

Endoscopic retrograde cholangiopancreatography (ERCP): core curriculum

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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 and is 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 in endoscopic retrograde cholangiopancreatography (ERCP) and to serve as a guide to published references, videos, 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 ERCP.

INTRODUCTION AND IMPORTANCE

Acquiring the skills to perform ERCP safely, effectively, and competently requires not only technical training but also an understanding of the indications, risks, benefits, limitations, and alternatives to the procedure. As a prerequisite, competence in upper endoscopy is required, including visualization of the upper GI tract, minimizing patient discomfort, proper identification of normal and abnormal findings, and mastery of basic therapeutic techniques. Only then can competency in using a side-viewing endoscope and the ability to selectively cannulate the bile duct and/or the pancreatic duct be achieved. It further requires competence in the production and interpretation of cholangiograms and pancreatograms while minimizing risk to the patient. The ASGE guideline, “Principles of Training in GI Endoscopy,” and the section,

“Training in Endoscopy,” of the Gastroenterology Core Curriculum (a combined effort of the ASGE, American College of Gastroenterology, and American Association for the Study of Liver Diseases) review the overall objectives of endoscopic training, the requirements for endoscopic trainers, and the training process itself.¹⁻⁴ The “ASGE GI Core Curriculum” also has a chapter on Training in Biliary Tract Diseases and Pancreatic Disorders, which is pertinent.¹ The evolving issues of tracking outcomes and assessing competency during endoscopy training are also reviewed. These core documents are recommended to both endoscopic trainers and trainees alike. Entrustable Professional Activities are pre-identified competencies that can be trained and are measurable and specific with direct impact on the professional activity at hand⁵; Entrustable Professional Activities have recently been developed specifically for pancreatic and biliary diseases and are excellent resources.⁶

GOALS OF TRAINING

Programs offering training in ERCP should define the goals of their training program. Specifically, training programs should determine whether they intend to offer fellows only exposure to ERCP, training to a level of competence sufficient for independent practice, or tertiary-level advanced skills, such as require a fourth year of commitment.

All GI trainees require some exposure to ERCP to develop an understanding of the diagnostic and therapeutic roles of the procedure including the indications, contraindications, and possible adverse events. This exposure is generally accomplished within the context of a 3-year gastroenterology fellowship training program. However, procedural exposure should not be equated to procedural competence. There is no consensus as to how many cases or how many months of rotation on an ERCP service are

necessary to gain satisfactory exposure for trainees not intending to perform ERCP.

For individuals seeking credentialing to perform independent ERCP after training, current ASGE guidelines emphasize objective measures over case volume. Historically, an accepted benchmark was set at a successful cannulation rate of greater than 80%.⁷ Others have suggested that a higher standard of 90% successful cannulation rate is more appropriate for those seeking independent practice upon completion of training. This level of competency is seldom achieved within a standard 3-year GI fellowship.⁸

The "Gastroenterology Core Curriculum," published in 2007, suggests that the minimum number of ERCPs required before competency is assessed should be at least 200.¹ The ASGE privileging guidelines clearly state that a trainee is not considered competent simply by reaching this threshold and that competence should be determined by objective criteria and direct observation rather than based on procedure numbers alone.⁹ The growing body of published data indicates that most trainees are not competent at this number of procedures and there is significant variation in the rate of skill acquisition among trainees.^{8,10,11}

Issues to consider in addition to procedural volume include the degree of fellow participation and the difficulty of each procedure performed. It is important for training directors to recognize that there can be considerable variation in how much of each procedure logged by a fellow was actually performed independently by the fellow. Trainee logbook records should specify particular skills completed by the fellow (cannulation, sphincterotomy, stent placement, tissue sampling) and indicate both the degree of difficulty of the attempted procedure (ie, hilar stricture, altered anatomy, etc.) and the number of complete cases the trainee performed without assistance. Training programs should emphasize that documented achievement of defined threshold standards (eg, deep biliary cannulation rates in the setting of a normal papilla), and not only case numbers, will form the primary basis for credentialing. Another important consideration in using benchmarks such as cannulation rates to gauge competency is the inherent difficulty of the attempted procedures. In a single-center study, Schutz and Abbot¹² developed a grading scale for ERCP based on difficulty. A modification of this score was adopted by the ASGE as part of their quality assessment document and is shown in Table 1.^{13,38}

Trainees who elect to pursue additional training in ERCP to attain procedural competence should have completed at least 18 months of a standard gastroenterology training program.¹ The minimum duration for training required to achieve advanced technical and cognitive skills is usually 12 months. This period of advanced training in most cases should be an additional year dedicated to advanced endoscopic procedures. Those interested in pursuing advanced endoscopic training are referred to the ASGE website on Advanced Training Programs.¹⁴

Faculty

Programs dedicated to teaching ERCP should have more than 1 faculty member expert in ERCP who is well experienced in performing diagnostic and therapeutic procedures.¹ It is expected that the ERCP faculty will have sufficient case volume and breadth to provide 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 ERCP cases. Regular didactic education should also be provided to the trainee by the ERCP faculty. Regular formative and summative feedback should be provided to the trainee. This ideally should occur after each case in addition to periodic formal feedback sessions.

Facilities

ERCP is typically performed in a hospital-based endoscopy unit. A processor, duodenoscope, fluoroscopic unit, and adequate accessories are the basic equipment necessary to perform ERCP. Ideally, training programs should also have the availability to perform EUS because many pancreaticobiliary diseases and ERCP procedures are complemented by EUS.

Endoscopic experience

The training program should be able to provide an adequate breadth of cases. The decision to train 1 or more fellows each year to achieve sufficient competency will depend on the volume of ERCPs performed at the institution and the availability of experts in ERCP to supervise the training of fellows. With data suggesting that well over 200 cases are required for most trainees to consistently cannulate the desired duct, programs with a limited case volume will have to weigh their training objectives with what is feasible.¹ Fellows must be aware of this information, which can be obtained directly from the programs or found on the ASGE training website (<http://www.asge.org/education>).³ However, as mentioned previously, the emphasis should be on competency as assessed by objective measures and not just procedural volume.

TRAINING PROCESS

Overview

To provide a well-rounded and comprehensive training experience, fellows should have a balanced exposure to patient care, didactics, and the technical aspects of ERCP. The cognitive aspects of ERCP training are critically important. This includes a thorough knowledge of pancreaticobiliary anatomy, including common variants, physiology, pathophysiology, which diseases and patients benefit from ERCP, and when this procedure may not be helpful or may even be harmful, all in the context of current evidence-based medicine practices as they pertain to ERCP.

TABLE 1. Grading scale for ERCP based on difficulty

	Biliary procedures	Pancreatic procedures
Grade 1	Diagnostic cholangiogram Biliary brush cytology Standard sphincterotomy ± removal of stones <10 mm Stricture dilation/ stent/ NBD for extrahepatic stricture or bile leak	Diagnostic pancreatogram Pancreatic cytology
Grade 2	Diagnostic cholangiogram with BII anatomy Removal of CBD stones >10 mm Stricture dilation/ stent/ NBD for hilar tumors or benign intrahepatic strictures	Diagnostic pancreatogram with BII anatomy Minor papilla cannulation
Grade 3	SOM Cholangioscopy Any therapy with BII anatomy Removal of intrahepatic stones or any stones with lithotripsy	SOM Pancreatoscopy All pancreatic therapy, including pseudocyst drainage

NBD, nasobiliary drain; BII, Bilroth II; CBD, common bile duct; SOM, sphincter of Oddi manometry.

Preprocedure assessment

The trainee should have a detailed understanding of the informed consent process. The trainee should be able to provide informed consent in terms understandable to the patient. The development of good communication skills is an important aspect of training.¹⁵ The preprocedure discussion with patients can be essential in relieving patient anxiety and improving the fellow's understanding of the indications and objectives of the planned intervention. In addition to providing informed consent, the trainee should be able to educate the patient in laypersons' terms regarding how the procedure will be performed, why the procedure is indicated, whether or not there are alternatives to ERCP for diagnosis and/or treatment of the patient's condition, and what to expect after the procedure. The trainee must also have a thorough knowledge of the contraindications to ERCP and apply this knowledge to each individual patient as appropriate.

The trainee should understand the potential adverse events and the rates at which they occur.¹⁶ These adverse events include but are not limited to pancreatitis, bleeding, infection (to include transmission of multidrug resistant organisms), oversedation/respiratory compromise, perforation, impacted devices, and other adverse events that can occur during upper endoscopy. The importance of proper patient selection should be emphasized to avoid marginally indicated procedures, especially in higher-risk patients. Using alternative imaging techniques such as MRCP in these situations should be considered. It is equally important for the trainee to recognize which indications for ERCP carry a higher risk for adverse events and ensure that any increased risk for adverse events is discussed with the patient when informed consent is obtained.

Special consideration should be given to choosing the proper method to sedate patients for ERCP.¹⁷ The choice of sedation (monitored anesthesia care or deep sedation) and patient positioning (supine, prone, or modified swimmer's) should be considered, and the risks and benefits of each should be weighed in the context of each patient's anesthesia risk and comorbidities. Although it is becoming

increasingly more common to perform ERCP with anesthesia assistance, conscious sedation is still preferred at some institutions and should be mastered by trainees.

Before the procedure, preferably during the initial patient encounter, the trainee must thoughtfully review the patient's comorbidities, anticoagulation status, and the need for antibiotics.¹⁸ The trainee should have experience using the American Society of Anesthesiology grading system for disease severity. Some patients may simply be too ill to benefit significantly from ERCP depending on the procedure indication and their comorbidities. The patient's medications must be reviewed carefully, especially given the many new anticoagulants on the market as well as herbal medications, which may need to be held before ERCP. The risks and benefits of holding any medication must be weighed carefully.

Prior imaging is often available and can be useful in planning a strategy for the upcoming procedure. Cholangiograms and pancreatograms from prior ERCPs or intraoperative procedures should be reviewed. CT scans and magnetic resonance, MRCP, and EUS images and reports may also be helpful.

Before the procedure the trainee should review pertinent medical history such as diabetes, heart and lung disease, anticoagulation status, need for antibiotics, pregnancy status, and need for additional shielding in young patients, allergies, and any other concerns. Before commencing with any procedure, a preprocedure "time-out" should occur. The required content of the time-out may vary by institution.

It is important to discuss positioning of the patient with the nursing staff and/or anesthesiologist. In addition to determining if prone, supine, or modified swimmer's position is best, care should be taken to ensure the brachial plexus is not at risk of pressure injury; that the shoulders, wrists, and neck are in proper alignment; and that the eyes are adequately protected. If a bite block is being used, ensuring the lips are not pinched is also important. Finally, it is often helpful to obtain an initial spot film before contrast injection to look for the presence of radio-opaque

structures, contrast in the intestine, air cholangiograms, and so on.

Procedural considerations and techniques

Patient management and physician management during procedures. Maintenance of patient comfort, dignity, and safety during the procedure is important. During the procedure, communication between the endoscopist, fellows, nurses, technicians, anesthesiologists, radiology technicians, and others is essential to ensure patient safety. Communication should be direct, timely, and professional. These skills may be underdeveloped in the early trainee who may be focused on the technical aspects of the procedure and should be taught by example with deliberate feedback given as appropriate.

Passage of the duodenoscope. Trainees must gain proficiency in passing the duodenoscope through the upper GI tract into an adequate position to perform ERCP. To do this, they must master use of the endoscope dials, scope torque, and body movement. The side-viewing scope limits visual examination of the upper GI mucosa, but a fairly thorough examination can be obtained with special care, and any abnormal findings should be documented.

Esophageal intubation. Only a trainee who demonstrates competence in esophageal intubation with the forward-viewing gastroscope should attempt esophageal intubation with the side-viewing duodenoscope. It is important to point out that the rounded tip of the duodenoscope may enter a Zenker's diverticulum or a deep pyriform sinus and that special care needs to be taken to avoid perforation. The trainee should be able to intubate with a duodenoscope in patients positioned prone, left lateral decubitus, and supine in patients with and without an endotracheal tube in place.

Traversing the stomach. The trainee must receive instruction on the most efficient method of traversing the stomach, with a focus on minimizing looping of the duodenoscope within the stomach. The trainer should explain techniques of pyloric intubation with a duodenoscope.

Navigating surgically altered GI anatomy. ERCP trainees should learn how to manage patients with surgically altered anatomy. This includes obtaining a proper preprocedure history and understanding specific techniques of endoscope passage and cannulation in patients who have undergone prior Billroth II gastrectomy, other gastric surgeries, pancreaticoduodenectomy, and Roux-en-Y reconstruction. Developing proficiency in some of these techniques may not be possible in the course of a standard 3-year fellowship and may be more appropriate for fellows who are performing an additional year in advanced therapeutic endoscopy.

Inspection of the papilla. The trainee should acquire the ability to identify the papilla in normal and in complicated anatomic situations (eg, the presence of a periampullary diverticulum). In addition, the trainee

should be able to recognize an abnormal papilla and to understand when biopsy sampling may be indicated and the safest way to perform biopsy sampling.

Cannulation. Positioning for cannulation. Proper positioning of the duodenoscope for successful cannulation is important. The trainee should learn to achieve a "short" position before attempting cannulation but also understand when a longer scope position is required. Some experts recommend spending a full 60 seconds examining the papilla to envision the path of the bile duct before attempting cannulation. Sometimes fluoroscopy is helpful in evaluating scope position, especially if there is an air cholangiogram or residual contrast from a prior intraoperative cholangiogram. Landmarks such as cystic duct clips may also be helpful.

Selective cannulation of the bile and pancreatic ducts. Selective deep cannulation of the intended ductal system is a skill that is difficult to master, even with a normal papilla. Successful cannulation requires coordinated movements of the scope, a catheter or sphincterotome, and/or a guidewire. To learn these techniques, the trainee will require extensive one-on-one training and should carefully review the references listed in the bibliography (including both book chapters, training videos, and other online resources).

Trainees should familiarize themselves with the various catheters and sphincterotomes available and should develop competence at handling each of the accessories both as the assistant and as the endoscopist. The trainee should be exposed to both wire-guided and injection techniques and should understand the merits and pitfalls of each in various clinical situations.¹⁹⁻²¹

In patients with standard and postsurgical anatomy, fellows must understand options for difficult or failed cannulation.²² This would include alternative techniques such as double-wire cannulation, septotomy, needle-knife sphincterotomy either over a pancreatic stent or free hand, subsequent attempt at ERCP at a later date by the same or a second endoscopist, interventional radiologic access with possible rendezvous ERCP techniques, EUS-assisted access, and surgical management. The choice of technique should be based on a thorough understanding of the relative merits of each option, the clinical situation, the urgency of access, and local expertise in the various options.

Wires. Short- and long-wire systems. Trainees should be aware of the 2 major types of wire systems (long and short).²³ Training in the use of a long wire, over which various devices are exchanged, includes demonstrating close communication with the assistant who is "running the wire." They should understand the advantages and disadvantages of each system.^{24,25} For example, advantages of the short-wire system include the ability to lock the wire into place for stability, improve the rate of device exchange, and the option for the endoscopist to manage his or her own wire (which is especially beneficial for

endoscopists who do not have assistants skilled in wire management). Disadvantages include incompatibility with some long-wire devices and difficulties in performing exchanges with hydrophilic wires. They must understand that a long wire may be used in a short-wire system and which devices require a long wire (such as dilating catheters, stent retrievers, and some dilating balloons). Trainees should also be aware of the variations in duodenoscope design, which may help lock the wire during exchanges.

Types of wires. The trainee should be familiar with the various types of wires available, their special properties, and situations in which a particular wire may be of benefit. These include wires of various diameters, degree of stiffness, length of the hydrophilic portion of the wire, and tip design such as angled and loop-tipped wires.²³⁻²⁵

Cholangiography. The trainee should be familiar with normal biliary anatomy and common anatomic variants. The cholangiogram changes observed in choledocholithiasis, benign and malignant bile-duct strictures, primary sclerosing cholangitis, choledochal cysts, and bile-duct leaks are required knowledge. The trainer should explain the indication and technique of occlusion cholangiography. The trainee should become adept at independent interpretation of the real-time cholangiogram and captured images. This process can be facilitated by participation in case conferences with surgeons and radiologists and by review of radiographs after the procedure with the ERCP instructor. The trainee should understand the various maneuvers to optimize the fluoroscopic image: adjustments in the position of the duodenoscope, the patient, and the fluoroscopy equipment to adequately visualize the biliary or pancreatic ducts; the use of dilute or undiluted contrast; changes in the radiation dose based on patient size; image magnification; and collimation.

Pancreatography. The trainee should be familiar with normal pancreatic duct anatomy and common anatomic variants, such as pancreas divisum and annular pancreas. Typical duct changes observed in pancreatic malignancy, chronic pancreatitis, and intraductal papillary mucinous tumors should be studied. Recognition of a pancreatic-duct disruption and the associated sequelae of a communicating pseudocyst or fistula are also important.

Low-pressure injection under continuous fluoroscopic observation is recommended to prevent excessive filling of the pancreatic-duct branches (ie, acinarization). The trainee should become adept at independent interpretation of the real-time pancreatogram and captured images.

As with cholangiography, the trainee should understand the maneuvers available to optimize the fluoroscopic image during pancreatography. The trainee should also learn how to place small-caliber pancreatic-duct stents to minimize risk of pancreatitis after pancreatography in patients at high risk for post-ERCP pancreatitis (PEP).

Tissue Sampling

During ERCP, biliary or pancreatic strictures may be encountered. To determine if the stricture is benign or malignant, tissue sampling is commonly performed under fluoroscopic guidance. Various tissue-sampling techniques include brush cytology, fluoroscopic-guided biopsy sampling, biopsy sampling during direct cholangioscopy, stent cytology, and bile/pancreatic juice aspiration for cytology. The trainees need to be familiar with the indications, techniques, and likelihood of an accurate diagnosis with each technique. Training should also address prompt in-room processing of the specimen, such as placing it into cytology solution or direct placement onto slides.

Standard therapeutic techniques

Biliary and pancreatic sphincterotomy. The instruction of sphincterotomy should be an integral part of ERCP training and a skill the trainee must master before independently performing ERCPs. The trainee should be aware of the differences between the various types of sphincterotomes and understand the positive and negative aspects of working over various guidewires during sphincterotomy.

Sphincterotomy is often taught to and performed by the trainee only after the trainee has demonstrated proficiency in the basic techniques of ERCP and ductal cannulation. The trainee should have an understanding of the principles of electrosurgery that underlie the use of cutting and/or blended current to perform sphincterotomy and should be aware of the settings and capabilities of their institutions' particular electrosurgical current generators.

The trainee should have an understanding of the indications for performing biliary and pancreatic sphincterotomies and the technical principles of performing sphincterotomy. Furthermore, they should have a full understanding of the risks of sphincterotomy, including bleeding and perforation. Other factors that influence risk for adverse events should be understood. Trainees should be aware of alternatives to sphincterotomy in certain clinical situations, such as temporary stent placement and balloon dilation.

A discussion of the specific techniques of sphincterotomy, including access papillotomy, is available in a number of text and media references and is beyond the scope of this discussion.^{19,22} The importance of good endoscopic position and steady instrument control during the performance of a sphincterotomy needs to be emphasized. The trainee should have knowledge of the technical differences in performing pancreatic sphincterotomy as opposed to biliary sphincterotomy. The trainee needs to be instructed on the proper management of immediate and delayed postsphincterotomy bleeding.

Trainees should also be aware of the option of rendezvous techniques for obtaining deep biliary access by using percutaneous transhepatic cholangiography (see below) or

EUS-guided access depending on local expertise. The trainee should also recognize the indications and potential benefit of short-term pancreatic-duct stent placement after pancreatic sphincterotomy to reduce the risk of pancreatitis.²⁶ The trainee should be aware of the indications for and various techniques in performing minor papilla papillotomy/sphincterotomy. Most therapeutic pancreatic endotherapies should be reserved for advanced trainees who have mastered biliary therapeutic techniques.

Extraction techniques. Stone extraction remains a major indication for ERCP. Extraction can be performed with extraction balloons or baskets or with mechanical, electrohydraulic, or laser lithotripsy.²⁷

The technical aspects of biliary stone extraction should be mastered by the trainee. Emphasis on technique and tool choice for most efficient stone extraction while minimizing the risks of impacting a stone or a basket at the ampulla should be emphasized to the trainee. The trainee should be aware of the indications for sphincteroplasty with large balloons and the use of this technique when indicated to avoid possible adverse events.

The trainee should be aware of the indications for salvage techniques with large stones, including electrohydraulic lithotripsy, laser, and extracorporeal shock wave lithotripsy. Electrohydraulic lithotripsy and laser use should be reserved for advanced trainees at sites where this is routinely performed, with extracorporeal shock wave lithotripsy being done by certain specialties depending on the center of practice. The trainee should be aware of the local practice patterns.

Dilation (balloon and catheter). Dilation of the biliary or pancreatic sphincter by using hydrostatic balloons is an available technique to perform therapy (usually stone extraction) in the biliary or pancreatic ducts in highly selected situations. The trainee should be aware of the controversies surrounding this technique with regard to the potential risk of pancreatitis.

Dilation may also be performed within the bile or pancreatic duct to treat strictures. The procedure may be performed with either graduated dilating catheters with increasing diameters passed over a guidewire or with hydrostatic, wire-guided balloons. The trainee should understand indications for dilation of biliary and pancreatic strictures and basic techniques in performing either catheter or balloon dilation.²⁸

Stent placement. The trainee should understand the indication for stents to provide adequate duct drainage, including after contrast injection in cases of obstruction, and the different types of stents available.²⁹ The trainee should be taught the principles of stent selection, such as the appropriate type, size, length, and number for a given situation. They should consider the mechanical properties of the stent, including foreshortening, open versus closed cell, straight, or pigtailed. The trainee must also understand the endoscopic principles required for optimal stent placement such as wire and pusher

requirements. Stent removal should also be mastered. Finally, the trainee should understand the duration of time a stent can remain in situ and be diligent to avoid patients lost to follow-up.

Appropriate use of fluoroscopy

Fluoroscopy is a necessary component of ERCP that exposes the patient, endoscopist, and ancillary staff (nurses, assistants, fellows, anesthesiologists) to radiation. The trainee is expected to have completed radiation safety training at their individual institutions, participate in radiation monitoring, and practice the "as low as reasonably achievable" principle with respect to radiation dose. Many states require licensing for fluoroscopy. This is especially important for the novice endoscopist who is often more focused on the technical aspects of the ERCP and therefore unaware of excessive radiation exposure during the procedure.

Trainees should understand and adhere to proper procedures for shielding of personnel and patients. Trainees should ensure that the patient is adequately shielded; special consideration should be given to pregnant or young patients undergoing ERCP.

Additional ERCP therapeutic techniques

The therapeutic ERCP techniques listed below may be performed in select specialty centers. These techniques are complementary to routine ERCP and require additional training after basic ERCP techniques are mastered by the trainee. The trainee should understand that the availability of training will be dictated by local expertise and resources and may be limited to a fourth-year fellowship. The trainee should understand the increased risks associated with these procedures.

ERCP in patients with altered anatomy. These procedures pose a unique set of challenges, and success in these cases is predicated upon proper knowledge of post-operative anatomy and training in conventional ERCP. In general, these procedures are technically challenging because of 3 issues that must be overcome: (1) endoscopically traversing the altered luminal anatomy, (2) identifying the papilla or duct-enteric anastomosis and cannulating the biliary or pancreatic orifice from an altered position, and (3) performing interventions with ERCP instruments in either suboptimal positions, or without a duodenoscope with an elevator, or both. Trainees should familiarize themselves with the various endoscopes and devices available for use in patients with altered anatomy (standard duodenoscope, forward-viewing gastroscopes and colonoscopes, enteroscopes with or without additional distal cap, specialized catheters/sphincterotomes). When using device-assisted enteroscopy to perform ERCP, training in deep enteroscopy (single-balloon, double-balloon, and spiral enteroscopy) may also be necessary.

Sphincter of Oddi manometry. At the time of ERCP, measurements of sphincter of Oddi pressures can be obtained using a manometry catheter. Sphincter of Oddi

manometry (SOM) is an advanced technique with limited indications that is associated with an increased risk of PEP. As such, not every ERCP trainee needs to master the technical aspects of performing this procedure. Before embarking on SOM, the trainee must exhibit a thorough understanding of the manometry system used, including accurate interpretation of manometry tracings, and should have a command of the most recent literature regarding the risk-to-benefit profile of this high-risk procedure. Give the high risks of the procedure, attention should be paid to proper informed consent and the available strategies to reduce the risk of postprocedure pancreatitis. Training will depend on local expertise, equipment, and patient population, with the trainee recognizing that there is very limited evidence to support the ongoing use of SOM in the diagnostic evaluation of patients with suspected sphincter of Oddi dysfunction.³⁰

Cholangioscopy and pancreatoscopy. Direct visualization of the biliary and pancreatic duct is technically possible and is an important tool for diagnosis and treatment of various disorders. Peroral cholangioscopy or pancreatoscopy can be performed by using a dedicated cholangioscope that is advanced through the accessory channel of a duodenoscope or by direct insertion of a small-diameter endoscope into the bile duct. With the introduction of high-definition ultraslim upper-endoscopes with narrow-band imaging capability, the popularity of direct peroral cholangioscopy has increased. The trainee should understand the potential applications of this advanced technique in the management of indeterminate biliary and pancreatic strictures, intraductal papillary mucinous tumors of the pancreas, and intraductal stones.

Ampullectomy. The trainee should recognize the endoscopic appearance of ampullary neoplasms, as well as the indications and contraindications for ampullectomy. The advanced ERCP trainee must learn appropriate patient selection and techniques to effectively resect the lesion, minimize the risk of residual or recurrent lesions, and mitigate adverse events. Considerations include the role of biliary and pancreatic sphincterotomy, the role of pancreatic-duct stent placement during or after resection, and benefits of various types of snares and electrocautery.

EUS as an adjunct to ERCP. EUS is a useful tool in the evaluation of patients with a variety of pancreaticobiliary disorders. The trainee should understand the role of EUS in the evaluation of suspected choledocholithiasis. The trainee should also recognize the role of intraductal US in the evaluation of indeterminate biliary strictures.

EUS-guided biliary drainage. The trainee should be aware of the potential role of EUS-guided biliary drainage in the setting of failed ERCP because of either an inaccessible ampulla or failed cannulation and the advantages and disadvantages of this procedure compared with biliary drainage performed by interventional radiology. These techniques should also be considered in patients with a contraindication to percutaneous biliary decompression.

EUS-guided rendezvous ERCP. The trainee should understand the role of EUS-guided rendezvous ERCP in the setting of a failed cannulation. EUS-guided rendezvous ERCP can be performed with passage of a transpapillary guidewire and then conversion to and completion of ERCP by the standard route. This procedure requires the trainee to be skilled in therapeutic EUS and ERCP and should be taught in specialized centers with a high volume of ERCP procedures.

EUS-guided choledochoduodenostomy and hepaticogastrostomy. The trainee should understand the role of EUS-guided biliary drainage in the setting of an inaccessible papilla. These procedures require identification of the biliary tract, followed by puncturing the bile or hepatic duct depending on the location of obstruction. Manipulation of the guidewire, dilation of the newly created tract, and placement of the stent are steps in which the trainee should be technically proficient. These techniques should be taught in specialized centers with a high volume of ERCP procedures.

Minor papillotomy. The trainee should understand the indications and limitations of minor papilla sphincterotomy in patients with pancreas divisum and recurrent acute pancreatitis or symptomatic chronic pancreatitis. The trainee should be able to identify the minor papilla and be knowledgeable of agents that may assist identification such as indigo carmine, methylene blue, and secretin.

Gallbladder stents. The trainee should understand the potential benefits of endoscopic transpapillary gallbladder stenting as either a bridge to surgery or definitive therapy for nonoperative patients with cholecystitis, biliary colic, or recurrent gallstone pancreatitis. This technique requires that the trainee be proficient in fluoroscopic direct identification and cannulation of the cystic duct and gallbladder stent placement as well as sphincterotomy.

Methods to reduce PEP

PEP remains the most common serious adverse event of ERCP. It is now widely accepted that procedural and patient selection factors contribute to the overall risk of PEP. PEP prevention begins with recognition of which patients are at increased risk because a high index of suspicion for and early identification of PEP are important in ensuring favorable clinical outcomes. The trainee must understand the known risk factors as well as the role of pancreatic stent placement, pharmacoprophylaxis, and fluid resuscitation in mitigating the risk and severity of PEP.

Prophylactic stent placement. Prophylactic stent placement is thought to reduce the risk of PEP by relieving pancreatic duct obstruction that develops as a result of transient procedure-induced stenosis of the pancreatic orifice. The trainee should understand the importance of properly selecting the appropriate type, size, and length of stent for a given situation. The trainee must also understand the endoscopic techniques required for optimal stent placement and know that the technique for

placement will vary with the type of stent used.²⁹ The trainee must also understand the potential disadvantages of prophylactic stent placement, including the increased risk of PEP above baseline in the setting of placement failure, the risks such as stent migration and duct perforation, and, finally, the effect of prolonged stent retention in inducing ductal changes that resemble chronic pancreatitis. The trainee should understand the need to be vigilant regarding follow-up abdominal radiography to ensure spontaneous passage of the stent versus subsequent endoscopic removal.

Rectal indomethacin. Nonsteroidal anti-inflammatory drugs are inexpensive, widely available, easily administered and have a favorable risk profile when given as a single dose, making them an attractive option in the prevention of PEP. The trainee should review the literature and published guidelines describing the use and indications for rectal nonsteroidal anti-inflammatory drugs.³¹

Fluid resuscitation. The benefit of aggressive fluid hydration is clear in the early treatment of acute pancreatitis. Trainees should be aware of recent evidence that supports aggressive intravenous hydration using lactated Ringer's solution during and after ERCP to prevent PEP.³²

Postprocedure considerations

After ERCP, communication of findings, therapeutic results, and a plan for follow-up must be emphasized to the trainee as an important part of patient care. This involves effective communication with the patient and referring health professionals. The importance of detailed procedure reporting using accepted nomenclature should be taught. The use of abbreviations should be minimized.

Simulators and additional training resources

Endoscopy simulators can provide trainees with the ability to practice specific ERCP techniques in a controlled environment while receiving expert feedback without risk to patients. Simulators may be strictly mechanical devices or may be computer based. In addition, animal models (either in vivo or ex vivo) are sometimes used for training purposes. Work on any of these models is best integrated into a curriculum that incorporates didactic material, step-by-step demonstration of proper technique, hands-on practice that includes troubleshooting common problems, and expert feedback. Despite the theoretical advantages to simulator-based training, an objective benefit of such activity for ERCP has not yet been demonstrated. It should be emphasized that no amount of training on a simulator or a model alone will confer competence in ERCP or substitute for the performance of supervised real cases. However, hands-on simulator work may supplement the clinical experience provided by the training program. ERCP trainers should be encouraged to gain familiarity by using available models and learn how to teach using these new methods.

ERCP trainees can also avail themselves of numerous supplemental resources to enhance their cognitive understanding of the various techniques detailed above. The ASGE Endoscopic Learning Library contains an array of well-narrated ERCP-related teaching videos that are available to complement the standard curriculum of patient-based teaching and supervised performance of procedures.

Recognition and management of adverse events

The risk of adverse events for ERCP is higher than for upper and lower endoscopy, and some adverse events such as pancreatitis, cholangitis, and postsphincterotomy hemorrhage are unique to the procedure.¹⁶ Severe adverse events such as acute pancreatitis and cholangitis may not clinically manifest for several hours after the procedure, and the trainee must maintain a high index of suspicion for these adverse events. The trainee should be able to appropriately triage postprocedure abdominal pain, which includes maintaining a broad differential and conducting the appropriate diagnostic evaluation.

Fellows should understand the 3 types of perforation that can occur during ERCP: free perforation of the bowel wall by the endoscope, extension of a sphincterotomy beyond the intramural portion of the bile or pancreatic duct, and at any location because of extramural passage or migration of guidewires or stents. Treatment of post-ERCP perforation depends on the characteristics of the perforation, the clinical condition of the patient, and the expertise of the endoscopist. The trainee should be taught to recognize these adverse events and to manage them appropriately when they occur.

Cardiopulmonary adverse events are a leading cause of death in ERCP. This is likely multifactorial but includes the inherent risk of these procedures, the often lengthy procedure duration, and the patient population undergoing these procedures who are often elderly patients with multiple comorbidities. Trainees should understand the need for coordination with anesthesia personnel to ensure adequate preprocedure risk assessment and to tailor the sedation/anesthetic plan according to that degree of risk.

Trainees should understand the risk of cholangitis associated with failed or incomplete biliary drainage. They should understand the need to aspirate infected bile from the biliary tree before contrast injection, minimize the volume of injected contrast, and achieve prompt endoscopic decompression of an obstructed biliary system, which includes percutaneous or surgical intervention if endoscopic therapy is not possible. Appropriate use of periprocedural antibiotics is also important.¹⁸

Trainees should understand the potential adverse events related to the placement of both plastic and self-expanding metal stents, including stent migration, perforation, stricture formation, cholangitis, and cholecystitis. The trainee should be aware of and understand how

to manage additional rare adverse events that can occur during ERCP, including impaction of baskets during stone removal, air embolism, and splenic and hepatic trauma.

ASSESSMENT OF TRAINING

Formal evaluation of each trainee's endoscopic skills has been traditionally obtained by applying the Accreditation Council for Graduate Medical Education core competencies: patient care, medical knowledge, interpersonal and communication skills, professionalism, practice-based learning and improvement, and system-based practice. It has been recognized that trainees must receive routine and timely feedback on their upper-endoscopy skills throughout their training experience. The Accreditation Council for Graduate Medical Education has therefore adopted the Next Accreditation System, which focuses on milestones and outcomes at various points of training, ensuring that competence is achieved by all trainees and making certain that these assessments are documented by their training program.^{33,34} The need for validated assessment tools that can be used for determining competency has subsequently become critical. A variety of tools are available on the ASGE Web site that can be used to assess ERCP competency.^{35,36} Use of these tools should provide a mechanism for detecting deficiencies in cognitive or motor skills necessary for the performance of ERCP. Furthermore, the trainee's progress can be measured based on the scores generated by these tools.

Quality Measurement

The importance of measuring and monitoring "quality" in the performance of ERCP has implications for trainees seeking credentialing and clinical privileges and ultimately may impact physician reimbursement based on patient outcomes. Several quality parameters for ERCP have been outlined by the ASGE/American College of Gastroenterology Task Force on Quality in Endoscopy.³⁷ These include pre-, intra-, and postprocedural quality indicators such as the documentation of an appropriate indication for the study, adequate preparation and obtaining informed consent, deep cannulation of the ducts of interest, removal of common bile duct stones < 1 cm in patients with normal anatomy, and the placement of stents in patients with biliary obstruction, in addition to rates of PEP and post-ERCP bleeding.

Performance targets, when available in the literature, are suggested by the Task Force. It should be recognized that certain quality indicators are common to all GI endoscopic procedures. The approach to quality measurement should be done with preprocedure, intraprocedure, and postprocedure indicators common to all procedures and also specific to ERCP. Independent performance of ERCP with outcomes that reach these targets is the ultimate goal of training and evidence of competency in this procedure.

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Videotapes

The following videotapes are available as part of the ASGE Endoscopic Learning Library. A portion of each videotape may be viewed online, and purchase information is available at www.asge.org/library or by calling ASGE at 866-353-ASGE (2743).

Biliary access techniques for ERCP: From Basic to Advanced (DV035)

Endoscopic papillectomy for tumors of the major duodenal papilla (DV038)

Endoscopic retrograde cholangiogram for benign biliary disease (DV044)

Techniques of endoscopic therapy in pancreatic disorders (DV043)

Clinical guidelines

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Abbreviations: PEP, post-ERCP pancreatitis; SOM, sphincter of Oddi manometry.

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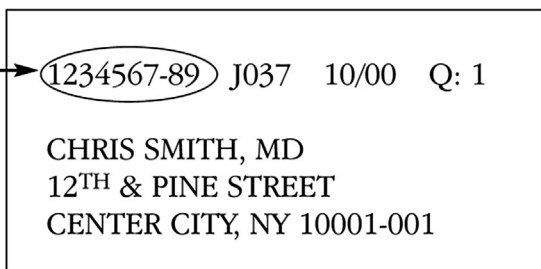
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