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Chapter

Anaesthetic Considerations in Gastrointestinal Endoscopies

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Abstract

Gastrointestinal endoscopy has become fundamental procedure for diagnosis and treatment of gastrointestinal tract diseases. Generally, the gastrointestinal endoscopy is minimally invasive procedure. However, it can cause considerable amount of discomfort and pain which make the procedure unsafe, complicated and refusal of follow up procedures if done without safe sedation. The sedation is required to alleviate anxiety, provide analgesia, amnesia and to improve endoscopic performance specifically in therapeutic procedures. The safe administration of sedative and analgesic medications, irrespective of the regimen used, requires knowledge of the individual needs of patients. The combination of benzodiazepines and opioids is now the most widely used sedation regimen for sedation in gastrointestinal endoscopic procedures. Generally, sedation for gastrointestinal endoscopy is considered safe, however, it has the potential for serious complications. Therefore, endoscopist should assess the patients properly before the endoscopy as well as should be aware of all possible complications and the risk factors. Furthermore, skilled staff and emergency equipment should be available in endoscopy suit. This chapter discuss in details all the aspects of safe procedural sedation during GI endoscopies.

Keywords: sedation, analgesia, gastrointestinal endoscopy, monitoring

1. Introduction

With the advancement in the field of medicine there is a consistent increase in number of diagnostic and therapeutic procedures which are done as day care basis. These procedures can cause considerable amount of discomfort and pain which make the procedure unsafe, complicated and refusal of follow up procedures if done without safe sedation. The GI endoscopies are a kind of procedures that need sedation to facilitate the procedures, alleviate discomfort, pain and eventually making them safe and successful.

Sedation is drug induced depression of the conscious level; it is also call as procedural sedation. Sedation is a continuum ranging from minimal sedation i.e., anxiolysis, moderate sedation (also known as Conscious sedation), Deep sedation and finally general anesthesia. Sedation for GI endoscopy needs proper planning

like preprocedural preparation, risk assessment, focus physical examination and optimization of comorbid condition if any. Other considerations in the sedation managements like the selection of a suitable sedation, analgesia regimen depends on the type and duration of procedure, patient and endoscopist satisfaction and last not the least on the competency of the provider. Monitoring during procedure is one of the crucial points in the safe sedation practice. The post procedure care is an essential part of patient safety which need monitoring of the patient in the recovery area where the adverse events secondary to the procedure or the sedation can be discovered and addressed promptly.

2. Definition

Sedation is the depression in the perception of patient's surroundings, leading to the decrease of his or her reactivity to external stimuli [1]. Sedation seldomly occurs without different degrees of related effects of sedative agents which may be dose-dependent, such as:

- **Anxiolysis:** Relieve of apprehension or agitation with limited sensory alteration.
- **Amnesia:** loss of consciousness for a period of time.
- **Analgesia:** pain relief without a change in level of consciousness.
- **Anesthesia:** loss of consciousness.
- Sedation has been a common addition to modern medical care as a means of promoting complicated or painful procedures in a safe, cost-effective and time-saving alternative to general anesthesia.

The endoscopist must completely comprehend the sedation being used. Patient factors, the setup of the GI endoscopy service and the variables of the procedure itself are to be carefully considered. Age, weight, medical history, concurrent drugs, airway anatomy, preprocedural anxiety and pain tolerance are patient variables. The amount of expected pain, the length of the test, and how invasive the procedure would be are examples of procedural variables.

The area of the endoscopy suite, the ease of staff moving around, the presence of emergency airway management equipment, the different level of skills of personnel present and whether the procedure is carried out in a hospital setting or in a stand-alone clinic are all important part of the setup.

3. Sedation levels

In recent years, four levels of sedation have been established that extend along a spectrum without clear limits: minimal sedation or anxiolysis, moderate sedation, deep sedation, and general anesthesia [1]. These sedation levels have been characterized by the reaction of a patient to verbal, light contact, or painful stimuli, although they are often associated with physiological changes in vital patient signs.

“Minimal sedation” is also known as anxiolysis and is defined as the lowest drug-induced stage of cognition-impairment. Individuals who are minimally sedated usually respond to simple orders and their breathing/cardiovascular

system is unaffected. Oral benzodiazepines are commonly used to achieve minimal sedatives.

“Moderate Sedation” has traditionally been referred to as “Conscious Sedation”. This entitles a deeper depression consciousness level. Individuals who are moderately sedated can still respond to verbal orders, often requiring physical stimulation, and their breathing/cardiovascular function is unaffected. Intravenous benzodiazepines and opioids are examples of drugs used to achieve moderate sedation.

‘Deep sedation’ leads to major depression of the central nervous system, where patients are no longer conscious and are more difficult to arouse. They will usually respond to painful stimuli but not to verbal or simple tactile stimuli. The respiratory system is stressed and some ventilatory assistance may be required.

Intravenous benzodiazepines, intravenous anesthetics such as propofol, ketamine, etomidate, and dexmedetomidine are examples of medicines used for deep sedation.

‘General anesthesia’ is the deepest type of sedation in which there is a total lack of consciousness and no response to stimuli. Cardiovascular and respiratory functions are often compromised, therefore, monitoring and assistance, such as ventilatory support, may be needed.

A fifth level/form of sedation, also known as ‘Dissociative sedation is a variant of moderate sedation characteristically produced by a medication class known as phencyclidine, such as ketamine, which induces a disconnection between the thalamo-neocortical system and the limbic structures, preventing sensory stimuli from being received by higher centers [2, 3].

4. Sedation indications

In most countries, procedural sedation and analgesia (PSA) is common practice in order to promote the success and ease of different diagnostic and therapeutic procedures which do not need muscle paralysis.

Alongside gastroenterology, many other medical disciplines, such as cardiology, gynecology, dentistry, radiology, dermatology, plastic surgery, and emergency medicine, are currently using PSA, and the list is ever expanding. The primary clinician and the patient make a mutual decision to carry out the procedure under PSA.

5. Principles of safe procedural sedation and analgesia

Most procedural sedation occur outside and far from operating theaters; others might occur in standalone clinics outside hospitals. This constitutes a risk, as should an airway emergency happen, anesthetists and other experts in airway management are usually not available to hand. Other emergencies such as cardiac arrests have been extensively reported in the medical literature. Based on above, it is paramount that patients selected for these procedures are carefully evaluated and stratified. A lot of emphasis should be put on airway assessment of these patients and if there is any doubt, they must be referred to a qualified anesthetist for further evaluation and classification.

5.1 Pre-procedure patient assessment

The first stage of secure sedation practice is the proper selection of patients for sedation. To assess his or her suitability for sedation outside the operating room, each patient must be explicitly evaluated.

Patient selection requires collecting patient information as well as supplying the patient with information. The retrieval and review of previous documents, i.e. medical, sedation, anesthesia and surgical history, should be included in pre-assessment wherever possible. Pre-procedural assessment should include history, examinations and laboratory investigations.

5.1.1 Preoperative history

The Preoperative history should include the patient's medical problems and the intended investigative or therapeutic procedure. History of chronic disease, severity and chronic medications should be investigated. Because of the possibility of drug interactions with anesthesia full medication history include using alcohol, tobacco, marijuana, cocaine, herbal medications, and psychotropic drugs (sedatives, anxiolytics, antidepressants, antipsychotics, antiepileptics, and drugs used in the treatment of mania) should be obtained from every patient. Previous allergic history should be elicited.

Furthermore, detailed history of previous sedation and anesthesia may disclose the previous perioperative challenges such as difficulty in airway management, aspiration, post-operative intensive care admission which may suggest unsuitability of such patients for out of hospital procedures. In addition, general review of organ system may be useful to identify undiagnosed problems.

5.1.2 Physical examination

Although, proper history direct the treating physician to perform focus examination, the physical examination is extremely important to detect abnormalities not obvious in the history. Both history and physical examination complement one another.

General examination should include minimally measurements of vital signs (Blood pressure, heart rate, respiratory rate and temperature), airway evaluation, cardiovascular and respiratory system examination.

5.1.2.1 Airway examination

Sedation practitioner should inspect patient's dentition for denture, bridges or loose teeth. Difficulty in mask ventilation and airway should be anticipated in edentulous as well as those with significant facial abnormalities such as micrognathia, prominent upper incisors, macroglossia, limited mouth opening, short neck, and limited neck mobilities. There are variety of airway reliable assessment scales such as upper lip bite test (ULBT) (**Table 1**) and Mallampati scale (**Table 2**) have been proposed to assist anesthesiologist and sedation practitioner to assist the airway. **Figures 1** and **2** [5].

Classes	Discription
Class I	lower incisors can bite the upper lip above the vermilion line.
Class II	lower incisors can bite the upper lip below the vermilion line.
Class III	lower incisors cannot bite the upper lip.

Table 1.
Upper lip bite test (ULBT).

Classes	Visible structures	Predicted intubation
Class 1	soft palate, fauces, uvula and pillars	Easy
Class 2	soft palate, fauces and base of uvula	Easy
Class 3	soft palate	Difficult
Class 4	hard palate	Difficult

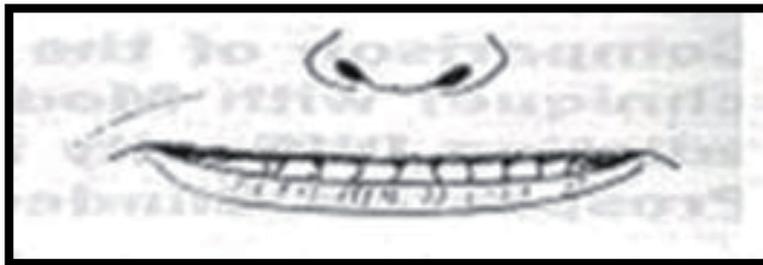
Table 2.
Mallampati score.

5.1.2.1.1 Upper lip bite test (ULBT)

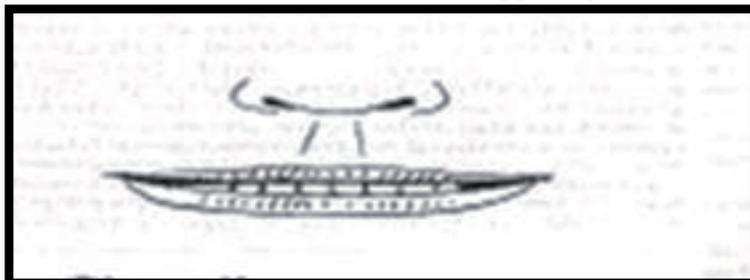
ULBT is one of the several bedside tests used for prediction of difficult intubation, it is performed by asking the patient to bite the upper lip (Table 1, Figure 1) [6].

5.1.2.1.2 Mallampati classifications

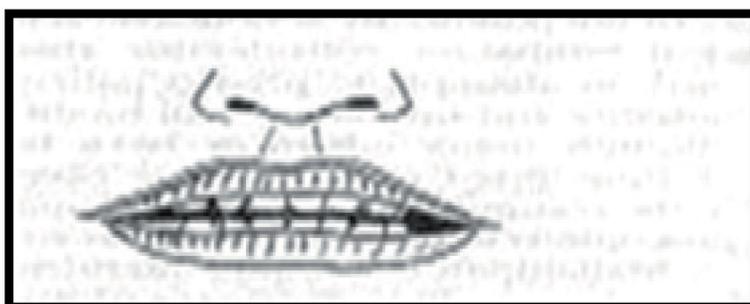
The Mallampati Classification is extremely useful in detection of potential obstructive sleep apnea as well as predictions of difficult endotracheal intubation,



Class I Lower incisors can bite the upper lip above Vermilion line.



Class II Lower incisors can bite the upper lip below Vermilion line.



Class 1 Lower incisors cannot bite the upper lip

Figure 1.
ULBT.

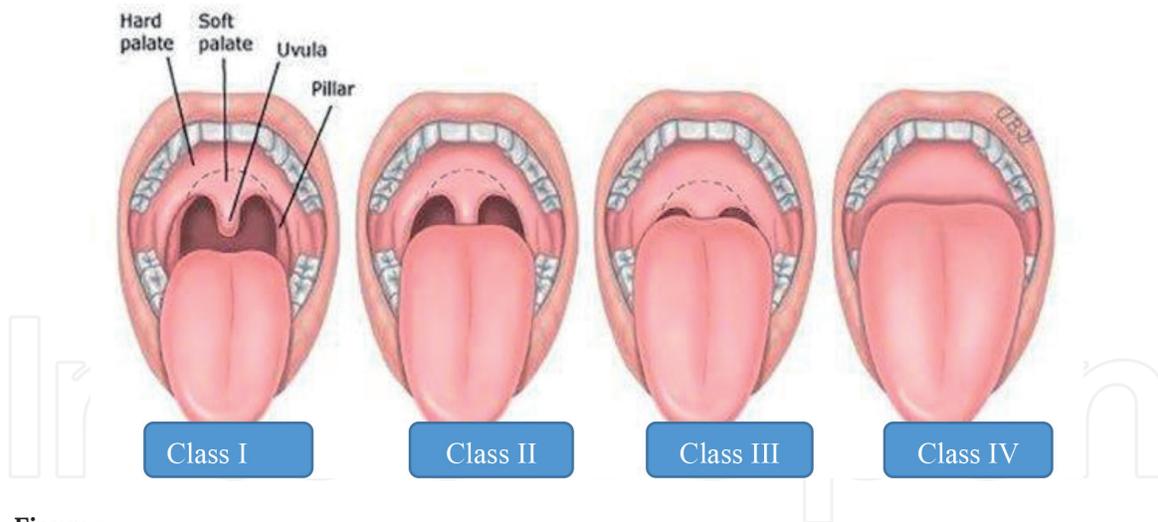


Figure 2.
Mallampati score [4].

The mallampati score is based on the visibility of the pharyngeal structures with maximal mouth opening and tongue protrusion in the setting position (**Table 2, Figure 2**).

5.1.3 Laboratory investigations

If the history and clinical examination fail to detect any abnormalities, routine investigations for healthy asymptomatic patients is not recommended as it increases the cost, delay the procedure and rarely changes the perioperative management. Therefore, investigations should be obtained only for specific clinical indication and for patients in whom the abnormality may be expected.

Pregnancy test may be considered for fertile women to avoid potential teratogenic effect for sedative agents on fetus in case of undiagnosed pregnancy.

5.1.4 ASA physical status classification

A re-evaluation of health status shortly before sedation and surgery is advised if the patient has been seen at an earlier appointment. The evaluation should be performed in accordance with the Physical Status Classification Scheme of the American Society of Anesthesiologists (ASA) (**Table 3**) [7]. Although the ASA classification is used by anesthesia and sedation suppliers to denote the overall preoperative status of a patient for anesthesia and sedation, a risk prediction cluster can be confused. It is necessary to note that this is not a classification of risk, but rather a clinical status assessment. For sedation outside the operating room, only patients in ASA Class I and II should be considered. ASA Class III, IV or V patients need higher levels of supervision and treatment. These patients are recommended to be carried out in-hospital.

5.2 Categories of patients that need special treatment include

5.2.1 Obese patient

Sedating the obese patients, especially out of hospital setting where the resources are limited is challenging to all sedative practitioners. Clinical assessment of functional capacity and myocardial functions of obese patient is not reliable due to sedentary life style and restricted physical activities. In addition, most of the obese patients suffer from chronic diseases such as diabetes mellites, hypertension, obstructive sleep apnea, and pulmonary hypertension which make

ASA PS Classification	Definition	Adult Examples, Including, but not Limited to:	Pediatric Examples, Including but not Limited to:	Obstetric Examples, Including but not Limited to:
ASA I	A normal healthy patient	Healthy, non- smoking, no or minimal alcohol use	Healthy (no acute or chronic disease), normal BMI percentile for Age	
	A patient with mild Systemic Disease	Mild diseases only Without substantive functional limitations. Current smoker, social alcohol drinker,	Asymptomatic Congenital cardiac disease, well controlled dysrhythmias, asthma without exacerbation,	Normal pregnancy*, well controlled gestational HTN, controlled preeclampsia without severe features, diet-controlled gestational DM.
		pregnancy, obesity (30 < BMI < 40), well-controlled DM/HTN, mild lung disease	well controlled epilepsy, non- Insulin Dependent Diabetes mellitus, abnormal BMI percentile for age,mild/moderate OSA, oncologic state in remission, autism with mild limitations	

ASA PS Classification	Definition	Adult Examples, Including, but not Limited to:	Pediatric Examples, Including but not Limited to:	Obstetric Examples, Including but not Limited to:
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 \geq 40), active hepatitis, Alcohol dependence or abuse, implanted pacemaker, Moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, history (>3 months) of MI, CVA, TIA, or CAD/stents.	Uncorrected Stable Congenital Cardiac abnormality, asthma with exacerbation, poorly controlled epilepsy, insulin Dependent Diabetes mellitus, morbid obesity, malnutrition, severe OSA, oncologic state, renal failure, Muscular dystrophy, cystic fibrosis, history of organ transplantation, brain/spinal cord malformation, Symptomatic hydrocephalus, premature infant PCA <60 weeks, autism with severe limitations, Metabolic disease, difficult airway, long term parenteral nutrition. Full term infants <6 weeks of age.	Preeclampsia with severe features, gestational DM with complications or high insulin requirements, a thrombophilic disease requiring anticoagulation.
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, shock, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis	Symptomatic Congenital cardiac abnormality, congestive heart failure, active sequelae of prematurity, acute hypoxic-ischemic encephalopathy, shock, sepsis, disseminated intravascular coagulation, automatic implantable cardioverter- defibrillator, ventilator dependence, endocrinopathy, severe trauma, severe respiratory distress, advanced oncologic state.	Preeclampsia with severe features complicated by HELLP or other adverse event, peripartum cardiomyopathy with EF <40, uncorrected/decompensated heart disease, acquired or congenital.
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	Massive trauma, intracranial hemorrhage with mass effect, patient requiring ECMO, respiratory failure or arrest, malignant hypertension, decompensated congestive heart failure, hepatic encephalopathy, ischemic bowel or multiple organ/system dysfunction.	Uterine rupture.
ASA VI	A declared brain-dead patient whose organs are being removed from donor purposes			

Table 3.
ASA physical status classification.

these group of patients are not candidate for day case surgery or out of hospital setting. Sedative, anesthetics and opioid promote pharyngeal collapse, airway obstruction and alter normal respiratory response to obstruction and apnea in patients who suffer from obstructive sleep apnea which might increase the jeopardy of mortality and morbidity. Moreover, obese patients have significant reduction in functional residual capacity and rapidly desaturated [8]. Establishment of intravenous access, airway management, positioning and monitoring of obese patients are extremely difficult and require well trained sedative practitioners as well as immediate help.

5.2.2 *Elderly patients*

The patient's upper age limit for outside-hospital procedures should be individually defined. The decision is based on considerations such as the invasiveness and length of the procedure, comorbidity, chronic medications and whether there is aftercare at home. Patients older than 65 years of age should be carefully selected for potential reduced organ function and increased occurrence of co-existing diseases. These patients often have limited reserves and can become degraded more rapidly and have more cardiac events. There is a strong correlation between advanced age and median successful dose reduction for all central nervous system medications regardless route of administration.

5.2.3 *Pregnancy*

Gastrointestinal endoscopy in pregnant women should only be carried out if it's strongly indicated and deferred to the second trimester wherever possible.

The pregnant woman should be properly aware of the essence of the procedure, the possible advantages and complications, including the risks resulting from sedative medications, on herself and the fetus, and should take a fully informed decision. Whenever possible, procedures should be carried out without any sedation, thus preventing ventilatory dysfunction as well as subsequent hypoxemia and potential teratogenicity. In situations where sedation is inevitable, a minimum clinically appropriate dosage must be maintained for sedative agents. Further advices involve maternal and fetal monitoring during endoscopy, and putting the patient in a lateral decubitus position, to avoid the vena caval and aortic compression through the gravid uterus, and applying the bipolar current to electrocoagulation.

Teratogenic effects of propofol and fentanyl in humans have never been proved conclusively and these agents have strong safety records in appropriate pregnant doses. While a correlation between benzodiazepine use and oral cleft abnormalities has been identified, this finding has not been verified by later case-control studies. Since the duration of organogenesis is during the first trimester of pregnancy, it is widely advised that all but truly emergency endoscopic procedures requiring sedation be delayed until later in pregnancy in order to prevent possible teratogenicity. A meta-analysis of anesthetic exposure studies during pregnancy concluded that the only potential issue concerning general-anesthetic exposure is a small increase in the incidence of miscarriage. Although most current anesthetic and analgesic agents cross the placental barrier to varying degrees, their possible adverse fetal effects tend to be limited and if administered judiciously, are well tolerated by the fetus. It should be stressed, however, that all the published recommendations are backed by minimal evidence, especially in the case of colonoscopy, and that adherence to those recommendations could not guarantee an uneventful course of pregnancy and the development of the fetus [9, 10].

5.2.4 Children

Pediatric patients are less supportive than adult patients, and their parents also feel more anxiety about the procedure. The effect of sedation varies according to the age of pediatric patients [11]. Children below the age of 6 months may have little anxiety and may be easily affected by sedation. Patients who are six months of age or older, however, have already developed unusual anxiety and will require that their parents stay with them during induction. For children of school age, sedating them is surprisingly challenging as they have developed concrete thinking. As a result, to minimize their level of discomfort, it is advised to carefully address what to expect during the operation.

5.3 Fasting guidelines

Preoperative fasting prior to a procedure carried under sedation is contentious. Some authorities regard it as unnecessary, especially in dentistry and emergency medicine; the idea being Airway protective reflexes are intact during mild and moderate sedation but may be lost during deep sedation. However, if deep sedation is planned, via dissociative or non-dissociative techniques, the following fasting duration recommendations should be followed: [12].

- 2 hours from the last ingestion of breast milk
- 4 hours from the ingestion of Formula for infants
- 6 hours from the consumption of nonhuman milk
- 2 hours from last intake of Clear liquids (defined as fluid without particles e.g. apple juice)
- 6 hours from any solid food intake:

In situations where mild to moderate sedation fails to facilitate the procedure, and the patient is not adequately fasting as above, the procedure should be halted. In an emergency, a general anesthetic can be considered with a rapid sequence induction technique.

6. Procedure monitoring

The Academy of Medical Royal Colleges in Safe Sedation Practice for Healthcare Procedures describes the principles of monitoring during and after the procedure. All sedation team members shall have a comprehensive knowledge of monitoring equipment and an interpretation of the information provided by monitoring devices.

The sedation technique employed is to decide what degree of monitoring is appropriate. This means either basic/standard sedation or advanced sedation.

During basic/standard techniques in which only one individual pharmacological agent is used, respiratory and cardiovascular systems typically are not affected. The intermittent examination of vital signs, e.g. sedation level, anxiety, skin color and breathing habits, is sufficient. A pulse oximetric and non-invasive blood pressure monitor are mandatory for extended procedures [13, 14].

When advanced sedation methods are deployed, the following must be controlled and documented:

1. **Levels and actions of distress** such as agitation and restlessness: This can suggest potential adverse events, such as hypoxemia, hypoglycemia, under-sedation or even over-sedation.
2. **In controlling the level of sedation;** frequent contact with the patient will help. A significant part of sedation is responsiveness to verbal command/light tactile stimuli, as lack of responsiveness means that the patient is going into deep sedation. The level of sedation monitoring must begin before sedation is administered and must continue throughout the procedure and recovery time before the facility is discharged [15]. As patients can respond to a standard dose or medication in an unpredictable manner, and as patients can drift in and out of different levels of sedation, monitoring of responsiveness should be monitored closely and assessed frequently. e.g. the Wilson sedation scale or the UMSS (University of Michigan Sedation Scale). It is proposed that the UMSS is used by sedation practitioners because the rating system matches the sedation levels on the scale of sedation. The importance of the electroencephalogram monitors processed, i.e. bispectral index (BIS) sedation monitoring outside the operating theater, is debatable. BIS might have a role during deep sedation and anesthesia.
3. **Pain and discomfort:** In cases where patients are unable to respond verbally due to the requirements of the procedure, e.g. dental work or head and neck operations, a pain or discomfort signaling device should be established before the sedation starts. This helps patients to prove whether they have pain or discomfort, for example, with thumbs up or thumbs down.
4. **Patency of airways:** Relaxation of the jaw and unintended mouth opening are early indicators of a deepening level of sedation. Noises produced during inspiration or expiration and or snoring suggest a partially blocked upper airway and should be rectified through head and neck repositioning and/or titration of sedation.
5. **Breathing and ventilation:** Throughout the duration of the operation, the breathing rhythm and movement of the chest and abdomen must be observed. Chest movements are expected to be rhythmic. Paradoxical respiration, rib retraction, the use of accessory muscles, and tracheal pull are all symptoms to look out for, all of which can suggest airway obstruction. The respiratory rate should be reported intermittently, except when using a capnograph, where it is constantly displayed. Capnography measures the end-tidal concentration of carbon dioxide, which is considered to be a more sensitive alveolar hypoventilation sensor than pulse oximetry [16, 17].

Patients undergoing PSA tolerate capnography applied via a nasal cannula, side-stream examination and transcutaneous approaches. Capnography is not compulsory for mild sedation, but is strongly advised in patients with fragile ASA II, elderly, obese, obstructive sleep apnea patients, and patients with respiratory problems such as chronic obstructive pulmonary disease (COPD) Nevertheless, Capnography can never replace ventilation/respiration clinical monitoring. If capnography is unavailable, use of a precordial stethoscope may be helpful.

6. **Heart Rhythm and Rate:** For most levels of sedation, the pulse rate, as recorded by pulse oximetry, should be enough. Electrocardiography (ECG) is not necessary in moderate sedation, where regular verbal communication with

the patient is established. However, when using advanced sedation procedures, an ECG is recommended for extended sedation or in delicate ASA II patients, patients with underlying cardiovascular disease and the elderly.

7. Non-invasive (NIBP) blood pressure. NIBP must be monitored at all sedation stages.

7. Post-sedation care

Patient is continued to be monitored in the recovery area. Vital signs (blood pressure, heart rate, respiratory rate, oxygen saturation), level of consciousness and level of pain must be monitored and recorded at regular intervals. The recovery area must be staffed with a skilled healthcare professional who certified with at least basic life support. The staff to patient ratio should not exceed two patients to one nurse.

7.1 Scoring systems for discharge

Discharge scoring systems may be used shortly before discharge to identify and record the psychological status of a patient. Modified Aldrete Scoring System (**Table 4**) is widely used to assess when patients from the post-anesthetic care unit are ready for discharge. Patients must score 9 out of 10 before discharge from the recovery room. In addition, the patient must be assisted by a responsible person at home and there must be no complications from surgery, such as bleeding or vomiting. It is no longer important to ensure that the patient is able to take fluids orally, or that before discharge at home, he or she has passed urine. However, if not able to move urine within 6–8 hours of discharge from the sedation unit, the patient must be instructed to contact the responsible practitioner.

Category	Description of Status	Aldrete Score
Respirations	Breathes, coughs freely	2
	Dyspnea	1
	Apnea	0
O2 Saturation	O2 Saturation > 92% on Room Air Supplemental oxygen with O2	2
	Sat > 90%	1
	O2 Saturation < 90% on O2	0
Circulation	BP +/- 20% pre-op value	2
	BP +/- 20–50% pre-op value	1
	BP +/- 50% pre-op value	0
LOC	Awake & oriented	2
	Wakens with stimulation	1
	Not responding	0
Movement	Moves 4 limbs on own	2
	Moves 2 limbs on own	1
	Moves 0 limbs on own	0

Table 4. Modified Aldrete discharge scoring system (Total* *a score of 10 was required for discharge from the endoscopy/ recovery room).

8. Medications used in GI endoscopy

There is still no perfect medication available for PSA and the combinations of two or more group of agents such as benzodiazepines, opioids, intravenous anesthetics inhalational anesthetics and topical anesthesia is commonly used (**Table 5**). Drug combinations works synergistically which reduces the doses of sedative agents and its side effects. Combination of opioid and sedation is most commonly used regimen. Sedative agents should be titrated to effect in divided doses and the amount of incremental doses should not exceed the maximum recommended doses. In the absence of a weight-related dosage (i.e., mg/kg) for drug doses, the dose for a 'normal' patient weighing 70 kg must be considered to be the dose.

Some anesthesiologist societies advise that general anesthetic inductors (propofol, ketamine, etomidate, dexmedetomidine) and short-acting opioids (fentanyl, alfentanil, sufentanil, remifentanil) should be used only by physicians who have

Medication	dosage	Analgesic effect	Onset	Duration	Side effects
Midazolam	Bolus for deep sedation: 0.1–0.4 mg/kg Bolus for moderate sedation: 0.01–0.1 mg/kg	—	1–5 min	<2 h	Paradoxical excitement (occasionally), hypotension, bradypnea
Propofol	Bolus for deep sedation: 1–2.5 mg/kg Infusion for moderate sedation: 25–100 µg/kg/min	—	<1 min	5–10 min	Hypotension, bradypnea/apnea
Dexmedetomidine	Bolus for deep sedation: 1 µg/kg over 10 min Infusion for moderate sedation: 0.2–0.7 µg/kg/h	++	10–15 min	~30 min	Biphasic hemodynamic effect: bolus administration has been associated with hypertension
Remifentanil	Infusion for moderate sedation: 0.05–2 µg/kg/min	+++	<1 min	5–10 min	Hypotension, bradypnea/apnea, bradycardia
Etomidate	Bolus for deep sedation: 0.2–0.5 mg/kg	—	<1 min	3–5 min	Adrenocortical dysfunction, especially in continuous IV administration
Ketamine	Bolus for deep sedation: 0.5–2 mg/kg Bolus for moderate sedation: 0.2–0.8 mg/kg Infusion for moderate sedation: 10–20 µg/kg/min	++	<1 min	12–25 min	Dissociative hallucination, increased ICP and IOP, tachycardia, and hypertension

ICP, intracranial pressure; IOP, intraocular pressure; IV, intravenous.

Moderate sedation (conscious sedation): purposeful response to verbal commands and intact airway and cardiopulmonary functions; deep sedation: response to painful stimulation and requirement of assistance for proper ventilation and airway patency.

Table 5.
 Summary of sedation drugs commonly used.

been specifically trained in anesthesia or intensive care medicine, or by experienced sedation professionals who have at least advanced life support certification and specialized in unique advanced sedation procedures with anesthetic expertise.

Benzodiazepines (e.g. midazolam, diazepam, flunitrazepam, lorazepam or temazepam) and dexmedetomidine are included as procedural sedative drugs. Midazolam is the most widely employed benzodiazepine [18].

Pharyngeal aerosol spray of local anesthetics such as lidocaine, benzocaine may be considered to suppress gag reflex, decrease the dose of sedatives, and facilitate insertion of endoscope. Their effect may last up to an hour.

Benzocaine may cause methemoglobinemia and should be avoided in patients with a previous history of methemoglobinemia or known glucose-6-phosphate dehydrogenase deficiency.

9. Complications of sedation

Sedation-related gastrointestinal endoscopy complications are generally transient and of a mild degree. Nevertheless, when occur, may lead to significant morbidity and occasional mortality especially with moderate and deep sedation. Patient age, comorbidity, as well as type of sedation agent, the dose and route of administration are the most important risk factors of these complications. Serious complications can be avoided by proper pre-operative evaluation, preparation, appropriate monitoring and post-operative management. In addition, skilled treating physicians should be aware, and prepared to treat these complications. Sedation-related endoscopy complications can be divided into cardiovascular, respiratory, gastrointestinal and allergic reactions [19].

9.1 Cardiovascular related complications

Cardiopulmonary related represent 50% of serious sedation related complications and 50% of sedation related deaths in gastrointestinal procedures. Commonly, it occurs in elderly group of patients or secondary to over sedation. Cardiovascular related complications include:

9.1.1 Hypotension

Defined as systolic blood pressure less than 90 mmHg. Generally, systolic blood pressure more than 90 mmHg should maintain mean adequate arterial blood pressure to perfuse all vital organs, BP less than 90 should be treated. Benzodiazepine or opioid alone rarely causes hypotension. However, combination of both or sedation with propofol, vasovagal attacks and hypovolemia are the most common causes of hypotension [19].

9.1.2 Hypertension

Defined as systolic blood pressure more than 160 mmHg, it is usually secondary to anxiety, pain, intubation and endoscopy.

9.1.3 Cardiac arrhythmias

They are commonly observed during gastro-endoscopy. Fortunately, most of arrhythmias are benign. Vasovagal attacks, pain and hypovolemia are the most common causes of arrhythmia. Opioid and buscopan are associated with bradycardia [15, 19].

9.1.4 Myocardial infarction (MI)

It may occur during endoscopy or within few days post endoscopy. It is commonly reported in patients with history of ischemic heart disease. Hypertension, severe hypotension, tachycardia, pain and anxiety are the leading cause of myocardial ischemia and anginal attacks. The following steps should be considered to treat and prevent perioperative MI and anginal attacks:

1. Pre-oxygenation of high risk patients and continues oxygen supplementation through the procedure.
2. Continue antihypertensive and antianginal medications up to the time of endoscopy.
3. Discontinue the intervention, oxygen supplementation, sublingual nitroglycerine should be considered if angina developed during the endoscopy.
4. 12 lead ECG and request cardiac enzymes if angina or MI are suspected [15, 19].

9.2 Respiratory -related complications

9.2.1 Respiratory depression

Both benzodiazepine and opioids may cause respiratory depression by blocking their receptors in brain and brainstem which may lead to hypoxia and CO₂ retention. Therefore, continues capnography monitoring is extremely important during endoscopic procedures. Drop in oxygen saturation on pulse oximetry is a late sign of respiratory depression especially if patients on supplemental oxygen. Patient stimulation and reversing the sedative agents should be considered to treat respiratory depression. Naloxone (1–2 mcg/kg intravenous) reverses both analgesic and respiratory depressant effect of the opioids, the dose can be repeated every 3 minutes with maximum dose 0.1 mg/kg. Naloxone has short half life (60–90 minutes), therefore patients should be observed at least for 2 hours after administration of naloxone to guarantee that re-sedation does not occur. Flumazenil (0.01 mg/Kg I.V) is a benzodiazepine antidote and useful to reverse both sedative and respiratory depressant effect of benzodiazepine. The half life of flumazenil is 40–80 minutes, therefore patients should be monitored for 2 hours after administration of flumazenil to ensure re-sedation does not occur [19–21].

9.2.2 Air way obstruction

Laryngospasm and bronchospasm are the most common cause of airway obstruction.

9.2.3 Pulmonary aspiration

Pulmonary aspiration of gastric contents during the gastro-intestinal endoscopic procedures are very common. It may lead to pneumonia and death. Over-sedation, gastro-intestinal bleeding, intestinal obstruction, elderly, and hepatic encephalopathy are the risk factors of pulmonary aspiration. Cough, cyanosis and respiratory distress are the early signs of pulmonary aspiration. If the aspiration is suspected, the procedure should be suspended, head down tilt, left lateral positioning,

suctioning of the fluid from the airway, encouraging patient and chest x ray should be considered [19].

9.3 Allergic reaction

The wide spectrum of allergic reactions may occur during sedation procedures, it ranges from minor local reaction to life threatening anaphylactic reactions. However, severe allergic reactions during sedation is rare. Diagnosis of anaphylactic reactions under anesthesia is not always easy. Treating physician should immediately stop of most likely precipitating agent, administer adrenaline 0.5 mg intramuscular (IM), secure the airway, administer hydrocortisone, antihistamine as well as IV fluid resuscitation [19].

9.4 Nausea and vomiting

Over-distension of the stomach and colon may induce nausea and vomiting after gastro-intestinal endoscopy. Furthermore, nausea and vomiting are common side effect of opioid agents. Anti -emetic agents such as ondansetron and metoclopramide might be considered to treat sever cases [19, 22].

9.5 Paradoxical reactions

Paradoxical reactions are commonly observed with benzodiazepines especially midazolam and diazepam, it is characterized by agitation, talkativeness, disorientation, combativeness and tachycardia. Flumazenil is very effective in management of these reactions [19, 23, 24].

10. Conclusion

Gastro-intestinal endoscopy is an extremely important diagnostic and therapeutic intervention of gastro-intestinal diseases. Sedation is usually required to alleviate considerable amount of anxiety, discomfort and pain which make the procedure unsafe, complicated and refusal of follow up procedures. Safety of endoscopic procedures under sedation needs awareness of especial needs of the patients. Combination of benzodiazepine and opioid is the most commonly used regimen in gastro-intestinal endoscopy. Though, the gastro-intestinal endoscopy is considered as minimally invasive surgery and sedation for these procedures is generally safe, life threatening sedation related complications may occur easily even in the healthy patients. Pre-procedural risk assessment, preparation, and perioperative as well as post-operative monitoring is mandatory to reduce sedation related complications. Furthermore, properly trained staff and emergency equipment should be available during procedure.

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