YALE JOURNAL OF BIOLOGY AND MEDICINE 93 (2020), pp.423-427.

BRIEF COMMUNICATION

YALE JOURNAL OF BIOLOGY AND MEDICINE
YJBM
CELEBRATING 90 YEARS 1928–2018

Resource Utilization in Implementation of a Point of Care Ultrasound Curriculum for Resident Training in Anesthesiology

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Purpose: Point of care ultrasound (POCUS) brings high-quality patient care to the bedside but continues to be an expensive training to implement in a residency program. There are multiple resources available to train providers in ultrasound, but they are all associated with significant cost. The Accreditation Council for Graduate Medical Education (ACGME) mandates anesthesiology residents to be competent in diagnostic and therapeutic uses of ultrasound. In this paper, we describe how an academic anesthesiology department implemented a POCUS curriculum for resident training. **Methods**: An anesthesiologist intensivist directed program was created to train residents in POCUS. We started by training a group of seven critical care trained anesthesiologists with the guidance of cardiologists. These anesthesiologists participated in the training of our anesthesiology residents. A hybrid curriculum consisting of a simulator as well as hands-on scanning of patients was created. We recorded the time that personnel spent in the training program as well as the money spent in acquiring equipment. **Results**: Seven faculty utilized a total of 270 hours of scanning and teaching time to train 48 residents who rotated through the ICU between July 2017 and June 2018. Simulation technicians used 48 hours to guide residents through simulation scenarios. The education administrator used 24 hours to coordinate sessions for residents. The technician and coordinator were both employees of the department with no additional cost for their responsibilities. The cost of equipment, including the ultrasound machine and simulator, was $45,000. An additional charge of $3500 was incurred for technician training time. **Conclusion**: Implementing a robust, sustainable POCUS curriculum requires a significant investment of time and money. Simulators and e-learning can allow efficiency in resource allocation and control cost in orienting new students to ultrasound. Having residents go through the simulator decreased the time that faculty would otherwise have spent going over basics with the students while allowing students to master these skills at their own pace. Advances in ultrasound technology have created newer, more affordable machines which can decrease cost considerably. It would serve departments well to consider alternatives and plan for resources when deciding to implement POCUS curriculum for resident training.

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Abbreviations: POCUS, Point of care ultrasound; ACGME, Accreditation Council for Graduate Medical Education; ICU, Intensive Care Unit; DICOM, Digital Imaging and Communications in Medicine; COVID-19, Coronavirus disease-19.

Keywords: POCUS, Ultrasound, Point of care, education, training, resource, anesthesiology, residency

Table 1. Curriculum for faculty.

Day	Morning session Hands on session 8a-noon	Afternoon session Cardiologist review 1-5p
1	Knobology/Machine/Normal anatomy scan	Image review
2	Outpatient scan/normal anatomy scan	Image review
3	Outpatient scan	Image review
4	Mechanically ventilated patient scan	Image review
5	Mechanically ventilated patient scan	Image review

PURPOSE

Ultrasound technology has changed the landscape of medicine both in diagnostic and therapeutic capabilities. Point of care ultrasound (POCUS) has found utility in multiple medical specialties and continues to spread its application. POCUS provides an efficient method in diagnosis and management of patients. Ultrasound has been part of standard training in anesthesiology for more than four decades. Transesophageal echocardiogram and ultrasound guided regional anesthesia are also a part of the POCUS spectrum and included in anesthesiology training. We now need to adapt our practice to the new era of expanded POCUS [1,2]. POCUS comprises any ultrasound modality that can help a physician or ancillary staff develop appropriate management modalities for a patient at the bedside. The goal is to improve the quality of care by focusing on efficiency in the hands of a qualified provider [3,4]. Traditionally, only a radiologist or a cardiologist could perform ultrasound scans [5]. With the easier availability of ultrasound devices, it has become common to see them on every medical floor, and many providers now have personal devices. The Accreditation Council for Graduate Medical Education (ACGME) currently mandates competency in use of POCUS [6-8]. Since POCUS is a relatively new technology, there is currently a void in training [9,10]. Commercial ultrasound courses might be a solution to training the trainer, but they are expensive and require an investment of time and resources by departments and hospitals. Some barriers that programs face include acquiring equipment and information technology support for this training.

A big question that needs to be answered is how do we maximize our available resources to train physicians in point of care ultrasound? The cost involved in training can be daunting and sometimes prohibitive. A survey of internal medicine educators done by Schnobrich and his group found that cost is a significant barrier to teaching internal medicine residents ultrasound [11]. We believe that the challenge can be addressed by knowing available resources and utilizing them in the best possible way.

We aim to describe a hybrid approach involving simulation and hands-on training to design and implement an ultrasound education curriculum for faculty and residents at a tertiary care academic department. We also describe the equipment selection, funding, assessment, and logistics involved in this process.

METHOD

With a plan to implement POCUS training for residents in July of 2017, we started in July of 2014 by addressing our deficiencies.

Our barriers included lack of trained faculty, time, financial constraints, lack of machines, and a lack of curriculum. We secured support from the principal stakeholders which included the chair of anesthesiology, anesthesiology critical care faculty, and residents.

STEP 1

Resources

Personnel: We selected a champion to lead the ultrasound training initiative. During our needs analysis we also realized that we lacked sufficient faculty trained in POCUS. To address this gap, we identified a team of physician trainers who could lead POCUS. We recruited twelve of our critical care faculty from the surgical and cardiothoracic intensive care units. In collaboration with the cardiology department, we developed a 5-day 40-hour intensive training program. Each faculty member on their academic time was assigned a week for training with an echocardiographer (Table 1). Our department contributed $500 per attending to the cardiology section for the technician time.

Equipment: Our first investment was in a Samsung Acuson® P300 machine, and at the same time, the surgery department obtained a Philips Sparq® device. We got these machines approved by our IT Department and had them connected to the hospital data server using Digital Imaging and Communications in Medicine (DICOM).

Seven critical care faculty volunteered to participate in the training program for residents. Two had prior ultrasound experience through their fellowship training (Table 1).

Table 2. Core simulator training modules.

1		Core Simulator training
	a	Imaging Physics & Instrumentation
	b	Cardiac Anatomy & Pathophysiology
	c	Pulmonary Anatomy & Pathophysiology
	d	Image Acquisition & Interpretation
	e	Patient Safety & Governance
2		SIM Cases - primary
	a	Core Aorta/IVC
	b	Core Cardiac
	c	Core Pulmonary
3		SIM Cases - secondary
	a	Core Airway
	b	Core Bladder
	c	FAST exam

After the faculty training in POCUS, the Department approved the purchase of a laptop-based ultrasound simulator (Sonosim®) for a cost of $20,000.

STEP 2

Our POCUS training program for residents was implemented in July 2017 in our tertiary care academic center, and data regarding resources utilized for the program were collected for one year. In the program, we focused on a few conditions that could benefit from being managed at bedside using an ultrasound.

Starting in July 2017, during their 4-week critical care rotation, all residents were mandated to attend a cumulative of 8 hours of POCUS training. The first week of the rotation was designated for ultrasound simulations.

The precall resident in a Q3 rotation was assigned a one-on-one session with one of the seven attendings after he/she had completed his/her simulation sessions. Another 2-week elective was also offered to senior residents (Clinical Anesthesiology Year-3) interested in improving their ultrasonography skills.

STEP 3

A comprehensive simulator training program using laptop based SonoSim LiveScan® was required at the beginning of their rotation to understand probe manipulation and sonoanatomy. A Simulation technician was trained to guide residents through the scenarios.

Simulation training was followed by one-on-one, hands on training under faculty supervision in the critical care unit. A simulation session followed Sonosims® core training module (Table 2).

RESULTS

Resource utilization was calculated in terms of personnel time and money for equipment. Seven faculty utilized 270 hours of scanning and teaching time for training 48 residents who rotated through the ICU between July 2017 and June 2018.

The simulation technician spent a total of 48 hours to guide residents through the simulation scenarios. The administrator spent 24 hours coordinating the POCUS sessions between residents and faculty. The technician and coordinator were both employees of the department with no additional cost for their responsibilities (Table 3).

Total time for 48 residents: 384 hours

Faculty: 336 hours

Simulation technician: 48 hours

Administrator: 24 hours

Cost for equipment: Our department invested in the purchase of a new ultrasound machine (Samsung Acuson P300- $25,000) as well as the laptop-based SonoSim LiveScan® ($20,000). Cardiology technician time: ($500 per faculty trained).

Total cost: $48,500

CONCLUSION

Implementing a POCUS curriculum requires an investment of resources, both in terms of time and money by residency programs. Simulators and e-learning can help maximize resource allocation and control costs in orienting new students to ultrasound.

There is a significant amount of literature on the utility and training in ultrasound for the anesthesiologist and the impediments in training future physicians [12,13]. There is an understanding that the cost of implementing a

Table 3. Resources utilized for resident training.

Resource utilized	Time cost/provider (hours)	Monetary cost/provider ($)
Ultrasound Machine		25000
Simulator		20000
Faculty training	40hrs	500
Resident	8	
Faculty	48	
Simulator technician	48	
Administrator	24	

sustainable ultrasound program is a significant obstacle in training. Faculty in this department are allocated paid academic time to work on their projects. As this was a faculty development initiative, attending anesthesiologist were allowed to use their academic time for this initiative. We were also able to provide faculty with invaluable one-on-one experience unlike any other commercially available course. Our relationship with our cardiology department was utilized to help our faculty gain experience in reading echocardiograms with the cardiologist assigned to the ECHO laboratory. If the anesthesiology faculty were to be reimbursed for their time that would amount to $5000 per faculty (125$/hr/faculty).

We have yet to come across any study addressing the resources needed to have a successful ultrasound curriculum for an anesthesiology residency program. We did recently find a study that looked at resource utilization for training physician assistants. This study also exhibited similar costs and human resource challenges [14]. Our methodology of developing our training protocol was tailored to our needs and available resources. With advances in ultrasound technology, there are newer, more affordable, portable handheld machines like the Philips Lumify, GE Vscan, and Butterfly. These devices can potentially help decrease the cost and improve access to POCUS. During the COVID-19 pandemic these devices were extremely useful for in-patient management [15].

We recommend that each program perform a needs assessment to direct optimal resource allocation. In our experience, the simulator's use saved time that faculty would otherwise have spent going over basics with the students. It can also decrease the patient-contact time with each trainee during the current pandemic situation. It allowed the students to master these skills at their own pace. It has become pertinent to identify collaborators and build a strong team that can engage trainees to sustain training programs. We are currently studying the impact of our initiatives in our residency program.

It would serve departments well to consider alternatives and plan for resources when deciding to implement POCUS curriculum for resident training.

Acknowledgments: Mr. Garrett Sendlewski, Communication Strategy Specialist at Yale Anesthesiology helped with coordinating the simulation sessions and collecting data for this program.

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