



The Future of Ultrasound for Acute Pain and Invasive Procedures in Anesthesia and Emergency Medicine Training Programs

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Editorial

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Abbreviations: PNB: Peripheral Nerve Blocks; FAST: Focused Assessment with Sonography in Trauma; UGRA: Ultrasound-Guided Regional Anesthesia; EM: Emergency Medicine; POCUS: Point-of-Care Ultrasound; PIV: Peripheral Intravenous; TEE/TTE: Transesophageal and Transthoracic Echocardiography.

Introduction

Pain is one of the most common complaints in the emergency department, representing the chief complaint in over 50% of ED visits [1]. Similarly, approximately 80% of patients undergoing surgery experience postoperative pain [2]. Uncontrolled acute pain leads to worse quality of life and development of chronic pain [3], while sufficient pain relief is associated with a decrease in cost [4] and duration of hospitalization [5]. Regional anesthesia techniques, particularly peripheral nerve blocks (PNB), have become commonplace as part of a multimodal perioperative pain relief approach and have also increased in popularity over the past decade in the emergency department [6], with the most common being interscalene, supraclavicular, and suprascapular nerve blocks [7]. The use of ultrasound guidance has helped facilitate visualization of desired nerves for anesthesia and aided the adoption of regional anesthesia into medical practice.

Ultrasound guided PNBs were first pioneered during the 1970s, when La Grange et al. described a supraclavicular block technique with doppler ultrasonography while avoiding major side effects [8]. These early modes of regional anesthesia were promising, but it wasn't until the advent of Point-of-Care Ultrasound (POCUS) did ultrasound rapidly gain popularity in fields beyond radiology [9]. POCUS

has now become a cornerstone in anesthesia, emergency medicine (EM), OB/GYN, cardiology, and critical care [10]. In this editorial, we will explore the usage of ultrasound-guided regional anesthesia (UGRA) for acute pain in anesthesia and emergency medicine and the potential for a unified curriculum within these residency programs.

Ultrasound has become an integral component of everyday management in anesthesiology, useful in areas such as airway management, vascular access, cardiac management, lung and gastric assessment, and regional anesthesia [11]. Its use can assist with anatomic visualization to avoid complications in high-risk procedures, such as the placement of a 12-14 F dialysis catheter in the internal jugular vein. Ultrasound allows the physician to quickly acquire a complete sense for the relationship of all the neurovascular structures in the region of interest. Furthermore, it provides real-time guidance as the procedure unfolds, from the placement of the needle and the guidewire to the visualization of the proper depth of cannula placement.

Anesthesiology training in POCUS can aid in the rapid diagnosis of perioperative hypotension via cardiac and pulmonary examination. POCUS can differentiate between etiologies such as hypovolemia, cardiac tamponade, pneumothorax, and right or left ventricular dysfunction in an expedient and reliable manner. Further, POCUS exams may be repeated to review if clinical interventions have provided expected outcomes or if further treatment is needed (i.e. resolution of pneumothorax with chest tube placement or improvement of hypovolemia with fluid resuscitation).

Finally, ultrasound has found a role with "mundane" procedures such as the placement of a peripheral intravenous

(PIV) catheter. PIV placement, a seemingly easy task, can be made surprisingly difficult due to either patient habitus, history (systemic chemotherapy), or multiple prior attempts. The above are but a few examples of ultrasonographic techniques that find daily use in anesthesiology training, with new applications being designed constantly.

In addition to daily use by general anesthesiologists, cardiac anesthesiologists are also increasingly using ultrasound to perform peripheral nerve blocks for their patients. Post-cardiac surgical pain control can be delivered by any number of anatomical approaches including the pectoralis, serratus anterior, transverse spine and erector spinae blocks [12]. Ultrasound plays a significant role in their safe and effective delivery.

Interestingly, early research on the use of ultrasound in cardiac imaging indirectly helped to give rise to ultrasound-guided peripheral nerve blocks as techniques of anatomical visualization were developed. Cardiac ultrasound dates to the early 1950s with the work of Edler and Hertz who pioneered ultrasound-guided studies of mitral regurgitation [13]. A decade later in 1966, M-mode interrogation of the fetal heart was accomplished [14].

Aside from their benefits clinically, the ACGME requires that anesthesiology residents obtain competency in transesophageal and transthoracic echocardiography (TEE/TTE), ultrasound for pneumothorax and pleural effusion, and vascular access [15]. Additionally, there are mandated minimums for neuraxial and peripheral nerve blocks. A 2019 survey of 30 programs suggested that most programs had a four-week regional anesthesia/acute pain medicine block for dedicated training [16]. Variability across the country on ultrasound proficiency is remedied through written and applied exams through board certification [17], requiring competence in ACGME requirements. However, there remains diversity in peripheral nerve catheter placements, nerve blocks, and use of nerve stimulators nationwide.

In comparison, EM integrates ultrasound in the management of the undifferentiated patient by providing guidance for procedures such as paracentesis or thoracentesis, the focused assessment with sonography in trauma (FAST), and assisting in diagnoses of vascular, musculoskeletal, gastrointestinal, obstetric, and cardiac pathology [18]. ACGME requires that EM residents gain proficiency in ultrasound for the purposes of diagnostic evaluation but does not specify a minimum or what procedures residents need be performed, such as FAST, lung assessments, or peripheral nerve blocks. Still, EM has further training in an ultrasound fellowship, and ABEM offers a focused practice designation in Advanced Emergency Medicine Ultrasonography

(AEMUS) [19]. The AEMUS fellowship includes chest, lung, and airway ultrasound training but does not presently incorporate a focused module on regional anesthesia [20]. Organizing an interdisciplinary curriculum that combines the breadth of ultrasound application within EM and the regional anesthesia experience from anesthesiology could augment the ultrasound-guided procedural capacity of future physicians across both specialties.

Ultrasound in anesthesia and EM residencies have significant overlap in procedural requirements. Both require competency in using POCUS for various procedures such as acquiring vascular access and echocardiography. Regional anesthesia is a required aspect of anesthesia residency [21]; in contrast, UGRA education is dependent upon programs placing emphasis on the skill or relevant experience of in-house faculty [22]. Therefore, we suggest that there be a joint curriculum in UGRA for both specialties for the management of acute pain.

Tools for learning UGRA exist beyond the typical “see one, do one, teach one” model. Simulation-based methods allow participants to repeatedly perform procedures risk-free and receive immediate feedback [23]. A meta-analysis comparing simulation-based methods to non-simulation training suggested that learning outcomes such as time taken, workflow, and success were all significantly improved [24]. Other available teaching methods can use models such as gelatin/agar constructs, cadavers, or 3D printed structures to provide diverse avenues for hands-on learning and practical experience [25]. Online resources such as NYSORA or YouTube channels specifically dedicated to regional anesthesia topics are worthwhile knowledge bases to consider incorporating. Other interesting developments include using wearable devices, virtual learning, haptic feedback devices, or augmented reality to facilitate grasping technical skills in UGRA [25].

Interdepartmental collaboration is another avenue for providing residents with important experience in UGRA. Lack of ED faculty experience sufficient for standardized education can be supplemented by collaboration with anesthesia faculty or by the establishment of credentialing pathways for attending physicians in EM to gain comfort and experience with UGRA. Establishment of a dedicated UGRA service in emergency departments as an elective for residents could also improve familiarity with procedures. Additionally, numerous EM programs already have connections with anesthesiology departments for airway training. These existing connections could facilitate a transition towards establishing a regional anesthesia elective for both specialties. As most anesthesia programs already have a block service, programs could benefit from cross-training in different environments.

For anesthesia acute pain services, having another resident available could increase the frequency of regional anesthesia procedures. A survey this year stated that the most significant obstacles to teaching regional anesthesia were limited time and limited surgical interest [26]. Increasing the number of staff available to perform pre-operative blocks could alleviate surgical concerns about procedural start times and increase the amount of time available to be allotted per block. As it could take at least 25-40 blocks to attain proficiency in blocking a specific region [27], improving numbers across the board via a structured, integrated elective can lead to increased confidence in training for today's practice environment for all residents.

On the national level, ACGME could begin mandating specific ultrasound training that EM residents should master. Currently, residents are required to demonstrate expertise in using ultrasound for bedside diagnostic evaluation, resuscitation, and procedural guidance. Regulatory bodies could begin setting minimum requirements on the number of ultrasound procedures such as FAST, lung assessments, and peripheral nerve blocks. Furthermore, having national bodies such as ACGME, ABA, and ABEM come together to set guidelines would contribute significantly to beginning a unified curriculum.

Given the dramatic improvement in outcomes and patient safety [28], UGRA has emerged as a premier technique for acute pain services and invasive procedures. The variability across current programs, such as AEMUS, in both curricula and faculty expertise has created inconsistencies when including UGRA into both EM and anesthesia residency programs. Interdepartmental collaboration between EM and anesthesia could remedy this deficiency by instituting a structured ultrasound curriculum focusing on regional anesthesia and invasive procedures. We recommend integrating this into EM and anesthesia residencies as it would empower programs to produce physicians capable of meeting the exploding demand for proficiency in UGRA and invasive procedures for acute pain.

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