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# An Integrated Multispecialty Curriculum for Point-of-Care Ultrasound

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## Abstract

Point-of-care ultrasound is increasingly recognized as a valuable tool for physicians practicing in a variety of specialties. Currently there is no standard curricula or assessment model for training primary care specialty residents in the use of ultrasound. This article presents a multispecialty experience in developing a list of 11 core Pediatric, 13 core Family Medicine and 22 core Internal Medicine ultrasound scans based on best available evidence for their clinical use.



## Keywords

Point-of-Care Ultrasound




## Conflict of Interest Statement

The authors have no conflicts of interest.


## Cover Page Footnote

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## INTRODUCTION

Multiple countries, specialties, residency programs and medical schools embrace point-of-care ultrasound (POCUS) as an essential technology for the modern physician. Advocates term ultrasound as the stethoscope of the 21st century.[1] A critical analysis that reviewed 473 texts regarding POCUS in medical education found the following three "dominant discourses":

1. A visuo-centric discourse prioritizing the visual information as truth over other clinical data;
2. A utilitarian discourse emphasizing improvements in patient care;
3. A modernist discourse highlighting the current and future needs of clinicians in our technological world.[1]

Some countries such as Canada have brought together consensus groups to determine the POCUS skills that each medical student should obtain prior to graduation. Similar efforts in graduate medical education seek to incorporate POCUS into the core curriculum of residency training.

This manuscript describes a multispecialty, collaborative approach to training primary care residents at a community hospital in core POCUS competencies. We outline expected competencies for graduates of Family Medicine, Internal Medicine, and Pediatric training programs at Cone Health System in Greensboro, North Carolina. While not required for graduation, learners are expected to gain familiarity with ultrasound in the first year of training followed by continued improvement in image acquisition and interpretation. The specific curricular elements included for each specialty reflect those that directly impact clinical care. Additionally, an example checklist of directly observed POCUS skills for Sports Medicine fellowship graduates serves as a model for program evaluation. Training with Emergency Medicine faculty and monthly simulation-based sessions highlights the multispecialty collaborative approach.

## FAMILY MEDICINE CURRICULUM

Family physicians utilize POCUS to enhance patient care, no matter the practice setting ranging from rural underserved areas to large academic centers. The American Academy of Family Physicians (AAFP) outlines competencies and skills for ultrasound training during residency. [2] Program directors face barriers in training residents, including limited resources for equipment and inadequately trained faculty.[3] Numerous Family Medicine programs plan to establish an ultrasound curriculum within their programs. [3]

Within our family medicine residency clinic, common ultrasound exams referred to specialty clinicians include vascular ultrasound for suspected deep venous thrombosis, echocardiogram, and obstetric ultrasound for dating and/or viability (Christie Reynolds MHA, e-mail communication, September 4, 2020). We outline 13 POCUS examinations frequently used in primary care with documented evidence of validity when applied in this setting. A multitude of primary care POCUS exams have been compared to the standard of care (radiologist or specialist assessment of the area of interest) and found to have similar diagnostic accuracy (Table 1).

**Table 1.** Recommended POCUS scans in Family Medicine residency education.

| **Point-of-Care Ultrasound Examination** | **Clinical Indications** | **Evidence for Use in Clinical Practice** |
|---|---|---|
| **Abdominal/Pelvic Imaging** | | |
| Abdominal Aorta Aneurysm Screening | Currently recommended by USPSTF screening guidelines | FM residents have similar accuracy with scans as compared to vascular technicians[4] |
| Renal | Suspected hydronephrosis from obstructive process | Scans in primary care are sensitive and specific for hydronephrosis[5] |
| Bladder | Post-void residual assessment | Bladder scan is accurate in primary care[5] |
| Gallbladder | Suspicion for cholelithiasis | POCUS is accurate in assessment of biliary colic[6] |
| **Obstetric Imaging** | | |
| First trimester | Pregnancy viability, location and dating by crown-rump length | FM residents have similar accuracy to radiologists in dating exams [7] |
| Third trimester | Fetal presentation, objective amniotic fluid assessment, and placental location | FM residents have similar accuracy to radiologists for biometry[7] |
| **Musculoskeletal Imaging** | | |
| Fracture evaluation | Metacarpal and metatarsal fractures | POCUS has high sensitivity and specificity for metacarpal fractures[8] |

| | | |
|---|---|---|
| Skin and soft tissue | Evaluation of suspected cellulitis versus abscess | POCUS changes management of skin infections in primary care[9] |
| Joint evaluation | Suspected joint effusion, ultrasound-guided aspiration and injections | Ultrasound can help to differentiate soft tissue edema versus effusion[10] |
| Tendon evaluation | Complete and partial rupture evaluation | POCUS is sensitive and specific for complete and partial tendon ruptures[11] |
| **Thoracic Imaging** | | |
| Basic Cardiac | Four view ultrasound to subjectively assess cardiac function and volume status | Family physicians quickly acquire basic echocardiogram skills and interpretation similar to that of cardiologists[12] |
| Lung | Evaluation of dyspnea, assessing effusions for potential thoracentesis | ED developed protocols for acute dyspnea can be sensitive and specific in identifying causes of dyspnea[13] |
| **Vascular Imaging** | | |
| Deep Venous Thrombus (DVT) | Evaluating suspected venous thromboembolism | Compression ultrasound by general practitioners has similar performance to those performed by vascular ultrasound experts[14] |

## INTERNAL MEDICINE CURRICULUM

POCUS has emerged as a validated tool for the evaluation and management of acutely ill patients admitted to the hospital.[15] POCUS is easy to perform and has better validity than many traditional physical exam maneuvers.[16] Growing numbers of Internal Medicine residencies have established a formal ultrasound curriculum.[17] Both medical students and residents want to prioritize ultrasound training and intend to utilize POCUS in their post-graduate practice.[18] Professional societies are defining the scope of practice for Internal Medicine POCUS users with a future goal of standardized credentialing.[19] We have identified 22 POCUS exams from 3 years of clinical experience that are the most common and useful in our hospital and clinic-based Internal Medicine practice (Table 2).

**Table 2**. Recommended POCUS scans in Internal Medicine residency education.

| **Point-of-Care Ultrasound Examination** | **Clinical Indications** | **Evidence for Use in Clinical Practice** |
|---|---|---|
| **Procedural Guidance** | | |
| Central venous catheter insertion | Direct needle guidance to access internal jugular, subclavian or femoral veins | Reduction in complications and infections, increase in procedural success[20] |
| Thoracentesis | Measure pleural effusion size and location, rule out loculation | Static and dynamic ultrasound guidance reduces risk of pneumothorax[21] |
| Paracentesis | Measure ascites volume, location and accessibility | Ultrasound increases procedural success and reduces bleeding[22] |
| Lumbar puncture | Identify midline, spinous process, inter-vertebral space | Ultrasound reduces number of attempts and increases procedural success rates[23] |
| Arthrocentesis | Measure effusion size and location for aspiration | Ultrasound improves accuracy and procedural pain scores as compared to landmark guided techniques[24] |
| **Cardiac Imaging** | | |
| Left ventricular contractility | Estimate ejection fraction range and increased end-diastolic pressure | POCUS assessment of ejection fraction has similar measurements as compared to expert consultation [25] |
| Pericardial effusion | Evaluate for pericardial effusion and signs of tamponade | POCUS improves physical exam accuracy for pericardial effusion[25] |
| Right ventricular enlargement | Identify right ventricular enlargement and signs of elevated pulmonary pressure (septal flattening) | Focused echocardiography may aid diagnosis of pulmonary embolism among patients with a high pretest probability[26] |
| Inferior Vena Cava (IVC)/Jugular Venous Pressure (JVP) | Identify elevated right atrial pressures with distended JVP or distended IVC with reduced respiratory variation | IVC collapsibility may help to determine volume responsiveness among hemodynamically unstable patients [27] |

| | | |
|---|---|---|
| **Abdominal Imaging** | | |
| Ascites | Identify and quantify ascites, helpful in the patient with obesity | POCUS aids in accurate assessment of ascites volume[28] |
| Bladder volume | Assess for bladder outlet obstruction | POCUS accurately assesses post-void residual[29] |
| Prostate size | Measure prostate in three dimensions and estimate prostate volume | Transabdominal POCUS by urologists accurately measures prostate volume[30] |
| Renal | Assess for hydronephrosis | Inpatient POCUS assessment appears to reliably diagnose hydronephrosis and obstruction[31] |
| Abdominal aortic aneurysm screening | Currently recommended by screening guidelines | Primary care residents attain similar accuracy as compared to vascular ultrasound technicians[4] |
| **Lung Imaging** | | |
| Pleural effusion | Identify pleural effusions, assess lung for consolidation or atelectasis, identify high risk features like loculations | Improved accuracy in diagnosing loculated effusions or lung consolidation[13] |
| Alveolar/Interstitial syndromes | Evaluate for findings of pulmonary edema or interstitial lung disease | POCUS has modest sensitivity and high specificity for pulmonary edema[13] |
| Consolidation, atelectasis | Assess consolidated lung for air bronchograms | Protocol-based POCUS assessment sensitive and specific for pneumonia [13] |
| Pneumothorax | Utilize M-mode after thoracentesis or central line placement | Ultrasound can identify post-procedural pneumothorax[21] |
| **Vascular Imaging** | | |
| DVT | Assess for lower extremity DVT | Hospitalists have similar accuracy in diagnosing DVT as compared to radiologist[32] |

| **Musculoskeletal Imaging** | | |
|---|---|---|
| Joint effusions | Identify effusions in upper and lower extremity joints, ultrasound guided aspiration and injections | Ultrasound improves diagnostic accuracy for suspected joint effusion[33] |
| Skin and soft tissue infections | Assess cellulitis, abscess, lymphadenopathy[34] | Learners can reliably diagnose abscesses after short training[35] |
| Tendon tears | Evaluate for complete or partial tendon tears | POCUS can guide management of common injuries in emergency settings[11] |

Abbreviations: IVC, inferior vena cava, JVP, jugular venous pressure, DVT, deep venous thrombosis, POCUS, point-of-care ultrasound

## PEDIATRIC CURRICULUM

POCUS holds promise for improving the care of pediatric patients, while lessening exposure to the risk of ionizing radiation. Lower body mass of most pediatric patients allows better image resolution and easier accessibility to internal organs.[36] POCUS may also avoid involved imaging procedures that can cause distress and even require sedation. Despite these advantages, incorporation of ultrasound education into Pediatric training lags. A 2019 survey of U.S. residency program directors found only 12% of Pediatric residency programs offered optional formal curricula, while none required ultrasound training. This contrasts to the 38% of Internal Medicine residency programs who reported formal ultrasound curricula.[37] POCUS training has progressed in the Emergency Medicine setting, and education guidelines have been proposed for Pediatric Emergency Medicine fellows.[38, 39] Proponents endorse POCUS as an integral tool for pediatricians practicing in multiple settings, including outpatient and hospital settings.[40]

Building on the experience of our colleagues in Emergency Medicine, we have identified six categories of scans that are reliable and beneficial tools for pediatricians (Table 3). Although fewer studies have assessed the performance of POCUS in pediatrics, current evidence is encouraging. We outline POCUS examinations appropriate for adoption in pediatric training that ultimately may become part of evidence-based standards of ultrasound proficiency in pediatric training.

**Table 3.** Recommended POCUS scans in Pediatric residency education

| **Point-of-Care Ultrasound Examination** | **Clinical Indications** | **Evidence for Use in Clinical Practice** |
|---|---|---|
| **Skin/Soft Tissue Imaging** | | |
| Skin/soft tissue infections | Assess for cellulitis, abscess, lymphadenopathy and retained foreign body | Pediatric trainees can accurately assess for foreign bodies after short training[41] |
| **Lung Imaging** | | |
| Pleural effusion, pneumothorax, hemothorax | Identify pleural effusions, track volume changes, assess for adjacent lung disease | Ultrasound can aid in evaluation of respiratory distress in children and accurately identify pleural effusions[42] |
| Alveolar/Interstitial disease | Identify presence of B lines consistent with pulmonary edema or interstitial lung disease | Ultrasound can identify signs of pulmonary edema in children[42] |
| Consolidation, atelectasis | Assess lung for hepatization and air bronchograms, differentiate consolidation from atelectasis, help diagnose pneumonia | Lung ultrasound can help rule in and rule out pneumonia in children[43] |
| **Cardiac Imaging** | | |
| Pericardial effusion | Evaluate for pericardial effusion and signs of tamponade | Ultrasound improves evaluation of pericardial effusion after penetrating trauma[42] |
| **Abdominal Imaging** | | |
| Bladder volume | Assess for presence of urine before catheterization, confirm urinary production or retention | POCUS may reduce failed attempts at catheterization[42] |
| Common bile duct and gallbladder | Identify gallstones, cholelithiasis, and cholecystitis | POCUS can aid in diagnosis of biliary tract disease[42] |

| **Musculoskeletal Evaluation** | | |
|---|---|---|
| Apophyseal/Physeal injuries | Evaluate for inflammation, swelling, widening | Ultrasound may aid in diagnosis of apophysitis[44] |
| Fractures | Identify cortical discontinuity, especially in diaphyseal fractures | Identify presence of fracture after trauma to affected area [8] |
| **Procedural Guidance** | | |
| Lumbar puncture | Identify midline, spinous process, inter-vertebral space | Ultrasound guidance reduces number of attempts and traumatic lumbar punctures[45] |
| Vascular access | Facilitate access with central venous catheter, arterial line, IV placement | Ultrasound reduces time to IV placement[46] and reduces complications in central venous catheter placement[47, 48] |

## SPORTS MEDICINE CURRICULUM

Teaching of musculoskeletal (MSK) ultrasound occurs within Physiatry and Radiology residencies as well as Sports Medicine and Rheumatology fellowships. For the past 15 years Sports Medicine fellowship training has incorporated ultrasound training and the ACGME now requires training as a core requirement of fellowship programs. The American Medical Society for Sports Medicine (AMSSM) developed a curriculum in 2010 and updated this in 2015.[49,50] The curriculum draws on the American Institute of Ultrasound in Medicine's Training Guidelines for both diagnostic ultrasound examinations and interventional procedures.[51, 52, 53] It includes core competencies as well as the minimum knowledge of MSK ultrasound a sports medicine fellow should acquire during fellowship.

Sports Medicine fellowship POCUS training includes four major components: didactic instructional sessions, didactic practice sessions, mentored clinical experience, and supplementary and continuing education. The AMSSM curriculum contains 155 scans from basic to advanced MSK ultrasound imaging. Our longitudinal curriculum at the Cone Health Sports Medicine Fellowship teaches these with an emphasis on 68 frequently used scans that cover the six major regions of the body (shoulder, elbow, wrist-hand, hip, knee, and ankle-foot).

Fellows are introduced to the technique for the 68 core scans at the beginning of fellowship in July. Competency assessment of these 68 scans occurs throughout the year culminating with an observed practical examination at the end of fellowship. An example of expected competency in image acquisition for the shoulder is highlighted in Table 4. Results of the first seven fellows to complete this practical examination reveal competence in demonstrating between 64 and 68 of the core scans.

**Table 4.** Example Core MSK US Exam Competency Checklist for Shoulder

| **Upper Extremity: Shoulder (10 Points Maximum)** |
|---|
| Proximal biceps tendon –longitudinal and transverse view |
| Pectoralis major insertion |
| Supraspinatus end plate |
| Supraspinatus dynamic |
| Infraspinatus |
| Teres minor |
| Subscapularis static and dynamic |
| Glenohumeral joint and posterior labrum |
| Acromioclavicular joint |
| Interval view |

## MULTIDISCIPLINARY APPROACH

Faculty from each of the above mentioned specialties work together to provide longitudinal, hands-on experiences for learners. Core POCUS faculty have all attended post-graduate training courses to develop, improve, and maintain POCUS skills and regularly attend workshops together. In addition, Emergency Medicine faculty play a key role in training both faculty and learners. POCUS training and practice in Emergency Medicine has occurred for decades. Emergency Medicine physicians are well suited to provide advanced instruction in POCUS, particularly as some have fellowship level ultrasound training.

To support continued ultrasound education and POCUS utilization, our Emergency Medicine group coordinates teaching with Family Medicine, Internal Medicine, Pediatrics, Sports Medicine and Obstetrics to organize monthly multispecialty ultrasound workshops for residents, medical students, PA students and nurse practitioners. These interactive workshops include structured didactics, image acquisition on standard patient models, and interpretation with the assistance from core POCUS faculty. Workshops typically focus on a particular anatomic area, with an initial 30-minute didactic session followed by three hours of dedicated time scanning.

## DISCUSSION

Here we present a multispecialty approach to implementation of a comprehensive point-of-care ultrasound curriculum at a community hospital program focused on primary care trainees in Family Medicine, Internal Medicine, and Pediatrics. Just like with other practice patterns, the use of POCUS in these fields has significant overlap and distinct differences. While Emergency Medicine and Sports Medicine have nationally recognized core requirements for specific ultrasound skills, primary care residencies in Family Medicine, Internal Medicine and Pediatrics have not established these. We used a multispecialty group of clinician educators to establish 11 core Pediatric, 13 core Family Medicine and 22 core Internal Medicine scan techniques that we incorporate into the educational experience of our primary care residencies. The core scans were chosen based on best available clinical evidence and expert opinion. It is our experience that residents universally value this training and most plan to incorporate it into their future practice if they can maintain and build upon foundational skills.

It was essential for administrative leadership to embrace the integration of ultrasound training into all aspects of graduate medical education. There are upfront costs to equipment that must be supported, though it is becoming more affordable as the technology advances and becomes more portable. There are also significant administrative implications to the health system in starting a POCUS program, as questions of credentialing, documentation, billing, and image storage must be addressed at the local level. Working with institutional leaders, information technology teams, and practice administration has allowed for implementation in a variety of practice settings within our healthcare system.

Future directions of such a POCUS program can also include delivering this curriculum to practicing primary care physicians who did not have exposure to POCUS in their training. Health education programs can also facilitate greater incorporation of POCUS into their system by developing a one-year clinical ultrasound fellowship to allow interested primary care residents to obtain advanced training in POCUS. These educational experiences during residency and beyond are expected to allow early career physicians to integrate POCUS as a part of their future practice.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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