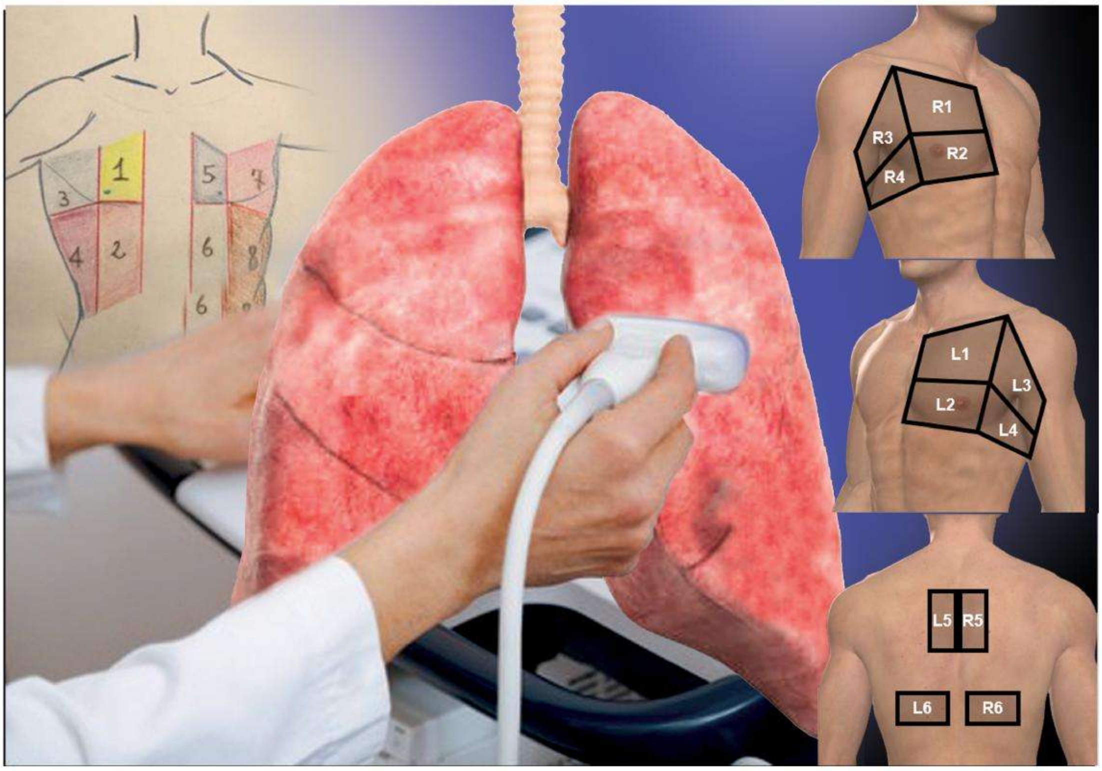
PAKISTAN CHEST SOCIETY
STRIVING FOR PULMONARY CARE

A guide to Point-of-care ultrasonography (POCUS) in Pulmonary and Critical care Medicine in Pakistan



December 2021

Point-of-care Ultrasonogtraphy (POCUS) Guide Working Group

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Message From President Pakistan Chest Society (PCS)

Point-of-care ultrasonography (POCUS) refers to portable ultrasound system in which physicians perform ultrasound at the bedside. It is a screening tool and is helpful to treating physicians including pulmonologists in rapidly diagnosing certain diseases like pneumonia, tension pneumothorax, deep vein thrombosis etc. It is also used to perform bed side procedures like aspirations which increases the safety and easiness of those procedures.

PCS members are always trying to learn innovation in line with standard international practice. We are proud of Prof. Nadeem Rizvi who is the pioneer in introducing this technology in Pakistan.

I would like to congratulate Dr. Moiz Salahuddin and his team for bring this guideline on such a short notice.

This guideline is covering complete methodology with sonological findings in using ultrasound in conditions like pleural effusion, pneumothorax, diaphragm evaluation, DVT and pulmonary edema evaluation. It also describes how to evaluate Inferior vena cava (IVC) collapsibility which is helpful in assessing the volume status.

This guideline is a valuable addition to PCS guideline shelf. I am sure that it will be of great benefit to our trainees working in Pulmonology, Critical care, ER and Internal Medicine. Beside our senior colleagues will also benefit.

PROFESSOR NISAR AHMED RAO
President,
Pakistan Chest Society.

Message By Chairman Guidelines Committee, Pakistan Chest Society (PCS)

It is a matter of great pleasure, pride and satisfaction that the first clinical guide on Point-of-care ultrasound (PoCUS) has been published by PCS. Governing Council of PCS has mandated the Guideline committee to develop evidence based guidelines for important pulmonary diseases. It is very encouraging to note that PCS has been consistently working on developing and updating guidelines. These guidelines provide a highly valuable resource for the trainees and practicing physicians.

Expediting triage and time to diagnosis are crucial to decreasing morbidity and mortality in critically ill patients. Point-of-care testing has been shown to achieve these goals, leading to improved operational efficiency and, ultimately, better patient outcomes. PoCUS is one of the point-of-care testing tools that can answers specific clinical questions that narrow differentials and guide clinical therapy. PoCUS is complementary to a medical examination performed by physicians in conjunction to physical examination to investigate unclear findings. In this document, authors have discussed the use of PoCUS in different conditions that can be applied in Pakistan for pulmonary and critical care physicians.

Finally, I would like to acknowledge the hard work of Dr. Moiz Salahuddin and other members of the working group who has prepared this very informative document. I am also thankful to the members of PCS guideline committee for reviewing the document. PCS remain committed to always endeavor for the achievement of the best possible clinical practice.

Prof. Muhammad Irfan
Chairman Guidelines Committee, PCS
Pakistan Chest Society.

Preface

Point-of-care ultrasound has become a valuable tool, as an addition to bedside physical exam. It provides real-time information to the clinician to make time-sensitive decisions. In patients with respiratory failure or hypotension/shock, POCUS can make decisions that impact patient care and outcomes. POCUS is being used in various fields of medicine, however in emergency medicine, pulmonary and critical care, POCUS has provided great value and is now commonplace.

In Pakistan, POCUS use amongst pulmonary and critical care physicians has not become widespread. This is likely due to less availability of portable ultrasound machines due to cost. However, even if machines are available, there may be limited experience in obtaining and interpretation of images. We have written this document to provide some basics of POCUS for pulmonary and critical care physicians. With basic understanding and experience, more physicians can gain expertise in this and with time this may become a widespread practice. This will eventually lead to better patient care and outcomes. This document is not meant to be a book on ultrasound, but rather provide relevant and quick information to physicians learning and practicing POCUS.

I am extremely grateful to all the contributors for their valuable contribution to accomplish this task.

Dr. Moiz Salahuddin
Chairman POCUS Working Group

Table of contents

Introduction:

Ultrasonography allows rapid acquisition of high-resolution images of anatomic structures in real time. The use of bedside ultrasound has grown tremendously over the last 2 decades in Europe, USA and Canada amongst pulmonary and critical care physicians[1]. Point-of-care ultrasonography commonly referred to as POCUS, is the common term used to describe bedside ultrasonography that relays quick and relevant information to the treating physician and enables real-time decision making[2,3,4]. The portable nature of new ultrasound machines allows feasible and timely bedside examination. The purpose of POCUS is not to perform formal ultrasound studies or replace them, but instead be used at the bedside to aid clinical decisions. POCUS also allows for image guided procedures at the bedside which improves procedural success and reduces potential complications.

Formal ultrasonography takes time and resources. For example, a patient may have undifferentiated shock and an echocardiogram order may take many hours prior to being performed, and then further time for cardiology review and reporting. If a critical care physician can perform bedside ultrasound and get basic echocardiogram information, this would immediately result in informed decision making. Another example is a patient with a new unilateral white out of the lung. A bedside ultrasound performed by a pulmonologist can evaluate for pleural effusion as the etiology. Or one may find no pleural effusion but instead find pleural sliding seen and a raised unilateral hemi-diaphragm, which would suggest complete lung collapse due to central airway obstruction. These are some scenarios where POCUS leads to critical and timely decision making for pulmonologists and intensivists.

In Pakistan, the use of POCUS amongst pulmonary and critical care physicians is currently not at its full potential[5]. Major factors to this limitation are cost, availability of ultrasound and training of physicians in POCUS. However, it is important to bear in mind that these factors were also present in Western countries about 20 years ago but as medicine evolved, the cost benefit, and training of physicians changed and continues to evolve. More ultrasounds are now available in hospitals and can be accessed in a shared manner amongst departments for providing patient care. However, training and expertise should be developed in due time as availability of ultrasound improves.

In this guidelines, we will discuss the use of POCUS in different conditions that can be applied in Pakistan for pulmonary and critical care physicians. The goal is to briefly describe when to use POCUS, the technique associated with it and brief interpretation of findings. For more detailed understanding of a certain topic, we recommend reviewing the referenced articles.

Ultrasound basics:

There are two main components of the ultrasound machine:

1. Display
2. Transducer: There are 3 commonly used transducers (also known as probes) which vary in their frequency and resolution.
   a. **Curvilinear**
   b. **Phased array**
   c. **Linear**

Ultrasound machines vary in the arrangement of their knobs. Know your machine well before using it. There are many knobs on ultrasound machines, however the main ones we need to know for doing a focused exam are the following:

1. **Gain:** Changing gain will change the amount of white, grey and black on the monitor. Increasing gain makes image white and under gain makes it black.
2. **Depth:** It determines how far into the tissue echoes are sent. Increasing depth decreases resolution.
3. **Time gain compensation:** It is a way to overcome ultrasound attenuation. Adjusting TGC makes equally echogenic tissues look the same even if they are located at different depths.

The common modes that are used are:

1. **B mode:** It is also called brightness mode. It shows white dots on black background.
2. **M-mode**: It is the motion mode, good for visualizing pleura.
3. **Colour doppler:** It looks at the flow of blood.

Pleural Effusion:

For pulmonologists, the highest utility of POCUS would be for evaluation of pleural effusion. Computed Tomography (CT) chest has the highest sensitivity for pleural effusion, but CT chest cannot be repeated due to cost and radiation. Chest radiography can be used as an initial study for pleural effusion, but at times it may be hard to differentiate atelectasis, consolidation, pleural effusion and raised hemidiaphragm on chest radiography (CXR).Ultrasonography provides real time assessment of pleural effusion. It can be repeated often for monitoring changes, assessing characteristics of the effusion and guiding drainage/tube insertion/biopsy. [6, 7] Ultrasound (U/S) guided thoracentesis was successful in 87% of patients who failed an attempted aspiration guided by physical examination. U/S guided thoracentesis is standard practice in the modern day.

Technique: The physician should use a curvilinear or phased-array probe to assess the pleura. The probe should be placed perpendicular to the ribs with the marker pointing cephalad. The goal is first to identify the diaphragm. This can be done by starting in the posterior thorax around the 11th intercostal space and usually the liver (right side) or spleen (left side) will be visualized. The probe should be moved 1 intercostal space upwards till the diaphragm is visualized. The probe should also be moved laterally and superiorly to find the diaphragm in 2 different locations of the thorax.

Superior to the diaphragm one of two views would be obtained ? either an echogenic (hypodensity) fluid filled space will be seen, or a sliding lung with a shiny pleural line will be visible. Fluid appears anechoic (black) and is usually dependent (in non-loculated effusions) and will be seen in line with the diaphragm. If no fluid is seen posteriorly or laterally with visualization of diaphragm, the chances of a pleural effusion being present is very low. However, it should also be searched anteriorly to assess for loculated effusions. Loculated effusions may sometimes be missed if effusion is loculated away from the diaphragm. However, even in loculated effusion there is some dependent fluid which can be identified with ultrasound.

Septation may be seen in the pleural effusion which suggest a complicated/loculated effusion. Septations can be better seen by U/S than CT scan. The presence of septations would guide the management approach, such as proceeding with tube thoracostomy and additional management such as intrapleural fibrinolysis, medical thoracoscopy or video-assisted thoracoscopic surgery.

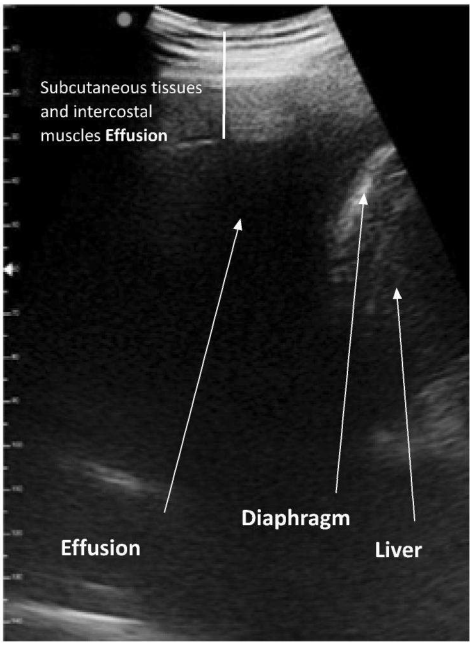

Figure 1: showing a simple right sidded pleural effusion, with liver at the right side of the screen, then going caudally comes the diaphragm and then effusion.

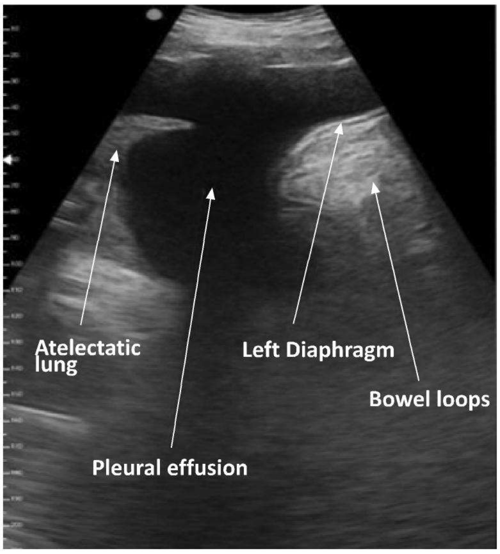

Figure 2: Simple pleural effusion with collapsed/atelectatic lung (inverted hockey sign) seen floating in the pleural effusion

Pleural effusion characteristics on ultrasound can help guide the physician as to the possible nature of the effusion. Transudative effusions are anechoic and homogeneous (appear black and clean). Exudative effusions will show multiple small echoes in pleural fluid that moves with respiration, known as “echogenic swirling” sign has been demonstrated to be highly sensitive for exudative effusion. This would occasionally have septation which may sometimes be seen on ultrasound which appear as strings in the black fluid[8]. Empyema, complicated effusions and hemothoraces would appear as heterogeneous with varying echoes in the fluid.

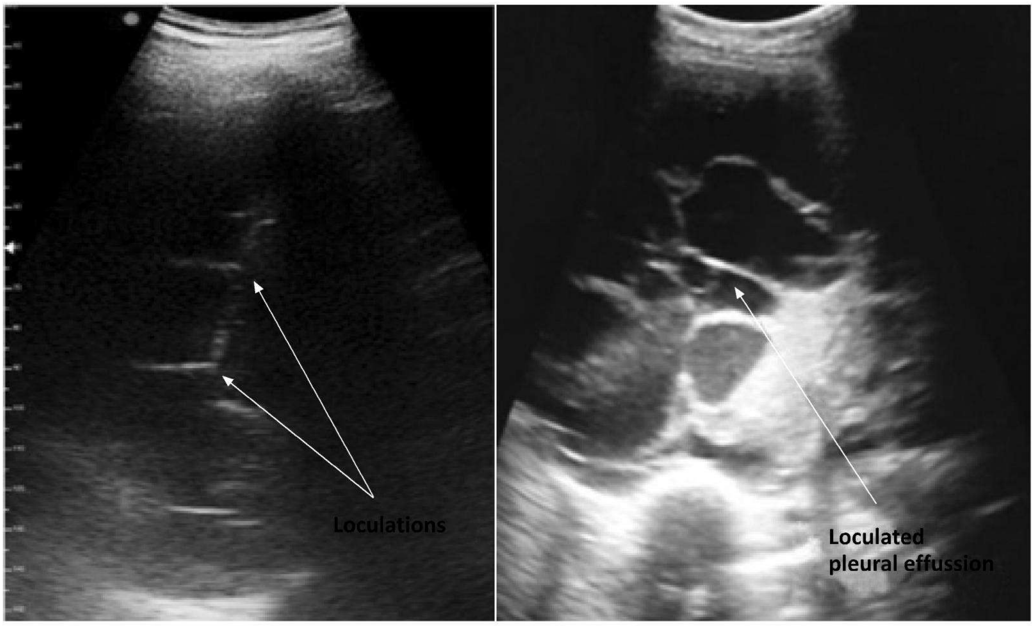

Figure 3: Hypoechoic pleural effusions seen with floating echogenic lines (white threads) representing loculations.

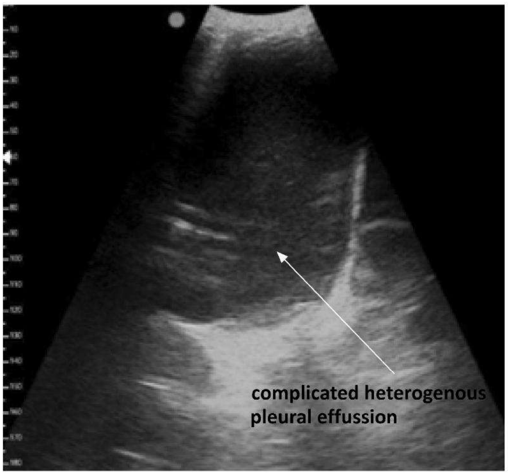

Figure 4: The pleural effusion is not homogenously black, but instead has heterogenous echoes. This suggests a complicated pleural effusion. This was a case of empyema due to MRSA. Hemothorax can also look similar, with floating heterogenous material seen in the effusion.

Pleural Procedure: Ultrasound guidance should be used for pleural procedures when available. Pulmonologists commonly perform thoracentesis and chest tubethoracostomy. Ultrasound-guided pleural biopsy gives higher diagnostic sensitivity for pleural tuberculosis and malignancies compared to blind Abrams needle biopsies. U/S can help in localizing peripheral lung masses and guided biopsies under real time. Other procedures such as tunneled pleural catheters and pleuroscopy are also performed with U/S guidance. The purpose of the ultrasound is to mark the skin site of entry into the pleural space. Ultrasound would identify the most dependent area of the fluid collection, or the largest area in a loculated effusion and allow successful entry into the pleural space. This would allow for the best drainage of the pleural space and decrease the chance of surrounding organ injury or accidently puncturing the lung and causing pneumothorax. The linear probe can also be used to identify an intercostal arterial vessel in the space one is planning to attempt tube insertion. We recommend ultrasound guided pleural procedures whenever ultrasound is available.

Pneumothorax:

Pneumothorax is a common problem encountered by the pulmonologist, and at times can bean emergent condition requiring immediate decision making. The sensitivity of CXR in supine position varies between 28 and 75%[9]. CT scan is more sensitive in detecting up pneumothoraces, however CT requires transport of patients who may be unstable and are time consuming. POCUS provides a quick assessment of pneumothorax in these situations.

On thoracic ultrasound examination, in patients with a normal lung and no pneumothorax, the lung will be sliding against the visceral pleural surface[10].

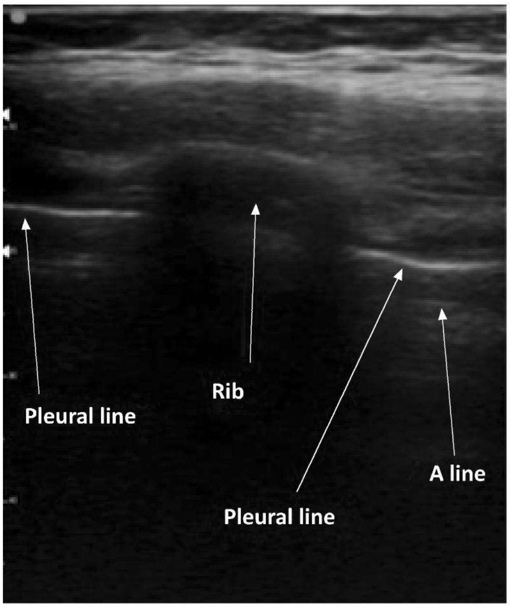

Figure 5: A rib bordered by the pleural line on both sides. The rib shadow does not allow the pleura to be seen behind it. The pleura appears as a thin shiny white line, and it slides with respiration. A-lines are artefacts which are seen due to ultrasound reflections from the pleura.

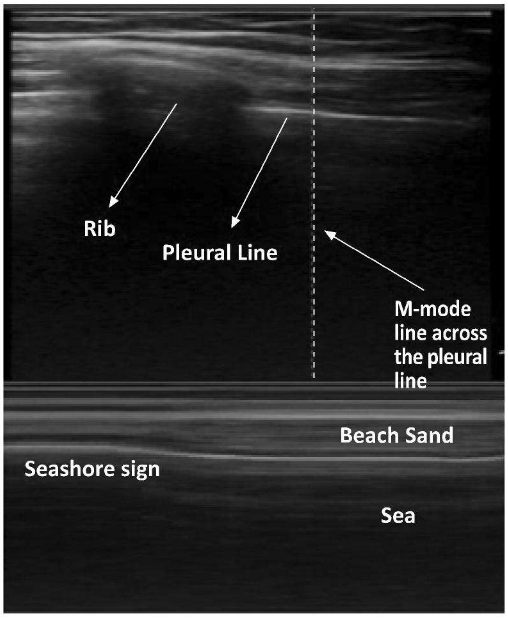

Figure 6: The top part of the picture with a linear probe shows a rib with the pleural line on the side. The M-mode of the ultrasound is then activated in this position, and below that we received an M-mode image of a 'seashore sign' which is normal and represents no pneumothorax.

The visceral pleural line can be seen as a shining white line that slides with each breath, and the lung underneath can also be seen to be sliding on inspiration. Reflected horizontal white lines in parallel that appear below the first white line are referred to as 'A-lines'[11]. These are reflections of the pleura and are seen in normal lungs.

Technique: The linear probe should be placed in the 2nd intercostal space anteriorly, then laterally in the 4th intercostal space, and then postero-laterally in the 6th intercostal spaceto get a thorough view of the pleura. In these areas, we should look for the presence of lung sliding. The curvilinear or phase-array probe can also be used similarly but may not provide as good a view of lung sliding as compared to the linear probe. M-mode scanning can further evaluate the presence of an occult pneumothorax. If lung sliding is present, the ultrasound image shows a granular appearance under the pleural line (resembling sand) and horizontal lines above the pleural line (resembling the horizon), and therefore this type of image is called the seashore pattern. In the presence of a pneumothorax, seashore pattern is replaced by straight horizontallines, called the stratosphere pattern- the barcode sign.

Presence of lung sliding in multiple thoracic areas can rule out pneumothorax (specificity = 91%). Absence of lung sliding suggests pneumothorax with a sensitivity of approximately 65-85% depending on clinical context. This can be confirmed by using M-mode at that location which would give the view of a barcode sign instead of the normal seashore sign. Findings of an area where we see both lung sliding and no lung sliding in the same image is referred to as lung point and this is the most specific finding (100 %)for pneumothorax but is not as commonly found. In M-mode, the lung point appears as an interchanging seashore pattern and stratosphere pattern.

Ultrasound is very useful in detecting pneumothorax in young healthy individuals but on the other hand patients with severe emphysema with bullae, previous pleurodesis, large bullae is difficult to differentiate from pneumothorax.

Procedural use: When pneumothorax is known with a CXR, ultrasound guidance can assist in entry for chest tube insertion. At times when pneumothorax suspicion is high, and no lung sliding is seen, tube thoracostomy can be performed in the area where there is no lung sliding. When there is an apical pneumothorax, then it is recommended to place an ultrasound guided apical chest tube in area where there is no lung sliding. It is not necessary to use ultrasound guidance for moderate to large pneumothoraces, especially when present in the lateral hemithorax. However, for apical pneumothoraces, we recommend ultrasound guidance for placement.

Diaphragmatic evaluation:

Patients can have small lung volumes on CXR due to atelectasis or unilateral diaphragm elevation. CT chest, fluoroscopy testing or ultrasound can also be done to evaluate the diaphragm location[12]. However, CT chest does not provide dynamic information. Fluoroscopy and ultrasound can be used to assess movement, and ultrasound can also assess diaphragmatic thickness. Change in diaphragm thickness can be used in place of fluoroscopy to suggest diaphragmatic paralysis[13]. There is also recent literature indicating that diaphragm thickness fraction can predict extubation success from mechanical ventilation[14]. However, this is not yet validated, therefore we do not strongly recommend its use in clinical practice.

Technique: As described in the pleural effusion section, the curvilinear or phase-array probe is placed between the mid-clavicular and the mid axillary lines, below the costal margin, and directed medially and cephalad[15]. In this image, we look at the diaphragm below the liver margin (on the screen) in B-mode. During inspiration, the diaphragm contracts (gets smaller) and moves down towards the probe. During expiration, the diaphragm will move superiorly and away from the probe. By putting on M-mode, one can see the linear movements of the diaphragm and can measure the change with inspiration and expiration. If the change is less than 1cm with inspiration and expiration, this indicates diaphragmatic weakness, and if it does not move at all this indicated diaphragmatic paralysis [16,17].

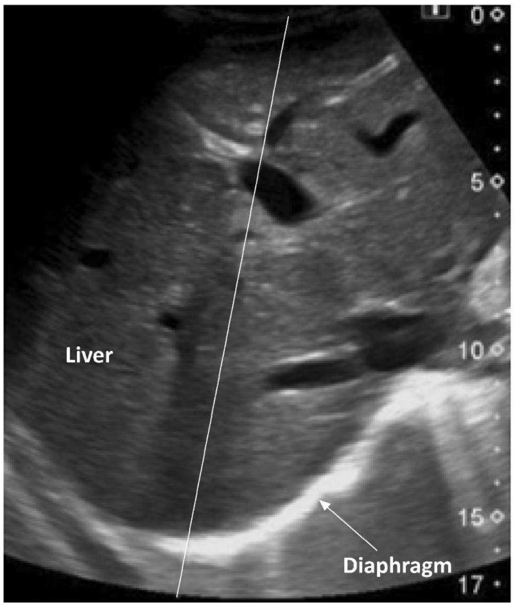

Figure 7: Placing probe in subcostal space in mid-clavicular line directing the probe medially and caudally, we get this image. The posterior diaphragm is seen inferiorly on the screen and can be seen moving with normal respiration. In paralyzed or weak diaphragms, the excursion is limited. If M-mode line is placed through the diaphragm in that location, diaphragmatic excursion measurements can be made.

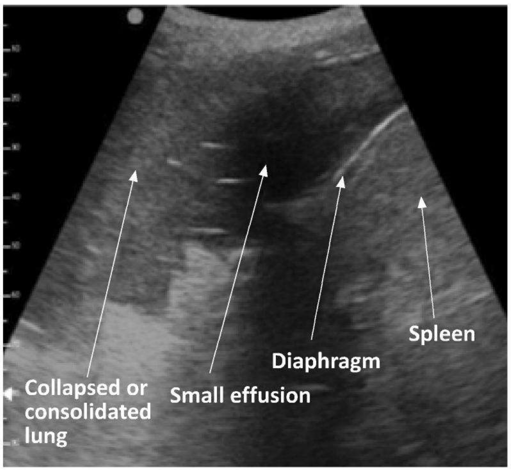

Figure 8: Large area of collapsed or consolidated lung. The lung should not be seen on ultrasound as air does not allow passage of sound waves. If there is dense consolidation or atelectasis, the lung will appear similar to the liver in appearance.

If a patient has lower lobe atelectasis or unilateral diaphragm elevation, the diaphragm along with sliding pleura/lung would be found much higher than the usual 10th intercostal space. At times, the diaphragm would be found near the edge of the scapula (6th intercostal space) indicating significant lung volume loss.

Once the diaphragm is identified, then the patient can be asked to take deep breaths and see if there is physical movement of the diaphragm. Lack of movement suggests paresis. This can be confirmed better with M-mode to assess the exact diaphragm excursion measurement. Lobar atelectatic lung may resemble hepatic parenchyma, referred to as "hepatized" in appearance. Static air bronchogram due to distal air trapping may be seen early in the hepatized lung.

For performing diaphragmatic thickness evaluation, more experience is needed than for other pleural findings. Therefore, we recommend caution with relying on ultrasound for unilateral diaphragmatic paralysis. We recommend ultrasound use to assist in the diagnosis of hemidiaphragm elevation or atelectasis.

Deep vein thrombosis:

Most internal medicine trained physicians would be proficient in placing central venous catheters especially in the femoral vein. Therefore, most trainees learn how to use ultrasound to look at the femoral vein. This technique involves correct identification of the femoral vein and popliteal veins to assess for deep venous thrombosis (DVT).

Technique: Using the linear probe, place the ultrasound perpendicular to the femoral vein. On confirming the location of the common femoral vein (medial to the femoral artery), we should compress the femoral vein with the probe under gentle pressure and observe whether the vein lumen compresses down. If a vein does not collapse on gentle compression with the probe, this indicates a thromboembolism in the vessel. Besides non-compressibility, the vein may also be dilated and show an echogenic thrombus. This compression technique should be done at 3 locations. The probe should first be placed at the common femoral vein then slowly brought down until the saphenofemoral junctionis visible. The femoral vein is assessed at upper thigh, mid-thigh and lower thigh[18]. Then the probe should be moved to the popliteal veinat the posterior aspect of the knee joint (this view is usually most technically challenging).

If these 3 views (3 femoral and 1 popliteal) are done bilaterally and compressibility of the veins are obtained, then this would successfully exclude DVT in 95% of cases[19]. There is data to suggest that doing 2 views (common femoral and popliteal vein) may be as good[20]. This is a highly useful tool to perform in cases of pulmonary embolism (PE). In cases of PE, about 50% would have active DVT as well[21]. A negative bilateral DVT evaluation would lower the chances of PE

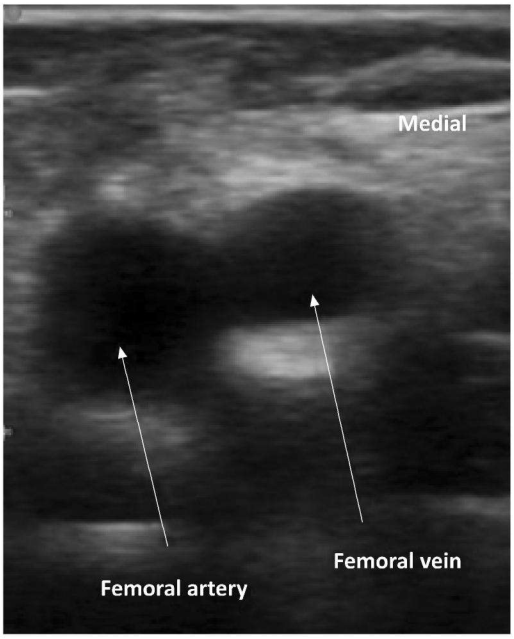

Figure 9: The femoral vein is seen medially and the femoral artery is seen laterally. They are usually found around midpoint of the inguinal ligament and can be traced inferiorly from there.

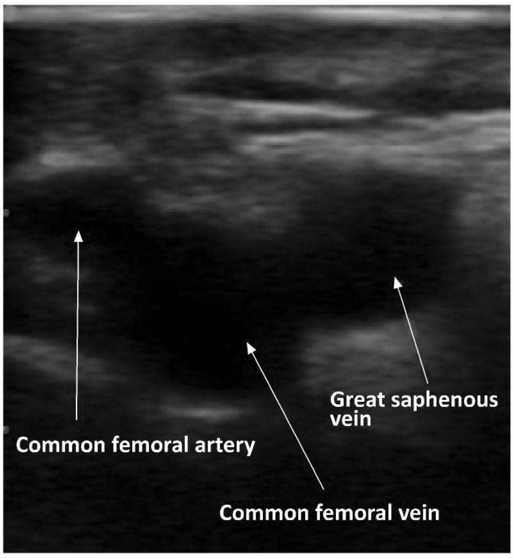

Figure 10: The 'mickey mouse sign' is seen where the great saphenous vein drains into the common femoral vein. This is 1 of the sites to assess for DVT.

but not exclude it. A positive DVT evaluation would strengthen the clinical probability of PE and decision to start anticoagulation. We recommend that when PE is intermediate to high probability on the differential and CT pulmonary angiogram cannot be done in a timely manner, POCUS of bilateral lower extremities can be considered to assess DVT.

Pulmonary edema evaluation:

For patients with suspected pulmonary edema, thoracic ultrasound can aid in the diagnosis. The presence of ‘B-lines’ can suggest pulmonary edema, however they can also be seen in other lung pathologies such as consolidation.

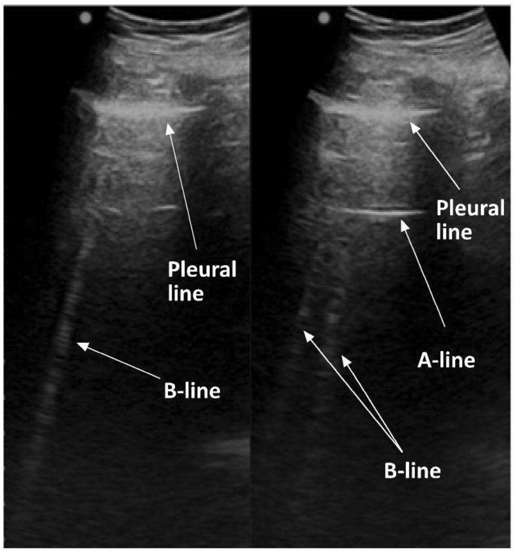

Figure 11: These figures show white longitudinal streaks like a comet tail emanating from the pleural surface, known as B-lines. On the left we only see 1 B-line in the window and on the right, we see 2 B-lines in one window. 3 or more B-lines are suggestive of pulmonary edema.

Technique: Place the curvilinear or phase-array probe on the anterior and lateral hemithorax and identify the visceral pleural line on ultrasound. Emanating from the visceral pleural line with be long streaks of hyperechoic areas (white) that pass through the lungs.

The presence of more than 3 B-lines in 1 ultrasound view is suggestive of pulmonary edema with a very high sensitivity of 94%[22,23]. However, B-lines can also be seen in consolidation and atelectasis[4,11]. B-lines should always be interpreted in association with clinical features and radiographic findings. Other ultrasound features that can assist in diagnosis of volume overload is distended inferior vena cava with a decreased ejection fraction. CXR is usually a good tool for diagnosis of pulmonary edema, however the severity of B-lines on POCUS can be used to monitor regression of pulmonary edema with diuresis –less B-lines indicates decrease in pulmonary edema. We recommend use of POCUS in volume overload assessment on a case-by-case basis when diagnosis is unclear, but we recommend interpreting it with the chest x-ray, IVC and bedside EF assessment.

IVC evaluation:

Inferior vena cava (IVC) collapsibility can be used as an adjunct for volume status assessment[24,25]. In mechanically ventilated patients, collapsibility should be assessed in expiration. However, some evidence suggests that IVC collapsibility during inspiration can be assessed in awake spontaneously breathing patients.

Technique: Place the curvilinear or phased-array probe perpendicular to the line of abdomen. Place the probe in the subxiphoid/epigastric area. In that view, the left lobe of the liver would be seen superiorly, but with gentle swivelling of the probe in that area, a vessel would be seen running parallel to the top of screen below the liver. It is important to differentiate as the aorta is larger, pulsatile and does not collapse. The IVC can be confirmed by slow movement to the right and seeing that the vessel drains into the right atrium. The IVC can also be confirmed by seeing hepatic veins draining into IVC (this is more easily seen). Once IVC is confirmed, then IVC collapsibility should be assessed approximately 2-3 cm proximal to the entry point into the right atrium. Usually a collapsibility index of 12-40% is considered significant, but a visual assessment can also be done.

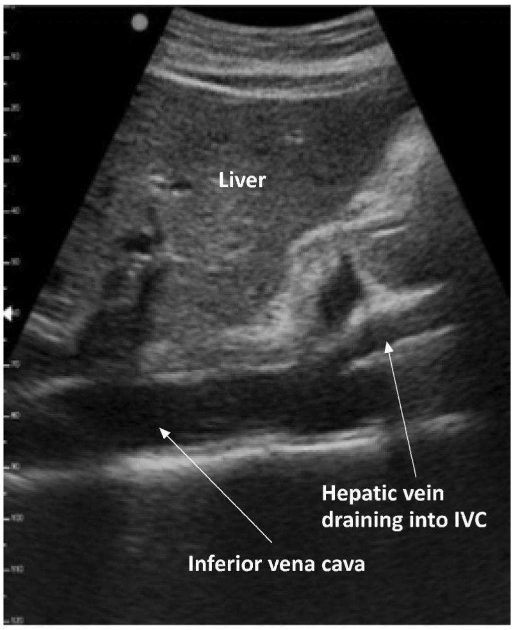

Figure 12: Image of IVC found below the inferior margin of the liver. This is confirmed to be IVC as we can visualize hepatic veins draining into IVC, and on slight tilting of the probe, entry into the right atrium can also be seen. This IVC is not dilated and measures 1.2cm.

The sensitivity of IVC collapsibility to predict fluid responsiveness is poor, around 65%. Other parameters such as interior jugular vein and subclavian vein collapsibility is also being studied[26]. All these parameters essentially are surrogates of right atrial pressure (RAP). A collapsible IVCor IVC < 2 cm suggests low RAP and likely the patient will be fluid responsive. A non-collapsible or distended (>2 cm) IVC does not exclude fluid responsiveness[24,25]. It should be kept in mind that any patient with acute or chronic right ventricular failure, right heart valvular pathologies and cardiac tamponade will lead to IVC distension. Therefore, IVC evaluation should be done in conjunction with cardiac and lung ultrasound exam to make an overall assessment of volume status[27]. We recommend that IVC evaluation be done at bedside in all patients where volume status is unclear. This is an easy skill to learn and easily repeatable in the patient.

Echocardiography:

Point-of-care echocardiography (POCUS ECHO) in the ICU is one of the most useful tools but also likely has the highest learning curve[28,29]. The basic goal of the intensivist is to estimate the left ventricular ejection fraction, estimate right ventricular size and function, and assess for pericardial effusion[29]. Essentially to assess whether the hypotension has a cardiac component. There are multiple calculations, measurements and additional information that can be obtained in POCUS ECHO, however that should be done for advanced practitioners who are more experienced.

Technique: There are 4 common views obtained with POCUS ECHO. The phased-array probe is preferable because of its resolution, depth and small footprint, but if not available then a curvilinear probe is acceptable but usually does not obtain the best view. We recommend starting with the parasternal long view, where the probe is kept on the 2nd or 3rd left intercostal space with the probe pointer facing towards the right shoulder of the patient. In this view (figure), one would see the transverse view of the heart, first visualizing the RV, then LV and then LA. Rotating the probe in the same area with the probe pointer towards the left shoulder, which shows the parasternal short view. Here one would see the RV and the LV in short axis. The 3rd and best view is the apical 4 chamber view, but this is the toughest view to obtain. The probe is kept at the apex of the heart near the mid-clavicular line 5th intercostal space and the pointeris towards the left axilla and the probe is pointing to the right should. Here all 4 chambers of the heart can be seen. The 4th view is the subcostal view where the probe is kept in the subxiphoid area and flattened nearly parallel to the abdomen. Then the probe is pointed towards the head or slightly to the left shoulder. Here also 4 views can be obtained but it is in a transverse axis. We recommend reviewing the article by Walley et al for a detailed view on obtaining views[30].

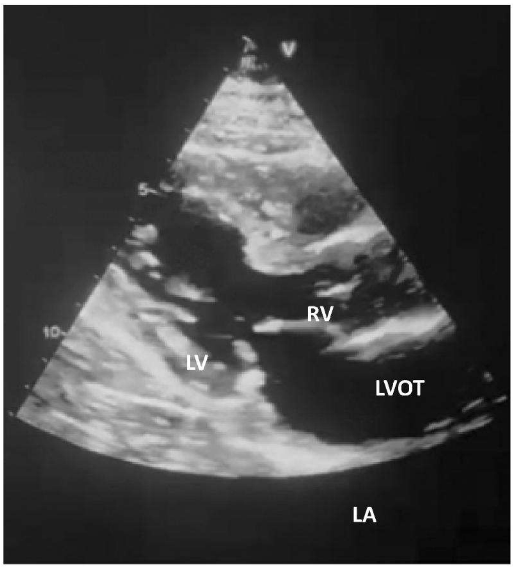

Figure 13: Parasternal long view, with the left atrium (LA), left ventricle (LV), left ventricular outflow tract (LVOT) and right ventricle (RV) seen.

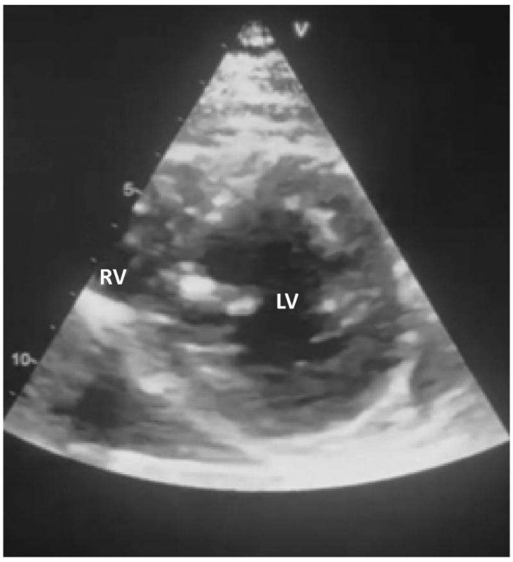

Figure 14: Parasternal short view, showing axial cuts of the LV and RV

Practitioners should aim to practice different views and usually 1-2 good views can be obtained in a patient depending on body habitus and pathology. Based on the views obtained, the physician should aim to estimate the LV function from a visual view without using calculations. This usually comes with the experience of seeing multiple ECHOs.

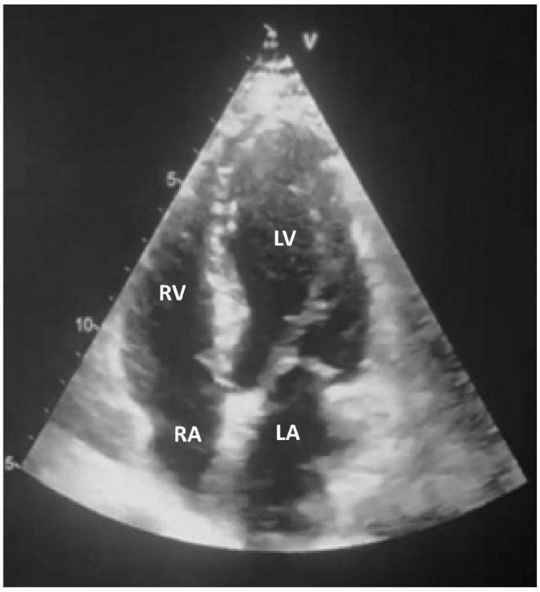

Figure 15: Apical 4 chamber view showing the LA, LV, RA and RV. This view gives a good estimate of ventricular function and size.

We recommend trying to label an LVEF into 4 different categories:

1. Hyperdynamic (>70%)
2. Appropriate LVED (55-65%)
3. Decreased LVEF (30-45%)
4. Poorly contractile LV (< 25%).

Identifying pathology usually comes with practice and we recommend comparing the POCUS physician's estimate to formal ECHO findings to correlate.

The RV contractility and size should be compared to the LV in the subcostal or apical 4 chamber view. The RV should be well contractile and smaller than the LV. The RV being similar in size or larger than the LV or a poorly contractile RV shows suggestions of RV overload and failure. Practitioners should also attempt to see if there is hypoechoic (black) fluid surrounding the heart which suggests a pericardial effusion and possibly pericardial tamponade. The LV and RV function in conjunction with the IVC evaluation may assist in assessment of volume status. Picking up valvular pathologies is generally beyond the scope of standard POCUS ECHO.

Point-of-care echocardiography (POC ECHO) provideson the spot information to guide clinical decision making[27]. In a patient with undifferentiated shock, through POCUS, once can assess LV and RV function, pericardial effusion, pericardial tamponade and assess IVC collapsibility and the lung for B-lines (suggesting pulmonary edema). This information willguide volume assessment and management decisions. POC ECHO can also be used in cardiac arrest, to identify pericardial tamponade or RV dilatation (suggesting PE) as potential etiologies of the arrest[31]. We recommend POC ECHO in patients who are hypotensive, or there is concern of LV or RV dysfunction driving the patient's condition. POC ECHO in cardiac arrest is not yet standard practice but can be done based on physician preference.

Conclusion:

POCUS is a rapidly evolving field in medicine and is being used in nearly every specialty. POCUS in pulmonary and critical care has become important, and we recommend adaption and practice of POCUS when feasible. Education in POCUS is an important aspect which will take time to develop. With workshops and clinical adoption of POCUS, practitioners will gain expertise, and this will slowly change our practice and improve patient care in the future.

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