

PAEDIATRIC SEDATION

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Self-assessment

Please answer the following questions prior to reading the tutorial

1. The following are contraindications to sedation
 - a. Abnormal airway
 - b. Raised intracranial pressure
 - c. Respiratory failure
 - d. History of sleep apnoea
 - e. Infants less than 1 year of age.

2. The following subgroup requires special caution for sedation
 - a. Neonates, especially if premature or ex-premature
 - b. Children with cardiovascular instability or impaired cardiac function
 - c. Renal and hepatic impairment
 - d. Children who have been fasted as for a general anaesthetic
 - e. Gastro-oesophageal reflux disease

3. Regarding sedation in children, the following statements are correct
 - a. To prevent hypoxic incidents sedation by non-anaesthetists should be limited to 'minimal sedation'
 - b. Non-anaesthetists should use drugs and techniques with a narrow margin of safety
 - c. Sedation calms but does not gain assent for a procedure
 - d. Sleep is less easily achieved in children for painless procedures
 - e. Recovery is more predictable in children compared to adults

4. Airway obstruction or apnoea is rare with the following sedation techniques
 - a. Calming an infant with intra nasal midazolam
 - b. Nitrous oxide used for dentistry
 - c. Rectal thiopental used for painless imagery
 - d. Low dose propofol used for painless imaging
 - e. Intra muscular ketamine for wound care

5. Regarding drugs used in sedation, the following statements are correct
 - a. Triclofos is more palatable but is slower and less potent compared to chloral hydrate
 - b. Laryngospasm, nausea and vomiting are potential complications with ketamine
 - c. Rectal thiopental induces sleep in children immediately after administration
 - d. Apnoea and desaturation are common when propofol is used for sedation
 - e. Opioid induced respiratory depression can be reversed with naloxone at a dose of 1mcg/kg IV

INTRODUCTION

Sedation is the use of drugs for reduction of fear and anxiety, induction of drowsiness or sleep and comfort. All sedation techniques carry risk and many procedures done under sedation are performed outside operating theatres. Sedation in children needs special considerations and some drugs used for sedation are not as reliable as those for anaesthesia. Its safety and success depends upon skill and judgement.

DEFINITIONS OF SEDATION

Sedation is a continuum of the awake state. The American Society of Anaesthesiologists uses the following definitions for levels of sedation:

Minimal sedation (formerly known as anxiolysis) is a drug-induced state during which patients respond normally to verbal commands. Although cognitive function and coordination may be impaired, respiratory and cardiovascular stability is unimpaired.

Moderate sedation (formerly known as conscious sedation) is a drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation. It is important to remember that reflex response to a painful stimulus is not a purposeful response. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular stability is usually maintained.

Deep sedation/analgesia is a drug-induced depression of consciousness during which patients cannot be easily roused but respond purposefully following repeated or painful stimulus. Patients may require assistance in maintaining a patent airway and spontaneous ventilation may be inadequate. Cardiovascular stability is usually maintained.

In the UK deep sedation is considered to be a part of the spectrum of general anaesthesia.

GOALS OF SEDATION

The goals of sedation in the paediatric patient for diagnostic and therapeutic procedures are to

- Guard the patient's safety and welfare
- Minimize physical discomfort and pain
- Control anxiety, minimize psychological trauma and maximize the potential for amnesia
- Control behaviour and/or movement to allow the safe completion of the procedure
- Return the patient to a state in which safe discharge from medical supervision is possible

PATIENT SELECTION

A careful assessment with detailed history and clinical examination is important to identify potential risk factors. Previous sedation history is important as previously failed sedation may indicate

a need for general anaesthesia. Although the ASA classifications are not totally appropriate for paediatrics, the Scottish Intercollegiate Guidelines Network advises that only patients in ASA classes I and II should be considered suitable for sedation as outpatients. Patients in classes III to V should be regarded as high risk patients who should only be managed in a hospital setting with the involvement of an anaesthetist trained in paediatric sedation, anaesthesia and resuscitation.

INDICATIONS FOR SEDATION

Painless Procedures

Transthoracic echocardiography
Radiotherapy
Computed tomography
MRI
Electroencephalography

Painful Procedures

Minor, painful oncology procedures
Interventional radiology
Dental procedures
Wound care, including burns dressings
Cardiac angiography
Fracture manipulation

CONTRAINDICATIONS TO SEDATION

Children with any of the following should not normally be sedated

- Abnormal airway including adenotonsillar hypertrophy causing obstruction to breathing when asleep (Obstructive Sleep Apnoea, or OSA), or any other anatomical abnormality of upper and lower airway.
- Raised intracranial pressure
- Depressed conscious level.
- History of sleep apnoea
- Respiratory failure
- Cardiac failure
- Neuromuscular disease
- Bowel obstruction
- Active respiratory tract infection
- Known allergy to sedative drug / previous adverse reaction
- Child too distressed despite adequate preparation
- Older child with severe behavioural problems
- Refusal by the parent / guardian / child.

The following subgroup of patients should not be sedated with nitrous oxide

There are specific contraindications to the use of nitrous oxide due to its ability to diffuse into enclosed air spaces causing them to expand or increase in pressure, or in the case of pulmonary hypertension, as it increases pulmonary vascular resistance.

- Intracranial air (e.g. after skull fracture)
- Pneumothorax, pneumopericardium

- Bowel obstruction
- Pneumoperitoneum
- Pulmonary cysts or bullae
- Lobar emphysema
- Severe pulmonary hypertension

Extra caution should be exercised when sedating children who have any of the following conditions

- Neonates, especially if premature or ex-premature
- Children with cardiovascular instability or impaired cardiac function
- Renal impairment
- Hepatic impairment
- Severe respiratory disease
- Gastro-oesophageal reflux
- Impaired bulbar reflexes
- Emergency cases who are not adequately starved
- Anticonvulsant therapy
- Children receiving opioids and other sedatives
- Children receiving drugs that potentiate the action of sedatives (e.g. macrolide antibiotics like erythromycin potentiate and prolong the sedative effects of midazolam)

PATIENT PREPARATION AND MONITORING

During procedural sedation when protective airway reflexes are lost, gastric contents may be regurgitated into the airway. Therefore, patients with a history of recent oral intake or with other known risk factors for aspiration should not be sedated.

Appropriate Intake of Food and Liquids before Elective Sedation

Ingested Material	Minimum Fasting Period (Hours)
Clear liquids: water, fruit juices without pulp, carbonated beverages, clear tea, black coffee	2
Breast milk	4
Infant formula / non human milk	6
Solids	6

Systematic approach to sedation

It is important to use a systematic approach to sedation techniques so as to not overlook an important drug, piece of equipment, or monitor that may be required at the time of a developing emergency. To avoid this problem, it is helpful to use an acronym that allows the same setup and checklist for every procedure.

A commonly used acronym that is useful in planning and preparation for a procedure is **SOAPME**:

S	Suction	Size-appropriate suction catheters and a functioning suction apparatus (e.g. Yankauer-type suction)
O	Oxygen	Adequate oxygen supply and functioning flow meters/other devices to allow its delivery
A	Airway	Size-appropriate airway equipment (nasopharyngeal and oropharyngeal airways, laryngoscope blades [checked and functioning], tracheal tubes, stylets, face mask, bag-valve-mask or equivalent device [functioning])
P	Pharmacy	All the basic drugs needed to support life during an emergency, including antagonists as indicated
M	Monitors	Functioning pulse oximeter with size appropriate oximeter probes and other monitors as appropriate for the procedure (e.g., non-invasive blood pressure, end-tidal carbon dioxide, ECG, stethoscope)
E	Equipment	Special equipment or drugs for a particular case (e.g., defibrillator)

This table summarizes the expected clinical responses and the ideal monitoring requirements for different levels of sedation:

	Minimal sedation	Moderate sedation	Deep Sedation
Responsiveness	Normal	Purposeful to light stimulation	Purposeful to painful stimulation
Airway	Unaffected	No intervention	(±) Intervention
Ventilation	Unaffected	Adequate	(±) Inadequate
Cardiac stability	Unaffected	Maintained	(±) Maintained
Monitoring	Observation & intermittent assessment	Pulse oximetry Heart rate Intermittent recording of RR and BP	Pulse oximetry ECG - continuous BP every 3-5 minutes (±) EtCO ₂ , precordial stethoscope

WHO SHOULD ADMINISTER SEDATION

The sedation practitioner should be trained in sedation techniques. They should be competent to consent, prescribe and administer sedative drugs, understand the pharmacology of the agents used and be capable of providing Paediatric Basic Life Support and preferably Paediatric Advanced Life Support. For deep sedation this should be an anaesthetist or a practitioner with training in anaesthesia.

DRUGS USED FOR SEDATION

A drug can only be considered safe after experience in hundreds and thousands of cases; however, few drugs have been studied to this extent. Good protocols are important for the safety and success of sedation.

Chloral hydrate and triclofos are effective oral sedatives and are metabolised to trichlorethanol. Chloral hydrate has an unpleasant taste and causes gastric irritation; triclofos is more palatable but is slower and less potent (1 g triclofos = 600 mg chloral hydrate). Respiratory complications, vomiting and paradoxical reactions can occur. Deaths have occurred in unattended children. Small children are calmed by 'sub sedation' doses.

Benzodiazepines

Midazolam

Midazolam induces anxiolysis, sedation and amnesia; it is absorbed enterally and via oral and nasal mucosa. By mouth, 0.5 mg/kg (maximum 20 mg, 30 min beforehand) reduces crying during induction of anaesthesia, but occasionally dizziness, dysphoria and paradoxical reactions occur. Its bitter taste needs masking with a sweetening agent. In the emergency department, 0.5–1 mg/kg orally is useful to calm children for suture of lacerations. Intranasal drops 0.2 mg/kg effectively calms irritable infants but this method is unpleasant and causes crying—an atomizer may be better. Absorption is so rapid that apnoea and desaturation occur occasionally.

Sublingual administration is more pleasant, equally rapid and effective, but requires co-operation. Rectally, 0.3–1 mg/kg may cause moderate sedation.

IV titration is best but effects are variable, unpredictable and depend upon the discomfort of the procedure (0.05–0.2 mg/kg for moderate sedation). Co-administration of opioids increases the risk of apnoea while co-administration of macrolide antibiotics may result in prolonged unconsciousness due to inhibition of hepatic metabolism. Occasionally children may develop paradoxical excitation and anxiety (confusion/disinhibition).

Diazepam

Intravenous diazepam (Diazemuls) is 4–5 times less potent than midazolam. Despite a longer elimination half-life, recovery profiles are similar (usually by 2 h). Dose- 200-300 microgram/kg orally and 100-200 microgram/kg IV.

Temazepam

Temazepam tablets are preferred to the taste of the elixir and doses of 0.5–1 mg/kg cause minimal sedation and sleep:

Reversal of benzodiazepine sedation

Flumazenil 20–30 microgram/kg i.v. can be used to reverse benzodiazepine sedation. There may be a risk of fitting from sudden benzodiazepine withdrawal. As the half-life of flumazenil is less than that of some benzodiazepines, there is a risk of re-sedation.

Barbiturates

Thiopental

Intravenous thiopental is too potent for non-anaesthetists. When given rectally in children, thiopental 25–50 mg/kg produces sedation after 30 min. Airway obstruction can occur and recovery takes between 30 and 90 min.

Pentobarbital and Quinalbarbital

Quinalbarbital (7.5–10 mg/kg orally) makes 90% of children (<5 yr) sleep but older children may have paradoxical excitement.

For painless imaging, pentobarbital 2–6 mg/kg i.v. is very successful but 1–3% of children have airway obstruction or paradoxical reactions. Pentobarbital is not available in the UK.

Propofol

The short action and lack of side effects make propofol the best of all the i.v. agents but, because apnoea and desaturation are common, it is not recommended for non-anaesthetists. Sedation is induced by 2–4 mg/kg and usually maintained by an infusion of 6–8 mg/kg/h; recovery is pleasant and occurs within a few minutes. Tolerance and behavioural disturbances are reported.

Melatonin

Natural sleep may be induced successfully in 55% for MRI and 80% for EEG. Doses range from 2–10 mg orally.

Opioids

Morphine

Morphine is useful for painful procedures such as wound care. A dose of 60 microgram/kg i.v. has been used in combination with midazolam 0.05 mg/kg i.v. without major respiratory effects.

Meperidine

Meperidine 0.5–1 mg/kg i.v. combined with midazolam 0.05–0.1 mg/kg i.v. provides effective sedation for endoscopy. However, oxygen desaturation has been reported in cases.

Fentanyl

The potency of fentanyl increases the risk of apnoea. For example, 5% of children given i.v. midazolam and fentanyl (1–6 microgram/kg) for gastroscopy required reversal with naloxone. Fentanyl is absorbed from the mucosa of the mouth and oral transmucosal fentanyl citrate is available both as a lozenge and a palatable lollypop; side effects include vomiting (30%) and desaturation.

Reversal of opioid-induced respiratory depression

Opioid-induced respiratory depression can be reversed with naloxone. The usual dose is 10 microgram/kg i.v, repeated as necessary.

Major tranquilizers

Trimeprazine

Trimeprazine 3–4 mg/kg orally causes sleep in 50% of children before anaesthesia. However, because of reports of hypotension, the maximum recommended dose is 2 mg/kg. At this dose, it can be combined with morphine 0.2 mg/kg i.m. for sedation of children >15 kg for MRI.

Chlorpromazine and promethazine

Chlorpromazine and promethazine have been combined together with meperidine (pethidine) to form pethidine compound (1 ml contains 25 mg meperidine, 6.25 mg chlorpromazine and 6.25 mg promethazine). It is for i.m. administration only and combines analgesia, anxiolysis and sedation; effective doses are between 0.06 and 1 ml/kg. This powerful combination can cause apnoea.

Nitrous Oxide

Nitrous oxide provides valuable analgesia and sedation in cooperative children for a wide variety of painful procedures. Loss of consciousness can occur when combined with other sedatives or when used alone in concentrations over 50%.

Ketamine

This anaesthetic drug causes a ‘dissociative’ sedation or anaesthesia with analgesia. In maintaining cardio-respiratory function, ketamine (i.v. or i.m.) is extremely useful when other methods of anaesthesia are unavailable or impractical. If non-anaesthetists use ketamine they must be prepared for laryngospasm and apnoea. Apnoea has occurred following 4 mg/kg i.m. and is more likely if ketamine is combined with opioids. Nausea and vomiting can occur in 15–33% and distressing hallucinations in 3% even when combined with midazolam. For needle-phobic children, 5 mg/kg orally causes variable sedation after 10–20 min, and 10 mg/kg makes 50% of children unconscious; recovery can take up to 2 h.

ANSWERS TO PRE ASSESSMENT MULTIPLE CHOICE QUESTIONS

1) TTTTF 2) TTTFT 3) TFTFF 4) TTFFT 5) TTFTF

KEY REFERENCES

SIGN. Safe sedation of children undergoing diagnostic and therapeutic procedures. A national clinical guideline. Scottish Intercollegiate Guidelines Network, 2004

<http://www.sign.ac.uk/guidelines/fulltext/58/index.html>

Charles J. Coté, Stephen Wilson and the Work Group on Sedation, Guidelines for Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures: An Update

Pediatrics 2006;118;2587-2602

Cote CJ, Notterman DA, Karl HW, Weinberg JA, McCloskey C. Adverse sedation events in pediatrics: a critical incident analysis of contributing factors. *Pediatrics* 2000; 805-814

M R J Sury Paediatric Sedation, **British journal of anaesthesia CEPD, Number 4, Volume 4 August 2004**

M R J Sury, Anaesthesia and sedation outside operating theatres, Chapter 44

Hatch and Sumner's Textbook of Paediatric Anaesthesia (2007 Edition)

Publisher – Hodder Arnold