Special Operator Level Clinical Ultrasound: An Experience in Application and Training

Andrew R. Morgan, MD; William N. Vasios, APA-C; David A. Hubler, 18D; Peter J. Benson, MD

Abstract

Over the past few decades, ultrasound has evolved from a radiology and subspecialist-centric instrument, to a common tool for bedside testing in a variety of specialties. The SOF community is now recognizing the relevancy of training medics to employ this technology for multiple clinical indications in the austere operating environment. In the Fall 2008 issue of *Journal of Special Operations Medicine* two of the authors described the concept of training SOF medics to employ portable ultrasound as a diagnostic aid. After over two years of concerted effort, the authors trained 29 out of 40 medics of a Special Forces battalion. Retrospective analysis of the quality assurance data for ultrasound studies conducted placed the 109 studies into six categories, allowing inference of trends in clinical indication for ultrasound exams as determined by the SOF medic-ultrasonographer. The resulting distribution suggests that indications for fractures and superficial applications are as prevalent as those for focused abdominal sonography in trauma (FAST) and pneumothorax exams. This analysis focuses on Special Operator Level Clinical Ultrasound (SOLCUS), an ultrasound training curriculum specifically for SOF medics, and helps appropriately prioritize its objectives. Despite the success of this experience, there are several issues requiring resolution before being able to integrate ultrasound training and fielding into the SOF medical armamentarium.

Background

While ultrasound (US) has only recently become of interest in Special Operations medicine, it has been a principal imaging modality in hospital-based medicine for four decades. In contrast to the radiation used in computed tomography (CT) and plain radiography, US uses high frequency sound to interrogate tissues and generate diagnostic images. In its infancy, US was the exclusive purview of specific medical specialties such as radiology, cardiology, and obstetrics and gynecology, but today it finds a role across primary care and clinical subspecialties.[1] The union of Special Operations medicine with US resulted from the combination of three elements: 1) a clinical body of knowledge – emergency ultrasound technique; 2) a technology – portable US; and 3) a clinician with an applicable capability gap – the SOF medic.

Emergency ultrasound (EUS) is a unique application of clinical US in an emergency department setting. In the last two decades the specialty of emergency medicine paved the way for novel applications with direct relevance to the treatment of acutely ill and injured patients. Emergency ultrasound exams are distinctly different from the broader category of diagnostic US, because they are performed rapidly, are limited in scope, and answer very specific clinical questions (e.g., Is there fluid in the abdomen, yes or no? Is this an abscess, yes or no? Is there a pneumothorax, yes or no?) Emergency ultrasound exams do not provide comprehensive surveys of the examined body part as in diagnostic US. In 2001 and again in 2008, the American College of Emergency Physicians (ACEP) issued a policy statement to formalize recommendations for the scope and training of emergency physicians in EUS.[2] The scope of EUS closely approximates the objectives of US in SOF, making it a logical framework model.

Advances in portable US technology permitted unprecedented mobility in a clinical setting and facilitated applying it to new venues. Momentum in emergency department applications for bedside US technology synergized with increasingly portable machines and enabled clinicians to discover additional practical uses in the emergent setting. While focused abdominal sonography in trauma (FAST) is the most familiar EUS exam, the convenience of portable machines allowed emergency physicians to take machines to the bedside of any patient and expand the horizon of US applications beyond the abdomen. Inevitably, Combat Surgical Hospitals and Forward Surgical Teams began to realize the power of US in austere settings and employ it where CT scan and x-ray are often unavailable.[3]

The last element in this equation is the SOF medic. More precisely, the impetus for this project was the Special Forces Medical Sergeants (18Ds) lack of a practical imaging capability at the Operational Detachment-Alpha (ODA) level. While these independent providers receive limited training in plain radiography, portable versions of these machines are neither readily available nor are they practical for the modern SOF battlefield.[4] Our extraordinarily talented medics possess the aptitude to learn and apply this skill and combining portable technology with the imaging ability for EUS, logically fills this deficiency.

Figure 1: *Venn diagram showing the relationship between emergency ultrasound, portable ultrasound technology and the SOF medic to create the Special Operator Level Clinical Ultrasound concept.*

The confluence of these three elements unites the exceptional talents of the SOF medic, with modern portable US technology and the techniques of EUS applications to solve the imaging capability gap in the far-forward austere environment. Placing a portable US machine into the hands of a trained SOF medic is a medical force multiplier on the modern battlefield. For nearly two and a half years the medical staff of 1st Battalion, 3rd Special Forces Group (Airborne) has worked to catalyze this reaction and package this idea, a concept they have titled "Special Operator Level Clinical Ultrasound" (SOLCUS) and introduced in the Fall 2008 publication of the *Journal of Special Operations Medicine*.[5] The program title intentionally highlights the non-physician clinician applying US to the Special Operations-unique environment. This current article builds on the previous by reporting our experiences through an actual deployment to Afghanistan with this program.

Adapting Training to SOF Missions

The greatest challenge in implementing the SOLCUS initiative is the lack of precedent for training non-physicians. Ultrasound technicians, such as the registered diagnostic medical sonographer (RDMS), registered diagnostic cardiac sonographer (RDCS), and registered vascular technician (RVT) are currently the only non-physicians routinely credentialed to perform diagnostic US. Since their curriculum requires months of training and focuses on the technical aspects of collecting images, not on clinical application, these objectives poorly align with those of SOLCUS. As discussed previously, the scope of EUS provides the best match, making ACEP's US guidelines a reasonable start point for developing the curriculum model.[2] There is no evidence-based precedent validating a training program for non-physician clinicians although recent evidence in one study suggests that non-physicians can interpret US images following a brief block of instruction.[6]

Using the curriculum development model proposed in the Keenan article, the training program focused on:[5]

1. Analyze the operational mission set and develop corresponding learning objectives. Special Forces units are capable of tackling a diverse mission set, and our recent rotation to Afghanistan focused on foreign internal defense (FID), counterinsurgency (COIN), security force assistance (SFA), and direct action (DA).[7] This variety of missions included elements of offensive, defensive, and stability operations executed through both lethal and non-lethal effects.[8] The uniqueness and versatility of these missions mandated mission specific medical support. Realizing that this would encompass aspects of trauma, routine, and chronic care for U.S. Soldiers, host national military soldiers, and host national civilians in both fixed and mobile settings, the US curriculum objectives were tailored to meet those challenges through complementary skills. Specific examples of these skills are discussed in subsequent sections.

2. Establish medical officer oversight and create a cadre of US subject matter experts. Using resident expertise from US credentialed medical officers within the battalion, supplemented by the expertise of nationally recognized EUS experts, efforts initially focused on a core of five to six hand-selected medics with aptitude and motivation for this project. These US "champions" attended several courses in a TDY status to build proficiency through multiple exposures to formal courses.

3. Plan an introductory course for the general target audience. After developing a base of expertise among our 18Ds to serve as role models and anecdotes of success, a series of courses were held in the battalion through a contracted course and trained a more general audience to give a larger cohort their first introduction to the power of this technology.

4. Develop a skill proficiency plan and privileging criterion. This final phase is where the most opportunity for growth exists. As with initial training, no data exists to prescribe the number of exams that a non-physician clinician should complete before earning independent credentials and privileges without 100% quality assurance oversight. For the use of US during the deployment, a number of control measures were emplaced to provide remote supervision and feedback while our medics operated with novice-level proficiency. As a majority of medics become SOLCUS trained there will be larger cohorts to cross-section for the degradation of US skills over time in this group.

Training Yields

After 26 months of concerted effort to train our battalion's medics, the authors exposed 29 out of over 40 18Ds to at least one session. During this period, these 29 medics attended anywhere from a single session up to seven separate sessions, each of variable length and format. For purposes of discussion, a "session" is any discrete US training course, of various composition, that could be as short as eight hours in a single day or as long as 24 hours over three consecutive days. The average number of sessions was 1.9 per medic. In terms of training hours, this translated to a range of 8 to 52 hours, with an average of 16.7 hours per medic. The American College of Emergency Physicians US guidelines recommend a minimum of 16 to 24 hours of didactics for emergency physicians pursuing a clinically-based pathway to US proficiency.[2] The modal number of hours in the trained cohort was eight hours (12 of 29 medics). The "champions," or medics specifically targeted for enhanced expertise based on particular aptitude and interest, yielded a range of 24 to 52 hours of instruction. In addition to these 29 medics, this program introduced SOLCUS to two physician assistants with no prior background in US.

Deployed Experience

In January 2009 the battalion deployed to Afghanistan with a complement of SOLCUS-trained medics. Though the standing authorization for US machines in a Special Forces battalion is one per battalion medical section, U.S. Army Special Forces Command acquired eight additional machines to deploy with 1/3 SFG(A) to test this novel concept.[9] The authors analyzed each ODA according to its assigned mission set, accessibility to higher-role care, and US skills of its respective medics to determine how to most efficiently distribute nine machines among nine separate firebase locations.

While the medics received initial didactics and hands-on training, at the time of deployment they had not accumulated sufficient proctored exams for the battalion's medical officers to consider them privileged for independent decision making. Since their training would be ongoing during the deployment, quality assurance was a paramount concern throughout this time period. Ideally novice ultrasonographers receive real-time feedback, but the geographic distribution necessitated mitigation of this shortfall with a number of control measures. Supervising medical officers instructed SOLCUS trained medics that since they were in training, they should *not* alter their clinical decision-making based upon an exam they independently performed unless they were proctored by a visiting medical officer credentialed in US, used a "gold standard" test, such as x-ray in the case of fractures, discussed the case with a medical officer by phone, or empirically decided to send the patient to a higher level of care for further evaluation. Each US-trained medic also received a written logbook with instructions to maintain a record of all patients US's performed with the requisite findings. In addition, each received a USB storage device to save images with the intent of allowing them to e-mail for review by a qualified medical officer, but the DoD ban on the use of USB data devices precluded this method early in the rotation.

Upon returning to the continental United States, the authors met with each medic to review their images and give formal feedback on technique and decision-making. Supervising medical officers compiled and tabulated the quality assurance data and categorized the cases to appreciate which indications our medics were finding to be most useful. These categories were:

- **Musculoskeletal:** Evaluation for fractures and some cases of tendon and muscle body tears.
- **Abdomen/Trauma:** Focused abdominal sonography in trauma (FAST), evaluation for pneumothorax and non-traumatic abdominal applications (the combination of the FAST exam with a scan for pneumothorax is called the extended-FAST (E-FAST)).
- **Superficial Applications:** Discriminating abscesses from cellulitis as well as detecting foreign bodies in wounds.
- **Special Applications:** A mix of more advanced applications that have potential relevancy to SOF medical practice, but should be reserved as advanced provider skills such as scans for fetal viability (other than first trimester), ocular foreign bodies and retinal detachment, obstructing nephrolithiasis, and some basic vascular studies.
- **Procedural Guidance:** Using real-time US for IV access or regional anesthetic blocks.
- **Miscellaneous:** Cases that were not interpretable from reviewing the images, the case log, or interviewing the medic/US operator.

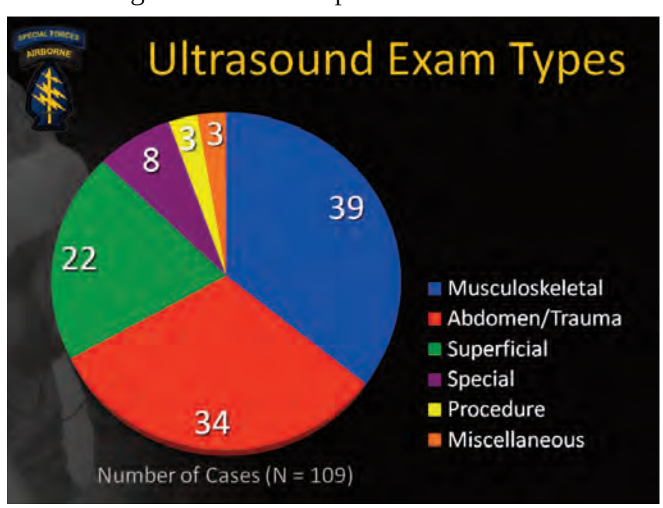

Figure 2: *Pie chart showing the distribution of ultrasound exam types (#'s of exams) by category.*

Discussion

Reviewing the distribution of these 109 quality assurance data points among the six categories reveals poignant utility trends. The most surprising observation is the predominance of musculoskeletal applications, of which fracture detection was the most common indication. Each course attended by our medics devoted some discussion of the potential uses for US in fracture detection, but the instruction was less emphasized since these courses focus on hospital-based EUS, rather than the austere environment peculiar to SOLCUS. Nevertheless, the numbers indicate that these medics took that seemingly insignificant application and highlighted its relevance to their practice.

The combination of musculoskeletal and superficial applications made up over half of the total case collection. While this may seem surprising at first glance, considering that musculoskeletal, dermatologic, and minor wound care complaints make up a significant proportion of a routine sick call log, it follows that our medics would record US applications with corresponding trends.

The second highest frequency category was abdominal applications, another unexpected outcome. Before collating this retrospective data, it was assumed that abdominal applications would be the most commonly studied anatomic region and that trauma would be the most common indication, accumulating higher numbers of FAST/E-FAST exams. While the medics recorded cases of FAST exams in blunt trauma successfully performed by these 18Ds, the reality of our mature theater was that most patients with penetrating or serious blunt mechanism were empirically evacuated. An abdominal US was unlikely to influence the evacuation decision in an environment with established MEDEVAC. However, for missions in immature theaters that lack readily available medical assets for either treatment or evacuation, the information provided by an E-FAST exam can provide critical information that could impact the allocation of scarce assets.

Procedural guidance numbers were understandably low since the curriculum only briefly covered these subjects. However, this category has the greatest potential for growth since indications like US-guided regional anesthesia have particular relevance to their practice. SOF medics already learn landmark-based regional anesthesia techniques in their initial training. The combination of this existing knowledge with evidence that US guidance decreases regional block complications, make this indication a logical target for deliberate development and future study.[10]

The more sophisticated indications in the “special” category may be reserved for more advanced courses and selectively introduced into a basic curriculum as we refine boundaries for SOLCUS. Several anecdotal experiences with exams in this category suggest benefits to SOF medics beyond pure clinical decision making and serve as rapport-building tools. For example, the assurance that a late trimester fetus has active fetal motion and cardiac activity is a potential skill that a non-physician healthcare provider can acquire, and while it may not always impact clinical care, instills a high degree of trust and reassurance in a host national patient receiving prenatal care for the first time. For SOF medics practicing in areas with underdeveloped or non-existent healthcare, the ability to use a diagnostic imaging device provides valuable clinical information, but also conveys a message to the host national patient that we are employing our most advanced technology to care for them. In short, US may provide intangible benefits to patient care in addition to tangible clinical data.

Detailed review of the complete case series indicated six cases (three musculoskeletal, two abdominal, and one superficial) that the authors believe, in the absence of control measures to ensure proper evacuation, US would have impacted the decision to evacuate to a higher level of care. The anecdotal experiences suggest that US has the power to provide information to obviate evacuation as well as justify the commitment of an evacuation asset to a high-risk situation.

To illustrate the decision making ability of a SOLCUS-trained medic, the efficacy of control measures, and the type of clinical scenario that warrants US as part of the clinical decision making process, consider this sample case: A SOLCUS trained medic at a remote firebase clinic treated an Afghan National Army soldier that negligently discharged his personal weapon into his left flank. The medic conducted his standard trauma evaluation and suspected that the wound was too lateral and too superficial to have entered the abdominal cavity, and as part of the evaluation at the firebase clinic, completed an E-FAST exam that confirmed the absence of pneumothorax or free fluid in the abdomen. He saved the images and, consistent with instructions, evacuated the patient to a Role II facility. There the general surgeon at this facility confirmed the negative E-FAST exam and the patient received local wound care before returning to duty a few days later.

While each of the 109 cases was subjected to at least one control measure, not every case received the benefit of each control measure, as exemplified in the case above. This would certainly have yielded more comprehensive results; however, the retrospective design and small sample size limited the value of the analysis. For example, the absence of confirmatory testing for every exam prevented the deduction of meaningful calculations for sensitivity and specificity. As a result of these constraints, the presented results suggest “how” medics used US, but provide only anecdotes of “how well” medics used US.

Conclusion

Within this generation, US has evolved from a radiology and subspecialist-centric instrument, to a common tool for bedside testing by a variety of specialties. The SOF community is now recognizing the relevancy of training our medics to employ this technology in our austere operating environment. This battalion's experience began with a training plan to teach a small list of applications relevant to their clinical practice and over the course of two years the authors were able to build a base of medics with basic proficiency in several relevant applications. The retrospective observation of this quality assurance data suggests that a formal SOLCUS curriculum should apportion instruction between E-FAST exams, basic fracture detection, and superficial applications with equitable effort. The authors believe procedural guidance possesses equal potential, but due to the lack of emphasis placed on it during this period, the data does not support this. In addition, our observations suggest that US has the potential to avert the urgency of evacuation as well as provide additional information to make cases more compelling for committing scarce assets. Despite the success suggested by these observations, this experience reveals a number of residual issues to focus future study:

- How will our community structure a standardized training program and who will execute it?
- What is the optimum number of didactic hours and clinical exams?
- What is the sensitivity and specificity for the various US applications in the hands of the SOF medical operator?
- What is the optimal sustainment plan?
- Since the responsibility of credentialing and privileging falls to medical officers, what should their education be if they do not already have the proper education from residency?
- What will be the basis of issue for portable US?
- Which machine best meets the community's needs?

May the challenge of these hurdles invigorate us as we expand the horizons of SOF medicine with these relevant US applications. This early experience strongly suggests that the alliance of SOF medic, portable US, and relevant clinical applications results in a medical force multiplier on the SOF battlefield.

References

1. Cosby, KS; Kendall, JL. (2006). *Practical Guide to Emergency Ultrasound* (Lippinicott, Philadelphia).
2. American College of Emergency Physicians Policy Statement on Emergency Ultrasound, Oct 2008.
3. Rush, RM, Jr. (2006). Surgical support for low intensity conflict, limited warfare and Special Operations. *Surg Clin North Am*, 86(3): 727-52.
4. Vasios, WN. (2010). Fracture detection in a combat theater: Four cases comparing ultrasound to conventional radiography. *JSOM*, 10(2); Spring: 11-15. (This edition)
5. Keenan, S; Morgan, AR; Blankenship R; Hubler DA. (2008). Ultrasound in Special Operations medicine: A proposal for application and training. *JSOM*; 8(4): 47-54.
6. Monti , JD; Younggren, B; Blankenship, R. (2009). Ultrasound detection of pneumothorax with minimally trained sonographers: A preliminary study. *JSOM*, 9(1); Winter: 43-46.
7. Olson, E. (2010). U.S. Special Operations: Context and capabilities in irregular warfare. *Joint Forces Quarterly*, (56): 64-70.
8. Headquarters, Department of the Army. *Field Manual 3-0 Operations*. 3-1 – 3-22.
9. United States Army Special Forces Command Table of Distribution and Allowance, Supplement 3.
10. Warman, P; Nicholls, B. (2009). Ultrasound guided nerve blocks: Efficacy and safety. *Best Pract Res Clin Anaesthesio*, 23(3):313-26.

MAJ Andrew Morgan, MC, is the Battalion Surgeon for 1st Battalion, 3rd Special Forces Group (Airborne) in Fort Bragg, NC. Prior to his assignment to 3rd SFG(A) he served in joint overseas assignments with various SOF units while practicing as a staff emergency physician at Womack Army Medical Center, Fort Bragg, NC. He is a 1998 graduate of the United States Military Academy at West Point, NY, a 2002 graduate of the Uniformed Services University of the Health Sciences, and a 2005 graduate of the Madigan AMC-University of Washington Emergency Medicine Residency.

CPT William Vasios, APA-C, is the outgoing Battalion Physician Assistant for 1st Battalion, 3rd Special Forces Group (Airborne) and the incoming Physician Assistant of the United States Army Special Forces Command (Airborne) in Fort Bragg, NC. He graduated the Special Forces Medical Sergeants course in 1995 and the Wake Forest School of Medicine physician assistant program in 2002. Over 20 of his 25 years of service are in the SOF Community.

SFC(P) David Hubler is the NCOIC and Senior Special Forces Medical Sergeant for 1st Battalion, 3rd Special Forces Group (Airborne) in Fort Bragg, NC. SFC(P) Hubler served five years as a medic on an operational detachment prior to becoming the Battalion Medical NCOIC for the past two years. He has five Operation Enduring Freedom deployments.

COL Benson is a graduate of Northeastern University ROTC program with a degree in mechanical engineering. Originally commissioned in the Infantry, he completed SFQC before attending the Uniformed Services University of the Health Sciences for medical school. He is board certified in emergency medicine and a Fellow of the American College of Emergency Physicians. He has served as a Special Forces Battalion Surgeon, Emergency Department Chief, Joint Task Force Surgeon, Theater Special Operations Command Surgeon, Special Forces Command Surgeon, and is the current Army Special Operations Command Surgeon.