Anesthesia for gastrointestinal endoscopy in adults

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INTRODUCTION

The field of gastrointestinal (GI) endoscopy is growing, both because of expanded recommendations for screening colonoscopy [1] and because of increasing use of extrapancreatic advanced endoscopic procedures [2]. Over 50 million GI endoscopic procedures were performed in the United States alone in 2017, including approximately 19 million colonoscopies [3].

This topic will discuss anesthetic management for both routine and advanced GI endoscopy. Management of monitored anesthesia care (MAC), office-based anesthesia, and procedural sedation and alternatives to sedation administered by non-anesthesia clinicians are discussed separately. (See "Monitored anesthesia care in adults" and "Gastrointestinal endoscopy in adults: Procedural sedation administered by endoscopists" and "Sedation-free gastrointestinal endoscopy" and "Office-based anesthesia".)

PREPROCEDURE EVALUATION

A medical history and anesthesia-directed physical examination should be performed in all patients who undergo any type of anesthesia, including sedation for endoscopy. The goals of preanesthesia evaluation are to identify underlying medical and physical conditions that may increase risks and to formulate an anesthetic plan that minimizes these risks. Hypoxemia and aspiration are the most frequent complications among patients undergoing GI endoscopic procedures. (See 'Complications' below.)

In anticipation of GI endoscopy, the patient should be evaluated for conditions that increase sensitivity to sedative and analgesic medications (eg, older age; obstructive sleep apnea; advanced chronic lung disease; pulmonary hypertension; coronary artery, liver, or severe kidney disease). Patients should also be evaluated for conditions that may require increased doses of sedatives and analgesics (eg, anxiety disorders; chronic pain; use of opioids, sedatives, or recreational drugs such as marijuana) to allow appropriate drug dosing and administration. (See "Gastrointestinal endoscopy in adults: Procedural sedation administered by endoscopists".)

- **ASA physical status** – Similar to other procedures that require anesthesia, patients with higher American Society of Anesthesiologists (ASA) physical status (table 1) classification are at increased risk of periprocedural adverse events [4,5]. The complexity and frequency of advanced endoscopic procedures are increasing, as well as the comorbidities of the patients who undergo such procedures. In particular, therapeutic endoscopic retrograde cholangiopancreatography (ERCP) is associated with increased risk of adverse events, regardless of ASA status [4], and is now performed for patients who were previously considered inoperable or who are critically ill. Patients with symptoms of achalasia including those who have undergone Heller myotomy or peroral endoscopic myotomy (POEM) are at increased risk of aspiration and should be carefully evaluated for need for tracheal intubation.

- **Preanesthesia testing** – Preoperative laboratory and cardiac testing should be performed as it would be for patients who undergo anesthesia for surgery. (See "Preoperative medical evaluation of the healthy adult patient".)

  Preoperative blood testing is not performed for most diagnostic endoscopies, unless indicated by patient comorbidities. Preprocedure testing for ERCP is discussed separately. (See "Overview of endoscopic retrograde cholangiopancreatography (ERCP) in adults", section on 'Patient preparation'.)

  We rely heavily on the patient's functional status when deciding whether to perform cardiac testing beyond an electrocardiogram for patients who undergo advanced endoscopic procedures, which confer higher risk of adverse events than diagnostic endoscopy. Endoscopic procedures are usually classified as conferring low risk of perioperative cardiac events. However, the commonly used revised cardiac risk index (RCRI) is not appropriate for patients having outpatient procedures, and the calculators that use National Surgical Quality Improvement (NSQIP) database (eg, Myocardial

Infarction or Cardiac Arrest [MICA] or American College of Surgeons Surgical Risk Calculator) do not include endoscopic procedures (see "Evaluation of cardiac risk prior to noncardiac surgery", section on 'Using risk assessment tools'). By contrast, the Surgical Outcome Risk Tool (SORT) includes the option to calculate risk for some advanced endoscopic procedures, including diagnostic and therapeutic ERCP.

ERCP carries an approximately 5 percent risk of major complications, including acute pancreatitis, bleeding, sepsis, and perforation, any of which can result in major cardiovascular events. (See "Evaluation of cardiac risk prior to noncardiac surgery" and "Overview of endoscopic retrograde cholangiopancreatography (ERCP) in adults", section on 'Patient preparation'.)

Airway evaluation should be performed for all patients who undergo anesthesia. Airway assessment is discussed in detail separately. (See 'Airway management' below and "Airway management for induction of general anesthesia", section on 'Airway assessment' and "Management of the difficult airway for general anesthesia in adults", section on 'Recognition of the difficult airway'.)

PREOPERATIVE FASTING

Patients should follow preoperative fasting guidelines as they would for any type of anesthetic (table 2). (See "Preoperative fasting in adults".)

In patients with impaired gastric emptying or high risk of aspiration and in emergencies, the potential for aspiration should be considered when determining the level of sedation and whether to intubate to protect the airway. Patients with a history of aspiration pneumonia and conditions such as severe gastroparesis and achalasia benefit from extended fasting times. (See "Rapid sequence induction and intubation (RSII) for anesthesia", section on 'Indications'.)

ANESTHETIC MANAGEMENT

There are many ways to provide anesthesia for endoscopy, and practice varies widely across the United States and the world. Factors that determine the choice of anesthesia are facility preference, resource availability (especially anesthesia providers), proceduralist preferences, and patient factors. These procedures may be performed in free-standing endoscopy units, in-hospital endoscopy units, or operating room suites. Basic and emergency equipment, medications, and personnel should be the same, regardless of anesthetizing location. (See "Office-based anesthesia", section on 'Safety concerns'.)

Choice of anesthetic technique — The choice of anesthetic technique should be based on patient factors and the requirements of the procedure, including anticipated duration and complexity. General anesthesia with tracheal intubation (GETA) may be the best choice for patients at high risk of aspiration and for many advanced endoscopic procedures, especially endobariatric and submucosal dissection. Total intravenous anesthesia (TIVA) must be used in facilities without anesthesia machines or gas scavenging, and therefore without the option for inhalation anesthesia. Induction and maintenance of general anesthesia are discussed separately. (See "Induction of general anesthesia: Overview" and "Maintenance of general anesthesia: Overview".)

Moderate or deep sedation is commonly used for patients without risk factors for aspiration. Moderate sedation (also called conscious sedation) refers to a level of sedation in which patients respond purposefully to verbal commands and maintain spontaneous ventilation without support. Patients under deep sedation cannot be easily aroused but respond purposefully to painful stimulation and may require assistance in maintaining a patent airway (table 3). However, patients often transition between various depths of sedation, and deep sedation can easily become general anesthesia, especially if propofol is administered [6]. (See "Monitored anesthesia care in adults", section on 'Clinical assessment of sedation' and "Monitored anesthesia care in adults", section on 'Propofol'.)

Unsedated endoscopy is rarely used in the United States and is more commonly used in other countries. Though most patients prefer sedation or anesthesia, for select patients (eg, some patients with severe cardiopulmonary disease) and procedures (such as a screening colonoscopy), sedation-free endoscopy may be preferred and is usually well tolerated. (See "Sedation-free gastrointestinal endoscopy".)

Monitoring — Monitoring for anesthesia for endoscopy should include standard physiologic monitors (table 4), with additional monitoring based on patient comorbidities. (See "Monitored anesthesia care in adults", section on 'Standard physiologic monitors'.)

Ventilation should be monitored with capnography during moderate or deep sedation. Capnography facilitates early detection of apnea and airway obstruction [7], predicts the development of hypoxemia [8], and may reduce patient injury related to respiratory depression [9]. Measurement of exhaled carbon dioxide (CO_2) may be challenging during upper endoscopic procedures (depending on the airway adjunct employed) but is usually possible using a two-channel nasal oxygen cannula or the end-tidal CO_2 tubing placed beneath or connected to an oxygen mask.

Airway management

Preparation for airway emergencies — Respiratory events, including hypoxemia, hypercarbia, and respiratory arrest, are among the most common complications of anesthesia for GI endoscopy. (See 'Complications' below.)

Airway emergencies such as laryngospasm and intractable airway obstruction may occur with little warning during both routine and advanced upper GI endoscopic procedures. Preparation for airway management should be the same for these procedures as it is for other anesthetics, with routine, specialized, and emergency airway equipment available. An air-mask-bag unit (AMBU) should be immediately available. (See "Induction of general anesthesia: Overview", section on 'Preparation for anesthetic induction'.)

Airway management strategy — Airway management for GI endoscopy should be based on patient- and procedure-related factors, including the degree of stimulation, risk of aspiration, and expected duration and complexity of the procedure. The majority of colonoscopies and upper endoscopies are performed with spontaneous ventilation, with or without airway devices, with sedation or general anesthesia. By definition, patients who are unresponsive to a painful stimulus are under general anesthesia, regardless of the airway management technique. (See "Monitored anesthesia care in adults", section on 'Monitoring depth of sedation and analgesia'.)

The following issues should be considered when planning airway management for endoscopy:

- **Predicted difficulty with airway management** – The choice of anesthetic technique and/or airway management may depend on the preoperative airway assessment. Any anticipated difficulty with mask ventilation and subsequent airway obstruction might call for use of tracheal intubation from the outset. However, with an expanding array of devices, the need for tracheal intubation has decreased. (See "Management of the difficult airway for general anesthesia in adults".)

  For patients who are at high risk of respiratory depression or obstruction, noninvasive ventilation or heated humidified high-flow oxygen may be helpful during sedation [10-12], though routine use is neither necessary nor cost effective.

- **Risk of aspiration** – Each patient who undergoes GI endoscopy should be evaluated for risk factors for aspiration, and the plan for sedation and risk of aspiration should be documented. In addition to patient factors that increase the risk of aspiration with sedation or anesthesia (table 5), some of the conditions for which endoscopy is performed are associated with a high risk of aspiration (eg, gastric outlet obstruction, achalasia, upper GI bleeding including actively bleeding varices, esophageal stricture, bowel obstruction). These patients should receive general anesthesia with rapid sequence induction and intubation, or awake tracheal intubation, to protect the airway and minimize the chance of aspiration. Patients who require a duodenal stent placement or removal should be carefully evaluated for the need for tracheal intubation. Often, they will be receiving jejunal feeds and the need for tracheal intubation may be reduced.

Delayed gastric emptying is a potential side effect of glucagon-like peptide 1 (GLP-1) receptor antagonists (eg, semaglutide, liraglutide), which are used to treat diabetes and are increasingly used for weight loss. Patients who take these medications may have residual gastric contents despite preoperative fasting and may be at increased risk of aspiration during induction of anesthesia. In 2023, the American Society of Anesthesiologists (ASA) issued guidance for patients taking GLP-1 agonists, including recommendations for holding the drug prior to surgery and rapid sequence induction precautions for patients with symptoms of delayed gastric emptying or full stomach on gastric ultrasound [13]. These issues are discussed in detail separately. (See "Rapid sequence induction and intubation (RSII) for anesthesia", section on 'Patients taking GLP-1 receptor agonists'.)

For patients with pharyngeal pouches, intubation in Trendelenburg position would allow drainage of pouch contents by gravity and may reduce the risk of aspiration before intubation. Alternatively, awake intubation may rarely be considered after discussion with the gastroenterologist and/or otolaryngologist. (See "Flexible scope intubation for anesthesia", section on 'Awake intubation'.)

During colonoscopy, gas insufflation into the colon and/or application of excessive manual abdominal pressure during the procedure may increase the risk of aspiration. In patients scheduled to undergo both upper GI endoscopy and colonoscopy, upper endoscopy should be performed first to allow suctioning of any residual gastric contents in a semireclining position and reduce the risk of aspiration.

- **Shared airway** – The anesthesiologist and the gastroenterologist share the airway during upper endoscopic procedures, and airway management must be coordinated among the care providers. As an example, laryngospasm can occur at the time of endoscope insertion or if secretions collect, especially if the depth of sedation is inadequate or the airway is irritable (eg, patients who smoke, recent or ongoing upper respiratory infection, those with postnasal drip).

- **Positioning for the procedure** – Some endoscopic procedures are routinely or often performed in prone or semiprone positions (eg, endoscopic retrograde cholangiopancreatography [ERCP]), thereby restricting access to the airway and options for a modification in airway management during anesthesia. Airway management for ERCP is discussed below.

Airway management devices — For upper GI endoscopy, the airway device used must allow insertion of the endoscope.

- **Devices for sedation – The au**thor routinely uses a Mapleson C breathing circuit for airway management. In addition to endoscopy face masks, a number of different airway devices that can be used for endoscopy have become available, including high-flow nasal cannula and nasal masks for noninvasive ventilation. Due to added cost, routine use of these some of these devices may not be reasonable, but the cost may be justified for high-risk patients (eg, patients with severe obesity or obstructive sleep apnea) and for advanced endoscopic procedures (eg, endoscopic ultrasound [EUS], ERCP).

- **Devices for general anesthesia** – Tracheal intubation is often performed for patients who have general anesthesia. Specialized supraglottic airways (SGAs) are available and are reasonable alternatives to tracheal intubation for some patients. The LMA Gastro is a dual-channel SGA with one lumen for passing the endoscope and another for ventilation (figure 1). (See "Supraglottic devices (including laryngeal mask airways) for airway management for anesthesia in adults", section on 'Choice of supraglottic airway'.)

Anesthetic requirements for endoscopic procedures — GI endoscopy requires a cooperative or still patient and a level of sedation/analgesia that provides anxiolysis, pain control, and amnesia. Different levels of sedation/analgesia may be required at various points of the procedure.

Broadly, the GI endoscopic procedures fall into three categories, each with unique requirements for sedation or anesthesia: screening colonoscopy, diagnostic upper endoscopy, and the advanced endoscopic procedures.

Diagnostic upper endoscopy — Upper GI endoscopy is performed in a head-up position, with the patient turned slightly towards the gastroenterologist. The most stimulating portion of a diagnostic upper endoscopy is the passage of the endoscope into the esophagus. Anesthesia for endoscope insertion must be deep enough to prevent coughing, gagging, retching, vomiting, and laryngospasm. We coordinate the timing with the gastroenterologist, and in most cases, the endoscope is inserted after a bolus of propofol. Lighter sedation is usually sufficient for the remainder of the procedure except during duodenal entry.

Colonoscopy — Colonoscopy is performed with the patient in the lateral position, though a switch to supine is occasionally necessary. Sedation and anesthesia are usually less challenging for colonoscopy than for upper endoscopy because the anesthesia clinician has complete access to the airway and the airway is not shared with the endoscopist. Insertion of the colonoscope is usually well tolerated, and the stimulating portions of the procedure relate to gas insufflation into the colon and manipulation of the colonoscope around curves. Gas insufflation and/or abdominal compression may increase the risk of aspiration, and aspiration is a constant risk during these procedures. The author prefers to maintain sedation light enough that airway reflexes are preserved for colonoscopy, while others administer deeper sedation.

Bowel preparation for colonoscopy has the potential to cause fluid and electrolyte shifts, which are more common with particular types of preparation solutions. The potential for hypovolemia should be considered when choosing the drugs and doses of medications used for anesthesia, particularly in older or frail patients. The choice of bowel preparation solutions and their side effects are discussed separately. (See "Bowel preparation before colonoscopy in adults".)

Advanced endoscopic procedures — The common advanced upper GI endoscopic procedures are ERCP, EUS, esophageal stricture dilatation and stenting, treatment of esophageal varices, and endoscopic mucosal resection for precancerous lesions. Endobariatrics, peroral endoscopic myotomy (POEM), and endoscopic submucosal dissection are relatively recently introduced procedures that are gaining popularity [14].

General considerations

- Advanced endoscopic procedures often require repeated insertion and removal of the endoscope and instruments. As a result, an adequate depth of anesthesia must be maintained at all times.

- The gastroenterologist may request glucagon for GI smooth muscle relaxation during advanced endoscopic procedures. Glucagon is usually supplied as a vial with 1 mg powder and a vial with 1 mL solvent; the usual initial dose is between 0.2 and 0.5 mg intravenously (IV). Glucagon may affect blood glucose and should be used with caution in patients with diabetes, insulinoma, or glucagonoma.

ERCP — ERCP is the most common advanced endoscopic procedure. ERCP is associated with an increased risk of adverse events compared with other GI endoscopies, and is often performed on patients with metabolic derangements or critical illness. ERCP is typically performed with moderate to deep sedation. Some clinicians use general anesthesia with tracheal intubation (GETA) for all or most patients who undergo ERCP, while others (including the author) intubate selectively. Guidelines from an international panel recommended using deep sedation with monitored anesthesia care (MAC) for short, routine ERCP, and GETA for patients with risk factors for aspiration and for those having complex, prolonged procedures [15].

- We suggest using GETA for ERCP in patients who are at high risk of sedation-related adverse events (eg, obstructive sleep apnea, abdominal ascites, body mass index >35 kg/m^2, chronic obstructive pulmonary disease, ASA class ≥3, predictors for difficulty with airway management, moderate to heavy alcohol use). (See 'Preprocedure evaluation' above.)

  This approach is supported by a trial including 200 patients with risk factors for difficult sedation who were randomly assigned to GETA or MAC with sedation (primarily propofol) [16]. Sedation-related adverse events were significantly more common in patients who received MAC (51.5 versus 9.9 percent), and the procedure was interrupted to convert to GETA in 10 percent of patients who received MAC. There were no differences in procedure or recovery time between groups.

  The LMA Gastro may be a reasonable alternative to tracheal intubation for ERCP [17,18]. (See 'Airway management devices' above.)

- For patients without risk factors for sedation-related adverse events who undergo ERCP, the author often uses deep sedation analgesia with a nasal trumpet connected to a Mapleson C breathing circuit (picture 1 and picture 2) [19]. The Mapleson C circuit is a widely available compact breathing circuit that allows ventilation with a breathing bag without the need for an anesthesia machine. High-flow nasal cannula and nasal mask connected to a Mapleson breathing system are other good options.

ERCP may be associated with increased risk of airway complications due to the following:

- ERCP requires a large endoscope, which can cause airway obstruction.

- The endoscope is often removed and inserted through the oropharynx more than once, which may be associated with microaspiration of bile in an unprotected airway.

- ERCP has usually been performed in the prone or semiprone position, which limits access to the airway.

  Some institutions have abandoned routine use of the prone position for ERCP, and instead at least sometimes perform the procedure in the lateral decubitus position. In one single-institution randomized trial that compared the lateral decubitus versus prone position for 266 patients who underwent ERCP, procedural outcomes including rates of biliary cannulation and cardiorespiratory complications were similar in the two groups [20]. (See

"Overview of endoscopic retrograde cholangiopancreatography (ERCP) in adults", section on 'Positioning'.)

EUS — EUS is one of the most commonly performed advanced endoscopic procedures. EUS may be lengthy and involve frequent insertion and removal of the endoscope. Thus, deep sedation or general anesthesia is needed and a short-acting opioid (eg, fentanyl) is often administered in incremental doses. EUS should be considered low risk in healthy patients but may be associated with higher risk in patients with ASA class 3 or 4, or with comorbidities such as obstructive sleep apnea or severe obesity. For patients who receive sedation for EUS, we often use a nasal mask device or high-flow nasal oxygen. (See 'Airway management devices' above.)

Other less common procedures

- **Esophageal dilation** – Esophageal dilatation with a bougie or balloon is very stimulating and requires deep sedation or anesthesia. Esophageal dilatation is most often performed for strictures that result from gastroesophageal reflux, though a variety of other etiologies are possible. (See "Endoscopic interventions for nonmalignant esophageal strictures in adults", section on 'Introduction'.)

  - Dilation of strictures at the upper esophageal sphincter requires GETA due to proximity to the glottis and intense stimulation.

  - Dilation of midesophageal strictures can be performed with deep sedation or general anesthesia with a natural airway unless food impaction is suspected. Patients with esophageal strictures are often keenly aware of a globus sensation if food is present; if so, GETA is indicated.

  Patients who have had esophagectomy (for cancer or achalasia) frequently present for esophageal dilation. In the absence of gastric motility concerns, we manage anesthesia for these patients with supplemental nasal oxygen or a nasal trumpet connected to a Mapleson C breathing system. Others may choose to perform tracheal intubation, as absence of a lower esophageal sphincter after surgery may increase the risk of aspiration.

- **Drainage of pancreatic pseudocyst** – Endoscopic drainage of large pancreatic pseudocysts should be performed with general anesthesia and tracheal intubation. Under ultrasound guidance, a stent is placed between the cyst and the stomach to allow drainage of the cyst contents into the stomach. The volume of drainage can be substantial and can increase the risk of aspiration. The risk of aspiration, and the plan for airway management, should be discussed preoperatively with the gastroenterologist. (See "Approach to walled-off pancreatic fluid collections in adults", section on 'Endoscopic drainage'.)

- **Peroral endoscopic myotomy** – POEM is the endoscopic equivalent of surgical myotomy and is a newer technique for the management of achalasia [21]. POEM is also used for other spastic foregut disorders.
  - Patients with achalasia are at high risk of aspiration, and these procedures should be performed with general anesthesia and tracheal intubation. Preprocedure esophageal drainage may be considered, as well as intubation in a semireclining position, with rapid sequence induction and intubation. Awake intubation may be considered for select patients. (See "Rapid sequence induction and intubation (RSII) for anesthesia", section on 'Airway evaluation'.)
  - POEM is a delicate endoscopic procedure that requires a still patient, usually with paralysis, though this varies among centers. The procedure is not particularly stimulating, and postoperative opioids are not usually required.
  - A small pneumoperitoneum occurs in up to 50 percent of POEM procedures. Airway pressures and tidal volumes should be monitored closely, as severe or tension pneumoperitoneum may rarely occur. Gastric distention should be ruled out prior to abdominal decompression with a Veress needle or angiocatheter. (See "Peroral endoscopic myotomy (POEM)", section on 'Pneumoperitoneum'.)
  - Pneumothorax, pneumomediastinum, and subcutaneous emphysema are other, less common complications of POEM. CO_2 should be used for insufflation, rather than air, to facilitate gas resorption. (See "Peroral endoscopic myotomy (POEM)", section on 'Adverse events'.)
  - POEM is also performed in the stomach at the level of the pylorus to treat gastroparesis (G-POEM). Anesthetic concerns are similar to those for esophageal POEM, with pathophysiology similar to patients with gastric outlet obstruction. (See "Peroral endoscopic myotomy (POEM)", section on 'POEM for gastroparesis'.)
- **Bariatric procedures** – Endoscopic procedures and devices placed endoscopically are increasingly being used for weight loss as a primary treatment or as an alternative to bariatric surgery [22]. These procedures are discussed in detail separately. (See "Bariatric procedures for the management of severe obesity: Descriptions".)

- Endoscopic placement of intragastric balloons and percutaneous gastrostomy tubes for gastric aspiration therapy may be performed with sedation; choice of anesthetic technique for these procedures is similar to other upper GI endoscopies. (See 'Choice of anesthetic technique' above.)

- Endoscopic sleeve gastroplasty and duodenal-jejunal bypass sleeve are performed under general anesthesia with paralysis. These procedures can take up to four hours, depending on the endoscopist's experience. Longer procedures and increased patient weight are both associated with increased risk for nerve compression injury and rhabdomyolysis. Bleeding and perforation are more common during these procedures. Prolonged insufflation of CO_2 causes hypercarbia, and ventilation should be appropriately adjusted to maintain normocapnia.

- **Endoscopic repair of tracheoesophageal fistula – GETA** should be performed for airway control and protection for patients who undergo treatment of tracheoesophageal fistulae (TEF) with clips or glue, and for those with a history of aspiration. These fistulae usually result from other esophageal surgical procedures or/and radiotherapy. These procedures are long and often complicated and may involve frequent endoscope changes. In addition, many patients with TEF have some degree of respiratory compromise due to ongoing aspiration. Anesthesia for other types of TEF repair is discussed separately. (See "Anesthesia for endotracheal stenting or repair of tracheoesophageal fistula" and "Anesthesia for esophagectomy and other esophageal surgery", section on 'Repair of tracheoesophageal fistula'.)

Choice of drugs for sedation/analgesia — The medications used for GI endoscopy should be based on patient factors, clinician preference and experience, and the desired depth of sedation or anesthesia. Dose, onset, duration, and effects of the drugs that are commonly used for sedation/analgesia are shown in a table and are discussed separately (table 6). (See "Monitored anesthesia care in adults", section on 'Drugs used for sedation and analgesia for monitored anesthesia care'.)

The use of sedatives and analgesics for endoscopic procedures is discussed here.

Local anesthetics

Topical — Pharyngeal topical anesthesia can be administered prior to upper GI endoscopy to facilitate insertion of the endoscope and suppress the gag reflex. Topical anesthesia may be useful for patients who have minimal or no sedation but has not been shown to be beneficial if used along with sedation [23-26]. (See "Gastrointestinal endoscopy in adults: Procedural sedation administered by endoscopists", section on 'Topical anesthesia'.)

Commonly used local anesthetics for topical anesthesia include lidocaine, benzocaine, and tetracaine, which are administered by aerosol spray or gargling. Benzocaine has been associated with methemoglobinemia and should be **avoided** in patients with a previous history of methemoglobinemia or known glucose-6-phosphate dehydrogenase (G6PD) deficiency. (See "Adverse events related to procedural sedation for gastrointestinal endoscopy in adults", section on 'Methemoglobinemia'.)

Intravenous — IV lidocaine is commonly administered to reduce the pain related to propofol administration. IV lidocaine is also sometimes used as an infusion during painful surgery as an analgesic adjunct, though the literature on such use is inconclusive. Whether IV lidocaine by bolus or infusion is beneficial during endoscopy is unclear, and we do not use it. In a meta-analysis of six trials (400 patients) that evaluated IV lidocaine for GI endoscopic procedures, IV lidocaine modestly reduced the total dose of required propofol and decreased recovery time by several minutes [26]. Conclusions from this study are limited by high statistical and clinical heterogeneity and unclear influence of anesthetic adjuncts used in the studies.

Propofol — Propofol is an essential agent for sedation for GI endoscopy. Advantages of propofol include its rapid effect site equilibration and short elimination half-time even after prolonged infusion. Thus, the depth of sedation can be adjusted rapidly (eg, a bolus can be administered to quickly deepen anesthesia for endoscope insertion) and patients recover quickly with minimal residual psychomotor effects.

However, propofol has a narrow therapeutic index, meaning that patients may rapidly transition to deeper levels of sedation, including general anesthesia, and apnea, airway obstruction, hypoxemia, and/or hypotension can result. There is no reversal agent for propofol, so oversedated patients must be managed with supportive measures, including proper airway management, until the drug wears off. In addition, depth of sedation may be unpredictable, especially in older patients, and when propofol is administered with opioids [27,28]. When propofol is administered without an endotracheal tube in place, too little propofol can result in coughing or laryngospasm, while too much can cause apnea. Thus, propofol should be titrated to effect and administered by clinicians who are able to manage airway and hemodynamic compromise.

Propofol may be used for patients with a prior history of difficulty with sedation using other medications (eg, benzodiazepines). It can be administered by infusion, intermittent bolus, or a combination of the two. The doses administered depend on the required depth of anesthesia. (See "Monitored anesthesia care in adults", section on 'Propofol' and "Maintenance of general anesthesia: Overview", section on 'Sedative-hypnotic agent: Propofol'.)

In practice, propofol is often administered with a small dose of midazolam (ie, 1 to 2 mg IV, modified for patient factors) to enhance amnesia, and with a low dose of opioid (eg, fentanyl or remifentanil) to provide analgesia and suppress cough. In one study, the combination of fentanyl (ie, 1 mcg/kg IV) or remifentanil (ie, 0.05 mcg/kg/min IV) with propofol (ie, 1.5 mg/kg IV followed by 1 mg/kg/hour IV) for sedation/analgesia for ERCP reduced the required dose of propofol and increased hemodynamic stability compared with propofol alone [29]. (See 'Opioids' below.)

Propofol may be associated with improved patient satisfaction during endoscopy compared with standard sedation [30,31]. In a prospective double-blind study of patients who underwent colonoscopy, those who were randomly assigned to receive propofol had higher patient satisfaction ratings than the group who received midazolam and fentanyl, all administered by anesthesia personnel [30]. In addition, nausea and vomiting were less common in those who received propofol. (See "Monitored anesthesia care in adults", section on 'Propofol' and "Gastrointestinal endoscopy in adults: Procedural sedation administered by endoscopists".)

Midazolam — Midazolam, alone or in combination with an opioid, is adequate for moderate sedation for most patients who undergo diagnostic upper endoscopy or colonoscopy [32]. A combination of midazolam and fentanyl is the most commonly used regimen for sedation by non-anesthesia clinicians for these procedures [33], though the use of propofol is increasing [34]. A combination of midazolam and fentanyl at safe doses is inadequate for most advanced endoscopic procedures.

Midazolam is occasionally administered prior to endoscopy as an anxiolytic premedication and by intermittent bolus during the procedure when used without propofol (table 6). Midazolam **potentiates the effects of other sedative/analgesic agents** and can cause respiratory depression when given in high doses or with other sedatives or opioids. (See "Monitored anesthesia care in adults", section on 'Midazolam'.)

Opioids — Opioids are administered during sedation/analgesia for endoscopy to provide analgesia, suppress cough, and reduce the required dose of propofol [29]. Opioids with rapid onset and short duration are generally preferred, unless prolonged analgesia is required. The most commonly used opioids in this setting are fentanyl and remifentanil. (See "Monitored anesthesia care in adults", section on 'Opioids'.)

- **Fentanyl** – Fentanyl is a short-acting opioid typically administered in small, intermittent IV boluses of 50 to 100 mcg, with reduced doses in older patients.
- **Remifentanil** – Remifentanil is an ultrashort-acting opioid with very rapid onset and reliably short offset regardless of the duration of infusion. It is usually administered by

infusion (starting at 0.1 mcg/kg/minute, modified for patient factors), with or without initial or intermittent boluses. Remifentanil can be used to provide intense, titratable analgesia during stimulating portions of a procedure of any duration, without residual respiratory depression when stimulation is over [19,35].

Unlike other longer-acting opioids, remifentanil can provide adequate analgesia for colonoscopy alone, without administration of sedatives, while still allowing rapid recovery and discharge. In one study, patients who were randomly assigned to receive remifentanil alone for colonoscopy had adequate analgesia with equivalent satisfaction, less respiratory depression, and faster recovery than patients who received a combination of midazolam and pethidine (meperidine) [36]. Whereas most patients who received remifentanil in this study appeared sedated, remifentanil does not reliably provide sedation or amnesia. Patients who receive only remifentanil should understand that they are likely to be conscious during the procedure.

Dexmedetomidine — Dexmedetomidine is a selective alpha2 agonist with sedative, anxiolytic, and modest analgesic effects. Similar to ketamine, dexmedetomidine can be administered along with propofol to reduce the propofol requirement. (See "Monitored anesthesia care in adults", section on 'Dexmedetomidine'.)

The role of dexmedetomidine in GI endoscopy may be limited by its prolonged onset time and even more prolonged and variable recovery time. For patients who would benefit from the use of dexmedetomidine, we often start sedation with propofol and follow with a dexmedetomidine infusion. With this strategy, the procedure can start almost immediately, while the dexmedetomidine infusion will produce the desired effect in five to seven minutes, and propofol can often be discontinued after 10 to 15 minutes. Timing of discontinuation of dexmedetomidine requires an understanding of the approximate length of the procedure. We stop the infusion approximately 15 minutes before the anticipated end of the procedure, with propofol administered thereafter only as necessary.

A limited number of small studies have compared the use of dexmedetomidine with other sedatives for GI endoscopy, and the results are conflicting and inconclusive [37-41]. A meta-analysis of six small randomized controlled trials (226 patients) that compared dexmedetomidine with propofol for sedation during endoscopy found no significant differences in hypotension, bradycardia, or oxygen desaturation between the groups [42]. Based on three trials (93 patients), patient satisfaction during diagnostic procedures was lower with dexmedetomidine than propofol.

In doses used for sedation, dexmedetomidine has been thought to have less respiratory depressant effects than other sedatives. However, some studies have reported upper respiratory obstruction and apneic episodes during sedation with dexmedetomidine, particularly during bolus administration. Two small, randomized volunteer studies that compared propofol with dexmedetomidine reported similar respiratory depressant effects. Thus, dexmedetomidine should not be viewed as protective against respiratory depression or airway obstruction, particularly in high-risk patients. (See "Monitored anesthesia care in adults", section on 'Dexmedetomidine'.)

Dexmedetomidine can cause bradycardia and hypotension, or hypertension, when administered rapidly or in high doses.

Ketamine — Ketamine produces a dissociative state accompanied by amnesia and intense analgesia with minimal respiratory depression at sedative doses (ketamine 0.25 to 0.5 mg/kg IV) (table 6). Ketamine may be administered in small doses along with propofol [43] or dexmedetomidine [44] to reduce the required doses and cardiovascular effects of those medications, enhance analgesia, and reduce the need for opioids. (See "Monitored anesthesia care in adults", section on 'Ketamine'.)

Remimazolam — In 2020, the US Food and Drug Administration (FDA) approved remimazolam, a new short-acting benzodiazepine, for IV administration as a slow bolus. The drug exhibits the organ-independent ester hydrolysis of remifentanil, while retaining the gamma aminobutyric acid (GABA) agonist property of midazolam. It can be safely used in patients with hepatic or renal impairment, without fear of prolonged duration of action, and can be reversed with flumazenil.

Because of its unique metabolism, remimazolam was expected to facilitate a faster recovery and earlier discharge from the postprocedure unit. Onset of clinical effect is similar to midazolam, whereas recovery is shorter [45]. However, published evidence is not convincing of clinical benefits. In our opinion, remimazolam does not provide significant advantages over midazolam for sedation for endoscopy for the following reasons:

- The FDA labeling recommends 5 mg push injection over a one minute time period followed by supplemental doses of 2.5 mg IV over a 15 second time period after at least two minutes. Such a regimen is impractical in a busy unit wherein an upper GI endoscopy could be completed in under 10 minutes.

- In a phase IIa study of patients undergoing upper GI endoscopy, a failure rate of 46 percent was observed due to need for rescue sedative, even at a dose of 0.2 mg/kg IV [46].

In another study of volunteers sedated with remimazolam and fentanyl for colonoscopy, sedation was inadequate for completion of the procedure in 30 percent of patients [47].

- In a randomized phase III study that compared midazolam, remimazolam, and placebo, midazolam and remimazolam resulted in similar incidences of recall [48]; patients often expect complete amnesia. Discharge times were similar with midazolam or remimazolam.

COMPLICATIONS

Complications of anesthesia — Anesthesia for GI endoscopy may be associated with a higher risk of complications than anesthesia for many other procedures. The reasons for this association are multifactorial and likely include the fact that most of these procedures are performed in out-of-operating room locations, increasingly complicated procedures and patients, and the anesthetic technique. Many complications of sedation for GI endoscopy involve respiratory events; cardiac arrest is most commonly preceded by hypoxemia. (See "Adverse events related to procedural sedation for gastrointestinal endoscopy in adults".)

Studies of complications of anesthesia for GI endoscopy are difficult to interpret because most complications are rare and much of the literature is retrospective or prospective and nonrandomized. One exception is the prospective randomized trial of general anesthesia with tracheal intubation versus monitored anesthesia care (MAC) with sedation for endoscopic retrograde cholangiopancreatography (ERCP), which is discussed above [16]. (See 'ERCP' above.)

In nonrandomized studies, comparisons among techniques may be confounded by patient factors. In some facilities, anesthesia services are requested for more complicated patients, while routine procedures in healthy patients are performed with non-anesthesia sedation, making comparison of techniques unreliable.

- An out-of-operating room, or remote, location is a risk factor for complications of anesthesia. Contributing factors may include unfamiliar procedure rooms and personnel, inadequate availability and space for routine anesthesia equipment, a dark environment, and inadequate monitoring. Retrospective reviews and analysis of malpractice claims have reported that most complications result from oversedation and inadequate oxygenation during MAC. An analysis of closed malpractice claims from the American Society of Anesthesiologists (ASA) Closed Claims Database from 1999 to 2009 found that respiratory events were twice as common in remote locations compared with the operating room, and inadequate oxygenation/ventilation was the most common specific event [49]. One-third of claims occurred in the GI endoscopy suite, and 80 percent involved MAC. One-third of events in remote locations were judged as having been preventable with better monitoring.

- The depth of sedation may affect the rate of complications during GI endoscopy, with deeper sedation (usually with propofol) [6] increasing the risk of respiratory and cardiopulmonary complications [50,51] and the risk of colonic perforation during colonoscopy [52].

- The patients who undergo elective and emergent GI endoscopy tend to comprise a high acuity population, who are older and sicker than the general surgical population. One prospective observational study included approximately 2100 patients who underwent GI endoscopy with sedation administered by anesthesia clinicians at several university hospitals [53]. In this study, 42 percent of patients had ASA physical status III or IV, 50 percent were >60 years of age, and 17 percent had emergency procedures. Significant unplanned events occurred in 23 percent of patients, including hypotension in 12 percent (defined as blood pressure <90 mm Hg requiring treatment).

Gas embolism during endoscopy — Gas embolism is an uncommon but potentially fatal complication of GI endoscopic procedures. It is most common during ERCP, with a reported incidence as high as 2.4 percent [54], but can also occur during esophagogastroduodenoscopy, enteroscopy, endoscopic ultrasound (EUS), colonoscopy, and sigmoidoscopy [55]. In a single-center prospective study of approximately 850 patients who underwent ERCP with precordial Doppler monitoring, venous gas embolism was detected in 2.4 percent of patients, one-half of whom exhibited hemodynamic changes as a result [54]. Since precordial Doppler is not routinely used during endoscopy, many cases of gas embolism may go undetected and result in no clinical consequences.

A high index of suspicion for gas embolism should be maintained in patients who exhibit unexplained sudden hemodynamic collapse during one of these procedures. Risk factors for gas embolism during ERCP include previous surgery or other intervention on the biliary tract, transhepatic portosystemic shunts, blunt or penetrating trauma to the liver, sphincterotomy, metallic stent placement, and hepatic abscess or tumor [55]. The consequences of gas embolism may be mitigated the use of carbon dioxide (CO_2) rather than air for insufflation, since CO_2 is more rapidly absorbed and eliminated if embolism occurs. Management of gas embolism during ERCP is similar to other settings, constrained by the prone position and limited resources related to the out-of-operating room location. Risk factors, clinical presentation, and management of gas embolism during endoscopy are shown in a table (table 7). (See "Intraoperative venous air embolism during neurosurgery", section on 'Management of intraoperative VAE'.)

Gas embolism and other complications of GI endoscopy are discussed more fully separately. (See "Overview of colonoscopy in adults", section on 'Adverse events' and "Uncommon complications of endoscopic retrograde cholangiopancreatography (ERCP)" and "Overview of upper gastrointestinal endoscopy (esophagogastroduodenoscopy)", section on 'Complications'.)

POST-ANESTHESIA CARE

The pharmacologic effects of drugs used for sedation/analgesia usually extend beyond the duration of the therapeutic or diagnostic procedure. Monitoring and supplemental oxygen should be maintained while the patient recovers from the effects of the sedative medications. Patient care should be transferred to personnel in the phase I recovery area (post-anesthesia care unit [PACU]) capable of prompt detection of respiratory or cardiovascular compromise, whether they have received general anesthesia or sedation.

Patients who have completely recovered (ie, breathing spontaneously without need for any form of airway support, alert, speaking, responding appropriately to commands, and hemodynamically stable) can be fast-tracked to the phase II recovery area (predischarge unit) for rapid discharge.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Procedural sedation in adults".)

SUMMARY AND RECOMMENDATIONS

- **Preanesthesia evaluation** – Preanesthesia evaluation for gastrointestinal (GI) endoscopy should be the same as for those who will undergo anesthesia for surgical procedures, focused on risks for aspiration and hypoxemia (table 5), factors that increase sensitivity to sedatives and analgesics, and the patient's ability to lie still, cooperate, and communicate. (See 'Preprocedure evaluation' above.)
- **Airway concerns**
  - Airway management may be complicated by the shared airway (for upper endoscopic procedures), positioning, and risk of aspiration. Preparation for airway management

should be the same as for other procedures, with routine and emergency equipment available. (See 'Airway management' above.)

- For patients who undergo peroral endoscopic myotomy (POEM), endoscopic drainage of a pancreatic pseudocyst, and application of clips or glue for treatment of gastroesophageal fistulae, we suggest tracheal intubation (**Grade 2C**). For other advanced endoscopic procedures (eg, endoscopic retrograde cholangiopancreatography [ERCP], esophageal dilatation, some endobariatric procedures), practice varies. (See 'Advanced endoscopic procedures' above.)

- **Diagnostic endoscopy** – For patients without risk factors for aspiration who undergo diagnostic endoscopy, we suggest using sedation rather than general anesthesia (**Grade 2C**).

  - **Diagnostic upper endoscopy** – For diagnostic upper GI endoscopy, the most stimulating portion of the procedure is insertion of the endoscope. The level of sedation or anesthesia must be deep enough to prevent coughing, gagging, retching, vomiting, and laryngospasm. We coordinate the timing with the gastroenterologist, and in most cases, the endoscope is inserted after a bolus of propofol. (See 'Diagnostic upper endoscopy' above.)

  - **Colonoscopy** – During colonoscopy, the stimulating portions of the procedure involve gas insufflation of the colon and manipulation of the colonoscope around corners within the colon. Aspiration is a constant risk during colonoscopy and may be increased by insufflation of gas and/or manual abdominal compression. (See 'Airway management' above and 'Colonoscopy' above.)

    The author prefers to administer sedation light enough to maintain airway reflexes during colonoscopy, while others administer deeper sedation with propofol or other sedatives and analgesics.

- **Advanced endoscopic procedures** – Advanced endoscopic procedures include ERCP, endoscopic ultrasound (EUS), esophageal stricture dilatation and stenting, treatment of esophageal varices, and various other specialized procedures. (See 'Advanced endoscopic procedures' above.)

  - ERCP is the most commonly performed advanced endoscopic procedure. It is performed in the prone or semiprone position and is often performed in patients with metabolic derangement and critical illness. ERCP is associated with increased adverse events compared with other endoscopic procedures. For patients with risk factors for sedation-related adverse events (eg, obstructive sleep apnea, abdominal ascites, body mass index >35 kg/m^2, chronic obstructive pulmonary disease, American Society of Anesthesiologists [ASA] class ≥3, predictors for difficulty with airway management, moderate to heavy alcohol use), we suggest general anesthesia with tracheal intubation (GETA) for ERCP (**Grade 2C**). Sedation without tracheal intubation for ERCP in high-risk patients is associated with increased risk of sedation-related adverse events and a significant incidence of the need to convert to general anesthesia. (See 'ERCP' above.)

  - These procedures often require repeated insertion and removal of the endoscope and instruments; an adequate depth of anesthesia must be maintained at all times. (See 'General considerations' above.)

- **Choice of medications**

  - For patients undergoing GI endoscopy, we suggest using propofol for sedation and anesthesia because of its rapid equilibration and short elimination half-life (table 6) (**Grade 2C**). . Propofol should be titrated to effect; patients who receive propofol may rapidly transition from sedation to general anesthesia. (See 'Propofol' above.)

    Other options include midazolam, opioids, ketamine, and dexmedetomidine. (See 'Choice of drugs for sedation/analgesia' above.)

  - Midazolam, alone or in combination with an opioid, is an alternative strategy and is adequate for moderate sedation for most patients who undergo diagnostic upper endoscopy or colonoscopy (table 6). (See 'Midazolam' above.)

  - Remifentanil is an ultrashort-acting opioid that may be used to supplement propofol anesthesia and can provide intense analgesia without residual respiratory depression. Remifentanil alone can provide adequate analgesia for colonoscopy, though without reliable sedation or amnesia. (See 'Opioids' above.)

- **Complications** – Anesthesia for GI endoscopy may be associated with a higher risk of complications than anesthesia for many other procedures. Many complications of sedation for GI endoscopy involve respiratory events and are often associated with deeper sedation with propofol. (See 'Complications' above.)

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GRAPHICS

American Society of Anesthesiologists Physical Status (ASA PS) Classification System

ASA PS classification	Definition	Examples, including, but not limited to:
ASA I	A normal healthy patient	Healthy, nonsmoking, no or minimal alcohol use.
ASA II	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Current smoker, social alcohol drinker, pregnancy, obesity (30<BMI<40), well-controlled DM/HTN, mild lung disease.
ASA III	A patient with severe systemic disease	Substantive functional limitations; one or more moderate to severe diseases. Poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESKD undergoing regularly scheduled dialysis, premature infant PCA <60 weeks, history (>3 months) of MI, CVA, TIA, or CAD/stents.
ASA IV	A patient with severe systemic disease that is a constant threat to life	Recent (<3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARDS, or ESKD not undergoing regularly scheduled dialysis.
ASA V	A moribund patient who is not expected to survive without the operation	Ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction.
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	

The addition of "E" to the numerical status (eg, IE, IIE, etc) denotes Emergency surgery (an emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part).

BMI: body mass index; DM: diabetes mellitus; HTN: hypertension; COPD: chronic obstructive pulmonary disease; ESKD: end-stage kidney disease; PCA: post conceptual age; MI: myocardial infarction; CVA: cerebrovascular accident; TIA: transient ischemic attack; CAD: coronary artery disease; DIC: disseminated intravascular coagulation; ARDS: acute respiratory distress syndrome.

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Fasting guidelines of international anesthesia societies

Anesthesia society	Fasting requirements at time of induction	Comments
American Society of Anesthesiologists, 2017[1,2]	▪ 2 hours clear liquids, excluding alcohol ▪ 4 hours breast milk ▪ 6 hours nonhuman milk, formula, light meal ▪ 8 hours or more for fatty meal, fried food, meat ▪ Chewing gum allowed up until induction	▪ Healthy patients, not in labor, elective surgery ▪ Light meal defined as toast or cereal with clear liquid ▪ Healthy adults should drink carbohydrate containing clear liquids up to 2 hours prior to surgery
European Society of Anesthesiology and Intensive Care[3,4]	▪ Adults: • 2 hours clear liquids • 6 hours milk, solid food • Chewing gum and sucking hard candy allowed up until induction	▪ Encourage oral fluid up to 2 hours
	▪ Children: • 1 hour clear liquids • 3 hours breast milk • 4 hours formula or nonhuman milk, light breakfast (weak recommendations) • 6 hours other solid food	▪ Encourage oral fluid up until fasting time
Australian and New Zealand College of Anaesthetists[5]	▪ Adults: • 2 hours clear liquids • 6 hours limited solid food	▪ Guidelines may not apply to patients who are at increased risk of perioperative regurgitation or vomiting ▪ Up to 400 mL of clear liquid up to 2 hours prior to induction for adults is likely safe
	▪ Children >6 months of age: • 1 hour clear liquids (≤3 mL/kg) • 4 hours breast milk • 6 hours formula and limited solid food	
	▪ Children <6 months of age:	

	• 1 hour clear liquids (≤3 mL/kg) • 3 hours breast milk • 4 hours formula	
Association of Anaesthetists in Great Britain and Ireland[6]	▪ 2 hours clear liquids ▪ 4 hours breast milk ▪ 6 hours solid food, formula and cow's milk	▪ Gum chewing treated as clear
Canadian Anesthesiologists' Society[7]	▪ 1 hour clear liquids for children ▪ 2 hours clear liquids for adults ▪ 4 hours breast milk ▪ 6 hours for solid food, infant formula, nonhuman milk, expressed breast milk fortified with additions	▪ Encourage oral clear liquids up until fasting time
Scandinavian Society of Anaesthesiology and Intensive Care Medicine[8]	▪ 2 hours clear liquids ▪ 4 hours breast milk and infant formula ▪ 6 hours solid food and cows milk ▪ 2 hours chewing gum and any tobacco product ▪ Up to 1 hour prior to induction, 150 mL of water	▪ 2 hours for preoperative carbohydrate drinks intended for preoperative nutrition
German Society of Anesthesiology and Intensive Care[9]	▪ 2 hours clear liquids ▪ 4 hours breast milk and infant formula ▪ 6 hours meal	
Pediatric societies		
Joint statement from Association of Paediatric Anaesthetists of Great Britain and Ireland, European Society for Paediatric Anaesthesiology, L'Association Des Anesthésistes-Réanimateurs	▪ 1 hour clear liquids for children up to 16 years of age	▪ Encourage intake of clear liquids

Pédiatriques d'Expression Française[10]		
Canadian Pediatric Anesthesia Society[11]	▪ 1 hour clear liquids for children	▪ Encourage intake of clear liquids
The Society for Paediatric Anaesthesia of New Zealand and Australia[12]	▪ 1 hour clear liquids for children	▪ Encourage intake of clear liquids

GERD: gastroesophageal reflux disease.

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Graphic 94641 Version 20.0

Continuum of depth of sedation: Definition of general anesthesia and levels of sedation/analgesia*

	Minimal sedation anxiolysis	Moderate sedation/analgesia ("conscious sedation")	Deep sedation/analgesia	General anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful¶ response to verbal or tactile stimulation	Purposeful¶ response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular function	Unaffected	Usually maintained	Usually maintained	May be impaired

- **Minimal sedation (anxiolysis)** is a drug-induced state during which patients respond normally to verbal commands. Although cognitive function and physical coordination may be impaired, airway reflexes and ventilatory and cardiovascular functions are unaffected.
- **Moderate sedation/analgesia ("conscious sedation")** is a drug-induced depression of consciousness during which patients respond purposefully¶ to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular function is usually maintained.
- **Deep sedation/analgesia** is a drug-induced depression of consciousness during which patients cannot be easily aroused but respond purposefully¶ following repeated or painful stimulation. The ability to independently maintain ventilatory function may be impaired. Patients may require assistance in maintaining a patent airway, and spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained.
- **General anesthesia** is a drug-induced loss of consciousness during which patients are not arousable, even by painful stimulation. The ability to independently maintain ventilatory function is often impaired. Patients often require assistance in maintaining a patent airway, and positive pressure ventilation may be required because of depressed spontaneous ventilation or drug-induced depression of neuromuscular function. Cardiovascular function may be impaired.
- Because sedation is a continuum, it is not always possible to predict how an individual patient will respond. Hence, practitioners intending to produce a given level of sedation should be able to rescue$^{\Delta}$ patients whose level of sedation becomes deeper than initially intended. Individuals administering moderate sedation/analgesia ("conscious sedation") should be able to rescue$^{\Delta}$ patients who enter a state of deep sedation/analgesia, while those administering deep sedation/analgesia should be able to rescue$^{\Delta}$ patients who enter a state of general anesthesia.

* Monitored anesthesia care (MAC) does not describe the continuum of depth of sedation; rather it describes "a specific anesthesia service in which an anesthesiologist has been requested to participate in the care of a patient undergoing a diagnostic or therapeutic procedure."

¶ Reflex withdrawal from a painful stimulus is **not** considered a purposeful response.

Δ Rescue of a patient from a deeper level of sedation than intended is an intervention by a practitioner proficient in airway management and advanced life support. The qualified practitioner corrects adverse physiologic consequences of the deeper-than-intended level of sedation (such as hypoventilation, hypoxia, and hypotension) and returns the patient to the originally intended level of sedation. It is not appropriate to continue the procedure at an unintended level of sedation.

Approved by the ASA House of Delegates on October 13, 1999, and last amended on October 15, 2014. Published in: American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists. Practice guidelines for sedation and analgesia by non-anesthesiologists. Anesthesiology 2002; 96:1004.

Graphic 109909 Version 4.0

Basic monitoring during anesthesia

Primary physiologic process/parameter targeted		Monitoring equipment	Principle	Derived information	Additiona function
Oxygenation	Inspired gas O_2 content	O_2 analyzer (with a low-limit alarm in use)	Paramagnetic sensor, fuel (galvanic) cell, polarographic (Clark) electrode, mass spectroscopy, or Raman scattering.	Inspired/expired O_2 concentration when placed downstream from fresh flow control valves	A low-level alarr automatically activated by turı on the anesthes machine
	Blood oxygenation	Pulse oximeter	The Beer-Lambert law applied to tissues and pulsatile blood flow. The relative absorbency at wavelengths of 660 and 940 nm is used to estimate saturation, which is derived from the ratio of oxyhemoglobin to the sum of oxyhemoglobin plus deoxyhemoglobin.	Hemoglobin saturation, pulse rate, relative pulse amplitude displayed on plethysmography waveform	Continuous evaluation of circulation, varia pitch pulse tone and audible low threshold alarm
Ventilation	Exhaled CO_2	Capnograph	CO_2 molecules absorb infrared radiation at 4.26 micrometers, proportionate to the CO_2 concentration present in the breath sample.	$ETCO_2$, inspired CO_2, diagnostic waveforms, respiratory rate, apnea detection	Instantaneous information abc ▪ Perfusion (effectively is being transporte through th vascular system) ▪ Metabolisr (how effec CO_2 is beir produced l

					cellular metabolisr ▪ Confirmati of tracheal tube placement after intubation
	Integrity of ventilation system during mechanical ventilation	Disconnection alarm	Detects the cyclical changes in airway pressure in the normal range.	Alarms if a significant decrease in rate or pressure occurs	Alarms if high pressures are sensed
	Pulmonary mechanics (volume, flow, pressure)	Pulmonary flow and pressure sensors	Volume of gas proportional to a drum movement, changes in differential pressure (near the Y-connector) or in electrical resistance (hot wire housed in a monitor or ventilator).	Inspired and expired volume, flow, and airway pressure	Pressure volum and flow volum loops
Circulation	Cardiac activity	ECG	The ECG monitor detects, amplifies, displays, and records the ECG signal.	Heart rate and rhythm	ST segment depression/elev and trend over t with an audible alarm warning c significant arrhythmias or asystole
	Arterial BP	Noninvasive BP monitor	Oscillometric devices automatically inflate and deflate the cuff, and have electronic pressure sensors that record the pressure oscillations of the	Arterial BP	Indicator of org perfusion

			arteries. The pressure at which maximal oscillations occur as the cuff is deflated corresponds with MAP. Proprietary algorithms are used to calculate systolic and diastolic BP.		
Temperature		Temperature monitor	Devices with a semiconductor, electrical resistance decreases as temperature decreases.	Core or peripheral temperature	A greater than 2 core-to-peripher temperature gradient is indic of low cardiac output

BP: blood pressure; CO_2: carbon dioxide; ECG: electrocardiogram; $ETCO_2$: end-tidal carbon dioxide; MAP: mean arterial pressure; O_2: oxygen.

Graphic 110080 Version 5.0

Conditions that increase risk of aspiration during induction of anesthesia

Full stomach – nonfasted, emergency surgery or trauma
Pregnancy after 12 to 20 weeks gestation (gestational age for increased risk is controversial)
Symptomatic gastroesophageal reflux
Diabetic or other gastroparesis
Hiatal hernia
Gastric outlet obstruction
Esophageal pathology
Bowel obstruction
Increased intra-abdominal pressure – ascites, abdominal mass

Graphic 98506 Version 8.0

LMA Gastro

The LMA Gastro has a dedicated lumen for passage of an endoscope while providing an unobstructed airway.

LMA: laryngeal mask airway.

Graphic 115383 Version 1.0

Airway setup for endoscopy

This photo shows one option for airway management for gastrointestinal endoscopy, in this case for endoscopic retrograde cholangiopancreatography (ERCP). A nasal trumpet is connected to a Mapleson C breathing circuit using an endotracheal tube connector. For further details, refer to UpToDate topics on anesthesia for gastrointestinal endoscopy.

Graphic 112185 Version 1.0

Mapleson C circuit for endoscopy

This graphic shows one option for airway management and ventilation for gastrointestinal endoscopy, in this case endoscopic retrograde cholangiopancreatography (ERCP). A nasal trumpet is connected to a Mapleson C breathing circuit using an endotracheal tube connector. The Mapleson C circuit is widely available and allows ventilation with a breathing bag without the need for an anesthesia machine. For further details, refer to UpToDate topics on anesthesia for gastrointestinal endoscopy.

Graphic 112186 Version 1.0

Drugs commonly used for monitored anesthesia care

Medication	Dose range*	Onset	Duration	Comments
Midazolam	0.5 to 2 mg IV prior to propofol over 2 to 3 minutes; may repeat after 2 to 5 minutes	1 to 2.5 minutes	10 to 40 minutes	▪ Potentiates the effects of other agents[1] ▪ Sedative and anxiolytic ▪ Prolonged effect or delayed recovery in older adults, obese, or impaired hepatic function
Propofol	250 to 500 mcg/kg IV bolus	30 seconds	5 to 10 minutes	▪ Sedative and amnestic, no analgesia ▪ Rapid recovery without residual ▪ Pain on injection common ▪ Respiratory depression and hypotension can occur ▪ Reduce dose by 20% in older adults
	25 to 75 mcg/kg/minute IV infusion	3 to 4 minutes, without bolus	4 minutes after discontinuation of infusion	
Dexmedetomidine	Loading: 0.5 to 1 mcg/kg over 10 to 20 minutes[2]	5 to 10 minutes	30 to 40 minutes[1]	▪ Sedative, analgesic, without amnesia ▪ Bradycardia and hypotension or hypertension may occur
	Maintenance: 0.2 to 1 mcg/kg/hour			
Ketamine	0.25 to 0.5 mg/kg IV	1 to 2 minutes	20 to 60 minutes	▪ Dissociative sedative, amnestic, analgesic ▪ Minimal cardiac or respiratory depression in small doses ▪ Emergence reactions, nausea

				and vomiting possible ▪ Prolonged effect in older adults
Opioids				▪ Analgesic, minimal sedation ▪ Respiratory depression, nausea and vomiting may occur
Fentanyl	0.5 to 2 mcg/kg IV, administered in intermittent boluses of 25 to 50 mcg IV	2 to 3 minutes	30 to 60 minutes	
Remifentanil	0.1 mcg/kg/minute IV, started 5 minutes prior to stimulus; wean to 0.05 mcg/kg/minute IV as possible¶	1 to 1.5 minutes	3 to 5 minutes after discontinuation of infusion	

IV: intravenous

* Doses should be modified based on patient factors (eg, doses reduced for older adult patients) and when combinations of drugs are administered.

¶ Remifentanil dose should be reduced when administered with midazolam or propofol.

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Graphic 110394 Version 4.0

Venous air embolism during gastrointestinal endoscopic procedures: Rapid overview

Risk factors

- Previous surgery, intervention, or injury of the bile duct system (eg, TIPS, blunt or penetrating liver trauma, percutaneous transhepatic biliary drain, postsurgical gastrointestinal fistula)
- Inflammatory conditions (eg, cholangitis, hepatic abscess, inflammatory bowel disease, necrotizing enterocolitis)
- Procedural issues (eg, sphincterotomy, metal stent, cholangioscopy, biliary sphincterotomy, high pressure or rate of gas insufflation)

Clinical signs*

- Decreased $ETCO_2$
- Decreased SPO_2
- Hypotension, cardiovascular compromise
- Neurologic deterioration (sedated patients)

Management

- Call for help
- Notify proceduralist
  - **Stop gas insufflation**
  - **Remove endoscope**
  - **Terminate procedure**
- Discontinue N_2O and administer 100% O_2
- Discontinue PEEP
- Turn patient to left lateral decubitus position, head down
- Airway management as needed
- Cardiovascular support
  - IV fluids
  - Vasopressors as needed
  - ACLS as necessary
- Urgent bedside echocardiography
- Monitor for signs of bleeding, perforation, sepsis

TIPS: transjugular intrahepatic portosystemic shunts; $ETCO_2$: end-tidal carbon dioxide; SPO_2: peripheral arterial oxygen saturation; N_2O: nitrous oxide; O_2: oxygen; PEEP: positive end-expiratory pressure; IV: intravenous; ACLS: advanced cardiac life support.

* Clinical signs depend on severity of venous air embolism.

Graphic 120289 Version 1.0

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