Paediatric sedation

Michael R. J. Sury FRCA

Key points

Sedation in children needs special consideration.

Conscious sedation requires cooperation: unlikely for many procedures especially if painful.

Deep sedation by non-anaesthetists is not recommended in the UK; training and specialty-specific protocols are needed.

The safety and success of sedation depends upon skill and judgement.

Drugs used for sedation are not as reliable as those used for anaesthesia.

M. R. J. Sury FRCA
Department of Anaesthesia
Great Ormond Street Hospital for Children NHS Trust
Great Ormond Street
London
WC1N 3JH
Tel: 020 7405 9200
Fax: 020 7405 8866
E-mail: surym@gosh.nhs.uk
(for correspondence)

An increase in the numbers of investigations and non-surgical interventions in children has created an enormous demand for sedation services. Limited anaesthesia resources mean that non-anaesthetists will inevitably be involved in providing this service. This article reviews the special considerations for paediatric sedation and describes contemporary drugs and techniques.

Definitions of sedation

As consciousness reduces, vital respiratory reflexes fail to maintain a patent airway and adequate breathing. Because the level of consciousness is difficult to measure, the point at which protective reflexes are affected is unknown and clinical experience shows that the effect of sedation varies between the drugs themselves, between patients and according to the arousal stimulus of the procedure.

It is generally accepted that sedation is a state of drowsiness or sleep from which a subject can be roused, whereas anaesthesia is an unrousable state in which vital respiratory reflexes may be lost. If non-anaesthetists (i.e. those lacking anaesthetic skills) use sedation that causes unintentional anaesthesia, and they are unable to give prompt attention to the airway and breathing, death or cerebral damage can follow. To prevent hypoxic incidents, sedation by non-anaesthetists has been limited by the Royal Colleges, to 'conscious sedation': meaning that response to a verbal command proves that a patient is not anaesthetized. A second accepted principle is that 'the drugs and techniques should carry a margin of safety wide enough to render unintended loss of consciousness unlikely'.

In the US, a stage in between conscious sedation and anaesthesia is recognized as 'deep sedation' and is 'a drug-induced depression of consciousness during which patients cannot be easily roused but respond purposefully following repeated or painful stimulation. Reflex withdrawal is not considered a purposeful response. The ability to independently maintain ventilatory function may be impaired. Patients may require assistance in maintaining a patent airway and spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained'.

Problems with conscious sedation in children

Sedation calms but does not gain assent; therefore a procedure cannot be done in a conscious, uncooperative patient unless they are restrained. Can cooperation be improved? Behavioural techniques such as play, relaxation, hypnosis and others help to counter fear and encourage the child to accept their situation. Experienced staff, including play specialists and nurses, can achieve cooperation in some children although time, skill and patient selection are required for good results. Nevertheless, many procedures are too demanding or distressing without the use of sedation.

'Verbal contact' during sedation is very safe because it ensures that protective reflexes are maintained; however, it is only useful in cooperative patients, and children, particularly ill children, are rarely in this category. There are two common scenarios. For painful procedures, cooperative children may breathe nitrous oxide or tolerate local anaesthesia but in uncooperative children it is difficult to achieve satisfactory analgesia that does not cause excessive sedation or require the use of restraint. For painless imaging, children frequently are not still enough, perhaps because they are frightened or uncomfortable. In this situation, they need to be asleep but trying to prove rousability during the procedure itself defeats the purpose of the sedation. Sedation (by non-anaesthetists) that causes sleep is controversial.

Problems with drugs

Anaesthetic drugs can be used in subanaesthetic doses to cause sedation but, because they are potent, the difference between sedative and anaesthetic doses is too small and airway

Continuing Education in Anaesthesia, Critical Care & Pain | Volume 4 Number 4 2004 DOI 10.1093/bjaceaccp/mkh034

Table 1 Contraindications to sedation in children (from SIGN guidelines)

Children with any of the following contraindications should not normally be sedated
Abnormal 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 or adverse reaction to sedative
Child too distressed despite adequate preparation
Older child with severe behavioural problems
Consent refusal by parent or patient

Table 2 Principles for design of safe and successful sedation protocols for non-anaesthetists

Success
Experienced staff
Minimize the distress of the procedure
Selection of children
Choose effective drugs/techniques
Quiet and child-friendly environment
Safety
Experienced staff
Enforce contraindications to sedation
Safe drugs - do not exceed maximum doses
Recovery and discharge criteria
Good facilities and equipment

skills are required too often for non-anaesthetists to use them. Conversely, safe sedation drugs are not as potent, have a wide margin of safety and will not always succeed. Increasing doses increases success but some children will sleep too deeply. Sedation drugs also have a long action and are unpredictable—even standard doses can cause deep and prolonged sedation. Occasionally, there are 'paradoxical' distress reactions perhaps attributable to dizziness, anxiety or hallucinations.

Safe practice for non-anaesthetists

There are special considerations for sedation of children and the SIGN guidelines have been developed after a review of literature and opinion in the UK and abroad. The list of contraindications is very important to safety (Table 1) and useful guidance on minimal monitoring and fasting protocol are given.

In 2001, an Intercollegiate Working Party chaired by the Royal College of Anaesthetists was convened in response to reports of dangerous practice (gastroscopy in adults was a specific concern). Their report is pertinent to paediatric services and recommended that:

(i) safe sedation techniques should be defined for each specialty;
(ii) organizations should ensure that staff receive sedation training;
(iii) hospitals should appoint lead consultants.

Drugs used for sedation

A drug can only be considered safe after experience in hundreds or thousands of cases and few drugs have been studied to this extent. Good protocols are important for the safety and success of sedation and principles are summarised in Table 2. The most important factor is the judgement of the medical and nursing staff.

Choral hydrate and triclofos

Choral hydrate and triclofos are effective oral sedatives and 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). In a large study, ~2000 children aged <18 months received chloral hydrate (up to 100 mg kg^{-1}) without respiratory complications, but in another study, out of 854 children, four had airway obstruction, 11 vomited and six had paradoxical reactions. Deaths have occurred in unattended children. Small children are calmed by 'subsedation' 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^{-1} (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 A & E, 0.5–1 mg kg^{-1} orally is useful to calm children for suture of lacerations. Intranasal drops 0.2 mg kg^{-1} effectively calm 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^{-1} may cause conscious sedation. I.v. titration is best but effects are variable, unpredictable and depend upon the discomfort of the procedure (0.05–0.2 mg kg^{-1} for conscious sedation). Mild desaturation is easily corrected by stimulation or oxygen treatment. To induce a 'deep' sleep, doses are usually >0.5 mg kg^{-1}. 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.

Diazepam

I.v. diazepam (diazemuls) is 4–5 times less potent than midazolam. Despite a longer elimination half-life, recovery profiles are similar (usually by 2 h).

Temazepam

Temazepam tablets are preferred to the taste of the elixir and doses of 0.5–1 mg kg^{-1} cause some anxiolysis and sleep: 70% of children (10–20 kg) sleep for MRI after 1 mg kg^{-1} combined with droperidol (0.25 mg kg^{-1} orally; top up with diazemuls (up to 1 mg kg^{-1} i.v., max 10 mg) improves success to 95%.

Reversal of benzodiazepine sedation

Flumazenil 20–30 μg kg^{-1} i.v. can be used to reverse benzodiazepine sedation. As the half-life of flumazenil is less than that of some benzodiazepines, there is a risk of re-sedation.

Barbiturates

Thiopental

I.v. thiopental is too potent for non-anaesthetists. When given rectally in children, thiopental 25–50 mg kg^{-1} produces sleep after 30 min. Airway obstruction can occur and recovery takes between 30 and 90 min. Defaecation is prevented by holding the buttocks together or using a balloon tipped catheter held in place for 15 minutes (further doses can then be added if necessary).

Pentobarbital and quinalbarbital

Quinalbarbital (7.5–10 mg kg^{-1} orally) makes 90% of children (<5 yr) sleep but older children may have paradoxical excitement.

For painless imaging, pentobarbital 2–6 mg kg^{-1} 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. Sleep is induced by 2–4 mg kg^{-1} and usually maintained by an infusion of 6–8 mg kg^{-1} h^{-1}; recovery is pleasant and 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

Although primarily used for analgesia, opioids improve success rates with other sedatives. They also calm children without necessarily affecting conscious level.

Morphine

Morphine is useful for painful procedures such as wound care. A dose of 60 μg kg^{-1} i.v. has been used in combination with midazolam 0.05 mg kg^{-1} i.v. without major respiratory effects.

Meperidine

Meperidine 0.5–1 mg kg^{-1} i.v. combined with midazolam 0.05–0.1 mg kg^{-1} i.v. provides effective sedation for gastroscopy. However, oxygen desaturation has been reported in 5% of cases.

Fentanyl

The potency of fentanyl increases the risk of apnoea. For example, 5% of children given i.v. midazolam and fentanyl (1–6 μg kg^{-1} i.v.) for gastroscopy required naloxone. Fentanyl is absorbed from the mucosa of the mouth and oral transmucosal fentanyl citrate (OTFC) 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 μg kg^{-1} i.v., which can be repeated as necessary.

Major tranquillizers

Trimeprazine

Trimeprazine 3–4 mg kg^{-1} orally causes sleep in ~50% of children before anaesthesia. However, because of reports of hypotension, the maximum recommended dose is 2 mg kg^{-1}. At this dose, it can be combined with morphine 0.2 mg kg^{-1} 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^{-1}. 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. In a series of almost 8000 cases in France over a 10 yr period, an 80% success rate was achieved. Loss of consciousness can occur when combined with other sedatives or when used alone in concentrations over 50%.

Ketamine

This anaesthetic drug causes 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 it they must be prepared for laryngospasm and apnoea. In a series of 1022 children in A & E, four had laryngospasm and two had apnoea; none required tracheal intubation. However, out of 625 children for gastroscopy, laryngospasm occurred in 52, airway obstruction in eight and one needed intubation. Apnoea has occurred following 4 mg kg^{-1} 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, 6 mg kg^{-1} orally causes variable sedation after 10–20 min, and 10 mg kg^{-1} makes 50% of children unconscious; recovery can take up to 2 h.

Common procedures and requirements for sedation

The sedation technique depends on the degree of immobility, the pain involved and how long the procedure takes. Each procedure below is coupled with the technique that is appropriate for the majority of children. Technical aspects of the procedures themselves are not considered.

Painless procedures

Transthoracic echocardiography—calming

Irritable infants and small children can be calmed by oral chloral hydrate, triclofos or midazolam. Anaesthesia is required for trans-oesophageal echocardiography.

Computed tomography—calming or short sleep

Modern computed tomography can take just 5 min. If a child will not lie still, either oral chloral hydrate, triclofos, or midazolam is usually effective. Anaesthesia will be necessary occasionally.

MRI—sleep (anaesthesia or sedation)

Routine imaging requires perfect immobility for up to 90 min in a noisy enclosed environment. Access to the patient is restricted. Infants <3 months should sleep naturally after a feed and children aged >8 yr may be cooperative enough but otherwise, the vast majority of other children need drug-induced sleep. Most UK hospitals provide an anaesthesia service but sedation services are developing and their success rates vary from 80 to 97%. Chloral hydrate is very successful for small children but older ones need a combination of drugs (e.g. temazepam and droperidol). Ketamine may preserve airway and breathing but facial movement and salivation are a nuisance. Melatonin may be useful.

Radiotherapy—sleep

Radiotherapy requires immobility for 10–20 min repeated each day for two or more weeks. Deep sedation or anaesthesia is necessary for uncooperative children.

Electroencephalography and brain stem evoked responses—sleep

The EEG is changed by sedation so natural sleep is preferred. Sleep deprivation or melatonin are useful measures for successful recordings. For brain stem-evoked responses, many deaf children are restless and need deeper sedation or light anaesthesia.

Painful procedures

Minor, painful oncology procedures—anaesthesia (occasionally conscious sedation)

Many children undergo repeated lumbar punctures, intrathecal injections and bone marrow aspirations. In cooperative children, behavioural techniques are worthwhile and conscious sedation using nitrous oxide alone or midazolam with fentanyl can be successful with local anaesthesia. Nevertheless, large numbers need anaesthesia. Deep sedation with combinations of midazolam, opioids and ketamine is possible but unreliable; it is not recommended.

Interventional radiology—anaesthesia (occasional conscious sedation)

Percutaneous biopsy of solid organs and tumours, drainage of abscesses and cysts, dilatation of stenoses and strictures, insertion of gastrostomy and nephrostomy tubes, and central venous catheters are now within the service capability of radiology departments. As almost all of these are painful, unpredictable and last a variable length of time, anaesthesia is preferable. Ketamine has been used with limited success but is a poor substitute for other anaesthesia techniques.

Cardiac angiography—anaesthesia (occasional conscious sedation)

Femoral cannulation is almost painless under local anaesthesia but can be technically challenging. Immobility is needed for both imaging and measurement of intravascular pressures that require steady state cardio-respiratory function. Balloon dilatations, insertion of coils and stents, cyanosis and cardiac failure are obvious potential hazards to consider. Virtually all cardiac angiography should be conducted under general anaesthesia because it provides optimum and reproducible steady state conditions with maximum safety.

Oesophagogastroscopy and colonoscopy—anaesthesia (occasional conscious sedation)

For uncooperative children, oesophagogastroscopy is only successful if the gag reflex is sufficiently suppressed. At this level of sedation, airway and breathing reflexes are affected and also the endoscope can mechanically obstruct the upper airway: if too large, the scope can even compress the trachea. Deep sedation is possible but anaesthesia is likely to be safer and faster.

Dental procedures—mainly conscious sedation but large numbers still need anaesthesia

Behavioural management and local anaesthesia should be attempted in most children and, if this fails, conscious sedation is helpful. Treatment can be spread over several visits and the ‘tell-show-do’ and positive reinforcement techniques are often successful. Only two sedation methods are recommended for use in community dental clinics in the UK. The ‘relative analgesia’ technique uses up to 70% nitrous oxide in oxygen administered via a nasal mask: it sedates and gives good analgesia. Adding low inspired concentrations of sevoflurane (0.1–0.3%) increases the success rate but is not yet recommended. A mouth gag must not be used because a closing mouth warns that sedation is becoming too deep. For patients over 16 yr, i.v. conscious sedation with a single drug such as midazolam is allowed. In all other circumstances, if the patient is not cooperative, deep sedation or anaesthesia has to be delivered by a consultant-led service in a specialist centre or in a hospital setting, which meets the standards as for general anaesthesia.

Wound care—treat pain, calming for short procedures, anaesthesia for remainder

Fortunately, many small wounds need only tissue adhesive or tape rather than sutures. Calming with midazolam is helpful and it is reasonable to hold a small child gently while local anaesthesia is inserted. Deep sedation techniques with ketamine or propofol are practised in the USA. In postoperative wards, the removal of drains and catheters need analgesia; opioids and nitrous oxide should be available.

Key references

Sury MRJ. Anaesthesia and sedation outside the operating room. In: Sumner E, Hatch DJ, eds. *Paediatric Anaesthesia*. London: Arnold, 1997; 565–88

Sury MRJ, Hatch DJ, Deeley T, Dicks-Mireaux C, Chong WK. Development of a nurse-led sedation service for paediatric magnetic resonance imaging. *Lancet* 1999; **353**: 1667–71

SIGN. Safe sedation of children undergoing diagnostic and therapeutic procedures. A national clinical guideline. Scottish Intercollegiate Guidelines Network, 2002

Safe sedation practice for healthcare procedures in adults. Report of an intercollegiate working party chaired by the Royal College of Anaesthetists, 2001. Academy of Medical Royal Colleges

Gall O, Annequin D, Benoit G, Glabeke E, Vrancea F, Murat I. Adverse events of premixed nitrous oxide and oxygen for procedural sedation in children. *Lancet* 2001; **358**: 1514–15

See multiple choice questions 90–94.