Title
Advanced Ultrasound Workshops for Emergency Medicine Residents

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Advanced Ultrasound Workshops for Emergency Medicine Residents

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ABSTRACT:

Audience and type of curriculum: This ultrasound curriculum is designed for second-year emergency medicine residents who have completed a 2-week dedicated ultrasound rotation covering the American College of Emergency Physicians (ACEP) core applications.

Introduction/Background: Ultrasound has become a standard component of emergency medicine residency training. Most residency programs fulfill this requirement with a dedicated rotation. At our institution this occurs in the intern year and focuses primarily on the ACEP core applications. This focused time allows intensive exposure, but for many residents, scanning declines after competency in the basic applications is achieved.

Objectives: We sought to renew interest in ultrasound by presenting two advanced workshops on nontraditional content. Sessions covered ways ultrasound could augment or replace aspects of the physical exam, and covered ultrasound guided nerve blocks.

Methods: The educational strategies used in this curriculum include: lecture-style, case-based didactic sessions and observed hands-on ultrasound scanning sessions.

Length of curriculum: The curriculum was run in 2 two-hour sessions.

Topics: Point of Care/Clinical/Focused Ultrasound as Adjunct to Physical Exam: splenomegaly, acute mitral regurgitation, aortic dissection, hepatomegaly, jugular venous distension, patellar tendon evaluation, shoulder dislocation.

Ultrasound Guided Nerve Blocks: posterior tibial nerve, ulnar nerve, radial nerve, femoral nerve, sciatic nerve, interscalene brachial plexus, supraclavicular brachial plexus.
Brief introduction:
Ultrasound has become a standard component of emergency medicine residency training. Most residency programs fulfill this requirement with a dedicated rotation. At our institution this occurs in the intern year and focuses primarily on the ACEP core applications. This focused time allows intensive exposure, but for many residents, scanning declines after competency in the basic applications is achieved.

Problem identification, general and targeted needs assessment:
At our institution, a majority of the resident ultrasound training occurs in the intern year. An intern may achieve proficiency in the ACEP core applications in August and then have relatively limited scanning experience on off-service rotations for the rest of the academic year. This curriculum addresses a decline in formal ultrasound education that occurs in our residency program after the intern year. Additionally, there is a decline in scanning that occurs among our senior residents. This curriculum exposes junior and senior residents to additional nontraditional ultrasound content to which they had previously very limited exposure. Many of the techniques presented in this curriculum were only taught on occasion when a resident was on shift with an ultrasound faculty member. This curriculum directly enhances patient care with advanced use of ultrasound.

Objectives of the curriculum:

Objectives: Module 1: Ultrasound as an Adjunct to the Physical Exam
After this session, the learners will be able to:
- Define splenomegaly
- Demonstrate ability to locate and measure the spleen
- Describe clinical scenarios where ultrasound exam to evaluate splenomegaly could be performed
- Obtain cardiac windows to evaluate for mitral regurgitation and demonstrate ability to use color doppler
- Interpret color doppler ultrasound images and identify the presence of mitral regurgitation
- Describe clinical scenarios in which acute mitral regurgitation could occur, and how it could potentially change management
- Describe the limitations of POC transthoracic ultrasound in the evaluation of aortic dissection
- Perform a comprehensive ultrasound exam of the thoracic and abdominal aorta
- Define hepatomegaly
- Demonstrate ability to identify the liver on ultrasound and measure its distance below the costal margin
- Demonstrate ability to calculate degree of jugular venous distension with ultrasound
- Identify and describe the ultrasonographic appearance of normal tendon (using the patellar tendon)
- Perform the ultrasound exam of the shoulder joint
- Interpret ultrasound images with normal anatomy, anterior and posterior shoulder dislocations
- Define anisotropy

Objectives: Module 2: Ultrasound Guided Nerve Blocks
After this session, the learners will be able to:
- Perform the ultrasound exams and correctly identify the posterior tibial nerve, ulnar nerve, radial nerve, femoral nerve, sciatic nerve, interscalene brachial plexus, and supraclavicular brachial plexus
- Demonstrate needle guidance on a phantom using in-plane and out-of-plane techniques
USER GUIDE

● Describe the risks and contraindications for nerve blocks in the emergency department
● Define patients at high risk for complications from ultrasound guided nerve blocks

Describe the sensory and motor innervation of the posterior tibial nerve, ulnar nerve, radial nerve, femoral nerve, sciatic nerve, interscalene brachial plexus, and supraclavicular brachial plexus

Educational Strategies:
(See attached curriculum chart) Please refer to the curriculum chart of linked objectives and educational strategies.

Associated Content:
See additional Powerpoint presentations for both modules.

Evaluation and Feedback:
Residents were given an anonymous self-assessment survey after the workshops:

For the Physical Exam workshop, the residents all reported an increased level of comfort using ultrasound, and many of them reported they were using ultrasound more frequently after the session. Changes for this year’s session include incorporation of additional hands-on instructors to ensure teacher-instructor ratio of 1:4.

For the Nerve Block session, the residents reported increased comfort performing these procedures; however, there was not a significant difference in self-reported nerve block procedure numbers pre- and post-workshop. The main challenges reported with attempting ultrasound guided nerve blocks were difficulty identifying the nerve and lack of attending comfort level in supervising the procedure. Based on this feedback, faculty development sessions focusing on advanced applications such as nerve blocks have been added.

References/Further Readings/Additional Resources:

Ultrasound Guided Nerve Blocks:


Ultrasound as Adjunct to Physical Exam:


<table>
<thead>
<tr>
<th>Topic</th>
<th>Recommended Educational Strategy</th>
<th>Educational Content</th>
<th>Objectives</th>
<th>Learners</th>
<th>Timing, Resources Needed (Space, Instructors, Equipment, Citations of JETem pubs or other literature)</th>
<th>Recommended Assessment, Milestones Addressed</th>
</tr>
</thead>
</table>
| Aorta       | 1. Brief lecture describing the technique in measuring the abdominal aorta        | -Proper technique and probe choice for image acquisition  
-How to measure the abdominal aorta  
-Size of normal and abnormal abdominal aorta  
-Pearls and pitfalls (how to minimize bowel gas, comprehensive scan to avoid missing infrarenal AAA) | The learner will demonstrate the ability to identify and measure aorta in short and long axis and describe normal and pathologic measurements of the aorta. | PGY-2    | 10 minutes (lecture)  
Instructors: 1  
Equipment: Powerpoint (and projector/screen)  
20 minutes (hands-on session)  
Instructors: 1 per 3 learners  
Equipment: 1 ultrasound machine and model per 3 learners | Milestone: PC12  
Assessment: Lecture: Quiz  
Hands-on: Checklist and/or Likert scale of skill mastery (see publication) |
|             | 2. Hands on session immediately following lecture                                 | For a full description of this session, see: King A, et al. Ultrasound of the Aorta, JETem 2016. |                                                                            |          |                                                                                                               |                                               |
| Splenomegaly| 1. Brief lecture describing the techniques to measure the spleen                  | -Proper technique and probe choice for image acquisition  
-Measuring the spleen  
-Size of normal and abnormal spleen  
-Pearls and pitfalls: Avoiding rib shadows; placing the probe posteriorly and fanning towards the bed to find the spleen | The learner will be able to identify and measure the spleen to assess for splenomegaly | PGY-2    | 5 minute (lecture)  
Instructors: 1  
Equipment: Powerpoint (computer/projector/screen)  
15 minutes (hands-on session)  
Instructors: 1 per 3 learners  
Equipment: 1 ultrasound machine and model per 3 learners | Milestone PC12  
Assessment: Direct observation by the instructor for each learner in their group. Evaluate image quality and accuracy of measurements obtained by learner. |
|             | 2. Hands on scanning session immediately following the lecture                    |                                                                            |                                                                            |          |                                                                                                               |                                               |
### Acute Mitral Regurgitation

1. **Brief lecture** describing the techniques to measure mitral regurgitation
   - Proper technique and probe choice for image acquisition
   - Identifying the mitral valve on an apical four chamber view
   - Pearls and pitfalls: setting gain and color scale, aliasing, differences between acute and chronic regurgitant jets

2. **Hands on scanning session immediately following the lecture**
   - Proper technique and probe choice for image acquisition
   - Identifying the mitral valve on an apical four chamber view
   - Proper technique for using color doppler to assess for mitral regurgitation
   - Pearls and pitfalls: setting gain and color scale, aliasing, differences between acute and chronic regurgitant jets

**Objectives**: The learner will be able to identify the mitral valve and assess for regurgitation.

**Learners**: PGY-2

**Timing, Resources Needed**
- **5 minute lecture**
  - Instructors: 1 per 3 learners
  - Equipment: Powerpoint (computer/projector/screen)

- **15 minutes hands-on session**
  - Instructors: 1 per 3 learners
  - Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners

**Recommended Assessment, Milestones Addressed**
- **Milestone PC12**
- Assessment: Real time review by the instructor for each learner in their group. Evaluate image obtained by the learner for quality and technique for assessing flow across the valve. Instructor will assess ability to obtain an apical four chamber view and appropriately set the color doppler to assess for mitral regurgitation.

### Aortic Dissection

1. **Brief lecture** describing ultrasound findings in aortic dissection and how to measure and identify them
   - Proper technique and probe choice for image acquisition
   - Measuring the thoracic aorta
   - Size of normal and abnormal thoracic aorta
   - Pearls and pitfalls: limitations of bedside ultrasound for making this diagnosis, challenges of identifying acute aortic regurgitation

2. **Hands on scanning session immediately following the lecture**
   - Proper technique and probe choice for image acquisition
   - Measuring the thoracic aorta
   - Size of normal and abnormal thoracic aorta
   - Pearls and pitfalls: limitations of bedside ultrasound for making this diagnosis, challenges of identifying acute aortic dissection

**Objectives**: The learner will be able to identify the aorta and the direct and indirect signs of thoracic aortic dissection.

**Learners**: PGY-2

**Timing, Resources Needed**
- **5 minute lecture**
  - Instructors: 1 per 3 learners
  - Equipment: Powerpoint (computer/projector/screen)

- **15 minutes hands-on session**
  - Instructors: 1 per 3 learners
  - Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners

**Recommended Assessment, Milestones Addressed**
- **Milestone PC12**
- Assessment: Real time review by the instructor for each learner in their group. Students will demonstrate ability to measure the ascending aorta on a parasternal long axis window.
<table>
<thead>
<tr>
<th>Topic</th>
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<th>Learners</th>
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<th>Recommended Assessment, Milestones Addressed</th>
</tr>
</thead>
</table>
| Hepatomegaly                         | 1. Brief lecture describing how to measure the liver with ultrasound                           | -Proper technique and probe choice for image acquisition  
-Measuring the liver  
-Size of normal and abnormal liver  
-Pearls and pitfalls: distinguishing normal from abnormal liver parenchyma | The learner will be able to identify and measure the liver to assess for hepatomegaly                                                              | PGY-2                                   | 5 minute (lecture)  
Instructors: 1  
Equipment: Powerpoint (computer/projector/screen)  
15 minutes (hands-on session)  
Instructors: 1 per 3 learners  
Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners | Milestone PC12  
Assessment: Real time review by the instructor for each learner in their group. Students will demonstrate ability to accurately measure the liver. The instructor will evaluate image quality and measurements obtained by learner. |
| Jugular Venous Distention (JVD)      | 1. Brief lecture describing the techniques to measure the jugular veins                         | -Proper technique and probe choice for image acquisition  
-Identifying and measuring the jugular veins  
-Appearance of normal and abnormal jugular veins  
-Pearls and pitfalls: using too much pressure, interpreting positive and negative results | The learner will be able to identify the jugular veins identify if they are distended or collapsed. Learner will demonstrate ability to measure ultrasonographic JVD | PGY-2                                   | 5 minute (lecture)  
Instructors: 1  
Equipment: Powerpoint (computer/projector/screen)  
15 minutes (hands-on session)  
Instructors: 1 per 3 learners  
Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners | Milestone PC12  
Assessment: Real time review by the instructor for each learner in their group. Instructor will evaluate learners ability to measure the height of JVD present on ultrasound. Evaluate image quality and measurements obtained by learner. |
<table>
<thead>
<tr>
<th>Topic</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Patellar tendon rupture</td>
<td>1. Brief lecture describing how to assess the patellar tendon</td>
<td>-Proper technique and probe choice for image acquisition</td>
<td>The learner will be able to identify the patellar tendon and evaluate for tendon disruption</td>
<td>PGY-2</td>
<td>5 minute (lecture)</td>
<td>Milestone PC12</td>
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<tr>
<td></td>
<td>2. Hands on scanning session immediately following the lecture</td>
<td>-Identifying normal patellar tendon</td>
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<td>Instructors: 1</td>
<td>Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner.</td>
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<tr>
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<td>-Distinguishing normal and abnormal (loss of architecture, hypoechoic tendon defects, surrounding hematoma )</td>
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<td>Equipment: Powerpoint (computer/projector/screen)</td>
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<td></td>
<td></td>
<td>-Pearls and pitfalls: dynamic scanning, comparison to normal side, anistropy</td>
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<td>15 minutes (hands-on session)</td>
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<td>Instructors: 1 per 3 learners</td>
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<td></td>
<td></td>
<td>Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners</td>
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<tr>
<td>Shoulder dislocation</td>
<td>1. Brief lecture describing the techniques to evaluate the shoulder joint</td>
<td>-Proper technique and probe choice for image acquisition</td>
<td>The learner will be able to identify the shoulder joint and assess for dislocation.</td>
<td>PGY-2</td>
<td>5 minute (lecture)</td>
<td>Milestone PC12</td>
</tr>
<tr>
<td></td>
<td>2. Hands on scanning session immediately following the lecture</td>
<td>-Identifying the shoulder joint</td>
<td></td>
<td></td>
<td>Instructors: 1</td>
<td>Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by learner and ability of the learner to identify the glenoid, humeral head, and rotator cuff tendon.</td>
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<tr>
<td></td>
<td></td>
<td>-Assessing the joint space for dislocation</td>
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<td>Equipment: Powerpoint (computer/projector/screen)</td>
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<tr>
<td></td>
<td></td>
<td>-Normal and abnormal shoulder joint space appearance</td>
<td></td>
<td></td>
<td>15 minutes (hands-on session)</td>
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<td></td>
<td></td>
<td>-Pearls and pitfalls, finding the shoulder joint, comparison to normal side, dynamic scanning, challenges of diagnosing a posterior shoulder dislocation</td>
<td></td>
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<td>Instructors: 1 per 3 learners</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners</td>
<td></td>
</tr>
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<td>Topic</td>
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<tr>
<td>Posterior tibial nerve block</td>
<td>1. Brief lecture describing the techniques to locate the posterior tibial nerve &lt;br&gt; 2. Hands on scanning session immediately following the lecture</td>
<td>-Proper technique and probe choice for image acquisition &lt;br&gt;-Locating and identifying the posterior tibial nerve &lt;br&gt;-Infiltrating the posterior tibial nerve &lt;br&gt;-Pearls and pitfalls (locate the posterior tibial artery by color doppler and medial malleolus, can do out-of-plane due to shallow depth)</td>
<td>The learner will be able to identify the posterior tibial nerve and infiltrate it with anesthesia.</td>
<td>PGY-2</td>
<td>5 minute (lecture) &lt;br&gt;Instructors: 1  &lt;br&gt;Equipment: Powerpoint (computer/projector/screen) &lt;br&gt;15 minutes (hands-on session) &lt;br&gt;Instructors: 1 per 3 learners  &lt;br&gt;Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</td>
<td>Milestone PC12  &lt;br&gt;Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner. Evaluate technique for infiltration on the nerve model.</td>
</tr>
<tr>
<td>Ulnar nerve block</td>
<td>1. Brief lecture describing the techniques to locate the ulnar nerve &lt;br&gt; 2. Hands on scanning session immediately following the lecture</td>
<td>-Proper technique and probe choice for image acquisition &lt;br&gt;-Locating and identifying the ulnar nerve &lt;br&gt;-Infiltrating the ulnar nerve &lt;br&gt;-Pearls and pitfalls (use color doppler to locate the ulnar artery, the nerve will be ulna to artery)</td>
<td>The learner will be able to identify the ulnar nerve and infiltrate it with anesthesia.</td>
<td>PGY-2</td>
<td>5 minute (lecture) &lt;br&gt;Instructors: 1  &lt;br&gt;Equipment: Powerpoint (computer/projector/screen) &lt;br&gt;15 minutes (hands-on session) &lt;br&gt;Instructors: 1 per 3 learners  &lt;br&gt;Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</td>
<td>Milestone PC12  &lt;br&gt;Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner. Evaluate technique for infiltration on the nerve model.</td>
</tr>
</tbody>
</table>
### Topic: Radial Nerve Block

<table>
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<th>Recommended Assessment, Milestones Addressed</th>
</tr>
</thead>
</table>
| 1. Brief lecture describing the techniques to locate the radial nerve | -Proper technique and probe choice for image acquisition  
- Locating and identifying the radial nerve  
- Infilarating the radial nerve  
- Pearls and pitfalls (identify triceps/bicep muscle junction and brachial artery, out-of-plane block easier to perform) | The learner will be able to identify the radial nerve and infiltrate it with anesthesia. | PGY-2 | 5 minute (lecture)  
Instructors: 1  
Equipment: Powerpoint (computer/projector/screen)  
15 minutes (hands-on session)  
Instructors: 1 per 3 learners  
Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners | Milestone PC12  
Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner. Evaluate technique for infiltration on the nerve model. |
| 2. Hands on scanning session immediately following the lecture | | | | | |

### Topic: Femoral Nerve Block

<table>
<thead>
<tr>
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</tr>
</thead>
</table>
| 1. Brief lecture describing the techniques to locate the femoral nerve | -Proper technique and probe choice for image acquisition  
- Locating and identifying the femoral nerve  
- Infilarating the femoral nerve  
- Pearls and pitfalls (need to place the needle below the fascia iliaca to get good distribution of anesthetic around nerve, requires significant volume 20-30 cc, dilute with NS 1:1 ratio) | The learner will be able to identify the femoral nerve and infiltrate it with anesthesia. | PGY-2 | 5 minute (lecture)  
Instructors: 1  
Equipment: Powerpoint (computer/projector/screen)  
15 minutes (hands-on session)  
Instructors: 1 per 3 learners  
Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners | Milestone PC12  
Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner. Evaluate technique for infiltration on the nerve model. |
| 2. Hands on scanning session immediately following the lecture | | | | | |

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## DIDACTICS AND HANDS-ON CURRICULUM

| Topic                            | Recommended Educational Strategy | Educational Content                                                                 | Objectives                                                                                                                                                                                                 | Learners | Timing, Resources Needed (Space, Instructors, Equipment, Citations of JETem pubs or other literature) | Recommended Assessment, Milestones Addressed |
|----------------------------------|----------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------
| Sciatic nerve block              | 1. Brief lecture describing the techniques to locate the sciatic nerve                | -Proper technique and probe choice for image acquisition                           | The learner will be able to identify the sciatic nerve and infiltrate it with anesthesia.                                                                                                                      | PGY-2    | 5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/screen)                                                                                               | Milestone PC12                                                                                      |
|                                  | 2. Hands on scanning session immediately following the lecture                      | -Locating and identifying the sciatic nerve                                         |                                                                                                                                                                                                          |          | 15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners                                                                                                        | Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner. Evaluate technique for infiltration on the nerve model. |

| Inter-scalene brachial plexus nerve block | 1. Brief lecture describing the techniques to identify and locate the brachial plexus using the interscalene approach | -Proper technique and probe choice for image acquisition                           | The learner will be able to identify the brachial plexus using the interscalene approach and infiltrate it with anesthesia.                                                                                       | PGY-2    | 5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/screen)                                                                                               | Milestone PC12                                                                                      |
|                                  | 2. Hands on scanning session immediately following the lecture                      | -Locating and identifying the brachial plexus using the interscalene approach       |                                                                                                                                                                                                          |          | 15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners                                                                                                        | Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner. Evaluate technique for infiltration on the nerve model. |
## DIDACTICS AND HANDS-ON CURRICULUM

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<tr>
<td>Supra-clavicular brachial plexus nerve block</td>
<td>1. Brief lecture describing the techniques to locate the brachial plexus using the supraclavicular approach 2. Hands on scanning session immediately following the lecture</td>
<td>- Proper technique and probe choice for image acquisition  - Locating and identifying the brachial plexus using the supraclavicular approach  - Pearls and pitfalls (identify the pleura so as avoid inadvertent puncture, rotating probe can place 1st rib under subclavian artery increasing safety)</td>
<td>The learner will be able to identify the brachial plexus using the supraclavicular approach and infiltrate it with anesthesia.</td>
<td>PGY-2</td>
<td>5 minute (lecture)  Instructors: 1  Equipment: Powerpoint (computer/projector/screen)  15 minutes (hands-on session)  Instructors: 1 per 3 learners  Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</td>
<td>Milestone PC12  Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner. Evaluate technique for infiltration on the nerve model.</td>
</tr>
</tbody>
</table>
### POINT OF CARE ULTRASOUND ASSESSMENT

**Resident:**

**Year:**  
- PGY-1  
- PGY-2  
- PGY-3  
- PGY-4  

**Exam Performed:**  

**Date:**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Unable to perform</th>
<th>Performs with assistance</th>
<th>Performs independently</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describes the indications for the ultrasound examination (Level 1, PC12)</td>
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<tr>
<td>Optimizes images using appropriate gain and depth (Level 2, PC12)</td>
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<tr>
<td>Selects the appropriate probe (Level 2, PC12)</td>
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<td>Places probe in correct position</td>
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<td>Acquires complete images</td>
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<td>Measures accurately (if applicable)</td>
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**Comments:**

**Supervised by:**

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