Course Description

The Clinical Foundations of Ultrasound is the first stage of a four-year integration of the Ultrasound in Medical Education curriculum. By learning the physics and optimization of ultrasound image acquisition, it serves as an introduction to live ultrasound anatomy and physiology. This helps students connect what they learn in basic science courses, anatomy laboratory, and basic clinical foundations and provides additional opportunities to practice patient-physician communication and draping techniques. This is achieved through participation in a series of hands-on sessions led by senior medical students, residents, fellows, and faculty. Students are evaluated periodically throughout the year including on the OSCE exam.

CLINICAL FOUNDATIONS I

Topics, Objectives, and Expected Competencies

Session I: Knobology
Describe the layout of the ultrasound system in terms of button location and functionality. Understand the concepts of frequency, depth, and gain effect on the image. Appreciate the artifacts of low attenuation, high attenuation, refraction, reverberation and mirror image. Understand which transducer is necessary to image each organ. Describe the orientation of the transducer with respect to the image on the screen.

Hands-on Objectives:
1. Turn on machine
2. Enter patient medical record number
3. Enter student name
4. Activate appropriate transducer
5. Adjust depth
6. Adjust Frequency
7. Adjust Gain
8. Demonstrate indicator orientation
9. Save images

You will be evaluated on knowledge of location and function of knobology.

Session II: Cardiovascular 1
Obtain subcostal, parasternal long, parasternal short, and apical 4-chamber views of the heart. Trace the pericardium in all four views of the heart. Identify the mitral valve, tricuspid valve, and aortic valve. Identify the descending aorta in parasternal long axis.
Parasternal Long Axis (PSL)
1. Activate the cardiac software setting
2. Choose the correct transducer to image the heart in the parasternal long axis
3. Place the patient in the correct position to obtain a PSL view
4. Aim the indicator in the correct direction
5. Demonstrate the RV, LV, LA, Mitral and Aortic valves
6. Appreciate the contractility of the LV and measure LVOT diameter (save it)
7. Verify how the anterior septal leaflet of the mitral valve contacts the septum

Parasternal Short Axis (PSS)
7. Aim the indicator in the correct direction to obtain a PSS view
8. Demonstrate the aortic valve, mitral valve, and papillary muscles
9. Identify the LV and the RV

Apical Four Chamber (A4C)
10. Aim the indicator to the correct position to obtain A4C
11. Trace the LV, RV, LA, RA and identify the septum
12. Appreciate the chamber size differences (RV 2/3 of LV)

Apical “fifth” Chamber (A5C)
13. From A4C, tilt transducer anteriorly to obtain A5C
14. Activate pulsed wave Doppler over Aortic valve and note the cardiac output

Sub-Costal View (SC)
15. Aim the indicator in the correct direction to obtain SC view and instruct patient to inhale deeply while flattening out transducer
16. Identify the RA, LA, RV, LV
17. Trace the pericardium

All image acquisition will be evaluated based on the following criteria:
-Can the organ and anatomy of interest be identified?
-Can the various chambers of the heart be identified from all views
-Is the proper transducer being used with the correct indicator orientation?
-Was the image obtained at the proper depth, gain, and frequency?

Session III: GI physiology
Trace the liver as it lies under the skin. Appreciate the gallbladder in its position within the main interlobar fissure of the liver. Understand the anatomy of the portal triad and utilize color Doppler to enhance visualization. Trace the spleen in its location under the skin. View the proximal esophagus adjacent to the trachea and observe saliva and air during swallowing. Perform "mowing the lawn" compression technique to observe intestinal loops.
Hepatobiliary System
1. Choose the correct transducer to assess the hepatobiliary system
2. Place the patient in the correct position to assess the hepatobiliary system
3. Demonstrate the gallbladder in long and short axis using both approaches:
   a. Subcostal Sweep
   b. X minus 7
4. Demonstrate the portal vein, hepatic veins, and IVC
5. Measure the common bile duct
6. Measure the long and short axis of the spleen

Intestinal system
7. Choose the correct transducer to assess the intestinal system
8. Demonstrate the esophagus and observe saliva being swallowed *Not Covered in Podcast but easy to do
9. Demonstrate compression of the abdominal wall musculature down to psoas muscle in an effort to visualize the appendix

All image acquisition will be evaluated based on the following criteria:
- Can the organ and anatomy of interest be identified?
- Is the proper transducer being used with the correct indicator orientation?
- Was the image obtained at the proper depth, gain, and frequency?
- Were adequate measurements taken?

Session IV: Cardiovascular 2
Using the parasternal long axis, measure the diameter of the left ventricular outflow tract. Using the apical 5-chamber view, maneuver the pulsed-wave Doppler gate over the aortic valve and operate the software to trace the velocity-time interval and calculate the cardiac output. Visualize color Doppler in the carotid arteries and note the intima-media thickness. Visualize the abdominal aorta from the celiac axis past the superior mesenteric artery and down to the bifurcation

Parasternal Long Axis (PSL)
1. Activate the cardiac software setting
2. Choose the correct transducer to image the heart in the parasternal long axis
3. Place the patient in the correct position to obtain a PSL view
4. Aim the indicator in the correct direction
5. Demonstrate the RV, LV, LA, Mitral and Aortic valves
6. Appreciate the contractility of the LV and measure LVOT diameter (save it)
7. Verify how the anterior septal leaflet of the mitral valve contacts the septum
8. Measure the Left Ventricular Outflow Tract Diameter (LVOTD)
9. Save this value using the ultrasound machine software

Apical Four Chamber (A4C)
9. Aim the indicator to the correct position to obtain A4C
10. Trace the LV, RV, LA, RA and identify the septum
11. Appreciate the chamber size differences (RV 2/3 of LV)
12. Apply colorflow Doppler over the tricuspid and mitral valves and observe the lack of a blue jet flowing backwards into atria

**Apical “fifth” Chamber (A5C)**
12. From A4C, tilt transducer anteriorly to obtain A5C
14. Activate pulsed wave Doppler over Aortic valve and note the cardiac output

All image acquisition will be evaluated based on the following criteria:
- Can the organ and anatomy of interest be identified?
- Is the proper transducer being used with the correct indicator orientation?
- Was the image obtained at the proper depth, gain, and frequency?
- Were the correct measurements taken?
- Were the correct applications used?

**Session V: Respiratory**
Demonstrate the windows necessary to view the lung fields in their entirety. Identify the pleural line in its location between each rib level. Appreciate the diaphragmatic excursion using coronal planes. Locate the cupula of the lung and the proximity to the subclavian vein.

**PNEUMOTHORAX**
1. Choose the correct transducer to assess for pneumothorax
2. Place the patient in the correct position to assess for pneumothorax
3. Identify bilateral lung sliding in 2D and M-Mode
   - What is the VPPI?
   - Describe “ants marching” and “sky-ocean-beach”
4. Demonstrate m-mode tracing

**PLEURAL EFFUSION**
5. Choose the correct transducer to assess for pleural effusion
6. Place the patient in the correct position to assess for pleural effusion
7. Identify the diaphragm and the mirror image artifact
   - Right chest
   - Left chest

**PULMONARY EDEMA**
8. Choose the correct transducer to assess for pulmonary edema
9. Demonstrate the 8 locations (4 per chest)
   - Identify A-lines in these location

**PNEUMONIA**
10. Choose the correct transducer to assess for pneumonia
11. Place the patient in the correct position
12. Identify the locations of the transducer needed to assess for pneumonia

All image acquisition will be evaluated based on the following criteria:
- Can the organ and anatomy of interest be identified?
- Is the proper transducer being used with the correct indicator orientation?
- Was the image obtained at the proper depth, gain, and frequency?
- Were the correct measurements taken?
- Were the correct applications used?

**Session VI: Musculoskeletal**
Differentiate the various soft tissue types such as muscle, bone, tendon, vasculature, nerve, and fat. Appreciate the joint spaces, musculature, and tendons during passive range of motion. Bones of the shoulder, knee, and hand should be identified. Utilize the water bath and gel standoff pads to view structures in the hand.

**Hands-on Objectives:**

**Shoulder**
1. Identify biceps tendon between subscapularis and supraspinatus in rotator cuff interval in both short and long axes
2. Identify subscapularis tendon in two planes
3. Identify coraco-acromial ligament
4. Identify supraspinatus and infraspinatus muscles
5. Identify posterior gleno-humeral joint
6. Identify supraspinatus tendon

**Leg**
7. Demonstrate quadriceps tendon with attachment to patella
8. Identify the patellar tendon with attachment to tibial tuberosity
9. Identify the medial collateral ligament
10. Identify the gastrocnemius and soleus muscles with Achilles tendon in both long and short axes

**Hand**
11. Demonstrate median nerve as separate from flexor tendons
12. In long axis of wrist identify distal radius, lunate, and capitate bones
13. Identify the pulley system of the digits and observe their function under the long axis

All image acquisition will be evaluated based on the following criteria:
- Can the organ and anatomy of interest be identified?
- Is the proper transducer being used with the correct indicator orientation?
-Was the image obtained at the proper depth, gain, and frequency?
-Were the correct measurements taken?
-Were the correct applications used?

Session VII: Genitourinary

Appreciate anatomical position of the kidneys by demonstrating long and short axes. Differentiate the renal pyramids from the renal cortex and renal pelvis. Demonstrate position of the prostate in relation to the bladder. Estimate the bladder volume by taking the height, width and length measurements. Apply power Doppler to the bladder to demonstrate the urine jets entering the trigone of the bladder.

Renal
10. Choose the correct transducer to assess the kidneys
11. Demonstrate a long axis and short axis of each kidney
   Differentiate the renal capsule, cortex, and pelvis

Bladder
12. Choose the correct transducer to assess the bladder
13. Measure the three planes of the bladder and estimate the bladder volume
14. If time permits, use power flow Doppler with a very low pulse repetition frequency to assess for bladder jets

All image acquisition will be evaluated based on the following criteria:
-Can the organ and anatomy of interest be identified?
-Is the proper transducer being used with the correct indicator orientation?
-Was the image obtained at the proper depth, gain, and frequency?
-Were adequate measurements taken?

Session VIII: Head and Neck

Examine the thyroid including the isthmus in longitudinal and transverse planes. Demonstrate the anterior neck musculature and attachment points along the clavicle. Outline the jugular veins and note the change in diameter during valsalva and body inclination and how the jugular vein abruptly tapers on sagittal view. Demonstrate anterior and posterior chambers of the eye and outline the optic nerve sheath.

Hands-on Objectives:
1. Demonstrate each lobe of the thyroid in transverse plane
2. Demonstrate each lobe of the thyroid in the longitudinal plane
3. Demonstrate the musculature of zone 2 of the neck
4. Demonstrate the jugular vein with and without body inclination
5. Demonstrate the anterior segment of the eye, differentiating lens from iris
6. Demonstrate the posterior segment of the eye locating the optic nerve
CLINICAL FOUNDATIONS II
Topics, Objectives, and Expected Competencies

Session I: Welcome back scanathon practice

All image acquisition will be evaluated based on the following criteria:
- Can the organ and anatomy of interest be identified?
- Is the proper transducer being used with the correct indicator orientation?
- Was the image obtained at the proper depth, gain, and frequency?
- Were the correct measurements taken?
- Were the correct applications used?

Session II: Using Ultrasound in the Evaluation of Fever

Objectives
1. Examine for lymphadenopathy in the:
   a. pre-auricular space
   b. submandibular region
2. Identify the LP Landmarks, mark them.
3. A-Lines in the 8 different lung zones
4. Apical 4-chamber view of the heart assess for endocarditis
   a. Without color Doppler
   b. With color Doppler
5. Using the water bath technique observe the tendons in the palmar aspect of the hand
6. Gallbladder
   a. Sagittal (long axis)
   b. Transverse (Short axis)
7. Fan through the liver observing its architecture to rule out liver abscess
8. Compress abdominal musculature down to psoas muscle in the right lower quadrant in the location of the appendix.

All image acquisition will be evaluated based on the following criteria:
Session III: Focused Assessment of the Thorax Exam (FATE)

Objectives
1. Sub-Xiphoid 4-chamber view
2. Inferior Vena Cava assessment
3. Apical 4-chamber view
   Colorflow Doppler across mitral valve
4. Apical 2-chamber view
5. Parasternal Long Axis
   Note mitral valve excursion and LV contractility
6. Parasternal Short Axis
   Papillary muscles
   Fish-mouth Mitral valve
   Mercedes benz aortic valve
7. Left chest
8. Right chest

All image acquisition will be evaluated based on the following criteria:
- Can the organ and anatomy of interest be identified?
- Is the proper transducer being used with the correct indicator orientation?
- Was the image obtained at the proper depth, gain, and frequency?
- Were the correct measurements taken?
- Were the correct applications used?

Session IV: Lung Ultrasound

PNEUMOTHORAX
1. Choose the correct transducer to assess for pneumothorax
2. Place the patient in the correct position to assess for pneumothorax
3. Identify bilateral lung sliding in 2D and M-Mode
   What is the VPPI?
   Describe "ants marching" and "sky-ocean-beach"
4. Demonstrate how to assess for pneumothorax size

PLEURAL EFFUSION
5. Choose the correct transducer to assess for pleural effusion
6. Place the patient in the correct position to assess for pleural effusion
7. Identify the diaphragm and the mirror image artifact
   Right chest
Left chest

**PULMONARY EDEMA**
8. Choose the correct transducer to assess for pulmonary edema
9. Demonstrate the 8 locations (4 per chest)
   Identify A-lines in these location

**PNEUMONIA**
10. Choose the correct transducer to assess for pneumonia
11. Place the patient in the correct position
12. Identify the locations of the transducer needed to assess for pneumonia

All image acquisition will be evaluated based on the following criteria:
- Can the organ and anatomy of interest be identified?
- Is the proper transducer being used with the correct indicator orientation?
- Was the image obtained at the proper depth, gain, and frequency?
- Were the correct measurements taken?
- Were the correct applications used?

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**Session V: Gastrointestinal and Genitourinary Ultrasound**

**Hepatobiliary System**
1. Choose the correct transducer to assess the hepatobiliary system
2. Place the patient in the correct position to assess the hepatobiliary system
3. Demonstrate the gallbladder in long and short axis using both approaches:
   - Subcostal Sweep
   - X minus 7
4. Demonstrate the portal vein, hepatic veins, and IVC
5. Measure the common bile duct
6. Measure the long and short axis of the spleen

**Intestinal system**
7. Choose the correct transducer to assess the intestinal system
8. Demonstrate the esophagus and observe saliva being swallowed
9. Demonstrate compression of the abdominal wall musculature down to psoas muscle in an effort to visualize the appendix

**Renal**
10. Choose the correct transducer to assess the kidneys
11. Demonstrate a long axis and short axis of each kidney
    Differentiate the renal capsule, cortex, and pelvis

**Bladder**
12. Choose the correct transducer to assess the bladder
13. Measure the three planes of the bladder and estimate the bladder volume
14. If time permits, use power flow Doppler with a very low pulse repetition frequency to assess for bladder jets

All image acquisition will be evaluated based on the following criteria:
- Can the organ and anatomy of interest be identified?
- Is the proper transducer being used with the correct indicator orientation?
- Was the image obtained at the proper depth, gain, and frequency?
- Were the correct measurements taken?
- Were the correct applications used?

Session VI: Cumulative Skills

1. Knobology:
   a. New patient information input
   b. 2-D
   c. M-Mode
   d. Color Doppler
   e. Power Doppler
   f. Frequency (Gen-Pen-Res)
   g. Transducers
   h. Depth
   i. Gain
   j. Artifacts (posterior acoustic enhancement, refraction, reverberation, mirror)

2. DVT: femoral and popliteal
3. Abdominal vasculature: aorta, IVC, left renal vein, SMA, splenic vein.
   a. Aorta assessment
   b. IVC assessment
4. Carotid: Intimal Medial Thickness
5. Thyroid short and long axes
6. Eye: Anterior chamber, lens, iris, pupil, posterior segment, retina, optic nerve sheath
7. MSK
   a. Tissue differentiation (muscle vs bone vs tendon)
   b. Patellar tendon
   c. Gastrocnemius and soleus muscles
   d. Shoulder joint
   e. Radius and ulna bones in long and short axis

8. CARDIAC
   a. Sub-Xiphoid 4-chamber view
   b. Inferior Vena Cava assessment
   c. Apical 4-chamber view
      i. Colorflow Doppler across mitral valve
d. Apical 2-chamber view

e. Parasternal Long Axis
   i. Note mitral valve excursion and LV contractility

f. Parasternal Short Axis
   i. Papillary muscles
   ii. Fish-mouth Mitral valve
   iii. Mercedes benz aortic valve

g. Left chest

h. Right chest

9. PNEUMOTHORAX
   a. Choose the correct transducer to assess for pneumothorax
   b. Place the patient in the correct position to assess for pneumothorax
   c. Identify bilateral lung sliding in 2D and M-Mode
      i. What is the VPPI?
      ii. Describe “ants marching” and “sky-ocean-beach”
   d. Demonstrate how to assess for pneumothorax size

10. PLEURAL EFFUSION
    a. Choose the correct transducer to assess for pleural effusion
    b. Place the patient in the correct position to assess for pleural effusion
    c. Identify the diaphragm and the mirror image artifact
       a. Right chest
       b. Left chest

11. PULMONARY EDEMA
    a. Choose the correct transducer to assess for pulmonary edema
    b. Demonstrate the 8 locations (4 per chest)
       a. Identify A-lines in these location

12. PNEUMONIA
    a. Choose the correct transducer to assess for pneumonia
    b. Place the patient in the correct position
    c. Identify the locations of the transducer needed to assess for pneumonia

13. Hepatobiliary System
    a. Choose the correct transducer to assess the hepatobiliary system
    b. Place the patient in the correct position to assess the hepatobiliary system
    c. Demonstrate the gallbladder in long and short axis using both approaches:
       a. Subcostal Sweep
       b. X minus 7
    d. Demonstrate the portal vein, hepatic veins, and IVC
14. Intestinal system
   a. Choose the correct transducer to assess the intestinal system
   b. Demonstrate the esophagus and observe saliva being swallowed
   c. Demonstrate compression of the abdominal wall musculature down to psoas muscle in an effort to visualize the appendix

15. Renal
   a. Choose the correct transducer to assess the kidneys
   b. Demonstrate a long axis and short axis of each kidney
      a. Differentiate the renal capsule, cortex, and pelvis

16. Bladder
   a. Choose the correct transducer to assess the bladder
   b. Measure the three planes of the bladder and estimate the bladder volume
   c. If time permits, use power flow Doppler with a very low pulse repetition frequency to assess for bladder jets

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- Were the correct measurements taken?
- Were the correct applications used?

CLINICAL FOUNDATIONS III
Topics, Objectives, and Expected Competencies

This two-hour session that begins just prior to ward rotations will serve three purposes:

1. Work with various simulators to identify pathology
   a. Gallstones
   b. Abdominal Aortic Aneurysm
   c. Hydronephrosis
   d. Hemoperitoneum
   e. Hemothorax
   f. Pericardial tamponade
   g. Poor ejection fraction
   h. Dehydration
   i. Deep Vein Thrombosis

2. Obtain basic competence in needle localization to a target under
ultrasound guidance
  a. Phantom skill station

3. Orient students to hand-held device
  a. SonoSite NanoMaxx with three transducers
  b. How to save images for review
  c. Policy on what to do when you find something

Policies Clinical Foundations Ultrasound

Clinical Foundations of Ultrasound sessions will be held in the Clinical Skills Center. Students are assigned a schedule time and location of attendance. These assignments facilitate efficient use of the time spent in ultrasound sessions, please be aware that these assignments are mandatory and students will not be able to switch groups, rooms, day, or time assignments.

Given the nature and recent implementation of CF Ultrasound, meeting core competencies will not generate its own course grade, however it will be reflected significantly in other areas of the curriculum and participation is mandatory. Ultrasound testing will be incorporated throughout the year in Anatomy and on the OSCE.

Remediation

Students must be prepared to demonstrate skills obtained in previous sessions and complete the tasks of the current session. Failure to meet core CF Ultrasound competencies in each session will result in remediation as instructed by the course director.

Attendance

Attendance and punctuality are expected at all assigned sessions. Any student more than ten minutes late to a CF Ultrasound session will be considered absent. A missed session is a lost learning opportunity. The first absence will be addressed by the Ultrasound Director. If there is a second offense the student will receive a citation and it will be addressed by the CF I Course Director. A third offense will be addressed by the Dean of Student Affairs.

It is a violation of the UC IRVINE School of Medicine Honor Code to sign in for another student, and will result in a peer review and/or Promotions and Honors Committee (P&H) hearing for both students.
**Code of Conduct**

Patients are present at essentially all ultrasound sessions. Any time a student is attending a mandatory CF Ultrasound session or any time a patient is present, medical students must dress professionally. Professional attire includes: the short white ironed lab coat, student ID and stethoscope. Men should wear slacks, collared long-sleeved shirts and ties. Women should dress professionally (business professional) with hair pulled back and nails trimmed. Blue jeans, scrubs, cargo pants, open toe and tennis shoes are not appropriate. No food, drinks, backpacks, or purses will be allowed in the CF Ultrasound sessions.

**Feedback**

Any student seeking feedback or additional ultrasound practice should contact the course coordinator or the course director. Additional Ultrasound Skills Lab Hours will be held throughout the year. The schedules hours can be found on the Ultrasound in Medical Education website calendar www.ultrasound.uci.edu