**APPENDIX 1**

**Ultrasound Director Responsibilities**

* Develops and propagates the education of hospitalists in current, specific knowledge, strategies, and practices of hospital medicine ultrasound.
* Finalizes completion criteria for the entire program
* Establishes course agenda and learning objectives for training program components
* Reviews online modules and provides feedback
* Determines faculty recruitment for ultrasound training program components, providing feedback and faculty development
* Provides on-site supervision with the in-person course components
* Oversees the evaluation for Portfolio Review with a Standardized Rubric
* Oversees assessments and determination of passing standards
* Develops and deploys a workflow that clearly communicates requirements and guides participants through the established training program pathway
* Understands the ultrasound workflow, electronic integration and quality assurance process
* Centralized point for troubleshooting, adaptation and response to changing departmental and hospital needs

**APPENDIX 2**

**ULTRASOUND FACULTY TEACHING GUIDE – GENERAL PRINCIPLES**

We hope this document provide tips to optimize your bedside ultrasound teaching skills. This is adapted off the CHEST faculty guide and represents the most effective and engaging ways to impart the technical acquisition skills and clinical application.

First, the TWELVE COMMANDMENTS:

Thou Shalt:

1. Never pick up the probe (almost never) to show learners an organ or view, instead allowing them to hold the probe while you guide their hand onto the view (saying “I am going to hold your hand now” seems to alleviate the violation of personal space some people may feel)
2. Never touch any knobs or buttons to make any adjustments at any time, instead ALWAYS asking a learner in the group to do so for you and explaining how
3. Ask the non-scanning learners in your group to adjust gain and depth for the learner who is scanning early in the course (i.e. while one is scanning, ask the other to properly set depth and gain – remember, depth is set so object of interest is at center of screen from side to side and back to back, always. Gain is set so all structures and borders are maximally resolved.) The learner should be able to adjust knobs independently as they become more comfortable with scanning.
4. Not recommend use of “auto-gain” as it tends to produce undergained images
5. Always have scanner scan from same side of the patient as the machine
6. Always remind learners to REST hypothenar eminence ON the patient, using a pencil hold of the probe, do not allow lazy, unstable probe handling – this needs to be checked with every scanner, every time
7. Rotate scanners frequently, never allowing a learner to become disengaged
8. Always regale learners with anecdotes of clinical cases, demonstrating situations where ultrasound answered an important clinical question or share with them situations where lung or cardiac or vascular ultrasound has been of particular use to you or a patient
9. Always INTEGRATE CLINICAL APPLICATIONS - remind/ask the learner the clinical information that each of the signs we teach them provide - for instance, during lung ultrasound, ask repeatedly and annoyingly, “does this patient (i.e. model) have a pneumothorax?” “Is this patient in pulmonary edema?” “Is a DVT causing their leg swelling?” Make them answer by “showing” you sliding lung and explaining why there is no pleural air, showing you longitudinal scan lines, absence of DVT, etc. In summary, challenge learners with clinical questions that they have to use ultrasound to prove to you whether they exist (maximize their simulation experience)
10. Repeatedly summarize scanning skills – towards end of each day (or session), have learners run through each of the exams that were taught – Ex. challenge them to do a full, bilateral lung scan and DVT study, then rotate learners, repeat. At end of course, challenge them to do a whole body “survey” in quick yet proper way: i.e. do a goal-directed cardiac – lung scan – dvt scan etc.
11. Repeatedly ask them to interpret the acquired images during scanning in a systematic (i.e. goal-directed fashion, while doing cardiac views – ask them “what is the LV function, how did you come to that conclusion? etc. – force them to list or reiterate “why” the LV or RV is normal in function and appearance (i.e. thickening, excursion, shape etc. (obviously the function will be normal in live human models)
12. Teach M mode analysis of lung sliding – this will not necessarily be emphasized in our lectures enough. Please review the seashore sign with learners.

**Next, THE TOP TEN FREQUENT AREAS OF CONFUSION**

# LUNG

Q – Is the vascular probe OK to use for lung scanning?

Yes. HOWEVER…Ideally, the phased array or “cardiac” probe because this will allow you to not only identify sliding lung, A lines and B lines but also best identify more complex lung pathology like complex consolidations and effusions. In your typical American patient, the deeper penetration of the low frequency phased array probe will come in very handy when searching for the diaphragm in the flanks. HOWEVER, if simply checking for sliding lung after a procedure, the vascular probe is excellent for this as the pleural line is not very deep and it affords very high resolution and clear demarcation of lung sliding.

Q - What pre-set should we use for lung?

A – We favor the abdominal preset. Remember, abdominal presets have higher “line density” and therefore resolution (the lung is not a fast moving organ like the heart). The better resolution allows for optimal identification and differentiation of other lung pathology aside from just a lines and b lines (like consolidations with necrosis, complex pleural effusions, loculations, masses, etc.

Q – How many points on the thorax do we need to scan for each lung– 3? or 4? Or more?

A – We feel 4 points for each lung would be a minimum interrogation when doing a full hemi-thorax survey. If simply excluding a PTX, 1-2 points on the anterior lung surface is likely sufficient., As skills progress and the sonographer becomes more adept, the more interspaces/points the better

– stick probe at an interspace, then move to another, then another (can cover thorax in 5-10 points very easily and quickly. But, as a minimum should do one anterior upper chest (upper lobe), one antero-lateral above nipple (middle lobe) and two in the posterior axillary line, one at level of diaphragm and one at an interspace above (lower lobe points)

Q – Is it correct to think that one should hold the probe marker “to the sky” when scanning the lung?

A – No. Probe marker is ALWAYS pointing cranially, thus showing the rib above and below the interspace you are scanning. This will always produce a longitudinal orientation when scanning (“to the sky” will afford a transverse view when scanning the axilla – remember, always longitudinal for lung).

# VASCULAR

Q – Where should the probe marker point when performing vascular access?

A – “Operator Left” – as in, to the left of the person holding the probe. This way, when facing the screen, the left of the screen will be the left of the operator. If doing a longitudinal technique of insertion, probe marker should by pointing to patient’s head

Q – Should we spend a lot of time teaching ultrasound guided subclavian/axillary vein access?

A – Not with our current course. If asked, we could point them to appropriate resources or show them with some advanced scanning time

# ECHO – subcostal view

Q – Should we use abdominal pre-set/orientation or cardiac pre-set/orientation for examining IVC?

A – We feel this should not be legislated and instead advocate for IVC scanning technique freedom. Some of us (the more intelligent ones) feel the abdominal affords better resolution and penetration for large body habitus patients and makes it easier to interrogate and measure. Others (the less intelligent ones) get used to the training videos by cardiologists, which have it oriented to the right of the screen and get irrevocably confused when it “points the other way”. We feel that as long as you can see the entrance to the RA, the orientation should not be confusing and that we should all remain flexible on this issue (“live and let live”)

Q – What method should we use for finding the apical 4 chamber - the one where you slides along the heart, down to the apex from the short axis view pointing up towards the right shoulder at the end or plopping the probe down at the apex?

A – Either. One technique demonstrated largely to integrate anatomy and orientation of the heart and views, not necessarily as “THE” method for finding the A4C. Most people start just inferolaterally to the nipple and fish around there for the apex. Reassure learners that with practice, they will find the apex very quickly in time using this simple method of “plunk and search”

Q – What should we do when attendees want to do the stuff they hear in the lectures, like asking us to do TAPSE measures or EPSS measures and other M-mode stuff or measuring RV free wall?

A – We are generally a “caliper-free” course in keeping with the qualitative aspects of basic point of care cardiac ultrasound. Inform them that those M-mode measures are quantitative and require measurements with calipers and thus are laborious and have several measurement pitfalls so we prefer relegating their measurement to “advanced echo”, instead using the concepts underlying these measures to inform our QUALITATIVE assessments – basic echo is qualitative. They can always watch the movement of the annulus or the mitral valve leaflet or RV thickness and “guesstimate” the distance of interest using the scale on the screen

Q – On the post-test, should we mess up the gain and the depth while they are scanning to “test them”?

A – NO. By convention, we set the screen at maximal depth and least gain prior to their beginning of scanning. WE do not try to challenge them on these settings after this point.

**APPENDIX 3**

**Online Modules (Learning Objectives and Sample Material)**

**Learning Objectives**

The following are general learning objectives specifically for the in-person course but are linked to the foundations here in the online course.  More specific learning objectives for the online modules are listed under their appropriate sections.

1. Demonstrate the basics of ultrasound physics and technology and the fundamentals to operate a portable ultrasound machine (“knobology”)
2. Identify the differences between the different types of ultrasound transducers and select the correct transducer type for various point-of-care applications.
3. Identify normal and abnormal anatomy focused on cardiac and lung ultrasound exam by recognizing and interpreting normal and abnormal cardiothoracic ultrasound images.
4. Recognize the normal sonographic appearance of abdominal solid organs, neck, and lower extremity vasculature by interpreting a series of abnormal ultrasound images.
5. Review relevant literature in point of care ultrasound and recognize potential appropriate applications for clinical integration with bedside ultrasound.

**APPENDIX 3: Continued**

**Module – Thoracic Ultrasonography (Sample Material)**

Complete the following in sequence

The required reading(s) and videos are to be completed prior to taking the quiz.

Estimated time for video content in this module is 85 minutes.

Learning Objectives:

* Recognize the sonographic anatomic landmarks of the normal chest
* Recall the general indications for pleural ultrasound
* Define how to assess simple and complex pleural effusions
* Recall how to use ultrasound to perform thoracentesis
* Review relevant literature in lung ultrasound and recognize potential clinical integration with its use

**Watch Introductory Video on Thoracic Ultrasound** (link provided)– 85 min

**Review following Literature (pdf provided):**

* Lichtenstein DA, Mezière GA, Lagoueyte JF, et al. A-lines and B-lines: lung ultrasound as a bedside tool for predicting pulmonary artery occlusion pressure in the critically ill. Chest. 2009;136:1014-20.
* Lichtenstein D, Mezière G: **Relevance of lung ultrasound in the diagnosis of acute respiratory failure. The BLUE-protocol.** Chest 2008,**134:** 117–125. 10.1378/chest.07-2800
* Volpicelli G, Zanobetti M. Lung ultrasound and pulmonary consolidations. Am J Emerg Med. 2015;33:1307-8.
* Volpicelli G. Point-of-care lung ultrasound. Praxis (Bern 1994). 2014;103:711-6

**APPENDIX 3: Continued**

**Quiz for Module (Sample Questions)**

1. The use of ultrasound for assessment of the pleural space and lung allows for rapid bedside diagnosis of which of the following condition(s)?

Select one:

a. Pneumothorax

b. Consolidation

c. Pleural Effusion

d. Pulmonary edema and interstitial syndromes

e. All of the above

1. When imaging the pleural space and lung, orientation of the ultrasound probe's index mark should, for most examinations, should be oriented:

Select one:

a. Towards the patient's torso (ventral)

b. Towards the patient's feet (caudal)

c. Towards the patient's head (cranial)

d. Towards the patient's back (dorsal)

e. More than one of the above

1. According to the blue protocol, if lung sliding is present and there are Bilateral B-lines, which of the following is the most likely diagnosis?

Select one:

a. COPD or Asthma

b. Pulmonary Edema

c. Pulmonary Embolism

d. Pneumonia

e. More than one of the above

**APPENDIX 4:**

**Schedule for 3 Day Course**

Day 1

|  |  |
| --- | --- |
|  |  |
| 7:00AM-8:15AM | Registration & Breakfast  Pre-Skills Based Image Acquisition Assessment |
| 8:15AM-8:45AM | Welcome, Introductions & Course Overview  *Note: All pre-course modules and assessments must be completed prior to start of this course* |
| 8:45AM-9:00AM | General Principles of Ultrasonography & Knobology |
| 9:00AM-9:30AM | Knobology & Image Acquisition with Live Models |
| 9:30AM-10:10AM | Lung UItrasonography |
| 10:10AM-11:00AM | Workshop Rotation  Case Based Image Interpretation: Groups 1-4  Image Acquisition using Live Models: Groups 5-8  *Note: 1 Rotation at 25 min* |
| 11:00AM-11:10AM | Break & Rotate Groups |
| 11:10AM-12:00PM | Workshop Rotation  Case Based Image Interpretation: Groups 5-8  Image Acquisition using Live Models: Groups 1-4  *Note: 1 Rotation at 25 min* |
| 12:00PM-12:45PM | Lunch |
| 12:45PM-1:45PM | Abdominal Ultrasonography: Kidney, Bladder, IVC, Aorta |
| 1:45PM-3:15PM | Workshop Rotation  Case Based Image Interpretation: Groups 1-4  Image Acquisition using Live Models: Groups 5-8  *Note: 2 Rotations - every 30 min* |
| 3:15PM-3:30PM | Break & Rotate Groups |
| 3:30PM-5:00PM | Workshop Rotation  Case Based Image Interpretation: Groups 5-8  Image Acquisition using Live Models: Groups 1-4  *Note: 2 Rotations – every 30 min* |

Day 2

|  |  |
| --- | --- |
|  |  |
| 7:00AM-7:45AM | Breakfast & Didactic  Point of Care Evaluation of the Heart  Parasternal Long & Short Axis |
| 7:45AM-9:15AM | Workshop Rotation  Case Based Image Interpretation: Groups 1-4  Image Acquisition using Live Models: Groups 5-8  *Note: Rotations – 30 min* |
| 9:15AM-9:25AM | Break & Rotate Groups |
| 9:25AM-10:55AM | Workshop Rotation  Case Based Image Interpretation: Groups 5-8  Image Acquisition using Live Models: Groups 1-4  *Note: Rotations – 30 min* |
| 10:55AM-11:25AM | Point of Care Evaluation of the Heart  Apical and Subcostal Views |
| 11:25AM-12:10PM | Lunch |
| 12:10PM-1:20PM | Workshop Rotation  Case Based Image Interpretation: Groups 1-4  Image Acquisition using Live Models: Groups 5-8  *Note: Rotations – 30 min* |
| 1:20PM-1:30PM | Break & Rotate Groups |
| 1:30PM-2:40PM | Workshop Rotation  Case Based Image Interpretation: Groups 5-8  Image Acquisition using Live Models: Groups 1-4  *Note: Rotations – 30 min* |
| 2:40PM-3:10PM | Vascular Ultrasonography |
| 3:10PM-4:00PM | Workshop Rotation  Case Based Image Interpretation: Groups 1-4  Image Acquisition using Live Models: Groups 5-8 |
| 4:00PM-4:10PM | Break & Rotate Groups |
| 4:10PM-5:00PM | Workshop Rotation  Case Based Image Interpretation: Groups 5-8  Image Acquisition using Live Models: Groups 1-4 |

Day 3

|  |  |
| --- | --- |
|  |  |
| 7:00AM-7:40AM | Breakfast & Didactic |
| 7:40AM-8:20AM | Interactive Mega-Case  Image Acquisition using Live Models |
| 8:20AM-8:30AM | Break |
| 8:30AM-9:30AM | Scanning Review  Image Acquisition using Live Models  *Note: 1 Rotation at 30 min* |
| 9:35AM-9:45AM | Break |
| 9:45AM-12:00PM | Case Based Image Interpretation  Post-Course Skills Assessment |
| 12:00PM-1:00PM | Lunch & Didactic:  Credentialing Policy & Procedure, Post-Course Portfolios |

**APPENDIX 5**

Schedule for 1 Day Advanced Course



**APPENDIX 6**

**Educational Domains**

|  |  |  |
| --- | --- | --- |
| **Domains Taught** | **Sample Image Interpretation Objective** | **Sample Hands-on Assessment Objective** |
| Machine Controls (“Knobology”) | Recognizes an under-gained image | Ensures the images is optimized (Gain, Depth, Correct Transducer, Image Marker in Proper Location) |
| Vascular Diagnostic | Identifies the venous structures relevant to compression ultrasound study of the lower extremity | Demonstrates a DVT exam of one leg (Including common femoral, great saphenous, femoral and popliteal veins) |
| Lung Ultrasound | Identifies the sliding (parietal and visceral pleura) and the appropriate pattern of lung aeration (ie, A-lines, B-lines) | Locates the hemidiaphragm on one side |
| Abdominal Ultrasound | Identifies the bladder and estimates the volume | Locates the right kidney in longitudinal and transverse planes |
| Cardiac Ultrasound | Estimates left ventricular systolic function (hyperdynamic, normal, mild dysfunction, moderate dysfunction, severe dysfunction) | Locates the cardiac parasternal long axis view & identify the left ventricle, right ventricle, left atrium, proximal aorta, valves and pericardium |

**APPENDIX 7: Skills Assessment Forms**

# Assessments (Pre and Post)

Faculty Score Sheet - Prompts for Skills Based Assessment

Faculty ID #: Learner #: Date:

**Initial machine set up**: Machine is on, linear transducer probe attached, vascular preset, at maximal depth, maximal reduction of total field gain, with image marker on the left of screen.

**Lung/Abdomen set up:** Phased array transducer attached (by either instructor or learner), abdomen preset, image marker on the left of the screen.

**Time:** 15 minutes

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Verbal Prompt to Learner** | **Task Demonstration** | **Done**  **(1 Point Each)** | **Not Attempted** | **Done Incorrectly** | **Comments** |
|  | **Vascular** |  |  |  |  |
| 1. “Assess the IJ for venous access” | Pre-scan the lung looking for sliding on both sides |  |  |  |  |
|  | Examine/compress IJ |  |  |  |  |
|  | Scan both sides of the neck |  |  |  |  |
| 1. "Demonstrate a DVT exam of one leg" | Include CFV, GSV, FV, Popliteal |  |  |  |  |
|  | Images Optimized in Vascular  (Gain, Depth, Correct Transducer, Image Marker in Proper Location) |  |  |  |  |
|  | **Lung** |  |  |  |  |
| 1. “Locate sliding lung on one side and A-lines” | Show sliding lung & A-lines |  |  |  |  |
| 1. "Demonstrate a screening exam of one lung" | Show longitudinal scan lines in with mid-clavicular line, anterior axillary line, mid-axillary line, posterior axillary line. |  |  |  |  |
| 1. “Locate the hemi-diaphragm on one side” | Show hemi-diaphragm |  |  |  |  |
|  | Images Optimized in Lung  (Gain, Depth, Correct Transducer, Image Marker in Proper Location) |  |  |  |  |
|  | **Abdomen** |  |  |  |  |
| 1. “Locate one kidney in longitudinal and transverse planes” | Show kidney in both planes |  |  |  |  |
| 1. “Locate the hepato-renal recess” | Show recess |  |  |  |  |
| 1. “Locate the bladder” | Show the bladder |  |  |  |  |
|  | Images Optimized in Abdomen  (Gain, Depth, Correct Transducer, Image Marker in Proper Location) |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Verbal Prompt to Learner** | **Task Demonstration** | **Done**  **(1 Point Each)** | **Not Done** | **Done Incorrectly** | **Comments** |
|  | **Cardiac** |  |  |  |  |
| 1. “Locate the cardiac parasternal long axis view & identify the LV, RV, LA, proximal aorta, valves and pericardium” | Show the parasternal long axis view and identify structures |  |  |  |  |
| 1. “Locate a parasternal short axis view at the papillary muscle level” | Show parasternal short axis at the papillary muscle level |  |  |  |  |
| 1. “Locate the apical 4 chamber view & identify the LV, RV, LA, RA & valves.” | Show apical 4 chamber view & identify structures |  |  |  |  |
| 1. “Locate the subcostal 4 chamber view and identify the LV, RV, LA, RA & valves.” | Show subcostal 4 chamber view & identify structures |  |  |  |  |
| 1. “Locate the IVC in longitudinal axis with entry into the RA” | Show the IVC in longitudinal axis & entry into the RA |  |  |  |  |
| 1. “Locate the Aorta in longitudinal and transverse planes” | Show the Aorta in Longitudinal and Transverse Planes.” |  |  |  |  |
|  | Images Optimized in Abdomen  (Gain, Depth, Correct Transducer, Image Marker in Proper Location) |  |  |  |  |

**TOTAL (Out of 20)**

**Add Points From**

**“Done” Column**

**From All Sections:**

This certifies that the above individual completed the skills evaluation in accordance with the goals and objectives of the Point of Care Ultrasonography Program.

1Adapted from CHEST Ultrasonography Courses

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