Review Article

Sedation during Imaging in Children: A Narrative Review

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ABSTRACT

Radiographic imaging, along with clinical signs and symptoms, go hand in hand to arrive at a diagnosis and formulate a proper treatment plan. These imaging techniques require the child to stay in one position, for a variable duration of time. The last two decades have, thus, seen an increase in procedures involving the use of sedatives in pediatric radiology. The use of sedatives ensures that the child complies throughout the procedure until the necessary data is collected. There are numerous classes of drugs used as sedatives in children, having their set of advantages and adverse effects. The need to follow a systematic protocol, proper monitoring and assessment, and selecting the drug after ruling out contraindications becomes manifold around children. This review hence, attempts to highlight the various sedative drugs in use, their adverse effects, protocols in place, and problems associated with the imaging modalities and sedative drugs in pediatric radiology.

Key words: Sedation, Sedatives, Pediatric Imaging, Magnetic Resonance Imaging, Computed Tomography

Pediatric imaging as a technology is expanding its horizons by the day with advancements like three-dimensional tomography, functional magnetic resonance imaging (MRI), and interventional radiology applications [1-3]. As a result, the need for sedation continues to increase, as high as 60%, as reported by the Pediatric Sedation Research Consortium [4]. Therefore, it becomes essential for sedation providers to be familiar with radiological advancements so they may be able to adapt to the technology to help facilitate smooth and effective data collection.

The physiologic effects of sedatives are described through the terms “sedation”, “conscious sedation” and “deep sedation”. These terms may be misleading as they incorrectly imply that sedation is a static process. On one hand ‘conscious sedation’ is a pharmacologically induced state of depressed consciousness wherein a patient can respond to verbal commands and an intact airway and protective reflexes are maintained. Whereas, on the other hand, deep sedation is a pharmacologically induced depressed state where a patient is unable to respond to verbal commands and needs external assistance in maintaining an intact airway and protective reflexes. This implies that the level of consciousness is not always predictable and a sedated child may fluctuate between different levels of consciousness during the procedure. Therefore, sedation may be considered a dynamic process that demands continuous evaluation of patient status [5].

The two main aims of sedation are control of anxiety and prevention of movement to ensure patient compliance and the successful collection of optimal images during the procedure.Another reason for choosing sedation could be to abide by the wishes of the parents to ensure the child does not remember the experience. The American Academy of Pediatrics (AAP) defines the goals of sedation in the pediatric patient for diagnostic and therapeutic procedures as follows: to guard the patient’s safety and welfare; to minimize physical discomfort and pain; to control anxiety, minimize psychological trauma, and maximize the potential for amnesia; to control behavior and/or movement to allow for the safe completion of the diagnostic/interventional procedure; and to return the patient to a state from which safe discharge is possible [6]. This review thus, aims to discuss the standard definitions, protocol, and personnel required for the safe administration of sedatives, various drugs in use, and their adverse effects and problems associated with imaging techniques on sedation.

History and Evolution

There were no guidelines for pediatric sedation up until 1985. Due to rising adverse events in dental offices, a need for awareness regarding pediatric sedation hazards was felt. Thus, AAP in 1985 formulated guidelines for elective use of sedatives and anesthesia, by a committee composed of Dr. Charles Coté and Dr. Theodore Striker [7]. The very same guidelines were modified in 1992 by the AAP Committee on Drugs wherein it was acknowledged that a deeper level of sedation can be easily achieved and that the use of a pulse oximeter was recommended in all patients undergoing sedation [8]. Gradually the guidelines underwent modifications in 1998, 2002, and 2006 according to BIR Publications. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) made certain modifications stating that the Department of Anesthesiology is responsible for developing ‘within-institution’ guidelines, which consequently led to the involvement of the American Academy of Anesthesiology (ASA) with sedation safety.

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The ASA was then successful in changing the terminology from 'conscious sedation' to a more precise term - 'sedation/analgesia'. Revised sedation guidelines were published by ASA in 2002, addressing all depths of sedation [9]. ASA in close association with JCAHO developed a new language to describe sedation's process. Currently, three stages are described, apart from General Anesthesia (GA) - minimal sedation, moderate sedation, and deep sedation. These definitions by ASA were recently adopted by AAP and released in 'Discharge Criteria for Children Sedated by Non-anesthesiologists: Is "safe" really safe enough?'.

The Neuroanesthesia and Neurointensive Study Group of the Italian Society of Anesthesia, Analgesia, Resuscitation, and Intensive Care (SIAARTI) with the Italian Society of Neonatal and Pediatric Anesthesia and Resuscitation (SARNePI) published the SIAARTI-SARNePI Guidelines in 2004 for sedation in pediatric neuroradiology [10]. However, all these studies failed to establish a standard set of definitions that could be followed throughout the pediatric fraternity. They also failed to highlight the adverse effects due to sedation and anesthesia.

Finally, an attempt to standardize the terminologies that could be adopted by all sedation providers was made in 2008, with the release of 'Quebec Guidelines' by a Consensus Panel on Sedation Research of Pediatric Emergency Research Canada and the Pediatric Emergency Care Applied Research Network [11]. The World Society of Intravenous Anesthesia in 2010 established the International Sedation Task Force (ISTF) ('Sedation/anesthesia in Pediatric Radiology Report'). It was composed of members from different countries and backgrounds. This was done in an attempt to standardize globally the definitions of adverse events which were objective, reproducible, and applicable to all settings worldwide focusing on events of clinical significance. They have also developed a standardized sedation outcome reporting tool outlining its aims, to establish an international consensus to produce a sedation monitoring record for performing and documenting pre-procedure assessment, monitoring, and discharge of any sedation patient [12].

Sedation - Definition and Classification

Sedation is a "medically controlled state of depressed consciousness or unconsciousness". The level of sedation can be categorized as per the ASA [13]. These levels include (1) minimal sedation (anxiolysis), (2) moderate sedation/analgesia (conscious sedation), (3) deep sedation/analgesia and (4) General Anesthesia (GA). The classification is based on the decreased levels of response, airway protection, and increased need for cardiovascular support, the most important being the child's ability to maintain protective reflexes [14]. Successful levels of sedation are said to be achieved when the child can stay still, throughout the procedure and the required data is easily achieved [15,16].

Minimal Sedation: A state during which patients are awake and calm and respond normally to verbal commands. Although cognitive function and coordination may be impaired, ventilatory and cardiovascular functions are unaffected.

Moderate Sedation: A state during which patients are sleepy but respond purposefully to verbal commands (known as conscious sedation in dentistry) or light tactile stimulation (reflex withdrawal from a painful stimulus is not a purposeful response)". No interventions are required to maintain a patent airway. Spontaneous ventilation is adequate. Cardiovascular function is usually maintained.

Deep Sedation: In this plane of sedation patients are asleep and cannot easily be roused but do respond purposefully to repeated or painful stimulation. The ability to maintain ventilatory function independently may be impaired. Patients may require assistance to maintain a patent airway.

General Anesthesia: This is a drug-induced loss of consciousness during which patients are not arousable, even by painful stimulation. The ability to maintain independent ventilatory function is often impaired. They need assistance with maintaining their airway and positive pressure ventilation is often required to maintain adequate gas exchange. Cardiovascular function may also be impaired.

Dissociative Sedation: Another category has been added by European pediatricians. This is defined as a trance-like cataleptic state induced by the dissociative agent ketamine or s-ketamine and characterized by profound analgesia and amnesia with retention of protective airway reflexes, spontaneous respiration, and cardiopulmonary stability [17].

Care should be taken not to adhere strictly to these definitions while selecting and administering sedative drugs as one drug might induce moderate sedation in one child, and the same might induce deep sedation in another. Therefore, the correct protocol should always be followed [18].

Sedation Protocol and Personnel

Personnel: Local licensing boards and individual institutions decide the scope of practice and access of qualified practitioners, registered nurses, non-anesthesiologist physicians, and anesthesiologists for administering sedation. The criteria for a sedation provider to be eligible to administer the drug include being able to identify the depth of sedation achieved or being skilled enough to rescue or reverse the sedation in case a level deeper than the intended depth is achieved or rapidly identify loss of airway patency/ventilatory function and to provide artificial respiratory support. Familiarity with the pharmacology of the sedative is also necessary for the provider including the dose, route of administration, adverse effects, contraindications, and potential drug reactions. The providers should have access to potential antagonists and be adept at intervening should any adverse event occur [19,20].

Pre-sedation Assessment: This step is necessary as it helps to determine the fitness of the patient for sedation. It primarily involves a detailed assessment of the child's current health, presence or history of any chronic illnesses, medication history to rule out potential drug interactions, and emphasis on the airway and respiratory status [21]. Modified Mallampati scoring may be used for physically examining and assessing the upper airway tract for any obstructions or intubation difficulties, in children old enough to spontaneously open their mouth for pharyngeal structure assessment [22]. A score of 3 or 4 indicates airway obstruction and intubation difficulty, directing the need for the lightest depth of sedation to avoid any adverse events. On the other hand, the opinion of an anesthesiologist can be considered. Confirming the NPO status of the patient is necessary. History of any previous sedation/anesthesia administration should be discussed to recognize

any adverse reactions and complications or sources of anxiety that need further assistance. Pre-assessment, thus, helps devise a sedation plan customized for that individual including arrangements to be made for skilled professionals, specific equipment, transport, or premedications.

Monitoring and Equipment: According to the ASA and the AAP, guidelines for monitoring during procedural sedatives have been provided. They direct the continuous monitoring of the heart rate, respiratory rate, oxygen saturation, and intermittent monitoring of blood pressure, while monitoring of end -tidal CO2 is encouraged [7,8,23,24]. While ECG is preferred to monitor the heart rate, a pulse oximeter may also be appropriate, provided the wavelength is reliable. Impedance plethysmography via ECG leads may be considered for monitoring respiratory rate, but the use of capnography is more reliable and thus highly encouraged. AAP recommends the frequency of at least every 5 minutes for monitoring the vital signs during deep sedation [8]. According to ASA guidelines [7] certain equipment is to be present starting from induction through recovery as mentioned in **(Table 1)**. According to AAP [8] recommendation the acronym **SOAPME** is widely followed for equipment and monitoring **(Table 2)**.

Table 1: Equipment to be present from induction through recovery

Category	Equipment
Airway	Suction apparatus and catheters
	Oral/nasal airways
	Oxygen delivery devices (nasal cannula, facemask)
	Bag–valve–mask system (self-inflating or anesthesia type)
	Laryngoscope handles/blades
	Endotracheal tubes and stylets
	IV access supplies including catheters, tourniquets, tape, arm boards
	Intraosseous needle and IV fluid tubing, T-connectors, 3-way stopcocks
Medications	Oxygen
	Albuterol
	Atropine/glycopyrrolate
	Calcium chloride/gluconate
	Dextrose 10 %/50 %
	Diphenhydramine
	Epinephrine
	Flumazenil
	Methylprednisolone
	Naloxone
	Racemic epinephrine
	Sodium bicarbonate
	Neuromuscular blocker (succinylcholine/ rocuronium)

Table 2: Method for equipment check and monitoring

Acronym	Full Form	How to Monitor
S	Suction	Suction catheters and/or Yankauer's suction with a functioning suction apparatus.
O	Oxygen	Adequate oxygen supply with optimal backup and functioning flow meters/other devices to allow its delivery
A	Airway	Nasopharyngeal and oropharyngeal airways, laryngoscope blades, endotracheal (ET) tubes, supraglottic airway devices, stylets, bougie, face mask, bag–valve–- mask/AMBU, or equivalent device.
P	Pharmacy	All the basic drugs needed to support life during an emergency, including antagonists as indicated.
M	Monitor	Functioning pulse oximeter with size-appropriate probes and other monitors (noninvasive blood pressure, end-tidal carbon dioxide monitors, electrocardiogram [ECG], stethoscopes)
E	Equipment	Special equipment or drugs for both anesthesia and resuscitation (e.g., defibrillator).

Sedation Candidates: The need for sedation in a child depends on various factors like developmental, technical, or patient health-related. Children who are above the age of 6-8 years and healthy have been shown to cooperate in non-invasive studies like ultrasounds, CT scans, and shorter MRIs without sedation. Furthermore, techniques that are of shorter duration might not require sedation in children even younger than 6-8 years. Infants 3-4 months old can also complete a brief non-invasive scan if allowed to fall asleep after feeding, just before the study. Children assessed as borderline for cooperation can be made to comply during a scan by distraction techniques, infant immobilizers, with the help of child life therapists, audiovisual projections, and music therapy instead of taking the aid of sedation [25-27]. Although non-pharmacological aids are present, certain children require sedation for almost all kinds of scanning procedures. In instances where the child has constant underlying pain may be unable to stay still during scans and thus require sedation. Children having developmentally delayed/behavior disorders, particularly anxiety, may require deep sedation. Finally, some children are poor candidates for sedation like the ones having baseline airway obstruction, central apnea disorders, active respiratory infection, or cyanotic/unrepaired congenital heart disease, and thus, be considered for GA or their procedure should be deferred till the health-related issue is resolved [28-33].

Drugs used for Sedation

Highlights the various classes of drugs, their route of administration, onset, and duration of action, and adverse effects used on children during imaging techniques **(Table 3)** [5,18,34, 35,36].

Table 3: Drugs used as sedatives in pediatric radiology

Dosage	Onset/ Duration of action (min)	Adverse effects	Remarks
1. Benzodiazepines			
A. Chloral hydrate (Oral/Rectal) - Sedative			
50-100 mg/kg, up to 120 mg/kg, max single dose 2 g	3-5/ 45-60	Unpleasant taste, Gastric irritation, Airway obstruction, Vomiting, Paradoxical reactions, Death in unattended patients	Unpredictable onset, long duration, lack of reversal drugs, and the possibility of the child waking up in the middle have led to its discontinuation in a lot of countries
B. Midazolam (Oral/Rectal/IV/IN) - Sedative anxiolytic, amnestic			
- 0.02-0.05 mg/kg IV, titrate using 1/2 original dose (2-4 mm) based on effect and oxygen saturation, max bolus dose 1 mg - 0.5–0.7 mg/kg (Oral) - 0.2–0.4 mg/kg(IN) 300–500 µg/kg(rectal)	IV: 2–5/ 30–45 Oral: 15–20/ Up to 60 IN: 5–10/ 30–45	Respiratory depression, apnea, paradoxical reactions like aggressiveness and crying	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.
C. Diazepam (IV/Oral) - Sedative, Anxiolytic, Amnestic			
0.05-0.1 mg/kg IV, max cumulative dose 5 mg; 0.2-0.3 mg/kg PD, max cumulative dose 10mg	IV: 5-15/ 30-120	Respiratory depression, hypotension, syncope, paradoxical reactions, bradycardia, cardiovascular collapse	IV diazepam is 4–5 times less potent than midazolam. Despite a longer elimination half-life, recovery profiles are similar (usually by 2 h).
2. Barbiturates			
A. Pentobarbital (IV/Oral/IM) - Sedative			
2-3 mg/kg doses titrated q 5-7 mm until sedated or max cumulative amount of 8 mg/kg not to exceed 200mg	5-10/ 40-60	airway obstruction or paradoxical reactions	For painless imaging, pentobarbital 2–6 mg kg1 i.v. is very successful. Pentobarbital is not available in the UK.
B. Methohexital (Rectal) - Sedative			
20 mg/kg in 10% solution	10-15/ 45	Respiratory depression, apnea, hiccoughs, cardiovascular depression, laryngospasm	Methohexital is contraindicated in acute intermittent porphyria (AIP).
C. Thiopental sodium (IV/Rectal) - Sedative			
1 to 2 mg /kg IV every 3 to 5 min up to maximum of 6 mg/kg	Less than 1/ 15-60	Respiratory depression, apnea, bradycardia, hypotension	Rarely used now due to the availability of better drugs
3. Opioids			
A. Morphine (IV/IM) - Analgesic with Sedative Properties			
0.1-0.2 mg/kg, max dose 3-4 mg	3-5/ Analgesia max 4 hr; sedation varies but is shorter	Hypotension, IVH, PVL, respiratory depression, cardiovascular collapse	Usually given in combination with midazolam
B. Fentanyl (IV) - Analgesic with Sedative Properties			
1 to 2 mcg/kg as induction dose and 0.5 to 1 mcg per kg as maintenance dose	5 to 10/ 30 to 60	Vomiting, respiratory depression, chest wall rigidity	Usually given in combination with propofol
C. Meperidine (IV/IM) - Analgesic with Sedative Properties			
1-2 mg/kg, max dose 100 mg	5-10/ Analgesia 1-2 hr; sedation varies but is shorter	Oxygen desaturation has been reported in 5% of cases.	Given in combination with midazolam

3. Anesthetics			
A. Propofol (IV) - GA			
6 mo to 2 y: 1 to 2 mg/kg IV > 2 y of age: 0.5 to 1 mg/kg IV bolus dose; Additional IV bolus dose 0.5 mg/kg every 3 to 5 min, up to 3 mg/kg	Within a minute/ 5 to 15 min after a single dose	Pain on injection, respiratory depression, apnea, airway obstruction hypotension, and/or rapid transition to deeper levels of sedation	One of the most used agents, excellent recovery profile
B. Ketamine (IM/IV) - GA			
1–2 mg/kg (IV); 0.5 to 1 mg/kg, repeated every 5 to 10 min with IV induction 4–5 mg/kg (IM)	1 to 2 min (IV) 5 to 10 min (IM)/ 15 to 30 min (IV) 30 to 60 min (IM)	Emergence reactions, vomiting	Lesser respiratory adverse effects than propofol produce dissociative anesthesia
4. Inhalational agents			
A. Nitrous Oxide (IN) - Analgesic, Sedative			
50 to 70% N2O administered with oxygen through a demand valve system with scavenging capability; Continuous use in the same concentration	Within a minute	Nausea, vomiting, dysphoria	Provides anxiolysis, amnesia, and loss of consciousness can occur when combined with other sedatives or when used alone in concentrations over 50%.
B. Sevoflurane (IN) - Analgesic, Sedative			
0.5% increased slowly to up to 8% in oxygen; Requires continuous administration	Depends on the concentration used within 2 to 3 min	Respiratory depression might occur with higher concentrations	Smooth induction

***IV:** Intravenous, **IN:** Intranasal, **IM:** Intramuscular, **GA:** General Anesthesia.

Drugs used for the reversal of Sedatives

Reversal of benzodiazepine sedation: Flumazenil in the dose of 0.01–0.01 mg/kg through IV route 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 resonation. The onset of action is 1–2 mins and lasts for 30–45 minutes.

Reversal of opioid-induced sedation and respiratory depression: Opioid-induced respiratory depression can be reversed with **Naloxone.** Administered via IV route, in the dose of 0.01–0.02 mg/kg. The onset of action is 1–2 minutes and lasts for up to 30–45 mins. **Nalmefene** may also be used. Administered by IV route, in the dosage of 0.25 µg/kg (maximum 1 µg/kg). The onset of action is 2–3 min and lasts for up to 120–180 mins [5].

Problems due to imaging modalities on sedation

MRI: As a radiographic modality MRI has its sets of advantages as it uses a powerful magnetic field and also is free from radiation but it also comes with its own set of hazards as well. The powerful magnetic field can transform any ferrous-containing article into a projectile object. Therefore, equipment being utilized for administering sedation has to be MR-compatible and all the incompatible equipment needs to be placed beyond the specified boundaries [37]. As MR-compatible equipment like pulse oximeters, ECG electrodes, and capnographs are not always available, especially in smaller imaging centers in developing countries, it is essential to constantly monitor respiratory movements visually, to detect any adverse events [38]. The main challenge arising for an anesthetist is inaccessibility to the head end for positive pressure ventilation and/or insertion of an airway tube in case of respiratory complications, in which case the patient needs to be pulled out thereby interrupting the procedure?

CT Imaging: The major challenge attached to this imaging modality is that the sedation provider cannot be in the same room due to the risk of radiation exposure and has to monitor the vitals through the readings on the monitor. Therefore, it is the responsibility of the provider before leaving the room, to first assess and closely monitor the vitals after administering the drug and ensure that there are no movements that may prevent acquisition of the correct data before the CT is started [18].

CONCLUSION

The need for imaging in children as a diagnostic tool is increasing along with the need for sedation during imaging. Hence, the need of the hour is to train more professionals and nurses as sedation providers; especially, in smaller imagingcenters. As there are various adverse effects related to the sedation drugs, the centers need to be well-equipped to handle any complications and have the necessary monitoring and assessment tools. The skilled professional should be qualified enough to precisely assess and differentiate adequately patients suitable for sedation or anesthesia or need deferred treatment.

REFERENCES

1. Glatz AC, Zhu X, Gillespie MJ, et al. Use of angiographic CT imaging in the cardiac catheterization laboratory for congenital heart disease. JACC Cardiovasc Imaging. 2010; 3:1149–57.
2. Driessen MMP, Breur JMPJ, Budde RPJ, et al. Advances in cardiac magnetic resonance imaging of congenital heart disease. Pediatr Radiol. 2015; 45:5–19.
3. Lord DJE. The practice of pediatric interventional radiology. Tech Vasc Interventional Rad. 2011; 14:2–7.
4. Cravero JP, Beach ML, Blike GT, et al. the Pediatric Sedation Research Consortium. Incidence and nature of adverse events during pediatric sedation/anesthesia for procedures outside the operating room: report from the Pediatric Sedation Research Consortium. Pediatrics. 2006; 118:1087–96.

5. Frush DP, Bisset GS, et al. Pediatric sedation in radiology: the practice of safe sleep. AJR Am J Roentgenol. 1996; 167(6):1381-7.
6. American Academy of Pediatrics. American Academy of Pediatric Dentistry, Cote CJ, Wilson S; Work Group on Sedation. Guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures: an update. (Local anesthetic systemic toxicity: current perspectives) (Complications associated with intravenous midazolam and ...). Pediatrics 2006; 118:2587–2602.
7. Committee on Drugs, Section on Anesthesiology, American Academy of Pediatrics. Guidelines for the elective use of conscious sedation, deep sedation, and general anesthesia in pediatric patients. Pediatrics. 1985; 76:317–321.
8. Cravero JP, Blike GT. Review of pediatric sedation. Anesth Analg 2004; 99(05):1355–1364.
9. Ruess L, O'Connor SC, Mikita CP, et al. Sedation for pediatric diagnostic imaging: use of pediatric and nursing resources as an alternative to a radiology department sedation team. Pediatr Radiol 2002; 32(07):505–510.
10. Levati A, Paccagnella F, Pietrini D, et al. SIAARTI. SIAARTI-SARNePI Guidelines for sedation in pediatric neuroradiology. Minerva Anestesiol. 2004; 70(10):675–697.
11. Green SM, Yealy DM. Procedural sedation goes Utstein: the Quebec guidelines. Ann Emerg Med 2009; 53(04):436–438.
12. Gozal D, Mason KP. Pediatric sedation: a global challenge. Int J Pediatr 2010; 701257.
13. Cote CJ, Wilson S. Guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures: an update. Am Acad Pediatr. 2006; 118:2587–602.
14. Mandell GA, Cooper JA, Majd M, et al. Procedure guideline for pediatric sedation in nuclear medicine. Society of Nuclear Medicine. J Nucl Med. 1997; 38:1640–3.
15. Manuli MA, Davies L. Rectal methohexital for sedation of children during imaging procedures. AJR Am J Roentgenol. 1993; 160:577–80.
16. Fallah R, Fadavi N, Behdad S, et al. Efficacy of chloral hydrate-hydroxyzine and chloral hydrate-midazolam in pediatric magnetic resonance imaging sedation. Iran J Child Neur. 2014; 8:11–17.
17. Meyer S, Grundmann U, Gottschling S, et al. Sedation and analgesia for brief diagnostic and therapeutic procedures in children. Eur J Pediatr. 2007; 166(04):291–302.
18. Choudhary P, Boski N. Sedation and General Anesthesia in Diagnostic Pediatric Imaging. J of Indographics 2023; 01(01):101-109.
19. American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists. Practice guidelines for sedation and analgesia by non-anesthesiologists: an update. Anesthesiology. 2002; 96:1004–17.
20. American Academy of Pediatrics, American Academy of Pediatric Dentistry, Cote CJ, Wilson S, 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; 118:2587–602.
21. Cravero JP, Beach ML, Blike GT, et al. The Pediatric Sedation Research Consortium. Incidence and nature of adverse events during pediatric sedation/anesthesia for procedures outside the operating room: Report from the Pediatric Sedation Research. Pediatrics. 2006; 118:1087–96.
22. Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. Anaesthesia. 1987; 42:487–90.
23. Gozal D, Mason KP. Pediatric sedation: a global challenge. Int J Pediatr. 2010; 701257
24. Joint Commission on Accreditation of Healthcare Organizations. Comprehensive accreditation manual for hospitals. Oakbrook Terrace: Joint Commission on Accreditation of Healthcare Organizations. 2005.
25. Golan A, Marco R, Raz H, Shany E. Imaging in the newborn: infant immobilizer obviates the need for anesthesia. Israel Med Associa J. 2011; 13:663–5.
26. Etzel-Hardman, Kapsin K, Jones S, et al. Sedation reduction in a pediatric radiology department. J Healthc Qual 2009; 31:34–39.
27. Kulkarni S, Johnson PCD, Kettles S, et al. Music during interventional radiological procedures, effect on sedation, pain and anxiety: a randomized controlled trial. Br J Radiol. 2012; 85:1059–63.
28. Evans RG, Crawford MW, Noseworthy MD, et al. Effect of increasing depth of propofol anesthesia on upper airway configuration in children. Anesthesio. 2003; 99:596–602.
29. Mahmoud M, Radhakrishman R, Gunter J, et al. Effect of increasing depth of dexmedetomidine anesthesia on upper airway morphology in children. Pediatr Anesth. 2010; 20:506–15.
30. The Royal College of Radiologists. Safe sedation, analgesia and anaesthesia within the radiology department. September 2003. Available from: http://www.rcr.ac.uk/publications.aspx?PageID=310&PublicationID=186
31. Grunwell JR, McCracken C, Fortenberry J, et al. Risk factors leading to failed procedural sedation in children outside the operating room. Pediatr Emerg Care. 2014; 30:381–7.
32. Scherrer PD, Mallory MM, Cravero JP, et al. for the Pediatric Sedation Research Consortium. The impact of obesity on procedural sedation-related outcomes: results from the Pediatric Sedation Research Consortium. Paediatr Anaesth. 2015; 25:689–97.
33. Kang J, Vann WF, Lee JY, et al. The safety of sedation for overweight/obese children in the dental setting. Pediatr Dent. 2012; 34:392–6.
34. Starkey E, Sammons HM. Sedation for radiological imaging. Arch Dis Child Educ Pract. 2011; 96(3):101-6.
35. Berkenbosch JW. Options and Considerations for Procedural Sedation in Pediatric Imaging. Paediatr Drugs. 2015; 17(5):385-99.
36. MRJ Sury. Paediatric sedation, Continuing Education in Anaesthesia Critical Care & Pain. 2004; 4(4):118–122.
37. Arlachov Y, Ganatra RH. Sedation/anaesthesia in paediatric radiology. Br J Radiol 2012; 85(1019):e1018–e1031.
38. Gooden CK. Anesthesia for magnetic resonance imaging. Curr Opin Anaesthesiol 2004; 17(04):339–342.

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