In this Pro-Con commentary article, the authors have been asked to refute or support a position regarding anesthesia for endoscopic retrograde cholangiopancreatography (ERCP). ERCPs are unique in that they not only necessitate a shared airway but are typically performed in the prone (or semiprone) position on a special procedural table. Moreover, procedural times can vary from <1 hour to several hours.

Table 1: Pro-Con Debate Summary.

<table>
<thead>
<tr>
<th>PRO side: arguments in favor of MAC for ERCP</th>
<th>CON side: arguments in favor of GEA for ERCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>No significant difference in overall serious adverse events when comparing MAC versus GEA in healthy, nonobese patients²⁻⁴</td>
<td>MAC is associated with unacceptably high rates of SRAEs (~20%), conversion to GEA (~3%), and hypoxic episodes (~10%–30%)⁵⁻¹⁰</td>
</tr>
<tr>
<td>Avoidance of the potential problems associated with GEA including intubation-related injury, hemodynamic instability, and medication side effects</td>
<td>The only randomized controlled trial to date comparing GEA to MAC (in high-risk patients) demonstrated significantly higher rates of adverse events in the MAC cohort¹⁰</td>
</tr>
<tr>
<td>Improved gastrointestinal suite efficiency metrics and shorter patient recovery time⁵</td>
<td>NORA carries inherent risk, often related to impaired oxygenation and/or ventilation.¹¹ GEA provides a definitive airway.</td>
</tr>
<tr>
<td>Low conversion rate from MAC to GEA of &lt;4%⁴</td>
<td>While MAC may be feasible for healthy, nonobese patients, in reality, these patients are few and far between. Patients presenting for ERCP are typically ill, often obese, and usually have multiple risk factors for SRAEs</td>
</tr>
<tr>
<td>Reliable detection of airway obstruction using end-tidal CO₂ monitoring and astute clinical observation, and rapid improvement with basic airway maneuvers</td>
<td>Efficiency metrics are unlikely to be improved by MAC—time saved is likely offset by interruptions for necessary airway interventions¹²</td>
</tr>
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</table>

The practice of medicine often varies among medical professionals when a defined standard of care does not exist. The cause of this variability is multifactorial. Patient factors and comorbidities, practitioner skills and experience, procedural needs, and the absence of data are a few of the considerations. Thus, it is not surprising that the primary mode of anesthesia for gastrointestinal (GI) endoscopy patients is sharply partitioned between those advocating for monitored anesthesia care (MAC) versus those who rely on general endotracheal anesthesia (GEA).

The importance of this debate is even more relevant because of the increasing recognition of significant potential morbidity and mortality associated with these anesthetics and procedures. A Closed Claims report from the American Society of Anesthesiologists (ASA) suggests that adverse events in nonoperating room anesthesia (NORA) sites result in a higher incidence of severe complications—including death and permanent brain damage—than similar events occurring in the operating room.¹ Indeed, the GI suite accounted for the highest percentage of adverse events across all NORA locations.

Anesthesia professionals will certainly encounter an increasing demand for services in the NORA setting and, especially, the GI suite. Thus, this Pro-Con debate provides insights into the care plan decision of MAC versus GEA for ERCP procedures, as summarized in Table 1. Our patients will ultimately benefit from further systematic clinical study of these variable approaches and their associated outcomes.

**PRO: ANESTHESIA FOR ERCP IS BEST DONE WITH MAC**

Samantha Stamper, MD, and Christopher A. Troianos, MD, FASE, FASA

ERCP utilizes fluoroscopy and endoscopy for both diagnostic and therapeutic interventions. Its use facilitates the evaluation of the liver, gall...

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Advanced endoscopic interventions have the added benefit of being minimally invasive, less painful, and seldom require muscle paralysis. More than 500,000 ERCPs are performed annually in the United States, with a majority requiring anesthesia services. ERCPs are more often performed in older patients; many of whom have a greater burden of comorbid conditions. While there is currently no outcome evidence performed based on prospectively randomized trials as to whether MAC or GEA is superior for patients undergoing advanced endoscopy interventions, there is convincing clinical rationale to prioritize a “MAC-first” approach in the majority of these endoscopy patients. While anesthetic plans are always tailored to each specific individual, the experienced endoscopy team will recognize that the MAC approach may be the superior one, particularly for healthier patients with a normal or near-normal body mass index (BMI). Clear communication between the endoscopist and anesthesia professional is critical. For instance, the specific indication for the ERCP (therapeutic versus diagnostic) and case duration are vital to create a shared mental model and will likely contribute to the determination of the optimal anesthetic. For example, if the intervention plan is a straightforward removal of a biliary stent, then MAC may be most appropriate. By contrast, drainage of a complex, septated pancreatic pseudocyst with necrotic walls will almost certainly require GEA. Therefore, the time and invasiveness of the intervention are vital inputs to the anesthetic choice, and the advantages and disadvantages of each anesthetic technique must be considered (Table 2).

Specific facility factors similarly contribute to the choice of the optimal anesthetic. These considerations include proximity to the main operating rooms, readiness of rescue equipment, adequate post anesthesia care unit, and the availability of additional help, if needed. Other considerations include the physical foot-print of the anesthesia workspace, which is often limited due to specialized equipment (e.g., anesthesia supplies, radiographic imaging equipment, ancillary display/viewing towers). Communication with both the institution and endoscopy team before the procedure is important to help mitigate any untoward complications. Moreover, the prudent practitioner must always ensure a clear plan and pathway are in place in case emergent airway rescue is needed. The factors listed above may contribute to the decision to prioritize MAC.

A major concern regarding MAC in the prone position is the potential need for urgent or emergent access to the airway, with the potential need for emergent endotracheal intubation. One potential, provocative strategy is for an adequately trained endoscopist to perform a gastroscopy-facilitated endotracheal intubation. This requires a smaller endoscope capable of being introduced into the trachea and an endoscopist who possesses these skills, readily facilitated by an anesthesia professional. The “ultraslim” gastroscopy functions similarly to a bronchoscope and has an outer diameter of 5.4 mm that can accommodate an adult endotracheal tube over the scope. In a review of over 3400 patients undergoing ERCP (46% with GEA versus 54% with MAC), the overall conversion rate from MAC to GEA was low at 2.3%. The authors described their successful use of gastroscope-facilitated tracheal intubation in 16 patients due to retained food in the stomach and/or hypoxia. An additional benefit of the gastroscope is that aspirated material can be immediately suctioned from the trachea and bronchi, thereby decreasing the risk of respiratory complications. Extubation was successful in all patients who underwent gastroscope-facilitated intubation, and no patients had radiographic evidence of aspiration pneumonia.

This novel approach to rescue the compromised or failing airway obviates the most commonly identified concern by clinicians considering the use of MAC in the prone or semiprone position. The endoscopist in the above-mentioned study was self-trained in this technique, highlighting the fact that there is currently no formal training or credentialing process for gastroscopy-facilitated intubation. This technique should only be considered under the direct supervision of an anesthesia professional or performed by an anesthesia professional. One important caveat to using the ultraslim gastroscopy for intubation is that the endoscopist must switch from the traditional side-viewing ERCP gastroscope to the ultraslim gastroscope loaded with an endotracheal tube. This exchange of gastroscopes provides the benefit of suctioning the stomach, esophagus, and hypopharynx on withdrawal—immediately before intubation—but should be performed in an expedited fashion to minimize potential delay to intubation.
### Appropriate Preoxygenation Before Sedation Can Increase Margin of Safety

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Table 3: Risk Factors for Sedation-Related Adverse Events During MAC.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio (95% CI)</th>
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<tbody>
<tr>
<td>Obstructive sleep apnea</td>
<td></td>
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<tr>
<td>Body mass index &gt;35</td>
<td></td>
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<tr>
<td>Male sex</td>
<td></td>
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<tr>
<td>ASA physical status &gt;I</td>
<td></td>
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<tr>
<td>Emergent procedure</td>
<td></td>
</tr>
<tr>
<td>Mallampati IV/difficult airway</td>
<td></td>
</tr>
<tr>
<td>Severe gastroesophageal reflux disease</td>
<td></td>
</tr>
<tr>
<td>Esophageal/gastric mass</td>
<td></td>
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</tbody>
</table>

Abbreviations: ASA, American Society of Anesthesiologists; MAC, monitored anesthesia care.

Table 3. Conditions that increase the likelihood of aspiration or desaturation. The risk of aspiration and desaturation is increased in patients with certain conditions. These conditions are often referred to as the “red flags” of aspiration. The presence of one or more of these conditions may increase the risk of aspiration and desaturation.

- **Obstructive sleep apnea**
- **Body mass index >35**
- **Male sex**
- **ASA physical status >I**
- **Emergent procedure**
- **Mallampati IV/difficult airway**
- **Severe gastroesophageal reflux disease**
- **Esophageal/gastric mass**

### Evaluating Preoxygenation

Appropriate preoxygenation before the administration of sedation is crucial in preventing desaturation. This is particularly important in patients with a history of obstructive sleep apnea or those at risk for aspiration during procedures. Preoxygenation is recommended for patients undergoing ERCP, endoscopy, and other procedures that may cause desaturation. Preoxygenation is defined as the administration of 100% oxygen for a minimum of 3 minutes or 4 vital capacity breaths, whichever is longer. This can be achieved using a face mask, nasal cannula, or breathing bag.

### The Importance of Preoxygenation

Preoxygenation helps to increase the oxygen储备 in the lungs, allowing for better oxygenation in the event of desaturation. It also allows for a longer duration of ventilation, which is particularly important in patients with obstructive sleep apnea. Preoxygenation is recommended for all patients undergoing sedation, especially those at risk for desaturation.

### Conclusion

Appropriate preoxygenation before the administration of sedation is crucial in preventing desaturation. This is particularly important in patients with a history of obstructive sleep apnea or those at risk for aspiration during procedures. Preoxygenation is recommended for patients undergoing ERCP, endoscopy, and other procedures that may cause desaturation. Preoxygenation is defined as the administration of 100% oxygen for a minimum of 3 minutes or 4 vital capacity breaths, whichever is longer. This can be achieved using a face mask, nasal cannula, or breathing bag.

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Inability to secure an airway and need for a surgical intervention. Succinylcholine is most often used for its rapid onset and short duration, and in the case of endoscopy, paralysis is usually not otherwise necessary. Potential adverse effects of succinylcholine include muscle pain, myoglobinemia, myoglobinuria, and malignant hyperthermia. The use of nondepolarizing muscle relaxants is associated with an increased risk of postoperative pulmonary complications from residual neuromuscular blockade. The anti-cholinergic effects associated with reversal of these paralytics must also be considered, though this may be less of an issue at institutions where sugammadex is readily available.

The depth of anesthesia required during GEA increases the risk of hypotension, which can subsequently lead to an increased risk of myocardial injury, renal injury, and possibly death. Because ERCP is performed in the prone or semiprone position, multiple people are required to safely position and secure the patient while turning from supine to prone position on the fluoroscopy table. There is always a risk of endotracheal tube displacement or accidental extubation during positioning. Finally, the NORA locations often have less support from colleagues and other team members to help during emergencies and anesthesia turnovers, which can subsequently decrease efficiency of the facility. Pertiani et al evaluated the impact of GEA on various efficiency metrics in a large interventional endoscopy center. More than 1400 patients who underwent 1635 interventional endoscopic procedures over a 6-month period were analyzed based on time stamps for anesthesia ready time, endoscopist ready time, procedure time, room exit time, time interval between successive procedures, nonprocedural time elapsed, total time elapsed in the endoscopy unit, and number of cases per room per day. All process efficiency metrics—aside from the time interval between successive procedures—were significantly prolonged among the patients who were intubated compared with nonintubated patients in the interventional endoscopy unit. A secondary aim of the study showed that patients undergoing ERCP were intubated more frequently than those undergoing other procedures (41.3% vs 12.4%).

In conclusion, MAC offers significant benefits over GEA in properly selected patients undergoing ERCP. These benefits include faster cognitive recovery, decreased side effects from the medications used to induce GEA, decreased risk of airway injury, decreased postoperative pulmonary complications, and reduced time spent at the hospital due to quicker induction and shorter time to discharge, thereby enhancing efficiency metrics for the unit, the providers, and the patients. With proper monitoring, supplemental oxygen, and sedation carefully titrated to maintain spontaneous ventilation, MAC during ERCP is a safe and often a superior alternative to GEA.

**CON: GEA OFFERS MAJOR ADVANTAGES OVER MAC**

*Luke S. Janik, MD, and Jeffrey S. Vender, MD, MCCC*

ERCP is a frequently performed procedure in the diagnosis and management of pancreaticobiliary disease. Each year, >500,000 ERCP procedures are performed in the United States, with the most common indications being bile duct stones and strictures of the biliary and pancreatic ductal systems. ERCP is an invaluable tool in the management of liver, biliary, and pancreatic disease, but is generally considered the most high-risk procedure performed in the GI suite, with an overall procedural complication rate of 4%. Procedural complications include pancreatitis (2%–10%), cholangitis/sepis (0.5%–3%), post sphincterotomy bleeding (0.3%–2%), duodenal perforation (0.08%–0.6%), and death (0.06%). However, what may be more concerning to those in the anesthesia profession is the high rate of SRAEs during the procedure, with an incidence reported as high as 2%. This begs the questions of who should be administering anesthesia and monitoring the patient during ERCP and what type of anesthesia should be administered. In this “Pro-Con,” we argue that a qualified anesthesiology professional should administer the anesthesia for ERCP, and that GEA offers significant advantages over MAC.

There is wide variability in the delivery models of anesthesia for ERCP. The 3 most common models of anesthesia care delivery are (1) endoscopist-directed sedation (EDS), (2) MAC, and (3) GEA. In the first model, EDS, the intravenous sedation is administered by a member of the GI team—usually a nurse—under the supervision of the endoscopist, who is often simultaneously performing the procedure. The use of traditional “conscious sedation” with titration of benzodiazepines and narcotics has generally fallen out of favor due to high procedure failure rates, poor patient satisfaction, and poor endoscopist satisfaction. Consequently, EDS has adopted the use of propofol sedation by nonanesthesia professionals, which the gastroenterology community touts as safe and effective. In the other 2 models of anesthesia care delivery, the patient is under the care of a qualified anesthesia professional, receiving either MAC with propofol-based sedation or GEA. The choice of anesthesia care delivery model is institution specific and depends on available resources and personnel, procedural complexity, patient characteristics and comorbidities, and individual preferences.

Before we discuss how the anesthesia should be performed, we need to acknowledge where it is performed. The risk of anesthesia in remote locations is widely recognized. An analysis of the ASA Closed Claims database reviewed malpractice claims against anesthesia professionals in remote locations and demonstrated that adverse events in remote locations resulted in higher rates of severe complications—including death and permanent brain damage—than adverse events in the operating room. In fact, the proportion of death was almost double in remote locations versus the operating room (54% vs 29%). Respiratory events were more common in remote locations than the operating room (44% vs 20%), with inadequate oxygenation/ventilation identified as the mechanism of injury in 2% of remote location claims versus 3% of operating room claims. The closed claims data specific to the GI suite demands further attention. Compared to all other remote venues, the GI suite accounted for the highest percentage of anesthesia malpractice claims (32%), the highest proportion of claims associated with oversedation (58%), and the highest rate of MAC utilization (>80%). These data do not come as a surprise to anesthesia professionals. Unfamiliar locations, lack of resources, poor ergonomics, limited assistance, variable cultures of safety, and the physical distance from additional anesthesia equipment and personnel are daily obstacles in the GI suite. In addition, the patients are often older and sicker. ERCP introduces other unique challenges, including the routine use of the prone position, limited access to the airway, and the use of an endoscope capable of causing airway obstruction and laryngospasm. Taking all of these challenges into consideration, anesthesia for ERCP carries substantial risk and should be approached with caution.

Proponents of MAC for ERCP point to numerous retrospective and prospective studies—mainly from the gastroenterology literature—which conclude that the technique is safe and effective. In a prospective study comparing MAC to GEA, Berzin et al reported an overall rate of SRAEs of 21%. Specific adverse events in the MAC cohort included hypoxemia (12.5%; defined as oxygen saturation <85%), unplanned mask ventilation (0.6%), unplanned intubation (3%), and procedure interruption (5%). From these data, the authors concluded that “minor sedation related events were common (21%) but lead to transient interruption of the procedure in only 5%
Endoscopy Suites Have Higher Rates of Severe Adverse Events vs. Operating Room Cases

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of cases.” They casually dismissed the 3% incidence of unplanned intubation by stating that “airway access was easily obtained on the rare occasion unplanned intubation was deemed necessary.” In a similar prospective study of ERCP under MAC, Zhang et al found that sedation-related complications occurred in 18% of patients, with hypoxemia (defined as oxygen saturation <90% for at least 2 minutes) occurring in 8% of patients, and >33% of patients experiencing multiple hypoxemic episodes. The authors noted that the incidence of hypoxemia in their study was comparable to the hypoxemia rate in other similar studies and, thus, concluded that “sedation by anesthesia personnel for ERCP is safe.” In a retrospective review of MAC for ERCP, Yang et al reported an incidence of hypoxemia (defined as oxygen saturation <90%) requiring airway manipulation in 28% of cases, with 16% of patients requiring conversion to GEA due to food in the stomach. Despite their findings, the authors concluded that “propofol can be used safely and effectively as a sedative agent for patients undergoing ERCP.”

How can studies that report such high rates of SRAEs, hypoxemic episodes, and necessary airway maneuvers conclude that the sedation is “safe” or “feasible” or “appropriate”? Just because a critical event does not lead to a critical outcome, does not mean the event is any less critical! The interpretation of data ultimately relies on the lens through which they are viewed. A gastroenterologist may not be alarmed by an unplanned intubation rate of up to 3%, or hypoxemia rates as high as 33%, as long as the patient did not suffer any long-term sequelae. However, an anesthesia professional who is responsible for emergency airway management and cardiopulmonary resuscitation may view each of these hypoxic episodes as a “near-miss” event. Keep in mind, pulse oximetry is a measure of oxygenation, not ventilation, and it cannot reliably be used to detect hypoventilation and progressive hypercarbia. Hypoxia in the setting of supplemental oxygen use—as is standard during MAC for ERCP—is a late marker of hypoventilation and is a harbinger of impending respiratory arrest.

For the sake of argument, let’s consider a different scenario. If we drive without wearing seatbelts for a year and are never harmed in any accidents that occur, are we correct to conclude that driving without seatbelts is safe, feasible, and appropriate? Normalizing and accepting high rates of hypoxemia during MAC for ERCP, while in a remote location, in the prone position, and with limited airway access, sets a dangerous precedent. We admit that it is difficult to define an “acceptable” rate of SRAEs and hypoxic episodes during sedation. However, in our opinion, the rates of SRAEs and hypoxic episodes reported in the aforementioned studies are worrisome and should be presented as a patient safety concern, rather than being dismissed as an inconsequential event.

Now, let’s turn our attention toward the evidence in support of GEA for ERCP. In a randomized controlled trial comparing the safety of MAC to GEA for ERCP, the results clearly favor GEA. This study included patients identified to be at high risk for SRAEs including those with a STOP-BANG (Scoring system involving: Snoring, Tiredness, Observed apnea, Blood Pressure, Body mass index, Age, Neck circumference, Gender) score >3, abdominal ascites, BMI >35, chronic lung disease, ASA physical status score >3, Mallampati class 4 airway, and moderate to heavy alcohol use. The rates of SRAEs were markedly higher in the MAC group compared to the GEA group (51.5% vs 9.9%). In the MAC group, hypoxemia (defined as oxygen saturation <90%) occurred in 19% of patients, with 45% requiring one or more airway maneuvers and 8% requiring bag-mask ventilation. Conversely, there were zero incidents of hypoxemia or airway maneuvers in the GEA group. The ERCP procedure had to be interrupted in 10% of the MAC group, requiring conversion to GEA for respiratory instability (8%) and retained gastric contents (2%). Of note, hypotension requiring a vasopressor occurred at similar rates in both groups, and there were no differences in procedure time, technical success, and patient recovery time.

Putting the data aside for a moment, let’s step back and discuss the reality of crisis management from an anesthesia professional’s perspective. Airway compromise in the prone position, while isolated in a remote location, and with limited help and resources is every anesthesia professional’s nightmare—as it should be. When every second matters, it may feel like an eternity to withdraw the endoscope, move the fluoroscopy equipment out of the way, bring the stretcher into the room, and turn the patient supine. By the time the patient is appropriately positioned to manage the airway, they may be on the verge of respiratory arrest. Yes, this is a relatively rare event during sedation for ERCP, but it is preventable. Why take this risk when the airway could be secured initially with endotracheal intubation in an elective, controlled manner? With the high rates of hypoxemia associated with sedation during ERCP and the numerous challenges associated with unplanned intubation in this environment, GEA is simply the logical choice.

There is a perception among gastroenterologists that MAC is quicker than GEA, requires less turnover time, and enables higher patient throughput. Although some data exist to support this perception, other data suggest that any time saved during sedation is likely offset by frequent procedural interruptions due to airway compromise. In reality, GEA suite efficiency is a complex product of many different variables (including procedural efficiency by the endoscopist), and it is shortsighted to think that efficiency is solely related to the presence or absence of an endotracheal tube. There is also a perception that MAC is inherently gentler, safer, and less invasive than GEA. Yes, the use of GEA introduces its own risks, including the potential for dental injury, residual neuromuscular blockade, hemodynamic instability, and adverse drug reactions. However, when comparing all of these risks with the risk of airway compromise during MAC for ERCP in the prone position, there frankly is no comparison. Our job as anesthesia professionals is to mitigate risk, and the potential for airway compromise during MAC for ERCP is a risk not worth taking.

Until further large scale, multi-center randomized controlled trials are conducted, the controversy regarding MAC versus GEA for ERCP will persist, and the standard of care will remain undefined. What all anesthesia professionals can agree on, however, is that regardless of the anesthetic technique, the anesthesia should be administered by a qualified anesthesia professional. In the United States, EDS for ERCP decreased from >50% of cases in 2005 to 5% in 2014, but it remains prevalent in Europe and other countries. A retrospective review of nearly 27,000 ERCPs performed over a 10-year span showed that EDS resulted in a higher rate of adverse events (OR = 1.86) and was nearly twice as likely to require an unplanned intervention than anesthesia-provided sedation. Studies also demonstrated that EDS led to a higher rate of sedation failure, and consequently procedural failure, than anesthesia-administered MAC or GEA. To make matters worse, EDS resulted in both poor patient satisfaction and poor endoscopist satisfaction. In our opinion, the EDS model for ERCP is a threat to patient safety and should be abandoned. We strongly believe that propofol sedation should only be administered by a qualified anesthesia professional equipped with the ability to quickly recognize airway compromise and the skills to manage an airway in the event of emergency. These skills fall outside the scope of practice of gastroenterology physicians, nurses, and technicians.
A Qualified Anesthesia Professional Should Determine the Optimal Anesthetic for Specified Patients and the Clinical Circumstance

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SUMMARY

This Pro-Con article was prompted by the growth in complex endoscopy procedures over recent years coupled with the lack of large randomized controlled trials to support a definitive anesthetic technique for patients having ERCP. The debate is particularly important because of the incidence of comorbidities and because the procedure involves a shared airway. The benefits of MAC include fewer hemodynamic perturbations, decreased side effects from inhalation agents, faster cognitive recovery, and shorter overall procedural time, which must be weighed against the incidence of critical events due to impaired oxygenation and/or ventilation known to occur during MAC. The 2 approaches highlighted in this discussion emphasize the importance of having a qualified anesthesia professional determine the optimal anesthetic for a particular patient and clinical circumstance.

Luke S. Janik, MD, is a clinical assistant professor at the University of Chicago and faculty in the Department of Anesthesiology, Critical Care and Pain Medicine, NorthShore University HealthSystem, Evanston, IL. 

Jeffery S. Vender, MD, MCCM, is a clinical professor emeritus in the Department of Anesthesiology at the University of Chicago, Chicago, IL. 

Samantha Stamper, MD, is an assistant professor at the Cleveland Clinic Lerner College of Medicine at Case Western Reserve University and faculty at the Anesthesiology Institute, Cleveland Clinic, Cleveland, OH. 

Christopher A. Troianos, MD, FASE, FASA, is clinical professor at the Anesthesiology Institute, Cleveland Clinic Lerner College of Medicine at Case Western Reserve University, Cleveland Clinic, Cleveland, OH. 

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REFERENCES