Ultrasound Use by Special Operations Combat Medics

A Narrative Review Limited to the JSOM

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ABSTRACT

Background: Ultrasonography has seen increasing integration into the clinical practice of Special Operations Combat Medics (SOCMs). However, there is limited literature available that describes SOCM use of ultrasonography. This narrative review aims to provide an overview of how SOCMs use ultrasound in clinical practice and explore proposed future applications. **Methods:** A PubMed search was conducted for articles discussing ultrasonography in the context of Special Operations medicine. This search initially included a broad PubMed search followed by a targeted search limited to the *Journal of Special Operations Medicine*. Inclusion criteria for this targeted search encompassed articles describing ultrasound use or advocating for ultrasound use in SOCM clinical practice. **Results:** The search was conducted in October 2023 and yielded 120 publications, of which 20 met inclusion criteria and are summarized in this review. Among these articles, 50% focused on cardiovascular applications, 35% on musculoskeletal applications, 20% on abdominal assessments (E-FAST exam), 15% on respiratory applications, and 10% on neurologic applications. Only 40% of the articles described operational use, while 60% advocated for use. Finally, 56.5% of the articles described diagnostic applications, while 43.5% pertained to procedural applications. **Conclusion:** SOCM use of ultrasonography likely differs from in-hospital provider use of ultrasonography. To improve ultrasound education for SOCMs, educators should consider customization of the curriculum to align with the unique mission requirements of individual units and an increased emphasis on procedure-based training.

KEYWORDS: *ultrasound; PoCUS; FoCUS; military medicine; Special Operations Medicine*

Introduction

Point-of-care ultrasonography (PoCUS) has become an integral and widely used tool in medicine, especially in acute settings. The American Society of Echocardiography recommends the use of focused cardiac ultrasonography (FoCUS) to guide clinical management in cases of shock or hemodynamic instability, with a grade I recommendation.[1] The Society of Critical Care Medicine also advocates for PoCUS in the evaluation of undifferentiated shock, chest trauma, and pneumothorax, as well as for procedural guidance in numerous critical care procedures.[2,3] The American College of Emergency Medicine has issued a policy statement endorsing the use of PoCUS for a wide range of clinical applications, including diagnostic assessments and the safe performance of various procedures, such as central venous access and thoracentesis.[4] Furthermore, this policy statement acknowledges the increasing evidence supporting the use of ultrasonography in pre-hospital, military, and tactical environments. Among these settings, the military and tactical environment implementation of ultrasonography may have the most significant impact, given the potential limitations on timely evacuation and the necessity for possible prolonged field resuscitation. These concerns are particularly relevant to Special Operations Combat Medics (SOCMs) because the unique operational mission requirements they face often involve providing advanced treatment and precise diagnoses while caring for patients and colleagues over extended periods.

Despite the demonstrated benefits of PoCUS in medicine, its widespread adoption and use have been slower in some fields and settings. For instance, in anesthesiology, the adoption of PoCUS for diagnostic purposes has lagged behind fields like emergency medicine and critical care medicine, with a lack of ultrasound equipment often cited as a reason.[5] A study of rural emergency departments in the United States and Canada found that a shortage of equipment and training contributed to the slow adoption of ultrasound in these environments.[6] These barriers in training and equipment can now be overcome with the current availability of portable, handheld ultrasound devices. These devices are cost effective compared to traditional cart-based hospital ultrasound equipment, allowing systems or units to acquire multiple devices, thereby providing increased access to ultrasound technology. Furthermore, many of these devices offer telemedicine capabilities, enabling performing practitioners to receive real-time guidance on image acquisition and interpretation. The availability of small, portable, lightweight, inexpensive ultrasound devices that offer the ability to receive telemedicine guidance makes this technology not only more accessible to in-hospital medical specialties but also to the SOCM community. Consequently, the use of ultrasound has been included in the scope of practice of SOCMs as demonstrated by the creation of the Special Operators Clinical Level Ultrasound (SOLCUS) course.[7]

Despite PoCUS being implemented in the scope of practice of SOCMs, its impact and usage is not well-documented in available medical literature. For instance, the use patterns and attitudes toward the utility of ultrasound in SOCM clinical practice among individual medics or among different units are not well described. An improved understanding of current and proposed future SOCM PoCUS practices would be beneficial, as it is possible that the value SOCMs receive from ultrasound

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use is different than that of in-hospital providers. In traditional hospital settings, ultrasound often assists in difficult diagnostic pathways. For example, undifferentiated shock may be difficult to appropriately categorize as distributive, cardiogenic, obstructive, or hypovolemic. However, in the combat theater, the etiology of shock is rarely a mystery. Furthermore, the implications of ultrasound findings in the hospital setting often drastically change management, such as the extended focused assessment with sonography in trauma (E-FAST), determining the need for surgical intervention. However, in the tactical environment, advanced interventions, such as surgery, are not immediately available, and the decision to not facilitate evacuation based on a negative ultrasound examination would be ill-advised. Given these differences between in-hospital and Special Operations medicine, it is worth evaluating the role of PoCUS specifically in SOCM practice.

Methods

To assess the current use of ultrasound in SOCM practice and explore potential future applications, the author first conducted a broad literature search specific to SOCMs. The author initially searched the PubMed database in September 2023 for any articles describing SOCM use of ultrasound in clinical practice. Upon completing this search, the author found no descriptions of SOCM-specific clinical ultrasound usage outside of the *Journal of Special Operations Medicine*. Additionally, only a single article outside of this journal was identified, which described a potential future application of ultrasound for SOCMs, specifically the ability of SOCM trainees to successfully perform optic nerve sheath examinations on healthy volunteers.[8]

Given the lack of literature outside of the *Journal of Special Operations Medicine*, a focused search was conducted within this journal. This search was conducted using the PubMed database with the following keywords: ((FoCUS) OR (PoCUS) OR (Ultrasound) OR (Ultrasonography)) AND (Journal of Special Operations Medicine)). This search occurred on October 9, 2023, resulting in 120 initial search results. All 120 abstracts were reviewed by the author with articles describing the clinical use of ultrasound by SOCMs or advocating for the implementation of ultrasound among SOCMs being selected for inclusion and further review. The included articles were then categorized by organ system, with distinctions made between operational descriptions and advocacy of use, as well as whether the described examination was procedural or diagnostic in nature. The summarized findings are presented in Table 1 and discussed in the following sections.

Literature Review, Content

General Overview / Multiple Systems Articles

Among the 20 articles included in this review there were 2 that presented a broad description of military and Special Operations Forces (SOF) medicine ultrasound use across a variety of organ systems. The first was a retrospective description of a Special Forces battalion's use of ultrasound during a deployment, and the second was a literature review covering military use of ultrasound, specifically in SOF medicine.

The first general article was a retrospective observational study by Morgan et al. based on quality assurance data from 109 studies conducted by 29 Special Forces medics from a single battalion during a deployment in 2009.[9] In this study, 29 out of 40 Special Forces medics (18Ds) received ultrasound training, with a modal number of 8 hours. The specific details of the training were not given; however, the authors noted that trauma diagnostic ultrasonography exams and E-FAST exams comprised most of the training. As a part of the 18Ds' ongoing training, they conducted ultrasound exams during the deployment to be reviewed later. Upon review, the authors found that out of the 109 exams performed 39 were classified as musculoskeletal (MSK), 34 as abdomen/trauma (E-FAST, covering lung, cardiac, and abdominal exams), 22 as superficial, 8 as special applications, 3 as procedural, and 3 as miscellaneous, defined as not interpretable/unknown. Of note, superficial was defined as abscess evaluation of a foreign body, and special applications was defined as advanced application relevant to SOF practice, including fetal viability, ocular foreign bodies, retinal detachment, nephrolithiasis, and vascular studies.

The second general article was a literature review that covered articles describing PoCUS use by military clinicians, with sensitivity and specificity reported. In this review by Savell et al.,[10] 14 studies were included with 4 that included SOCMs. The authors concluded that the evidence describing military use of PoCUS is limited. They also concluded that the limited evidence available supports the theory that military clinicians can perform various PoCUS examinations with adequate sensitivity and specificity, particularly FAST exams and fracture detection.

Neurologic Articles

In this review, a single article addressing the diagnostic application of ultrasound for neurologic pathology was identified. This article by Hightower et al.,[11] describes the pathophysiology and logistics related to detecting elevated intracranial pressure by measuring optic nerve sheath diameter. The authors argue that employing ultrasound for this purpose could be beneficial in military field setting, especially for SOF medics who have received the necessary training.

Additionally, the previously discussed article by Morgan et al.[9] references the procedural application of ultrasound in relation to neurologic structures. In this article, 3 of the 109 reviewed cases were of a procedural nature, with the authors defining procedures as intravenous access or regional anesthesia blocks.[9] However, no additional details were provided regarding the specific types of regional blocks performed or the circumstances surrounding their application.

Respiratory Articles

In this review, the author identified three articles supporting the use of ultrasound by SOF medics for diagnosing respiratory pathology, specifically pneumothoraces. The first article, an observational study by Monti et al.,[12] involved 22 non-physician military members, including physician assistants (without prior ultrasound training), SOCM and conventional medics, veterinary technicians, and food inspectors. The study demonstrated that this diverse cohort was able to successfully detect a pneumothorax in 44 hemithoraces using a pig model, achieving high sensitivity and specificity after a brief training presentation. The second article, an observational study by Meadows et al., detailed 43 conventional medics examining 258 hemithoraces in a cadaver model and identifying the presence of a pneumothorax with a high level of sensitivity and specificity.[13] The third article presented a clinical scenario

TABLE 1 *Summary of Review Findings*

Article	Article type	System category	Operational use or advocating for use	Diagnostic (D) vs. procedural (P)	Ultrasound user category	No. exams/ participants	Finding/conclusion
Morgan et al.	Retrospective observational	Mixed: neurologic/CV/ Abd/MSK	Operational	P-Neurologic P-CV D-Abdominal D-MSK	SOCM	109 exams 29 18Ds	Described trends of use in 109 studies conducted by 29 18Ds over a single deployment. Found 18Ds primarily used for US for superficial and MSK exams
Savell et al.	Review	Mixed: abdominal and MSK	Advocating	D	Mixed (Included SOCM)	NA	Military practitioners can perform PoCUS with acceptable sensitivity and specificity, particularly E-FAST and MSK exams. PoCUS has potential to improve diagnostic accuracy and care with military operational field use
Hightower et al.	Review	Neurologic	Advocating	D	NA	NA	Measurement of optic nerve sheath diameter may be a useful diagnostic tool for SOCMs
Monti et al.	Prospective observational	Respiratory	Advocating	D	Mixed (Including SOCM)	44 hemithoraces 22 participants	Non-physician providers were able to detect pneumothorax after minimal training.Sensitivity 95.4% and specificity 100% using swine model
Meadows et al.	Prospective observational	Respiratory	Advocating	D	CCM	258 hemithoraces 43 participants	Combat medics can detect pneumothorax in human cadaver. Sensitivity 91% and specificity 80% using cadaver model
Rapp and Hampton	Clinical prompt	Respiratory	Advocating	D	NA	NA	Case description of pneumothorax diagnosis utilizing ultrasound imaging
Borger van der Burg et al.	Prospective observational	CV	Advocating	P	Mixed (including SOCM)	23 providers (10 SOCM)	Training can prepare providers without prior ultrasound experience to place REBOA on a synthetic model. Increased level of training (MD>RN>SOCM) reduced procedure times
Borger van der Burg et al.	Prospective observational	CV	Advocating	P	Mixed (including SOCM)	11 medics (6 QRT-FF, 5 SOCM)	Non-physician providers can learn to place REBOA on a synthetic model. There may be a role for REBOA in the field environment
Pasley et al.	Prospective observational	CV	Advocating	P	USAF IDMT	6 timed trials on model 11 IDMTs	IDMTs can be trained to place REBOA on a synthetic model.Arterial access should be focus of future training to promote the procedure closer to point of injury
Teeter et al.	Prospective observational	CV	Advocating	P	Mixed (including SOCM)	6 timed trials on model (2 MD, 1PA, and 1 SOCM)	Demonstrated non-physician providers can learn placement of REBOA after arterial access is established. Discusses ultrasound use for obtaining arterial access though the access component was not studied
Lopachin et al.	Prospective observational	CV	Advocating	P	Emergency medicine MDs	10 MDs 20 placement confirmations 2 cadavers	Demonstrated sensitivity of 83%, Specificity of 76%, and accuracy of 80% in identifying location of REBOA placement. Advocated for use of ultrasound in confirming placement of REBOA in austere environments
Manley et al.	Case series	CV, abdominal	Operational	P- REBOA D- FAST	USAF SOST (MDs)	4 cases	REBOA can be placed safely and effectively using handheld ultrasound devices and their use can provide hemostasis till surgical intervention is available
Wall et al.	Prospective observational	CV	Advocating	P	—	15 human subjects	Doppler signal used as control for assessment of tourniquet presence, suggesting Doppler is recognized as method to ensure tourniquet effectiveness
Kirkpatrick et al.	Case report	CV	Operational	P	Untrained first responder	1 case	Case study demonstrating ultrasound guided manual compression using Innovative Trauma Care compression device
McLeroy et al.	Case Report	CV, abdominal	Operational	D	SOCM	1 case	E-FAST performed with concern for pericardial effusion in pediatric patient No change in management Actual pathology: pneumopericardium and pneumoperitoneum
Snyder et al.	Case report	MSK	Operational	D	Emergency medicine MD	1 case	Rib fracture diagnosis with ultrasound Operational description; however, advocacy of implementation in SOCM operational practice
Heiner et al.	Prospective observational	MSK	Advocating	D	SOCM	5 models 20 18Ds	100% sensitivity and 90% specificity in long bone fracture detection Concluded 18Ds can detect long bone fractures
Goudard et al.	Case report	MSK	Operational	D and P	Forward surgical team (MD)	1 case	Ultrasound can be used for pelvic fracture diagnosis and reduction
Ball et al.	Case series	MSK	Operational	D	SOCM	2 cases	Description of diagnosis of pectoralis major muscle tears using ultrasound
Hubler et al.	Case series	MSK	Operational	D	SOCM	4 cases	Description of 4 long bone fractures diagnosed with ultrasound Advocates consideration of SCOM carrying ultrasound and omitting portable radiography

CV = cardiovascular; MSK = musculoskeletal; SOCM = Special Operations Combat Medic; 18D = Special Forces medic; PoCUS = point-of-care ultrasonography; E-FAST = extended focused assessment with sonography in trauma; CCM = Conventional Combat Medics; REBOA = resuscitative endovascular balloon occlusion of the aorta; MD = physician; RN = registered nurse;
QRT-FF = Quick Response Team Fire Fighters; USAF = United States Air Force; IDMT = Independent Duty Military Medical Technician; PA = physician assistant.

educational prompt (fictional training case description) discussing and advocating for the use of ultrasound imaging of the lung to assess for pleural sliding to rule out a pneumothorax.[14] All these articles endorse the use of ultrasound among SOCMs to assess for the presence of a pneumothorax. The author did not find any descriptions of procedural use of ultrasound in relation to the respiratory system.

Cardiovascular Articles

The author identified a single article describing the diagnostic use of ultrasound in relation to the cardiovascular system. The article is a case report by McLeroy et al. describing the clinical scenario surrounding a 5-year-old host nation child who sustained an injury from a small, 5cm knife.[15] During the initial assessment in this case, an SOF medic conducted an E-FAST examination, revealing a possible pericardial effusion. Subsequent radiographic imaging suggested pneumopericardium as well as pneumoperitoneum with concern for left diaphragm rupture.

In contrast, the author found eight articles advocating for and detailing the procedural use of ultrasound among SOF medics for hemorrhage control, along with a single article that noted ultrasound use for intravenous access. Most of the articles on hemorrhage control focused on resuscitative endovascular balloon occlusion of the aorta (REBOA). For reference, REBOA involves arterial access followed by the placement of an inflatable balloon device to occlude distal blood flow and control bleeding. Four articles demonstrated that non-surgeon providers could successfully place REBOA devices in a simulation setting with minimal training and advocated for the consideration of REBOA in combat operational environments.[16–19] Another article described the ability of emergency medicine physicians to identify the location of previously placed REBOA devices in a cadaver model using ultrasound assessment, again advocating for the ability to place and position REBOA devices in the austere environment using ultrasound.[20] A single case series by Manley et al.[21] was identified, which described four cases in which a forward operating surgical team used a handheld ultrasound device to diagnose hemoperitoneum and place and position REBOA devices leading to stabilization of these patients until surgical intervention could be achieved. Additionally, two articles included in this review referenced ultrasound as the gold standard for ensuring hemorrhage control, with one assessing tourniquet effectiveness using Doppler,[22] and the other, ultrasound to detect adequate compression to control bleeding.[23] Finally, in the previously discussed article by Morgan et al.,[9] 3 out of the 109 reviewed cases were procedural in nature with the procedural category including obtaining intravenous access.

Abdominal Articles

In conducting this review, the author did not identify any articles specifically dedicated to describing procedural or diagnostic abdominal ultrasound examinations. However, several of the previously discussed articles referenced the E-FAST examination, in addition to the topics previously covered. Morgan et al.[9] reported that 34 out of the 109 reviewed cases were categorized as "abdomen/trauma," a classification defined by the authors as requiring FAST or E-FAST examinations. Furthermore, the literature review by Savell et al.[10] discussed the specificity and sensitivity of military PoCUS use across various examination types, and concluded that military clinicians have demonstrated "the ability to perform focused exams, including FAST exams and fracture detection, with acceptable sensitivity and specificity." Lastly, the case report by McLeroy et al.[15] described a clinical scenario in which a SOCM employed an E-FAST examination following a knife wound sustained by a 5-year-old foreign national child.

Musculoskeletal Articles

In this review, the author identified five articles that discussed the use of ultrasound for MSK assessment purposes. Notably, there was a prospective study by Heiner et al.[24] involving 20 U.S. 18Ds who evaluated the presence or absence of fractures in five models made using turkey legs surrounded by a gelatin solution. The result of the study revealed that the 18Ds achieved 100% sensitivity and 90% specificity. Additionally, the author identified four case reports that described ultrasound assessments related to various MSK issues, including pectoralis major muscle tears,[25] pelvic fracture diagnosis and ultrasound guided reduction,[26] operational diagnosis of a long bone fracture,[27] and diagnosis of rib fractures.[28]

Literature Review, Descriptive Results

In this review, the majority of the 20 articles included described ultrasound applications in relation to the cardiovascular system (50%), followed by the following systems: MSK (35%), abdominal (20%), respiratory (15%), and neurologic (10%). Among these articles, the majority (60%) advocated for the use of ultrasound in relation to their respective organ system, rather than describing operational usage (40%). The proportion of diagnostic and procedural exam articles was similar at 56.5% and 43.5%, respectively. When assessed by organ system, the proportion of articles describing diagnostic versus procedural use of ultrasound was as follows: neurologic, 50% diagnostic and 50% procedural; respiratory, 100% diagnostic; cardiovascular, 10% diagnostic and 90% procedural; abdominal, 100% diagnostic; and MSK, 100% diagnostic and 14% procedural (1 article both diagnostic and procedural). These descriptive results are summarized in Table 2; note that some totals exceed 100% due to some articles being categorized as both diagnostic and procedural.

Discussion

The most relevant of the articles reviewed above is the article by Morgan et al.[9] It is distinguished from the others as it provides a detailed account of how SOCMs used ultrasound over an extended period. This retrospective observational study yielded several noteworthy findings.

First, it was evident that ultrasound was not commonly used among SOCMs. In this study, 29 18Ds conducted only 109 ultrasound examinations over an entire deployment, although the actual duration of the deployment was not specified. While this lack of ultrasound integration into routine clinical practice is notable, any attempt to explain this finding would be speculative and warrants further investigation and research.

Second, when SOCMs did employ ultrasound, they demonstrated adaptability by extending its use beyond their initial training to meet mission specific needs. This adaptability is evident from the finding that the most frequent use of ultrasound in this retrospective review was for MSK purposes with 39 out of 109 exams. When considering all "sick call"-related exams, including MSK, superficial assessments (covering skin and minor wound care complaints), and "special exams" (such as

TABLE 2 *Literature Review Descriptive Results*

	No. (%) of articles				
	Total	Diagnostic	Procedural	Operational	Advocating use
Neurologic	2 (10.0)	1 (50.0)	1 (50.0)	1 (50.0)	1 (50.0)
Respiratory	3 (15.0)	3 (100.0)	0 (0.0)	0 (0.0)	3 (100.0)
Cardiovascular	10 (50.0)	1 (10.0)	9 (90.0)	4 (40.0)	6 (60.0)
Abdominal	4 (20.0)	4 (100.0)	0 (0.0)	3 (75.)	1 (25.0%)
Musculoskeletal	7 (35.0)	7 (100.0)	1 (14.3)	5 (71.4)	2 (28.6)
Total by article	20	13* (56.5)	10* (43.5)	8† (40.0)	12† (60.0)

Note: Some percentage totals are greater than 100 due to some articles having more than one descriptive category.
*13 is actual count of number of articles with diagnostic use and not sum of column. The discrepancy is due to some diagnostic articles describing diagnostic use in multiple organ systems. Subsequently the percentage is ratio of 13/23, where 3 articles were both diagnostic and procedural so total 23.
†Total article count is not equal to sum of column values due to some articles discussing more than a single system. In this case percentage calculation uses total articles of 20.

fetal viability, retinal detachment, and nephrolithiasis), these collectively accounted for 69 out of the 109 performed exams. The authors noted that the training for these "sick call" exams was a minor component of the SOCM ultrasound training and that "these medics recognized the relevance of this seemingly insignificant application to their practice."[9] This finding that the 18Ds used ultrasound to augment their mission-specific needs, which for special forces medics includes a substantial amount of sick call/clinic, is striking and relevant.

Finally, it is noteworthy that abdominal and trauma assessments (E-FAST comprising abdominal, cardiac, and pneumothorax evaluation) with ultrasound constituted only 34 out of the 109 exams conducted by the 29 SOCMs throughout an entire deployment. This is despite the E-FAST exam being the most extensively covered content in the pre-deployment ultrasound training. The authors explained this unexpected finding by stating: "In our mature theater, most patients with penetrating or serious blunt injuries were empirically evacuated. An abdominal ultrasound was unlikely to influence the evacuation decision in an environment with established MEDEVAC procedures."[9]

When collectively evaluating the results of this literature review, we found they align with the findings presented in the article by Morgan et al.[9] First, within this review, 35% of the included articles described MSK-related ultrasound examinations, making it the second most common topic covered, following only cardiovascular ultrasound, which comprised 50% of the included articles. This likely represents publications reflecting the 18Ds' adaptation to using ultrasound for the Special Forces' unique mission set. Secondly, the author found limited references to the E-FAST examination being advocated for (1 article) or used by SOCMs (3 articles). Notably, there were no articles exclusively covering abdominal ultrasonography; instead, the articles mentioned the E-FAST examination while discussing general or other system ultrasound applications. Furthermore, among the three operational descriptions: the Morgan et al. article concluded that abdominal ultrasound was not common[9]; the paper by McLeroy et al. merely mentioned the performance of an E-FAST exam and the potential finding of a pericardial effusion;[15] and finally the Manley et al. article, although mentioning the E-FAST exam, focused on the placement of a REBOA device by a surgical team (physician) in the setting of hemoperitoneum. Ultimately, there is a lack of literature supporting the notion that the E-FAST examination significantly alters the management of abdominal pathology in current SOCM practice. This absence of supporting literature does not diminish the importance of SOCMs learning this exam, but it highlights why this examination may not offer the same level of significance to SOCMs as it does to in-hospital providers.

A notable difference in these literature review findings compared to the retrospective study by Morgan et al. is the proportion of procedure-based ultrasound described. In the Morgan et al. retrospective study, only 3 of the 109 exams were classified as procedural. The authors reported that this was expected given the pre-deployment curriculum "only briefly covered these subjects."[9] In contrast, in this literature review, 90% of the most common reported organ system use, cardiovascular, was procedural, and 43.5 % of all articles were procedure-based. Further, most of the diagnostic exams, outside of the MSK exams, were ones that would directly lead to a procedure or SOCM scope of practice intervention: neurologic assessment for intercranial pressure would potentially lead to hypertonic intravenous infusions; the three articles describing assessment for pneumothorax would lead to chest tube or needle decompression; the sole cardiovascular diagnostic description of an E-FAST with the finding of a possible pericardial effusion could lead to pericardiocentesis depending on the circumstances. Finally, the only described abdominal exam that led to a change in management was the single procedure-based article describing REBOA use.[21]

The findings of this literature review provide insight into how SOCM training may be improved. First, individual units should reflect on specific unit mission characteristics when developing an ultrasound training program for their unit and mission. In addition, this review suggests that, when training an SOCM unit to use ultrasound, a more substantial emphasis on procedural training may be beneficial. In particular, the author would advocate for: increased training in regional anesthesia for pain control especially among units that have a high likelihood of treating trauma; ultrasound guidance for chest tube placement or needle decompression and for assistance in establishing emergency airway access; and ultrasound for venous access and consideration for assessment and possible control of ongoing hemorrhage.

This review has multiple limitations. First, the author identified a limited number of articles describing both current and proposed SOCM ultrasound use, and many of the articles found did not meet high-level evidence standards. Consequently, any conclusions regarding SOCMs use of ultrasound in clinical

practice or proposed future applications must be interpreted cautiously. Additionally, the search was confined to the *Journal of Special Operations Medicine*, which may have led to the omission of relevant articles, particularly among articles advocating for use. However, this search approach was chosen to align with the specific goal of evaluating how ultrasound is being employed among Special Operations medics. Further, this approach was deemed as the most appropriate method to evaluate the literature specific to SOCMs, given that an earlier broad-based PubMed search produced no articles that described the clinical/operational use of ultrasound among SOCMs, outside those of the *Journal of Special Operations Medicine*. Last, a significant limitation is that only 20 articles were included, with only 8 (40%) describing operational use. While this limitation affects the generalizability and accuracy of the review, it underscores the point made by the review of Savell et al. that there is a general lack of evidence pertaining to the use of PoCUS among military medics.[10] This highlights the need for increased reporting on ultrasound utilization within military units.

Conclusion

Future SOF medic ultrasound training may benefit from mission-specific diagnostic imaging and procedural training. Traditional diagnostic exams may have limited value in the combat theater, in comparison to traditional hospital medicine, unless a clear change in patient management would occur based on the exam findings.

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