EUS core curriculum

This is one of a series of documents prepared by the American Society for Gastrointestinal Endoscopy (ASGE) Training Committee. This curriculum document contains recommendations for training, intended for use by endoscopy training directors, endoscopists involved in teaching endoscopy, and trainees in endoscopy. It was developed as an overview of techniques currently favored for the performance and training of EUS and to serve as a guide to published references, videotapes, and other resources available to the trainer. By providing information to endoscopy trainers about the common practices used by experts in performing the technical aspects of the procedure, the ASGE hopes to improve the teaching and performance of EUS.

INTRODUCTION/IMPORTANCE

EUS is a minimally invasive endoscopic modality that allows the acquisition of real-time, high-resolution images of luminal and extraluminal structures. EUS-guided FNA (EUS-FNA) allows the endoscopist to safely and effectively access regions in proximity of the GI tract that were only previously accessible by percutaneous or surgical means. The ability to provide accurate tumor staging and rapid tissue acquisition has led to physician reliance on EUS services throughout the world and has brought this technology to the forefront at most academic and nonacademic centers. In addition, EUS is evolving as a conduit for therapeutic interventions, such as tumor ablation and duct access.

Because EUS expands the endoscopist's armamentarium of diagnostic and therapeutic tools, proficiency in EUS has become a highly sought-after skill. For most trainees, the amount of EUS exposure and training is highly variable and often program dependent. Some GI training programs incorporate EUS training into the traditional 3-year fellowship. On the other hand, many fellowship programs do not provide this opportunity, and trainees must pursue a dedicated fourth year to learn EUS. The combination of increased demand for acquiring skills in EUS and heterogeneity in learning opportunities makes a curriculum-based training experience essential. This will allow the trainee to achieve procedural competence leading to optimal patient outcomes.

0016-5107/$36.00
http://dx.doi.org/10.1016/j.gie.2012.04.437

GOALS OF TRAINING

Trainee

Before initiating training in EUS, fellows are expected to have completed at least 18 months of a standard GI training program and should have already achieved expertise in basic endoscopy, including diagnostic and therapeutic EGD and colonoscopy.

All GI trainees require some exposure to EUS during their training to develop an understanding of the diagnostic and therapeutic role of the procedure. However, procedural exposure should not be equated with procedural competence. Achieving competence in performing EUS is not a standard part of general GI fellowship. As such, fellows should pursue additional training in EUS only if they intend to have a sufficient case volume in practice to maintain their skills.

Faculty

Programs dedicated to teaching EUS should have at least 1 expert faculty member in EUS who is well experienced in performing diagnostic EUS (with both radial and linear echoendoscopes) and FNA. It is expected that the EUS faculty will have a sufficient case volume and breadth to allow for a well-rounded training environment. Involved faculty should have a track record of effective endoscopic teaching and must be willing to provide the trainee access to their patients and EUS cases. Regular didactic education should also be provided to the trainee by the EUS faculty.

The ideal environment would also provide the trainee in EUS with interaction with a multidisciplinary team including surgeons, oncologists, pathologists, radiologists, and radiation oncologists. This approach will provide a framework to understand how the endosonographer can play a vital role in patient management.

Facilities

EUS is typically an outpatient procedure and can be performed in either a hospital-based endoscopy unit or an ambulatory surgery/endoscopy center. An EUS processor, radial and linear echoendoscopes, catheter-based EUS probes (optional), and EUS needles are the basic equipment necessary to perform the procedure. In addition, knowledge of proper processing of tissue specimens, by either endoscopy staff or cytopathology staff, is necessary to ensure quality outcomes.

Endoscopic experience

The training program should be able to provide a breadth of cases, including, but not limited to, staging of luminal GI malignancies (esophageal, gastric, rectal), evaluation of benign and malignant pancreaticobiliary disease, and the evaluation of subepithelial GI lesions.

In 2001, the ASGE published a guideline for credentialing and granting privileges for EUS and suggested 2 levels of competence: one for mucosal and submucosal lesions and a second more comprehensive competence to include pancreaticobiliary EUS. This document suggested a minimum number for each type of EUS procedure that should be performed during training: 75 mucosal tumors, 75 pancreaticobiliary cases, 40 submucosal abnormalities, and 50 EUS-FNA. The document emphasized that competency was not to be evaluated before the attainment of these benchmarks. This guideline also made it clear that training was not simply to focus on technical issues, but should include study of the indications and contraindications to performing EUS, as well as how to create an accurate procedure report with appropriate descriptions of endosonographic findings. The EUS Core Curriculum represents guidelines for comprehensive training in EUS, including pancreaticobiliary EUS and FNA.

A growing number of therapeutic applications for EUS have emerged (eg, celiac plexus neurolysis, biliary access, tumor ablation). Exposure to these newer modalities may be program dependent. Thus, trainees wishing to enhance their training may need to seek out other opportunities for hands-on experience if their program does not offer exposure to these interventional EUS techniques.

TRAINING PROCESS

Equipment

Basic principles. As with any endoscopic procedure, it is essential to understand the basic tenets of how the relevant equipment works and how images are obtained. Trainees are expected to understand the process through which US images are generated via sound waves. In addition, it is essential that they comprehend the relationship between sound-wave frequency, depth of penetration, and implications on EUS imaging. Trainees should also understand the principles of Doppler imaging because this is used in the majority of studies in which vascular structures need to be defined.

Processors. EUS processors from various manufacturers offer similar capabilities; however, not all processors can perform equal functions. Thus, trainees should gain knowledge in the differences between an electronic EUS system and a mechanical system. In particular, the trainee should understand which type of imaging device is compatible with each processor and what the limitations are when using a mechanical system. To help understand the requisites systems necessary for equipping an EUS unit, it is important for the trainee to understand and evaluate the features, strengths, costs, and compatible imaging devices that can be used with the processor.

Imaging devices and accessories. Echoendoscopes are available in 2 major designs: radial array and curvilinear array. Trainees should develop proficiency in the use of both types of echoendoscopes in identifying normal anatomic structures as well as luminal and extraluminal pathology in the mediastinum, abdomen, and pelvis. In addition, trainees must understand how imaging differs with respect to each modality, the limitations of each, and which imaging modality to choose when proceeding with an EUS evaluation.

Trainees should have the opportunity to gain proficiency in the use of EUS catheter probes (mini-probes) and how they can help guide endoscopic resection of small mucosal or submucosal lesions. Furthermore, trainees should have a firm understanding of the limitations of this modality. Proficiency in the use of catheter probes for ERCP-based intraductal US should only be sought by those trainees with previous or concurrent training in ERCP.

EUS trainees must learn the principle of acoustic coupling and how the presence of a fluid medium is often necessary to optimize the image. They should have an appreciation of the focal length of the instrument and the need to image from an appropriate distance. Trainees are expected to learn how to use a disposable balloon to this effect. They should be able to identify the appropriate balloon to be used for their selected endoscope, be able to place it accordingly, and learn techniques to appropriately de-aerate the balloon.

The timing of introduction of EUS-FNA is at the discretion of the endosonography trainer. Some endosonographers prefer that their trainees have proficiency in EUS anatomy before teaching FNA, whereas some programs allow trainees to perform FNA at the onset of training. Trainees are expected to understand the various mechanical aspects of the EUS needle, including how to advance and withdraw the needle and the sheath, appropriate use of stylet and suction, and proper safe handling. In addition, the trainee should be aware that various types of EUS needles are available. Indications, contraindications, and technique in use may require additional exposure and training.

Basic techniques

Passage of the echoendoscope. Maneuvering both the radial and linear echoendoscope through the GI tract is much more challenging than a standard forward-viewing endoscope. The trainee should have a detailed understanding of the construction of the tip of the echoendoscope and relation of the location of the optics to the transducer.

When training in EUS, an emphasis should be placed on the safe passage of the echoendoscope across vital structures in the oropharynx and upper GI tract. Trainees are expected to gain proficiency in safely intubating and traversing the esophagus, traversing the gastroesophageal junction, and intubating and maneuvering through the pylorus and duodenal sweep. Trainees should become familiar with techniques in rectal and sigmoid intubation and should appreciate the risks associated with FNA in this region.

TABLE 1. Basic structures and pathology in EUS

Organ	Structures	Pathology
Esophagus	Normal wall layers	Esophageal cancer staging Submucosal lesions
Stomach	Normal wall layers	Gastric cancer staging Submucosal lesions
Duodenum	Normal wall layers	Submucosal lesions, polyps
Ampulla	Normal appearance	Ampullary polyps/masses
Pancreas	Normal parenchyma Normal ducts	Parenchymal abnormalities (atrophy, lobularity, calcifications, hyperechoic strands/foci) Solid masses Cystic lesions Ductal abnormalities (dilation, strictures, tortuosity, stones, intraductal masses/nodules, dilated side branches)
Biliary tree (intrahepatic, extrahepatic, cystic duct)	Normal appearance	Presence of stones, sludge Dilation Strictures Wall thickening Masses Foreign bodies (stents)
Gallbladder	Normal appearance	Stones, sludge, wall thickening, pericholecystic fluid Polyps/masses
Ano-rectum	Normal wall layers Internal and external anal sphincters	Rectal cancer staging Sphincter tears Fluid collections

	Mediastinum	Abdomen	Pelvis
Lymph nodes	Posterior Inferior Aortopulmonary window	Celiac Perigastric Gastrohepatic ligament Portahepatis Peripancreatic	Perirectal Iliac
Vascular structures	Aorta Pulmonary artery Azygous vein Aberrant vessels	Aorta Celiac artery SMA Splenic artery Gastroduodenal artery Portal vein SMV Splenic vein IVC Hepatic veins	Iliac arteries and veins
Non-GI organs	Heart (left atrium) Lungs Trachea Bronchi	Liver Spleen Kidneys Adrenal glands	Urinary bladder Prostate, seminal vesicles, urethra Uterus, vagina

SMA, Superior mesenteric artery; *SMV*, superior mesenteric vein.

In addition, trainees should have exposure to patients with surgically altered anatomy and understand the variations in technique that may be required for safe and effective performance of EUS in this patient population.

Evaluation of structures. The key to performing a safe and successful EUS evaluation is attaining proficiency in endoscope positioning to allow for interrogation of luminal and extraluminal structures. A basic list of structures that trainees should become proficient in evaluating with EUS is shown in Table 1.

EUS image generation and manipulation. In learning EUS, it is critical for the trainee to understand the various features of the US processor that can be used to generate the highest quality image.

Trainees should become well versed in B-mode, or brightness mode, imaging and how this differs from other types of US imaging (eg, M mode and D mode). The use of color Doppler imaging is critical in assessing vascular structures. The use of cine view can be helpful in reviewing a finite set of recently obtained images.

Image manipulation and fine-tuning is achieved via the use of various processor functions. Trainees should have a clear understanding of how to improve image quality by adjustment of amplification (gain) and time gain compensation. Detailed examination of a target lesion can also be enhanced by manipulating the frequency and by using functions for magnification, zooming, and isolating a particular zone of the field.

Trainees are expected to gain proficiency in measuring target lesions and including appropriate annotations such as labels and arrows. Trainees should also be able to appropriately capture, store, and retrieve images for documentation and review.

Tissue sampling

The success of EUS-guided FNA is not only dependent on the ability to perform safe and effective tissue acquisition, but also on the ability of the endosonographer to appropriately handle tissue specimens. The appropriate acquisition and handling of tissue specimens is important for successful performance of EUS-FNA.

Tools and techniques. There are numerous needles available to obtain both cytologic and histologic specimens (ie, tissue cores). Trainees are expected to understand the advantages and limitations of each needle type and thus choose the appropriate needle for a given target lesion. Emphasis should be placed on optimal technique for needle insertion, including EUS visualization of the needle tip at all times, avoidance of intervening vascular and ductal structures, and representative sampling from multiple locations throughout the lesion. In addition, trainees should understand the relevant issues regarding the use of a stylet and suction syringe during FNA. Emphasis should be placed on the collection of an adequate tissue specimen with a minimal number of FNA passes.

Trainees should be familiar with the technique of fine-needle biopsy to obtain core tissue samples from target lesions. In particular, trainees should learn the differences between an FNA needle and the various types of core biopsy needles available, as well as the technical aspects of tissue acquisition and tissue handling when obtaining core biopsy specimens. Emphasis should be placed on the indications for fine-needle biopsy, contraindications, and potential complications.

Specimen handling. Once tissue has been obtained from the target lesion, appropriate handling of the specimen is essential for proper pathologic evaluation and interpretation. Trainees should participate in the tissue handling process, including the delivery of tissue from the needle to a slide and/or a preservative solution, in addition to the preparation of smears, fixation (alcohol or air-dried), and staining for rapid on-site specimen interpretation, if available. It is critical that trainees also understand when supplementary studies such as flow cytometry, tumor marker analysis, immunohistochemical staining, and cytogenetics may be necessary, and how to appropriately handle tissue specimens for these tests.

Documentation. It is essential for the endoscopist to provide the cytopathologist with relevant clinical information to allow accurate interpretation of the cytology specimens in an appropriate context. The requisition form accompanying the specimen should document pertinent patient history and radiologic/endoscopic findings. A description of the lesion, including location, size, and whether it is solid, cystic, or necrotic is also extremely helpful for the cytopathologist. Finally, for extraluminal lesions, it is important to note the route by which the needle was inserted to obtain a specimen (eg, transduodenal or transgastric).

Interpretation. When a diagnosis is not possible from a cytopathologic analysis of the tissue specimen, it is critical for the trainee to understand the nomenclature used to describe the specimen. Terms such as atypical, suspicious, negative, and nondiagnostic may not indicate an absence of malignancy. Thus, the trainee should gain appreciation that in the appropriate clinical context, it may be necessary to pursue repeat tissue sampling.

Management of complications

It is essential that trainees familiarize themselves with the potential complications related to the performance of EUS, such as endoscope trauma and perforation, as well as those related to FNA, such as infection, bleeding, and site-specific inflammation (eg, pancreatitis, bile peritonitis). Emphasis should be placed on techniques to minimize these risks, in addition to the recognition and management of adverse events.

Advanced EUS

Diagnostic techniques. Trainees should recognize that there are numerous other diagnostic devices designed to complement and enhance standard diagnostic imaging with radial and linear echoendoscopes.

Catheter probes can be advanced through the accessory channel of standard endoscopes for the evaluation of small mucosal or submucosal lesions. Catheter probes can similarly be used during ERCP for evaluation of strictures and lesions of either the bile duct or pancreatic duct.

EUS elastography and contrast-enhanced endosonography are emerging modalities that provide the endosonographer with information regarding stiffness and microvasculature, respectively, of the target lesion and surrounding tissue, and may aid in differentiating benign and malignant lesions that are difficult to diagnose by EUS-FNA.

Exposure to these modalities may be program and/or endoscope manufacturer dependent. Thus, trainees wishing to enhance their training may need to seek out other opportunities for hands-on experience.

TABLE 2. Therapeutic EUS procedures

Celiac plexus blockade and neurolysis
Fiducial placement
Pseudocyst and abscess drainage
Pancreaticobiliary duct access and drainage
Ablation of solid and cystic neoplasms
Vascular access and embolization

Therapeutic techniques. Given the proven ease and safety of diagnostic EUS, a growing number of therapeutic applications have emerged (Table 2). These interventional techniques make use of FNA needles as a conduit for drainage or targeted delivery of agents and devices. A comprehensive review of these techniques is beyond the scope of this document, but it should be noted that many of the procedures that listed EUS are experimental and should only be performed under investigational protocol.

Trainees seeking experience and proficiency in these techniques are expected to have achieved considerable skill and proficiency in basic diagnostic EUS and FNA techniques. In addition, EUS-guided drainage and ductal access procedures require the use of fluoroscopy and ERCP techniques. Those trainees who desire exposure to these new therapeutic applications of EUS are advised to seek out training at high-volume academic centers where animal experiments and/or clinical research trials evaluating these techniques are more likely to be performed.

ASSESSMENT OF TRAINING

Proficiency in performing EUS goes beyond mastering the technical skills. Training programs in EUS must emphasize the importance of periprocedure patient care, appropriate physician behavior, and the cognitive aspect of the procedure as well.

Patient care

Before any consideration is given to performing an EUS procedure, emphasis should be placed on whether the patient is a candidate for an endoscopic procedure because EUS is often performed on patients with suspected malignancy who are commonly older and may have multiple comorbidities. Appropriate patient assessment includes taking a relevant history, performing a physical examination, and a review of relevant cross-sectional imaging. A discussion of the potential risks, benefits, and alternatives of the EUS is essential during the informed consent process.

Trainees must learn the indications for periprocedure antibiotic administration as well as periprocedure management of antiplatelet drugs, anticoagulants, and other medications (ie, antihyperglycemic agents). In addition, trainees should learn to anticipate potential medical issues that may lead to an increased risk of complications when proceeding with an EUS (eg, associated gastric outlet obstruction when staging a gastric malignancy), to coordinate appropriate preprocedure interventions (eg, general anesthesia), and to discuss the role of possible therapeutic endoscopic interventions at the time of diagnostic EUS (eg, enteral stent placement, celiac plexus neurolysis, or feeding tube placement).

The trainee is also expected to develop an understanding of the role of EUS in the workup of the patient and its impact on further management decisions. This aspect is critical to avoid performing unnecessary procedures in patients, thus placing patients at risk of a procedure-related complication and/or a delay in treatment.

Trainees should be taught to recognize the signs and symptoms of immediate and delayed procedure-related complications and learn how to manage these events appropriately.

Medical knowledge

Trainees should undergo frequent assessment of clinically applicable medical knowledge and their application of this knowledge to clinical decisions regarding the appropriate use of EUS in the management of patients. Given the large role that EUS plays in the evaluation and workup of patients with GI malignancies, trainees should familiarize themselves with the TNM staging classification systems for the various GI cancers and should be comfortable with assigning a cancer stage based on endosonographic findings.

Trainees are expected to supplement their hands-on learning experience in EUS with self-directed learning through the use of books, videos/DVDs, and participation in endoscopy workshops.

Interpersonal/communication skills and professionalism

Given the implicit association between EUS and a possible cancer diagnosis, emphasis should be placed on patient comfort, dignity, and privacy. The trainee should be sensitive to the implications of patient interactions and conversations during both the preprocedure and postprocedure periods as well as statements and impressions made on the written endoscopy report.

During the procedure, the trainee must learn how to orchestrate accurate and timely communication with the assisting nurse/technician, cytology support service, and the staff administering sedation. Trainees should also be assessed in their effective communication as they participate in a multidisciplinary team that includes surgeons, oncologists, radiation oncologists, radiologists, and pathologists.

Preparation of a timely, detailed, and accurate procedure report is essential to communicate findings to the patient's care providers. In addition to reporting details of both normal and pathologic findings, trainees should come to appreciate the importance of detailed descriptions of any diagnostic or therapeutic techniques per-

formed, including needle type, size, and route of access. When EUS is performed for staging purposes, it is important for the trainee to document the presence/absence of vascular invasion, nodal involvement, invasion into adjacent structures, and ascites.

Practice-based learning and improvement

Training performance measurements have not been standardized. In general, the intention should be to train the trainee in performing accurate TNM staging of malignancies and to perform safe EUS-FNA with sensitivity, specificity, accuracy, and complications in keeping with the national averages. Trainees are thus expected to use this information to identify areas for improvement in technique and interpretation.

System-based practice

The practice of EUS requires the ability to interact with a multidisciplinary team of physicians from various specialties. Trainees should be assessed in their ability to understand, access, and use resources and providers such as surgeons, oncologists, pathologists, and radiologists to provide optimal endoscopic care and have the ability to apply evidence-based, cost-conscious strategies for the prevention, diagnosis, and management of GI disease.

DISCLOSURE

Dr Adler, consultant for BSC, BEE, and Merit; Dr McHenry, consultant for Conmed Endoscopic Technologies, Honorarium from Cook Endoscopy. All other authors disclosed no financial relationships relevant to this publication.

Abbreviations: EUS-FNA, EUS-guided FNA.

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Digital Media

ASGE Online Learning Center

ASGE 2011 Postgraduate course: EUS in GI malignancies.

ASGE DVDs

DV031: EUS in hand. Meenan J, Vu C.

DV040: EUS-guided tissue sampling techniques: cytology and biopsy. Gerke H, Rizk MK, Proctor KA, et al.*

DV042: Therapeutic EUS. Levy MJ, Topazian MD.

DV048: A primer to hepato-pancreato-biliary EUS. Lee J, Sachithanandan S, Raman K, et al.

DV207: EUS set (DV031, DV040, DV042, and DV048)

*Also available at ASGE On-Line Learning Center)

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This document is a product of the ASGE Training Committee. This document was reviewed and approved by the Governing Board of the ASGE.