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
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

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<td>Ultrasound Fundamentals: Chris Byrne &amp; Robert Arntfield</td>
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# Agenda: August 25, 2013

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<td>1100</td>
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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.
Review pertinent anatomy in the thoracic cavity.

The heart and great vessels are approximately in the ________ of the thorax.

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.

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.

The anterior surface of the heart is formed mainly by the ________.

The inferior or diaphragmatic surface is formed mainly by the ________ and partly by the right 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.

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.
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.

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.

The fluid-filled, hypoechoic __________ is in the immediate far field of the inferior pericardium.

A bright echogenic line representing the _________ separating the right and left ventricles is also visible.

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

The patient should be assessed in the __________ position.

A curvilinear or __________ probe can be used. The depth should initially be set at about 20 cm.

The examiner should be oriented with the probe marker to the patient’s __________ and the probe perpendicular to the patient’s skin.

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.

A full __________ of the heart should be performed such that the posterior pericardial cavity is not missed.

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

To detect the presence of pericardial __________ and to assess global systolic function.
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.

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 ________.

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

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.

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.

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

Acute cardiac tamponade is life-threatening if not promptly treated. Signs and symptoms include chest pain, tachypnea, and dyspnea with markedly elevated ________ pressure.
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.
**Review pertinent anatomy in the thoracic cavity.**

The ________ lung contains superior, middle and inferior lobes. The left lung contains superior and inferior lobes.

The ________ pleura covers the lungs and is adherent to all its surfaces.

The ________ pleura is adherent to the thoracic wall, the mediastinum, and the diaphragm.

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.

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.

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**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.

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.

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.

The fourth landmark is known as the _________ point. It represents an extreme inferior and posterolateral probe position that is a hotspot for lung pathology.

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.

The liver and _________ are additional landmarks that help guide the costophrenic angle and PLAPS views, depending on which hemithorax is being scanned.

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.

For the costophrenic and PLAPS views, the bright, hyperechoic _________ represents an additional area of interest.
**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.  

Any probe can be used, though the linear probe does not have much value outside of assessing for the presence or absence of ________. 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.

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

*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.

*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.

On ultrasound assessment, the presence of _________ rules out a pneumothorax at the position being scanned.

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

Review pertinent anatomy in the abdominal cavity.

The right paracolic gutter runs from the hepatorenal recess (also known as ________) to the pelvis.

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.

As a result, fluid generally flows more freely toward the ________ paracolic gutter.

The hepatorenal recess represents a ________ space located in the right upper quadrant between the external surface of the liver and the renal fascia.

The ________ is the potential space located in the left upper quadrant between the spleen and the renal fascia.

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.

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 **kidney** represents the sonographic landmark that assists in identifying the area of interest.

**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 **spleenorenal recess**.

Being potential spaces, these recesses are normally represented by a bright white or **hyperechoic** line that represents an interface between the kidney and liver or spleen.

In the left upper quadrant, one must also pay special attention to the echogenic **diaphragm** as blood often collects in the subdiaphragmatic space in the setting of shear injury at the splenic hilum.

**Briefly describe the technique used during the FAST exam.**

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

A phased-array or curvilinear probe may be used. Some sonographers prefer the narrower-footprint **phased-array** probe as one can obtain images between the ribs more readily.

The examiner should be oriented with the probe marker to the patient’s **head** and the probe perpendicular to the patient’s skin.
To get a good view of the entire recess, the probe can be moved along the longitudinal plane of the _______ line.  

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.

It is also important to _______ anterior and posterior to ensure the entire area is assessed.

**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 _______.

A minimum of _______ of free fluid is required for detection.  

The exam can be particularly challenging in _______ patients.

**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.

Emergent _______ or embolization remains a life-saving measure for unstable patients.

Infection with the _______ virus is associated with splenic rupture in the setting of abdominal trauma.
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.
Review pertinent anatomy in the female pelvis.

The __________ is a cartilaginous joint formed by the midline union of the pubic bones.

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 __________.

The __________ of the bladder points toward the superior edge of the symphysis pubis.

The fundus is opposite of the apex, forming the bladder’s __________ wall.

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.

The body of the uterus is typically lying on the urinary bladder with its __________ wedged between the urinary bladder and the rectum.

The position of the uterus changes with the degree of __________ of the bladder.

The __________ is the inner mucous coat of the uterus, which firmly adheres to the myometrium and is actively involved in the menstrual cycle.

**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.

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.

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.

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

The patient should be assessed in the __________ position.

A phased-array or curvilinear probe may be used. The initial depth should be set at __________.

The examiner should begin at the pubic symphysis in the longitudinal plane with the probe marker to the patient's __________.

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

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.

With more substantial pelvic free fluid collections, one may also find evidence of fluid in the __________ pouch.

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WORKSHOP: FOCUSED OBSTETRICAL AND GYNECOLOGICAL ULTRASOUND

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

**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-syncpe or syncpe, 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 trauma or potential ruptured ectopic pregnancy.

**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 symphysis pubis as possible.

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

**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 vaginal bleeding will eventually be diagnosed with an ectopic pregnancy. Reference: CMAJ. 2005;173(8):905.
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 common iliac arteries.

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

The inferior vena cava begins anterior to the L5 vertebra by the union of the common iliac veins.

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

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

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 xiphoid process serves as a reminder of where to place the probe on a patient’s body when beginning an ultrasound study of the abdominal aorta.
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.

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.

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.

By contrast the __________ is a thin-walled, almond-shaped structure located to the patient’s right, which is compressible and varies with respiration.

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

The patient should be assessed in the __________ position.

A curvilinear or phased-array probe can be used with initial depth set at __________.

The length of the aorta should be scanned in __________ section from the xiphoid process to its bifurcation near the umbilicus.

The examiner should be oriented with the probe marker to the patient’s __________ and the probe perpendicular to the patient’s skin.
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.

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.

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

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

Most AAAs are __________ and discovered incidentally.

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 __________.

<table>
<thead>
<tr>
<th>Body habitus</th>
<th>3 cm</th>
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<tbody>
<tr>
<td>5.5 cm</td>
<td></td>
</tr>
<tr>
<td>Atherosclerotic</td>
<td></td>
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<tr>
<td>Asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Hypotension</td>
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</table>
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.

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.

The ________ contacts the visceral surface of the liver, the transverse colon, and the superior part of the duodenum.

The ________ is narrow, tapered, and directed toward the porta hepatis.

The gallbladder neck makes an S-shaped bend and joins the __________.

The cystic duct connects the neck of the gallbladder to the _________.

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.

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

If the patient recently ate a meal, especially if the meal contained ______ foods, the gallbladder may be too contracted to assess with confidence.

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.

Over 95 percent of cases of acute cholecystitis are caused by _______.

_______ describes acute pain and inspiratory arrest elicited by palpation of the right upper quadrant during inspiration. Signs of acute cholecystitis on ultrasound include:

- Thickened gallbladder wall (greater than ________);
- ______ fluid;
- ______ gallbladder;
- ______ or cystic duct stone present

and sonographic ________.

Mainstay of treatment includes intravenous fluids, antibiotics and early ________.
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.

The right kidney lies at a slightly lower level than left kidney owing to its relationship to the ________.

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.

The renal ________ is occupied mostly by fat in which the renal pelvis, calices, blood vessels, and nerves are embedded.

At the renal hilum, the renal vein is anterior to the renal artery, which is ________ to the renal pelvis.

The renal parenchyma is composed of the renal cortex and medullary ________.

---

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.

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.

 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.

Similarly, the __________ can serve as an acoustic window in locating the double density left kidney.

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

A double-density structure consisting of a central hyperechoic (bright) __________ …

… surrounded by grainy gray echoes representing the renal __________.

 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.

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

The patient should be assessed in the __________ position.

A __________ probe should be used.
PART 3: RENAL ULTRASOUND

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

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 posterior. Gently rock the probe to scan the entire kidney.

Left kidney: Place probe in the posterior axillary line at the level of the xiphoid. The placement of the probe will be more cephalad than when viewing the right kidney.

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. Hydronephrosis can be present in the absence of obstruction.

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 obstruction is a reversible cause of kidney injury that is important to recognize.

If uncorrected, it may predispose to urosepsis and end-stage renal disease.

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).
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.
**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.

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.

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.

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

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

![Diagram of the cervical region](image)

*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.
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.

Delivery of medications that can only be given centrally, for example _________ such as epinephrine or dopamine, chemotherapy, and parenteral nutrition.

__________ replacement therapy such as hemodialysis.

Poor _________ access.

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.

Periprocedure _________ can occur with guide wire or catheter placement into the right heart.


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.

Pleural puncture can quickly evolve into a tension _________.

Venous air _________ is a serious complication that can occur when a needle or catheter is left open to the atmosphere.

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

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

# 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/