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FULL PAPER

Paediatric sedation for imaging is safe and effective in a district general hospital

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Objective: To devise a safe and effective sedation protocol for imaging paediatric patients in a small district general hospital (DGH).
Methods: Chloral hydrate, alimemazine and learned best practice were used for imaging 105 children between January 2013 and May 2015. We retrospectively reviewed case notes for this time period to establish rates of successful sedation and adverse events.
Results: Scanning was successful in 100/105 (95%) children. No serious adverse events were reported. Non-serious adverse events occurred in eight cases. 12 patients were discharged more than 4 h after scanning owing to prolonged sedation.
Conclusion: This is a safe and effective protocol for delivering sedation for imaging in paediatric patients. We would encourage similar centres to adopt this protocol where resources for i.v. sedation and general anaesthesia are limited.
Advances in knowledge: There are many different sedation protocols in the literature for imaging in paediatric patients, with varying levels of success and adverse event rates. We present here a protocol that offers a high efficacy and safe sedation for imaging in a DGH.

INTRODUCTION

To acquire useful data from imaging, it is important for the patient to lie still during the scanning procedure. Children can find it difficult to keep still for the time taken to acquire a scan. For CT, the child needs to lie still for 10–15 min.[1] With MR and nuclear medicine (NM) scans, the time taken is longer, typically between 30 and 60 min.[2,3] There are a number of methods which can be employed to limit the movement of the child during a scan.

Methods to reduce movement during imaging can be loosely classified into (1) non-pharmacological, (2) sedative and (3) general anaesthesia (GA). Non-pharmacological interventions include behavioural and cognitive approaches, such as desensitization, distraction and relaxation. These are complementary to pharmacological interventions and, in some children, may prevent the need for sedation/GA altogether.[4,5] In young children, particularly in those with behavioural difficulties, it can be difficult for them to keep still for the length of the time required. In these children, sedation and GA need to be considered. GA provides a high success rate for image acquisition. However, it must be undertaken by specialist paediatric anaesthetists, and in the case of MR, using equipment that is safe in the strong magnetic field.[6,7] Sedation provides a useful alternative to keep the child still for the duration of image acquisition, although there is no consensus in the paediatric community as to which pharmacological agent is best in this setting.

Sedation is a medically controlled state of depressed consciousness or unconsciousness. The level of sedation can be categorized as per the American Society of Anesthesiologists.[8] These levels include (1) minimal sedation (anxiolysis), (2) moderate sedation/analgesia (conscious sedation), (3) deep sedation/analgesia and (4) GA. With each level of sedation, there is a decrease in the child's response, airway protection and an increasing need for cardiovascular support. The important distinction between these states revolves around the child's ability to maintain protective reflexes.[9] Successful sedation is generally considered to be achieved when the child is kept still long enough to acquire the necessary data.[1,10] Best practice should be used with sedation to reduce the likelihood of adverse events and to minimize their effect should they happen.

Sedation is given by two main routes: i.v. and oral. Other routes include per rectum, nasal and inhalation.[11] Adverse event rates are evenly distributed across the different sedative agents and routes.[12] Adverse events are usually minor and mainly comprise airway difficulties owing to a reduced conscious level.[12] Prolonged sedation and vomiting have also been reported.[12] If appropriately managed, lasting

adverse effects can be easily minimized.[13] Severe adverse events, such as severe respiratory depression and death, are rare.[12]

There are many i.v. sedative agents available for paediatric imaging including etomidate, propofol, dexmedetomidine and midazolam.[12,14] Adverse event rates have been described ranging from 2% of children receiving etomidate or propofol sedation to 7% of children receiving midazolam. These events have primarily consisted of transient oxygen desaturation and, less commonly, apnoea.[15–17] I.v. sedation, like GA, can be resource intensive.[18,19]

Oral agents used for sedation in imaging include chloral hydrate, alimemazine (trimeprazine) and melatonin.[20,21] The success rates of these different agents have been reported as between 50% and 100%.[22,23] Chloral hydrate has been widely used since its introduction by Liebreich in 1869.[24] There are many articles on the use of chloral hydrate as a sedative agent in paediatric patients for imaging, and it has been successfully given with other sedative agents.[12,15,25] The reported success rates vary considerably, as also seen with other sedative agents.[12] The most commonly reported adverse event for chloral hydrate is hypoxia, with an incidence rate of 3.0–5.1%.[12] Vomiting is the second most common event, with a rate of 2.9%.[12] The active metabolite of chloral hydrate, trichloroethanol, has a maximum concentration at around 40 min.[26,27] This metabolite has been shown to have a half-life of 9.7 h in toddlers.[28]

There are several articles covering the use of alimemazine as a sedative agent in paediatrics, but few in relation to imaging.[29–31] Two groups have reported a success rate of 85% for imaging acquisition when alimemazine was combined with either chloral hydrate or papaveretum (a mixture of opioids).[12,32] The pharmacokinetics of alimemazine are well studied, showing a maximal venous blood drug concentration 1–2 h after ingestion and with a half-life of 6.8 h.[33] A survey of parents showed a median time of "return to normality" of the child of 21.5 h when chloral hydrate and alimemazine were used together.[20]

Our hospital is a small district general hospital (DGH), with approximately 300 scans (CT, MR and NM) being performed on paediatric patients each year. Around 50 of these scans need to be carried out under sedation or GA. Provision of dedicated anaesthetic lists for imaging these children was deemed not to be possible without recruiting new staff. Also, owing to financial restrictions, we were not able to provide MR-safe equipment for GA. Our group sought to devise a sedation protocol that could be used safely and effectively for paediatric imaging (CT, MR and NM), given the above restrictions. We report here the results, in terms of successful sedation for imaging and adverse events, for the first 105 children undergoing this new sedation protocol.

METHODS AND MATERIALS

In 2012, after a local clinical governance meeting, which included anaesthetists and paediatricians, we devised a local protocol for paediatric sedation for imaging purposes. This protocol was a "learned best practice" from a centre of excellence, Great Ormond Street Hospital (GOSH), London, UK, and was adopted following a visit by our team to this unit. A paediatric consultant (AS) and an advanced nurse practitioner (ANP; GD) visited the MR day unit at GOSH. They went on a patient journey from arrival, through sedation and then discharge. After consultation with the lead GOSH consultant anaesthetist and sedation nurse specialist, the GOSH protocol was tailored to our local situation.

The protocol is outlined in Table 1.

At the pre-sedation assessment clinic, the designated paediatric consultant for sedation evaluated the child's medical condition, fitness for sedation and ability to lie still for the duration of the scan (Appendix A). Those deemed able to lie still with help were provided with play therapy including parent involvement. Those with contraindications to sedation were referred to the local tertiary centre for GA. Informed consent was obtained from parents of the children who were eligible for sedation. Written advice on fasting and sleep deprivation (where appropriate) prior to sedation was provided. A patient-specific sedation plan was then written, based on the weight of the child.

Chloral hydrate as a single agent was used for children <15 kg, which is in agreement with the National Institute for Health and Care Excellence guidelines.[28] A combination of alimemazine and chloral hydrate was used for those >15 kg. For those between 12 and 15 kg, either one or two agents were employed, based on how "active" or "energetic" the child was. The sedation consultant and the parents jointly decided if dual sedation in this weight group would be required.[34] In children >12 kg and with learning difficulties, autism or attention deficit hyperactivity disorder, the higher end of the dosage range of alimemazine was used (up to 2 mg kg^{-1}). Again, this decision was made jointly with parents at the pre-assessment clinic. The dosings and timings of both chloral hydrate and alimemazine (as its tartrate salt) were in keeping with that described in the British National Formulary (BNF).[35]

Sedation was administered by an advanced life support-trained nurse, usually an ANP. All dosages of medication were double-checked by the nursing staff (as per standard procedure). Alimemazine was given earlier (1.5–2 h before imaging) than chloral hydrate (45–60 min); this was for two reasons. Firstly, chloral hydrate has an unpleasant taste, and this is less of an issue, if given after initial sedation with alimemazine. Secondly, these timings correlated with the maximum venous concentrations of trichloroethanol (chloral hydrate's active metabolite) and alimemazine.

Oxygen saturations and vital signs were monitored regularly after sedative administration and until the child was back to baseline. Portable resuscitation equipment was always kept at hand while the child was being scanned.

In our study, children were discharged to the parents' care only when their observations were back to baseline. In addition, they had close adult supervision after discharge for the first 24 h. We gave parents clear safety instructions to follow during this period. Failed sedations were considered for either resedation on a separate day or for GA.

CT scans were performed on one of two General Electric Optimas (64-slice scanners; GE Healthcare, Milwaukee, WI), and MR scans

Table 1. Current in-house sedation protocol

Pre-sedation • Outpatient assessment by senior paediatrician of fitness for sedation, along with counselling of parents. Written consent taken and a procedure-specific leaflet provided • Appointment of an ANP, with either APLS or EPLS training, to oversee the sedation at all times • Necessary resuscitation equipment always readily at hand • Mild sleep deprivation (1 h late to bed and 1 h up early) • Optimal preparation by fasting using the "4, 4, 2 rule" • Clear documentation (using a documentation pack containing: consent form, in-house sedation *pro forma*, as well as drug and PEWS charts) Sedation • Child in own pyjamas (no metallic poppers) • Observations every 15 min (continuous in the scanning room)	
Infants <5 kg	No sedation required, solely feed and swaddle
Children 5–15 kg	Chloral hydrate 100 mg kg^{-1} (max. 2 g) PO/PR 45–60 min before imaging
Children 12–40 kg	Chloral hydrate 100 mg kg^{-1} (max. 2 g) PO/PR 45–60 min and alimemazine 1–2 mg kg^{-1} (max. 60 mg) PO 1.5–2 h before imaging
• No additional sedative agents to be given if the above regime does not work • Use of ear plugs (cut in half, placed before transfer from ward to radiology department), as well as warming and light dimming of scanning room. Scanning table at operational height before child arrives • A clear escalation plan to involve the lead consultant paediatrician if observations fall outside of predetermined ranges Imaging • Single sedation: ANP to be present throughout the scanning procedure • Double sedation: ANP and senior paediatrician to be present throughout the scan • Continual monitoring of oxygen saturation and heart rate. If there are concerns for the child's wellbeing, the scanning process is stopped and necessary interventions made Post imaging • One-to-one nursing on return to ward, with 15-min observations until child is awake • Discharge home only when fully conscious and ambulant. Open access to the ward provided for 24 h. Parents given advice for the safe management of child at home	

4,4,2 rule, no solids, formula milk or juice 4 h before the procedure, and no clear fluids or breast milk 2 h before; ANP, advanced nurse practitioner; APLS, advanced paediatric life support; EPLS, European paediatric life support; max., maximum; PEWS, paediatric early warning score; PO, orally; PR, per rectum.

were performed on either a Siemens Aera or Symphony Tim® (both 1.5 T; Siemens Healthcare, Erlangen, Germany). Pulse oximetry was carried out with MR-safe TeslaONE® (Mammendorfer Institute für Physic und Medizin, Mammendorf, Germany). A scan of good quality not degraded by movement artefacts and which could be used to answer the original clinical question was used as a surrogate marker of successful sedation.

We have established local governance stating that nurses involved in sedation are required to achieve competencies in this area. Competencies are monitored by the local paediatric practice development nurse. This is a learned best practice from GOSH. These competencies are ratified in departmental clinical governance meetings and checked at annual nursing appraisals. Competencies include knowledge and understanding of sedative pharmacology, applied physiology, assessment of a child admitted for sedation, recovery complications and management, as well as paediatric life support certification. Competencies in effectively delivering the chosen sedative agent, preparing the child prior to sedation and using monitoring equipment are also assessed.

We undertook a retrospective cohort study of all patients under the age of 16 years who underwent sedation for CT, MR or NM imaging between January 2013 and May 2015. We reviewed rates of correct sedation prescription, sedation success (determined by the final imaging report), adverse events, scanning results, completion of all paperwork (consent form, sedation *pro forma*, observation and drug charts) and prolonged stay (stay over 4 h post imaging).

RESULTS

105 children were sedated for imaging during the study period. Of these, 98 children had MRI, 5 had CT and 2 had renography. A breakdown of the body parts scanned is given in Table 2. The median age was 2 years and 11 months (range 5 months–10 years and 11 months), with a median weight of 12.4 kg (range 5.1–35.9 kg). 63 children had single sedation and 42

had double sedation. We did not need to give chloral hydrate *via* the per rectum route. Using the criteria for choice of single or double sedation, all but one were given the correct combination of sedative agents. One of the patients, who was 17.1 kg, should have received dual sedation according to our new protocol, but was given only a single agent. However, imaging in this case was still successful. All patients had the correct sedative dosage prescribed for their weight, allowing for a 10% variance between the calculated and prescribed dose. The maximum dose of alimemazine (2 mg kg^{-1}) was rarely used, and most dosages were at the lower end of the drug's prescription range (1 mg kg^{-1}).

Out of the 105 patients who were sedated, 100 had a successful scan (95%). Of the five failed sedations, one child vomited the sedative agent, one was not adequately induced and three woke up in the scanning room. Four of the failed sedations were referred to the local tertiary centre for GA. The other patient was successfully resedated and scanned at a later date. No major adverse events were noted. Non-serious adverse events occurred in eight cases (Table 3). 12 patients had an admission lasting more than 4 h after imaging owing to prolonged sedation. For those with a prolonged admission, the median stay was 5 h and 36 min (range 4 h and 18 min to 33 h and 30 min). Prolonged sedation did not correlate with the patient receiving single or double sedation (seven double, five single).

The imaging results were reported as pathological in 31 out of 100 cases. All paperwork was fully complete in 96 of 105 cases. The drug chart was correctly completed in all 105 cases.

DISCUSSION

Through using a combination of sedative agents, along with learned best practice, we have developed a sedation service for paediatric imaging, suitable for a DGH, with a 95% success rate. This has shown a low rate (8%) of non-serious adverse events and no serious events. This is in spite of being limited in our trust to only enteral sedation owing to financial restrictions and advanced staff competencies. Our strategy utilizes alimemazine, a new drug in the arsenal for paediatric sedation, described in neither the National Institute for Health and Care Excellence nor the Royal College of Radiologists guidance.[28,36]

Table 2. Body parts scanned

Body part	Number
Head	74
Spine	10
Head and IAM	9
Head and spine	4
Pelvis and hips	3
Cranial–facial	2
Renogram	2
Head and abdomen	1
Total	105

IAM, internal acoustic meatus.

At our centre, non-serious adverse events were quickly recognized and managed through utilizing appropriately trained staff. 11% of patients needed to stay in the hospital for more than 4 h after their scan owing to prolonged sedation. These patients were discharged home only when they were back to baseline and it was safe to do so.

The choice of sedative is only part of the story: both the success rate and the safety of paediatric sedation hinge on "best practice".[2,28,37] Currently, there is no consensus on the optimum sedation practice for use in imaging.[38] Good practice should include but is not limited to: adequate pre-assessment, written consent, appropriate fasting, sleep deprivation, use of trained staff during sedation, understanding the pharmacokinetics and dynamics of prescribed sedative agents, availability of emergency equipment, frequent observations and appropriate discharge.[12,37,39] Adverse event rates have been shown to be increased by inadequate pre-assessment, monitoring and resuscitation, administration of three or more sedative agents, incorrect dosing and sedation outside of the hospital setting.[12,37] We found it beneficial to screen children referred for imaging at a pre-sedation assessment clinic, to appropriately select patients for sedation, and to identify those more appropriate for GA. Our practice indicates that sedation is seldom required in children over the age of 6 years. Older children usually settle with careful preparation, relaxation and play therapy. Safety is optimized by having appropriately trained nursing personnel, an agreed sedation plan with parents, frequent monitoring and safe discharge. Having established competencies for nurses involved in sedation and undertaking annual audits are vital in terms of quality improvement.

As previously mentioned, audit of sedation at our trust was undertaken retrospectively. There are obvious weaknesses in this method of data collection. Taking this project forward, we will undertake a prospective audit, utilizing data-collection methods that reduce reporting bias. For example, success of sedation could be judged by combining data from both radiographers and the sedation team. The former could be based on whether the scan was successfully achieved and the latter on a sedation score, such as the Minnesota Sedation Assessment Tool or Ramsey Scale.[40,41] Imaging could be objectively assessed by using an agreed scale (*e.g.* scale of 1–5, 1 = uninterpretable, 2 = poor quality, 3 = considerable ambiguity, 4 = good quality and 5 = perfect) and data interpreted by someone not involved in the sedation process. The study period should be extended to incorporate more subjects to make adverse events from sedation (which are uncommon) more statistically meaningful.

Finally, in the age of austerity, there is an economic argument for the proposed strategy of sedation using oral agents *vs* GA. From an internal cost analysis by our finance team, the estimated cost of imaging using oral sedation is £462 per patient, as opposed to £770 under GA. Hence, the actual financial cost of using oral sedation *vs* GA is almost half.

CONCLUSION

At present, there is no consensus among paediatricians, radiologists and anaesthetists as to the best sedation agent and protocol for paediatric imaging. This is due to the vast

Table 3. Adverse events. Both patients who desaturated required only a brief period of jaw thrust to help return their saturations to normal

Adverse event	Sedation type	Scanning successful?
Vomited after taking medication	Single	No
Vomited and pyrexia after scanning	Single	Yes
Became distressed and vomited	Single	Yes
Vomited after eating	Single	Yes
Drop of saturations to 85% and small vomitus	Single	Yes
Tachycardia	Single	Yes
Drop of saturations to 89%	Single	Yes
Thrashing and flailing after imaging	Double	Yes

amount of sedatives available, with agent choice being dependent on previous experience, cost and available resources. A national protocol would be beneficial, which states specific sedative agents and reinforces "best practice". This would counter the lower sedation rates seen with some agents and minimize risk. However, a national protocol would require a multidisciplinary team to research and decide upon the best sedative agent or agents, as well as best practice. The final decision would also need to take into account restrictions imposed by some trusts owing to availability of paediatric and anaesthetic services. Clearly, costs should be considered as well.

At our local trust, we have developed a successful and safe sedation service for imaging paediatric patients in a DGH, based on a protocol used in a centre of excellence. Our centre combines best practice with select oral sedation agents in a clear protocol, with a service which costs just over half of that for GA. With our high success rates and low number of adverse reactions, we would like to put our protocol forward as a candidate for a nationwide protocol. We acknowledge that further audit is required. However, our service has been welcomed by paediatricians, radiologists, radiographers and anaesthetists alike. Going forward, we will be collaborating with other DGHs and undertake a larger prospective study. We will also investigate further the cost–benefit of the sedation service *vs* GA, including costs associated with resedation following failed procedures.

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APPENDIX A

SEDATION GUIDELINE FOR CHILDREN UNDERGOING MRI/CT/NUCLEAR MEDICINE

Date:

Referring clinician:

Part of body being scanned matches request:

Main diagnosis(es):

Pre-admission information

	YES	NO
Has your child/family member ever experienced any problems with an anaesthetic? Give details:		
Is your child taking any regular medication (in the last year)? Please list		
Any known drug allergies? Or food intolerances? Please specify		
Does your child have any breathing problems? Respiratory failure ☐ Asthma ☐ Recurrent coughs/colds/chest infections ☐ Croup ☐ Pneumonia ☐ TB ☐		
Any heart problems? Congenital abnormalities ☐ Surgically corrected yes☐ no☐ Hypertension ☐ Murmur ☐ Other ☐		
Was your child born prematurely? Lung problems ☐ Ventilated ☐ For how many weeks		
Any kidney problems? Transplant ☐ Renal failure ☐ Recurrent UTI ☐		
Any history of raised ICP? Drowsy ☐ Lethargic ☐ Headaches ☐		
Seizures? Epilepsy ☐ Febrile seizures ☐ Other ☐		
Any neurological or neuromuscular disorders? Developmental delay ☐ Major behavioural problems ☐ Communication problems ☐ Impaired swallow/cough ☐ Other ☐		
Any underlying metabolic or liver disorders? Details		
Gastroenterology problems? Reflux ☐		

(Continued)

(Continued)

	YES	NO
Constipation □ PEG feeds □ Other □		
Any blood disorders? Bleeding problems □ Anaemia □ Diabetes □ Sickle cell/thalassaemia □		
Any further significant details?		
Is the child suitable for sedation? If no, state reason		

Pre-admission explanation

	YES	NO
Sedation procedure		
Potential side effects of sedation		
Chances of success/failure with sedation		
Explained fasting times[42] Solids 4 hrs prior to sedation Formula milk, juice 4 hrs prior to sedation Clear fluids/breast milk 2 hrs prior to sedation		
Sleep deprivation needed?		
Parents to inform if child develops a cough/cold		
Avoid distractions—like other children, games		

Pre-admission preparation

	YES	NO
Weight		
Pre-visit needed?		
Consent taken?		
Safety check?		
Prescribed sedation?		

Signed:

Medications for painless procedures lasting >20 min[42]

Infants <5 kg	Nil sedation, feed and wrap
Children 5–15 kg[42]	Chloral Hydrate 100 mg kg^{-1} PO/ PR (max 2 g) 45–60 min prior to the procedure. Oral route preferred over rectal route, although both permitted.
Children 12–40 kg	Chloral Hydrate 100 mg kg^{-1} P^{-1}O/PR (max 2g) + Alimemazine 1–2 mg kg^{-1} (max 60 mg)[43]—to be given 1.5–2 hours prior to the procedure.
Notes: If the child vomits, a repeat dose should not be given. No top-up doses or i.v. sedation to be given. Please ensure this sedation sheet is attached to the patient's notes. Parents must accompany child to scan to identify patient. Follow nursing care plan. Vital observations to be recorded on PEWS chart every 15 min. The accompanying nurse and/or doctor must remain with the child always, including in the scanner.	

Post-sedation

Successful	Yes	No
If unsuccessful, state reason		

Post-procedure

1. If unsuccessful, please document reason. Discuss with the consultant on duty. A second attempt may be decided for another date, or referral to Addenbrooke's Hospital for undertaking the procedure under general anaesthesia.
2. If successful, please inform referring consultant.
3. Monitor and record observations every 15 minutes.
4. The child should remain for at least 2 hours post-sedation until alert, able to tolerate oral fluids and vital signs returned to normal prior to discharge.
5. Provide ward contact details on discharge.

ICP, intracranial pressure; PEG, percutaneous endoscopic gastrostomy; PEWS, paediatric early warning score; TB, tuberculosis.

Paediatric sedation policy

The primary aim of procedural sedation is to provide anxiolysis, analgesia and control of movement during painful or unpleasant procedures.

This policy is meant for children being electively admitted to the F1 ward needing minimal to moderate sedation only. It aims to optimize safety and prevent common adverse events during sedation.

The adverse events during sedation in children can occur owing to a variety of reasons, such as drug overdose, inadequate monitoring, drug errors, inadequate skills of the personnel administering drugs and premature discharge. In total, 80% of the complications during sedation and analgesia are secondary to adverse airway/respiratory events.[13] Up to 9% of children will have agitation secondary to sedation, but serious adverse events in this group is rare.[9] Two large database studies from the Paediatric Sedation Research Consortium, published in 2006, evaluated adverse events among 30,000 sedation encounters for procedures outside the operating room. They reported that there was no incidence of death, one cardiac arrest and one aspiration episode. 1 in every 200 sedations required airway and ventilation interventions, such as bag–mask ventilation, oral airway placement or emergency intubation.[13]

The failure rate to achieve goals of anxiolysis, analgesia and control of excessive movement has been reported to be from as infrequent as 1–3% to as frequent as 10–20%.[13]

Sedation is a medically controlled state of depressed consciousness or unconsciousness. The levels of sedation are based on those of the American Society of Anesthesiologists (ASA). In order of increasing levels of sedation, the levels are: minimal sedation (anxiolysis), moderate sedation/analgesia (conscious sedation), deep sedation/analgesia and general anaesthesia. With each increasing level, there is a decrease in the child's response, airway protection and an increasing need for cardiovascular support. The important distinction between these states revolves around the ability to maintain their protective reflexes.[9]

EVALUATION/ASSESSMENT

Contraindications to sedation[44,45]

- Abnormal airway including adenotonsillar hypertrophy causing obstruction to breathing when asleep (obstructive sleep apnoea or OSA) or any other anatomical abnormality of the upper or 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.

Extra caution should be exercised when sedating children who have any of the following conditions[45]

- 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 can potentiate and prolong the sedative effects of midazolam).

MANAGEMENT

- If sedation is felt to be necessary to keep the child still, the child will be seen at a pre-assessment clinic. Sedation consultant and a play specialist will meet the family in clinic.
- The play specialist will ensure that the child or young person is prepared psychologically for sedation by offering information about the procedure, what the child or young person should do and what the healthcare professional will do, the sensations associated with the procedure and how to cope with the

procedure. Ideally, this preparation will have already taken place 5–7 days before the elected date of the procedure.[42]
- The consultant on duty should be informed that a child is being sedated in the ward environment.
- The person responsible for assessing the child (doctor) must ensure fitness for sedation, take consent and prescribe sedation. They should have a thorough understanding of the pharmacokinetics and pharmacodynamics of the drugs prescribed.[42]
- Informed consent for the procedure and sedation should be obtained on the trust consent form as per trust policy. This should include a thorough explanation of the procedure, risks, and the plan of care in hospital and after discharge.
- Take a detailed history and examine the child on the form provided above. This must be attached to the case notes and accompany the child to the procedure.
- Ensure that the child is fasted as per guideline. Fasting is not needed for moderate sedation during which the child or young person will maintain verbal contact with the healthcare professional.[1] For urgent procedures, shorter periods of fasting must be considered on a case-by-case basis by the consultant on duty.
- Ensure that there is a systematic setup for the sedation. 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, tracheal tubes, stylets, face mask, bag-valve mask or equivalent device)
  - **P Pharmacy**, all the basic drugs needed to support life during an emergency, including antagonists as indicated
  - **M Monitors**, pulse oximeter (MR compatible) with size-appropriate oximeter probes and other monitors as appropriate for the procedure (*e.g.* non-invasive blood pressure, electrocardiogram and stethoscope)
  - **E Equipment**, special equipment or drugs for a particular case (*e.g.* defibrillator).

- Administer the sedation as per the guideline. Recommended doses (see children's BNF) must not be exceeded and 'second' doses must not be given. Please also refer to the section on 'drugs used for sedation' (see below).
- Suitably trained individuals must monitor children until they are ready for discharge and not just until the end of the procedure. Staff accompanying the child to the scanner or procedure must have paediatric life support skills and be able to recognize the early symptoms of possible complications of sedation. Parents must accompany the child to the scanner whenever possible.
- Monitor the child's condition continuously and record observations before, during and after the procedure on a PEWS chart.
- The child should have continuous oxygen saturation monitoring (MR compatible where necessary) until full recovery.[13]
- The consultant on duty must be informed if:
  - the oxygen saturation falls below 93%
  - there is tachycardia or bradycardia
  - sedation score responding to pain or unresponsive on the alert-voice-pain-unresponsive (AVPU) scale.
- Do not feed the child till fully awake. Introduce clear fluids and then progress to solids when tolerating fluids well. Children should be discharged only when the vital signs have returned to the baseline, moving around as normal and able to tolerate oral fluids.
- Families should be given post-sedation instructions and telephone numbers to contact if they have questions or emergencies.

DRUGS USED FOR SEDATION

Choral Hydrate

Potential side effects include:
- Unpleasant taste
- Respiratory complications, vomiting and paradoxical reactions
- Deaths have occurred in unattended children.

Notes from the National Institute for Health and Care Excellence guideline[42]

Chloral hydrate is an oral drug and unfortunately causes nausea and vomiting when large volumes of the drug are used. Chloral hydrate is therefore likely to be less successful in larger children (>15 kg). More than 1 g of chloral hydrate may be vomited and hence be unsuccessful. This may explain why choral hydrate is thought to be more effective in smaller children. The guideline development group concluded that uncooperative children needed to be asleep for imaging and that high doses of chloral hydrate were successful in approximately 90% of children under 15kg.

Alimemazine (trimeprazine)

Potential side effects include
- Dry mouth
- Constipation
- Urinary retention
- Blurred vision.

AUDIT

(1) Complications
(2) Critical incidents
(3) Failure rates.

TRAINING

Nursing and medical staff involved in sedation should have:
(1) Undertaken either European or advanced paediatric life support training
(2) Read and understood the paediatric sedation policy
(3) Record of practical experience of sedation techniques, including details of:
  (a) Sedation in children and young people performed under supervision
  (b) Successful completion of work-based assessments.

PARENT INFORMATION

Always go through the leaflet with the family when handing it out.
- Royal College of anaesthetists. Sedation for children leaflet series http://www.rcoa.ac.uk/index.asp?PageID=1436
- Royal Children's Hospital, Melbourne. http://www.rch.org.au/kidsinfo/handout/index.php?doc_id=11362, http://www.rch.org.au/kidsinfo/factsheets.cfm?doc_id=8627