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Sedation and anesthesia issues in pediatric imaging

Thomas L. Slovis

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Abstract Sedation and anesthesia for pediatric imaging departments has changed dramatically for the following reasons: (1) radiologists have stopped sedating patients; (2) the majority of sedations are *not* for CT (because of the speed of the procedure) but for MR, which lasts 45 min or greater; (3) a cadre of services—pediatricians, emergency medicine physicians, hospitalists and intensivists, as well as anesthesiologists—can provide the services. These changes have significantly influenced the type of agents utilized for sedation and anesthesia and, most important, have created operational issues for MR departments. Nevertheless, it is important for each imaging department to create a uniform approach to sedation, taking into account patient expectations, efficiency of through-put, facilities and personnel available, and institutional costs.

Keywords Imaging · Sedation · Anesthesia · Children

Introduction

Dr. Charles Macias has covered the basics, emphasizing the use of the ASA Physical Status Classification [1] and the Ramsay Sedation Score [2] and covering the drugs most often used in CT sedation. It is important to have general rules when we discuss imaging sedation (Fig. 1). The percentage of CT examinations needing sedation is relatively small (this varies by setting and referral base but probably ranges between 1% and 10% and the examinations are brief). In addition, CT examinations are decreasing for children, while MR examinations are dramatically increasing [3]. In MR, older children and adolescents without neurodevelopmental challenges might be able to use goggles and watch a movie, without sedation. Increasing effort is needed to minimize the use of sedation in children [4, 5]. But, the younger children (younger than 5 years) need pharmacological aids to lie still. At Children's Hospital of Michigan 50–70% of MR patients get sedated.

T. L. Slovis (✉)
Department of Pediatric Imaging,
Children's Hospital of Michigan,
3901 Beaubien Blvd,
Detroit, MI 48201, USA
e-mail: pedradeditor@med.wayne.edu

Medications (Table 1)

Ketamine [6]

Ketamine is a dissociative anesthetic agent. It "disassociates" the cerebral cortex from the limbic system, one of the reasons it provides profound analgesia. It preserves the gag reflex and laryngeal irritability and respiratory activity. Major side effects include increased secretions, hypertension, hallucinations and nightmares. Ketamine is an excellent analgesic and has amnesic properties. It has rapid induction but slow emergence. Its success rate is over 90% [7]. Ketamine, however, is not generally used for imaging sedation because of its side effects.

Dexmedetomidine [6]

It is a highly selective α2 adrenoreceptor agonist that has sedative and analgesic properties. Its major side effects are

Fig. 1 General rules of imaging sedation

- Use drugs appropriately (indication, dose, monitoring)
- Practice efficiency: induction, emergence, post care
- Limit side effects
- Avoid sedation when possible

Fig. 2 Who should do sedation and anesthesia?

- Radiologist
- Pediatric groups
  - Pediatricians
  - Emergency medicine
  - Hospitalist
  - Intensivist
- Anesthesia
- Combination of above

bradycardia (16%) and alterations in mean arterial pressure. It is administered as a 10-min bolus followed by an intravenous infusion. The bolus dose for CT is 2 μg/kg with the infusion rate of 1 μg/kg/hr [8–10]. Bradycardia and up to 20% change from baseline of mean arterial pressure can occur during bolus or infusion *without* predictability. Infrequently, the mean arterial pressure changes reach 30% of baseline [9].

The dosing for MR is greater than that for CT because of the duration of the procedure. The suggested bolus for MR is 2–3 μg/kg and the infusion dose is 1–2 μg/kg/hr.

Dexmedetomidine has a mean time for induction of about 12 min, a mean time for emergence of about 25 min and a 97.6% success rate as a single agent [9].

Propofol [6]

Propofol is an anesthetic agent classified for use by anesthesiologists or their designees. Its major side effects are respiratory depression (1–12%), myocardial depression and hypotension [11]. It is administered as a bolus of 1–2 mg/kg followed by continuous infusion, which is titrated between 150 and 200 μg/kg/min [12]. There is rapid induction and rapid emergence of patients from this form of anesthetic. A major benefit is the absence of paradoxical reactions. It is 99% successful.

Table 1 Comparison of agents

Drug	Induction	Emergence	Side effects	Success rate
Ketamine (dissociative anesthetic)	Rapid (<1 min I.V.)	Long (>30 min) (agitation)	Hallucinations Hypertension Increased secretions	91%
Dexmedetomidine	Intermediate (mean 12 min)	Intermediate (mean 25 min)	Bradycardia (16%) Mean arterial pressure Rebolus (34%) 2nd drug (2%)	97.6%
Propofol	Rapid (<1 min)	Rapid (<10 min)	Respiratory distress (up to 12%); Hypotension Myocardial depression	99%

Who should perform sedation and anesthesia? (Fig. 2)

It is clear that the radiologist (except, perhaps, the interventionalist) cannot be responsible for sedation. The regulations concerning constant attendance at the examination prohibit the radiologist from being able to carry out other responsibilities and conduct efficient sedation.

Any of the pediatric groups (pediatricians, emergency medicine physicians, hospitalists and intensivists) have or can acquire the skill to perform pediatric sedation. These groups are most likely to continue with general concepts of sedation already in place. The hours will be from early morning (6:30 or 7 a.m. first case) to late in the evening (8 p.m. last patient) and family-centered care would continue.

When anesthesia departments are the sole purveyor of MR sedation, a great cultural change is necessary between departments. Our patients are not OR patients but MR patients, and the scheduling, paperwork, etc., needs to resemble what we are doing in radiology, not what is done in the OR. Scheduling must not be OR scheduling, but longer hours as detailed above. The anesthesia department must be willing to do both sedation and anesthesia, depending on the patient's needs. Technological difficulties, such as greater atelectasis, must be avoided.

Both groups should be aware of the level of sedation and anesthesia necessary for each examination, whether it is CT or MR or an interventional procedure.

It is my opinion that the general safety net for all hospital sedation should rightly fall into the realm of the anesthesia department. The anesthesia department must approve all protocols and procedures. Anesthesia can designate any of the pediatric groups to give sedation, but the anesthesiologists ultimately are the sole quality purveyor of the standard of patient care at the institution. The pediatric groups can use most of the drugs described, except propofol.

Fig. 3 Factors influencing who sedates

- Availability
- Facilities
- Cost

A team led by an anesthesiologist seems to be ideal to do institutional sedation. The team can give general anesthesia when necessary, provide sedation when appropriate, and have the best of both worlds.

But many questions must be asked in determining who performs sedation and anesthesia in any given situation. There is no one answer. Which group has enough manpower? Which group wants to deal with it? It's hard to set up a team. Many factors have to be considered (Fig. 3). Imaging must be available 24/7. We frequently have 12-h days. Ideally, the patient should expect the same treatment regardless of whether the examination takes place during regular business hours or after-hours.

What facilities are available? When anesthesia is involved, it would be ideal to have a post-recovery area (PACU, post anesthesia care unit) for all patients. What is the personnel situation? Are nurses available to provide pre- and post-examination care?

Finally, the costs of sedation are vastly different [13] among geographical regions, but it has been reported that sedation by anesthesiologists is three times more expensive than that of pediatric groups. What are the hospital's financial objectives? When the pediatric groups perform sedation, the hospital frequently needs to supplement their income. Anesthesiologists are more expensive but with complete facilities, including a PACU, they can make their salaries and might even make money for the institution. All of these factors play a role in determining who carries out the job.

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