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Americas Hepato-Pancreato-Biliary Association HPB Ultrasound and Advanced Technology post-graduate course: Overview and review

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ABSTRACT

Background: Americas Hepato-Pancreato-Biliary Association (AHPBA) established the Hepato-Pancreato-Biliary (HPB) ultrasound (US) and Advanced Technology Post-Graduate Course in 2012 in response to a perceived gap in training and practice.
Methods: The HPB US and Advanced Technology Post-Graduate Course consists of both didactic and hands-on skills sessions. The didactic sessions are divided into foundational, organ-focused, and application content. Hands-on sessions are constructed to immediately practice skills in the simulation setting which were taught during the didactic sessions. Course participant demographic data (practice location and practice type) and participant evaluations were reported.
Results: Since the first course in 2012, 298 participants have taken the post-graduate course. Most participants reported the content quality, delivery effectiveness, and practice relevance to be either excellent or above average (93.6 %, 91.1 %, 93.6 %, respectively). Participants' motivations to take the course included to enhance skills, knowledge, to incorporate US into practice, or to obtain formal training or qualification/certification, or to teach.
Conclusion: The HPB US and Advanced Technology Post-Graduate Course has filled a gap in HPB US training for practicing HPB surgeons. The annual course has been well-received by participants (Kirkpatrick Level 1 Program Evaluation) and will continue to fill the gap in training in operative US for the HPB surgeon.
Key message: Americas Hepato-Pancreato-Biliary Association established the HPB Ultrasound and Advanced Technology Post-Graduate Course in 2012. The Course has been well-received by participants and will continue to address a gap in surgical HPB training.

Introduction

The use of ultrasound (US) in the operating room is a requirement for surgeons performing hepato-pancreato-biliary (HPB) procedures. Modern HPB surgical practices must include the use of surgeon-performed US in the operating room in order to adhere to the highest standards of safety and patient care. In 2012, a need for US training was identified based on informal interviews of surgeons performing HPB procedures (Ellen Hagopian, personal communication, January 30, 2023). These informal interviews concluded that surgeons performing HPB procedures did not consistently use operative US, despite its well-known applications and utility in the operating room [1–3].

Based on these informal interviews and the lack of structured US curricula during surgical residency or fellowship training, it was surmised that the lack of use of US during HPB procedures was due to a gap in surgical training. This led to the development of the *HPB Ultrasound and Advanced Technology Post-Graduate Course* through the Americas Hepato-Pancreato-Biliary Association (AHPBA). AHPBA, as a society, has shown a true commitment to the education and training of its membership and fellowship training programs. The institution of the *HPB Ultrasound and Advanced Technology Post-Graduate Course* is an example of the society's commitment. The first course was given in 2012, and since then, has been given nearly each year at the AHPBA Annual Meeting.

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The aim of this paper is to provide a description and brief evaluation of the *HPB Ultrasound and Advanced Technology Post-Graduate Course*. The evaluation met criteria for exemption by the Hackensack University Medical Center Institutional Review Board (Pro2018-0616).

Methods

Curriculum framework. The overall goal of the *HPB Ultrasound and Advanced Technology Post-Graduate Course* (Course) is to provide practicing surgeons and surgical trainees (HPB, advanced gastrointestinal, minimally invasive, surgical oncology, transplantation) with advanced education and training in HPB US. The Course reviews the basic principles of US while providing in-depth instruction on the techniques of US in HPB surgery. Centering on intraoperative and laparoscopic approaches, the Course provides a comprehensive understanding of the anatomy of the HBP system in addition to US scanning techniques, methods, US guidance, and tumor ablation. The Course utilizes two pedagogies: large group learning sessions and hands-on skills sessions.

Large group sessions

Large group sessions are conducted using direct and case-based instruction. These sessions are divided into three major sections, including foundational, organ-specific US, and US application (Table 1, large group sessions). US principles, physics, and instrumentation constitute the foundational sessions. One of the most important learning curves in surgical US is image interpretation, which requires optimization of the US image. A solid understanding of *US principles* and physics provides the foundational knowledge of the US system to effectively adjust the US controls, such as frequency, gain, focus, and depth, to optimize the image. The functionality, use, and selection of the various US probes in transabdominal, open and laparoscopic approaches are detailed in the *US instrumentation* session. A session dedicated to *US scanning techniques* demonstrates foundational technical skills in transabdominal, open, and laparoscopic approaches and builds the surgeon's repertoire in image recognition. Organ-specific US sessions include *Liver* and *Pancreatobiliary* and focus on systematic approaches, scanning techniques, and normal and pathologic organ-specific imaging.

The foundational and organ-specific US sessions provide the basis for organ examination and the diagnosis of pathology. In the final section of the large group sessions, practical clinical uses (application) of US in the operating room are reviewed. *US guidance techniques* focuses on approaches in targeting in open and laparoscopic operative settings, and while an emphasis is placed on tumor targeting, the principles taught during this session are applicable to any targeting procedure. A session on *Tumor ablation* follows, where ablation technologies are discussed. Case-based presentations of US (*Practical uses of US*) have been recently added. During this session, faculty review operative HPB cases and show how US was used throughout specific operations in diagnosis, decision making, and procedural guidance. Other practical aspects, such as *Coding and billing* and *Getting started* using US in a HPB surgical practice, conclude the large group sessions. Large group sessions with linked course learning objectives are outlined in Table 1.

Skills sessions

The goal of the skills sessions is to continue instruction from the large-group sessions to hands-on practice in a supervised setting. Participants practice techniques in transabdominal, intraoperative, and laparoscopic US while gaining a comprehensive understanding of HPB ultrasound anatomy and performing US guidance procedures. A variety of models are utilized including human and phantom models for instruction in US technique and anatomy in addition ex-vivo organs (e.g., bovine liver) for practice in US guidance, targeting, and tumor ablation.

The first hands-on skills session immediately follows the large group foundational and organ-specific sessions (outlined above). During the *HPB US Anatomy and Technique* skills session (Table 1, Skills sessions), participants practice transabdominal US utilizing standardized human patients. The focus is on image (and anatomy) recognition in human models, while performing real-time image optimization to solidify understanding of US principles and physics. In more recent years, standardized patients have not been consistently used in instruction.

A transition to the use of inanimate models for anatomy instruction and ex-vivo organs for targeting occurs during the second hands-on skills session, which follows the large group US application section. Participants rotate through multiple stations, including *Intraoperative*

Table 1
Curriculum framework.

Instructional sessions (methods)	Course learning objectives
Large group sessions (direct; case-based)	1. Define the principles of US physics.
Foundational principles and technique	2. Review open and laparoscopic scanning methods.
US principles & instrumentation	3. Describe HPB US normal anatomic and pathologic findings.
US scanning techniques	4. Distinguish the various liver ablation technologies.
Organ-specific US	5. Appraise the various uses of US in HPB surgery.
Liver US: Normal anatomy and pathologic findings	
Pancreatobiliary US: Normal anatomy and pathology	
US application	
Techniques in US guidance	
Methods of tumor ablation in HPB surgery	
Practical uses of US in HPB surgery	
Coding and billing	
Getting started	
Skills sessions (demonstration; guided practice)	
HBP US anatomy and technique	6. Describe HPB US normal anatomic and pathologic findings.
Image optimization	7. Demonstrate intraoperative and laparoscopic US exams of the liver, pancreas, and biliary tree.
Transabdominal US	
Intraoperative US anatomy and technique	
Open intraoperative US anatomy	
Laparoscopic US anatomy	
US guidance technique	8. Demonstrate open and laparoscopic targeting methods in US guidance.
Open intraoperative targeting	9. Distinguish the various liver ablation technologies.
Laparoscopic targeting	
Liver tumor ablation	

Note. US, ultrasound; HPB, hepatopancreatobiliary.

Table 2
Hands-on skills learning objectives.

HBP anatomy and technique
Transabdominal scanning (human model)
By the end of the transabdominal scanning hands-on lab, the participant will:
Show proper handling of the transabdominal US probe.
Operate controls (frequency, depth, gain, TGC, focus) properly to optimize the ultrasound image.
Describe and demonstrate slide, rotate, rock, and tilt probe manipulations.
Describe and perform transverse and longitudinal scanning planes.
Demonstrate transabdominal liver ultrasound and identify:
- the junction of the vena cava with each hepatic vein (right, middle and left).
- the portal vein bifurcation and follow its right and left branches.
Demonstrate transabdominal gallbladder and bile duct ultrasound.
Identify the pancreas under transabdominal ultrasound.
Identify and measure either the bile duct or pancreas duct.
Techniques/technology in ultrasound guidance and HBP surgery
Open intraoperative ultrasound anatomy (phantom)
By the end of the open intraoperative ultrasound (IOUS) scanning hands-on lab, the participant will:
Show proper handling of the intraoperative US probe.
Operate controls (frequency, depth, gain, TGC, focus) properly to optimize the ultrasound image for IOUS.
Describe and demonstrate slide, rotate, rock, and tilt probe manipulations on either the liver or pancreas.
Describe and perform transverse and longitudinal scanning planes of the liver, gallbladder, bile duct and pancreas.
Demonstrate intraoperative liver ultrasound and identify:
- the junction of the vena cava with each hepatic vein (right, middle and left).
- each hepatic vein and scan from its origin to termination.
- the portal vein bifurcation and scan to its right and left branches.
- the right portal vein and its segmental branches.
- the left portal vein and its segmental branches.
Demonstrate intraoperative liver parenchymal sweep-scan while identifying liver sections, sectors, and segments.
Demonstrate intraoperative gallbladder and bile duct ultrasound.
Demonstrate intraoperative pancreas ultrasound using direct, compression, and saline immersion scanning methods.
Find, localize, describe, and measure a lesion in the liver and pancreas.
Laparoscopic ultrasound anatomy (phantom)
By the end of the laparoscopic ultrasound (LAPUS) scanning hands-on lab, the participant will:
Show proper handling of the laparoscopic US probe.
Identify trocar placement for laparoscopic ultrasound.
Operate controls (frequency, depth, gain, TGC, focus) properly to optimize the ultrasound image for LAPUS.
Describe and demonstrate slide, rotate, rock, and tilt probe manipulations on either the liver or pancreas.
Demonstrate laparoscopic liver ultrasound and identify:
- the junction of the vena cava with each hepatic vein (right, middle and left).
- each hepatic vein from its origin to termination.
- the portal vein bifurcation and follow its right and left branches.
Demonstrate laparoscopic liver parenchymal sweep-scan while identifying liver sections, sectors, and segments.
Demonstrate laparoscopic gallbladder and bile duct ultrasound.
Demonstrate laparoscopic pancreas ultrasound using direct, compression, and saline immersion scanning methods.
Find, localize, describe, and measure a lesion in the liver and pancreas.
Ultrasound guidance: intraoperative free-hand targeting (ex-vivo liver)
By the end of the intraoperative ultrasound targeting hands-on lab, the participant will:
Show proper handling of the US probe for open intraoperative targeting.
Identify a target "lesion" under open intraoperative ultrasound.
Demonstrate freehand targeting of a "lesion" under open intraoperative ultrasound.
Ultrasound guidance: laparoscopic free-hand targeting (ex-vivo liver)
By the end of the laparoscopic ultrasound targeting hands-on lab, the participant will:
Show proper handling of the US probe for laparoscopic targeting.
Identify a target "lesion" under laparoscopic ultrasound.
Demonstrate freehand targeting of a "lesion" under laparoscopic ultrasound.
Techniques/technology in ultrasound guidance and HBP surgery
Ultrasound guidance: liver tumor ablation (ex-vivo liver)
By the end of the liver tumor ablation hands-on lab, the participant will:
Operate controls on microwave/radiofrequency generator.
Select proper settings for microwave/radiofrequency tumor ablation.
Demonstrate satisfactory ablation of one liver "lesion."

US (open and laparoscopic), *US guidance, and Liver tumor ablation* (Table 1, Skills sessions, Intraoperative US anatomy and technique). At each station, techniques are demonstrated by expert faculty and participants have opportunities to practice open and laparoscopic US and targeting under direct faculty supervision. The learning objectives for the hands-on skills sessions are outlined in Table 2.

In the recent years, the Course has transitioned to a "flipped" format (since 2021) whereby participants view pre-recorded videos in advance of the in-person course component. In this model, in-person instruction focuses on skills demonstration, mentored guided practice, and case-based discussions.

Evaluation framework. Kirkpatrick's four-level model is a simple and practical framework for program evaluation. The initial levels (steps) center on the learners, their satisfaction with the course (level 1), what they have learned (level 2), and how their behavior changed (level 3) after the course. The last level (level 4) measures the success, or outcomes, of the program and is arguably the culmination of the successes of all proceeding levels [4,5]. Table 3 outlines Kirkpatrick's four-level model and example measurements for the present Course. Kirkpatrick's framework was adopted for this brief evaluation, focusing on participants' "reactions" (level 1) to course content and delivery in addition to participants' motivations for coursework.

Demographics

The Course administrative database was investigated to tally the yearly number of participants. Participant practice specialties and practice locations were collected and tabulated.

Survey

Immediately following each course, participants were requested to complete an anonymous course evaluation. Participants were asked to rate the course in terms of 1) quality of content, 2) effectiveness of delivery, and 3) relevance to practice using a 5-point scale (5, excellent; 4, above average; 3, average; 2, below average; 1, poor). Participants were also asked: *Why did you take this abdominal ultrasound course?* Responses to the open-ended query were reviewed to identify common

Table 3
Kirkpatrick's four-level model [4] for HPB US program evaluation.

Evaluation level	Description
Level 1 reaction	Measure of how participants feel about the coursework/training program. *HPB US Course measure: Trained surgeons will report value in course completion.*
Level 2 learning	Measure of the change in knowledge, skills, and/or attitudes following the course/training program. *HPB US Course measure: Trained surgeons will report and demonstrate competent operative US skills.*
Level 3 behavior	Measure of the extent to which participant change their behaviors after the course/training program. *HPB US Course measure: Trained surgeons will actively use operative US in their practice.*
Level 4 results	Measure of the success of the final results due to the coursework/training program. *HPB US Course measure: Trained surgeons will have improved clinical and patient outcomes after incorporating operative US into their practice.*

themes using a grounded theory approach [6]. Each phrase was assigned a theme and the frequency of each theme determined, based on the total number of coded phrases. Exemplar quoted phrases were selected to illustrate themes. Descriptive statistics were applied to report participants' quantitative (scaled) and qualitative (open-ended) responses.

Results

Course participants. The Course has been offered each year since 2012 at the AHPBA Annual Meeting, except for 2016. Per course offering, an average of 30 ($SD \pm 5.37$, range 20–35) surgeons participate, and since the initial offering, a total of 298 surgeons, including practicing surgeons and some trainees (fellows, residents) have completed the Course. Course participants represent an international community, although predominately from the United States and Latin America (Table 4). Participants' practice specialties span HPB, Transplantation, Surgical Oncology, General Surgery, and General Surgery with experience in HPB (i.e., HPB-experience despite no formal HPB training). A small number of non-surgical specialties also participated (e.g., Radiology, Gastrointestinal Endoscopy) (Table 4).

Post-course evaluation (Kirkpatrick level 1)

Content

Completed surveys were collected from 225 (75.5 % response rate) participants (data from 2013 was missing) and reflected a positive reaction to the course content (Table 5). Greater than 90 % of participants reported that the quality of content, effectiveness of delivery, and the relevance of content were either excellent or above average (Fig. 1).

Motivation. A total of 230 phrases were coded in response to the question: *Why did you take this abdominal ultrasound course?* A total of 5 themes were identified. The most frequent themes found included the desire to enhance skills (38.7 %) and knowledge (29.6 %). Other less frequent themes identified included to incorporate US into practice (14.8 %), to obtain formal training (7.8 %), for qualification/certification (6.5 %), and to teach (2.6 %). Table 6 details themes identified with accompanying demonstrative quotes.

Discussion

The AHPBA HPB US and Advanced Technology Course is the first US course offered that focuses on HPB surgical US directed toward HPB surgeons. The range of content spans from foundational material to organ-specific examination (liver, pancreas and biliary) to finally application of surgical US in the clinical setting. There is an emphasis on skills, with dedicated laboratory time in diagnostic US, targeting, and tumor ablation with alongside expert faculty. Using Kirkpatrick's framework (level 1, participant reaction) of program evaluation, the Course performed extremely well, with the majority of participant ratings as excellent or above average. With the favorable evaluations and a consistent full annual subscription, the Course has demonstrated value among the HPB surgical community and will continue to fill a gap in training.

Table 4
Course participant demographics (2012–2022).

	N (%)
Practice location	
United States	190 (63.76 %)
Latin America	46 (15.44 %)
Canada	19 (6.38 %)
Europe	19 (6.38 %)
Asia	18 (6.04 %)
Australia	6 (2.01 %)
Practice specialty	
HPB	89 (29.87 %)
Transplantation	78 (26.17 %)
Surgical oncology	67 (22.48 %)
General surgery	36 (12.08 %)
General surgery with HPB experience	25 (8.39 %)
Other (e.g., radiology)	3 (1.01 %)
Total participants	298

Note. Percentages (%) are based on the total participants across all years.

Table 5
Participants' reaction to course (Kirkpatrick Level 1).

Content rating	Quality of content	Effectiveness of delivery	Relevance to practice
Excellent (5)	145 (64.4 %)	133 (59.3 %)	172 (76.6 %)
Above average (4)	66 (29.2 %)	71 (31.8 %)	38 (17.0 %)
Average (3)	8 (3.5 %)	13 (5.7 %)	5 (2.2 %)
Below average (2)	0 (0.0 %)	2 (0.9 %)	1 (0.5 %)
Poor (1)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)
Missing data	6 (2.67 %)	5 (2.22 %)	8 (3.56 %)

Note. Percentages are based on 225 completed surveys (75.5 % response). Missing data refers to those missing from completed surveys. Survey data from 2013 were not collected.

Gap in training. Motivations for the course work were varied, but most commonly participants sought to enhance their knowledge and skills. The Course was initially developed to fill a presumed gap in surgical training. The finding that the majority of participants' reasons to take the Course were to either enhance knowledge or skills (68.3 %) emphasizes this gap to be real, and not presumed. To address this gap, US training was intentionally incorporated into Fellowship Council-AHPBA (FC-AHPBA) accredited HPB fellowship training and minimal US case volumes are required for the AHPBA-awarded Certificate in HPB Surgery [7]. Other HPB training pathways also exist, including American Council of Graduate Education accredited Complex General Surgical Oncology and American Society Transplant Surgeons accredited Transplant fellowships [8]. The gap in general surgery training has been partially addressed by the development of resident training courses, such as the *UltraSound Essentials for Residents* (USER) Course developed by the National Ultrasound Faculty of the American College of Surgeons [9] and the incorporation of US into the Surgery Council on Resident Education (SCORE) Curriculum [10]. However, organ-specific diagnostic US is a not considered a core operation/procedure as liver, biliary tract, pancreas, thyroid, or vascular US are advanced, while the focused assessment with sonography for trauma (FAST) and US use for intravascular access are core operations/procedures [10]. Furthermore, the American Board of Surgery does not require applicants for board certification to have experience in ultrasound or have a defined minimum number of required US procedures [11,12]. The Surgery Review Committee of the ACGME refers to “diagnostic ultrasound” without further specification in the *Program Requirements for General Surgery* [12] but does not specify a minimum US case volume [13]. To ensure the gap in US is addressed in training, both diagnostic and procedural US should be incorporated into General Surgery training with a defined curriculum and required case volume minimum.

Transition to a flipped format. The Course was originally designed as a day-long, on-site course, with a mixture of large group sessions and hands-on skills sessions. However, in the past two years, the Course has been given as a “flipped” class, where participants learn foundational material in advance of the course. In this format, participants view on-demand videos to learn content normally delivered in the large group sessions (foundational, organ-specific, and selected application sessions). At the start of the on-site course a brief review of content is given, followed by the skills sessions (see Table 1). Emphasizing participants' skills development, the new format maximizes valuable time in direct instruction and saves classroom time for case-based discussions.

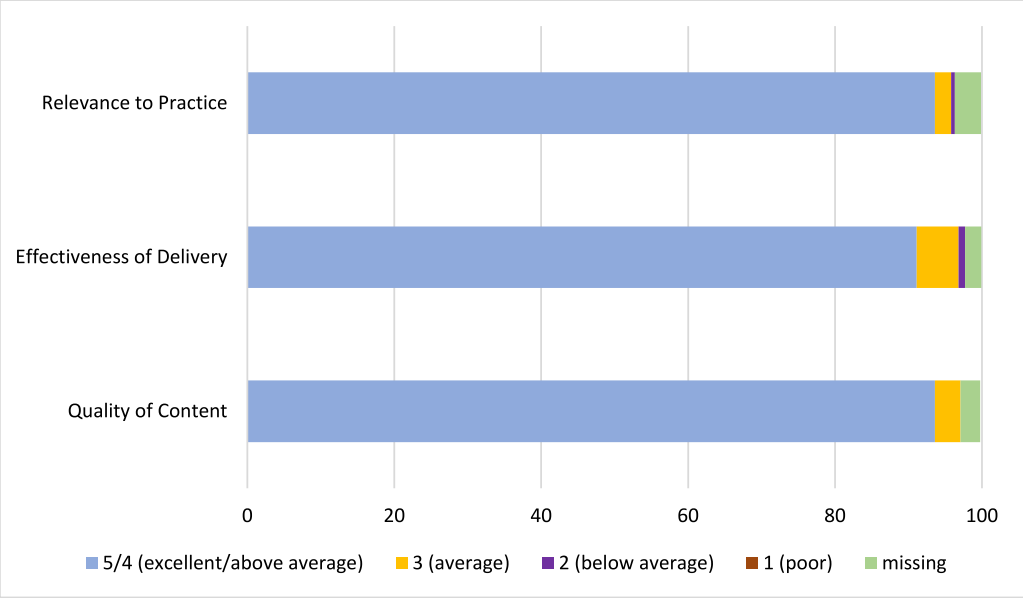

Fig. 1. Participants' reaction to course (Kirkpatrick Level 1).
Note. The majority of participants rated the Course as either excellent or above average (5/4, blue) in terms of relevance to practice, effectiveness of delivery and quality of content. Missing (green) data refers to those missing from completed surveys.

Opportunity for mentorship. The structure of the AHPBA-sponsored HPB US training for FC-AHPBA accredited HPB fellowships is similar to the Post-Graduate Course. Although the curriculum, including the large group and skills sessions are similar, a key difference between the two courses is in the follow-up mentored practice. Following on-site coursework, HPB fellows return to their home institution to practice US in the operative setting under the supervision of local faculty. In this setting, local faculty guide the practice in the clinical setting, acting as a resource for mentorship. The HPB US and Advanced Technology Post-Graduate Course does not have a formal, structured mentorship program for practicing surgeons completing this course. The creation of such a resource for surgeons who are actively incorporating US into their practices would be a valuable addition to the Course.

Conclusion

Operative ultrasonography is a mandatory tool for the HPB Surgeon. The AHPBA-sponsored HPB US and Advanced Technology Post-Graduate Course has been well-received by participants and fills a gap in surgical US training for practicing HPB surgeons.

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Ethical approval statement

Exemption by the Hackensack University Medical Center Institutional Review Board (Pro2018–0616).

CRediT authorship contribution statement

Dr. Hagopian: study conception and design; data collection and analysis; interpretation of results; manuscript preparation
Dr. Adams: interpretation of results; manuscript preparation
Dr. Machi: interpretation of results; manuscript preparation.

Table 6
Participants' motivation for course (Kirkpatrick Level 1).

Themes	Frequency (%)	Demonstrative quotes
Skills enhancement	89 (38.7 %)	"Would like to improve US skills and techniques." "To improve my ability and to offer to my patients better results." "I wasn't using ultrasound to its potential. Wanted to feel more confident with targeting procedures and make a more comprehensive assessment of anatomy during resection procedures."
Knowledge enhancement	68 (29.6 %)	"Reinforce knowledge and learn the correct way to use the technology." "Improve knowledge and comfort with US use." "Better understanding of liver and pancreatic anatomy while performing laparoscopic ultrasound."
Practice incorporation	34 (14.8 %)	"To incorporate US into my practice." "To gain more experience so I can incorporate it into my practice."
Qualification and/or certification	15 (6.5 %)	"For assistance with ultrasound privileging." "To get a certificate for my hospital, documenting formal training course …" "For experience and certificate."
Formal training	18 (7.8 %)	"Had never taken a formal course before. I am glad I did." "To get formal training to perform ultrasound by myself." "Because I had never done a formal training in ultrasound."
Teaching	6 (2.6 %)	"To learn how to use it efficiently, and teach it." "Extra training, and to learn about the course to be able to organize such a course … in the future myself." "Review, be more effective, and to be able to teach residents more effectively."

Note. Frequency is based on a total of 230 coded phrases.

All authors reviewed the results and approved the final version of the manuscript.

Conflict of interest

None.

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