Sedation and analgesia for gastrointestinal endoscopy in children

Sediranje in analgezija za endoskopske preiskave prebavil pri otrocih

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Abstract

Different sedation or anesthesia protocols are available to enable gastrointestinal endoscopic examinations in children. None is optimal. Sedation is organized according to the medical system, resources and the availability of personnel and medication (sedatives, anesthetics, analgesics). If anesthesiologist's sedation teams for children are not available, strong evidence supports sedation safety and efficiency when it is performed by specially educated non-anesthesiologists and registered nurses. This review is a brief synthesis of main guidelines and position papers of procedural sedation in children and, when unavailable, in adults, who are eligible for pediatric gastrointestinal endoscopy sedation by non-anesthesiologist. Published data are supplemented by clinical experience and the findings of author's research on ketamine sedation. Other established sedative combinations are benzodiazepine and opioid or propofol as a sole agent or in combination with analgesics. Special stress is given on a proper choice of the sedation protocol for specific examination or procedure in accordance with institution's policy. Whole endoscopic team has to be engaged in the implementation of new evidence and continuous education to achieve the highest possible safety and quality standards.

Izvleček

Na voljo so različni protokoli za sediranje in anestezijo, ki omogočijo izvajanje endoskopskih preiskav prebavil pri otrocih. Nobeden od njih ni idealen. Sediranje se organizira glede na zdravstveni sistem in razpoložljiva sredstva ter dostopnost osebja in zdravil (sedativov, anestetikov in analgetikov). Če ni na voljo anesteziološke ekipe za sediranje otrok, je s trdnimi dokazi potrjena varnost in učinkovitost sediranja, kadar jo izvaja dodatno usposobljen neanesteziolog in diplomirana medicinska sestra. Članek je kratka sinteza ključnih smernic in stališč o sediranju za preiskave pri otrocih, če teh ni, pa pri odraslih, če so bili ustrezni za sediranje za endoskopske preiskave prebavil, ki jih ne izvaja anesteziolog. Objavljeni podatki so dopolnjeni s kliničnimi izkušnjami in izsledki lastnih raziskav o sediranju s ketaminom. Ostale uveljavljene kombinacije sedativov so kombinacija benzodiazepina in opiata ali propofol kot samostojni sedativ ali v kombinacijah z analgetiki. Poseben poudarek je na izbiri pravega načina sediranja za določeno vrsto preiskave ali posega v skladu z doktrino zdravstvene ustanove. Celotna endoskopska ekipa mora uvajati nova spoznanja in se stalno izobraževati, da doseže najvišjo stopnjo varnosti in kakovosti.

1. Introduction

Sedation and analgesia is undoubtedly a prerequisite for safe and efficient endoscopic investigations or procedures in children. Beyond this statement, many questions regarding this important pediatric issue still remain insufficiently resolved as a result of different backgrounds of societies, medical systems and resources.

The aim of this article is to review good practice protocols for safe and efficient sedation by non-anesthesiologists for pediatric gastrointestinal endoscopies.

American Society of Anesthesiologists describes different levels of sedation and analgesia:[1]

- Minimal sedation *(anxiolysis)* is a state of normal verbal responses after a drug is given to lessen the fear before medical procedure. Airway and cardiovascular function are unaffected, ventilation is spontaneous.
- In moderate sedation *(conscious sedation)* consciousness is depressed, patients respond purposefully to verbal commands. Airway and spontaneous ventilation are maintained as is usually cardiovascular function.
- In *deep sedation* patients respond to painful stimulation only. Ventilatory function may be impaired due to airway obstruction or inadequate ventilation. Cardiovascular function is usually maintained.
- In *general anesthesia* patients are unarousable and mostly require endotracheal intubation and positive pressure ventilation.

Sedation is a continuum and it is impossible to predict an individual patient's response to sedatives and analgesics; therefore, a physician performing sedation must be skilled to maintain ventilation and circulation in patients whose sedation becomes deeper than intended. For example, those performing deep sedation must be confident in airway maintenance and ventilatory support if a patient enters the state of general anesthesia.[1]

If there are no personnel or cost limitations, an anesthesiologist and anesthesiology registered nurse should perform sedation for pediatric gastrointestinal endoscopy[2]. Unfortunately, in most medical systems it is very difficult to organize such sedation teams. Costs of medical care are growing and even in wealthy countries the necessity of sedation for gastrointestinal endoscopy performed exclusively by anesthesiologist is being challenged.[3]

Guidelines for procedural sedation by non-anesthesiologists in pediatric and adult patients are developed in general or specifically for different medications. The most comprehensive pediatric general sedation guidelines (in general, not specifically for gastrointestinal endoscopy) are those of the American Academy of Pediatrics,[4] and the British National Institute for Health and Clinical Excellence (NICE) guidelines published in 2010[5], which are also available as quick reference guide[6]. Both publications address among others: presedation preparation, personnel and training, proposed sedatives and analgesics, monitoring and discharge criteria. Sedation guidelines in emergency departments are developed specifically for ketamine[7] and have been updated recently[8]. An update for endoscopic practice for pediatric patients was published by the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) and the American Society for Gastrointestinal Endoscopy (ASGE) in 2008.[9] Propofol sedation is gaining evidence regarding safety and efficiency in adult gastroenterology.[10,11] Guidelines for its use in sedation for gastrointestinal endoscopy for pediatric population have not been developed yet. Different sedation protocols for pediatric gastrointestinal endoscopies are discussed below.

Table 1: American Society of Anesthesiology (ASA) classification of physical status. Adapted from[1].

ASA class	Description
ASA I	a normally healthy patient.
ASA II	a patient with mild systemic disease (e.g. asthma controlled with maintenance treatment with stable peak expiratory flow (PEF))
ASA III	a patient with severe systemic disease (e.g. hemodynamically important congenital heart disease)
ASA IV	a patient with severe systemic disease that is a constant threat to life (e.g. a child with status asthmaticus)
ASA V	a moribund patient who is not expected to survive without surgery (e.g. a patient with severe cardiomyopathy requiring heart transplantation)

2. General principles

To decrease the sedation-related risk to the lowest possible level when performed by non-anesthesiologists, it is important to have a systematic approach. It is recommended to have a sedation protocol consistent with hospital sedation and analgesia policy. Each team member has to know its obligations. Periodic re-evaluation of safety issues and regular re-education and update of protocols are essential.[4]

2.1. Patient selection and evaluation

When performing sedation, non-anesthesiologists are limited with patient's condition and planned investigation or procedure. In general, patients must be otherwise healthy (ASA class I) (Table 1) or may have at the time of endoscopy a controlled mild chronic disease (ASA class II; e.g. a patient with stable asthma on a regular maintenance therapy) (Table 1).[4]

In case of any other condition which might impede sedation (e.g. anatomic airway abnormalities) an anesthesiologist has to be engaged in the decision about the best sedation and must in most cases carry out the sedation.[4] In elective investigations, contraindications to the sedation by non-anesthesiologist have to be foreseen before the admission.

Indications for endotracheal intubation and general anesthesia in pediatric gastrointestinal endoscopies are: unstable patient (ASA class III or higher), limitations with sedatives or analgesic use (e.g. allergy), patient's or physician's preference, the type of procedure (foreign body removal, acute bleeding, percutaneous gastrostomy placement, and some other complex investigations or procedures).[4,9]

On the day of the investigation, patient has to be re-checked: current condition (any current infectious disease, fasting period (6h in most cases), allergies, current medications, any contraindication to the planed use of sedatives and analgesics) and vital signs measured before sedation. An intravenous line is placed for sedative application and has to stay inserted until the patient is suitable for discharge.[4]

Table 2: Sedatives, analgesics and antagonists for pediatric gastrointestinal endoscopy sedation.

Generic name	Mechanism of action	Main undesirable effect1s	References
Sedatives			
Fentanyl	binds to opioid receptors analgesia	respiratory depression, hypotension, pruritus	12
Ketamine	binds to the NmethylDaspartate (NMDA) receptors anesthesia, analgesia, amnesia, sedation, immobilisation;	laryngospasm, hypertension, tachycardia, hypersalivation, vomiting, random movements, increase in intraocular pressure, emergence phenomena (floating sensations, vivid dreams, blurred vision, hallucinations, and delirium).	12,20
Midazolam	GABA receptor agonist anterograde amnesia, anxiolysis, sedation, hypnosis	respiratory depression, hypotension, paradoxic agitation,	12
Nitrous oxide	inhalation anaesthetic	vomiting, dizziness, voice change, euphoria, laughter	12
Propofol	GABA receptor agonist sedation, hypnosis, amnesia	respiratory depression, apnoea, hypotension, painful injection	13
Sevoflurane	inhalation anesthetic	recovery agitation, bradicardia, hypotension, cough, vomiting, seizures	21,22
Antagonists			
Flumazenil	benzodiazepine antagonist	nausea, vomiting	12
Naloxone	opioid antagonist	nausea, vomiting, tachycardia	12

Table 3: The list of sedatives, adjuvant medications and antagonists with usual dosage regimens, and main contraindications.

Generic name	Route	Dose	Median sedation duration	Repeating time and dose	Contraindications	References
Sedatives						
Fentanyl	i.v.	1–2 µg/kg (up to 50 µg)	20–40 min (30–60 min)	3 min 1–1.25 µg/kg		12
Ketamine	i.v.	1–1.5 mg/ kg	15 min	10 min 0.5 mg/kg	severe cardiovascular disease, malignant hypertension, cerebro-spinal fluid obstructive states (controversial), increased intraocular pressure; previous psychotic illness, hyperthyroidism; porphyria.	12,20
Midazolam	i.v.	0.05–0.1 mg/kg in < 5 years (max. 0.6 mg/kg); in 6–12 years 0.025–0.05 mg/kg (max.0.4 mg/kg); in older than 12 years 2–2.5 mg (in total not per kg BW)	45–60 min	repeating doses every 2–5 min until desired effect; in children 6 mths.–5 years total dose up to 0.6 mg/kg or max. 6 mg; in 6 years – 12 years total dose up to 0.4 mg/kg or max. 10 mg; in older than 12 years additional boluses of 1 mg until desired sedation	respiratory depression, hypotension	12
Nitrous oxide	inh.	mostly the mixture of nitrous oxide (50 %) and oxygen	5 min	continuously or "on demand"	pneumothorax, bowel obstruction, head injury, pregnancy	12
Propofol	i.v.	2 mg/kg in infants and young children; 1 mg/kg in older children	5–15 min	1 mg/kg (infants and young children); 0.5 mg/kg (older children) to reach the desired sedation; may be continuously infused (100 µg/kg per min and increasing the speed of infusion by 50 µg/kg per min) for prolonged procedures	egg or soy allergy	12
Sevoflurane	inh.	different concentrations according to the age			Duchenne's muscular dystrophy, liver disease of unknown etiology, history of malignant hyperthermia	21,22
Antagonists						
Flumazenil	i.v.	0.02 mg/kg (max. 1 mg)	30 min	1 min; same dose	chronic benzodiazepine use; ingestion of drugs that place them at risk for seizures development (e.g. cyclic antidepressants, cyclosporine, and others)	12
Naloxone	i.v. or i.m.	0.1 mg/kg (max. 2 mg)	20–40 min	2 min; same dose	hypersensitivity only	12

2.2. Personnel requirements

In most cases, the sedation and endoscopy team is lead by an endoscopist. One of team members (usually registered nurse) is responsible only for sedatives and analgesics application and monitoring of the patient's vital functions, and has to be skilled in pediatric basic life support.[4]

At least one of the team members must be trained in advanced pediatric life support.[4]

2.3. Monitoring during sedation

Besides observing patient's skin color and appearance, basic monitoring parameters are hemoglobin saturation with oxygen (SaO_2) and heart rate. Additional monitoring parameters are electrocardiogram (ECG), arterial blood pressure and end-tidal carbon dioxide monitoring (capnography) when available.[4]

In case of any deviation from normal, the team leader has to be informed immediately and appropriate measures taken according to the resuscitation protocols adopted by the hospital (e.g. restoration of airway). In the majority of such cases, except in mild short-lasting monitoring parameter deviations, the endoscopy has to be discontinued.

2.4. Discharge criteria

Patients may be discharged when their vital parameters, consciousness level and other functions (e.g. eating and drinking) return to the state they were in before the sedation, in most cases after few hours (depending on the sedatives used).[4]

3. Sedatives and analgesics

There is no ideal sedative for procedural sedation in children. Different combinations of sedatives, anesthetics and analgesics are used by non-anesthesiologists and anesthesiologists. The choice depends on the medical system legal issues in each country and on the policy of medical institution.[4,5] Mechanisms of action for selected sedatives, analgesics and antagonists are listed in Table 2, and usual dosage and main contraindications are given in Table 3.

There are different sedation protocols:[12]

- Benzodiazepine (midazolam or diazepam) and opioid (fentanyl or meperidine). The drawback of this combination is respiratory depression which is caused by both drug classes, but, on the other hand, it is reversed by antagonists flumazenil (for benzodiazepines) and naloxone (for opioids).
- Propofol[13] is a widely used aesthetic but without analgesic properties. Therefore it is combined with analgesics. In some countries its use is limited to anesthesiologists, yet in others propofol is legally administered by non-anesthesiologists or registered nurses[14]. Education curriculum is published[15] for the education of adult non-anesthesiologists but unfortunately not yet for non-anesthesiologists sedating children.
- Ketamine[16] is dissociative anesthetic with good safety profile but quite a few contraindications. It does not depress breathing but is usually combined with benzodiazepine to prevent emergence phenomena.
- Many different combinations and routes of administration of the above mentioned medications are used in some centers, including inhalation anaesthetics (e.g. sevoflurane) but their use is limited for various reasons, which are beyond the scope of this article.

4. Our experience in sedation for gastrointestinal endoscopies

In our centre we added ketamine to midazolam sedation protocol for gastrointestinal endoscopies in 2003. The analysis of sedations in 2005 revealed that lower doses of ketamine than recommended were used but due to retrospective design of the study sedation adequacy was not assessed.[17] When we tried to verify this finding in prospective study including the observation of sedation adequacy we have found that lower initial ketamine dose resulted in unsatisfactory sedation. So for the starting dose of ketamine we use 1 mg/kg.[18] We also proved slight advantage with midazo-

lam premedication in lowering the incidence of emergence phenomena usually described in adults sedated with ketamine[19] only but being a bit controversial in children.[18]

In both our studies[17,18] we reported of a need to administer additional oxygen during the procedure in many patients due to transitory desaturation (in up to 62 % in the retrospective[17] and up to 46 % in the prospective study[18]). Therefore we decided to administer oxygen via nasal cannula routinely in all sedations. This measure prevented most of previously seen transient desaturations.

Conclusion

Sedation and analgesia for endoscopic procedures is a constantly changing field. New medications and research findings force us to challenge the sedation protocols regularly. Gastrointestinal endoscopy is a teamwork where every member has its role. The achievement of reliability of all team members in sedation process ensures the highest level of safety and efficiency.

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