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CURRICULUM

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.¹ At our institution this occurs in the intern year and focuses primarily on the ACEP core applications.² 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.



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Learner Audience:

Interns, junior residents, senior residents, faculty

Length of Curriculum:

The curriculum was run in 2 two-hour blocks. These sessions were conducted with a combined short didactic presentation utilizing PowerPoint and then a hands-on supervised scanning session. The content and format of these sessions may be modified into shorter segments and used as a bedside teaching tool or in a flipped classroom setting.

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.

Objectives:

We sought to renew interest in ultrasound by presenting two advanced workshops on nontraditional content. Sessions covered several ways ultrasound could augment or replace aspects of the physical exam and introduced students to regional anesthesia with ultrasound guided nerve blocks.

Brief introduction:

Ultrasound has become a standard component of emergency medicine residency training. Most residency programs fulfill this requirement with a dedicated rotation.¹ At our institution this occurs in the intern year and focuses primarily on the ACEP core applications.² 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:

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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
Aorta	<ol style="list-style-type: none"> Brief lecture describing the technique in measuring the abdominal aorta Hands on session immediately following lecture <p><i>For a full description of this session, see: King A, et al. Ultrasound of the Aorta, JETem 2016.</i></p>	<ul style="list-style-type: none"> -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	<p>10 minutes (lecture) Instructors: 1 Equipment: Powerpoint (and projector/screen)</p> <p>20 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine and model per 3 learners</p>	<p>Milestone: PC12</p> <p>Assessment: Lecture: Quiz</p> <p>Hands-on: Checklist and/or Likert scale of skill mastery (see publication)</p>
Spleno-megaly	<ol style="list-style-type: none"> Brief lecture describing the techniques to measure the spleen Hands on scanning session immediately following the lecture 	<ul style="list-style-type: none"> -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	<p>5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine and model per 3 learners</p>	<p>Milestone PC12</p> <p>Assessment: Direct observation by the instructor for each learner in their group. Evaluate image quality and accuracy of measurements obtained by learner.</p>



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
Acute Mitral Regurgitation	<ol style="list-style-type: none"> Brief lecture describing the techniques to measure mitral regurgitation Hands on scanning session immediately following the lecture 	<p>-Proper technique and probe choice for image acquisition</p> <p>-Identifying the mitral valve on an apical four chamber view</p> <p>-Proper technique for using color doppler to assess for mitral regurgitation</p> <p>-Pearls and pitfalls: setting gain and color scale, aliasing, differences between acute and chronic regurgitant jets</p>	The learner will be able to identify the mitral valve and assess for regurgitation.	PGY-2	<p>5 minute (lecture)</p> <p>Instructors: 1</p> <p>Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session)</p> <p>Instructors: 1 per 3 learners</p> <p>Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>
Aortic Dissection	<ol style="list-style-type: none"> Brief lecture describing ultrasound findings in aortic dissection and how to measure and identify them Hands on scanning session immediately following the lecture 	<p>-Proper technique and probe choice for image acquisition</p> <p>-Measuring the thoracic aorta</p> <p>-Size of normal and abnormal thoracic aorta</p> <p>-Pearls and pitfalls: limitations of bedside ultrasound for making this diagnosis, challenges of identifying acute aortic regurgitation</p>	The learner will be able to identify the aorta and the direct and indirect signs of thoracic aortic dissection	PGY-2	<p>5 minute (lecture)</p> <p>Instructors: 1</p> <p>Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session)</p> <p>Instructors: 1 per 3 learners</p> <p>Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>



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
Hepato-megaly	<ol style="list-style-type: none"> Brief lecture describing how to measure the liver with ultrasound Hands on scanning session immediately following the lecture 	<ul style="list-style-type: none"> -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 hepato-megaly	PGY-2	<p>5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>
Jugular Venous Distention (JVD)	<ol style="list-style-type: none"> Brief lecture describing the techniques to measure the jugular veins Hands on scanning session immediately following the lecture 	<ul style="list-style-type: none"> -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	<p>5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>



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
Patellar tendon rupture	<ol style="list-style-type: none"> Brief lecture describing how to assess the patellar tendon Hands on scanning session immediately following the lecture 	<ul style="list-style-type: none"> -Proper technique and probe choice for image acquisition -Identifying normal patellar tendon -Distinguishing normal and abnormal (loss of architecture, hypoechoic tendon defects, surrounding hematoma) -Pearls and pitfalls: dynamic scanning, comparison to normal side, anistropy 	The learner will be able to identify the patellar tendon and evaluate for tendon disruption	PGY-2	<p>5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners</p>	<p>Milestone PC12</p> <p>Assessment: Real time review by the instructor for each learner in their group. Evaluate image quality obtained by the learner.</p>
Shoulder dislocation	<ol style="list-style-type: none"> Brief lecture describing the techniques to evaluate the shoulder joint Hands on scanning session immediately following the lecture 	<ul style="list-style-type: none"> -Proper technique and probe choice for image acquisition -Identifying the shoulder joint -Assessing the joint space for dislocation -Normal and abnormal shoulder joint space appearance -Pearls and pitfalls, finding the shoulder joint, comparison to normal side, dynamic scanning, challenges of diagnosing a posterior shoulder dislocation 	The learner will be able to identify the shoulder joint and assess for dislocation.	PGY-2	<p>5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine and model (live or mannequin) per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>



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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
Posterior tibial nerve block	<ol style="list-style-type: none"> Brief lecture describing the techniques to locate the posterior tibial nerve Hands on scanning session immediately following the lecture 	<ul style="list-style-type: none"> -Proper technique and probe choice for image acquisition -Locating and identifying the posterior tibial nerve -Infiltrating the posterior tibial nerve -Pearls and pitfalls (locate the posterior tibial artery by color doppler and medial malleolus, can do out-of-plane due to shallow depth) 	The learner will be able to identify the posterior tibial nerve and infiltrate it with anesthesia.	PGY-2	<p>5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>
Ulnar nerve block	<ol style="list-style-type: none"> Brief lecture describing the techniques to locate the ulnar nerve Hands on scanning session immediately following the lecture 	<ul style="list-style-type: none"> -Proper technique and probe choice for image acquisition -Locating and identifying the ulnar nerve -Infiltrating the ulnar nerve -Pearls and pitfalls (use color doppler to locate the ulnar artery, the nerve will be ulna to artery) 	The learner will be able to identify the ulnar nerve and infiltrate it with anesthesia.	PGY-2	<p>5 minute (lecture) Instructors: 1 Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session) Instructors: 1 per 3 learners Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>



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
Radial nerve block	<ol style="list-style-type: none"> Brief lecture describing the techniques to locate the radial nerve Hands on scanning session immediately following the lecture 	<p>-Proper technique and probe choice for image acquisition</p> <p>-Locating and identifying the radial nerve</p> <p>-Infiltrating the radial nerve</p> <p>-Pearls and pitfalls (identify triceps/bicep muscle junction and brachial artery, out-of-plane block easier to perform)</p>	The learner will be able to identify the radial nerve and infiltrate it with anesthesia.	PGY-2	<p>5 minute (lecture)</p> <p>Instructors: 1</p> <p>Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session)</p> <p>Instructors: 1 per 3 learners</p> <p>Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>
Femoral nerve block	<ol style="list-style-type: none"> Brief lecture describing the techniques to locate the femoral nerve Hands on scanning session immediately following the lecture 	<p>-Proper technique and probe choice for image acquisition</p> <p>-Locating and identifying the femoral nerve</p> <p>-Infiltrating the femoral nerve</p> <p>-Pearls and pitfalls (need to place the needle below the fascia illiaca to get good distribution of anesthetic around nerve, requires significant volume 20-30 cc, dilute with NS 1:1 ratio)</p>	The learner will be able to identify the femoral nerve and infiltrate it with anesthesia.	PGY-2	<p>5 minute (lecture)</p> <p>Instructors: 1</p> <p>Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session)</p> <p>Instructors: 1 per 3 learners</p> <p>Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>



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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	<ol style="list-style-type: none"> Brief lecture describing the techniques to locate the sciatic nerve Hands on scanning session immediately following the lecture 	<p>-Proper technique and probe choice for image acquisition</p> <p>-Locating and identifying the sciatic nerve</p> <p>-Infiltrating the sciatic nerve</p> <p>-Pearls and pitfalls (locate the popliteal artery/vein in popliteal crease, the nerve bundle will be above it - scan proximally until common peroneal and tibial nerves merge into sciatic nerve)</p>	The learner will be able to identify the sciatic nerve and infiltrate it with anesthesia.	PGY-2	<p>5 minute (lecture)</p> <p>Instructors: 1</p> <p>Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session)</p> <p>Instructors: 1 per 3 learners</p> <p>Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>
Inter-scalene brachial plexus nerve block	<ol style="list-style-type: none"> Brief lecture describing the techniques to identify and locate the brachial plexus using the interscalene approach Hands on scanning session immediately following the lecture 	<p>-Proper technique and probe choice for image acquisition</p> <p>-Locating and identifying the brachial plexus using the interscalene approach</p> <p>-Infiltrating the brachial plexus</p> <p>-Pearls and pitfalls (locate the anterior and middle scalene muscles--the interscalene will appear as "traffic lights" between scalene muscles; use color doppler to identify vessels prior to performing block; do not perform this block on patients with compromised baseline respiratory function eg, COPD)</p>	The learner will be able to identify the brachial plexus using the interscalene approach and infiltrate it with anesthesia.	PGY-2	<p>5 minute (lecture)</p> <p>Instructors: 1</p> <p>Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session)</p> <p>Instructors: 1 per 3 learners</p> <p>Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>



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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
Supra-clavicular brachial plexus nerve block	<ol style="list-style-type: none"> Brief lecture describing the techniques to locate the brachial plexus using the supraclavicular approach Hands on scanning session immediately following the lecture 	<p>-Proper technique and probe choice for image acquisition</p> <p>-Locating and identifying the brachial plexus using the supraclavicular approach</p> <p>-Pearls and pitfalls (identify the pleura so as avoid inadvertent puncture, rotating probe can place 1st rib under subclavian artery increasing safety)</p>	The learner will be able to identify the brachial plexus using the supraclavicular approach and infiltrate it with anesthesia.	PGY-2	<p>5 minute (lecture)</p> <p>Instructors: 1</p> <p>Equipment: Powerpoint (computer/projector/ screen)</p> <p>15 minutes (hands-on session)</p> <p>Instructors: 1 per 3 learners</p> <p>Equipment: 1 ultrasound machine, model (live or mannequin) and nerve model per 3 learners</p>	<p>Milestone PC12</p> <p>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.</p>



POINT OF CARE ULTRASOUND ASSESSMENT

Resident:

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

Exam Performed:

Date:

	Unable to perform	Performs with assistance	Performs independently
Describes the indications for the ultrasound examination (Level 1, PC12)			
Optimizes images using appropriate gain and depth (Level 2, PC12)			
Selects the appropriate probe (Level 2, PC12)			
Places probe in correct position			
Acquires complete images			
Measures accurately (if applicable)			

Comments:

Supervised by: