Pediatric sedation/anesthesia outside the operating room

David Gozal[a] and Yaacov Gozal[b,c]

[a]Department of Anesthesiology and Critical Care Medicine, Hadassah University Hospital, [b]Hebrew University-Hadassah Medical School and [c]Department of Anesthesiology, Perioperative Medicine and Pain Treatment, Shaare Zedek Medical Center, Jerusalem, Israel

Correspondence to Yaacov Gozal, MD, Chair, Department of Anesthesiology, Perioperative Medicine and Pain Treatment, Shaare Zedek Medical Center, P.O.B. 3235, Jerusalem 91031, Israel
Tel: +972 2 6555 614; fax: +972 2 6666 003; e-mail: gozaly@szmc.org.il

Current Opinion in Anesthesiology 2008, 21:494–498

Purpose of review
The demand of procedures performed on children outside the operating room setting often exceeds the capacity of anesthesia services. The number of children requiring sedation outside the traditional operating room is rapidly approaching the number of children requiring anesthesia in the operating room. We address some of the major issues and controversies in this continuously evolving field.

Recent findings
Pediatric sedation continues to be a challenging field. Recently, the Society of Pediatric Sedation has been created. In the last year, important issues have been raised among pediatric sedation providers, keeping on feeding the debate within all the recognized experts.
Why worry about nihil per os status? Is bispectral index useful as a sedation monitor? Should there be standards for simulation-based training of nonanesthesiologists for delivery of sedation? Is propofol well tolerated? Is dexmedetomidine a good choice for painful procedures? What is the role of etomidate?

Summary
A standard approach (adequate preparation, clinical assessment of the child, fasting as required and right sedation plan) is mandatory to provide safety and efficiency. Sedation is a continuum, and it can be easy to advance from one level to the next and even reach a state of general anesthesia. Newer modalities such as end-tidal CO_2 and, maybe, bispectral index monitoring are indeed enhancing the safety of procedural sedation and analgesia.

Keywords
adverse outcomes, anesthesia, etomidate, pediatric sedation, procedural sedation, propofol

Curr Opin Anaesthesiol 21:494–498

0952-7907

Introduction

In their excellent and important review of the ‘making’ of sedation in children, Krauss and Green [1] have brought to our notice that the number of procedures performed in children outside the traditional operating room setting has grown substantially over the past years. Consequently, there has been an increasing demand for providing safe and effective sedation/analgesia to these children.

The increased demand for sedation services often exceeds the capacity of anesthesia services in many hospitals. In many children’s hospitals, the number of children requiring sedation outside the traditional operating room is rapidly approaching the number of children requiring anesthesia services in the operating room.

The Joint Commission on Accreditation of Healthcare Organization (JCAHO) and other regulatory bodies stipulate that the anesthesiologists are responsible for developing ‘institutional guidelines’ for sedation practices in their institutions. The American Society of Anesthesiologists (ASA) has published guidelines for sedation administered by nonanesthesiologists that have been enclosed by the American Academy of Pediatrics (AAP) and the JCAHO [2–4].

The aim of the present review is to address some of the major issues and controversies in the evolving field of pediatric procedural sedation.

Goals of sedation

An ideal ‘sedation plan’ should achieve the following goals:

(1) allay fear and anxiety (in both children and parents),
(2) obtain the cooperation of the child,
(3) achieve immobilization to the degree needed for the procedure,
(4) induce awareness and amnesia,
(5) reduce discomfort and pain,
(6) keep the child safe.

Nonpainful procedures (diagnostic imaging), minimally painful procedures (instrumentation and minor trauma) and painful procedures (deeply invasive instrumentation and significant trauma) differ in their requirements for sedation, analgesia and amnesia.

Some procedures may be successfully completed using special techniques; distraction, hypnosis, relaxation, cognitive and behavioral therapy and guided imaging (virtual reality) [5] are some of the modalities that should be helpful in reducing the need for pharmacologic sedation and thus adverse reactions.

Level of sedation

There are four levels of sedation defined by the ASA [3]: minimal sedation (anxiolysis), moderate sedation (conscious), deep sedation (unconscious) and general anesthesia (Table 1).

Some may add a fifth state to this classification, that is, 'dissociative sedation' provided by ketamine, which also causes analgesia and amnesia, without a loss of airway protective reflexes or cardiopulmonary stability [6].

These levels are often discussed as a 'continuum' [1]. Depending on many factors, such as degree of stimulation, patient-to-patient variability, drug profile, polypharmacy interactions, level of distress and anxiety before the procedure, previous hospital experiences, and age and developing stage of the child, procedural sedation and analgesia (PSA) [1,4], intended to provide a child with a specific state of sedation, may result in a deeper state with unexpected ease and rapidity. Therefore, theJCAHO came up with the 'sedation rescue' philosophy in 2000, in which the sedation provider must know how to rescue the child from general anesthesia if deep sedation was the intended level [2]. In the same year, Coté *et al.* [7], in a key review in the sedation literature, concluded that 'a failure to rescue the patient' was the result of a correlation between serious adverse events and inadequate resuscitation.

Conscious sedation in children has been shown to be a myth, because the goal of PSA is to get a nonresponsive child to respond to vocal commands and pain interventions (deep sedation) [8].

Personnel

To safely provide PSA, the personnel must have the proper training and skills for patient rescue [2]. The person providing sedation and maintaining the child should not be the person performing the procedure and should be trained in pediatric advanced life support (PALS).

The practitioner should recognize the different levels of sedation and intervene immediately if partial or total airway obstruction and apnea occur (maintain airway patency and assist ventilation). He should understand the pharmacology of the different drugs used and their possible adverse events [1,7,9,10].

The role and the importance of support personnel increase with an increased level of sedation. They must be trained in pediatric basic life support (PBLS) and are required to monitor the patient, complete the documentation and assist with resuscitation when needed.

The AAP and American Academy of Pediatric Dentistry published a joint update in 2006 [4] with a recommended checklist with the acronym SOAPME (suction, oxygen, airway, pharmacy, monitors, equipment) to be available in case of an emergency situation (Table 2).

If nurses are to provide sedation, such as in the excellent model developed by Gozal *et al.* [11], the limitation should be healthy children older than 1 month for noninvasive procedures in which visual contact with the child is maintained at all times. They have proved that a mobile sedation unit run by anesthesiologists is very efficient and safe.

Presedation assessment and patient selection

The sedation must be patient oriented and tailored to a specific procedure while ensuring the child's safety throughout the procedure. A complete preprocedural assessment should be completed before any sedation in any child [2].

Most organizations follow the presedation evaluation guidelines of the ASA [3] according to which three components exist:

Table 1 Levels of sedation

Factors	Minimal sedation	Moderate sedation/analgesia	Deep sedation	General anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response to repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular function	Unaffected	Usually maintained	Usually maintained	May be impaired

Adapted from [3].

Table 2 SOAPME checklist

S (suction)	Size-appropriate catheters and functioning suction apparatus
O (oxygen)	Adequate supply and functioning flow meters
A (airway)	Size-appropriate airway equipment
P (pharmacy)	Basic drugs for life support and antagonists
M (monitors)	Standard
E (equipment)	Ancillary such as defibrillator

Adapted from [4].

(1) child's medical history,
(2) focused physical examination,
(3) risk assessment.

The child's medical history

(1) any major medical illness affecting the respiratory, cardiovascular, renal or hepatic systems,
(2) history of any sedations, anesthesia exposure, surgeries and outcomes,
(3) drug, food and latex allergies,
(4) current medications,
(5) history of snoring, sleep apnea or hypoventilation,
(6) review of organ systems.

Physical examination

(1) vital signs: heart rate (HR), respiratory rate and oxygen saturation (SaO_2),
(2) blood pressure (BP) and temperature,
(3) weight,
(4) auscultation of heart and lungs,
(5) evaluation of the airways: facial dysmorphism, retrognathia and micrognathia,
(6) loose teeth, tonsillar hypertrophy, visibility of uvula (Mallampati) and short neck.

Risk assessment: ASA classification

ASA physical status of at least three has been shown to correlate with an increased risk of sedation-related adverse events. The AAP encourages consulting with a pediatric anesthesiologist for patient's ASA physical status of at least three.

Fasting

For nonurgent procedural sedation, the patient should be fasted according to the ASA preprocedure fasting guidelines [3].

In emergency situations or in cases of children with increased risk of aspiration of gastric contents, the risks versus benefits of sedation must be assessed and communicated to the family.

The options are:

(1) to delay the procedure as long as possible
(2) to use a lower level of sedation
(3) to be based more on analgesia and less on sedation
(4) to use general anesthesia and rapid sequence intubation.

Any factor that may increase the risk of pulmonary aspiration is important to take into consideration; however, a significant concern regarding fasting time may be unfounded. Aspiration data from which the guidelines were established have been taken from data on general anesthesia. The aspiration risk is increased during general anesthesia because of manipulation of the airway with intubation and extubation. Because airway manipulation is a rare occurrence with procedural sedation, aspiration is probably less likely during sedation [12,13••,14]. Despite the lack of evidence-based sedation guidelines, as emphasized in an editorial by Green [15], it does not allow the practitioner to 'disregard or trivialize fasting assessments' [2,16].

Informed consent

The different options, risks and alternatives should be discussed with the parents/guardians of the child, and informed consent should be obtained and documented in the patient's record [1,2,3].

Equipment

The available equipment should be aimed at the possibility of performing general anesthesia. Thus, the appropriate equipment for airway management and resuscitation of a pediatric patient should be available at the location of the procedure. All the equipment should be checked before each sedation procedure.

Monitoring techniques

The personnel in charge should closely observe the child and continuously assess the level of sedation and physiologic changes [12].

Observation of the patient's face and chest wall motion allows for a rapid detection of the most common sedation-related adverse events, respiratory depression and airway obstruction [3]. The JCAHO requires documenting the following: level of consciousness, HR, BP, respiratory rate and SaO_2 [2]. In situations in which direct physical observation of a child is not possible (MRI), continuous capnography is essential to detect airway obstruction or apnea [3].

Continuous ECG monitoring is no longer required in children without cardiovascular disease. The recording of the BP may be omitted during the procedure should its measurement interfere (wake up) with optimal sedation [3]. Because ventilation and oxygenation are separate physiologic mechanisms, a failure in ventilation may not be reflected immediately by a failure in oxygenation [3]. Therefore, the practitioner relying solely on pulse oximetry may fail to detect either airway obstruction or respiratory depression or both.

Supplemental oxygen delays the onset of desaturation or pulse oximetry, therefore the direct observation of the patient is very important [17].

Level of sedation

The bispectral index (BIS) monitor processes the electroencephalogram (EEG) to derive a neurophysiologic variable from zero to 100 that correlates with the level of sedation. The variable, based entirely upon EEG data, defines 70–90 as light-to-moderate sedation, 60–70 as deep sedation, 40–60 as general anesthesia and 0–40 as a deep hypnotic state [18,19]. However, the application to pediatric patients is uncertain because the monitor was developed to use with inhalation agents in adults. Recently, several studies have shown the monitor to be useful also in children older than 1 year. They have found a significant correlation between the BIS values and the sedation state [19].

A recent literature review concluded that bispectral values correlate fairly well with commonly used clinical sedation scores, but more variability in the scores has been observed at lighter levels of sedation [20].

In fact, further studies correlating BIS scores with sedation levels are needed before interpretative use begins in the PSA setting.

Documentation

For a child undergoing a procedure under sedation, a recording of the level of consciousness, (conscious, sleeping/reacting to stimulus and sleeping/nonreacting to stimulus), the SaO_2, HR, end-tidal CO_2 ($EtCO_2$) and respiratory rate is recommended at 5 min intervals at every stage of the procedure. If possible, the baseline vital signs must be documented. Also, the names, routes, time and doses of drugs should be recorded [1–4].

Recovery and discharge

Children receiving sedation should be observed in an appropriately staffed [with nurses (one nurse for four patients)] and equipped (with a pulse oximeter) recovery area at the end of the procedure until they fulfill the following guidelines for discharge:

(1) Back to the preprocedural mental status and aroused easily,
(2) Stable cardiorespiratory status, intact protective reflexes and patent airway,
(3) Back to the preprocedural motor function status,
(4) Two hours after antidote,
(5) Responsible adult,
(6) Written instructions and emergency number.

Sedative agents used on pediatrics outside the operating room

Propofol

The use of propofol remains a subject of controversy between anesthesiologists and physicians [21,22]. However, its use outside the operating room and by nonanesthesiologists has been increasing over the past years [23,24].

Although there are multiple reports of the safety of propofol in pediatric procedural sedation, it is a potent ultra-short-acting agent used to induce general anesthesia and is associated with a rapid increase in sedation level to that of general anesthesia. Its therapeutic window is very narrow [11,21,22].

Etomidate

Etomidate is increasingly considered for procedural sedation in the emergency department. It has been shown that etomidate allows fracture reduction with the same success as other drugs (midazolam), although the adequacy of sedation was not complete [25]. However, etomidate had some side effects (pain on injection and myoclonus).

Dexmedetomidine

Dexmedetomidine, an $\alpha 2$ adrenergic selective agonist, was initially licensed in the US for use in sedation in intensive care settings in 1999.

The sedative, analgesic and anxiolytic properties of dexmedetomidine in sedation have been investigated. For example, dexmedetomidine provides a well tolerated and effective sedation during EEG analysis in children with autism, without interfering with the EEG examination. It may be a successful method of providing sedation to a challenging patient population [26•].

Adverse outcomes

The majority of reported complications result from respiratory depression or airway obstruction leading to hypoxemia. But the actual incidence is unknown. The cardiac events are limited to bradycardia secondary to hypoxia. However, if their detection or the rescue response is delayed, cardiac arrest can occur.

They occurred more in a nonhospital setting (2.5 times more). The risks increase when multiple medications are used, with an inadequate presedation evaluation, absence of monitoring, medication errors and inadequate recovery [27], as reported in 2006 by the Pediatric Sedation Research Consortium (PSRC) with Joe Cravero at its head. Many of these complications are preventable.

Controversial issues

The demand for services continues to increase, although the capacity of many anesthesia services to provide these services is outreached. So, challenging questions remain without a clear-cut answer:

(1) Does every child who needs sedation need an anesthesiologist?
(2) Can internists and emergency room physicians be eligible to provide deep sedation?
(3) With the publication of many articles in the literature proving a well tolerated use of propofol by non-anesthesiologists, should propofol be restricted to anesthesiologists?
(4) Is the BIS monitor useful for procedural sedation?
(5) Although there are no evidence-based guidelines, should the practitioner follow or disregard fasting assessments?
(6) What is the best training for nonanesthesiologists to get the credentials to provide safe sedation?

Conclusion

The increasing use of sedation to increase pediatric patients' wellbeing during PSA has been understood by the JCAHO, specialty societies and the families (parents and children). In all institutions where sedation is provided outside the operating room, the department of anesthesiology should have the responsibility to define safe practice standards because anesthesiologists, although possess unique qualifications to provide such services, remain with limited availability because of their commitments to the operating room, ICU or pain service. Considerations are given to facilities, back up of emergencies, equipment, education, informed consent, documentation and release from the medical facility. There should be a real collaboration between the department of anesthesiology and other concerned departments in order to enhance safety, efficiency and reliability during the provision of sedation.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
•• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 526).

1 Krauss B, Green SM. Procedural sedation and analgesia in children. Lancet 2006; 367:766–780.

2 Joint Commission on Accreditation of Healthcare Organizations. Comprehensive accreditation manual for hospitals. Oakbrook: JCAHO; 2005.

3 American Society of Anesthesiologists. Practice guidelines for sedation and analgesia by nonanesthesiologists: a report by the American Society of Anesthesiologists Task Force on sedation and analgesia by nonanesthesiologists. Anesthesiology 2002; 96:1004–1017.

4 American Academy of Pediatrics Committee on Drugs. Guidelines for maintaining and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures: an update. Pediatrics 2006; 118:2587–2602.

5 Anderson K, Weismann S. Non pharmacologic methods of analgesia and sedation. Clin Pediatr Emerg Med 2007; 8:24–28.

6 Meyer S, Grundmann V, Gottschling S, *et al.* Sedation and analgesia for brief diagnostic and therapeutic procedures in children. Eur J Pediatr 2007; 166:291–302.

7 Coté CJ, Notterman DA, Karl HW, *et al.* Adverse events in pediatrics: a critical incident analysis of contributing factors. Pediatrics 2000; 105:805–814.

8 Coté CJ. 'Conscious sedation': time for this oxymoron to go away! J Pediatr 2001; 139:15–17.

9 Shavit I, Keidan I, Augarten A. The practice of pediatric procedural sedation and analgesia in the emergency department. Eur J Emerg Med 2006; 13: 270–275.

10 Doyle L, Colletti JE. Pediatric procedural sedation and analgesia. Pediatr Clin North Am 2006; 53:278–292.

11 Gozal D, Drenger B, Levin PC, *et al.* A pediatric sedation/anesthesia program with dedicated care by anesthesiologists and nurses for procedure outside the operating room. J Pediatr 2004; 145:45–52.

12 Godwin SA, Caro DA, Wolf SS, *et al.* Clinical policy, procedural sedation and analgesia in the emergency department. Ann Emerg Med 2005; 45:177–196.

13 •• Cherny KW, Watson ML, Field SG, *et al.* Aspiration pneumonitis requiring intubation after procedural sedation and analgesia: a case report. Ann Emerg Med 2007; 49:462–464.
Aspiration does exist during sedation, and this case report provides a very good example with all its implications.

14 Roback MG, Bajuj L, Wathen JE, *et al.* Preprocedural fasting and adverse events in procedural sedation and analgesia in a pediatric emergency department: are they related? Ann Emerg Med 2004; 44:454–459.

15 Green SM. Fasting is a consideration – not a necessity – for emergency department procedural sedation and analgesia. Ann Emerg Med 2003; 42: 647–650.

16 Green SM, Roback MG, Miner JR, *et al.* Fasting and emergency department procedural sedation and analgesia: a consensus-based clinical practice advisory. Ann Emerg Med 2007; 49:454–461.

17 Soto RG, Fu ES, Vila H, *et al.* Capnography accurately detects apnea during monitored anesthesia care. Anesth Analg 2004; 99:379–382.

18 Anderson JL, Junkins E, Pubble C, *et al.* Capnography and depth of sedation during propofol sedation in children. Ann Emerg Med 2007; 49:9–13.

19 Bowle TA. Depth of anesthesia monitoring. Anesthesiol Clin North Am 2006; 24:793–822.

20 Dominguez TE, Helface MA. Review of bispectral index monitoring in the emergency department and pediatric intensive care unit. Pediatr Emerg Care 2006; 22:815–821.

21 Barbi E, Bruno I, Ventura A. Widening sedation availability. J Pediatr 2005; 146:438–439.

22 Gozal D, Gozal Y. Re-widening sedation availability. J Pediatr 2005; 146:439.

23 Rex DK, Overley CA, Walker J. Registered nurse administered propofol sedation for upper endoscopy and colonoscopy: Why? When? How? Rev Gastroenterol Disord 2003; 3:70–80.

24 Stonell CA, Leslie K, Absalom AR. Effect-site targeted patient-controlled sedation with propofol: comparison with anaesthetist administration for colonoscopy. Anaesthesia 2006; 61:240–247.

25 Liddo LD, D'Angelo A, Nguyen B, *et al.* Etomidate versus, midazolam for procedural sedation in pediatric outpatients: a randomized controlled trial. Ann Emerg Med 2006; 48:433–440.

26 • Tobias JD. Dexmedetomidine: application in pediatric critical care and pediatric anesthesiology. Pediatr Crit Care Med 2007; 8:115–131.
A good review article by one of the leaders in the field.

27 Cravero JP, Blike GT, Beach M, *et al.* 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; 118:1087–1096.