# Sedation for procedures in children: a guide for the non-anaesthetist

***The aim of this review is to provide a succinct guide to sedation of children for procedures. Uncooperative children are notoriously hard to sedate and the choice of appropriate technique depends upon the intended procedure. It is too easy to exceed safe dose limits and cause airway obstruction or respiratory depression. 'Sedationists' must remember that safety is paramount; they must receive training and work within protocols. Published guidelines are available.***

Many procedures are distressing to children who often need sedation. Sedation occasionally becomes too deep, resulting in anaesthesia by accident, in which airway obstruction and respiratory depression may be unrecognized. Anaesthetists, by training, are alert to these problems and have the necessary skills to prevent accidents. Further, they can use potent and short-acting agents that are always successful whereas non-anaesthetists, in contrast, may not have sufficient training to use potent drugs safely, and are therefore constrained to use drugs with a 'wide margin of safety' (Royal College of Anaesthetists and Royal College of Radiologists, 1992). Unfortunately, while these drugs are safe in the hands of non-anaesthetists, they are neither potent nor short acting and therefore are unreliable. Paediatric anaesthetists cannot service all minor procedures and consequently sedation – in practical and general terms – means the use of slow-acting drugs, with a wide margin of safety, that may not achieve the desired end-point, by non-anaesthetists.

This review provides a concise guide for non-anaesthetists who are considering sedation for children. It does not address sedation in intensive care nor the management of acute psychiatric distress. It will begin by asking 'Is sedation appropriate?' and discuss the alternatives. Then it will explain the different types of sedation and related states, give a brief overview of the practical management of common procedures and describe some useful techniques for non-anaesthetists. Finally, there are important safety considerations.

## Is sedation appropriate?

At one extreme, a simple intravenous cannula can be inserted with a combination of local anaesthesia and distraction, and at the other, a complex cardiac angiograph in a sick infant needs anaesthesia and controlled ventilation. *Table 1* lists the techniques available. The appropriate choice for an individual will depend on the degree of the child's cooperation, the degree of discomfort and the length of the procedure. Some techniques have risks and resource implications that may be out of proportion to the potential benefit of the procedure.

Behavioural techniques should not be overlooked. Play specialists have the skill and time to reassure many children and can either reduce the sedation requirement or make it unnecessary altogether (Pressdee et al, 1997). While it is true that effective behavioural preparation can be time consuming and impractical, if repeated procedures are planned, the time investment can be invaluable for gaining trust and confidence for the future (Armstrong and Aitken, 2000).

Procedures can loosely be divided into painless and painful. Painless imaging can often be managed with sedation whereas painful procedures are best managed by anaesthetists. Depending upon the circumstances, some painful procedures can be managed well without anaesthesia.

## Types of sedation and related states

### Systemic analgesia

Used alone, opioids are not usually sufficient for painful procedures but can be an important component. Beware of the synergistic effect of opiates and other sedation (Yaster et al, 1990; Pena and Krauss, 1999) – preparation for respiratory depression is essential (reversal agents

**Table 1. Techniques**

| The following techniques are arranged in ascending order of complexity (appropriate use of local anaesthesia is assumed): |
|---|
| Behavioural techniques |
| Systemic analgesia |
| Anxiolysis |
| Conscious sedation |
| Deep sedation |
| Dissociative sedation |
| Anaesthesia |

**Dr MRJ Sury** *is Consultant Paediatric Anaesthetist in the Department of Anaesthesia, Great Ormond Street Hospital for Children NHS Trust, London WC1N 3JH*

naloxone and flumazenil must be available). Nitrous oxide is a potent analgesic and does not cause anaesthesia in inspired concentrations less than 50% when used alone (Gall et al, 2001). Both morphine and nitrous oxide have weak sedative and euphoric effects.

### Anxiolysis

Low doses of benzodiazepines calm children without affecting conscious level (McCluskey and Meakin, 1994); this is helpful only if children are cooperative.

### Conscious sedation

Conscious sedation is a calm state combined with a reduction in consciousness to the level of maintaining a purposeful response to verbal stimulus (Royal College of Anaesthetists and Royal College of Radiologists, 1992; Academy of Medical Royal Colleges, 2001). In non-verbal children an equivalent physical stimulus may be used but judgment of what is appropriate will be difficult (Scottish Intercollegiate Guidelines Network, 2002). Conscious sedation is safe because airway and breathing is always maintained if a patient is easily roused.

Conscious sedation is usually impractical in uncooperative children (Scottish Intercollegiate Guidelines Network, 2002). First if the child is awake, he/she can object to the procedure. Second, if he/she is asleep, he/she could be roused by pain, and third, if the scan is painless, the depth of sedation is uncertain because it cannot be tested for fear of waking him/her.

### Deep sedation

Sedation is deep if the child can only be roused with difficulty (American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists, 2002). In this state appreciable airway and breathing effects are common and care should be equivalent to that of anaesthesia (Scottish Intercollegiate Guidelines Network, 2002).

### Dissociative sedation

Ketamine, in low doses, causes a unique unresponsive state in which eyes are open, vital reflexes are retained and there is effective analgesia. Higher doses cause anesthesia. The margin of safety may be wide enough for use by non-anaesthetists, although this is controversial in the UK (McGlone et al, 2004; Morton, 2004).

### Anaesthesia

This is an unrousable state in which vital reflexes are suppressed and both airway obstruction and respiratory depression are commonplace. Short-acting anaesthetics can induce anaesthesia and then, once a child is asleep, sub-anaesthetic doses can maintain a sleep state in which airway and breathing support is unnecessary; the child may be easily roused and recovery is rapid (Frankville et al, 1993). Such techniques have been published and described inaccurately as sedation (Seifert et al, 2000; Cravero and Blike, 2004). This is misleading because they involve a period of brief anaesthesia, and they are not safe enough for non-anaesthetists. However, they could be described as 'minimal' or 'light' anaesthesia as distinct from 'conventional' anaesthesia where airway and breathing support is essential (Vangerven et al, 1992; Sury et al, 2005).

## Management of common procedures

The following should help to choose a technique that is effective and appropriate to the procedure (see *Table 2* for painless procedures and *Table 3* for painful procedures). Greater detail is available in published reviews (Cote, 1994; Krausse and Green, 2000; Sury, 2004).

## Management of painless imaging

### Key points

- Small infants may sleep naturally after a feed
- Well children can be managed with either behavioural or sedation techniques
- Ill children need anaesthesia (see *Table 4*).

### Useful sedation techniques for painless procedures

#### Infants <5 kg

**Natural sleep:** Infants less than 6 months of age often sleep after food and if they are comfortable and warm (Sury et al, 1999).

**Table 2. Appropriate management of painless procedures**

| Procedure | Method of sedation |
|---|---|
| Transcutaneous echocardiography/ultrasound in infants | Occasional need for conscious sedation (calming) |
| Computed tomography scanning | Conscious sedation or sleep |
| Magnetic resonance imaging | Sleep (anaesthesia or sedation) |
| Radiotherapy | Sleep (anaesthesia or sedation) |
| Electroencephalography | Sleep (natural or melatonin) |
| Brainstem evoked responses | Sleep (anaesthesia or sedation) |
| Eye examinations | Sleep (anaesthesia or sedation) |





**Table 3. Appropriate management of painful procedures**

| Procedure | Method of sedation |
|---|---|
| Dental procedures | Nitrous oxide or anaesthesia |
| Venepuncture and venous access | Behavioural, nitrous oxide |
| Wound care, removal of sutures | Analgesia, nitrous oxide (conscious sedation for short procedures, anaesthesia for remainder) |
| Minor injuries (accident and emergency) | Ketamine or anaesthesia |
| Burns dressings | Opiate-based conscious sedation, ketamine or anaesthesia |
| Minor painful oncology procedures | Anaesthesia (nitrous oxide, conscious sedation for cooperative children) |
| Insertion of long-term venous access | Anaesthesia |
| Interventional radiology | Anaesthesia (occasional conscious sedation) |
| Renal and hepatic biopsy | Anaesthesia |
| Cardiac angiography | Anaesthesia |
| Oesophagogastroscopy and colonoscopy | Anaesthesia (occasional conscious sedation) |

#### Small children (<15 kg)

**Chloral hydrate or triclofos:** Small oral doses calm irritable small children and are suitable for echocardiography or computed tomography (CT) scanning (Napoli et al, 1996). Larger doses of chloral 50–100 mg/kg reliably cause sleep lasting 30–60 minutes in 95% of children; this is suitable for magnetic resonance (MR) imaging. Chloral has an unpleasant taste and is a gastric irritant – triclofos is better tolerated but has a slower onset. Several large series demonstrate that there are hazards of unpredictable and prolonged sedation.

**Benzodiazepines:** Midazolam is short acting and when administered by mouth, via the nose or per rectum, will calm children within a few minutes (Kupietzky and Houpt, 1993). Paradoxical reactions can occur, but may be reversed with flumazenil (Sanders, 2003).

#### Children >15 kg

It is difficult to sedate an uncooperative child of this size; behavioural problems are especially difficult. Play specialists give invaluable help (Pressdee et al, 1997).

**Benzodiazepines:** Benzodiazepines alone are insufficient for scans that need prolonged sleep. Temazepam combined with droperidol has a 70% success rate in children between 15 and 25 kg and the success rate can be increased to 95% with intravenous diazepam (Sury et al, 1999); the manufacture of droperidol has been reduced and it may soon not be available. Combinations of sedatives are potentially useful but data are not available to show whether they are safe enough. Dexmedetomidine combined with midazolam is a promising combination (Koroglu et al, 2005), but there are insufficient data yet to recommend its widespread use (Serlin, 2004).

**Barbiturates:** Pentobarbital, which is not available in the UK, is regarded as a safe intravenous sedative in North America; however, significant numbers of children have airway obstruction or paradoxical excitement reactions (Malviya et al, 2004). Quinalbarbitone, given orally, makes 90% of children (<5 years) sleep but older children have more paradoxical reactions (Simpson et al, 2000).

**Melatonin and natural sleep:** Up to 10 mg of melatonin by mouth has been used with limited success to make children sleep for imaging (success rate 50–65%; Johnson et al, 2002) and for electroencephalography (EEG) (Wassmer et al, 2001). However, 3 mg for children <15 kg and 6 mg for those weighing 15–40 kg does not improve the reliability of sedation for MR imaging (author's unpublished data). Tiredness caused by sleep deprivation may be helpful although evidence is conflicting.

**Table 4. Contraindications to sedation in children**

| 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 |

From Scottish Intercollegiate Guidelines Network (2002)

## Painful procedures

### Key points

- Only cooperative children can cope with local anaesthesia, behavioural techniques or conscious sedation
- Cooperation can be improved with careful preparation – reassurance and practise will gain trust and confidence
- Uncooperative children are best managed with anaesthesia
- Without anaesthesia services, sub-anaesthetic doses of ketamine may be the best option.

### Useful sedation techniques for painful procedures

#### Nitrous oxide

Up to 50% inspired concentration of nitrous oxide (equivalent to Entonox) can be used alone with little, if any, chance of causing an unrousable state (Gall et al, 2001). Nevertheless the child needs to be cooperative and to firmly apply the facemask to avoid air dilution. With care and patience, nitrous oxide is effective for many short painful procedures. In the UK, Entonox is available and administered via a demand valve. In France, a free flow apparatus makes delivery more practical in small children. Dentists are expert in using nitrous oxide via a nasal mask, and up to 90% of children can be managed for dental treatment in this way (Roberts, 1979); the technique is called relative analgesia or RA. There are specific contraindications to nitrous oxide (Scottish Intercollegiate Guidelines Network, 2002).

#### Opiates combined with benzodiazepines

This combination is helpful but its efficacy and safety are unpredictable. Care must be taken with titration because effective doses of opiates are often respiratory depressant. Usually, the length of action of the sedation is much longer than the procedure itself. For example, the common combination of midazolam and fentanyl is useful but does have an appreciable adverse reaction rate (5%) (Pena and Krauss, 1999). The adverse events include respiratory depression, paradoxical reaction and vomiting, and these effects are unpredictable but more common in small children.

### KEY POINTS

- Sedation techniques vary according to the procedure.
- Sedation can be difficult and is not always appropriate.
- Behavioural techniques and play specialists are valuable.
- Safe protocols and patient assessment are essential.
- Plan for staff, facilities and equipment.
- Anaesthesia and sedation services should be linked.
- 'Sedationists' need training.

#### Ketamine

Use of ketamine by non-anaesthetists is controversial in the UK. Intravenously 1–2 mg will quieten a child and facilitate a short minor procedure such as wound care. Laryngospasm or apnoea can occur but are almost always self-limiting or can be managed with basic airway skills (Green et al, 1998).

## Safety

No sedation technique has a perfect safety record and the following are essential measures that any organization must consider – there are published UK recommendations (Academy of Medical Royal Colleges, 2001; Scottish Intercollegiate Guidelines Network, 2002).

## Training

The safety (and success) of any sedation service is dependent upon the skills and judgment of the staff. At present, there is no UK accreditation in paediatric sedation.

There are resuscitation courses, and skills can be learnt. The recognition of the sick child is vital and courses for the medical assessment of children will be helpful. Local training should train staff to follow safe protocols.

## Protocols

Features of a safe protocol include:

- Dose limitation. This is important to avoid accidental anaesthesia – acceptance that sedation occasionally fails is vital
- Recognition that sedation is unsafe in some children (see contraindications)
- Assessment and preparation of children (fasting before sedation is recommended to prevent pulmonary aspiration)
- Criteria for recovery and discharge.

## Governance

Teams should deliver sedation; leadership and responsibility should be explicit. Anaesthetists may not be able to deliver sedation services but they can help with development of safe and effective protocols – and with training.

## Equipment and facilities

Resuscitation and monitoring equipment are essential. All sedated children should at least have pulse oximeter monitoring. Capnography is useful for deep sedation. Planning facilities will improve both safety and efficiency. MR requires special planning and equipment.

## Contraindications to sedation

Contraindications published by the Scottish Intercollegiate Guidelines Network (2002) are listed in *Table 4*. Common contraindications appropriate to sedation for painless imaging are also published (Sury et al, 1999).





## Conclusions

High quality paediatric services need to plan and control the use of sedation for procedures. Delivery of effective safe sedation depends mainly upon trained and experienced people who recognize the appropriateness and limitations of their practice. BJHM

*Conflict of interest: none.*


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

American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists (2002) Practice guidelines for sedation and analgesia by non-anesthesiologists. *Anesthesiology* **96**(4): 1004–17

Armstrong TS, Aitken HL (2000) The developing role of play preparation in paediatric anaesthesia [editorial]. *Paed Anaesth* **10**(1): 1–4

Cote CJ (1994) Sedation for the pediatric patient. A review. *Ped Clin N Am* **41**(1): 31–58

Cravero JP, Blike GT (2004) Review of pediatric sedation. *Anesth Analg* **99**(5): 1355–64

Frankville DD, Spear, RM, Dyck JB (1993) The dose of propofol required to prevent children from moving during magnetic resonance imaging. *Anesthesiology* **79:** 953–8

Gall O, Annequin D, Benoit G, Glabeke E, Vrancea F, Murat I (2001) Adverse events of premixed nitrous oxide and oxygen for procedural sedation in children. *Lancet* **358**(9292): 1514–15

Green SM, Rothrock SG, Lynch EL et al (1998) Intramuscular ketamine for pediatric sedation in the emergency department: safety profile in 1022 cases. *Ann Emerg Med* **31:** 688–97

Johnson K, Page A, Williams H, Wassemer E, Whitehouse W (2002) The use of melatonin as an alternative to sedation in uncooperative children undergoing an MRI examination. *Clin Radiol* **57**(6): 502–6

Koroglu A, Demirbilek S, Teksan H, Sagir O, But A, Ersoy MO (2005) The sedative, haemodynamic, and respiratory effects of dexmedetomidine in children undergoing magnetic resonance imaging examination: Preliminary results. *Br J Anaesth* **94:** 821–4

Krauss B, Green SM (2000) Sedation and analgesia for procedures in children. *N Engl J Med* **342**(13): 938–45

Kupietzky A, Houpt MI (1993) Midazolam: a review of its use for conscious sedation of children. *Pediatr Dent* **15:** 237–41

Malviya S, Voepel-Lewis T, Tait AR, Reynolds PI, Gujar SK, Gebarski SS, Petter EO (2004) Pentobarbital vs chloral hydrate for sedation of children undergoing MRI: efficacy and recovery characteristics. *Paediatr Anaesth* **14**(7): 589–95

McCluskey A, Meakin GH (1994) Oral administration of midazolam as a premedicant for paediatric day-case anaesthesia. *Anaesthesia* **49:** 782–5

McGlone RG, Howes MC, Joshi M (2004) The Lancaster experience of 2.0 to 2.5 mg/kg intramuscular ketamine for paediatric sedation: 501 cases and analysis. *Emerg Med J* **21**(3): 290–5

Morton NS (2004) Ketamine is not a safe, effective, and appropriate technique for emergency department paediatric procedural sedation. *Emerg Med J* **21**(3): 272–3

Napoli KL, Ingall CG, Martin GR (1996) Safety and efficacy of chloral hydrate sedation in children undergoing echocardiography. *J Pediatr* **129:** 287–91

Pena BM, Krauss B (1999) Adverse events of procedural sedation and analgesia in a pediatric emergency department. *Ann Emerg Med* **34**(4 Pt 1): 483–91

Pressdee D, May L, Eastman E, Grier D (1997) The use of play therapy in the preparation of children undergoing MR imaging. *Clin Radiol* **52**(12): 945–7

Roberts GJ (1979) Relative analgesia: an introduction. *Dent Update* **6:** 271–84

Royal College of Anaesthetists and Royal College of Radiologists (1992) *Sedation and Anaesthesia in Radiology.* Report of a joint working party. Royal College of Anaesthetists and Royal College of Radiologists, London

Sanders JC (2003) Flumazenil reverses a paradoxical reaction to intravenous midazolam in a child with uneventful prior exposure to midazolam. *Paediatr Anaesth* **13**(4): 369–70

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

Seifert H, Schmitt TH, Gultekin T, Caspary WF, Wehrmann T (2000) Sedation with propofol plus midazolam versus propofol alone for interventional endoscopic procedures: a prospective, randomized study. *Aliment Pharmacol Ther* **14**(9): 1207–14

Serlin S (2004) Dexmedetomidine in pediatrics: controlled studies needed.[see comment]. *Paediatr Anaesth* **14**(6): 532

Simpson JH, West CD, Law PJ (2000) Paediatric sedation for CT scanning: the safety and efficacy of quinalbarbitone in a district general hospital setting. *Br J Radiol* **73**(865): 7–9

Sury MRJ (2004) Paediatric sedation. *Continuing Education in Anaesthesia, Critical Care and Pain* **4**(4): 118–22

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

Sury MR, Harker H, Begent J, Chong WK (2005) The management of infants and children for painless imaging. *Clin Radiol* **60**(7): 731–41

Vangerven M, Van Hemelrijck J, Wouters P, Vandermeersch E, Van Aken H (1992) Light anaesthesia with propofol for paediatric MRI. *Anaesthesia* **47:** 706–7

Wassmer E, Fogarty M, Page A, Johnson K, Quin E, Seri S, Whitehouse W (2001) Melatonin as a sedation substitute for diagnostic procedures: MRI and EEG. *Develop Med Child Neurol* **43**(2): 136

Yaster M, Nichols DG, Deshpande JK, Wetzel RC (1990) Midazolam-fentanyl intravenous sedation in children: case report of respiratory arrest. *Pediatrics* **86:** 463–7