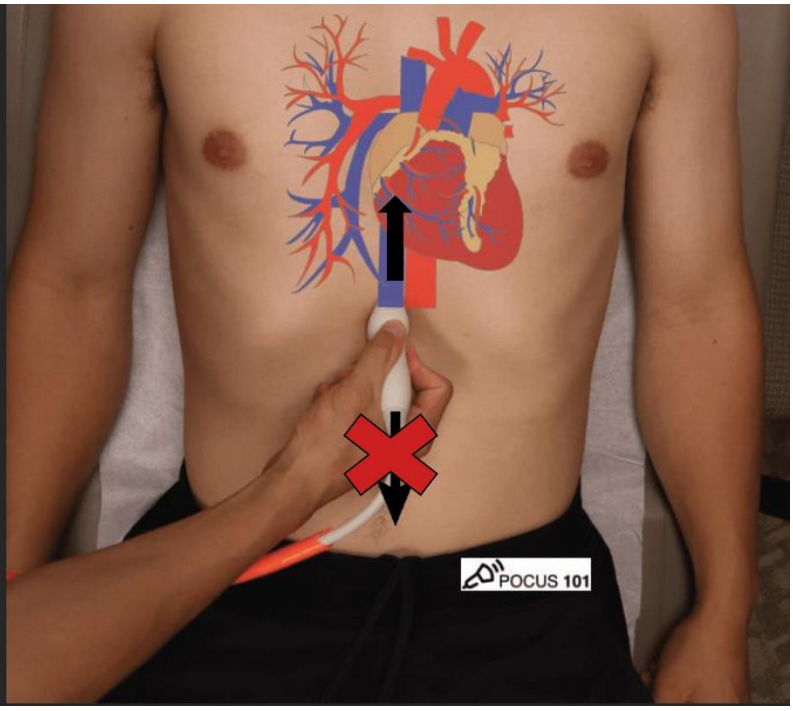




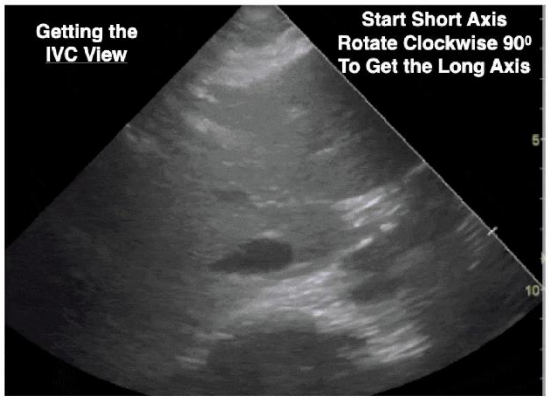
If you approach from inferiorly and to the patient's right, you can use the liver as an acoustic window and avoid bowel gas. A small amount of downward pressure can also help to remove bowel gas.

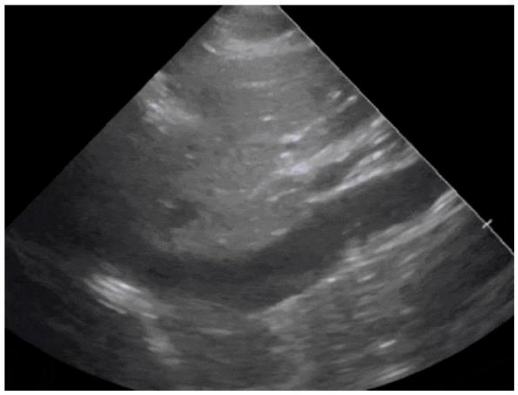
Inferior vena cava view

- Probe indicator: to patient's **head**.
- Position: under the subcostal arch. Rotate the probe 90° with the right atrium/IVC in the center of your screen.
- Assess width (within 2 cm of atrium or at level of portal vein) + collapsibility (inhalation/sniff test).



Normal IVC view

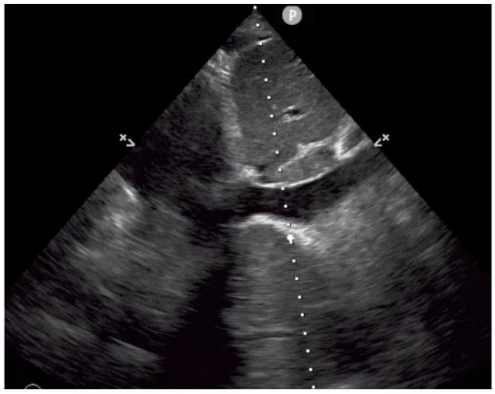




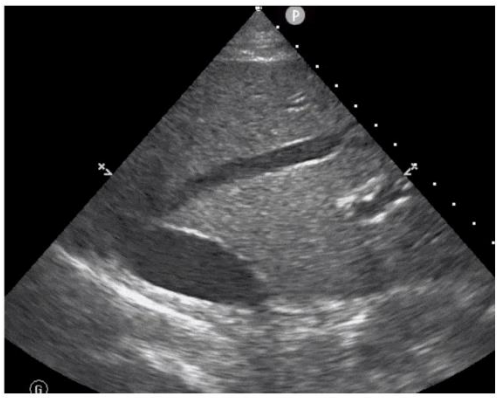
Images from POCUS 101

Abnormal IVC view

Small, collapsible IVC



Dilated, non-collapsible IVC and portal vein



Images from POCUS 101

Assessment of the inferior vena cava

- IVC assessment can be helpful in assessing a patient's volume status and while this technique has been widely discussed and even applied in recent years, there is limited evidence actually confirming it's utility.
- Bottom line: it may be a useful tool but clinical judgement is still key!
- When assessing for volume overload don't forget lung US for B-lines which may have increased clinical utilities.

IVC Size	IVC Collapsibility	Interpretation (CVP)
< 1.5cm	>50% collapsibility	0-5 mm Hg (Low CVP)
< 1.5-2.5cm	>50% collapsibility	6-10 mm Hg
1.5-2.5cm	<50% collapsibility	11-15 mm Hg
>2.5cm	<50% collapsibility	16-20 mm Hg (High CVP)

LITFL: The Dark Art of IVC Ultrasound (Nov 2020)

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3. The Dark Art of IVC Ultrasound. Life in the Fast Lane (November 2020). Accessed Jan 16, 2025 from https://litfl.com/the-dark-art-of-ivc-ultrasound/

Post session quiz – Scan the QR code!

https://docs.google.com/forms/d/e/1FAIpQLSewkkywWtC_kpMUlPR9nW0SFiXWKFjcUQ6lDHctjOl7QEz4Sw/viewform?usp=dialog