Medical Student Ultrasound Symposium

Event Syllabus & Workbook

August 24 & 25, 2013

THANK YOU!

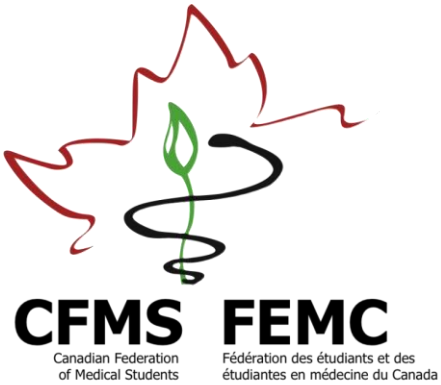
The Western Medical Student Ultrasound Symposium planning committee would like to thank all faculty and resident instructors for graciously donating their time and energy in support of this event.

We would like to acknowledge both the Hippocratic Council at the *Schulich School of Medicine & Dentistry* as well as the Canadian Federation of Medical Students for making the symposium possible through their generous financial contributions.

In addition, we would like to recognize Philips Canada, SonoSite Canada, Siemens Canada and General Electric Canada for supplying ultrasound equipment for the weekend.

Also, thanks to the staff at the Canadian Surgical Technologies and Advanced Robotics at London Health Sciences Centre for their expertise and guidance.

Finally, we are appreciative to the Canadian Association of Emergency Physicians for officially endorsing this event.



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WELCOME

Dear Colleagues,

It is with great pleasure that we welcome you to our first ever Medical Student Ultrasound Symposium here at the *Schulich School of Medicine & Dentistry* at *Western University*. Together, you represent a group of highly motivated individuals who have shown interest in the application of ultrasonography at the bedside. Thank you for taking the time during one of the last weekends of your summer to participate.

This event would not have been possible without the support of the many individuals and organizations acknowledged on page 2 of this workbook. However, we would like to give special mention to Dr. Robert Arntfield, Dr. Drew Thompson and Dr. Sugantha Ganapathy for their expertise, guidance and passion, which first became apparent with the launch of the point-of-care ultrasound interest group at *Schulich* in September 2012. Their dedication continues to inspire a growing group of ultrasound enthusiasts within the *Schulich* medical student community.

At this symposium, our goal is to introduce you to various applications of point-of-care ultrasonography that will serve as a foundation for future learning and clinical application. We are confident that you will acquire new knowledge and skills that will prove useful in your future medical education and later in your careers. It is our hope that this two-day event ignites a passion for bedside ultrasound that can be shared with fellow students at your home institutions.

There are several interactive discussions and hands-on workshops planned for the weekend. In preparation, we recommend you peruse the 'Pre-Symposium Materials' detailed on the next page. We hope the workbook materials will serve as a valuable reference during the weekend and beyond. Finally, if you are interested in bringing point-of-care ultrasound to students at your home institutions, we encourage you to check out the 'Post-Symposium Materials' outlined on page 40.

Enjoy the symposium!

Sonographically,

Western Medical Student Symposium Planning Committee

PRE-SYMPOSIUM MATERIALS

Below are several valuable educational resources we encourage participants to peruse in advance of the symposium. These resources are easily accessible from the Western Sono website via the link at the bottom of this page.

Though not mandatory, we highly recommend all participants complete the Ultrasound Fundamentals tutorial (number 1 in the list below). A sound understanding of the basics will allow participants to make the most of hands-on scanning time over the course of the weekend.

1. Point-of-Care Ultrasound: The Fundamentals by Chris Byrne and Dr. Robert Arntfield
2. Cardiac Ultrasound: Subxiphoid Scanning Technique by Dr. Ram Reddy
3. Cardiac Ultrasound: Left Ventricular Function Assessment by Dr. Danny Peterson
4. Lung Ultrasound: Image Acquisition by Dr. Robert Arntfield
5. Focused Assessment with Sonography in Trauma: Scanning Technique by Dr. Heather Hames
6. Obstetrical and Gynecological Ultrasound: Scanning Technique by Dr. Drew Thompson
7. Obstetrical and Gynecological Ultrasound: Positive Obstetrical Study by Dr. Drew Thompson
8. Abdominal Aorta Ultrasound: Scanning Technique by Dr. Drew Thompson
9. Renal Ultrasound: Image Interpretation & Hydronephrosis by Dr. Behzad Hassani
10. Procedural Ultrasound: Sterile Technique for Ultrasound Guided Central Line by Dr. Robert Arntfield

The above resources are easily accessible from the Western Sono website at the following link:

http://westernsono.ca/pre-symposium-materials/

AGENDA: AUGUST 24, 2013

Time	Event	Location
0830	**Registration & Breakfast**	CSTAR Lobby
0900	**Welcome & Introduction**: Planning Committee	Multimedia Theatre
0910	**Program Overview**: Planning Committee	Multimedia Theatre
0915	**Keynote Lecture**: Robert Arntfield	Multimedia Theatre
1000	**Ultrasound Fundamentals**: Chris Byrne & Robert Arntfield	Multimedia Theatre
1045	*BREAK*	
1100	**Cardiac Ultrasound**: Robert Arntfield	Skills Lab
1230	**Lunch**	CSTAR Lobby
1330	**Lung Ultrasound**: Robert Arntfield	Skills Lab
1430	**Focused Assessment with Sonography in Trauma**: Drew Thompson	Skills Lab
1530	**Obstetrical and Gynecological Ultrasound**: Drew Thompson	Skills Lab
1630	**Free Scanning Time**	Skills Lab
1700	**End of Day**	CSTAR Lobby
1930	**Social Event**: Appetizers Provided	Joe Kool's Patio

AGENDA: AUGUST 25, 2013

Time	Event	Location
0830	**Registration & Breakfast**	CSTAR Lobby
0900	**Ultrasound in Medical Education**: Matt Dawson & Mike Mallin	Multimedia Theatre
0930	**Aorta, Hepatobiliary & Renal Ultrasound**: Drew Thompson	Skills Lab
1100	**Procedural Ultrasound**: Sugantha Ganapathy	Skills Lab
1300	**Lunch**	CSTAR Lobby
1400	**Sono Games**: Ramiro Arellano & Dave Ouellette	Skills Lab
1630	**End of Day**	CSTAR Lobby

WORKSHOP: CARDIAC ULTRASOUND

Objectives:

1. Review pertinent anatomy in the thoracic cavity.
2. Appreciate the anatomic landmark used to orient subxiphoid ultrasound assessment of the heart.
3. Appreciate the sonographic landmark used to identify the area of interest during subxiphoid ultrasound assessment of the heart.
4. Describe the area of interest visible during subxiphoid ultrasound assessment of the heart.
5. Briefly describe the technique used in subxiphoid ultrasound assessment of the heart.
6. Describe two major indications for bedside ultrasound assessment of the heart.
7. Describe how to distinguish between a small pericardial effusion and epicardial fat during subxiphoid ultrasound assessment of the heart.
8. Recognize other commonly used acoustic windows applied during ultrasound assessment of the heart.
9. Briefly review a scenario demonstrating clinical application of bedside cardiac ultrasound.

WORKSHOP: CARDIAC ULTRASOUND

Review pertinent anatomy in the thoracic cavity.

The heart and great vessels are approximately in the _____ of the thorax.	*middle*
The heart and roots of the great vessels are posterior to the sternum, costal cartilages, and the medial ends of the _____ ribs on the left side.	*third to fifth*
The _____ of the heart is directed towards the left hip and is formed by the anterolateral part of the left ventricle. It is located posterior to the left fifth intercostal space in adults, usually about 9 cm from the midsternal line.	*apex*
The anterior surface of the heart is formed mainly by the _____.	*right ventricle*
The inferior or diaphragmatic surface is formed mainly by the _____ and partly by the right ventricle.	*left ventricle*

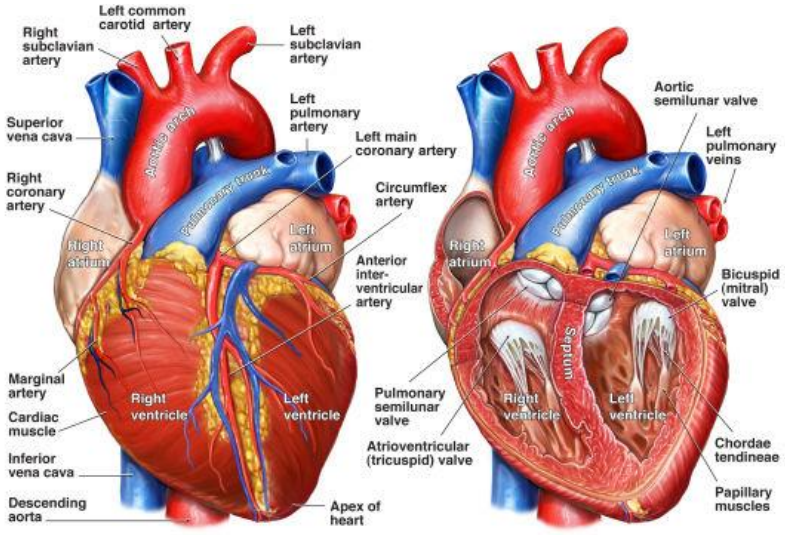

Figure 1. The image on the left shows the external anatomy of the heart, coronary vessels, and the great vessels. The image on the right depicts a cut away view of the heart revealing its internal anatomy, including the ventricles, atria, and valves.

Appreciate the anatomic landmark used to orient subxiphoid ultrasound assessment of the heart.

Our aim is to generate a _____ view of the heart.	*coronal*
The _____ serves as a reminder of where to initially place the probe on a patient's body when beginning a subxiphoid ultrasound study of the heart.	*umbilicus*

WORKSHOP: CARDIAC ULTRASOUND

Appreciate the sonographic landmark used to identify the area of interest during subxiphoid ultrasound assessment of the heart.

The _____ serves as an acoustic window in locating the sonographic landmark, which in this case is the heart itself.	*liver*

Describe the area of interest visible during subxiphoid ultrasound assessment of the heart.

A bright echogenic line in the immediate far field of the liver represents the inferior _____. This is the area of interest.	*pericardium*
The fluid-filled, hypoechoic _____ is in the immediate far field of the inferior pericardium.	*right ventricle*
A bright echogenic line representing the _____ separating the right and left ventricles is also visible.	*interventricular septum*

Briefly describe the technique used in initial bedside ultrasound assessment of the heart.

The patient should be assessed in the _____ position.	*supine*
A curvilinear or _____ probe can be used. The depth should initially be set at about 20 cm.	*phased-array*
The examiner should be oriented with the probe marker to the patient's _____ and the probe perpendicular to the patient's skin.	*right*
The assessment should begin with a subxiphoid approach, with the probe initially placed just superior to the umbilicus and translated cephalad until the heart and inferior _____ are visible.	*pericardium*
A full _____ of the heart should be performed such that the posterior pericardial cavity is not missed.	*sweep*

Describe two major indications in bedside ultrasound assessment of the heart.

To detect the presence of pericardial _____ and to assess global systolic function.	*effusion*

WORKSHOP: CARDIAC ULTRASOUND

Describe how to distinguish between a small pericardial effusion and epicardial fat.

Epicardial fat can sometimes mimic the appearance of a small pericardial effusion. In the supine position, pericardial fluid will accumulate in the _____, gravity-dependent portions of the pericardial cavity.

posterior

Recognize other commonly used acoustic windows applied during ultrasound assessment of the heart.

For the _____ long axis view of the heart, a phased-array probe should be placed in the third or fourth intercostal space, immediately left of the sternum. When the screen orientation marker is on the left of the image, the probe orientation marker should point toward the patient's left _____.

parasternal

hip

From the parasternal long axis view, rotate the probe orientation marker to the right hip to obtain a parasternal _____ view.

short axis

The apical four chamber view is obtained at the _____ of the heart, which is typically located at the nipple line. The probe should be positioned at the point of maximal impulse, aiming towards the patient's _____ shoulder.

apex

right

Briefly review a scenario demonstrating clinical application of bedside cardiac ultrasound.

Scenario: A 22-year-old male presents with chest pain that is worse in the supine position and improved with erect posture or sitting up. A rough, scratchy sound is heard on cardiac auscultation. ECG findings include diffuse ST segment elevation. He reports symptoms of an upper respiratory tract infection that began three days ago. You suspect a diagnosis of pericarditis.

_____ is characterized by the accumulation of pericardial fluid under pressure. As a result, cardiac filling is impeded.

cardiac tamponade

As cardiac tamponade progresses, the chambers become smaller and chamber _____ compliance is reduced.

diastolic

Acute cardiac tamponade is life-threatening if not promptly treated. Signs and symptoms include chest pain, tachypnea, and dyspnea with markedly elevated _____ pressure.

jugular venous

WORKSHOP: LUNG ULTRASOUND

Objectives:

1. Review pertinent anatomy in the thoracic cavity.
2. Appreciate the anatomic landmarks used to orient ultrasound assessment of the lungs and pleura.
3. Appreciate the sonographic landmarks used to identify the areas of interest during ultrasound assessment of the lungs and pleura.
4. Describe the areas of interest visible during ultrasound assessment of the lungs and pleura.
5. Briefly describe the technique used in ultrasound assessment of the lungs and pleura.
6. Understand the value of a focused clinical question in the context of ultrasound assessment of the lungs and pleura.
7. Briefly review a scenario demonstrating clinical application of bedside lung and pleura ultrasound.

WORKSHOP: LUNG ULTRASOUND

Review pertinent anatomy in the thoracic cavity.

The _____ lung contains superior, middle and inferior lobes. The left lung contains superior and inferior lobes.	*right*
The _____ pleura covers the lungs and is adherent to all its surfaces.	*visceral*
The _____ pleura is adherent to the thoracic wall, the mediastinum, and the diaphragm.	*parietal*
The _____ is the potential space between the visceral and the parietal layers of the pleura. It contains a layer of serous pleural fluid, which lubricates the pleural surfaces and allows them to slide smoothly over one another during respiration.	*pleural cavity*
At the _____, the lung pleura extend superiorly into the root of the neck 2 to 3 cm superior to the level of the medial third of the clavicle. Inferiorly, the pleura cover the superior surface of the diaphragm.	*apices*

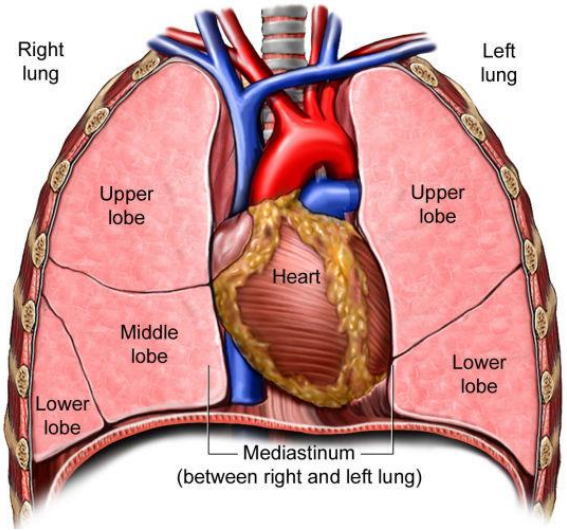

Figure 1. Anterior view of the thorax depicting lung anatomy and the relationship of the lungs to other thoracic structures.

WORKSHOP: LUNG ULTRASOUND

Appreciate the anatomic landmarks used to orient ultrasound assessment of the lungs and pleura.

The lungs can be imaged from anywhere on the thorax, but an approach that balances comprehensiveness and efficiency is most practical.	
Each hemithorax should be assessed via four anatomic landmarks.	
The first is the _____ chest wall at the second or third intercostal space along the midclavicular line.	*anterior*
Second is the lateral chest wall at the fourth or fifth intercostal space along the _____ line. This region corresponds to the nipple area in most patients.	*anterior axillary*
The third landmark represents the _____ angle, which can be found along the mid-axillary line, just inferior to where the lateral chest wall is scanned.	*costophrenic*
The fourth landmark is known as the _____ point. It represents an extreme inferior and posterolateral probe position that is a hotspot for lung pathology.	*PLAPS*

Appreciate the sonographic landmark used to identify the area of interest during ultrasound assessment of the lungs and pleura.

The ribs and their corresponding acoustic _____ represent sonographic landmarks that help identify the area of interest.	*shadows*
The liver and _____ are additional landmarks that help guide the costophrenic angle and PLAPS views, depending on which hemithorax is being scanned.	*spleen*

Describe the areas of interest visible during ultrasound assessment of the lungs and pleura.

The first bright, hyperechoic line deep to the onset of a rib's acoustic shadow represents the _____, which is the area of interest.	*pleural line*
For the costophrenic and PLAPS views, the bright, hyperechoic _____ represents an additional area of interest.	*diaphragm*

WORKSHOP: LUNG ULTRASOUND

Briefly describe the technique used in initial bedside ultrasound assessment of the lungs and pleura.

The patient should be assessed in the _____ position. *supine*

Any probe can be used, though the linear probe does not have much value outside of assessing for the presence or absence of _____. *lung sliding*
When using the curvilinear or phased-array probe, depth is typically set to 10 cm.

The examiner should be oriented with the probe marker to the patient's _____ and the probe perpendicular to the patient's skin. *head*

The lungs and pleura should be systematically assessed via the anatomic landmarks previously described, highlighting the presence of absence of lung sliding, A lines, and _____. *B lines*

Highlight the importance of a focused clinical question in the context of lung ultrasound assessment.

The clinical context and suspected disease process can help guide lung ultrasound assessment: _____ rises, fluid sinks, and parenchymal disease can be patchy. *air*

Briefly review a scenario demonstrating clinical application of bedside lung ultrasound.

Scenario: A 26-year-old man is involved in an altercation in the parking lot after a hockey game. He suffers a single stab wound 2 cm superior to the right nipple. His blood pressure is 115/78 mm Hg and his heart rate is 75 beats per minute. He does not appear to be in any respiratory distress.

A _____ represents an abnormal collection of gas in the pleural space. *pneumothorax*

On ultrasound assessment, the presence of _____ rules out a pneumothorax at the position being scanned. *lung sliding*

Evidence of laboured breathing and hemodynamic compromise suggests a possible tension pneumothorax, which necessitates emergency _____. *decompression*

WORKSHOP: FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA (FAST)

Objectives:

1. Describe the main objectives of the FAST exam.
2. Review pertinent anatomy in the abdominal cavity.
3. Appreciate the anatomic landmarks used to orient the FAST exam.
4. Appreciate the sonographic landmarks used to identify the areas of interest during the FAST exam.
5. Describe the areas of interest visible during the FAST exam.
6. Briefly describe the technique used during the FAST exam.
7. Explain three major limitations of the FAST exam in assessing for intra-abdominal injury.
8. Briefly review a scenario demonstrating clinical application of the FAST exam.

WORKSHOP: FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA (FAST)

Describe the main objective of the FAST exam.

The main objective of the FAST exam is to detect free intraperitoneal, intrathoracic, or pericardial fluid in the setting of _____. Here we will focus on the intraperitoneal component of the FAST exam.	*trauma*

Review pertinent anatomy in the abdominal cavity.

The right paracolic gutter runs from the hepatorenal recess (also known as _____) to the pelvis.	*Morison's pouch*
The left paracolic gutter is not as deep as the right paracolic gutter. In addition, the _____ ligament blocks some fluid movement to the left paracolic gutter.	*phrenicocolic*
As a result, fluid generally flows more freely toward the _____ paracolic gutter.	*right*
The hepatorenal recess represents a _____ space located in the right upper quadrant between the external surface of the liver and the renal fascia.	*potential*
The _____ is the potential space located in the left upper quadrant between the spleen and the renal fascia.	*splenorenal recess*
Owing to the position of the splenocolic ligament, blood usually collects in the _____ space in the left upper quadrant in the setting of hemorrhage from the splenic hilum.	*subdiaphragmatic*

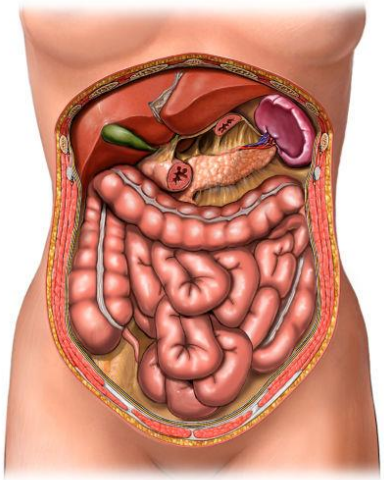

Figure 1. Anterior view of the abdomen, showing normal anatomy.

WORKSHOP: FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA (FAST)

Appreciate the anatomic landmarks used to orient the FAST exam.

Irrespective of whether the right or left upper quadrant is being assessed, the anatomic landmark is the anterior axillary line at the level of the _____.	*xiphoid*

Appreciate the sonographic landmark used to identify the area of interest during the FAST exam.

For both the right and left upper quadrants, the double density of the _____ represents the sonographic landmark that assists in identifying the area of interest.	*kidney*

Describe the areas of interest visible during the FAST exam.

For the right upper quadrant, the area of interest is the _____.	*hepatorenal recess*
For the left upper quadrant, the area of interest is the _____.	*splenorenal recess*
Being potential spaces, these recesses are normally represented by a bright white or _____ line that represents an interface between the kidney and liver or spleen.	*hyperechoic*
In the left upper quadrant, one must also pay special attention to the echogenic _____ as blood often collects in the subdiaphragmatic space in the setting of shear injury at the splenic hilum.	*diaphragm*

Briefly describe the technique used during the FAST exam.

The patient should be assessed in the _____ position.	*supine*
A phased-array or curvilinear probe may be used. Some sonographers prefer the narrower-footprint _____ probe as one can obtain images between the ribs more readily.	*phased-array*
The examiner should be oriented with the probe marker to the patient's _____ and the probe perpendicular to the patient's skin.	*head*

WORKSHOP: FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA (FAST)

To get a good view of the entire recess, the probe can be moved along the longitudinal plane of the _____ line.	*anterior axillary*
The _____ of the kidney should be viewed on both right and left upper quadrant views as it is the most posterior or dependent part of the peritoneal cavity.	*inferior pole*
It is also important to _____ anterior and posterior to ensure the entire area is assessed.	*sweep*

Explain three major limitations of the FAST exam in assessing for intra-abdominal injury.

The FAST exam is insensitive in diagnosing hemorrhagic injuries involving the _____.	*retroperitoneum*
A minimum of _____ of free fluid is required for detection.	*200-250 ml*
The exam can be particularly challenging in _____ patients.	*obese*

Briefly review a scenario demonstrating clinical application of the FAST exam.

Scenario: An 18-year-old male has had a sore throat, mild abdominal pain, and fever for 4 days. He was playing football with some friends, and was tackled just short of the goal line, hitting the turf somewhat forcibly. He complains of abdominal pain and passes out. EMS is called and his vital signs reveal a heart rate of 140 beats per minute and a blood pressure of 80/40 mm Hg. His abdomen is distended.

The _____ is one of the most commonly injured intra-abdominal organs. The diagnosis and prompt management of potentially life-threatening hemorrhage is the main goal.	*spleen*
Emergent _____ or embolization remains a life-saving measure for unstable patients.	*splenectomy*
Infection with the _____ virus is associated with splenic rupture in the setting of abdominal trauma.	*Epstein-Barr*

WORKSHOP: FOCUSED OBSTETRICAL AND GYNECOLOGICAL ULTRASOUND

Objectives:

1. Review pertinent anatomy in the female pelvis.
2. Appreciate the anatomic landmark used to orient transabdominal ultrasound assessment of the female pelvis.
3. Appreciate the sonographic landmark used to identify the area of interest during transabdominal ultrasound assessment of the female pelvis.
4. Describe the area of interest visible during transabdominal ultrasound assessment of the female pelvis.
5. Briefly describe the technique used in transabdominal ultrasound assessment of the female pelvis.
6. Describe two major indications for transabdominal ultrasound assessment of the female pelvis.
7. Describe three ways to optimize transabdominal ultrasound assessment of the female pelvis.
8. Briefly review a scenario demonstrating clinical application of bedside ultrasound assessment of the female pelvis.

WORKSHOP: FOCUSED OBSTETRICAL AND GYNECOLOGICAL ULTRASOUND

Review pertinent anatomy in the female pelvis.

The _____ is a cartilaginous joint formed by the midline union of the pubic bones.	*symphysis pubis*
When the urinary bladder is empty, it rests posterior and slightly superior to the pubic bones. As the bladder fills, it may ascend as high as the level of the _____.	*umbilicus*
The _____ of the bladder points toward the superior edge of the symphysis pubis.	*apex*
The fundus is opposite of the apex, forming the bladder's _____ wall.	*posterior*
The uterus is a thick-walled, pear-shaped, hollow muscular organ. In the setting of an empty bladder, it is usually _____, meaning tipped anterosuperiorly relative to the axis of the vagina.	*anteverted*
The body of the uterus is typically lying on the urinary bladder with its _____ wedged between the urinary bladder and the rectum.	*cervix*
The position of the uterus changes with the degree of _____ of the bladder.	*fullness*
The _____ is the inner mucous coat of the uterus, which firmly adheres to the myometrium and is actively involved in the menstrual cycle.	*endometrium*

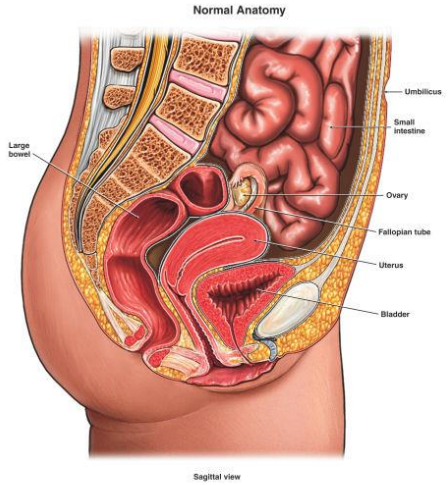

Figure 1. Mid-sagittal view of the normal anatomy of the female pelvis. In this illustration, the uterus is anteverted.

WORKSHOP: FOCUSED OBSTETRICAL AND GYNECOLOGICAL ULTRASOUND

Appreciate the anatomic landmarks used to orient trans-abdominal ultrasound assessment of the female pelvis.

The _____ serves as a reminder of where to initially place the ultrasound probe. | *symphysis pubis*

Appreciate the sonographic landmark used to identify the area of interest during trans-abdominal ultrasound assessment of the female pelvis.

The hypoechoic _____ serves as an acoustic window and is the sonographic landmark in a trans-abdominal ultrasound of the female pelvis. | *bladder*

Describe the area of interest for trans-abdominal ultrasound assessment of the female pelvis.

The bright and white echogenic _____ serves as the area of interest in a trans-abdominal ultrasound of the female pelvis. It marks the centre of the uterus. | *endometrial stripe*

Briefly describe the technique used for trans-abdominal ultrasound assessment of the female pelvis.

The patient should be assessed in the _____ position. | *supine*

A phased-array or curvilinear probe may be used. The initial depth should be set at _____. | *15-18 cm*

The examiner should begin at the pubic symphysis in the longitudinal plane with the probe marker to the patient's _____. | *head*

First look for the echogenic _____ stripe. Before assessing for features of pregnancy, the examiner must be certain that she is looking at the uterus. | *endometrial*

The recto-uterine pouch (also known as the _____) represents the most dependent region of the pelvis where free fluid tends to accumulate first. It should be assessed in every pelvic scan. | *pouch of Douglas*

With more substantial pelvic free fluid collections, one may also find evidence of fluid in the _____ pouch. | *vesico-uterine*

WORKSHOP: FOCUSED OBSTETRICAL AND GYNECOLOGICAL ULTRASOUND

The entire uterus should be swept in the longitudinal plane to look for findings of _____. A similar sweep should be performed in the transverse plane with the probe's orientation marker on the patient's right.

pregnancy

Describe two major indications for trans-abdominal ultrasound assessment of the female pelvis.

Any female of reproductive age with abdominal pain, vaginal bleeding and pre-syncope or syncope, particularly in the context of a positive _____.

beta hCG

A second scenario would be to determine the presence or absence of free fluid in the pelvis, particularly in the context of _____ or potential ruptured ectopic pregnancy.

trauma

Describe three ways to optimize trans-abdominal ultrasound assessment of the female pelvis.

A trans-abdominal pelvic ultrasound study is considered indeterminate when the examiner cannot visualize the entire uterus. The acoustic window can be maximized by filling the bladder and ensuring the ultrasound probe is as close to the _____ as possible.

symphysis pubis

Alternatively, a _____ approach can be attempted. The trans-vaginal approach is not covered in these objectives.

trans-vaginal

Briefly review a scenario demonstrating clinical application of ultrasound assessment of the female pelvis.

Scenario: A 26-year-old woman complains of severe abdominal pain, nausea, and vaginal spotting. She has a positive pregnancy test, a quantitative beta hCG of 4658 mIU/mL, and both a trans-abdominal and trans-vaginal ultrasound showing no intrauterine pregnancy.

Ectopic pregnancy most commonly occurs in the _____.

Fallopian tube

An estimated six to 16 percent of women presenting to the emergency department in their first trimester with abdominal or pelvic pain or _____ will eventually be diagnosed with an ectopic pregnancy. *Reference*: CMAJ. 2005;173(8):905.

vaginal bleeding

WORKSHOP: ABDOMINAL AORTA, HEPATOBILIARY AND RENAL ULTRASOUND

Objectives:

Part 1: Aorta

1. Review pertinent anatomy in the abdominal cavity.
2. Appreciate the anatomic landmark used to orient ultrasound assessment of the abdominal aorta.
3. Appreciate the sonographic landmark used to identify the area of interest during ultrasound assessment of the abdominal aorta.
4. Describe the area of interest visible during ultrasound assessment of the abdominal aorta.
5. Briefly describe the technique used in ultrasound assessment of the abdominal aorta.
6. Describe how to distinguish the abdominal aorta from the inferior vena cava.
7. Describe two major limitations in ultrasound assessment of the abdominal aorta.
8. Briefly review a scenario demonstrating clinical application of bedside ultrasound assessment of the abdominal aorta

Part 2: Hepatobiliary

1. Review pertinent anatomy in the abdominal cavity.
2. Appreciate the anatomic landmark used to orient ultrasound assessment of the gallbladder.

3. Appreciate the sonographic landmark used to identify the area of interest during ultrasound assessment of the gallbladder.
4. Describe the area of interest visible during ultrasound assessment of the gallbladder.
5. Briefly describe the technique used in ultrasound assessment of the gallbladder.
6. Describe how to distinguish the gallbladder from hepatic blood vessels.
7. Describe two major limitations in ultrasound assessment of the gallbladder.
8. Briefly review a scenario demonstrating clinical application of bedside ultrasound assessment of the gallbladder.

Part 3: Renal

1. Review pertinent anatomy in the abdominal cavity.
2. Appreciate the anatomic landmarks used to orient ultrasound assessment of the kidney.
3. Appreciate the sonographic landmarks used to identify the area of interest during ultrasound assessment of the kidney.
4. Describe the areas of interest visible during ultrasound assessment of the kidney.
5. Briefly describe the technique used in ultrasound assessment of the kidney.
6. Describe how to distinguish the renal sinus from the renal parenchyma during ultrasound assessment of the kidney.
7. Describe two major limitations in ultrasound assessment of the kidney
8. Briefly review a scenario demonstrating clinical application of bedside ultrasound assessment of the kidney.

PART 1: ABDOMINAL AORTA ULTRASOUND

Review pertinent anatomy in the abdominal cavity.

The abdominal aorta, approximately 13 cm in length, begins at the aortic hiatus in the diaphragm at the level of the T12 vertebra and ends at the level of the L4 vertebra by dividing into two _____ arteries.

common iliac

The level of the aortic bifurcation is 2 to 3 cm inferior and to the left of the _____ at the level of the iliac crests.

umbilicus

The _____ begins anterior to the L5 vertebra by the union of the common iliac veins.

inferior vena cava

This union occurs approximately 2.5 cm to the _____ of the median plane, inferior to the bifurcation of the aorta and posterior to the right common iliac artery.

right

The IVC ascends on the right side of the bodies of the L3-L5 vertebrae and anterior to the _____ muscle to the right of the aorta and leaves the abdomen by passing through the caval opening in the diaphragm to enter the thorax.

psoas major

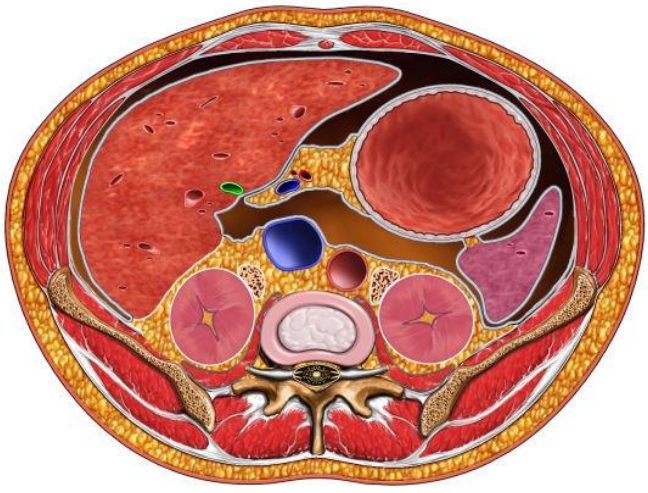

Figure 1. An abdominal cross section at the level of T12, with the abdominal aorta directly adjacent to the vertebral body. This cross section is regarded as being viewed from the patient's feet, so the left side of the illustration as you view it is the right side of the patient.

Appreciate the anatomic landmark used to orient ultrasound assessment of the abdominal aorta.

The _____ serves as a reminder of where to place the probe on a patient's body when beginning an ultrasound study of the abdominal aorta.

xiphoid process

PART 1: ABDOMINAL AORTA ULTRASOUND

Appreciate the sonographic landmark used to identify the area of interest during ultrasound assessment of the abdominal aorta.

The _____ is visible as a curvilinear echogenic line with an acoustic shadow immediately in the far field.	*vertebral body*

Describe the area of interest visible during ultrasound assessment of the abdominal aorta.

The abdominal aorta, specifically its _____ echogenic outer wall, lies immediately adjacent to the vertebral body and is the area of interest in bedside ultrasound assessment.	*white*

Describe how to distinguish the abdominal aorta from the inferior vena cava.

The _____ is on the patient's left directly adjacent to the vertebral body, thick-walled, non-compressible and shows no respiratory variation in its structure.	*abdominal aorta*
By contrast the _____ is a thin-walled, almond-shaped structure located to the patient's right, which is compressible and varies with respiration.	*inferior vena cava*

Briefly describe the technique used in bedside ultrasound assessment of the abdominal aorta.

The patient should be assessed in the _____ position.	*supine*
A curvilinear or phased-array probe can be used with initial depth set at _____.	*18-20 cm*
The length of the aorta should be scanned in _____ section from the xiphoid process to its bifurcation near the umbilicus.	*transverse*
The examiner should be oriented with the probe marker to the patient's _____ and the probe perpendicular to the patient's skin.	*right*

PART 1: ABDOMINAL AORTA ULTRASOUND

Describe two major limitations in bedside ultrasound assessment of the abdominal aorta.

Both _____ and the presence of bowel gas can impede generation of a crisp image in the far field. One can attempt to displace bowel gas by applying firm, tonic pressure with the ultrasound probe or by asking the patient to deeply inhale and exhale.

body habitus

Briefly review a scenario demonstrating clinical application of bedside abdominal aorta ultrasound.

Scenario: A 71-year-old Caucasian male presents with a two hour history of moderate back pain. He has a 30 pack year smoking history and his father died of a ruptured abdominal aortic aneurysm at age 77. On exam, his blood pressure is 110 mmHg systolic over 85 mm Hg diastolic and you note a pulsatile abdominal mass on palpation.

An abdominal aortic aneurysm (AAA) represents an abnormal dilation (greater than _____ in diameter) of the abdominal aorta.

3 cm

Surgical repair is typically indicated when the AAA exceeds _____ cm in diameter.

5.5 cm

The most common etiology is believed to be _____ in nature.

atherosclerotic

Most AAAs are _____ and discovered incidentally.

asymptomatic

When symptoms do occur, they range from vague epigastric discomfort to back and abdominal pain. Signs of a ruptured AAA include the classic triad of abdominal pain, pulsatile abdominal mass and _____.

hypotension

PART 2: HEPATOBILIARY ULTRASOUND

Review pertinent anatomy in the abdominal cavity.

The pear-shaped gallbladder, (_____ in length) lies in the gallbladder fossa on the visceral surface of the liver.	*7-10 cm*
The gallbladder has three parts. The _____ projects from the inferior border of the liver and is usually located at the tip of the right ninth costal cartilage in the mid-clavicular line.	*fundus*
The _____ contacts the visceral surface of the liver, the transverse colon, and the superior part of the duodenum.	*body*
The _____ is narrow, tapered, and directed toward the porta hepatis.	*neck*
The gallbladder neck makes an S-shaped bend and joins the _____.	*cystic duct*
The cystic duct connects the neck of the gallbladder to the _____.	*common hepatic duct*

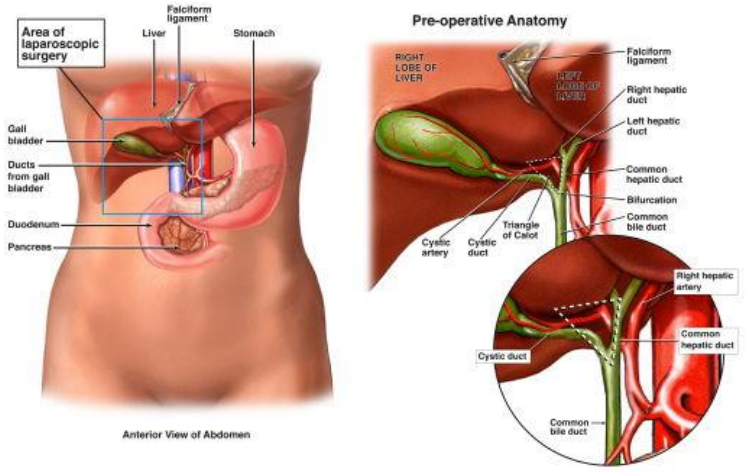

Figure 2. Normal anatomy of the gallbladder and its associated ducts and arteries. The Triangle of Calot is highlighted.

Appreciate the anatomic landmark used to orient ultrasound assessment of the gallbladder.

The _____ serves as a reminder of where to place the probe on a patient's body when beginning an ultrasound study of the gallbladder.	*xiphoid process*

PART 2: HEPATOBILIARY ULTRASOUND

Appreciate the sonographic landmark used to identify the area of interest during ultrasound assessment of the gallbladder.

The main _____ is visible as an echogenic line that extends from the neck of the gallbladder to the portal vein. | *lobar fissure*

Describe the area of interest visible during ultrasound assessment of the gallbladder.

The complex of the gallbladder, main lobar fissure, and portal vein has the appearance of an _____ and they together represent the area of interest. | *exclamation point*

Describe how to distinguish the gallbladder from hepatic blood vessels.

The gallbladder is an elongated, pear-shaped organ with an identifiable _____ at the fundus. | *blind end*

Briefly describe the technique used in bedside ultrasound assessment of the gallbladder.

Note that the gallbladder is not a fixed organ. As a result, its location in the right upper quadrant is _____. | *variable*

The patient should be assessed in the supine position. A _____ or phased-array probe should be used. | *curvilinear*

The examiner should be oriented with the probe marker to the patient's right _____ and the probe perpendicular to the patient's skin. | *shoulder*

Instruct the patient to take a _____. | *deep breath*

The examiner should then translate the probe inferiorly and laterally from the xiphoid process along the _____ margin. | *subcostal*

Once the gallbladder is identified, stop moving the probe. Small adjustments should be made to optimize the long-axis view. The probe can be rotated 90 degrees, so that the orientation marker points to the patient's right, to generate a _____ view. | *short-axis*

The entire organ should be scanned in both the long- and short-axes, using sweeping motions.

PART 2: HEPATOBILIARY ULTRASOUND

Describe two major limitations in bedside ultrasound assessment of the gallbladder.

Air in the _____ can interfere with the ability to image the gallbladder. One can attempt to displace bowel gas by applying firm, tonic pressure with the ultrasound probe or by asking the patient to deeply inhale and exhale.	*duodenum*
If the patient recently ate a meal, especially if the meal contained _____ foods, the gallbladder may be too contracted to assess with confidence.	*fatty*

Briefly review a scenario demonstrating clinical application of bedside hepatobiliary ultrasound.

Scenario: An overweight 39-year-old mother of three presents with unrelenting right upper quadrant pain, fever and nausea. She also notes discomfort in the area of her right shoulder. She denies any history of abdominal surgery and is on no medications.

Obstruction of the _____ leads to inflammation of the gallbladder.	*cystic duct*
Over 95 percent of cases of acute cholecystitis are caused by _____.	*calculi*
_____ describes acute pain and inspiratory arrest elicited by palpation of the right upper qudrant during inspiration. Signs of acute cholecystitis on ultrasound include:	*Murphy's sign*
Thickened gallbladder wall (greater than _____);	*3 mm*
_____ fluid;	*pericholecystic*
_____ gallbladder;	*distended*
_____ or cystic duct stone present	*gallstones*
and sonographic _____.	*Murphy's sign*
Mainstay of treatment includes intravenous fluids, antibiotics and early _____.	*cholecystectomy*

PART 3: RENAL ULTRASOUND

Review pertinent anatomy in the abdominal cavity.

The kidneys lie _____ on the posterior abdominal wall at the level of the T12-L3 vertebrae.	*retroperitoneally*
The right kidney lies at a slightly lower level than left kidney owing to its relationship to the _____.	*liver*
Each kidney has anterior and posterior surfaces, medial and lateral margins, and superior and inferior poles. The medial margin is _____ where the renal sinus and renal pelvis are located, giving the kidney a bean-shaped appearance.	*concave*
The renal _____ is occupied mostly by fat in which the renal pelvis, calices, blood vessels, and nerves are embedded.	*sinus*
At the renal hilum, the renal vein is anterior to the renal artery, which is _____ to the renal pelvis.	*anterior*
The renal parenchyma is composed of the renal cortex and medullary _____.	*pyramids*

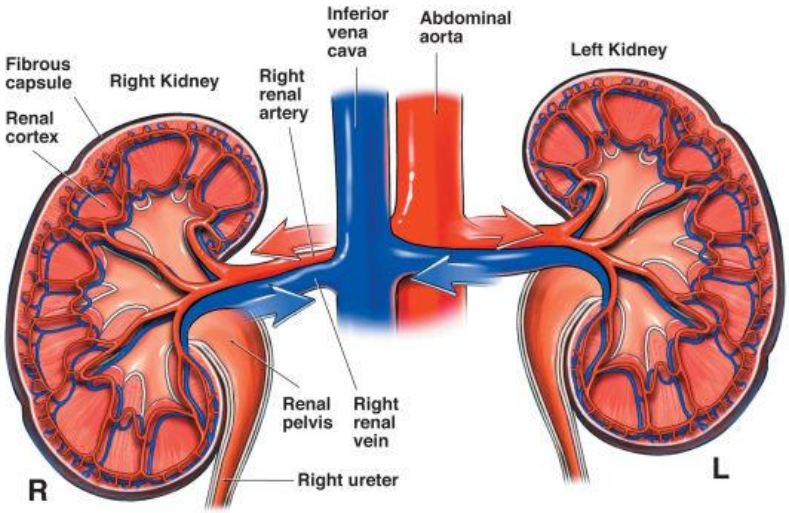

Figure 3. Blood circulation into and out of the kidney is highlighted in this frontal plane of the kidneys.

PART 3: RENAL ULTRASOUND

Appreciate the anatomic landmark used to orient ultrasound assessment of the kidney.

The _____ line at the level of the xiphoid serves as a reminder of where to place the probe on a patient's body when beginning an ultrasound study of the right kidney.	*mid-axillary*
For the left kidney, the _____ line at the level of the xiphoid is used. This more posterior view helps to avoid interfering air in the stomach and intestine.	*posterior axillary*

Appreciate the sonographic landmark used to identify the area of interest during ultrasound assessment of the kidney.

For the right kidney, the _____serves as an acoustic window to locate our sonographic landmark, which in this case is the double density right kidney itself.	*liver*
Similarly, the _____ can serve as an acoustic window in locating the double density left kidney.	*spleen*

Describe the area of interest visible during ultrasound assessment of the kidney.

A double-density structure consisting of a central hyperechoic (bright) _____ …	*renal sinus*
… surrounded by grainy gray echoes representing the renal _____.	*parenchyma*

Describe how to distinguish the renal sinus from the renal parenchyma.

The presence of _____ tissue within the renal sinus causes its characteristic hyperechoic appearance. This is in contrast to the renal parenchyma, which is of similar echogenicity to the adjacent liver or spleen.	*fatty*

Briefly describe the technique used in bedside ultrasound assessment of the kidney.

The patient should be assessed in the _____ position.	*supine*
A _____ probe should be used.	*curvilinear*

PART 3: RENAL ULTRASOUND

The examiner should be oriented with the probe marker to the patient's _____ and the probe perpendicular to the patient's skin.	*head*
Right kidney: Place probe in the mid-axillary line at the level of the xiphoid. Using the liver as the acoustic window, aim the probe slightly _____. Gently rock the probe to scan the entire kidney.	*posterior*
Left kidney: Place probe in the posterior axillary line at the level of the xiphoid. The placement of the probe will be more _____ than when viewing the right kidney.	*cephalad*
Both kidneys should be scanned in both the long- and short-axes, in a sweeping motion.	

Describe two major limitations in bedside ultrasound assessment of the kidneys.

Typically, renal ultrasound cannot identify _____.	*ureteral stones*
_____ can be present in the absence of obstruction.	*hydronephrosis*

Briefly review a scenario demonstrating clinical application of bedside renal ultrasound.

Scenario: A 27-year-old female presents with persistent flank pain, fever and nausea. She describes painful urination over the previous week. On exam, she is tender to palpation at the right costovertebral angle.

Urinary tract _____ is a reversible cause of kidney injury that is important to recognize.	*obstruction*
If uncorrected, it may predispose to _____ and end-stage renal disease.	*urosepsis*
The clinical presentation is variable depending on the degree and site of obstruction. Signs and symptoms include pain, change in urine output, hematuria, and an increased serum _____.	*creatinine*
Ultrasound is the modality of choice for diagnosis. For most patients, a negative scan is sufficient to exclude obstruction. The hallmark finding is dilation of the collecting system in one or both kidneys (_____).	*hydronephrosis*

WORKSHOP: PROCEDURAL ULTRASOUND

Objectives:

1. Review pertinent anatomy for central venous catheterization of the internal jugular vein.
2. Appreciate the anatomic landmarks used for central venous catheterization of the internal jugular vein.
3. Appreciate the sonographic landmarks used for central venous catheterization of the internal jugular vein.
4. Describe the area of interest for central venous catheterization of the internal jugular vein.
5. Briefly describe the technique used for central venous catheterization of the internal jugular vein.
6. Describe four indications for central venous catheterization of the internal jugular vein.
7. Describe five complications of central venous catheterization of the internal jugular vein.
8. Recognize other common clinical applications of procedural ultrasound.

WORKSHOP: PROCEDURAL ULTRASOUND

Review pertinent anatomy for central venous catheterization of the internal jugular vein.

The internal jugular vein (IJV) is contained within the _____ region of the neck. It is usually the largest vein in the neck. This region of the neck also contains the carotid system of arteries.

anterior cervical

The IJV drains blood from the brain, anterior face, cervical viscera, and deep muscles of the neck. It commences at the _____ in the posterior cranial fossa as a continuation of the sigmoid sinus.

jugular foramen

The IJV runs inferiorly in the neck within the _____ alongside the internal carotid artery superior to the bifurcation of the common carotid artery. Inferior to the bifurcation of the common carotid artery, the IJV runs with the common carotid artery and the _____ cranial nerve.

carotid sheath

tenth

The IJV lies _____ to the common carotid within the carotid sheath and leaves the anterior cervical region by passing deep to the sternocleidomastoid muscle.

lateral

Posterior to the sternal end of the clavicle, the IJV unites with the _____.

subclavian vein

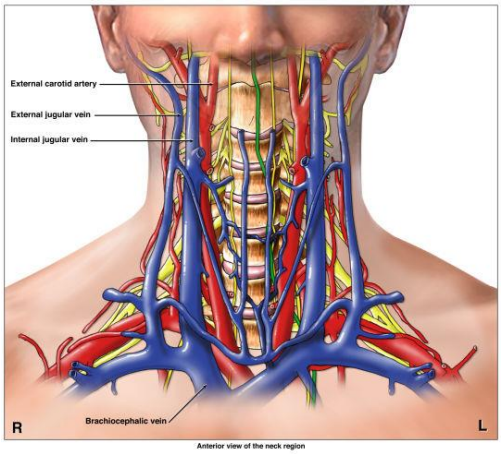

Figure 1. This anterior view depicts the anatomy of the cervical region. Labeled structures include the external carotid artery, external jugular vein, internal jugular vein and brachiocephalic vein.

Appreciate the anatomic landmarks for central venous catheterization of the internal jugular vein.

The anatomic landmark is the triangle formed by the sternal head of the _____ muscle medially, the clavicular head of the sternocleidomastoid muscle laterally, and the superior border of the medial third of the clavicle inferiorly.

sternocleidomastoid

WORKSHOP: PROCEDURAL ULTRASOUND

Appreciate the sonographic landmarks for central venous catheterization of the internal jugular vein.

The sonographic landmarks of interest are the two adjacent hypoechoic oval-shaped structures representing the IJV and _____.	*carotid artery*

Describe the area of interest for central venous catheterization of the internal jugular vein.

The thin-walled, compressible _____ represents the area of interest.	*internal jugular vein*

Briefly describe the technique used for central venous catheterization of the internal jugular vein.

Note that this is a _____ procedure. The patient should be assessed in the supine or Trendelenburg position.	*sterile*
If cannulating the right IJV, the patient's head is usually turned to the left. However, keeping the head in a neutral position may permit the IJV to assume a more _____ position.	*lateral*
A high frequency _____ probe should be used. The transducer should be oriented in the same direction as the indicator on screen, preferably the upper left hand side of the display.	*linear*
The transducer is placed in _____ orientation over the triangle formed by the two heads of the sternocleidomastoid muscle. The probe is translated distally until the area of interest is identified.	*transverse*
The IJV should be positioned in the centre of the image on screen. The _____ of the IJV from the skin should be estimated.	*depth*
Cannulation of IJV under direct ultrasound guidance is now considered the _____ and is best learned with practice models or at the bedside.	*standard of care*

Describe four major indications for central venous catheterization of the internal jugular vein.

WORKSHOP: PROCEDURAL ULTRASOUND

Hemodynamic monitoring of the _____ pressure in acutely ill patients to quantify fluid balance.	*central venous*
Delivery of medications that can only be given centrally, for example _____ such as epinephrine or dopamine, chemotherapy, and parenteral nutrition.	*vasopressors*
_____ replacement therapy such as hemodialysis.	*renal*
Poor _____ access.	*peripheral venous*

Describe five complications of central venous catheterization of the internal jugular vein.

The most common complications of an indwelling central venous catheter are _____ and thrombosis.	*infection*
Periprocedure _____ can occur with guide wire or catheter placement into the right heart.	*arrhythmia*
Arterial puncture occurs in _____ percent of central venous access procedures. *Reference*: N Engl J Med. 2003;348(12):1123. Once an arterial stick is suspected, the needle is immediately withdrawn and direct non-occlusive pressure applied to the site continuously for 15 minutes to prevent hematoma formation.	*3 to 15*
Pleural puncture can quickly evolve into a tension _____.	*pneumothorax*
Venous air _____ is a serious complication that can occur when a needle or catheter is left open to the atmosphere.	*embolism*

Recognize other common clinical applications of ultrasound for procedural guidance.

Central venous catheterization of femoral or subclavian veins; peripheral venous catheterization; pleural effusion and thoracentesis; ascites and paracentesis; joint effusions and arthrocentesis; foreign body identification/localization; abscess drainage; lumbar puncture; pericardiocentesis; detection of pacing capture; bladder aspiration; regional nerve blocks.

GLOSSARY OF TERMS

Acoustic Window	An area that sound waves can pass without interference by air or bone
Far Field	The part of the ultrasound beam located furthest from the transducer Bottom of the ultrasound monitor
Near Field	The part of the ultrasound beam located closest to the transducer Top of the ultrasound monitor
Echogenicity	The ability of a substance to reflect sound waves
Anechoic	Does not reflect sound waves Black on the ultrasound monitor
Hypoechoic	Reflects some sound waves Light grey on the ultrasound monitor
Hyperechoic	Greatly reflects sound waves White on the ultrasound monitor

REFERENCES

We would like to acknowledge the use of *Essential Clinical Anatomy, 4th Ed (by Moore, Agur and Dalley)*, *Manual of Emergency and Critical Care Ultrasound, 2nd Ed (by Noble and Nelson)* and *Understanding Ultrasound Physics, 4th Ed (by Edelman)* as informative references that formed the basis for background reading in preparation for the production of this unique educational resource.

POST-SYMPOSIUM MATERIALS

As mentioned previously, it is our hope that this two-day event ignites a passion for bedside ultrasound that can be shared with fellow students at your home institutions. We hold the belief that point-of-care ultrasound education should be part of undergraduate medical curricula across Canada.

With this, we also recognize that with limited classroom time and a breadth of evolving technologies and progress in medicine to represent, tough decisions regarding curricular content must be made. Uniquely, ultrasound does not demand standalone course time. Though destined to be a tool of clinical value to medical students in their clerkship years and beyond, introductory ultrasound training may occur through integration in to existing core curricular activities such as anatomy and physiology. In this fashion, ultrasound enriches, rather than competes for, existing classroom or lab experiences.

For those of you with a desire to bring more point-of-care ultrasound training to your institution, we encourage you to review two Western Sono resources. The first resource is a succinct video recapping the one year *Western University* experience, beginning with the launch of the point-of-care ultrasound interest group in September 2012. The second resource is a recorded panel discussion on point-of-care ultrasound in medical education featuring Drs. Robert Arntfield and Drew Thompson of Western University and Dr. Michael Woo of the University of Ottawa. Both clips are accessible at:

http://westernsono.ca/post-symposium-materials/

In addition, you may find the following resources useful:

1. Western Sono
   Accessible Online: http://westernsono.ca/

2. BoringEM
   Article - Point-of-Care Ultrasound: Hyperechoic Future in Medical Education?
   Accessible Online: http://boringem.org/2013/05/02/point-of-care-ultrasound-a-hyperechoic-future-in-med-ed/

3. SonoSpot: Topics in Bedside Ultrasound
   Accessible Online: http://www.sonospot.com/

4. Ultrasound Podcast
   Accessible Online: http://www.sonospot.com/

5. SonoCloud
   Accessible Online: http://sonocloud.org/

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