

Anesthesia and sedation in pediatric gastrointestinal endoscopic procedures: A review

Abdul Q Dar, Zahoor A Shah

Abdul Q Dar, Zahoor A Shah, Anesthesiology and Critical Care, Sheri Kashmir Institute of Medical Sciences, Srinagar, Kashmir 190011, India

Author contributions: Both Dar AQ and Shah ZA have anesthetized children in the endoscopy unit and contributed equally to the manuscript.

Correspondence to: Abdul Q Dar, MD, FRCA, M MedSci, Additional Professor, Anesthesiology and Critical Care, Sheri Kashmir Institute of Medical Sciences, Srinagar, Kashmir 190011, India. qayoom_dar@yahoo.co.in

Telephone: +91-0194-2401013-2158

Received: November 16, 2009 Revised: May 26, 2010

Accepted: June 2, 2010

Published online: July 16, 2010

Abstract

Gastrointestinal (GI) endoscopic procedure has become an essential modality for evaluation and treatment of GI diseases. Intravenous (IV) sedation and General Anesthesia (GA) have both been employed to minimize discomfort and provide amnesia. Both these procedures require, at the very least, monitoring of the level of consciousness, pulmonary ventilation, oxygenation and hemodynamics. Although GI endoscopy is considered safe, the procedure has a potential for complications. Increased awareness of the complications associated with sedation during GI endoscopy in children, and involving the anesthesiologists in caring for these children, may be optimal for safety. Belonging to a younger age group, having a higher ASA class and undergoing IV sedation were identified as risk factors for developing complications. Reported adverse events included inadequate sedation, low oxygen saturation, airway obstruction, apnea needing bag mask ventilation, excitement and agitation, hemorrhage and perforation. A complication rate of 1.2% was associated with procedures performed under GA, as compared to 3.7% of complications associated with IV sedation. IV sedation was seen to be independently associated with a cardiopulmonary complication rate 5.3% times higher

when compared to GA. GA can therefore be considered safer and more effective in providing comfort and amnesia.

© 2010 Baishideng. All rights reserved.

Key words: Gastrointestinal; Endoscopy; Pediatrics; Sedation; General anesthesia

Peer reviewer: Kazuki Sumiyama, MD, PhD, Department of Endoscopy, the Jikei University School of Medicine, 3-25-8 Nishi Shinbashi, Minato-ku, Tokyo 105-8461, Japan

Dar AQ, Shah ZA. Anesthesia and sedation in pediatric gastrointestinal endoscopic procedures: A review. *World J Gastrointest Endosc* 2010; 2(7): 257-262 Available from: URL: <http://www.wjgnet.com/1948-5190/full/v2/i7/257.htm> DOI: <http://dx.doi.org/10.4253/wjge.v2.i7.257>

INTRODUCTION

Gastrointestinal (GI) endoscopic procedure has become an essential modality for evaluation and treatment of gastrointestinal diseases. Intravenous (IV) sedation and General Anesthesia (GA) have been employed by anesthesiologists and non-anesthesiologists to minimize discomfort and provide amnesia. The American Society of Anesthesiologists (ASA) has published guidelines for the safe conduct of sedation during GI endoscopy^[1,2]. Conscious sedation has been widely accepted as primary sedation for children undergoing these procedures^[3]. However, regardless of the sedation regimen used, the overall immediate non-fatal hypoxia-related reversible complication rate of pediatric GI endoscopic procedures is 2.3%^[4]. The American Academy of Pediatrics Committee on Drugs and The Joint Commission on Accreditation on HealthCare Organizations (JCAHO) have published guidelines to ensure safety and to reduce the risks associated with sedation in pediatric GI endoscopic

procedures^[5,6]. Children often become agitated and restless, thus increasing the risk of complications associated with the procedures. GA is considered safe and effective in providing comfort and amnesia. However, GA requires expertise and has been viewed as not being cost effective^[3].

There exists a great variation in sedation practice for pediatric endoscopy. Increased awareness of the complications associated with sedation during GI endoscopic procedures in children, the institution of modern monitoring modalities to identify these complications, and the involvement of the anesthesiologists in looking after these children in, or outside, the operating room may be optimal for the safety of these patients^[7]. The JCAHO has made it mandatory to provide the same standard of care and monitoring for children who undergo sedation or GA for these procedures^[6].

AIMS AND OBJECTIVES

The aims and objectives of providing care during IV sedation or GA on children for these procedures are: (1) To allow the children to tolerate the unpleasant procedures with amnesia; (2) To allow the children to remain motionless, in order to prevent complications; (3) To ensure safety by provision of standard monitoring and care by adequately trained staff; (4) To provide high quality and cost effective care; and (5) To ensure early discharge from the facility to home.

SEDATION GUIDELINES

The American Society of Anesthesiologists Task Force^[1] defined "Sedation and Analgesia" as a state that allows patients to tolerate unpleasant procedures while maintaining adequate cardiorespiratory function and the ability to respond purposefully to verbal commands and/or tactile stimulation. The Task Force decided that the term "Sedation and Analgesia" more accurately defines this therapeutic goal than does the commonly used but imprecise term "Conscious Sedation".

The purpose of these guidelines is to allow clinicians to provide their patients with the benefit of sedation and analgesia while minimizing the associated risks. Sedation and analgesia allows patients to tolerate unpleasant procedures by relieving anxiety, discomfort or pain. In children and uncooperative adults, sedation and analgesia may expedite the conduct of procedures that are not particularly uncomfortable but require the patient to remain motionless. Excessive sedation and analgesia may result in cardiac or respiratory depression that must be rapidly recognized and appropriately managed to avoid the risk of hypoxic brain damage, cardiac arrest or death. Conversely, inadequate sedation and analgesia may result in undue patient discomfort or injury because of lack of cooperation or adverse physiologic response to stress. The following practice guidelines for safe conduct of the GI endoscopic procedures were recommended by

the ASA Task Force and have been found to improve patient satisfaction, increase clinical benefits and reduce adverse outcomes: (1) A pre - procedure patient evaluation (history, physical examination, laboratory evaluation); (2) A pre - procedure preparation of the patient (counseling, fasting); (3) Patient monitoring (level of consciousness, pulmonary ventilation, oxygenation, hemodynamics); (4) Contemporaneous recording of monitored parameters (such as level of consciousness, respiratory function, hemodynamics); (5) Availability of a staff person dedicated solely to patient monitoring and safety; (6) Education and training of sedation and analgesia providers; (7) Availability of appropriately sized emergency and airway equipment as well as trained staff; (8) Use of supplemental oxygen; (9) Use of multiple sedative and analgesic agents; (10) Titration of sedative and analgesic medication to achieve the desired effect; (11) Administration of sedative/analgesic agents by the intravenous route; (12) Availability of reversal agents (e.g. naloxone, flumazenil); (13) Post-procedure monitoring (during stay in a recovery facility, post-discharge); and (14) Special regimens for patients with special problems (e.g. including the uncooperative, the very old or the very young, those with severe cardiac, pulmonary, hepatic, renal, or central nervous system disease, those with morbid obesity, those exhibiting sleep apnea, pregnant patients, drug or alcohol abusers, emergency and unprepared patients, and those with metabolic and airway difficulties).

RISK STRATIFICATION

During pre - procedure evaluation of children, one must attempt to stratify the patients as per the ASA classification. Thakkar *et al*^[4] found that, the younger the age group, the higher the ASA class and IV sedation as risk factors for developing complications. Selection of patients according to this risk stratification may help to prevent or reduce complications associated with the procedure^[8].

ASA Class 1 status (Healthy Children) and ASA Class 2 status patients (mild systemic illness such as asthma under good control) can be considered for IV sedation. ASA Class 3 status patients with severe systemic disease must be evaluated on an individual basis, and should be considered either for IV sedation or GA. ASA class 4 status patients with severe systemic disease which is a constant threat to life, and ASA class 5 status patients who are moribund patients and not expected to survive 24 h with or without the operation, must be considered for GA.

SEDATION LEVEL

Definitions of sedation levels have been published by the American Society of Anesthesiologists^[2], and are as follows.

Moderate sedation/analgesia (conscious sedation)

A drug- induced depression of consciousness, during

which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular function is usually maintained.

Deep sedation/analgesia

A drug- induced depression of consciousness, during which patients cannot be easily aroused but respond purposefully to repeated or painful stimulation. The ability to maintain ventilator function may be impaired. Patients may require assistance in maintaining a patent airway, and spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained.

General anesthesia

A drug- induced loss of consciousness, during which patients are not arousable, even by painful stimulation. The ability to maintain independent ventilator function is often impaired. Patients often require assistance in maintaining a patent airway, and positive pressure ventilation may be required because of depressed spontaneous ventilation or drug- induced depression of neuromuscular function. Cardiovascular function may be impaired.

Monitoring during sedation and general anesthesia

Whatever the sedation method (IV Sedation or GA) is used, the care- givers need to be vigilant in their monitoring to avoid adverse events leading to fatalities. JCAHO has recommended mandatory uniform monitoring standards for children undergoing these procedures with either IV sedation or GA. The standard procedures as per the ASA Task Force guidelines include monitoring the following^[1].

Level of consciousness: The response of patients to commands serves as a guide to their level of consciousness. Patients who respond as reflex withdrawal to painful stimuli are likely to be deeply sedated, approaching a state of general anesthesia. The members of the Task Force support the contention that monitoring the level of consciousness reduces risk and the overall cost.

Pulmonary ventilation: The primary cause of morbidity associated with sedation/analgesia is drug- induced respiratory depression, thus monitoring of respiratory function reduces the risk of adverse outcomes associated with sedation and analgesia. This can be monitored by observation of spontaneous respiratory activity or auscultation of breath sounds. In situations where patients are separated from care- givers, automated apnea monitoring (by detection of exhaled Carbon dioxide) may decrease the risk.

Oxygenation: Published data suggest that early detection of hypoxemia through the use oximetry during sedation and analgesia decreases the likelihood of adverse out-

comes such as cardiac arrest and death. The Task Force members agree that hypoxemia during sedation and analgesia is more likely to be detected by oximetry than by clinical assessment alone. However, oximetry is not a substitute for monitoring respiratory function.

Hemodynamics: It is the opinion of the Task Force members that sedation/analgesia may blunt the appropriate autonomic compensation for hypovolaemia and the procedure related stress. Regular monitoring of vital signs reduces risk and cost. The Task Force members suggest the use of continuous electrocardiography (ECG) monitoring in patients with hypertension, cardiac disease or dysrhythmias. They suggest ECG monitoring is not generally required in patients without cardiac disease.

Blood pressure should be determined before sedation and analgesia is initiated, and at regular intervals during the procedure.

ROLE OF BISPECTRAL INDEX MONITORING

Bispectral index (BIS) monitor is a processed electroencephalogram (EEG) parameter that measures the hypnotic effect of anesthetic and sedative drugs. The computer produces a single numeric value (0-100). Its manufacturer claims that a BIS score of 40-60 indicates general anesthesia, < 40 indicates deep anesthetic state, 61-70 indicates deep sedation, 71-90 indicates conscious sedation and > 90 indicates an awake state. The goal is to give an objective quantitative assessment of level of hypnosis. This has been validated in pediatric general anesthesia^[9] and has also been validated as a measure of sedation in spontaneously breathing children aged less than 12 years^[10]. Motas *et al*^[11] used BIS and the University of Michigan Sedation Scale to assess depth of sedation. They concluded that there was a wide variation in depth of sedation attained and the goal of sedation was not achieved. They considered use of sedation by non-anesthesiologists as a therapeutic failure. They speculated that BIS may prove to be more suitable monitor than scoring systems that require interaction with the patient for assessment during the procedure.

ROLE OF PULSE OXIMETRY

Pulse oximetry is a valuable tool to pick up oxygen desaturation which could be due to poor respiratory effort in children undergoing IV sedation. However, oxygen desaturation is a relatively late sign of depressed ventilation, especially in the presence of supplemental oxygen. Malviya *et al*^[12] picked up desaturation in 5.5% of patients and achieved a reduction in bad outcomes. Hypoxemia secondary to depressed respiratory activity is the most important risk factor for near misses and death during sedation for children undergoing procedures. Early detection may be valuable in avoiding morbidity and mortality in pediatric sedation procedures.

ROLE OF CAPNOGRAPHY

In the presence of supplemental oxygen, detection of hypoventilation by pulse oximetry alone may be delayed, with disastrous consequences. In children undergoing endoscopy with conscious sedation, microstream capnography has been shown to reveal hypoventilation in some patients when it was not detected by routine electronic monitoring and clinical assessment^[13]. In a graphic assessment of respiratory activity with sidestream capnography, Vargo *et al*^[14] reported episodes of apnea or disordered respiration detected by capnography. With simultaneous respiratory rate measurements obtained by means of capnography and auscultation with a pretracheal stethoscope, the authors verified that capnography was an excellent indicator of respiratory rate. They concluded that apnea and disordered respiration commonly occurs during therapeutic upper GI endoscopy and frequently precedes the development of hypoxemia. Potentially important abnormalities in respiratory activity remain undetected with pulse oximetry and visual assessment.

ADVERSE EVENTS DURING SEDATION AND GENERAL ANESTHESIA

Although GI endoscopy is generally considered safe, the procedure does have a potential for complications. The safety of children undergoing the procedure under sedation has long been an issue of concern, especially after a death associated with pediatric sedation in a dental practice was reported^[15].

Motas *et al*^[11] in a prospective study of children undergoing sedation by non-anesthesiologists for various procedures reported failure to achieve sedation in 12%-28% using BIS or the University of Michigan Sedation Scale respectively as a monitor of sedation.

Malviya *et al*^[12], in another prospective study involving 1140 children sedated by a non-anesthesiologist for various procedures, reported a 20.1% incidence of adverse events. These included inadequate sedation, low oxygen saturation, airway obstruction, apnea needing bag mask ventilation, and excitement and agitation.

Lightdale *et al*^[16] prospectively reviewed more than 2300 endoscopic procedures and reported agitation, respiratory events, incomplete procedures, hemorrhage and perforation as adverse events. Agitation was significantly associated with endoscopist-administered sedation.

Mamula *et al*^[17] in a retrospective review of conscious sedation in children also reported approximately 20% incidence of non-life threatening adverse events.

Levis *et al*^[18] reported a 20% incidence of recall in children following esophago-gastroduodenoscopy, thus increasing their level of anxiety and reluctance to accept subsequent procedures.

Thakkar *et al*^[4], in a cross sectional retrospective study of 10236 upper GI endoscopic procedures in 0-18 year-old children reported an overall immediate complication rate of 2.3%. IV sedation with Midazolam, Fentanyl,

Meperidine or Ketamine was used in 46% of procedures, whereas 54% procedures were performed under GA. Cardiopulmonary complications were reported in 79.9% of procedures, gastrointestinal complications were reported in 18% of procedures, whereas in 5.9% of procedures complications such as prolonged sedation, drug reaction or rash were reported. All complications were non-fatal and most were hypoxia-related and reversible. They identified a younger age, higher ASA class, female sex and IV sedation as risk factors for developing complications. A complication rate of 1.2% was associated with procedures performed under GA as compared to a 3.7% incidence associated with IV sedation. After adjusting with all other variables, they reported IV sedation to be independently associated with a cardiopulmonary complication rate 5.3% times higher when compared to GA.

IV SEDATION AND ANESTHESIA REGIMENS FOR PEDIATRIC GI ENDOSCOPY

The most common IV sedation regimen for pediatric GI endoscopy is the use of an opioid and a benzodiazepine combination to achieve analgesia and amnesia so that children tolerate the procedure well. Although mostly safe regimens were reported, it was found that the attending physician, whether an endoscopist, nurse assistant or an anesthesiologist must exercise extreme caution while administering the sedation to children for GI endoscopy. The best regimen is the use of IV agents because of their reliability, efficacy and easy titration to achieve the end point. However, monitoring during the procedure is essential.

MIDAZOLAM

Midazolam is water-soluble and a more readily metabolized drug. It is presented as a clear solution of pH 3.5, and after injection the chemical structure undergoes modification, increasing its lipid solubility, thus enhancing its diffusion into the central nervous system (CNS). Onset of action is rapid (usually within 90 sec) and it has a relatively short duration of action. It has an initial distribution half-life of 7-20 min and the elimination half-life of 2 h.

It is metabolized in the liver and excreted in the urine. Its main metabolite (1 hydroxymidazolam) has some pharmacological activity but undergoes rapid conjugation, thus limiting any effect.

Midazolam has a high affinity for the benzodiazepine receptors in the CNS and possesses classic hypnotic, anxiolytic, amnesic and anticonvulsant properties. It produces marked anterograde amnesia. It is administered in a dose of 0.05-0.15 mg per kilogram IV, in 2-3 divided bolus doses, each bolus dose to be given over 1-2 min. Its peak effect comes in 2-3 min and lasts for up to 45 min.

Being water-soluble, it takes three times as long for midazolam to reach a peak electroencephalographic effect as compared to fat-soluble diazepam^[19]. The importance of this observation is that one must wait at least 3 min between IV doses to avoid “Stacking” of its effect. Midazolam must always be used with caution when administered with opioids because of the potential for respiratory depression.

FENTANYL

This is the most commonly used narcotic in infants and children. It has a rapid onset of action of about 30 sec, and a brief duration of action of 30-45 min. Termination of the effect of low doses of fentanyl results primarily from redistribution. Fentanyl is used for sedation in a dose range of 1-5 microgram per Kilogram in 0.5-1.0 microgram per Kilogram bolus doses given every 3 min till the desired effect is achieved. The drug must be injected slowly to avoid chest wall rigidity associated with rapid administration. Fentanyl is metabolized in the liver. Fentanyl-induced bradycardia may need treatment with a vagolytic drug such as atropine.

REMIFENTANIL

Remifentanyl is the most recent opioid available for use as an analgesic in a hospital setting. It is broken down by non-specific plasma and tissue cholinesterases, thus the importance of maturation of renal and hepatic function is minimal. Thus the half life of remifentanyl in infants and adults does not differ, and is independent of the duration of infusion. Its action is therefore very brief. Bolus doses of remifentanyl are associated with hypotension, bradycardia and chest wall rigidity. For safety reasons, the drug should be administered only by continuous infusion in a dose of 0.1 microgram per kilogram per minute.

Remifentanyl has been shown to have propofol-sparing effect, thus allowing a lower dose of propofol to be used for the maintenance of anesthesia^[20]. A combination of remifentanyl and propofol is considered safe, effective and acceptable for sedation in children undergoing gastrointestinal endoscopy^[21]. However, the authors recommend the use of this combination by an experienced anesthesiologist in a hospital setting, as the combination may result in apnea and the need to control the airway.

PROPOFOL

Propofol is a substituted phenol derivative, metabolized rapidly in the liver to water soluble compounds which are excreted by the kidneys. After a single bolus injection, propofol levels rapidly decrease in the blood as a result of redistribution and elimination. Its initial distribution half-life is 2-8 min, and its elimination half-life varies from 1-3 h. The context-sensitive half-life of propofol for infusions lasting up to 8 h is less than 40 min. The time to peak

effect is 90-100 sec after a dose of 2.5 mg per Kilogram. A dose of 2-3 mg per Kilogram is needed for induction of GA in children and an infusion of 50-150 microgram per Kilogram per minute for maintenance, in combination with an opioid or Nitrous oxide. Abu-Shawan I and Mack D in a small study of 42 procedures used a dose of 50-80 microgram per Kilogram per minute of propofol in combination with 0.1 microgram per Kilogram per minute of remifentanyl^[21]. The authors recommend this combination for sedation in children in a hospital setting in presence of an anesthesiologist. When compared with midazolam for sedation, propofol provides equal or better control and more rapid recovery^[20].

CONCLUSION

A review of the relevant literature in Pubmed and Medline regarding use of IV sedation and GA for GI endoscopy in children, showed that GA is considered safe and effective, especially in developing countries where the level of monitoring and postanesthesia care may not be optimal. However, in developed countries with better monitoring, the use of IV sedation in children undergoing GI endoscopy may be considered safe.

REFERENCES

- 1 Practice guidelines for sedation and analgesia by non-anesthesiologists. A report by the American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists. *Anesthesiology* 1996; **84**: 459-471
- 2 Practice Guidelines for Sedation and Analgesia by Non-Anesthesiologists: an updated report by American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologist. *Anesthesiology* 2002; **96**: 1004-1017
- 3 Squires RH Jr, Morris F, Schluterman S, Drews B, Galyen L, Brown KO. Efficacy, safety, and cost of intravenous sedation versus general anesthesia in children undergoing endoscopic procedures. *Gastrointest Endosc* 1995; **41**: 99-104
- 4 Thakkar K, El-Serag HB, Mattek N, Gilger MA. Complications of pediatric EGD: a 4-year experience in PEDS-CORI. *Gastrointest Endosc* 2007; **65**: 213-221
- 5 American Academy of Pediatrics Committee on Drugs: Guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures. *Pediatrics* 1992; **89**: 1110-1115
- 6 Commission on Accreditation of Healthcare Organizations. Accreditation manual for hospitals St Louis, MO: Mosby - Year Book, 1993
- 7 Hassall E. Should pediatric gastroenterologists be i.v. drug users? *J Pediatr Gastroenterol Nutr* 1993; **16**: 370-372
- 8 Hoffman GM, Nowakowski R, Troshynski TJ, Berens RJ, Weisman SJ. Risk reduction in pediatric procedural sedation by application of an American Academy of Pediatrics/American Society of Anesthesiologists process model. *Pediatrics* 2002; **109**: 236-243
- 9 Denman WT, Swanson EL, Rosow D, Ezbicki K, Connors PD, Rosow CE. Pediatric evaluation of the bispectral index (BIS) monitor and correlation of BIS with end-tidal sevoflurane concentration in infants and children. *Anesth Analg* 2000; **90**: 872-877
- 10 McDermott NB, VanSickle T, Motas D, Friesen RH. Validation of the bispectral index monitor during conscious and deep sedation in children. *Anesth Analg* 2003; **97**: 39-43, table of contents

- 11 **Motas D**, McDermott NB, VanSickle T, Friesen RH. Depth of consciousness and deep sedation attained in children as administered by nonanaesthesiologists in a children's hospital. *Paediatr Anaesth* 2004; **14**: 256-260
- 12 **Malviya S**, Voepel-Lewis T, Tait AR. Adverse events and risk factors associated with the sedation of children by nonanesthesiologists. *Anesth Analg* 1997; **85**: 1207-1213
- 13 **Lightdale JR**, Sethna NF, Heard LA, Donovan KM, Fox Vil. A pilot study of end tidal carbon dioxide monitoring using microstream capnography in children undergoing endoscopy with conscious sedation. *Gastrointest Endosc* 2002; **55**: AB145
- 14 **Vargo JJ**, Zuccaro G Jr, Dumot JA, Conwell DL, Morrow JB, Shay SS. Automated graphic assessment of respiratory activity is superior to pulse oximetry and visual assessment for the detection of early respiratory depression during therapeutic upper endoscopy. *Gastrointest Endosc* 2002; **55**: 826-831
- 15 **Jastak JT**, Pallasch T. Death after chloral hydrate sedation: report of case. *J Am Dent Assoc* 1988; **116**: 345-348
- 16 **Lightdale J**, Mahoney L, Levine P, Heard L, Fox V. Safety of endoscopist versus anesthesiologist administered sedation for pediatric endoscopy: in and outside the operating room. *Gastrointest Endosc* 2006; **63**: AB94
- 17 **Mamula P**, Markowitz JE, Neiswender K, Zimmerman A, Wood S, Garofalo ML, Nieberic M, Trautwein A, Lombardi S, Sargent-Harkins L, Puma A, Liacouras C. Conscious sedation with midazolam and fentanyl for pediatric endoscopy. *Gastrointest Endosc* 2003; **57**: AB121
- 18 **Levis CR**, Walker LS, Barnard JA. Children's knowledge, anticipatory anxiety, procedural distress and recall of esophagogastroduodenoscopy. *J Pediatr Gastroenterol Nutr* 2002; **34**: 68-72
- 19 **Ronald DM**, Miller's Anesthesia, Sixth Edition. Elsevier: Churchill Livingstone, 2009: A2376
- 20 **O'Hare RA**, Mirakhur RK, Reid JE, Breslin DS, Hayes A. Recovery from propofol anaesthesia supplemented with remifentanyl. *Br J Anaesth* 2001; **86**: 361-365
- 21 **Abu-Shahwan I**, Mack D. Propofol and remifentanyl for deep sedation in children undergoing gastrointestinal endoscopy. *Paediatr Anaesth* 2007; **17**: 460-463

S- Editor Zhang HN **L- Editor** Herholdt A **E- Editor** Liu N