

Point-of-Care Ultrasound in Austere Environments



A Complete Review of Its Utilization, Pitfalls, and Technique for Common Applications in Austere Settings

Laleh Gharahbaghian, MD^{a,*}, Kenton L. Anderson, MD^b, Viveta Lobo, MD^a,
Rwo-Wen Huang, MD^a, Cori McClure Poffenberger, MD^a, Phi D. Nguyen, MD^c

KEYWORDS

- Point of care • Ultrasound • Austere • High altitude • Resource limited • Disaster
- Battlefield • Military

KEY POINTS

- Ultrasound systems must be handheld, battery operated, durable, and able to withstand extremes of temperature and altitude, while additional equipment may be necessary to help prevent battery degradation and equipment damage.
- Point-of-care ultrasound is portable and lightweight, and can be used to screen for a wide variety of pathology and injury common to austere environments, disaster situations, and resource-limited settings.
- Common point-of-care ultrasound applications used in austere environments include the Extended Focused Assessment with Sonography in Trauma, musculoskeletal and soft tissue injury, high-altitude pulmonary edema, high-altitude cerebral edema, pneumonia, volume status, and various procedural guidance applications.
- The various point-of-care applications used in austere environments for procedural guidance include peripheral vascular access, nerve blocks for pain control, foreign body removal, and abscess drainage.
- Point-of-care ultrasound is a reliable tool to assist in triage, resource allocation decisions, and screening for conditions common in austere environments.

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^a Emergency Ultrasound Program, Department of Emergency Medicine, Stanford University School of Medicine, 300 Pasteur Drive, Alway Building M121, Stanford, CA 94304, USA;

^b Emergency Ultrasound Research and Scholarly Activity, Department of Emergency Medicine, Stanford University School of Medicine, 300 Pasteur Drive, Alway Building M121, Stanford, CA 94304, USA; ^c Stanford/Kaiser Emergency Medicine Residency Program, 300 Pasteur Drive, Alway Building M121, Stanford, CA 94304, USA

* Corresponding author.

E-mail address: Lalehg@stanford.edu

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INTRODUCTION: POINT-OF-CARE ULTRASOUND AND HANDHELD SYSTEMS

Ultrasound technology continues to advance and has come a long way from large wall-mounted systems with poor image quality to small handheld devices with good image quality. Ultrasound systems were optimized for medical military use in the 1980s. Due to its successful utilization at the point-of-care, its lack of ionizing radiation, and the expansion of computer technology, point-of-care ultrasound (POCUS) rapidly spread to trauma, emergency department, and “out-of-hospital” settings, including in austere environments where other imaging modalities cannot be carried.^{1,2}

There are various handheld systems that can fit into a large coat pocket, and the power supply and case can fit into any backpack. Their power timing and image quality is less than that of laptop-based systems, but their portability and ability to transfer images wirelessly to electronic mailing or via text messaging make these systems unique. The GE (Chicago, IL) VScan was one of the first handheld devices to come to market with a “flip-open” and touch-sensor style, now with a dual probe for both high-frequency and low-frequency imaging. The SonoSite (Bothell, WA) iViz is one of the newest devices on the market with a larger screen, good image quality, and touch-screen capability. The Philips (Andover, MA) Lumify is another new system that currently requires a subscription. Other devices, including handheld devices by Clarius (Burnaby, Canada) and Signostics (Bothell, WA) provide a probe and require a smart phone for scanning.

POINT-OF-CARE ULTRASOUND IN AUSTERE ENVIRONMENTS: UTILITY AND PITFALLS

The first portable ultrasound machine weighed just over 5 pounds, was the first battery-operated ultrasound machine, and was durable enough to withstand unpredictable battlefield environments.³ Austere environments continue to pose special challenges to ultrasound equipment, including battery degradation, hard-drive failure, and physical abuse. Advances in equipment design and environment-specific care have allowed successful use of ultrasound in these extreme situations.

MILITARY AND COMBAT ENVIRONMENTS

Ultrasound on the Battlefield

The battlefield is an unforgiving environment for ultrasound machines. In Iraq and Afghanistan, ambient temperatures fluctuate greatly, resulting in battery degradation.^{4,5} The environment is also sandy and dusty, contributing to overheating. Ultrasound machines are often treated roughly out of necessity. There are space limitations in medical treatment facilities, so equipment may inadvertently be jostled or knocked to the ground during a mass casualty incident (MCI). Medics may carry small portable ultrasound machines in their packs to the point of injury. Therefore, machines must be handheld, use cooling fans, and have extra batteries available.

Because most battlefield deaths are caused by hemorrhage, the most common role for ultrasound in this environment is the focused assessment with sonography in trauma (FAST) examination, which parallels the civilian MCI experience in which triage of casualties is the priority.⁶ Computed tomography (CT) may not be available, and physicians in war zones found ultrasound to be invaluable during triage.⁷ The FAST examination can identify occult blood loss in young, highly conditioned patients whose physiologic reserve undermines the reliability of vital signs until late stages of shock.⁸

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