Interv Pain Med Neuromod. 2022 December; 2(1):e123157. https://doi.org/10.5812/ipmn-123157.

Published online 2022 July 31. **Review Article**

Bedside Point-of-Care Ultrasonography in Anesthesiology and Pain Management: A New Trend in Iran: A Narrative Review

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Received 2022 February 06; **Revised** 2022 May 26; **Accepted** 2022 May 28.

Abstract

Since the emergence of ultrasonography, many specialists, including anesthesiologists, have become interested in its practices. Technological innovations in portable ultrasonography devices and their quality enable anesthesiologists to use ultrasonography in various medical conditions and improve their diagnostic and therapeutic interventions. This article clarifies the significance of point-of-care ultra-sonography (POCUS) and highlights the challenges ahead. POCUS can help regional anesthesiologists and pain physicians in vascular access, airway management, focused cardiac ultra-sound (FoCUS), lung ultrasound, gastric ultrasound, focus assessment with sonography in trauma (FAST), regional and neuraxial nerve blocks, and acute and chronic pain management. However, similar to any new clinical method, there are challenges to POCUS, especially in developing countries like Iran. These challenges include the need for more budget allocation for medical equipment and portable devices, developing a comprehensive local curriculum and transparent framework to train residents and postgraduates, creating and/or revising university policies, clinical coordination with healthcare networks, and collaboration with healthcare providers. This article expresses the importance and effectiveness of point-of-care sonography performed by anesthesiologists and pain specialists in Iran and highlights the challenges ahead.

Keywords: Focused Assessment with Sonography for Trauma, Point-of-care Systems, Point-of-care Testing, Pain Management, Anesthesiology, POCUS

1. Introduction

Ultrasonography has been used in medical practice for many years (1, 2). Over time, ultrasonography has found widespread interest among various medical specialties, including anesthesiologists, for nerve blocks and vascular access (1). In addition, as a safe, non-invasive method, bedside point-of-care ultrasonography can be used by anesthesiologists for clinical management of patients in perioperative and intensive care units (ICUs) as further assistance for clinical examinations (2). Recently, anesthesiologists and pain specialists have increasingly used ultrasound for various medical conditions (1). Bedside point-of-care ultrasonography (POCUS) can be used to assist different procedures in anesthesiology and pain management, some of which are stated below in detail.

1.1. Airway Ultrasound

POCUS can be used to outline anatomical variations, determine difficult airways by measuring the interspace from skin to the thyrohyoid membrane, hyoid bone, or epiglottis, confirm the appropriate insertion place of the endotracheal tube in difficult airways, detect the cricothyroid membrane in emergency airway access, and confirm the correct placement of the nasogastric tube (1, 2). Furthermore, ETT size prediction would be more accurate with POCUS than with age-based formulas (3). Even in pediatric patients, it seems that in the near future, POCUS will be a standard of care in airway management (4). Moreover, POCUS has the potential to predict the weaning consequences when used in lung and diaphragm ultrasound (5).

1.2. Gastric Ultrasound

Anesthesiologists administer moderate to deep sedation for different procedures without a fixed and secured airway. Therefore, it is necessary to evaluate aspiration risk by measuring the cross-sectional area (CSA) of the gastric antrum, which correlates with gastric volume. Although

this technique should not replace the American Society of Anesthesiologists Protocols for NPO times, it seems helpful in special situations such as critically ill patients, neuromuscular disorders, altered mental states, obstetrics, pediatrics, and diabetic patients who are more at risk of aspiration (1, 2, 6, 7).

1.3. Focused Cardiac Ultrasound (FoCUS)

Regional anesthesiologists may encounter patients with different comorbidities that are not accurately diagnosed or treated. In this situation, focused cardiac ultrasound (FoCUS) might help evaluate cardiac function by measuring volume status, valvular function, and focus-assessed transthoracic echocardiography (FATE). FOCUS can help diagnose and manage adverse events following regional anesthesia interventions. It can help differentiate between low intravascular volume status and severe hypotension due to spinal anesthesia, cardiogenic shock, pulmonary embolism, and left ventricular dysfunction, in addition to improving CPR quality (1, 2, 8). POCUS is also used in rare conditions such as refractory ventricular fibrillation, which can be managed by ultrasound-guided stellate ganglion block (9).

1.4. Lung Ultrasound

This is used to diagnose pneumothorax, bronchospasm, consolidation, atelectasis, pulmonary embolism, pulmonary edema, pleural effusion, and contusion. It is also used to diagnose acute respiratory failure using "bedside lung ultrasound emergency (BLUE)" protocol (1, 10). In US-guided regional anesthesia (UGRA), bedside sonography is used to differentiate complications of regional anesthesia from other lung pathologies in a safer and faster manner than other imaging modalities. These complications include pneumothorax, phrenic nerve paralysis, and hemothorax following peripheral nerve blocks and regional anesthesia (1, 10, 11). Furthermore, transesophageal lung ultrasonography (TELU) is a newly introduced technique for the detection of hypoxemia that might be beneficial when transthoracic lung ultrasonography is mandated, but the thorax is not accessible (12).

1.5. Abdominal and Pelvic Ultrasound

Sonography is readily available for identifying bleeding in the abdomen and pelvic cavities. It is portable, making the tool more beneficial (13). Abdominal and pelvic sonography can assess pain or nausea after arthroscopy and measure intra-abdominal fluid extravasation following hip arthroscopy. Focus assessment with sonography in trauma (FAST) can be used mainly to determine the presence of free fluid in the abdominal and pelvic cavities. The FAST technique can also determine pericardial effusion, pleural effusions, and postoperative urinary retention. This technique can also be helpful in the diagnosis of hypotension both in PACU or ICU (11, 14). Like TELU, transgastric abdominal ultrasonography (TGAUS) is a novel technique for evaluating abdominal structures and functions when a transabdominal approach is not possible (15).

1.6. Neuro-Monitoring Ultrasound

Non-invasive neuromonitoring techniques are newly available monitoring methods with many advantages such as the lower risk of infection and bleeding, more feasibility, and patient safety compared to traditional invasive techniques. This method can be part of the multimodality neuromonitoring technique in subarachnoid hemorrhage, traumatic brain injury, and stroke patients (16). Furthermore, ultrasound-guided neuromonitoring is used for defining pupillary light reflex (PLR), transcranial doppler (TCD) and determining increased intracranial pressure (ICP) by measuring the optic nerve sheath diameter (ONSD) (17).

1.7. Ultrasound in Regional Anesthesia

Today, ultrasound is a standard of care in peripheral regional anesthesia (18). Ultrasound helps the anesthesiologist perform more precise and accurate nerve blocks more conveniently. POCUS can also be used in neuraxial blocks. Some advantages of POCUS in regional anesthesia include decreased complications, a better quality of blocks, reduced time to onset, and increased block duration (17). It is important to note that one method alone cannot guarantee patient safety, and it should be kept in mind that patient safety is a goal that can be achieved by meticulous attention to all aspects of a selected intervention (18).

1.8. Ultrasound for Vascular Access

POCUS can be used for central venous line implementation, peripheral vein access, and arterial cannulation, reducing the complications and time to perform (2, 17).

1.9. Chronic Pain Management

For long-term persistent pain, the best available evidence is about nerve blocks, and ultrasound guidance can improve our performance. The procedures that successfully use ultrasound include intra-articular injections, facet joint blocks, stellate ganglion blocks, trigeminal blocks, nerve root blocks, and lumbar epidural injections for chronic pain (17). Ultrasound can be a therapeutic

modality for knee, shoulder, and hip pain and is often combined with other physiotherapeutic modalities (19). High-intensity focused ultrasound (HIFU) is a recently developed technique approved for chronic pain management (20). Ultrasound has some unique advantages in chronic pain management. One of them is eliminating or reducing radiation exposure compared to fluoroscopy while providing comparable clinical outcomes (21).

2. Barriers

Although there has recently been a significant improvement in training anesthesiologists and pain fellows in performing the above-mentioned procedures, there are considerable barriers to performing point-of-care ultrasonography peri-operatively, in the ICU, and in-patient pain management, especially in developing countries such as Iran. Expenditure of medical equipment is a substantial challenge, which is expected to grow regarding portable medical devices. Compared with other diagnostic modalities, ultrasonography is considered a relatively low-cost method, yet in developing countries (e.g., Iran), the procurement of bedside portable ultrasonography devices and related equipment for medical departments requires a significant budget allocation (7, 22, 23). There is a need for economic evaluations of medical devices, considering their cost-effectiveness (24).

Job stress and burnout are other common challenges while practicing anesthesiology, which need to be considered in lower- and middle-income countries where job stressors may differ from high-income countries. Using new technologies without appropriate infrastructures will increase perceived task load and fatigue levels in anesthesiologists and thus needs to be well-thought-out before implementing new emerging technologies in the field (25). The role of POCUS would be more evident when it comes to special pandemic situations such as COVID-19. In particular cases, this technology for regional rather than general anesthesia will reduce the need for intubation and patient transfers, subsequently lowering the risk of spreading viral infections for anesthesiologists and patients (26).

Regarding POCUS in Iran, there is no well-unified standard or comprehensive curriculum for universities across the country. New models of the curriculum can be inspired by the American Board of Anesthesiology (ABA), the Accreditation Council for Graduate Medical Education (ACGME), or the American Society of Regional Anesthesiologists (ASRA) (4). However, these resources need to be adapted based on the setting, assets, and feasibility of direct supervision in the universities of Iran. Although universities were confined to traditional classroom-based learning and clinical rounds to teach practical skills like POCUS in the past, new research showed that both internet-based webinars and traditional classes might complement each other in accomplishing the new skills (22).

A high level of clinical coordination with healthcare networks and collaboration with anesthesiologists, radiologists, and other healthcare providers is needed to figure out imaging Indication, Acquisition, Interpretation, and Medical decision-making (I-AIM) while minimizing potential conflicts and miscommunications (23). A recommended framework for accomplishing this goal is the I-AIM structure for each POCUS skill (7). We recommend standardizing our training programs in Iran according to the local settings and requirements.

3. Recommendations

Although there has been increasing interest in point-of-care ultrasound (POCUS) as an aid to traditional examination techniques, its efficacy in anesthesiology and pain medicine needs to be studied based on feedback and outcome analysis. Hopefully, this data will accumulate with time

since there is increasing evidence showing improved patient safety and enhanced diagnosis accuracy, while there is little evidence to suggest harms associated with this imaging modality (7, 23, 27, 28). Besides, departments of anesthesiology and pain management should plan a strategy for developing a comprehensive local curriculum and a clear framework to train residents and postgraduates with up-to-date technologies. The POCUS practice is time-consuming; thus, universities must allocate a significant learning curve in their training curriculum and organize their infrastructures for POCUS to be performed in the best possible style (2, 7, 23). This policy will support trainers to comprehensively applying this technology in their future practice (28).

4. Conclusion

Healthcare optimization and new trends in medicine are always appreciated. As a new assistive technology, POCUS can be considered an invaluable assistive novel method for anesthesiologists, especially pain specialists, when performing their procedures and managing the probable complications. With promising potential throughout pre and postoperative practice and ICU care, POCUS can be considered the "stethoscope of the new era." To make the best use of it, one has to be empowered with knowledge and skills in this field.

Footnotes

Authors' Contribution: Study concept and design, R.A and S.S; Acquisition, analysis, and interpretation of data, A.Z; Drafting of the manuscript, A.Z; Critical revision of the manuscript for important intellectual content, R.A; Administrative, technical, and material support, S.S and R.A; Study supervision, R.A and S.S.

Conflict of Interests: The authors are from Qom, Shahid Beheshti, and Urmia Medical Universities. Dr. R. Aminnejad and Dr. S. Safari are editorial members and reviewers of this journal.

Funding/Support: This research is supported by the Clinical Research Development Centre of Shahid Beheshti Hospital, Qom, Iran.

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