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The utility of remote supervision with feedback as a method to deliver high-volume critical care ultrasound training☆,☆☆

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ABSTRACT

Objective: Despite international agreement that critical care ultrasound (CCUS) is an essential skill for intensive care providers, CCUS training and dissemination is complicated by a shortage of educators. Newer technology now permits remote, offline supervision as a method of overseeing trainees undergoing CCUS instruction.
Design: This was a retrospective, descriptive report of a CCUS curriculum and its output of clinical ultrasound examinations at an academic critical care training program over a 1-year period. The curriculum consisted of typical didactic and hands-on training as well as wireless archiving of examinations with remote, offline oversight and feedback provided by the director using ultrasound management software.
Setting: A tertiary-care, academic critical care training program.
Measurements and Main Results: Twenty-nine trainees acquired and archived a total of 2531 CCUS studies (average 76 studies per trainee) for 1 year. Of these, 1807 (71%) examinations had a typewritten report generated by the operator, and 1788 of these examinations were overread and subjected to feedback from the curriculum director. The predominant application of CCUS was for cardiac (62%), thoracic (32%), and abdominal (5%) assessment.
Conclusions: This study suggests that the use of wireless archiving and offline oversight in a CCUS curriculum is a feasible and highly-efficient strategy permitting a small number of faculty to supervise a large number of trainees. This approach provides an efficient method to address unmet demand for CCUS education.

1. Introduction

Despite international agreement that critical care ultrasound (CCUS) is an essential skill for intensive care providers [1] and recent evidence to suggest that it improves outcomes [2], CCUS training and dissemination is complicated by a shortage of educators [3]. Many critical care training programs, particularly in North America, are without a CCUS curriculum and/or CCUS educators [4]. In the face of this short supply of CCUS trainers, novel approaches to training that maximize the impact of CCUS educators are necessary.

Because of advances in technology, innovative techniques can be applied to help overcome the rate-limiting step in providing CCUS training, namely, the expert oversight and longitudinal supervision of ultrasound image acquisition and interpretation required to assure competency. These advances include wireless image transmission from point-of-care ultrasound machines and corresponding software that allows the remote review and delivery of written feedback over e-mail to those performing the ultrasound examinations.

Here we describe the process and training impact of a CCUS curriculum predicated on wireless archiving, offline supervision, and written feedback in the context of a large critical care training program in a Canadian academic center over a 1-year period.

2. Materials and methods

2.1. Study design

Retrospective, descriptive analysis.

2.2. Inclusion

All ultrasound examinations recorded and archived by trainees using intensive care unit (ICU)–based ultrasound machines during the period of September 1, 2012, to August 31, 2013.

2.3. Setting

An academic, tertiary care hospital system with 3 ICUs (2 mixed medical-surgical and 1 cardiac surgical, total annual admissions of 3727, total capacity of 70 beds). This study was conducted with Western University Research Ethics Board approval (File 105354).

Abbreviations: CCUS, critical care ultrasound; DICOM, Digital Imaging and Communication in Medicine; DVT, deep venous thrombosis; ICU, intensive care unit; PGY, postgraduate year.

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2.4. Curriculum structure

A CCUS curriculum was structured and implemented on September 1, 2012, according to the competence guidelines on CCUS that have been endorsed internationally [6]. This curriculum was introduced to both postgraduate residents specializing in critical care medicine and senior residents (postgraduate year 3 or above) in anesthesiology, internal medicine, and emergency medicine pursuing additional critical care training. The curriculum director's (author) qualifications include completion of a 1-year ultrasound fellowship with testamur status through the National Board of Echocardiography's Examination of Special Competence in Adult Echocardiography and being a Registered Diagnostic Medical Sonographer.

2.5. Curriculum

In keeping with training guidelines [1], each learner's curriculum was composed of a mix of didactic course and self-study work, hands-on training on healthy volunteers, and sustained, longitudinal feedback via e-mail, as described below. A dedicated, month-long ultrasound rotation was also available to all learners.

The details of the entire curriculum are outlined in Table 1.

2.6. Technological components of curriculum

Each ICU in our center has at least 1 multipurpose, portable ultrasound machine with wireless connectivity to the hospital network and an ability to export files wirelessly in DICOM image standard.

Point-of-care ultrasound archiving and quality assurance software (Qpath, Telexy Healthcare, Maple Ridge, Wash) was installed institution-wide and available on all hospital-based computers and by home access to trainees and the curriculum director via remote access. The approximate cost of installation, including software and hardware requirements, was 25 thousand Canadian dollars.

2.7. Ultrasound study workflow

With introduction of the CCUS curriculum, it was strongly encouraged that all CCUS examinations performed by trainees (excluding those for procedural guidance) be recorded and archived using the wirelessly enabled ultrasound machines in each ICU. It was further emphasized that without such recordings of ultrasound examinations, informed feedback and instruction cannot take place. Critical care ultrasound examinations take, on average, 5 to 15 minutes to complete, depending on scope and complexity. Once images were successfully archived, the user would then complete a typewritten report using the archiving software. Taking 5 to 10 minutes to complete, reports consisted of trainee interpretation and clinical recommendations based on their examination findings and the clinical data (Fig. 1). An e-mail notification with a copy of the report, generated from within the ultrasound management software, would then be sent to the curriculum director to prompt a review of the study. For urgent review (<1 hour), the curriculum director was contacted directly (pager or phone). A representative screenshot of the software portraying its 3 fundamental functions—image archival, examination reporting, and written feedback with quality assurance—is shown in Fig. 2.

Table 1
Curriculum contents for Western University CCUS Curriculum

Curricular item	Total time	Mandatory or optional
2-d didactic CCUS course with hands-on training	18 h	Mandatory
E-learning content	15 h	Mandatory
Instructions on how to comply with wirelessly archive and report ultrasound examinations (www.westernsono.ca)	1 h	Mandatory
One month dedicated CCUS rotation devoted to scanning in ICU environment	120 h (approx.)	Optional (20/29)
1-h review sessions for ICU trainees as part of critical care fellowship didactic curriculum	2 h	Mandatory (for ICU trainees)
Review of curriculum director written feedback on CCUS examinations and their reports (delivered by e-mail)	3 h	Mandatory

2.8. Ultrasound oversight workflow

The curriculum director devoted an average of 4 to 6 hours per week to the responsibility of providing oversight of CCUS studies, most of which was conducted remotely via the archiving software. No other physicians were known to have provided oversight, either in person or remotely. No direct funding was provided for the oversight.

Feedback provided on examination images and reports was routinely structured to emphasize opportunities for improvement, as they existed, with regard to any or all of image acquisition, image interpretation, and clinical integration. Requiring an average of 2 to 4 minutes to review images and generate comments, feedback was sent in an e-mail form, supported with visual educational aids in the way of relevant thumbnail images from the examination, to the trainee(s) who completed the examination and report. An example of a representative feedback document is shown in Fig. 3.

2.9. Competency determination

A determination of competency was conducted for each trainee. Because of having a single educator responsible for the both the training and competency assessment without a validated assessment process, this step was necessarily subjective and bias could not be excluded.

Competency assessment was carried out in keeping with recently published Canadian CCUS training guidelines [5]. This consists of a combination of directly observed studies of consistently acceptable quality, accurate image acquisition, and interpretation across studies reviewed as part of the trainee portfolio.

In addition, trainees who completed the month-long rotation were able to undergo a proctored, end of rotation assessment. In this assessment, trainee derived image acquisition, interpretation, and clinical integration of cardiac and thoracic ultrasound images from a ventilated, critically ill patient were evaluated in real time. They were then compared to a reference standard of the curriculum director's images, interpretation, and clinical impression from the same patient obtained immediately prior to the learner assessment.

3. Results

In the first year of the CCUS curriculum, 29 different trainees carried out a total of 2531 ultrasound examinations across the 3 ICU environments that operated with a collective mean occupancy of 90% during this time. There were 3727 patients admitted and therefore eligible for ultrasound examinations. Of these admissions, 1451 of these were cardiac surgical in nature, whereas the remaining 2276 were general medical-surgical patients.

Of these 2531 examinations performed, the types of examinations performed included 1565 (62%) cardiac ultrasound examinations (1% of these being transesophageal echocardiograms), 821 (32%) thoracic (lung and/or pleural) examinations, 112 (5%) abdominal (free fluid, biliary, renal or aorta) examinations, 10 (0.4%) deep venous thrombosis (DVT) examinations, and 3 (0.1%) skin and soft tissue examinations. Although not required to be archived, 20 (1%) procedural guidance examinations were also captured (Fig. 4).

The average number of examinations, per trainee, was 76 ± 51 total examinations (2-223), 49 ± 32 cardiac examinations (1-142), and 27 ± 20 thoracic examinations (1-81). As the study period (September 1–August 31) overlapped with the July start of the academic year, some