Anesthesia for Gastrointestinal Endoscopic Procedures

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The provision of sedation and analgesia always has been a critical component of performing endoscopic procedures on the gastrointestinal (GI) tract. The procedures create some pain and discomfort and are associated with anxiety for the patient. Of course, comfort is paramount, but patient cooperation also is critical to the success of the examination. In the early days of endoscopy, it was routine practice for the sedation and analgesia to be provided by the endoscopist, who ordered a benzodiazepine, such as diazepam, and an opioid, such as meperidine, that were administered by a nurse. Monitoring was provided by periodic visual observation by the physician and/or the nurse. The administration of supplemental oxygen was inconsistent.

In the current environment, things are changing. The demand for endoscopy, especially screening colonoscopies, has increased dramatically. More stimulating and complex procedures that can be accomplished with the endoscope are emerging. New medications for sedation and analgesia are either under investigation or already are on the market. Standards for monitoring and criteria for discharge are improving.

Because of these changes, anesthesiologists have become involved in the care of many of these patients.[1] In some situations, endoscopists may not want to divide their attention between performing the procedure and maintaining the sedation. In other situations, there may be a need for more sophisticated medications that require the expertise of an anesthesiologist. Occasionally, the need for sedation is escalated, sometimes to the point of requiring general anesthesia, because of the complexity of the procedure. Last, these procedures also are becoming common in children, whose cooperation may be gained only with the administration of general anesthesia.

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The provision of anesthesia or sedation for endoscopy is associated with issues that are different from care during surgical cases. Some of those areas of difference relate to the location in which the care is provided, relationships with the endoscopists, relationships with payors, varying levels of patient preparation, the use of different medications, and the management of complications in an out-of-operating-room environment. This article covers all of these areas.

VENUES

Historically, GI endoscopy was performed in a hospital setting. A recent survey of members of the American College of Gastroenterology shows this still is true most of the time. The ambulatory surgery center (ASC) now is becoming the preferred location for these procedures,[2] however, and approximately 35.8% of endoscopists consider an ASC as their primary location for performance of endoscopy.[1] There seem to be significant regional differences in where endoscopies are done. For example, office endoscopy accounted for 19.8% of procedures in the Mid-Atlantic region but only 0.4% in the Northeast in the 2004 survey.[1] Some of these differences are related to reimbursement issues,[3] and some are related to local customs and practices.

From the perspective of the anesthesiologist, the venue is important for several reasons. The most important is the capability for patient monitoring and resuscitation that is available in a particular location. Secondary considerations involve the scheduling and availability of anesthesia personnel, if requested for assistance in the sedation. Most anesthesiologists believe that an operating room provides the most flexibility for caring for medically challenging patients. Endoscopy equipment is relatively portable, compared with the equipment for other nonsurgical procedures in which anesthesiologists are involved (eg, CT scanning). This portability makes it possible for endoscopy cases to be treated in an operating room even if that location is not the endoscopist's preference.

SEDATION VERSUS GENERAL ANESTHESIA

In the survey mentioned previously, gastroenterologists in the United States reported that sedation is provided for 98% to 99% of esophagogastroduodenoscopies (EGDs) and colonoscopies.[1] It seems likely that this nearly universal use of sedation also is the practice for other procedures performed in the GI suite, such as endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic ultrasonography (EUS). Most patients received sedation under the supervision of the gastroenterologist; the survey reported that anesthesia care providers (both anesthesiologists and certified registered nurse anesthetists) were responsible for providing sedation in approximately 28% of cases. Of note, the use of anesthesia personnel varies widely among geographic areas. Fewer than 10% of patients undergoing procedures in the Northeast, Midwest, and Southwest regions have an anesthesia care provider involved in their care, but 17% of patients in the South and more than one third of patients in the Mid-Atlantic area have anesthesia professionals responsible for administering their sedation. Some of these regional differences may be economically driven and are discussed later in this article. Although are no data are available to describe what patient characteristics prompt the GI physician to use anesthesia professionals, the experience of most anesthesiologists is that they are asked to care primarily for pediatric patients, patients who have a history of being difficult to sedate, and patients who have life-threatening medical conditions.

When anesthetizing patients in the GI suite, an anesthesiologist first must decide what level of sedation or anesthesia is required. Many factors play a role in this

decision-making process. The patient's medical status, including whether the patient is at risk for aspiration and requires protection of the airway with an endotracheal tube, is an essential factor to consider. The complexity of the GI procedure, the patient position required to perform the procedure, and the proximity of the anesthesia care provider to the patient's airway during the procedure also must be considered when developing an anesthetic plan. Other factors that often are used in this decision-making process include a patient's history of failed sedation by non-anesthesia health care providers, substance abuse, or mental illness.

Relatively healthy patients who are undergoing simpler procedures, such as EGD or colonoscopy, often tolerate the procedure well with moderate sedation. At many institutions these patients are sedated without the involvement of anesthesia personnel. A significant number of GI facilities, however, do use anesthesia care providers for nearly all sedation procedures, and anesthesiologists can expect to provide moderate sedation to the most of their patients in such a practice setting. In most GI units, however, anesthesia professionals usually are involved only for more complex patients or procedures. These situations often require deep sedation or general anesthesia to achieve adequate patient comfort, cooperation, and optimal operating conditions for the GI physician.

One challenge for both gastroenterologists and anesthesiologists is to predict before the procedure which patients will require deep sedation or general anesthesia not because of the patient's medical condition or the complexity of the procedure but to provide sufficient patient cooperation and comfort. Data to determine patient factors that could assist in identifying patients who may be difficult to sedate do not seem to be available and could be the focus of future study. In areas outside North America, many patients undergo simple GI procedures, such as EGD, without any sedation. There are data from Europe identifying factors that predict poor patient tolerance of an unsedated EGD, and these same patient characteristics also might predict patients who will require deeper levels of sedation or general anesthesia for a successful procedure in practice settings where sedation is used for all patients. Both apprehension about the procedure, as rated by the patient, and high levels of anxiety, as measured by administering the state trait anxiety inventory before the procedure, were associated with poor patient tolerance.[4]

OTHER PRACTICAL ISSUES

Scheduling

Facility scheduling for endoscopic procedures shares many characteristics with scheduling for surgical procedures. One consideration is the availability of multiple resources, including the endoscopist, nursing personnel, endoscopy equipment, and a physical location for the procedure. Some gastroenterologists favor an open-access model of scheduling[5] in which patients are referred from other physicians and there is no preprocedure office visit. This method does present challenges in assuring that the proper procedure is indicated and that the patient is prepared adequately.

If the gastroenterology practice uses an anesthesiologist to provide sedation for only selected cases, the matter of scheduling becomes even more complicated. The availability of an anesthesiologist then must be considered as an additional resource that must be scheduled. Cases requiring the service of an anesthesiologist should be grouped together when possible to increase the likelihood of financial viability for that provider. If the volume of sedation cases is large enough, an anesthesiologist may dedicate the entire day to the endoscopy facility. Otherwise, the anesthesiologist probably will spend part of the day providing sedation for endoscopies and part of the day providing anesthesia in another location.

Preprocedure Evaluation

If the expectation is that the anesthesiologist will provide deep sedation or general anesthesia for a patient, the principles of pre-anesthetic evaluation that apply to surgical cases should apply to these endoscopic cases also. This evaluation requires a significant amount of communication between the anesthesiologist and the gastroenterologist about the patients in question. If there is a well-defined process, the patient must follow the same steps for evaluation. Depending on the patient's condition, these steps could include laboratory testing and EKG and echocardiographic evaluations. If processes for routine performance of a pre-anesthetic evaluation are not in place, the anesthesiologist must ensure that the gastroenterologist understands the expectations regarding pre-anesthetic evaluation.

The pre-anesthetic evaluation has become one of the challenges of providing anesthesia for these cases. Often the patient arrives in the facility for monitored anesthesia care or general anesthesia poorly prepared for an anesthetic. This situation results in frustration for everyone involved.

One area of particular concern is management of antiplatelet medications, especially when patients have had recent placement of a drug-eluting stent. This concern is pertinent in procedures in which there is a chance for bleeding, such as banding of esophageal varices or ERCP with sphincterotomy. As with surgical cases, the decision of whether to withhold these medications is complex and must be made in collaboration with the cardiologist, gastroenterologist, and anesthesiologist. One approach that has been advocated when patients are taking anticoagulants[6] is to perform an initial diagnostic endoscopy for visualization only while the still patient is following the usual anticoagulant regimen. Once the results of that endoscopy are known, an informed decision can be made about managing anticoagulation if a therapeutic endoscopy is needed. It is reassuring that a small case-control study of ERCP with sphincterotomy suggested that the risk of clinically significant bleeding is not increased in patients who have been taking antiplatelet medications within 10 days of the procedure.[7]

Reimbursement for Sedation and Analgesia

In the traditional model in which the gastroenterologist administers sedation, payors typically do not provide separate reimbursement for the sedation. As anesthesiologists have begun to provide this service, separate claims are being submitted for the sedation. Estimates are that charges to Medicare for anesthesia for colonoscopy increased by 86% between 2001 and 2003, to $80,000,000.[3] In response to that rapid rise, payment for anesthesia for endoscopy has been scrutinized. Most payors distinguish between high-risk and average-risk cases. In general, they have allowed charges for anesthesia in high-risk patients. Payment policies for average-risk patients are evolving, however, and there are differences among Medicare contractors. Consequently, regional differences in practice have developed that seem to be influenced by reimbursement patterns. For example, the growth in charges by anesthesiologists to Empire Medicare Services[3] in the metropolitan New York area is far steeper than the national growth rate, presumably in part because at this Medicare contractor's policies allow reimbursement.

MEDICATIONS FOR SEDATION AND ANALGESIA

The most widely used combination for sedation for GI endoscopy is a benzodiazepine, such as midazolam, and an opioid, such as meperidine or fentanyl,[8] but several other medications have been explored in the quest for ease of titration, rapid recovery, and minimization of untoward side effects.[9]

Propofol

Propofol is an agent that typically has been used for general anesthesia, but in subhypnotic doses it can produce moderate levels of sedation. Its therapeutic window is very narrow, making it easy to move from the level of moderate sedation into deep sedation or general anesthesia. Therefore the Food and Drug Administration (FDA) product label currently states that propofol "should only be administered by persons trained in the administration of general anesthesia," which also would give them the ability to rescue a patient from unintended levels of deep sedation.[10] This practice also is consistent with the Joint Commission for the Accreditation of Health Care Organization's current approach to sedation. Their standards state that practitioners providing sedation should be able to rescue patients who slip into a deeper-than-desired level of sedation.[11] Specifically, persons providing moderate sedation should be qualified to rescue patients from deep sedation and be competent to manage a compromised airway and provide adequate oxygenation and ventilation.

The drive to use propofol as an adjunct to endoscopy goes hand-in-hand with the increased demand for these procedures. Because the practice of endoscopists has become busier, there are increased needs for efficiency.[9] In the past, prolonged recovery and relatively long discharge times resulted in a loss of efficiency. Because propofol has a fast onset and allows rapid recovery, gastroenterologists have become interested in using it for their procedures. The restrictions mentioned previously, however, suggest that an anesthesiologist should be involved in the sedation.

These governmental restrictions are not as clear-cut in other countries. Quoting a worldwide experience with gastroenterologist-directed administration of propofol for procedural sedation in 200,000 patient encounters with no mortalities, several gastroenterology-related professional societies have questioned the medical necessity of restricting its use to anesthesiologists.[8] In 2005, the American College of Gastroenterology petitioned the United States FDA to remove the section of the warning label pertaining to administration by individuals trained in general anesthesia.[12]

In response to the current political and regulatory environment and in combination with escalating costs associated with administering propofol by an anesthesiologist in the United States, several alternative models of administration have emerged.[13] One alternative is nurse-administered propofol sedation. In this model, propofol is administered by registered nurses under a strict protocol and under the supervision of the endoscopist.[14] There are several studies of this model in the literature, covering more than 200,000 administrations. Questions still remain about the true incidences of airway complications[13] and need for airway interventions. Debate also continues about whether this model obviates the need for the endoscopist to have skills in deep sedation and airway rescue.

Another alternative model for propofol administration is patient-controlled sedation. The theoretic advantage of patient-controlled sedation is that it allows the patient to match his or her sedation needs to the discomfort of the procedure while avoiding the effects of oversedation.[13] This model is discussed further later in this article.

Fospropofol

Fospropofol is a water-soluble prodrug of propofol that currently is being evaluated as a sedative agent for diagnostic and therapeutic procedures.[15] It is hydrolyzed rapidly to release propofol. Following intravenous (IV) administration, the plasma concentration profile of fospropofol-derived propofol is characterized by a smooth and predictable rise and decline instead of the rapid spike observed following administration of

the lipid-emulsion formulation of propofol. The elimination kinetics of propofol is similar, whether it was derived from fospropofol or not.

One dose-ranging study appears in the literature. Cohen[15] studied 127 patients receiving either midazolam or one of four different doses of fospropofol for sedation for elective colonoscopy. The investigators examined rates of sedation success, time to sedation, requirements for alternative sedative medication, requirements for assisted ventilation, supplemental doses of sedative, time to discharge, and satisfaction of the physician with the sedation. Only one patient required any kind of airway intervention, and that was verbal stimulation to address hypoxemia. The investigators concluded that the 6.5-mg/kg dose provided the ideal balance of efficacy and safety.

The medication is currently under phase III trials and has not yet been approved for use in the United States. Interestingly, the American Society of Anesthesiologists has submitted formal comments to the FDA requesting that the fospropofol label contain restrictions similar to those for propofol,[16] because they believe that this drug also will be able to produce a state of general anesthesia in patients.

Dexmedetomidine

Dexmedetomidine is another relatively new agent that has been considered for sedation for endoscopy. It is a highly selective α_2-adrenoreceptor agonist with sedative and analgesic effects[17] that was approved in 1999 by the FDA for sedation in patients in ICUs.[18] One significant reported advantage is that patients can be sedated but are able to be roused to full consciousness easily.[19]

Only a handful of studies have examined this agent specifically in the setting of endoscopy. Demiraran and colleagues[20] compared dexmedetomidine and midazolam as the sedative agent for EGD. No opioids were given in this small study of 50 patients that was performed in Turkey. The investigators concluded that dexmedetomidine and midazolam have similar efficacy and safety profiles.

Another study from Poland examined dexmedetomidine in comparison with meperidine or fentanyl as a single agent for sedation for colonoscopy. The investigators found that patients in the dexmedetomidine group required significant supplemental fentanyl and had a high risk of bradycardia and hypotension. They concluded was that dexmedetomidine is not a suitable agent for sedation.[21]

Ketamine

Ketamine has been examined both as a sole agent and in combination with other medications in adults and children. Most references in the literature relate to its use in children. Gilger and colleagues[22] retrospectively examined 402 procedures in which various combinations of midazolam, meperidine, and ketamine were used. They found that the midazolam/ketamine combination had the lowest rate of complications and a rate of adequate sedation equivalent to that of the other combinations. Intramuscular ketamine also has been studied as a sole agent for sedation in pediatric endoscopy but was found to have a high failure rate in a small study.[23] Kirberg and colleagues[24] have described their experience with ketamine in both pediatric endoscopy and adult endoscopy and have found it to be an effective agent. In advanced endoscopic procedures in adults, such as ERCP and EUS, ketamine is a useful adjunct to more traditional sedation agents and helps produce acceptable procedural conditions.[25]

Benzodiazepines

Benzodiazepines have long been an integral part of the sedation regimen for GI endoscopy. The early preparations of IV benzodiazepines were lipid soluble, creating issues with administration. During that time, diazepam was the medication in this class most

frequently used for endoscopy. Once water-soluble midazolam became available in the late 1980s, it quickly gained favor.[26] Today, midazolam is strongly favored over diazepam.[1]

Opioids

The second part of the conventional sedation combination is an opioid. Twenty years ago, meperidine was a mainstay.[26] Today, meperidine and fentanyl are used about equally.[1] Some practitioners also have begun to use other fast-acting opioids such as remifentanil,[27] although usually not as a single agent.

SEDATION/ANESTHESIA FOR SPECIFIC PROCEDURES

GI endoscopic procedures vary significantly in their complexity and the degree of patient stimulation and pain that occur. Therefore, the optimal sedation or anesthetic techniques for various procedures for various procedures differ.

Esophagogastroduodenoscopy

Adequate sedation for EGD can be achieved in most patients with a combination of an IV benzodiazepine and opioid, but most anesthesiologists use IV propofol for EGD sedations. When surveyed, gastroenterologists have reported greater satisfaction with propofol than with the conventional sedation technique of benzodiazepine and an opioid. In fact, the median satisfaction score for propofol was 10 on a 10-point scale in which 10 was defined as best.[1] Moderate and deep sedation as well as general anesthesia can be achieved with propofol. Patients who have a history of substance abuse or of being difficult to sedate usually require deep sedation or general anesthesia for an EGD procedure. Even when moderate sedation is the intended goal for the procedure, however, deep sedation often is achieved. In one study, 60% of patients undergoing EGD reached a level of deep sedation despite a preprocedure plan for moderate sedation.[28]

Another factor to consider when choosing between sedation and general anesthesia for EGD is whether endotracheal intubation is needed. The indication for performing EGD, such as persistent vomiting or severe gastroesophageal reflux disease, may dictate protection of the airway with an endotracheal tube. In other patients, such as those who are obese or who have obstructive sleep apnea, significant airway obstruction during deep sedation may necessitate endotracheal intubation. Patients who do undergo endotracheal intubation usually require a level of general anesthesia to tolerate adequately both the endoscopic procedure and the presence of the endotracheal tube.

A unique anesthetic technique for EGD that has been reported is general anesthesia via a ProSeal laryngeal mask airway (LMA).[29] The drain tube of this specialized LMA can serve as a conduit to guide the gastroscope into the stomach, thus possibly improving the ease of the endoscopic procedure for the gastroenterologist. In the recent study that described this technique, the anesthesia and endoscopy times were significantly shorter in the group of patients randomly assigned to the use of the ProSeal LMA than in patients who received the same anesthetic drugs but whose airways were managed with chin lift/jaw thrust as needed and oxygen via nasal cannula. In addition, the mean oxygen saturation was higher and fewer episodes of arterial oxyhemoglobin saturation (SpO_2) less than 90% occurred in the ProSeal group than in the nasal cannula group.

An adjunct to sedation for EGD that often is overlooked but should be considered by anesthesiologists is topical pharyngeal anesthesia. Although some studies have

reported no added benefit from topical anesthesia in sedated patients,[30] other individual studies[31] as well as a meta-analysis[32] have reported that ease of endoscopy is improved in patients who receive topical pharyngeal anesthesia in addition to sedation. In the United States, commercially available local anesthetic sprays, including Cetacaine and Hurricane sprays, are used most commonly to provide pharyngeal anesthesia. These sprays contain benzocaine, which has been associated with the development of methemoglobinemia.[33] Another option for topical anesthesia that could avoid the risk of methemoglobinemia is use of a lidocaine lollipop. Investigators at an institution in Lebanon found this technique very effective. In fact, only one third of patients who received the lollipop required IV sedation for EGD, whereas nearly 100% of the patients who did not receive topical anesthesia required sedation.[34]

Colonoscopy

Like EGD, adequate sedation for colonoscopy can be achieved with a combination of benzodiazepine and an opioid in most patients. One study found that when moderate sedation was planned, deep sedation was less likely to be achieved during colonoscopy than during EGD, ERCP, or EUS.[28] This difference may be explained by the apparently less stimulating nature of colonoscopy compared with the other procedures. When anesthesia professionals provide sedation for colonoscopy, however, they usually use propofol and often plan to attain a level of deep sedation or general anesthesia. In fact, it seems likely that even when gastroenterologists are responsible for the sedation during colonoscopy, they and their patients actually prefer to achieve at least deep sedation rather than moderate sedation. In a study of nurse-administered propofol sedation that was performed under the supervision of the GI physician, the mean bispectral index score was 59, indicating a state of general anesthesia.[35]

Several sedation or anesthesia techniques for colonoscopy have been studied. Remifentanil is a very short-acting opioid that may offer advantages for patients undergoing outpatient colonoscopy. Moerman and colleagues[36] compared IV remifentanil versus IV propofol. They found that measures of early recovery, such as spontaneous eye opening and following commands, occurred sooner in the patients who received remifentanil. Recovery of cognitive function also was faster with remifentanil than with propofol. Respiratory depression occurred more frequently in the remifentanil group, however, and patient satisfaction was lower in this group than in the propofol group. In another study that compared remifentanil and propofol, postprocedure nausea and vomiting was a significant problem with remifentanil sedation.[37] General anesthesia using an inhalational technique of sevoflurane/nitrous oxide has been compared with total IV anesthesia (TIVA) using propofol/fentanyl/midazolam for colonoscopy. Patients who received the inhalational anesthetic were less sedated 20 minutes after the procedure than patients who received TIVA. A greater degree of psychomotor impairment that lasted longer also was reported in the TIVA group.[38]

The use of propofol alone to achieve deep sedation has been compared with lower doses of propofol in combination with fentanyl and/or midazolam titrated to moderate sedation. Patients who received the combination therapy were discharged more quickly than patients who received only propofol with no differences found between the groups in satisfaction scores, vital signs, or oxygen saturation.[39]

Patient-controlled sedation with propofol is a new technique that seems to be effective for sedation during colonoscopy. A prospective, randomized study in France compared patient-controlled sedation with anesthesiologist-administered propofol. Patients in the patient-controlled group self-administered 20-mg boluses of propofol as needed with a lock-out time of 1 minute. Patients in the anesthesiologist-controlled group received a continuous infusion of propofol that was titrated to effect. Success of

the colonoscopy, which was defined by reaching the cecum, and technical ease of the procedure as rated by the gastroenterologist did not differ between the groups. In addition, patient satisfaction was similar between the groups. Several advantages were reported for patient-controlled propofol administration compared with administration by an anesthesiologist. Depth of sedation was less in the patient-controlled group, and fewer episodes of SpO_2 less than 94% were reported. Time to discharge also was shorter with patient-controlled sedation. The most striking difference reported was the mean total dose of propofol administered: 60 mg in the patient-controlled group versus 248 mg in the physician-administered group.[40] It is quite probable that patient-controlled sedation may become a preferred method of sedation for colonoscopy in the future.

Endoscopic Retrograde Cholangiopancreatography

Patients undergoing ERCP often are more severely ill than patients undergoing EGD or colonoscopy. Common presenting diagnoses include pancreatitis, pancreatic cancer, and cholangitis. The serious medical conditions of these patients may account in part for the high risk of cardiopulmonary complications associated with ERCP. In one study of patients cared for by anesthesia care providers, approximately 25% of patients age 65 years or older developed new electrocardiographic changes during or after ERCP, and 11% of patients in that age group had elevated cardiac troponin levels after the procedure.[41] Relatively complex therapeutic procedures that are of longer duration than EGD or colonoscopy, such as biliary sphincterotomy, removal of bile duct stones, and placement of biliary stents, frequently are undertaken during the ERCP. Patient immobility is an important factor in the successful completion of these technically challenging procedures. Most endoscopists perform ERCP in the prone position. Finally, some of these patients require chronic opioid therapy because of their underlying biliary disease. Therefore, management of patients presenting for ERCP often is more challenging for the anesthesiologist than providing anesthesia for EGD or colonoscopy.

Despite these challenges, some anesthesiologists successfully provide moderate or deep sedation for ERCP. Propofol usually is the preferred sedative drug. One study compared sedation with midazolam or propofol. The procedure was completed successfully more often in patients receiving propofol (97.5%, versus 80% for midazolam), and recovery time was significantly shorter.[42] Anesthesiologists also have provided successful sedation for ERCP by using a target-controlled infusion of propofol and titrating to a target concentration of 2 to 5 μg/mL.[43]

Several of these issues encountered with ERCP have led many anesthesiologists to prefer general anesthesia for this procedure. There are data that support this clinical approach. In one retrospective study of more than 1000 patients, the ERCP failure rate with moderate sedation was double that with general anesthesia (14% versus 7%), with most failures resulting from inadequate sedation.[44] It also has been reported that complication rates associated with therapeutic interventions during ERCP may be significantly lower when general anesthesia is used, perhaps because the absence of patient movement makes the procedure technically less difficult.[45]

When general anesthesia is administered for ERCP, the airway often is protected by endotracheal intubation because of the prone position required during the procedure and because of the presence of risk factors for aspiration in some patients. Investigators, however, have used the LMA successfully for ERCP performed under general anesthesia, in some cases even placing the LMA while the patient was in the prone position. They reported that the endoscope was advanced without difficulty, and time to removal of the airway device was shorter than in patients who underwent endotracheal intubation.[46]

Endoscopic Ultrasonography

Like ERCP, EUS is a more complex procedure than EGD or colonoscopy. It is used for diagnosing and staging GI and pancreatic tumors. Needle-aspiration biopsies often are performed that require examination by a pathologist to determine the adequacy of the sample before the procedure can be completed. Therefore, EUS procedures may be relatively long in duration. In addition, the specialized ultrasound-containing endoscope is significantly larger than a standard endoscope, and insertion causes more patient discomfort than experienced during EGD. As a result, adequate sedation for the procedure is more likely to require deep sedation or general anesthesia.

Some patients satisfactorily tolerate an EUS procedure with a combination of benzodiazepine and an opioid. Titration to an adequate level of sedation while avoiding airway obstruction and hypoxemia may be more problematic during EUS than during EGD or colonoscopy, however. As a result, alternative sedation techniques have been investigated. In one study, preprocedure sedation with moderate doses of benzodiazepine and an opioid were supplemented as needed during the EUS with either ketamine or additional doses of the benzodiazepine and opioid. Improved sedation (as measured by patient comfort and degree of sedation-related technical difficulty) and faster recovery were achieved with ketamine. In addition, approximately one third of patients who were assigned randomly to the benzodiazepine/opioid arm of the study had to cross over to ketamine to achieve an adequate level of sedation to complete the EUS successfully.[25]

Propofol, of course, is another preferred anesthetic drug for EUS. A propofol infusion controlled manually by the anesthesiologist is used most commonly, but other techniques, including a target-controlled propofol infusion, have been used successfully for sedation during EUS. Because preprocedure anxiolysis is beneficial in some patients, one group of investigators studied the effect of administering a dose of midazolam before initiating the target-controlled infusion. Administration of midazolam did not reduce significantly the amount of propofol required during the EUS, but it also did not delay the time to discharge readiness.[47] Patient-controlled sedation with propofol and fentanyl, using 4.25-mg boluses of propofol and 3.75-μg boluses of fentanyl without a lock-out time, also has provided sedation successfully during EUS.[48]

Pediatric Procedures

Most pediatric patients require deep sedation or general anesthesia to tolerate GI endoscopic procedures. Therefore, anesthesiologists are more likely to participate in pediatric procedures than in adult procedures. At many institutions, anesthesia care providers administer the sedation or anesthesia for all or most pediatric endoscopies. Many of the anesthetic principles and drugs used in caring for adult GI patients are pertinent in the pediatric population, but there are additional challenges. Typically, pediatric patients require larger per-weight doses of the sedative medications than adults. One group of investigators determined the median effective concentration of propofol required for EGD in children. It was significantly higher (3.55 μg/mL) than the usual concentration required in adults undergoing this procedure.[49]

Other challenges encountered when caring for children in the GI suite that are unique to the pediatric population are distress caused by the insertion of an IV catheter and by separation from parents. When young children are anesthetized in the operating room, IV catheters usually are placed after mask induction with a volatile anesthetic agent. At many GI facilities, it is not practical to have an anesthesia machine available, and IV drugs are used to provide both sedation and general anesthesia. Insertion of the IV catheter often is the most difficult part of the sedation procedure for

everyone involved (patient, parents, and practitioner). Techniques that can facilitate IV placement as well as separation from the parents are invaluable. In one study, preprocedure administration of oral midazolam was more effective in improving both concerns than the use of IV propofol only. The researchers also found that administration of oral midazolam significantly decreased the dose of propofol required during endoscopy. Recovery time was significantly longer in patients who received midazolam, but longer recovery time seems a small price to pay to make the procedure less traumatic for both child and parents, especially because the mean recovery time still was only 26 minutes.[50]

MANAGING COMPLICATIONS

One prospective cohort study has reported on cardiopulmonary complications that occurred during nearly 12,000 colonoscopies or EGDs in which patients received monitored anesthesia care with propofol. The overall rate of complications was 0.86% for colonoscopy and 1.01% for EGD. The rate of serious adverse events was much lower, however: 13 of 8129 colonoscopies and 6 of 3762 EGDs. Of interest, the rate of complications was lower for both procedures when an anesthesia practitioner, rather than a gastroenterologist, provided sedation.[51] There are few other data available about sedation or anesthesia-related complications associated with GI endoscopy when sedation was provided by an anesthesiologist.

Despite the limited data, anesthesiologists should anticipate that anesthetic complications will occur occasionally. The principles for management of these complications do not differ from management in the operating room, but anesthesia practitioners also must realize that the resources available for handling these problems in the operating room suite may not be as readily accessible in the endoscopy suite. Support personnel in the operating room may be comfortable assisting anesthesiologists during acute cardiopulmonary events, but nursing staff in the GI suite have more limited exposure to such events and may not be able to provide the same level of assistance. Necessary equipment, such as that needed for advanced airway techniques, may not be available immediately. Before providing anesthesia services in the endoscopy unit, the anesthesiologist should anticipate, based on the patient's medical condition, what equipment might be needed and have it present in the GI suite. The anesthesiologist also should have a plan for obtaining additional assistance in the event of a serious adverse event. Many of these endoscopy procedures can be performed in an operating room. In certain high-risk patients, it is appropriate to request that the anesthetizing location be moved to the operating room where serious anesthesia-related complications can be managed more efficiently and effectively.

POSTANESTHESIA RECOVERY

At facilities where most endoscopy procedures are performed with gastroenterologist-administered moderate sedation, the anesthesiologist must understand fully the capabilities of the nursing staff responsible for monitoring patients during the recovery period. These units sometimes are equipped only to provide nursing care at the level necessary for monitoring patients who have received moderate sedation. It is essential that patients who have received deep sedation or general anesthesia for their endoscopy procedures receive the same level of nursing care they would in the postanesthesia care unit (PACU) of the institution's surgical suite. In fact, regulatory organizations such as the Joint Commission for Accreditation of Health Care Organizations require that equivalent postanesthesia care be delivered in all locations within the health care facility. Information such as the type of training the recovery nurses in

the endoscopy suite have received (eg, is the training equivalent to that required of nurses who work in the surgical postanesthesia care unit?) and whether the same patient/nurse staffing ratio used in the surgical PACU can be achieved in the GI suite must be determined when deciding on the appropriate location for recovery of these patients. If adequate nursing care is available, it is preferable for the postanesthesia recovery to occur in the endoscopy suite to avoid transportation of the patient to another location in the immediate postprocedure period. If the anesthesia care provider does not feel comfortable with the level of care available in the GI suite, however, arrangements to transfer the patient to the surgical suite's PACU should be made. Even when satisfactory recovery room care is available in the endoscopy suite, it may be advisable to monitor patients who are at especially high risk for developing anesthesia-related complications in a unit such as the surgical suite's PACU, where these complications are encountered and managed on a frequent basis.

Discharge criteria should be the same as those used for patients who receive anesthesia or sedation in the operating room. Recovery nurses need to understand fully the criteria and know how to contact anesthesia personnel for assistance during the recovery period. Postanesthesia management of patients who have obstructive sleep apnea may be especially challenging. Based on the guidelines published by the American Society of Anesthesiologists,[52] it should be expected that prolonged recovery times may be required for these patients. If logistical or staffing issues do not allow extended monitoring of these patients, arrangements for postanesthesia recovery in another location will be necessary.

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