Southern California CSU DNP Consortium
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ANESTHESIA PRACTICE GUIDELINES FOR PATIENTS UNDERGOING ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY

A DOCTORAL PROJECT
Submitted in Partial Fulfillment of the Requirements
For the degree of
DOCTOR OF NURSING PRACTICE

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ABSTRACT

Endoscopic retrograde cholangiopancreatography (ERCP) is a common procedure used to diagnose and treat disorders of the biliary and pancreatic ductal systems. The number of procedures performed annually is rising. Endoscopists are challenged with determining the optimal sedation/anesthesia technique for each patient. ERCPs can be performed under conscious sedation, deep sedation, or general anesthesia. The choice of technique is based on the patient’s health status and patient/provider preference. An extensive literature review and expert consultation uncovered numerous safety concerns and complications encountered during ERCPs. In addition, several recommendations were found that have the potential to prevent adverse events, enhance patient safety, and improve efficiency.
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I would like to thank my family and friends who loved and tolerated me throughout this process. A special thank you to Sandy Bordi for providing endless moral support and friendship during this program. I am eternally grateful to my husband Garrett Mendez who has never stopped encouraging me, without him I would not have committed to this program. To my boys Sammy and Gage, your kisses and cuddles made this all possible.
BACKGROUND

Endoscopic retrograde cholangiopancreatography (ERCP) is the combination of endoscopy and fluoroscopy to diagnose and treat disorders of the biliary or pancreatic ductal systems. This procedure requires a scope to be passed from the patient’s mouth to the duodenum resulting in patient discomfort and a compromised airway (Souter, 2006). ERCP is a relatively safe procedure that may be done on an inpatient or outpatient basis, depending on the health status of the patient. Optimal sedation, analgesia, and patient cooperation are necessary to successfully complete an ERCP (Collins & McDowell, 2014). An ERCP is most commonly performed under moderate to deep sedation administered by non-anesthesia providers (anesthesiologists and nurse anesthetists); this practice is widely accepted. For example, at Kaiser Permanente Riverside (KPR) a Registered Nurse (RN) administers sedation under the supervision of the endoscopist. Level of sedation is determined through clinical assessment by the endoscopist who will request more or less sedation as deemed necessary. Restless and inadequately sedated patients carry an increased risk of complications such as gastrointestinal bleeding, perforation, and aspiration of gastric contents. Conversely, over-sedation may result in hypoventilation, arrhythmias, and cardiopulmonary arrest. In addition, comorbidities such as obesity, cardiac disease, diabetes, and pulmonary disease increase the risk of adverse events during an ERCP. The endoscopist typically chooses the sedation technique based on patient history, patient/provider preference, and health status. Frequently, anesthesia services will be requested for patients that require airway management, increased monitoring, very deep sedation, or general anesthesia.
**Problem Statement**

The number of ERCPs performed annually is on the rise (Bo et al., 2011). Currently, there are no practice guidelines for anesthetic techniques for ERCP. In an effort to increase patient safety and to ensure cost containment, it is necessary to develop practice guidelines to aid providers in the decision making process. Therefore, the primary objective for this Doctor of Nursing Practice project is to conduct a thorough review of the literature, expert consultation, and evaluation deidentified data (procedure length, recovery time, cost, complications, number of procedures, number of procedures rescheduled) obtained from KPR via personal communications. The secondary objective for this project is to develop practice guidelines to support providers in their decisions regarding sedation/anesthesia for ERCPs.

The development and dissemination of anesthesia practice guidelines for ERCP may have a long-lasting and meaningful impact on the medical professionals from the gastrointestinal and anesthesia communities, locally and nationally. The purpose of the guidelines is to improve patient safety and department efficiency.

**Purpose Statement**

The first phase of this project is to identify the best evidence to support the development of anesthesia practice guidelines for ERCPs. The final product is a systematically developed set of recommendations that will assist providers in deciding which patients should receive conscious sedation, deep sedation, or general anesthesia when undergoing ERCP. The practice guidelines are intended to be an assistive tool that can be accepted, rejected, or modified according to the needs of the provider and the patient.
The practice guidelines were developed by conducting an extensive literature review to identify the best possible evidence. In this project, practice guidelines were developed to prevent adverse events, enhance patient safety, and improve efficiency of ERCPs. This was achieved through comparison of anesthetic techniques and evaluation of safety and complications. The findings from the literature were synthesized and analyzed to determine the best evidence that supports the development of anesthesia practice guidelines for ERCPs.

The resulting practice guidelines should assist providers in deciding whether a patient should receive conscious sedation, deep sedation, or general anesthesia for an ERCP. The guidelines are not protocol and do not guarantee a specific outcome. However, the guidelines will assist providers in choosing the appropriate sedation/anesthetic technique for ERCPs based on the best available evidence. In addition, patients should benefit from the implementation of these practice guidelines. The guidelines account for patient safety, best outcomes, patient and provider satisfaction, and efficiency. Current practice at KPR utilizes conscious sedation, administered by a RN under the supervision of the endoscopist. According to the literature, this may be the most cost effective technique but not always the safest or most satisfactory for the patient (Amornyotin, Na-Pomphet, Wongwathanyoo, & Chalayonnawin, 2004). The implementation of practice guidelines will help providers decide on the appropriate sedation/anesthetic technique and support the use of anesthesia providers when necessary.

The implementation of the practice guidelines depends on the approval and acceptance by the anesthesia and gastrointestinal departments at KPR. The practice
guidelines will be presented to the main stakeholders (the chief of anesthesia, the chief of gastroenterology, and the department administrators) with plans to discuss the feasibility of implementing the guidelines at KPR. The expected results will be the acceptance and implementation of the practice guidelines at KPR.

**Supporting Framework**

A conceptual framework provides scholars with guidelines to organize, communicate, and present ideas or concepts. They offer a foundation to explain and develop projects in an efficient and meaningful way. It is important to choose a framework that is based on the assumptions, findings, and ideas of others with similar objectives. The purpose of this project was to evaluate the current literature, identify the best evidence, and develop practice guidelines. According to Kitson et al. (2008), implementation of evidence and guidelines requires a system change. Therefore, it is necessary to choose a framework that focuses on system change using the best evidence.

**Promoting Action on Research Implementation in Health Services**

This project is framed in the Promoting Action on Research Implementation in Health Services (PARiHS) model. Kitson, Harvey, and McCormack first introduced the PARiHS model in 1998; since then, the framework has been further developed and refined (Rycroft-Malone, 2004). This model serves as a framework for implementing evidence-based research into practice. Unlike comparative change models, the PARiHS framework is multidimensional and is comprised of three elements (Rycroft-Malone, 2004). The three elements, evidence, context, and facilitation, are used to achieve a successful system change. The quality of the three elements is divided into sub-elements, each of which are rated on a low to high continuum.
Evidence. Traditionally evidenced-based practice (EBP) is the product of research. However, the PARiHS framework recognizes that the basis for EBP comes from a variety of sources that yield credible information such as local data and information, clinical experience, patient experience, and research (Rycroft-Malone, 2004). Local data and information comes from chart audits, pilot projects, and local research. Clinical experience is based on individual and group practice and opinion. Patient experiences are the values and beliefs of the consumers of health-care. Research is comprised of systematic reviews, randomized control trials (RCTs), and qualitative studies. For this project, the highest quality of evidence was obtained through an extensive literature review. Several systematic reviews and RCTs were analyzed, patient and clinician experiences were obtained through qualitative studies and editorials, and local data and information was investigated.

Context. According to Rycroft-Malone (2004), the PARiHS framework defines context as the environment or setting where health-care is received or change is to be implemented. Context encompasses three sub-elements, culture, leadership, and evaluation. Culture is defined by beliefs and attitudes about healthcare, as well as morale within the intended environment or setting. Leadership is based on the ability to motivate, inspire, and challenge those within the context. Evaluation must be done prior to practice change, continue throughout the development and implementation, and be done to assess outcomes post-implementation. Identification and assessment for this project has been completed and an assessment of needs has been developed based on those findings. The needs assessment clearly defines the context in which this policy development and change will take place.
Facilitation. The PARiHS framework defines facilitation as the process of assisting implementation of the best evidence into practice (Rycroft-Malone, 2004). An individual or group who desires to make the implementation of evidence easier for others carries out facilitation. Facilitation is divided into three sub-elements, purpose, role, and skills and attributes (Rycroft-Malone, 2004). The PARiHS framework encourages facilitation to become a “holistic” approach, permitting individuals to scrutinize the situation and themselves. Purpose includes offering support and knowledge to achieve goals and encouraging others to analyze and reflect on their own beliefs and attitudes (Rycroft-Malone, 2004). The role encompasses hands-on interaction and offers support, influences others, and promotes action (Kitson et al., 1998). Counseling, feedback, and flexibility during the change process are necessary skills and attributes required for facilitation.

Low-to-high continuum. The three elements are valued on a low to high continuum that reflects the strength of the elements for successful implementation. The ideal scenario for successful implementation is to have all aspects of evidence, context, and facilitation at the highest point on the continuum (Rycroft-Malone, 2004).

Project planning, development, and implementation can generate a variety of relationships among and within the evidence, context, and facilitation. For example, the evidence and facilitation could be high and the context could be low. This scenario would require that the strength of the evidence and the facilitators compensate for the “less friendly to change” context to achieve implementation (Kitson et al., 1998). The least desirable scenario would include low context and low facilitation with high
evidence. Despite the strength of the evidence, it would be difficult to implement change in the presence of inadequate facilitation and context.

The sub-elements of evidence, context, and facilitation can be used to evaluate changes made at the individual level. For example, if an intervention is based on strong evidence but the patient (context) and the clinician (facilitator) are reluctant then the intervention is unlikely to be adopted (Kitson et al., 1998). Conversely, if a patient and clinician are in favor of an intervention that is not based on strong evidence the intervention is likely to be continued.

**Summary.** The PARiHS framework accurately characterizes the complexities involved in successful implementation and system change. It is a meaningful and effective model to guide clinicians who are interested in making a practice change based on the best possible evidence. Despite the possibility of a wide variety of relationships to exist among and within the elements, success can still be achieved as the elements with the greatest strength overcome the weaker ones. For this project, the PARiHS framework was utilized as a road map to assist in the identification of the best evidence, context, and facilitation.
REVIEW OF LITERATURE

Overview

The primary objective for this project was to conduct a thorough literature review and evaluate existing data from KPR. The secondary objective for this project was to develop practice guidelines to support providers in their decisions regarding anesthesia for ERCPs. A thorough review of the literature generated many articles that studied anesthetic techniques for ERCPs and focused on complications and safety associated with the procedure. A table of evidence compares anesthetic considerations for ERCP (see Appendix A) and a second table of evidence summarizes the complications and safety concerns associated with ERCPs (see Appendix B).

Anesthetic Considerations

Anesthetic considerations are a vital component when planning an ERCP. Providers are challenged with deciding which sedation/anesthetic technique should be implemented. There are four levels of sedation: minimal sedation, conscious sedation, deep sedation, and general anesthesia (see Table 1). Minimal sedation utilizes a very small amount of medication to attain decreased anxiety and minimize discomfort without affecting a patient’s level of consciousness or physical status. Conscious sedation is achieved by titrating medication to slightly alter a patient’s level of consciousness and physical status, rarely requiring intervention. During deep sedation medication is titrated until the patient no longer responds to verbal stimuli, physical status is often depressed and may require intervention. General anesthesia requires the titration of medication or gases to achieve a patient that does not respond to painful stimuli, frequently the patient will require an airway intervention and assisted ventilation. There is a fine line between
these levels of sedation; all patients react differently to medications and there is no set amount that each patient should receive. Frequently, patients transition from one level of sedation to another. Therefore, increased vigilance is imperative to minimize adverse events.

Table 1

**Levels of Sedation**

<table>
<thead>
<tr>
<th></th>
<th>Minimal Sedation</th>
<th>Conscious Sedation</th>
<th>Deep Sedation</th>
<th>General Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsiveness</td>
<td>Normal response</td>
<td>Purposeful response</td>
<td>Purposeful response</td>
<td>Unarousable even</td>
</tr>
<tr>
<td></td>
<td>to verbal stimulus</td>
<td>to verbal or tactile stimulus</td>
<td>response to painful stimulus</td>
<td>with painful stimulus</td>
</tr>
<tr>
<td>Airway</td>
<td>Unaffected</td>
<td>No intervention</td>
<td>Intervention may be required</td>
<td>Intervention required</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>Unaffected</td>
<td>Adequate</td>
<td>May be inadequate</td>
<td>Inadequate</td>
</tr>
<tr>
<td>ventilation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Unaffected</td>
<td>Maintained</td>
<td>Usually maintained</td>
<td>May be impaired</td>
</tr>
<tr>
<td>function</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Endoscopic retrograde cholangiopancreatography is a very uncomfortable and often painful procedure requiring deep sedation or general anesthesia (Amornyoitin et al., 2004). General anesthesia has been found to have fewer complications compared to deep sedation because the airway is protected and an anesthesia provider is continuously monitoring the patient and intervening as necessary (Etzkorn et al., 1998). However, deep sedation is effective and safe (Bo et al., 2011). At KPR most ERCPs are performed under conscious or deep sedation administered by a RN under the supervision of the
endoscopist (J. Pyne, personal communication, November 11, 2013). The RN is responsible for administering medication, monitoring the patient, charting, and assisting with the procedure. Conscious sedation administered by RNs is safe and effective; however, deep sedation and general anesthesia should be administered by an anesthesia provider (Amornyotin et al., 2004). At KPR, the RNs utilize the Aldrete Postanesthesia Scoring System to evaluate the patient’s level of sedation (see Table 2). In contrast, anesthesia providers have special training in airway management, physiology, pharmacology, and critical care and rely greatly on their clinical judgment to monitor sedated/anesthetized patients.

The presence of an anesthesia provider during an ERCP allows for immediate recognition and treatment of cardiac or respiratory events (Berzin et al., 2011). Anesthesia providers offer the safest means of sedating and monitoring patients undergoing ERCP (Berzin et al, 2011; J. Pyne, personal communication, November 11, 2013; Thompson et al., 2004). However, non-anesthesia providers are safe and further studies should be conducted to determine the extent to which anesthesia providers should be present for ERCPs (Garewal, Powell, Milan, Nordmeyer, & Waiker, 2012). Commonly, anesthesia providers are not used for sedation during ERCPs because this increases costs for the procedure (Amornyotin et al., 2004). However, costs may be offset by efficiency, patient safety, and patient/provider satisfaction.

A growing trend in sedation and anesthesia is the use of propofol. Propofol is a short-acting intravenous drug that is administered for induction and maintenance of general anesthesia, procedural sedation, and therapeutic sedation. Propofol is considered
Table 2

*Aldrete Postanesthesia Scoring System*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>1 min</th>
<th>15 min</th>
<th>30 min</th>
<th>45 min</th>
<th>60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Able to move on command voluntarily</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Four extremities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two extremities</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No extremities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Respiration</td>
<td>Able to breathe deeply, cough freely</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difficult or limited breathing</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Apnea</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Within 20% of baseline</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20%-40% of baseline</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt; 40% of baseline</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Consciousness</td>
<td>Fully awake</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arousable to verbal stimuli</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Oxygen saturation</td>
<td>&gt; 90% in room air</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 90% with supplemental oxygen</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&lt; 90% with supplemental oxygen</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>


to be more effective than traditional sedation regimens (benzodiazepines and opioids) and is effective for endoscopic gastrointestinal procedures (Lee et al., 2012; Wehrmann, Kokabpick, Lembcke, Caspary, & Seifert, 1999). Propofol has a rapid onset and very
short clinical duration. Therefore, propofol is an ideal drug for sedation/anesthesia during ERCP. Propofol has been proven to be safe, efficient, and cost-effective for gastrointestinal procedures without any increase in adverse events compared to traditional regimens (Qadeer, Vargo, Khandwala, Lopez, & Zuccaro, 2005). Conversely, Angsuwatcharakon et al. (2012) observed that oxygen desaturation occurred more often in patients receiving propofol than with traditional sedation. The use of propofol is associated with greater patient and provider satisfaction (Angsuwatcharakon et al., 2012). In addition, propofol is often the preferred intravenous drug for sedation during ERCP due to its rapid onset and brief recovery time (Garewal et al., 2012).

**Complications and Safety**

Safety is a major concern for staff during an ERCP due to increased risk for allergic reactions to medications or radiologic dyes, aspiration, airway compromise, cardiac or respiratory events, or inadequate sedation. In most cases, ERCPs are performed in the endoscopy suite, outside of the operating room (OR). The administration of deep sedation or general anesthesia in an out-of-OR setting contributes to a multitude of safety concerns for anesthesia providers. These include limited or no availability of anesthesia providers, less or minimal anesthesia supplies and equipment, and unfamiliar staff and setting. Proper training and adherence to facility guidelines will help to minimize adverse events and increase patient safety.

According to the American Society for Gastrointestinal Endoscopy (ASGE, 2006), sedation-related complications or adverse events during ERCP range from minor (hypoxemia and hemodynamic changes) to major (aspiration and cardiopulmonary arrest) events. Complications may arise due to underlying conditions, sedation, or the procedure
itself. The ASGE (2003) acknowledges that cardiopulmonary complications associated with ERCPs are rare (1-2%). However, they account for 50% of all reported complications and are a prominent cause of death from ERCP (Fisher, Fisher, & Thomson, 2006). Therefore, the ASGE (2003; 2006) has made sedation-related recommendations for ERCPs. These include thorough pre-sedation evaluation, use of pulse oximetry and electrocardiogram, availability of reversal agents, and consideration of sedation by anesthesia providers for high American Society of Anesthesiologist (ASA) status (see Table 3), hemodynamic instability, or high risk of being difficult to sedate. In addition, the literature provides substantial findings to guide providers during ERCP.

Table 3

American Society of Anesthesiologists Physical Status Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Physical Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No organic, physiologic, biochemical, or psychiatric disturbance (e.g., healthy patient)</td>
</tr>
<tr>
<td>II</td>
<td>Mild to moderate systemic disturbance (e.g., heart disease with minimal limitations, hypertension, diabetes, anemia, obesity, extreme ages)</td>
</tr>
<tr>
<td>III</td>
<td>Severe systemic disturbance that limits activity (e.g., heart or lung disease, poorly controlled hypertension, diabetes with vascular complications, chest pain, previous heart attack)</td>
</tr>
<tr>
<td>IV</td>
<td>Severe systemic disturbance that is life threatening (e.g., advanced lung, kidney, or liver disease, heart failure, persistent chest pain)</td>
</tr>
<tr>
<td>V</td>
<td>Moribund patient with minimal chance for survival (e.g., uncontrolled bleeding)</td>
</tr>
<tr>
<td>E</td>
<td>Emergency</td>
</tr>
</tbody>
</table>

Several studies that focused on the complications and safety associated with ERCP were identified. Marriott et al. (2004) determined that 35% of patients sedated for gastrointestinal procedures encountered at least one adverse event; despite adverse events 93% of patients were satisfied with their sedation. Interestingly, the authors also revealed that over sedation often resulted in a greater incidence of adverse events and uncooperative patients. Thompson et al. (2004) found that perforation, delayed or prolonged procedures, failure to recognize complications, overdose of sedation, and aspiration were the main contributing factors of mortality.

One of the most frequent and concerning adverse events is oxygen desaturation. Alcaín, Guillén, Escolar, Moreno, and Martín (1998) established that patients at risk for oxygen desaturation during ERCP had one or more of the following characteristics: baseline oxygen saturation less than 95%, hospitalized, body mass index (BMI) greater than 28, respiratory disease, cirrhosis, ASA status III or greater, emergency ERCP, or more than one attempt at esophageal intubation. They also determined that gender, hemoglobin level, smoking status, presence of heart disease, advanced neoplasm, duration of the ERCP, endoscopist experience, and heart rate had no significant impact on oxygen desaturation. In a similar study, Berzin et al. (2011) determined that patients with ASA status III or greater and BMI greater than 30 are at an increased risk for adverse cardiopulmonary events during ERCP. Muller, Prolla, Maguilnik, and Breyer (2004) discovered that patients older than 60 and ASA III or greater were at greatest risk for oxygen desaturation. Rigg, Watt, Tweedle, and Martin (1994) identified prolonged duration of ERCP, cardiopulmonary disease, deep sedation, prone positioning, and darkness of the procedure room as factors that affect oxygen desaturation. Surprisingly,
El Chafic, Eckert, and Rex (2012) concluded that females are at a lower risk for oxygen desaturation during ERCP.

In addition to oxygen desaturation, hemodynamic and electrocardiogram (ECG) changes are common complications of ERCP (Fisher et al., 2006). Intra-procedure oxygen desaturation and myocardial infarction were found to be associated with prolonged procedure time and post-ERCP pancreatitis (Fisher et al., 2006). Likewise, El Chafic et al. (2012) determined that deep sedation and prolonged procedure times for ERCP were associated with hemodynamic changes and oxygen desaturation. They determined that prolonged procedure times, pediatrics, and those who developed a cough had the greatest changes in heart rate.

Providers are often concerned for the elderly patient and the potential for complications that may arise due to advanced age. ERCP with sedation is safe for patients over 80 years old and less sedation is required; however, elderly patients had longer procedure times and more complications related to existing comorbidities (Ali, Ward, Staley, & Duerksen, 2010). On the contrary, Fisher et al. (2006) determined that the elderly tolerated ERCP well and that adverse events were the same among all ages.

The literature provided an abundance of studies regarding oxygen desaturation, hemodynamic changes, and elderly patients undergoing ERCP. However, some challenges were explored by a small number of studies. For example, El Chafic et al. (2012) observed patients undergoing ERCP to determine the incidence of coughing and associated adverse events. Sedation and stimulation from passing the scope through the mouth may initiate coughing in some patients. These authors found that coughing most often occurred in smokers, when propofol was used, in the presence of hiccups, and
during longer procedures. An increase in heart rate was frequently observed in younger patients and those who developed a cough (El Chafic et al., 2012). The use of intravenous lidocaine was found to have no effect on coughing. Ferreira and Baron (2008) determined that supine positioning resulted in increased procedural difficulty and longer procedure times compared to standard positioning (prone or left lateral decubitus). Supine positioning did not result in more significant adverse events than standard positioning.

Ultimately, sedation and anesthesia during ERCP is accompanied by a multitude of possible complications and safety concerns. Therefore, the development of anesthesia practice guidelines is essential to increasing patient safety and preventing adverse events.
METHODS

The methods used in this literature review focused on identifying complications, safety concerns, efficiency, and patient/provider satisfaction related to sedation for ERCPs. The literature also provided insight to the pros and cons of various sedation/anesthesia techniques used for ERCPs. In addition, existing deidentified data was obtained from KPR to enhance the recommendations for ERCP. Institutional Review Board and department approval was obtained to maintain ethical standards. However, the data that was collected from KPR did not provide substantial findings that would improve the final product for this project. Therefore, the practice guidelines were developed based on an extensive literature review and expert opinion.

Search Methods

The literature review for this project was conducted by accessing the Cumulative Index to Nursing and Allied Health Plus, PubMed, Cochrane Library, and Google Scholar. The following key terms and combinations were used: conscious sedation, deep sedation, general anesthesia, ERCP, safety, propofol, complications, and anesthetic techniques.

The in-depth literature review included research studies, case reports, and professional consensus. The population of interest was adults undergoing ERCP with sedation. Studies were excluded if they involved pediatric patients, pregnant women, or were not written in English. This project was exclusively based on available data from the literature review and expert opinion, no humans or protected data were used for this project.
Search Results

The literature review produced an abundance of evidence. After implementation of inclusion and exclusion criteria, 18 research articles were identified and analyzed. Based on the evidence hierarchy (Polit & Beck, 2012), these were categorized as follows: five retrospective control studies (level II), three observational studies (level IV), seven controlled trials (level II), two meta-analyses (level I), and one systematic review (level I). In addition, this project utilized textbooks and expert opinion (level VII).

Project Product

The final product for this doctoral project is a systematically developed set of recommendations (see Appendix C) that will assist providers in deciding which patients should receive conscious sedation, deep sedation, or general anesthesia when undergoing ERCP. These guidelines are intended to increase safety, efficiency, and patient/provider satisfaction. The guidelines that are developed were subjected to evaluation prior to conclusion of this project. Evaluation was conducted by peer review and expert consultation.
RECOMMENDATIONS FROM THE LITERATURE

The review of the literature uncovered numerous complications and safety concerns associated with ERCP. Additionally, a variety of sedation/anesthesia techniques were scrutinized. Several recommendations were noted throughout the literature and from expert consultation.

The frequent occurrence of oxygen desaturation and hemodynamic changes resulted in similar recommendations by most authors. Alcaín et al. (1998), Muller et al. (2004), and Thompson et al. (2004) advocated for the routine use of pulse oximetry to monitor oxygen saturation. In addition to pulse oximetry, J. Pyne (personal communication, November 11, 2013) and Thompson et al. (2004) believed that providers should routinely monitor ECG and blood pressure and administer supplemental oxygen. Anesthesia providers should implement the routine use of capnography while administering propofol (Angsuwatcharakon, 2012). Patients 65 years of age and greater are at an increased risk for myocardial injury during ERCP; therefore, cardiac troponins should be measured before and 24 hours after ERCP (Fisher et al., 2006). Rigg et al. (1994) suggested that oxygen desaturation can be prevented by initiating pre-oxygenation with four liters of oxygen via nasal cannula for 5 minutes pre-procedure and continued throughout the procedure. To decrease the incidence of oxygen desaturation, Muller et al. (2004) promoted deep breathing and coughing; however, it is near impossible for patients to follow commands while receiving sedation. Thus, deep breathing and coughing should be encouraged post-procedure.

Providers utilize monitors (e.g., pulse oximetry, ECG, blood pressure, capnography) and clinical assessment (e.g., patient response, respirations, heart rate,
color) to determine level of sedation/anesthesia. During ERCP, the room lights are dim (so the endoscopist can visualize the anatomy under fluoroscopy) making clinical assessment challenging; consequently, increased vigilance is extremely important (Muller et al., 2004). Deep sedation with propofol, prolonged procedures, patients with hiccups, and changes in positioning carry an increased risk for adverse events and should be closely monitored (El Chafic et al., 2012). Optimal sedation must be reached prior to insertion of the endoscope to avoid patients gagging, moving, or coughing (Jeurnink, Steyerberg, Kuipers, & Siersema, 2012). Administration of tetracaine lozenges may inhibit gagging or coughing during ERCP (Alcaín et al., 1998). However, this recommendation was made by only one set of authors and would need further investigation prior to recommending routine use of tetracaine lozenges.

Positioning is a crucial part of a successful ERCP. Patients are usually placed in the left lateral decubitus or prone positions to allow endoscopists to navigate the scope with ease. Current literature does not support performing ERCPs in the supine position; however in the event that a patient cannot assume the left lateral decubitus or prone positions, supine positioning is acceptable. Supine positioning should be considered for patients who cannot lie prone due to severe abdominal pain, abdominal distension, ascites, morbid obesity, recent abdominal or neck surgery, or presence of indwelling catheters (Ferreira & Baron, 2008). ERCPs performed in supine position without endotracheal intubation require more intense monitoring because the supine position may be more technically difficult and carry the potential for more adverse events (Ferreira & Baron, 2008).
General anesthesia is not routinely performed for all ERCPs. The course of an anesthetic is dependent upon the provider and the facility. Interestingly, anesthesia providers in many countries outside of the United States provide general anesthesia for ERCPs, because it is the only way to guarantee complete patient cooperation and allows for increased speed and ease of the procedure (Jeurnink et al., 2012). General anesthesia should be considered for patients at an increased risk of post-ERCP complications (e.g., therapeutic ERCP, cholangitis, pancreatitis), those with mental health problems, and pediatrics (Jeurnink et al., 2012). Amornyotin et al. (2004) advocated for the use of general anesthesia for pediatrics, refusal of conscious/deep sedation, and comorbidities that contribute to prolonged or more painful ERCPs. In addition, Etzkorn et al. (1998) recommended the use of general anesthesia for patients with drug/alcohol abuse, inability to cooperate, severe anxiety, septic shock, muscle diseases, patients requiring airway protection, and previous failed attempts at ERCP under conscious/deep sedation. General anesthesia is appropriate for certain patients and in some cases may reduce mortality associated with ERCP (Thompson et al., 2004). The ASGE (2003; 2006) encourage providers to complete a thorough pre-sedation evaluation, use continuous pulse oximetry and electrocardiogram, keep reversal agents readily available, and consider the use of anesthesia providers for high ASA status, hemodynamic instability, or high risk of being difficult to sedate.

Berzin et al. (2011) concluded that deep sedation for ERCPs should be administered by anesthesia providers; this recommendation that is echoed by J. Pyne (personal communication, November 11, 2013). There are numerous advantages to the presence of anesthesia providers during ERCP: increased efficiency, faster sedation and
recovery times, fewer sedation-related procedure failures, increased safety, and immediate recognition and treatment of adverse events (Berzin et al., 2011). Non-anesthesia providers can administer propofol with minimal complications under supervision of endoscopist for non-complicated cases; however, anesthesia providers should be utilized for complex ERCP (Garewal et al., 2012). Several studies found that patients with ASA status III or greater and increased BMI are at greatest risk for adverse events. Therefore, the use of anesthesia providers should be considered for sedation of ASA status III or greater and BMI greater than 28.

In an effort to prevent adverse events, enhance patient safety, and improve efficiency of ERCPs the findings of this project were used to create a comprehensive set of recommendations that can be found in the document Anesthesia Practice Guidelines For Patients Undergoing Endoscopic Retrograde Cholangiopancreatography (see Appendix C).
REFERENCES


# APPENDIX A

## TABLE OF EVIDENCE: COMPARISON OF ANESTHETIC CONSIDERATIONS

*Comparison of Anesthetic Considerations for Endoscopic Retrograde Cholangiopancreatography (ERCP)*

<table>
<thead>
<tr>
<th>Study Design and Source</th>
<th>Sample</th>
<th>Findings</th>
<th>Limitations</th>
<th>Conclusions</th>
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</table>
| Retrospective chart review (Amornyotin et al., 2004) | 2,144 pts undergoing ERCP from 1999-2003 | ● DS 96.4%  
● GA 3.6% Adverse events  
● Hypotension 8.8%  
● Hypertension 0.7%  
● Arrhythmia 0.4%  
● Procedure failure was double in the DS group | ● Very few pts received GA  
● Only propofol was given for DS | ● Indications for GA: pediatrics, refusal of CS, comorbidities that contribute to prolonged and more painful ERCPs  
● ERCPs performed with anesthesia providers have higher costs per procedure  
● DS and GA provided adequate anesthesia for ERCP  
● Anesthesia providers should be present during ERCPs with DS & GA |

| Randomized controlled study (Angsuwatcharakon et al., 2012) | 205 pts undergoing ERCP; 103 pts received propofol; 102 pts did not receive propofol | ● No significant baseline difference in ASA class, age, sex, BMI, or comorbidities  
● Adverse events identified (no difference): Hypotension, change in heart rate, & apnea  
● Adverse event identified (difference): desaturation (< 90% O2) greater in propofol group | ● Pt. cooperation level was not assessed appropriately | ● Pts who received propofol had shorter recovery times and greater satisfaction  
● Oxygen desaturation occurs more frequently with propofol than conventional sedation  
● Supplemental oxygen & capnography should be used |
<table>
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<tr>
<th>Study Design and Source</th>
<th>Sample</th>
<th>Findings</th>
<th>Limitations</th>
<th>Conclusions</th>
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</table>
| Meta-analysis (Bo et al., 2011) | 6 studies (663 pts total) obtained from electronic databases | • Recovery time for pts receiving propofol significantly shorter  
• Adverse events (no significant difference among propofol and non-propofol): hypotension, desaturation, change in blood pressure or heart rate | • Small number of participants in each study | • Propofol for DS during ERCP is safe and effective |
| Retrospective chart review (Etzkorn et al., 1998) | 63 pts requiring GA for ERCP | Indications for GA:  
• 48% drug or alcohol abuse  
• 19% anxiety or inability to cooperate  
• 11% adverse event/drug reaction during previous CS  
• 6% refused CS  
• 3% septic shock  
• 0.6% myasthenia gravis | • Study only reviewed GA cases | • Indications for GA: drug or alcohol abuse with a previous failed attempt under CS, anxiety and inability to cooperate (no history of substance abuse, cerebral palsy, mental retardation), adverse reaction to medications used for CS, refusal of CS, septic shock, myasthenia gravis or other muscle diseases, airway protection, and pediatrics  
• Complication rates are slightly lower with GA  
• GA requires larger rooms for anesthesia equipment, incurs more costs, and offers less movement of pts resulting in greater success |
<table>
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<tr>
<th>Study Design and Source</th>
<th>Sample</th>
<th>Findings</th>
<th>Limitations</th>
<th>Conclusions</th>
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</thead>
<tbody>
<tr>
<td>Systematic review (Garewal et al., 2012)</td>
<td>4 randomized trials (510 participants)</td>
<td>All studies: * 2% airway protection * 11% pediatric pts</td>
<td>Studies focused on administration of sedation by non-anesthesia providers only</td>
<td>Propofol provides a better recovery profile than traditional sedation with meperidine and midazolam * Propofol is preferred choice for sedation * Further studies should be conducted to determine extent to which anesthesia providers should be present for ERCPs * Non-anesthesia providers can administer propofol with minimal complications under supervision of endoscopist for non-complicated cases * Anesthesia providers should be utilized for complex ERCP</td>
</tr>
<tr>
<td>Prospective study (Jeurnink et al., 2012)</td>
<td>139 consecutive pts undergoing ERCP</td>
<td>Complications (most often experienced by younger pts, those with mental health problems, and those undergoing therapeutic ERCP): * Sore throat * Discomfort * Pain</td>
<td>Questionnaires were only completed by those that were healthy and may have been biased by pts experience</td>
<td>GA should be considered for pts &lt; 45 years old, have mental health problems, or undergoing therapeutic ERCP * Endoscope should only be inserted when optimal sed. reached * Pts with an increased risk of post-ERCP complications (e.g., pancreatitis, cholangitis) should receive DS with propofol or GA</td>
</tr>
<tr>
<td>Meta-analysis (Qadeer et al., 2005)</td>
<td>12 studies (1,161 pts); propofol n = 634; midazolam,</td>
<td>Complications: * Hypoxia * Hypotension * Arrhythmias * Apnea</td>
<td>Studies included all GI procedures not just ERCPs</td>
<td>Propofol safe, effective, and cost-effective for procedures in gastroenterology suite * No difference in complication rates between propofol and non-propofol sed.</td>
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<tr>
<td>Study Design and Source</td>
<td>Sample</td>
<td>Findings</td>
<td>Limitations</td>
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</table>
| Prospective controlled study (Wehrmann et al., 1999) | 198 consecutive pts undergoing routine ERCP; DS with propofol $n = 71$; CS with midazolam $n = 67$ | - Propofol group: faster time to pt. ready, shorter procedure time, faster recovery time, superior pt. cooperation, greater desaturation, greater hypotension, greater pain at injection site | - DS with propofol more effective than CS without propofol  
- Propofol safe when monitored appropriately, DS requires closer pt. monitoring than CS  
- Propofol has faster recovery time than traditional sedation with meperidine and midazolam  
- Costs may be higher with propofol due to additional anesthesia providers, however costs may be offset by efficiency | |

*Note.* ERCP = endoscopic retrograde cholangiopancreatography; sed. = sedation; GA = general anesthesia; CS = conscious sedation; DS = deep sedation; pts = patients; ASA = American Society of Anesthesiologists; BMI = body mass index; sed. sedation; GI = gastrointestinal.
## APPENDIX B

### TABLE OF EVIDENCE: COMPLICATIONS AND SAFETY

*Complications and Safety Associated with Endoscopic Retrograde Cholangiopancreatography (ERCP)*

<table>
<thead>
<tr>
<th>Study design</th>
<th>Sample</th>
<th>Findings</th>
<th>Limitations</th>
<th>Conclusions</th>
</tr>
</thead>
</table>
| Prospective observational     | 481 consecutive pts undergoing UGI procedures; Pre-medicated with a 4%  | • Mild desaturation (O$_2$ 90-94%) 23.7%  
• Severe desaturation (O$_2$ < 90%) 6.4%                                                                 | • Pts not sedated  
• Older study, findings still pertinent                                                        | • Pts with baseline O$_2$ < 95%, inpatient status, BMI > 28, respiratory disease, cirrhosis, ASA III or greater, emergent ERCP, > one attempt at esophageal intubation at risk for desaturation  
• Gender, hemoglobin level, smoking status, heart disease, advanced neoplasm, duration of procedure, endoscopist experience, and heart rate no significant relationship to desaturation  
• Baseline O$_2$ should be recorded, pulse oximetry should be used routinely                        |
| observational study (Alcaín   | 493 adult pts undergoing ERCP divided into 2 groups: Group 1: < 80    | Group 2: longer procedure times, required less sed.                                                    | • Complication rates may have been underestimated                                                   | • ERCP is safe for those > 80 years of age; procedure times longer; require less sed.  
• ERCP in the elderly has a greater potential for complications related to comorbidities          |
| et al., 1998)                 | years of age (391) Group 2: > 80 years old (102)                      |                                                                                                       |                                                                                        |
| Retrospective chart review    | 528 consecutive pts undergoing ERCP                                   | 120 intra-procedure sed. related adverse events were identified                                       | • Cost not analyzed  
• Outcomes of DS by anesthesia providers not compared to outcomes from CS by non-anesthesia providers | • Pts with higher ASA class (III & IV) and BMI (> 30) are associated with an increased risk of cardiac and respiratory adverse events during ERCP  
• DS administered by anesthesia providers is the safest option for most pts  
• Advantages to sed. provided by anesthesia providers                                             |
<table>
<thead>
<tr>
<th>Study design</th>
<th>Sample</th>
<th>Findings</th>
<th>Limitations</th>
<th>Conclusions</th>
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<tbody>
<tr>
<td>Prospective observation</td>
<td>757 consecutive pts undergoing ERCP</td>
<td>• Unplanned intubation (16)</td>
<td>- Non-randomized</td>
<td>- Procedure efficiency, faster sed./recovery times</td>
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<tr>
<td>study (El Chafic et al.,</td>
<td></td>
<td>• Termination of ERCP (1)</td>
<td></td>
<td>- Deeper sed./GA result in 50% fewer procedure failures</td>
</tr>
<tr>
<td>2012)</td>
<td></td>
<td>30 post-procedure sed. related adverse events identified</td>
<td></td>
<td>- Safety, anesthesia providers provide immediate recognition and treatment of cardiac/ respiratory events</td>
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<tr>
<td></td>
<td></td>
<td>• Hypotension (5)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Endotracheal intubation (2)</td>
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<td></td>
<td></td>
<td>• Arrhythmias (12)</td>
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<td></td>
<td></td>
<td>• Minor cough (13%)</td>
<td>• Incidence of cough slight predictor of aspiration, clinically insignificant</td>
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<td></td>
<td></td>
<td>• Persistent cough (3%)</td>
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<td></td>
<td>• Position change (33%) developed cough</td>
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<td>• 95% dropped O₂ during procedure (no interventions required)</td>
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<td></td>
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<td>• 7.3% decrease in systolic BP; 5.6% decrease in diastolic BP (no interventions required)</td>
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<td></td>
<td></td>
<td>• 15% decrease in HR; 20% increased in HR (no interventions required)</td>
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<tr>
<td>Retrospective study</td>
<td>649 pts undergoing ERCP</td>
<td>• 506 prone position (1 GETA, 505 CS)</td>
<td>• Retrospective study</td>
<td>• No episodes of aspiration or severe complications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Analyses of only one</td>
<td>• Superseded study</td>
<td>• Supine position should only be considered for pts</td>
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<td></td>
<td></td>
<td>• Incidence of cough slight predictor of aspiration, clinically insignificant</td>
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<td></td>
<td></td>
<td>• Cough more common in non-smokers, use of propofol, longer procedures, &amp; hiccups</td>
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<td></td>
<td></td>
<td>• Cough or absence of is not associated with use of intravenous lidocaine</td>
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<td></td>
<td></td>
<td>• Females are lower risk for desaturation</td>
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<td></td>
<td></td>
<td>• DS is associated with greater desaturation and hypotension</td>
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<td></td>
<td></td>
<td>• Longer procedure times associated with changes in HR</td>
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<td></td>
<td></td>
<td>• Younger age and coughing associated with increased HR</td>
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<td></td>
<td></td>
<td>• Increased vigilance for aspiration required for: DS, propofol use, longer procedure times, hiccups, and position changes</td>
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<tr>
<td>Study design</td>
<td>Sample</td>
<td>Findings</td>
<td>Limitations</td>
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</table>
| (Ferreira et al., 2008) by one endoscopist over an 18-month period | • 143 supine position (63 GETA, 80 CS)  
• Procedural degree of difficulty and time greater with supine position  
• Respiratory adverse events ($O_2 < 90\%$) 10% supine; 5.2% prone  
• Cardiovascular adverse events minimal, no significant difference between groups | endoscopist  
• Some pts may have assumed prone position after sed., however endoscopist chose not to turn pts | who cannot lie prone: severe abd. pain, abd. distension/ascites/morbid obesity, recent abd. or neck surgery, indwelling catheters  
• ERCPs performed in supine position without endotracheal intubation require more intense monitoring because the supine position may be more technically difficult and carry the potential for more adverse events  
• Current literature does not support supine positioning for ERCP |
| Prospective cohort study (Fisher et al., 2006) 130 consecutive pts undergoing ERCP divided into 2 groups: Group 1: 65 years of age and older  
Group 2: less than 65 years of age | • Group 1: ECG changes 24%  
Hypoxia 16.2%  
6 pts with prolonged (>30 minutes) procedure times had increased troponin levels  
Post ERCP deaths: 1 MI  
1 ascending aortic aneurysm  
• Group 2: ECG changes 9.3%  
Hypoxia 21.4% | Not a randomized control trial | • ERCP is commonly associated with hemodynamic changes, hypoxemia, & ECG changes  
• Adverse outcomes are similar among all ages, elderly pts tolerate ERCP well  
• Myocardial injury was associated with prolonged procedure time  
• Measurement of cardiac troponins are recommended for those 65 and older before and 24 hours after ERCP  
• Desaturation and myocardial injury are associated with post ERCP pancreatitis |
| Prospective cohort study (Marriott et al., 2011) 117 pts undergoing gastrointestinal | • Agitation (20 events) | Scoring method for sed. level is subjective  
• Outcomes of CS not | Adverse events - 35\% of pts receiving CS  
• Adverse events coincide with deeper sed. |
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<th>Findings</th>
<th>Limitations</th>
<th>Conclusions</th>
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</table>
| al., 2004) | procedures | • Hypotension (15)  
• Hypoxia (3)  
• More than 1 adverse event (3)  
• 12 pts required intervention  
• 39 pts over sedated  
• 93% pts satisfied with sed. | compared to outcomes of DS or GA | • Patient satisfaction high  
• Pts who received highest sed. score (no response) still restless  
• Over sed. may result in increased restlessness |
| Transversal study (Muller et al., 2004) | 186 consecutive pts undergoing ERCP | • Mild desaturation, $O_2 < 92\%$ (22 events)  
• Severe desaturation, $O_2 < 90\%$ (51 events) | Recovery and procedure times not recorded  
• Outcomes of CS not compared to outcomes of DS or GA | • Pts 60+ years of age & ASA III+ associated with oxygen desaturation  
• Use of pulse oximetry essential during ERCP; promoting deep breathing should be encouraged during CS  
• Dark room makes detection of signs of oxygen desaturation difficult |
| Non-randomized control trial (Rigg et al., 1994) | 50 consecutive pts (25 male/ 25 female) undergoing ERCP | • Pre-oxygenation group: 0% fell below 90%  
• Non-pre-oxygenation group 36% fell below 90% | Study from 1994, however provides significant findings regarding importance of pre-oxygenation | • Factors affecting hypoxia: prolonged procedure time, cardiopulmonary disease, level of sed., darkened room, & prone position  
• Hypoxia during ERCP prevented by pre-oxygenation with 4 liters oxygen via nasal cannula for 5 minutes, continued use throughout ERCP |
| Retrospective study (Thompson et al., 2004) | 153 pts who died after UGI in Scotland during 1999; reported to national registry | • Mortality rate for diagnostic ERCP: .006%  
• Mortality rate for therapeutic ERCP: .01%  
• 91% ASA III-V  
• 88% sed. without anesthesia provider | Number of deaths may be underestimated if not all deaths were reported to the registry  
• Improper charting by staff | • Anesthesia providers should be considered for ASA III-V, airway management, sed., & monitoring  
• GETA may be appropriate for some, may reduce mortality  
• Supplemental oxygen should be utilized & monitoring of BP, $O_2$, & ECG should be standard  
• Adverse events contributing to death after UGI: perforation, delay in procedure, failure to recognize complications, overdose, & aspiration |
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<th>Limitations</th>
<th>Conclusions</th>
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<td>• 20% given sed. or&lt;br&gt;GA by anesthesia&lt;br&gt;provider&lt;br&gt;• 45% supplemental&lt;br&gt;oxygen&lt;br&gt;• 56% monitored for&lt;br&gt;ECG, BP, &amp; oximetry</td>
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</table>

*Note.* UGI = upper gastrointestinal endoscopy; O₂ = oxygen saturation; pts = patients; BMI = body mass index; ASA = American Society of Anesthesiologists; ERCP = endoscopic retrograde cholangiopancreatography; BP = blood pressure; HR = heart rate; GA = general anesthesia; ECG = electrocardiogram; MI = myocardial infarction; abd. = abdominal; pts = patients; GETA = general endotracheal anesthesia; CS = conscious sedation; sed. = sedation.
APPENDIX C

ANESTHESIA PRACTICE GUIDELINES FOR PATIENTS UNDERGOING ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY

In an effort to prevent adverse events, enhance patient safety, and improve efficiency of ERCPs the following practice guidelines have been developed. These recommendations are based on the best evidence discovered in an extensive literature review and expert opinion.

- **All ERCPs**
  - Thorough pre-sedation/anesthesia evaluation
  - Obtain O₂, ECG, BP pre/post procedure
  - Routine monitoring of O₂, ECG, BP
  - Pre-oxygenate: 4L via nasal cannula for 5 minutes
  - Supplemental oxygen: 2-4L during ERCP
  - Obtain cardiac troponins pre-procedure and 24 hours post-procedure for patients ≥ 65 years old
  - Left lateral decubitus or prone position (supine positioning should be considered for patients who cannot lie prone due to severe abdominal pain, abdominal distension, ascites, morbid obesity, recent abdominal or neck surgery, or presence of indwelling catheters)
  - Obtain optimal sedation prior to insertion of the endoscope
  - Increased vigilance is required, especially when the procedure is taking longer than expected, the patient develops hiccups or cough, changes in position is required
  - Reversal agents must be readily available
  - Post procedure coughing and deep breathing
  - All staff is required to attend annual critical events training

- **Conscious Sedation**
  - Medications and patient monitoring provided by a RN under the supervision of an endoscopist
  - Aldrete Postanesthesia Scoring System for sedation assessment
  - Indicated for ASA I-II
  - Call anesthesia for airway compromise

- **Deep sedation**
  - Medications and airway management are provided by a CRNA or anesthesiologist
  - Continuous capnography
  - Intervention for cardiopulmonary events as needed
  - Indicated for ASA III-V and BMI ≥ 28, hospitalized patients, and emergent procedures
• General anesthesia
  • Medications and airway management are provided by a CRNA or anesthesiologist
  • Continuous capnography
  • Intervention for cardiopulmonary events as needed
  • Indicated for ASA III-V and BMI $\geq 28$, emergent procedures, hospitalized patients, patients at an increased risk of post-ERCP complications (e.g., therapeutic ERCP, cholangitis, pancreatitis), those with mental health problems or drug/alcohol abuse, pediatrics, patient refusal of conscious/deep sedation, inability to cooperate, severe anxiety, septic shock, muscle diseases, patients requiring airway protection, comorbidities that contribute to prolonged or more painful ERCPs, and previous failed attempts at ERCP under conscious/deep sedation.

*Note.* ERCP = Endoscopic Retrograde Cholangiopancreatography; $O_2$ = Oxygen saturation; ECG = electrocardiogram; BP = blood pressure; RN = registered nurse; ASA = American Society of Anesthesiologists; CRNA = certified registered nurse anesthetist; BMI = body mass index.
REFERENCES USED FOR DEVELOPMENT OF GUIDELINES


