

# Trauma Association of Canada 2009 Presidential Address: Trauma Ultrasound in Canada—Have We Lost a Generation?

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(*J Trauma*. 2010;68: 2–8)

On the occasion of the third joint meeting of the Trauma Association of Canada (TAC) and the Australasian Trauma Society, there remain innumerable challenges to be tackled in eradicating preventable death in both our societies. In Canada, the personnel, structure, and processes to take on these challenges currently exist under the auspices of TAC. Healthy, growing, relevant, and especially committed are descriptors appropriate to the current status of TAC. This was not always the case though, and the very survivability of TAC was in question as recently as the onset of this new millennium. The first joint meeting of TAC and the Australasian Trauma Society occurred in 2001, in Darling Harbor, Australia and was a notable event coinciding with a relative rebirth in the health of TAC as an organization. The Annual Scientific meetings have been growing every year since, not only in attendance but also in the quality and number of scientific presentations. This rebirth owes much to every TAC member in general, but past presidents Van Wijngaarden-Stevens, Kortbeek, Simons, and Brennehan in particular.

The TAC accreditation/verification committee in particular is one of the most dedicated committees. This group has now graduated to the stage of verifying regional systems across large areas of Canada. In terms of how to best to save lives that are otherwise needlessly lost, this may be the most crucial way to reach out to the population at risk. There are now verified trauma centers and systems that stretch from coast to coast. Past President, Richard Simons, is the current winner of the McLaughlin-Gallie award of the Royal College, an incredibly prestigious award, for his work on trauma

systems. TAC now has a memorandum of understanding with Accreditation Canada, the leading independent accreditor of Canadian hospitals.<sup>1</sup> Currently, TAC and Accreditation Canada are evaluating each other regarding a goal of one day amalgamating to increase the efficiency of trauma verification across the country. TAC now has a host of active committees working on prevention, performance improvement and patient safety, guidelines, international, pediatric, publications, and Canadian forces liaison issues, as well as many active research initiatives.<sup>2</sup>

An organization does not get better by focusing on what it is good at, however. It also needs to look to its weaknesses to truly improve. Unfortunately, one of the organizational weaknesses of TAC is a total lack of any position on trauma ultrasound (US).

## HISTORICAL BACKGROUND AND PERSPECTIVES ON FOCUSED CLINICAL ULTRASOUND IN CANADA

The decades preceding the new millennium were a very promising time for focused trauma US in general, and for Canadian trauma surgeons and US more specifically. Trauma surgeons in the United States demonstrated that a focused clinical US assessment technique developed by European surgeons was also a valuable technique for North Americans and promoted it widely.<sup>3–5</sup> Similarly, Bernard Boulanger and Fred Brennehan from Sunnybrook hospital were early pioneers in these activities and became world leaders in bringing US to the injured patient's bedside. They wrote a number of the leading articles in this period of awakening, culminating in a seminal article that showed clinical care emphasizing the use of US was quicker, cheaper, and as accurate as one using only computed tomography (CT) and diagnostic peritoneal lavage.<sup>6–10</sup> They also contributed to our current definition of the examination we now know as the focused assessment with sonography for trauma (FAST).<sup>11</sup>

Another notable article that Drs Boulanger and Brennehan produced in 1999 was a survey across North America as to the reported adoption and use of the FAST examination.<sup>12</sup> Understanding the limitations of survey methodology, the FAST examination was reportedly used significantly less in Canada, with only 39% of Canadian centers using the FAST compared with 79% of centers in the United States.<sup>12</sup> Furthermore, although 100% of respondents thought the FAST examination was an advance in management and 86% thought it should be part of surgical training, none of the Canadian regional trauma centers had any formal resident

Submitted for publication April 7, 2009.

Accepted for publication April 15, 2009.

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Presented at the Annual Scientific Meeting of the Trauma Association of Canada, March 5–7 2009, Auckland, New Zealand.

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DOI: 10.1097/TA.0b013e3181b0fd2f

teaching on FAST. This article reflected on the status quo and the predicted future of focused trauma US just as the millennium was turning. In the 10 years since this survey was compiled though, there have been extraordinary changes in imaging modalities in general, and the technologies of CT and US more specifically.

CT scanners have undergone tremendous improvements in the speed of image acquisition and quality, but especially in their capability to reconstruct and reformat images to understand the anatomy of injuries.<sup>13</sup> CT scanners are being increasingly incorporated into the physical flow of resuscitation areas and will soon be built into the resuscitative suites of hospitals in the developed world. The luxury of easier access to CT offers an easier route for clinicians but may be promoting less reliance and even laziness in the diligence involved in examining the injured patient. Clinicians may simply rely on CT to catalogue the injuries that will be watched nonoperatively. The evolution in nonoperative management has been considered one of the major reasons leading to a decline in interest in trauma surgery as a highly sought after profession.<sup>14–16</sup> Is there a role for surgeons anymore in trauma care? Can they stay in bed and concentrate on developing elective or acute surgery practices?

But even as the need for trauma surgeons is being questioned, the problem of excessive and potentially preventable trauma deaths has not disappeared. Trauma is still an epidemic all over the world. It remains our leading public health problem in Canada and the leading cause of death from ages 1 years to 44 years in the developed world and overall causes 16% of the world's burden of disease.<sup>17,18</sup> Up to 48% of the time deaths may be preventable and involve reproducible conditions involving the airway, breathing, shock and hemorrhage, and brain injuries.<sup>19</sup> In the United States, trauma surgeons have addressed declining operative volumes by often redefining themselves as acute care trauma surgeons.<sup>20–22</sup> In Canada, trauma surgeons have actually been fortunate (although they may not have appreciated it previously) and have not had to redefine their occupations, as there has never been the volume of operative trauma to allow any surgeon to solely focus on trauma at the expense of a broad general surgical practice. This seems to be simply a realization that good trauma providers are essentially those who care and will be in the hospital when you need them acutely. This remains true whether they are emergency physicians (EPs) or surgeons. Grossman et al.<sup>23</sup> recently described the value that a well-trained EP brought to trauma care on their trauma service that was previously run solely by trauma surgeons. One of the strengths of TAC is that it is a multidisciplinary group that speaks for all bedside trauma providers, regardless of discipline. Reports such as this validate approach of TAC of welcoming all involved disciplines under one umbrella to work cooperatively. Since its inception, many of the past presidents of TAC have been EPs, as is the current president-elect.

If the essence of our calling is being at the bedside when needed, should not we collectively embrace anything that improves the bedside care of the critically ill and improves our initial examination of them? Focused clinical US is such a tool. Bleeding to death has long been considered the

leading cause of potentially preventable injury-related death and accounts for 80% of early in hospital deaths.<sup>24,25</sup> Intra-abdominal bleeding is the most common anatomic site, and one in which making the diagnosis and operating quickly may make the difference between living and dying. Common sense would suggest using a noninvasive tool in our hands that can give an answer in seconds,<sup>7,26</sup> versus invasive techniques that will take at least minutes. FAST has been shown in randomized trials to get patients to the operating room quicker when they need it.<sup>27</sup> The FAST has its pitfalls and limitations involving injuries without free fluid, retroperitoneal trauma, and its use in the obese.<sup>28</sup> The FAST is nowhere near as accurate for minute detail as CT scanning, but in cases where life-saving surgery is needed all patients are usually correctly identified.<sup>7,29</sup> Although the utility of the FAST in simply expediting the management of exsanguinating intra-abdominal hemorrhage justifies its inclusion in the skill-set of all bedside trauma providers, I believe that trauma US should not just comprise the FAST, but should be more, much more, addressing all areas of preventable death. US technology has definitely become cheaper, better, and smaller, being now truly portable. I personally am not sponsored by any commercial entity but felt strongly enough about the importance of this tool to have purchased my own machine many years ago. Such flexibility means that we have been able to take US onto mountains, war zones, weightlessness in parabolic flight, and ultimately true space aboard the International Space Station (ISS).<sup>30–32</sup>

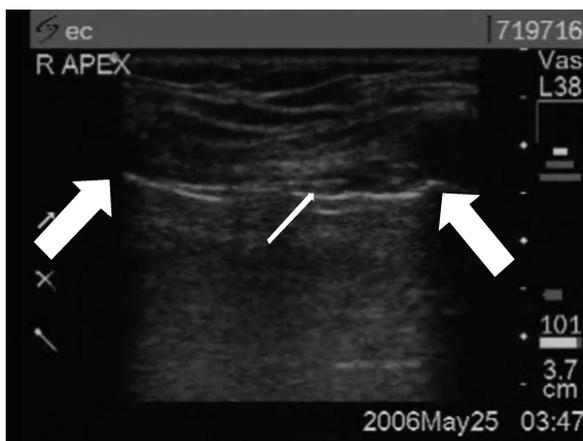
When US is your only tool, you are forced to do more with it. Onboard the ISS, there is only US, no x-ray, CT, or magnetic resonance imaging. That is why the National Aeronautics and Space Administration has led the way in developing US techniques to aid in nearly every facet of the physical examination and diagnosis.<sup>33–36</sup> It would be untrue to claim that space medicine has solely driven the revolution regarding the extended focused assessment with sonography for trauma (EFAST), but there is no question that Space medicine-targeted studies have greatly helped introduce the North American trauma community to the potential expanded role of US in trauma resuscitation and diagnosis.<sup>37–39</sup> These programs generated much data and brought some largely European work regarding the expanded scope of the FAST or EFAST to the attention of a North American audience.

This meant that more clinicians had US available when resuscitating the sickest patients. Simply using it more often was empowering. For instance, not only the real-time diagnosis of a tension pneumothorax could be made (arguably one that should be apparent clinically) but further this diagnosis could be confirmed, and formal documentation of both its presence and resolution could be captured without the clinician ever leaving the patient's bedside (<http://www.traumacanada.org/media/videolinks.htm>).<sup>40</sup> Even if a patient were near a CT scanner, imaging is not continuous nor would an unstable patient ever be taken to a scanner. This is just one aspect of what can be learned at the bedside with US. I truly believe that focused US is immediate, powerful, and it should simply be part of our resuscitative algorithms.

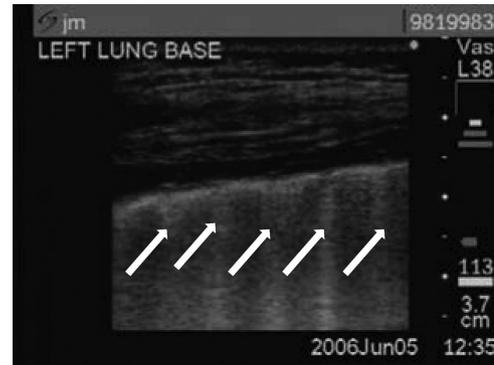
## FOCUSED CLINICAL ULTRASOUND AND THE BEDSIDE EXAMINATION

When US is readily available and familiar, it becomes part of one's physical examination and as natural (or more so for surgeons) as using one's stethoscope. Seeing the beating heart becomes akin to hearing heart sounds. If one commits to care for the critically ill or injured, a minimum expectation should be the ability to look at the heart and appreciate unobvious differences between normal and grossly abnormal. This does not mean performing formal echocardiography, which is a highly skilled art, but simply appreciating the obvious, such as recognizing the difference between the vigorously beating, healthy heart from the failing heart in dilatational left ventricular failure. Any cardiac activity should be easily contrasted against none, such as confirming cardiac standstill. Focused US integrated with advanced cardiac life support algorithms has recently demonstrated that many cases of possible pulseless electrical activity are not and are actually pseudo-pulseless electrical activity with a different outcome.<sup>41,42</sup>

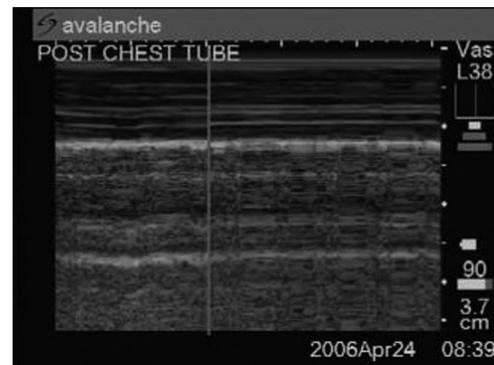
Before a clinical need forced investigators to look outside the standard boxes, air was considered the "enemy of US," and respected textbooks dismissed lung US.<sup>43</sup> The high acoustic density of air largely prevents the transmission of US waves through it, with the acoustic density of air being essentially off the scale. Thus nearly all of an US beam is reflected by an air-containing interface leaving almost no transmitted beam. Although the normal lung is functionally just a bag of air of which the interior cannot be interrogated by US, most life-threatening thoracic trauma involves the pleural space, which is typically very well seen with US.<sup>44</sup> In health, the to and fro movement of the visceral on the parietal pleura is easily detected, a movement known as lung sliding, and when located just under two rib shadows generates the "batwing sign" (Fig. 1).<sup>45,46</sup> When one is comfortable with the EFAST seeing, this sliding becomes simply analogous to



**Figure 1.** Batwing sign. Still image of the "Batwing" sign representing the visceral-parietal interface (small arrows), best appreciated in real-time imaging. Large arrows indicate two rib shadows between which the pleural interface is normally seen to "slide" with respiration providing the visual equivalent of hearing breath sounds.



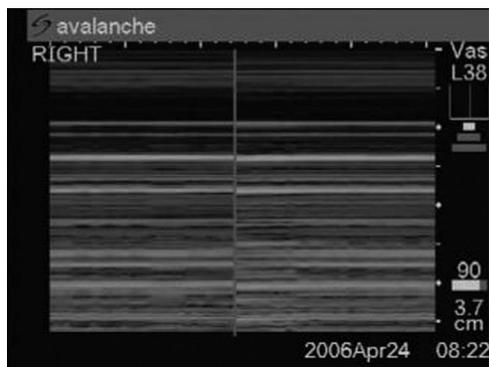
**Figure 2.** Comet-tail artifacts. Still image of the visceral-parietal pleural interface from which multiple comet-tail artifacts are seen to emanate from (arrows). This can be considered the visual equivalent of hearing lung crepitations.



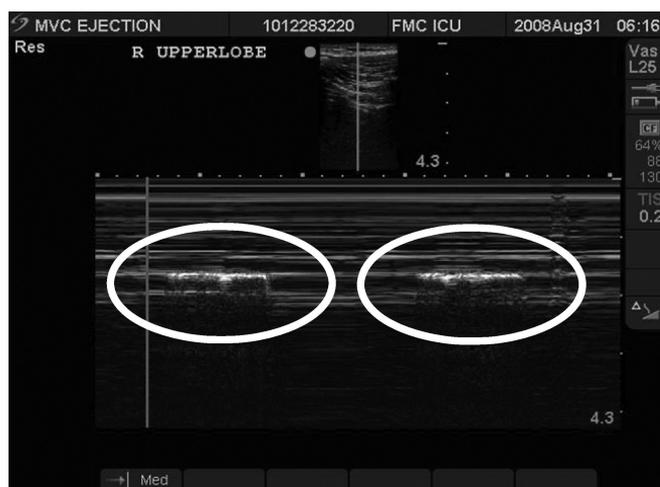
**Figure 3.** Seashore sign. M-mode image of the now normal visceral-parietal interface after a pneumothorax has been evacuated revealing movement (blurred pattern) deep to the nonmoving chest wall (continuous lines), representing the visual equivalent of hearing breath sounds.

hearing breath sounds with a stethoscope; its presence reassures, yet does not rule out many other subtle findings.<sup>39</sup> Another basic sign is the comet-tail artifact, a vertical line which emanates from the pleural interface and is believed to arise from water-filled interstitial lymphatics or flooded alveoli (Fig. 2).<sup>47,48</sup> This sign is the visual equivalent of hearing crepitations. Although there are many reasons to have them, they infer increased lung substance water density for whatever reason.

When even small amounts of air accumulate between the pleura (also known as a pneumothorax), there will be absent breath sounds depicted visually through absent sliding, which is actually a monotonous finding as nothing will be observed to be happening; that is the point. The EFAST is also smarter than the stethoscope, because it can record and document dramatic physiology simply even with single images.<sup>49</sup> The M-mode or time-motion mode depicts a typical pattern of normal breathing producing the so-called seashore sign of a normal lung (Fig. 3). Alternatively when a pneumothorax (PTX) is present, a dramatically different picture known as the stratosphere sign results (Fig. 4).<sup>44,46</sup> The EFAST is actually much more elegant than the stethoscope as



**Figure 4.** Stratosphere sign. M-mode image of the abnormal visceral-parietal interface due to a pneumothorax that obscures all lung movement leaving only a continuous monotonous pattern, representing the visual equivalent of hearing no breathe sounds (same patient as in Fig. 3, but before the chest tube insertion).



**Figure 5.** Lung point. M-mode pattern revealing the physical point on the chest wall where an underlying collapsed lung intermittently contacts the parietal pleura demonstrating the physical extent of the collapse at this anatomic location. The duration of pleural contact is emphasized by circles. This visual finding has no auscultatory equivalent.

the physical extent of the pneumothorax can often be demonstrated, by detecting the junction between the lung and the air, known as the lung point<sup>46,50</sup> (Fig. 5). This would be the equivalent of detecting the exact point with a stethoscope at which there are and are not breath sounds, something the stethoscope cannot do. Blaivas et al.<sup>51</sup> has noted good correlation between the estimates of PTX size and CT findings using the relative thoracic topography of lung sliding. With respiration, a portion of the visceral lung fleetingly appears against the parietal pleura producing a sign termed the lung point that is easily confirmed and documented on M-mode. This sign is 100% correlated with a pneumothorax.<sup>46</sup> As emphasized in the Advanced Trauma Life Support course, absent of breath sounds during the primary survey might be either a pneumothorax or a hemothorax, but the stethoscope

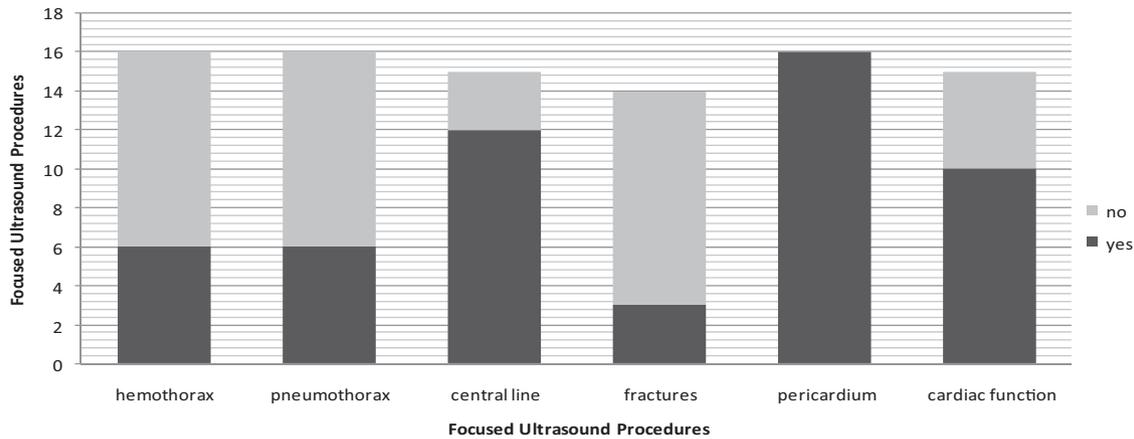
does not distinguish. The EFAST does in seconds. Progressing from the standard FAST, it is only natural to look above the diaphragm for fluid representing pleural effusion or hemothorax.<sup>52,53</sup>

The more you use US, the more it will be depended on for just about everything.<sup>54</sup> Using US guidance to make central venous access safer is rapidly becoming a mandatory tool, rather than just a recommended one.<sup>55,56</sup> Further ways one can augment the physical examination are nearly endless. Long bone fractures can also be quickly confirmed visually in all kinds of settings.<sup>38</sup> The point is that bedside US is almost limitless in scope and simple.<sup>54</sup> Comparison to another imaging modality, such as CT, is not a fair comparison though. Of course CT is better, and if you can safely get your patient there, it remains the gold standard. Further, it remains controversial as to the exact risk, but there is no question that being callous with CT scanning will ultimately hurt patients, due to the risk of transport, and the radiation exposure.<sup>57,58</sup> North Americans also need a reality check; in 2009, most people still do not have a CT scanner in the emergency room, or even in the building sometimes. As citizens of the world, it should be recognized that most trauma victims will live their entire lives and die without ever seeing a true hospital, never-mind one with a CT in the emergency room. The relevant paradigm is comparing the EFAST to physical examination. The challenge for the future is how then to transition our whole profession from one that never learned to examine patients with US, to one that seamlessly incorporates this modality into every critical patient encounter.

## SURVEYED TRAUMA US PRACTICES AMONG ACADEMIC TRAUMA PROGRAMS IN CANADA

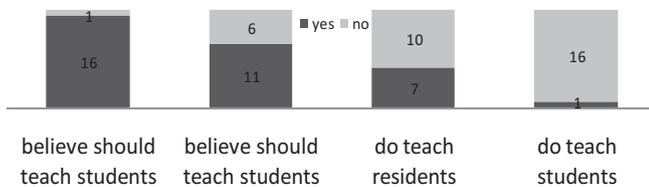
To prepare this address, the Trauma Director or designate of all 17 medical school-associated trauma centers in Canada were surveyed to gauge where trauma US in Canada has progressed in 10 years. Of these 17, all but one now use the FAST in trauma resuscitations, compared with only 39% 10 years ago. Who generally performs the FAST has changed a great deal though. Radiologist and surgeons who perform the examination in only 6% and 13% of the centers that used the FAST, respectively, seem to have literally abandoned the FAST, in favor of emergency medicine colleagues who were reported to conduct the examination in 88% of settings. Although an EFAST was unknown a decade ago, nearly half the centers reported regularly or occasionally looking for both pneumothoraces (38%) and hemothoraces (44%); most to guide central line placement (81%); few to confirm fractures (19%); and all to look for pericardial fluid, the majority (63%) will at least look beyond the pericardium to grossly see the actual cardiac function (Fig. 6).

In the academic trauma centers at least, the use of the FAST is reportedly expanding in both its scope and penetration, but the current generation of Canadian trauma surgeons seems to have abandoned it to their emergency medicine colleagues. Like anything though, the future will reflect what is taught now. In 1999, 96% of all American and Canadian centers felt that the FAST should be a formal component of surgical resident training. Today though, while the vast ma-



**Figure 6.** Reported frequency of extended focused ultrasound techniques among Canadian academic trauma centers using ultrasound in trauma resuscitation (as reported by the trauma director or designate).

**Focused clinical ultrasound education for residents and medical students: perceptions and reality**



**Figure 7.** Reported Canadian academic trauma centers activities regarding surgical residents and medical students education in focused clinical ultrasound (as reported by the trauma director or designate).

majority (94%) thinks we should teach surgical residents, most (56%) do not. While many (69%) think we should teach students, almost nobody does (6%) (Fig. 7). This inattention should be appreciated in light of an appreciation that US is coming to medical school curriculums in selected centers.<sup>59,60</sup> It is currently speculation, but I would envision a not too distant day when gross anatomy is considered intrinsically linked to sonographic anatomy as a prerequisite to learning proper physical examination.

As advocates for improved trauma care across Canada and potentially the world, it is unfortunate that the TAC is doing nothing to improve this situation. TAC has no position whatsoever on the use of US in trauma care, other than to note it as essential for Level I trauma centers in the Verification guidelines.<sup>61</sup> If TAC considers the FAST essential, how can this service be provided to all injured Canadians who might potentially require it? Although radiologists and technicians are highly skilled, they will simply not be available on an immediate basis. One of the greatest technological revolutions ever is currently unfolding in the realm of informatics. It is possible that telemedicine and informatics might allow trauma centers providing emergent clinical US to increase their geographic coverage. To this end, the Calgary trauma program has been investigating the use of real-time trauma telesonography to enhance communication between our cen-

ter and the Banff Mineral Springs hospital in the Rockies.<sup>62</sup> This is another direct spin-off from Space Medicine. Although there is an US in space, there is no guarantee of an experienced user or even of a physician. Given the presence of US capability in space, National Aeronautics and Space Administration has led the way in developing telesonography and most importantly protocols for using remote experts on the ground to guide the inexperienced adult learner to acquire useful images using just-in-time techniques.<sup>33-36</sup> We believe this technology is useful to provide clinical care and to educate.<sup>62,63</sup> At the time of writing, functional tele-US links between Ottawa, Iqualuit, Cambridge Bay, and Rankin Inlet in the arctic testing are further exploring these concepts.

Although there seems to be tremendous potential in exploring telesonography and real-time telementoring, I believe the real key is to provide a basic fundamental education to all trauma providers. Continuing with the survey, as the emergentologists have generally assumed the responsibility to properly examine the victims of trauma in our academic centers, so have they led in developing appropriate educational tools. The most accepted course in Canada is called the Emergency Department Echo course, which emphasizes a methodical, standardized approach to image generation. More importantly, Canada has developed a national certifying body for US—the Canadian Emergency Ultrasound Society (CEUS) ([www.ceus.org](http://www.ceus.org)). The CEUS has developed rigorous standards for a limited number of life-threatening indications and has become the primary standard recognized for trauma providers across our country. Among reported standards, it was even between the CEUS standard versus none reported (44% each). Before concluding that TAC should accept the CEUS standard as the way forward to the future, a quick review reveals that other educational avenues exist for trauma providers in Canada. The American College of Surgeons (ACS) has a number of US courses provided under the auspices of the Committee on Emerging Surgical Technologies and Education.<sup>64</sup> This committee holds regular courses and envisions an exportable training model based on the ATLS course. The relevance of this organization has recently been greatly increased as the ACS has begun a major revision

of the basic course CD to upgrade it using multimodality and advanced graphics techniques again piloted for space requirements onboard the ISS,<sup>65</sup> to allow self-directed users to learn at their own pace, and to explore and learn using virtual reality. This major redesign should result in both a better and more accessible entranceway for students and residents to learn the basics of US, and the overall curriculum of the ACS is intended to provide continuing educational opportunities for more advanced users. Another initiative is the World International Network Focused on Critical Ultrasound (WIN-FOCUS), which aims to improve primary, emergency, and critical care by incorporating “point of care” US into clinical practice.<sup>66</sup> This is a similar aim to many groups, but WIN-FOCUS has great visions and is very much working in the third world where they are creating simple courses aimed at adding focused US into the basic resuscitative algorithms and maternal care that are such targets for preventable loss of life in developing countries. As one example, WINFOCUS is partnered with groups under the auspices of United Nations Educational, Scientific and Cultural Organization, the UN Environmental, Social, and Cultural organization to study bringing focused US training to rural villages in Madagascar.<sup>67</sup> US is a cost effective technology with many, many machines being purchasable for the cost of purchasing a typical magnetic resonance imaging, notwithstanding the ongoing costs of service and maintenance.

## CONCLUSIONS AND RECOMMENDATIONS

To conclude, this review has attempted to highlight why focused clinical US is important to clinicians and patients whether they be in academic trauma centers, the most rural clinics, the high arctic, or the developing world. This importance and wide clinical audience highlights the failure of an otherwise tremendously successful professional society to promote better care or even to assume an official policy in this area. I thus believe that TAC should not be on the sidelines and ignore this any longer; TAC should have a clear position statement regarding focused clinical US.

I believe that TAC should strongly promote the learning and use of focused US to enhance the physical examination of the injured. As an organization of bedside providers, TAC should strive to be a leading organization in improving the bedside care of the injured and thus contribute to a rebirth of the clinical doctor who does a comprehensive examination whether they be surgeons, emergentologists, or family practitioners. TAC seems to have lost a generation of trauma surgeons though, so we should not lose any more. TAC does not need to invent something new, good courses exist, we just need to endorse them and learn from them. Ultimately, if TAC supports teaching these basic examination skills within the standard medical curriculum, then success would be reflected in the eventual redundancy of all these postgraduate courses to teach us clinicians what we should have learned in our basic approach to the injured and ill patient.

## ACKNOWLEDGMENTS

I thank Dr. Chad G. Ball, Departments of Surgery and Trauma and Critical Care, Grady Memorial Hospital, At-

lanta, GA; Dr. Lawrence Gillman, Department of Critical Care Medicine and Regional Trauma Services, Foothills Medical Centre, Calgary, Alberta, Canada; Captain Ray Wiss, M.D., Secretary Canadian Emergency Ultrasound Society for review of the manuscript.

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