AMERICAN ASSOCIATION OF NURSE ANESTHETISTS

Point-of-Care Ultrasound in Anesthesia Care

Practice Considerations

Purpose

Point-of-Care Ultrasound (POCUS) is emerging as a critical and core skill that Certified Registered Nurse Anesthetists (CRNAs) should possess. CRNAs have the foundational knowledge, skills and abilities, which supplemented by professional development and life-long learning, provide the ability to use POCUS to guide patient care. Nurse anesthesia educational programs may incorporate POCUS education and training into their preparation of CRNAs for entry into practice. CRNAs may also engage in professional development and life-long learning to obtain and enhance their expertise in POCUS.

This document provides an overview of common applications of POCUS in anesthesia care and considerations for CRNAs and facilities for developing strategies for training, implementation, and use of POCUS. The education and training required for specific application of POCUS will differ based on the CRNA's existing skill and the level of complexity of the procedure (e.g., Transesophageal Echocardiography).

Background

POCUS refers to the use of portable ultrasonography at a patient's bedside for therapeutic and procedural (e.g., image-guidance) and diagnostic (e.g., symptom or sign-based examination) purposes.[1] POCUS for image guidance improves the safety and efficacy of many interventions used in anesthesia care such as regional anesthesia procedures (e.g., central neuraxial and peripheral nerve blocks) and vascular access.[2] With significant advances in technology, POCUS has also emerged as a valuable diagnostic tool in a wide range of clinical settings.[1]

For diagnostic purposes, POCUS is a safe, fast, effective, and relatively inexpensive tool that helps address a specific clinical question to guide the evaluation and management of the patient and is often seen as complimentary to the physical examination.[3] Its ability to diagnose potentially life-threatening conditions in a timely manner is especially beneficial in resource-poor settings where access to other types of imaging is not available.[3,4] The use of POCUS, however, is not intended to replace detailed diagnostic examination performed by a radiologist, and should always be considered within the clinical context and integrated with other available patient information.[5,6-8]

Growing evidence suggests that POCUS contributes to earlier and improved diagnosis, helps reduce cost of care, and improves patient outcomes.[9] Though POCUS examination is beneficial, some anesthesia professionals may face barriers to use of POCUS, including developing and maintaining competence, establishing curriculum standards for training, and managing unexpected diagnoses (see Table 3 for a list of other barriers to POCUS use).[9,10]

Applications of POCUS in Clinical Anesthesia

There are multiple applications of POCUS in clinical anesthesia, the most common of which include airway ultrasound; lung ultrasound; focused cardiac ultrasound; gastric ultrasound; and abdominal ultrasound. POCUS may also be used for image guidance of anesthesia or anesthesia-related procedures. Examples of various POCUS applications in anesthesia care

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are outlined in Table 1. For comprehensive POCUS guidelines, see the American Institute of Ultrasound in Medicine (AIUM) *Practice Parameter for the Performance of Point-of-Care Ultrasound Examinations*. In addition, the AIUM has developed *Practice Parameters for the Performance of Selected Ultrasound Guided Procedures* to assist clinicians performing ultrasound-guided procedures.

Table 1. Examples of POCUS Application in Anesthesia Care[1,9]

Diagnostic Applications	Image-guided or Procedural Applications
• Airway, lung, gastric and abdominal evaluations	• Guidance of regional and neuraxial techniques[11]
• Transthoracic Echocardiography (TTE)[12]	• Guidance of central and peripheral vascular access
• Transesophageal Echocardiography (TEE)[12]	• Arterial access
• Airway management	• Pain management (acute and chronic pain procedures)
• Bladder scan	• Urgent decompression of cardiac tamponade
	• Needle decompression for pneumothorax

Airway Ultrasound

Airway ultrasound has broad applications for safe airway management. Preoperatively, it can determine the airway size and identify anatomical variations or abnormalities (e.g., vocal cord dysfunction) that can lead to difficult endotracheal intubation. Airway ultrasound can help verify endotracheal tube placement with a high degree of sensitivity (93-99 percent) and specificity (97-98 percent) without requiring confirmation by end-tidal CO_2.[13-16] Recent studies demonstrate the ability of airway ultrasound to predict difficult laryngoscopy by measuring the anterior neck soft-tissue thickness.[17-19] Airway ultrasound can also identify the cricothyroid membrane for emergent cricothyrotomy. This may be particularly useful if inspection by external visualization or palpation is not possible in certain patients, for example those with obesity or anatomical abnormalities, before or during emergency airway management.[20,21]

Focused Lung Ultrasound

Lung ultrasound (LUS) is a useful tool for evaluating pleural effusion, pneumothorax, pneumonia, and acute lung oedema.[3,22] For instance, pneumothorax, a condition of lung pleura, is uncommon but can be life-threatening as it can progress to significant cardiorespiratory instability, especially in unstable patients with tension pneumothorax that requires immediate needle decompression.[23]

Definitive diagnosis is necessary for treatment of pneumothorax as it may require chest tube placement. Chest radiography, however, may be impractical to perform intraoperatively, as the patient may have to undergo additional imaging that may lead to a delayed diagnosis.[24] A LUS bedside application is a better solution for these patients, as it provides real-time diagnostic and timely clinical evaluation that can lead to a fast decision to drain in case of pneumothorax.[3]

LUS can be especially beneficial for pediatric patients for diagnosing pulmonary diseases, such as obstructive and compressive atelectasis that is typically small and not visible on standard chest radiograph.[25] While computer tomography or magnetic resonance imaging (MRI) can easily confirm this condition, these types of imaging modalities may expose pediatric patients to harmful ionizing radiation.[3]

Focused Cardiac Ultrasound

Identification and management of patients who are at risk of cardiopulmonary disease is an important goal of preoperative evaluation. Patients with ischemia, heart valve disease, and ventricular hypertrophy are particularly at high risk for adverse events in the perioperative phase. These conditions, however, often go undetected during a routine preoperative evaluation and may result in significant perioperative adverse events.[26]

Point-of-care focused cardiac ultrasound (FOCUS), a subtype of POCUS, is a simple, rapid exam that uses basic binary (yes or no) clinical questions to facilitate perioperative management. The most common pathologies that can be identified or ruled out with FOCUS include pericardial effusions, severe left and right ventricular failure, regional wall motion abnormalities suggestive of coronary artery disease, gross valvular pathology, and a dynamic assessment of the inferior vena cava.[27] Preoperative FOCUS exam can modify perioperative and perianesthesia management, including increased patient monitoring, use of different anesthesia techniques and drugs, and changes in postoperative care.[28,29]

Gastric Ultrasound

POCUS assessment of gastric contents and volume is important prior to induction of anesthesia. The fasting status that is typically determined with a preoperative verbal check may not be reliable, as some patients are reluctant to disclose noncompliance with fasting guidelines due to fear of delay or cancellation of surgery.[30] Furthermore, patients who are pregnant or have certain conditions (e.g., diabetes, renal or liver dysfunction, gastroesophageal reflux disease) may experience delayed gastric emptying resulting in a “full stomach” despite following recommended fasting intervals.[31,32] For example, in a retrospective study involving 538 patients, Van de Putte et al.[32] found that after undergoing bedside gastric ultrasound, 32 (6.2 percent) patients presented with a full stomach, nine of which (1.7 percent) had solid contents, 23 (4.5 percent) had clear fluids, and six patients had prolonged gastric emptying (1.1 percent). In another study involving 222 patients, Ohashi et al.[33] reported that four percent of fasted patients had a gastric residual volume (GRV) > 100 ml and three percent had a GRV >1.5 ml/kg, values that put these patients at risk for pulmonary aspiration.

While rare, pulmonary aspiration of gastric contents remains one of the most fatal complications in the perioperative phase.[33] Gastric ultrasound provides a reliable assessment of type of content (empty, clear fluid, or solid) and volume before a surgical procedure. It also identifies the level of aspiration risk that can lead to changes in anesthetic management of patients who do not follow fasting guidelines or high-risk patients with decreased gastric emptying.[31]

Abdominal Ultrasound

The Focused Assessment with Sonography for Trauma (FAST) is a POCUS exam to analyze the peritoneal cavity for free fluid and pericardial effusions.[34] The FAST exam is primarily used in emergency medicine and trauma to manage patients for blunt and/or penetrating abdominal and/or thoracic trauma.[35] Other applications of abdominal ultrasound include rapid detection of abdominal aortic aneurysm and hydronephrosis after acute kidney injury.[36]

Anesthesia professionals have started to utilize the FAST exam to help identify persistent bleeding following abdominal surgery that contributes to a rapid decision to return the patient to the operating room for further surgical exploration.[37] It can also help identify intra-abdominal fluid extravasation (IAFE) causing pain following hip arthroscopy[38] and diagnose postoperative urinary retention, as it provides pelvic views.[39]

Table 2. Common Applications of POCUS in the Perioperative Setting[27,40]

Examples of POCUS Applications in Phases of Anesthesia Care			
Technique	**Preoperative**	**Intraoperative**	**Postoperative**
Airway	• Identification of patients at risk for difficult airway ◦ Locating the cricothyroid membrane to facilitate easy identification should invasive airway access be needed. • Identification of vocal cord palsy and other pathology	• Verification of endotracheal tube (ETT) positioning • Assessment of ETT depth • Localization of the cricoid membrane	• Emergency airway interventions (by visualization of trachea and cricothyroid membrane)
Lung	• Identification of patients at risk for respiratory distress (e.g., pleural effusions, pulmonary edema, pneumothorax)	• Assessment for the specific causes of respiratory distress (e.g., pleural effusions, pulmonary edema, pneumothorax)	• Assessment for post-procedural complications (e.g., pleural effusions, pulmonary edema, pneumothorax)
Cardiac	• Identification of patients at risk for cardiopulmonary disease	• Assessment for acute cardiac changes	• Assessment for acute cardiac changes
Gastric	• Assessment of gastric contents (e.g., empty, clear fluid, or solid) and volume	Not applicable	• Assessment of patients with abdominal distension and/or ileus
Abdominal	• Initial evaluation of hypotensive trauma patients	Not applicable	• Identification of intra-abdominal fluid extravasation following hip arthroscopy • Identification of urinary retention

POCUS Practice Considerations

CRNAs are responsible for following the POCUS-related requirements specified in federal, state, and local law, accreditation standards, and facility policies.

Professional Development

Specific training and expertise are essential to operate POCUS effectively and safely to prevent adverse patient outcomes.[41] Competencies related to POCUS should be built on a general understanding of the physics of ultrasound transmission, appropriate transducer selection for specific applications, and knowledge of potential limitations and artifacts.[1] It is important to maximize accuracy for image-guidance or diagnostic purposes through optimal image acquisition that requires selecting the most appropriate patient position, probe, and scanning protocol, followed by good interpretation skills.[8,42] Spectral, color, and power Doppler imaging should be considered, for example, when trying to differentiate vascular from nonvascular structures in any location.[41] Measurements should be taken if an abnormal area is encountered. [41] A comprehensive study might be necessary if the clinical question cannot be addressed with POCUS or if there is an incidental finding that warrants further investigation.[41]

Training[9,42-48]

The AANA supports CRNAs who advance their clinical expertise and competency through various pathways, such as continuing education courses, workshops, self-study, mentored practice, accredited fellowships, as well as other educational activities (see the AANA *CRNA Specialty Clinical Practice, Position Statement*). The AANA's *Considerations for Adding New Activities to Individual CRNA Scope of Practice* may help guide CRNAs who want to incorporate new techniques and technologies into their practice to improve patient outcomes.

Other training considerations include:

- Develop evidence-based POCUS curriculum that covers common pathologies and clinical scenarios.
- Use both didactic and hands-on expert-guided training that includes high-frequency, structured feedback.
- Use simulation-based methods with guided feedback, especially during the early phases of skill acquisition.
- Implement training in image interpretation:
    - Incorporate a variety of images to understand normal and abnormal anatomy and physiology as well as changes from the baseline US assessment.
- Incorporate training on human models followed by mentored patient-based scanning.

Credentialing and Privileging

- CRNAs should seek to become credentialed and privileged within their facility for the use of POCUS based on their facility credentialing and privileging requirements.

- The AANA supports the integration of POCUS into credentialing and privileging processes for CRNAs.

Maintaining Competence

- Implement multimodal, longitudinal programs that include online modules as well as proctored and repeated hands-on expert-guided training.[5] For example, the American Institute of Ultrasound in Medicine (AIUM) recommends a minimum of 50 POCUS examinations per year in a variety of applications to maintain the provider's skills.[49]
- Incorporate ongoing coaching and mentoring.

Documentation[41,50]

- Document patient information, images (both normal and abnormal), and patient management in a timely manner. This documentation should describe the structures evaluated, presence or absence of relevant anatomy or pathology, and interpretation of findings.
- Consider saving images that are linked to patient's clinical record in the electronic health record.

Patient Education

- Provide appropriate patient education.

Equipment[23,41]

- Adjust equipment to operate at the highest clinically appropriate frequency (note that there is a trade-off between resolution and beam penetration: high frequencies (7-12 MHz) allow for improved tissue resolution, but at the expense of limited tissue penetration; whereas low frequencies (2-6 MHz) allow for optimal tissue penetration, but at the expense of picture resolution.)
- Monitor equipment performance and complete manufacturer's recommended maintenance.

Quality Assurance[5,41]

- Consider establishing a facility interdisciplinary team (e.g., emergency medicine, anesthesia, cardiology, radiology) responsible for providing POCUS training and oversight in image acquisition, interpretation, and mastery of skill.
- Seek consultation and/or collaboration with colleagues and other healthcare providers, including radiologists, for complex issues or when unsure.
- Perform timely imaging review (even remotely).

Barriers to POCUS Implementation and Use

Establishing POCUS as a standard in anesthesia practice remains challenging due to the need for developing and maintaining competence, establishing standard terminology, and acquiring skills to manage unexpected findings or diagnoses.[9] Furthermore, a different set of skills in ultrasonography may be required depending on a specific phase in anesthesia care, such as preoperative clinic, preoperative evaluation, perioperative phase, or postanesthesia care unit.[46] Potential barriers to POCUS implementation and use are outlined in Table 3.

Table 3. Potential Barriers to POCUS Implementation and Use[1,9,10,41,51-53]

Facility-specific
• Lack of time
• Lack of training
• Cost of training and equipment
• Equipment quality
• Credentialing requirements
Staff-specific
• Missed or incorrect diagnoses
• Difficulty managing unexpected diagnoses
• Image quality due to lack of practice
• Lack of knowledge of potential limitations and artifacts
Patient-specific
• Difficulty obtaining images perioperatively (e.g., patient is covered; patients are obese or pregnant)
Reimbursement-specific
• Incomplete or improper documentation that prevents coding, billing, and compensation for patient care
Discipline-specific
• Lack of faculty proficient in POCUS
• Lack of universal standards, terminology
• Lack of curriculum standards for training
• Lack of validated assessment tools
• Fellowship experiences are limited to medical diagnostic specialties

Conclusion

POCUS is a safe, fast, effective, and relatively inexpensive modality. Specific training, continuing education, and expertise, as well as a good quality assurance program are essential for POCUS efficacy and safety. CRNAs are well positioned to use POCUS to guide patient care.

References

1. Kendall JL, Hoffenberg SR, Smith RS. History of emergency and critical care ultrasound: the evolution of a new imaging paradigm. *Crit Care Med.* 2007;35(5 Suppl):S126-130.
2. Zheng BX, Zheng H, Lin XM. Ultrasound for predicting difficult airway in obstetric anesthesia: Protocol and methods for a prospective observational clinical study. *Medicine (Baltimore).* 2019;98(46):e17846.
3. Dominguez A, Gaspar HA, Preto M, Ejzenberg FE. Point-of-care lung ultrasound in paediatric critical and emergency care. *J Paediatr Child Health.* 2018;54(9):945-952.

4. Miller DL, Abo A, Abramowicz JS, et al. Diagnostic Ultrasound Safety Review for Point-of-Care Ultrasound Practitioners. *J Ultrasound Med.* 2019.
5. Adler AC, Brown KA, Conlin FT, Thammasitboon S, Chandrakantan A. Cardiac and lung point-of-care ultrasound in pediatric anesthesia and critical care medicine: Uses, pitfalls, and future directions to optimize pediatric care. *Paediatr Anaesth.* 2019;29(8):790-798.
6. Breunig M, Kashiwagi D. Using point-of-care ultrasound: Lungs. *JAAPA.* 2018;31(8):48-52.
7. Adler AC. Perioperative Point-of-Care Ultrasound in Pediatric Anesthesiology: A Case Series Highlighting Intraoperative Diagnosis of Hemodynamic Instability and Alteration of Management. *J Cardiothorac Vasc Anesth.* 2018;32(3):1411-1414.
8. Goffi A, Kruisselbrink R, Volpicelli G. The sound of air: point-of-care lung ultrasound in perioperative medicine. *Can J Anaesth.* 2018;65(4):399-416.
9. McCormick TJ, Miller EC, Chen R, Naik VN. Acquiring and maintaining point-of-care ultrasound (POCUS) competence for anesthesiologists. *Can J Anaesth.* 2018;65(4):427-436.
10. Kimura BJ. Point-of-care cardiac ultrasound techniques in the physical examination: better at the bedside. *Heart.* 2017;103(13):987-994.
11. *Regional anesthesia and analgesia techniques - an element of multimodal pain management.* Park Ridge, IL. American Association of Nurse Anesthetists, 2018.
12. Hahn RT, Abraham T, Adams MS, et al. Guidelines for performing a comprehensive transesophageal echocardiographic examination: recommendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. *Anesth Analg.* 2014;118(1):21-68.
13. Kameda T, Kimura A. Basic point-of-care ultrasound framework based on the airway, breathing, and circulation approach for the initial management of shock and dyspnea. *Acute Med Surg.* 2020;7(1):e481.
14. Gottlieb M, Holladay D, Peksa GD. Ultrasonography for the Confirmation of Endotracheal Tube Intubation: A Systematic Review and Meta-Analysis. *Ann Emerg Med.* 2018;72(6):627-636.
15. Chou EH, Dickman E, Tsou PY, et al. Ultrasonography for confirmation of endotracheal tube placement: a systematic review and meta-analysis. *Resuscitation.* 2015;90:97-103.
16. Das SK, Choupoo NS, Haldar R, Lahkar A. Transtracheal ultrasound for verification of endotracheal tube placement: a systematic review and meta-analysis. *Can J Anaesth.* 2015;62(4):413-423.
17. Ezri T, Gewurtz G, Sessler DI, et al. Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue. *Anaesthesia.* 2003;58(11):1111-1114.
18. Fulkerson JS, Moore HM, Anderson TS, Lowe RF, Jr. Ultrasonography in the preoperative difficult airway assessment. *J Clin Monit Comput.* 2017;31(3):513-530.
19. Koundal V, Rana S, Thakur R, Chauhan V, Ekke S, Kumar M. The usefulness of point of care ultrasound (POCUS) in preanaesthetic airway assessment. *Indian J Anaesth.* 2019;63(12):1022-1028.
20. Kimura BJ, Lou MM, Dahms EB, Han PJ, Waalen J. Prognostic Implications of a Point-of-Care Ultrasound Examination on Hospital Ward Admission. *J Ultrasound Med.* 2020;39(2):289-297.
21. You-Ten KE, Siddiqui N, Teoh WH, Kristensen MS. Point-of-care ultrasound (POCUS) of the upper airway. *Can J Anaesth.* 2018;65(4):473-484.
22. Caballero-Lozada A, Giraldo A, Benitez J, Naranjo O, Zorrilla-Vaca C, Zorrilla-Vaca A. Bedside ultrasound for early diagnosis and follow-up of postoperative negative pressure pulmonary oedema: case reports and literature review. *Anaesthesiol Intensive Ther.* 2019;51(3):253-256.

23. Kiley S, Cassara C, Fahy BG. Lung ultrasound in the intensive care unit. *J Cardiothorac Vasc Anesth.* 2015;29(1):196-203.
24. Karagoz A, Unluer EE, Akcay O, Kadioglu E. Effectiveness of Bedside Lung Ultrasound for Clinical Follow-Up of Primary Spontaneous Pneumothorax Patients Treated With Tube Thoracostomy. *Ultrasound Q.* 2018;34(4):226-232.
25. Acosta CM, Maidana GA, Jacovitti D, et al. Accuracy of transthoracic lung ultrasound for diagnosing anesthesia-induced atelectasis in children. *Anesthesiology.* 2014;120(6):1370-1379.
26. Pallesen J, Bhavsar R, Fjolner J, et al. The effects of preoperative point-of-care focused cardiac ultrasound in high-risk patients: study protocol for a prospective randomised controlled trial. *Dan Med J.* 2020;67(1).
27. Haskins SC, Vaz AM, Garvin S. Perioperative Point-of-Care ultrasound for the Anesthesiologist *Journal of Anesthesia and Perioperative Medicine* 2020;5(2):92-96.
28. Botker MT, Vang ML, Grofte T, Sloth E, Frederiksen CA. Routine pre-operative focused ultrasonography by anesthesiologists in patients undergoing urgent surgical procedures. *Acta Anaesthesiol Scand.* 2014;58(7):807-814.
29. Canty DJ, Royse CF, Kilpatrick D, Williams DL, Royse AG. The impact of pre-operative focused transthoracic echocardiography in emergency non-cardiac surgery patients with known or risk of cardiac disease. *Anaesthesia.* 2012;67(7):714-720.
30. Parekh UR, Rajan N, Iglehart RC, McQuillan PM. Bedside ultrasound assessment of gastric content in children noncompliant with preoperative fasting guidelines: Is it time to include this in our practice? *Saudi J Anaesth.* 2018;12(2):318-320.
31. Alakkad H, Kruisselbrink R, Chin KJ, et al. Point-of-care ultrasound defines gastric content and changes the anesthetic management of elective surgical patients who have not followed fasting instructions: a prospective case series. *Can J Anaesth.* 2015;62(11):1188-1195.
32. Van de Putte P, Vernieuwe L, Jerjir A, Verschueren L, Tacken M, Perlas A. When fasted is not empty: a retrospective cohort study of gastric content in fasted surgical patientsdagger. *Br J Anaesth.* 2017;118(3):363-371.
33. Ohashi Y, Walker JC, Zhang F, et al. Preoperative gastric residual volumes in fasted patients measured by bedside ultrasound: a prospective observational study. *Anaesth Intensive Care.* 2018;46(6):608-613.
34. Weile J, Nielsen K, Primdahl SC, et al. Ultrasonography in trauma: a nation-wide cross-sectional investigation. *Crit Ultrasound J.* 2017;9(1):16.
35. Goel N, Jain K, Dhiman D, Gowtham K. Utility of Point-of-Care Ultrasonography in Diagnosing Submassive Pulmonary Thromboembolism in a Trauma Patient and Subsequent Anesthetic Management: Case Report and Literature Review. *Anesth Essays Res.* 2019;13(4):695-698.
36. Soni NJ, Lucas BP. Diagnostic point-of-care ultrasound for hospitalists. *J Hosp Med.* 2015;10(2):120-124.
37. Manson WC, Kirksey M, Boublik J, Wu CL, Haskins SC. Focused assessment with sonography in trauma (FAST) for the regional anesthesiologist and pain specialist. *Reg Anesth Pain Med.* 2019;44(5):540-548.
38. Haskins SC, Desai NA, Fields KG, et al. Diagnosis of Intraabdominal Fluid Extravasation After Hip Arthroscopy With Point-of-Care Ultrasonography Can Identify Patients at an Increased Risk for Postoperative Pain. *Anesth Analg.* 2017;124(3):791-799.
39. Ramsingh D, Bronshteyn YS, Haskins S, Zimmerman J. Perioperative Point-of-Care Ultrasound: From Concept to Application. *Anesthesiology.* 2020;132(4):908-916.
40. Adler AC, Chandrakantan A, Conlin FT. Perioperative point of care ultrasound in pediatric anesthesiology: a case series highlighting real-time intraoperative diagnosis

and alteration of management augmenting physical examination. *J Anesth.* 2019;33(3):435-440.
41. The American Institute of Ultrasound in Medicine. AIUM Practice Parameter for the Performance of Point-of-Care Ultrasound Examinations. 2019; https://www.aium.org/resources/guidelines/pointofcare.pdf. Accessed August 4, 2020.
42. Beaulieu Y, Laprise R, Drolet P, et al. Bedside ultrasound training using web-based e-learning and simulation early in the curriculum of residents. *Crit Ultrasound J.* 2015;7:1.
43. Ogilvie E, Vlachou A, Edsell M, et al. Simulation-based teaching versus point-of-care teaching for identification of basic transoesophageal echocardiography views: a prospective randomised study. *Anaesthesia.* 2015;70(3):330-335.
44. Narasimhan M, Koenig SJ, Mayo PH. A Whole-Body Approach to Point of Care Ultrasound. *Chest.* 2016;150(4):772-776.
45. de Oliveira Filho GR, Mettrau FAC. The Effect of High-Frequency, Structured Expert Feedback on the Learning Curves of Basic Interventional Ultrasound Skills Applied to Regional Anesthesia. *Anesth Analg.* 2018;126(3):1028-1034.
46. Jasudavisius A, Arellano R, Martin J, McConnell B, Bainbridge D. A systematic review of transthoracic and transesophageal echocardiography in non-cardiac surgery: implications for point-of-care ultrasound education in the operating room. *Can J Anaesth.* 2016;63(4):480-487.
47. Ramlogan R, Niazi AU, Jin R, Johnson J, Chan VW, Perlas A. A Virtual Reality Simulation Model of Spinal Ultrasound: Role in Teaching Spinal Sonoanatomy. *Reg Anesth Pain Med.* 2017;42(2):217-222.
48. Poth JM, Beck DR, Bartels K. Ultrasonography for haemodynamic monitoring. *Best Pract Res Clin Anaesthesiol.* 2014;28(4):337-351.
49. The American Institute of Ultrasound in Medicine. Training Guidelines for Physicians and Advanced Clinical Providers Performing Point-of-Care Ultrasound Examinations. 2019; https://www.aium.org/officialStatements/74. Accessed August 5, 2020.
50. Hughes D, Corrado MM, Mynatt I, et al. Billing I-AIM: a novel framework for ultrasound billing. *Ultrasound J.* 2020;12(1):8.
51. AlEassa EM, Ziesmann MT, Kirkpatrick AW, Wurster CL, Gillman LM. Point of care ultrasonography use and training among trauma providers across Canada. *Can J Surg.* 2016;59(1):6-8.
52. Morata L, Ogilvie C, Yon J, Johnson A. Decreasing Peripherally Inserted Central Catheter Use With Ultrasound-Guided Peripheral Intravenous Lines: A Quality Improvement Project in the Acute Care Setting. *J Nurs Adm.* 2017;47(6):338-344.
53. Botker MT, Jacobsen L, Rudolph SS, Knudsen L. The role of point of care ultrasound in prehospital critical care: a systematic review. *Scand J Trauma Resusc Emerg Med.* 2018;26(1):51.

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