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One Year of Experience in Using Hand-Held Ultrasound as a Learning Tool in Ultrasound Rotation at the Emergency Department

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Abstract

BACKGROUND: Recent advancements in ultrasound technology have been introduced in medical education. The use of the hand-held ultrasound device (the HHU device) has been implemented in many medical schools. However, no studies have previously been conducted in Thailand.

AIM: We aimed at evaluating the experience of using the HHU device in the ultrasound rotation for the emergency medicine (EM) residents.

METHODS: A survey was conducted of 1st-year EM residents at the Emergency Department at Srinagarind Hospital, who had been trained to use point-of-care ultrasound and who were provided with a HHU device during their 2-week ultrasound rotation during the period from July 2019 to June 2020. The survey consisted of ten questions about the participants' learning experiences in using the HHU. Moreover, we evaluate the process of reviewing the ultrasound images and ultrasound video clips from the HHU device.

RESULTS: The response rate for the survey was 100%. On the baseline survey, most participants rated their learning experiences in using the HHU device at more than four points. Overall, 106 patients were examined with the HHU device. All ultrasound video clips and images were examined in the section for "reviewing the ultrasound images." The three areas that were the most frequently examined had been the abdomen, the heart, and the soft tissue and musculoskeletal, respectively. During these ultrasound examinations, 82 positive findings (77.36%) were discovered.

CONCLUSIONS: These results suggest that the participants had agreed that the HHU device was a tool, which had the potential to promote learning during the ultrasound rotation.

Introduction

At present, ultrasound is being implemented during residency training programs in many medical schools. Point-of-care ultrasound (POCUS) is one of the core competencies in the Emergency Medicine (EM) residency training program. In Thailand, the ability to acquire the knowledge of POCUS is still limited because there are only a few experts and the cost of ultrasound equipment is high. However, recent advancements in ultrasound technology have yielded the hand-held ultrasound (HHU) device, which has broadened the scope of ultrasound education. The HHU device, which is cost-effective and offers learning that is faster and more accessible, is suitable for hands-on ultrasound teaching [1]. Meanwhile, in the curricula of most modern medical schools, portable ultrasound units are continuously employed as their main teaching modality [2], [3], [4], [5]. Hence, we first introduced the HHU device to the 1st-year EM residents on the ultrasound rotation. In terms of the curriculum for the EM residents, we were able to provide the POCUS training, which included didactic lectures, bedside ultrasound trainings, the journal club, and instructions on the processes of reviewing the images. We also provided an HHU device to be used during this rotation. Our hypothesis was that the HHU device could enhance the students' POCUS learning experiences.

In this study, we aimed at evaluating the participants' experiences of using the HHU device as their ultrasound learning tool during the ultrasound rotation and of describing the ultrasound video clips and images that were provided by their use of the HHU device.

Methods

Study design

This was a retrospective, single-center, and descriptive study, which was carried out in a tertiary university hospital in Thailand. Ethics approval was provided by the Khon Kaen University Ethics Committee for Human Research and was registered with the Thai Clinical Trials Registry (HE631379).

Participants

EM residents at the Department of EM at the Faculty of Medicine at Khon Kaen University, who

studied in the ultrasound rotation were enrolled in this study.

Sample size

We included all 1st-year EM residents, who participated in the ultrasound rotation during the period of July 2019–June 2020. Any EM residents, who had not participated in this rotation, were excluded from the study.

The ultrasound curriculum

The ultrasound curriculum at the Department of EM at Khon Kaen University was first implemented in July of 2019. With the 1st-year EM residents, the curriculum, consisting of a 2-week rotation in the emergency department, was initiated. During this period, the following was provided: bedside ultrasound learning with a supervisor, who was a specialist in POCUS; the journal club; and reviews of the ultrasound images. The topics consisted of a basic introduction to ultrasound technology (heart, lungs, abdomen, the inferior vena cava, and the aorta) and ultrasound protocols, such as FAST examination, the RUSH protocol, and the CASA protocol.

In terms of reviewing of ultrasound images, we provided an HHU device for the residents, and they were allowed to perform ultrasounds with the devices at any time. However, all ultrasound video clips and images were reviewed with the supervisor.

The ultrasound equipment

This study was conducted with a HHU device, which is named the Butterfly IQ (2D array, 9000 micro-machined sensors, USA). The images can be obtained in B mode, M mode, color Doppler, and in power Doppler mode. In terms of the transducer, the preset of the images can be set for cardiac, cardiac deep, abdomen, abdomen deep, the aorta, the gall bladder, the lungs, FAST, vascular, musculoskeletal, nerves, obstetrics, small organs, and pediatrics.

The evaluation

During the 2 weeks of the ultrasound rotation, the participants gained experience in using the HHU device for the purpose of POCUS self-study. The evaluation was conducted using a self-administered survey using Google Form based on the 5-Likert score pattern. The survey consisted of 10 questions focusing on the participants' experiences of using the HHU as an aspect of POCUS learning. E-mail messages, which contained links to the survey, were sent to the participants. The survey and collected data were organized by the Department of EM, and the collected data was anonymous. To ensure anonymity and to allow for the emails to be sent to non-responders, each participant was given access to a personalized, but a de-identified online survey. Moreover, two email reminders were sent to non-responders over the period of 1 week to encourage survey completion.

To achieve the primary outcome of this study, the aim was to explore the experiences of the participants about the use of a HHU device for the purpose of learning ultrasound techniques at the department of EM.

The secondary outcome was to evaluate the process of reviewing the ultrasound images and ultrasound video clips with the supervisors. The data collected for the present study included the areas that were examined using ultrasound and the reviews of the ultrasound findings by the participants and by the supervisor.

Statistical analysis

To represent the overall agreement of the participants, mean Likert scale values and standard deviations (SD) for each of the electronic survey responses were obtained. With the aim of assessing the participants' perceptions within the domains, the responses were also presented as frequencies with percentages. For all surveys, the responses were summarized in five categories to reflect agreement: Strongly agree (5), agree (4), neutral (neither agree nor disagree) (3), disagree (2), and strongly disagree (1). Continuous-type variables in the data were summarized as means and SD or as medians and range as appropriate. Categorical variables were summarized as counts and percentages.

Results

During the period of July 2019–June 2020, nine of 1st-year EM residents participated in the ultrasound rotation. After training, the survey response rate was 100%.

To explore the participants' opinions about using the HHU devices as a learning tool for the personnel during the ultrasound rotation, a survey consisting of 10 questions, which focused on their learning experiences, was utilized (Table 1). Agreement was high across most items (mean score > 4) except in the aspect of "The ease of obtaining an image," in which the participants had rated at 3.67 ± 0.71 points.

During the ultrasound rotation, 106 patients were examined with the HHU devices. All ultrasound video clips and images were examined in the section for "reviewing the ultrasound images." It was found that the

Table 1: The Likert scores of the learning experiences with the HHU device

Participants' opinions about the POCUS learning experience	Likert scores Mean±SD
Enjoyable	4.67 ± 0.5
Accessibility	4.78 ± 0.44
Comfortable to use	4.44 ± 0.53
Improved ability to scan	4 ± 0.87
Improved ability to interpret images	4 ± 0.71
Usefulness for the learning experience	4.44 ± 0.53
The ease of obtaining an image	3.67 ± 0.71
Convenience of performing procedures	4
Easy-to-use (device qualification)	4.11 ± 0.60
Encourages the POCUS learning experience	4.67 ± 0.50

POCUS: Point-of-care ultrasound.

three most examined areas had been the abdomen, the heart, and soft tissue and musculoskeletal, respectively. During the ultrasound examinations, 82 positive findings (77.36%) were found (Table 2).

Table 2: The findings of the ultrasound video clips and images during the ultrasound rotation

Ultrasound findings from the area of examination	Number of patients (%) n = 106
Cardiac	17 (16.04)
Negative findings	4
Heart failure	6
Arrhythmia	2
Hypertensive crisis	4
Takotsubo cardiomyopathy	1
Abdomen	32 (30.19)
Negative findings	9
Thick wall gall bladder in dengue hemorrhagic fever	2
Appendicitis	8
Appendiceal abscess	1
Abdominal intramuscular abscess	1
Liver mass	3
Liver abscess	3
Small bowel obstruction	1
Large bowel obstruction	1
Gall stone	2
Gall bladder mass	1
KUB system	9 (8.49)
Negative findings	1
Hydronephrosis	6
Bladder stone	2
Lungs	13 (12.26)
Pneumonia	6
Pleural effusion	6
Endotracheal tube confirmation	1
Male genital tract	3 (2.83)
Torsion testis	1
Epididymo-orchitis	1
Groin hernia	1
OB-GYN system	11 (10.38)
Negative findings	1
Ruptured corpus luteal cyst	1
Ovarian cyst	2
Ruptured ectopic pregnancy	2
Adenomyosis	1
Tubo-ovarian abscess	2
Intra-uterine pregnancy	2
Ocular	3 (2.83)
Negative findings	3
Soft tissue and musculoskeletal	15 (14.15)
Negative findings	0
Cellulitis	4
Lymphadenitis	2
Anal abscess	1
Bone fracture	4
Joint effusion	3
Pyomyositis	1
Vascular	3 (2.83)
Deep vein thrombosis	3

Discussion

With regard to the results of survey response when the participants were asked to evaluate their ultrasound learning experience while using the HHU device, the study showed agreement with respect to most items. These results were consistent with findings from a study by Ireson *et al.* [6], who had provided all of their 1st year medical students with HHU devices. On their baseline survey, overall agreement was observed for the following criteria: (1) Enhancement on performance of ultrasounds (62.5%), (2) interpretation of ultrasounds (56.3%), (3) understanding anatomy (68.8%), (4) learning anatomy (61.3%), (5) ease (78.1%), (6) comfort (59.4%), and (7) the benefits provided by the incorporation of insonation into the medical school curricula. In this study, participants rated the highest score in the aspect of "Accessibility," which is the qualification of the HHU [7], [8]. The survey scores, which were rated second highest, were the aspects of "Enjoyable" and "Encourages the POCUS learning experience," which was consistent with results from a study by Hammoudi *et al*. [9]. Their findings indicated that the HHU device had increased students' motivation to learn. In terms of "The ease of obtaining an image," the participants neither agreed nor disagreed. In the author's opinion, the HHU device that was used in this study was the Butterfly IQ, and its transducer has been designed to be used in all areas of examination. However, for some parts of the body, such as in cardiac ultrasound, the shape of the transducer was wider than the standard echocardiography probe. Therefore, the width made it difficult to access the patient's rib space to obtain the cardiac image.

We examined 106 patients, who were emergency patients, at an academic tertiary hospital. All ultrasound video clips and images were reviewed with the supervisor. The area, which was most frequently examined, had been the abdomen, including the gall bladder, liver, appendix, small bowel, and the large bowel, which was consistent with findings from a study by Wibulpolprasert *et al*. [10]. The study's results indicated that the anatomical region, which was most commonly examined in the emergency department, had been the abdomen (80%). The participants detected 77.36% positive findings on the ultrasound examination, which was consistent with many studies that recognized the use of self-directed learning packages to aid in ultrasound learning and in the recognition of pathology [8], [11], [12]. During 1 year, participants also found a lot of interesting ultrasound results, especially under emergency conditions, such as torsion of the testes, heart failure, and ruptured ectopic pregnancy. Some conditions, such as Takotsubo cardiomyopathy, were rare. However, with the system for collecting ultrasound video clips and images from this device, participants were able to study by themselves at any time.

With respect to the limitations of this study, we had only one hand-held device that was unable to represent all HHU devices that provide variety functions. Another limitation was the small number of the sample size, which was limited by a lack of teachers, the number of ultrasound devices, and the number of

EM residents on the rotation. There were variety of ultrasound video clips and images that each participant obtained, which contributed to the heterogeneity of the acquired knowledge for each person.

Conclusions

These findings suggested that the participants had agreed that the HHU device is a potential tool that can be studied and utilized in the ultrasound rotation.

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