Procedural sedation and analgesia for paediatric patients in the emergency department

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Children presenting to the emergency department (ED) often require sedation for brief procedures such as fracture and dislocation reductions, laceration repairs, and imaging procedures that are painful, anxiety provoking or both.This article presents three cases of paediatric patients who require sedation and/or analgesia, and summarizes important aspects of procedural sedation for the primary care practitioner in the emergency setting. Presedation assessment and monitoring equipment are detailed. Discussion of routes of administration and different agents including barbiturates, opiates, benzodiaxepines, the 'cardiac coctail', ketamine, propofol, nitrous oxide, and etomidate follow. Emphasis is placed on indications, contraindications, dosing, timing and advantages and disadvantages of each. Reversal agents are mentioned, and discharge criteria are outlined.

Key Words: *Procedural sedation; Emergency; Sedatives; Analgesia*

La sédation et l'analgésie en cas d'intervention chez les patients pédiatriques au département d'urgence

Les enfants qui se présentent au département d'urgence (DU) ont souvent besoin de sédation pour subir de brèves interventions douloureuses, anxiogènes ou les deux, comme la réduction de fractures et de luxations, la réparation de lacérations et des interventions d'imagerie. Le présent article porte sur trois patients pédiatriques qui ont eu besoin de sédation ou d'analgésie et résume d'importants aspects de la sédation en cas d'intervention pour le praticien de première ligne à l'urgence. L'évaluation avant la sédation et le matériel de surveillance sont détaillés. Un exposé sur les voies d'administration et sur divers agents, y compris les barbituriques, les opiacés, les benzodiazépines, le « cocktail cardiaque », la kétamine, le propofol, l'oxyde nitreux et l'étomidate, suit. On fait ressortir les indications, les contre-indications, la posologie, la synchronisation et les avantages et inconvénients de chacun. Les agents d'inversion sont indiqués et les critères pour accorder le congé, soulignés.

CASE 1

A 2-year-old boy has a 4 cm laceration across his cheek that requires suturing, but he will not stay still. With what medication(s) would one choose to sedate him for this procedure?

CASE 2

An 8-year-old girl presents with a displaced fracture of her radius and ulna that needs closed reduction. With what medication(s) would one choose to sedate her to provide pain control?

CASE 3

A 6-month-old baby has had a partial seizure and needs a semi-urgent CT scan of his head. With what medication(s) if any would one choose to sedate him?

INTRODUCTION

Procedural sedation (previously termed 'conscious sedation') is defined as

> a technique of administering sedatives or dissociative agents with or without analgesics to induce a state that allows the patient to tolerate unpleasant procedures while maintaining cardio-respiratory function. Procedural sedation and analgesia is intended to result in a continuum of depressed levels of consciousness that allows the patient to maintain airway control independently and continuously. Specifically, the drugs, doses and techniques used are not likely to produce a loss of protective 'airway reflexes' (1).

Oligoanalgesia (inadequate pain control) and insufficient sedation are concepts that are becoming better known and less acceptable to emergency physicians, nurses, patients and their families. Compared with adults, children receive less medication per kilogram for pain. Without adequate procedural sedation, children experience unnecessary pain and/or anxiety. In addition, parents and health care professionals have anxieties of their own. A suffering child is an uncooperative patient who impairs control over the

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TABLE 1
American Society of Anesthesiologists' physical status classification system

ASA 1	A normal, healthy patient
ASA 2	A patient with mild systemic disease
ASA 3	A patient with severe systemic disease
ASA 4	A patient with severe systemic disease that is a constant threat to life
ASA 5	A moribund patient who is not expected to survive without the operation
ASA 6	A declared brain-dead patient whose organs are being removed for donor purposes

Data from the American Society of Anesthesiologists. <http://www.asahq.org/clinical/physicalstatus.htm> (Version current at May 14, 2003). ASA American Society of Anesthesiologists

procedure, making it difficult to successfully complete. Procedures that frequently require such control include complex lacerations, fractures or dislocation reductions, burn dressings, wound debridements and repairs, foreign body removals, eye examinations, gynecological examinations and, occasionally, diagnostic imagings.

Reasons for this common problem include a lack of consensus on the best medication, dose and route of administration for procedures. Other obstacles include a lack of agreement on monitoring and a fear of adverse effects. The purpose of this practice point is to review these issues with the goal of enhancing physician comfort with procedural sedation to improve patient care.

SETTING

Challenges associated with procedures done in the emergency department (ED) such as acute and unexpected injury, concurrent or comorbid illness, full stomachs, a noisy environment, and limited preparation time are different than those of elective cases. Additional distinctions include available monitoring, allied health professionals (such as respiratory therapists) and the relatively short nature of most emergency procedures.

PRESEDATION ASSESSMENT

An appropriate history and a focused physical examination should be done before initiating procedural sedation. Allergies (or prior problems with anesthetics), medications, past medical history, last meal and events leading to the need for sedation are important to ascertain. The examination should focus attention on the upper airway (the Mallampati classification, dental devices, mandible size, neck size and flexion), breathing and signs of perfusion (including blood pressure and level of consciousness).

Fasting guidelines for healthy patients undergoing elective procedures may not be appropriate in emergency situations.

Anesthesia should be consulted and consideration be given to performing the procedure in the operating room for patients with an American Society of Anesthesiologists classification of P3 or greater (Table 1).

MONITORING AND EQUIPMENT

Depending on the depth of sedation desired, different levels of monitoring should be instituted. Aside from the person performing the procedure, one health care worker who is trained in sedation and skilled in airway management should be designated to manage the medications and their possible adverse effects. An oxygen delivery system, an oral airway and a bag-valve-mask should be at the bedside. An intravenous line may be placed at the physician's discretion. A cardiac arrest cart with standard medications for resuscitation should be nearby. Exhaled carbon dioxide levels, if available, may also be useful. Monitoring should include pulse oximetry for light sedation, and continuous electrocardiograph and intermittent blood pressure monitoring for deeper sedation. Vital signs should be recorded at baseline, after each dose of medication, every five minutes during deep sedation, at the end of the procedure, during recovery, and at discharge. A standard procedural sedation record should be used.

NONPHARMACOLOGICAL MEASURES

Several techniques have been used to reduce anxiety and the perception of pain in children, including hypnosis, distraction, visual imagery, and simple explanation and preparation of the child. While these techniques are useful for short, less painful procedures and are good adjuncts for longer, more painful procedures, many emergency procedures necessitating sedation in children are too painful or anxiety provoking to be tolerated without pharmacological influence.

IDEAL AGENT

The ideal agent for procedural sedation would:

- have a rapid onset and recovery time;
- be titratable;
- be consistently efficacious in achieving loss of consciousness and amnesia with or without analgesia while maintaining cardiopulmonary homeostasis;
- be painless to administer;
- cause no significant adverse effects; and
- be easy to reverse.

Although many pharmaceutical agents have some of these qualities, none possess all of them.

ROUTES

There are five routes for administering medications to children, each with advantages and disadvantages.

Oral/rectal

Giving drugs orally and rectally are popular choices. However, these routes have an unpredictable, prolonged onset of action and an unacceptably protracted recovery time. They have variable absorption and sedation levels.

Intranasal

Some researchers have advocated administering drugs intranasally because of absorption across richly vascularized mucosa with direct transport of the medication into the systemic circulation. This avoids first-pass metabolism and may increase bioavailability. Some believe there is high patient acceptability compared with rectal, intramuscular or intravenous methods. Disadvantages include variable absorption (with potential for prolonged onset and offset of action), variable levels of sedation and irritation on administration. These problems render intranasal medications unsuitable for many procedures done in EDs.

Intramuscular

Intramuscular injection is a painful route that cannot be titrated; thus, the onset of the resulting sedation is erratic.

Intravenous

The intravenous approach is commonly used. The main drawbacks are that it is painful, particularly if multiple attempts are required, and that there is a remote risk of introducing infection. The benefits include direct delivery to the systemic system, which affords rapid and reliable onset and duration of effect. Intravenous access is allowed in case any of the following are needed:

- drug titration
- a reversal agent
- other medications
- fluid

For most emergency procedures that require sedation and analgesia, intravenous access is not only warranted but the ideal route.

AGENTS

Barbiturates

Barbiturates are the typical choices for patients with suspected increased intracranial pressure (ICP) (Table 2). These sedative hypnotics have no analgesic properties and; therefore, are useful for nonpainful but anxiety-provoking procedures (such as diagnostic imaging). However, if analgesia is required, they must be combined with another agent. Side effects include rate and dose dependent laryngospasm, bronchospasm, cough, respiratory suppression, myocardial depression and hypotension. They are contraindicated in patients with porphyria. One study reported no laryngospasm, bronchospasm or hypotension with 25 mg/kg of rectal thiopental in 1000 patients (2).

Benzodiazepines

As the most commonly used sedative hypnotics without analgesia, benzodiazepines have the added benefit over barbiturates of amnesia. They are often used in conjunction with narcotics, which may exacerbate the associated risks of respiratory depression and hypotension. Paradoxical excitation or hyperagitation can occur in some children, a particular challenge in children requiring a procedure for which they need to be relatively still. Contraindications include hypersensitivity; acute, narrow and/or open-angle glaucoma; myasthenia gravis; and hepatic or renal dysfunction.

TABLE 2
Medications used for procedural sedation

Medication	Dose (route)	Onset of action	Duration of action
Thiopental	25 mg/kg (PR)	5-15 min	60-90 min
Pentobarbital	1-3 mg/kg (IV)	1-5 min	15-60 min
	2-5 mg/kg (IM)	5-15 min	2-4 h
	2-3 mg/kg (PO)	15-60 min	2-4 h
Methohexital	20-30 mg/kg (PR)	5-15 min	20-90 min
	0.75-1.0 mg/kg (IV)	<1 min	5-10 min
Midazolam	0.05-0.15 mg/kg (IV)	1-2 min	30-60 min
	0.05-0.2 mg/kg (IM)	2-15 min	30-60 min
	0.2-0.5 mg/kg (IN)	10-15 min	45 min
	0.5-1 mg/kg (PR)	5-15 min	30-60 min
	0.25-0.75 mg/kg (PO)	10-20 min	1-4 h
Lorazepam	0.05-0.1 mg/kg (IV)	3-5 min	2-6 h
	0.05-0.1 mg/kg (IM)	10-20 min	2-6 h
	0.05-0.1 mg/kg (PO)	60 min	2-8 h
Diazepam	0.1-0.2 mg/kg (IV)	2-3 min	30-90 min
	0.3-0.5 mg/kg (PR)	5-15 min	2-4 h
Morphine	0.05-0.1 mg/kg (IV)	5-10 min	2-4 h
Fentanyl	1-4 µg/kg (IV)	1-3 min	20-90 min
	0-5 µg/kg (TM)	15-30 min	60-120 min
Ketamine	0.5-2 mg/kg (IV)	1-2 min	15-60 min
	3-5 mg/kg (IM)	3-10 min	15-60 min
	5-10 mg/kg (PO)	30-45 min	2-4 h
Chloral hydrate	25-100 mg/kg (PO/PR)	15-30 min	2-3 h
Propofol	0.5-1 mg/kg or 25-125µg/kg/min	<1-2 min	3-10 min
Nitrous oxide	30%-50%	1-5 min	3-5 min
Etomidate	0.1-0.3 mg/kg	<1 min	5-15 min

Data from reference 3. IN Intranasal; IM Intramuscular; IV Intravenous; PO Oral; PR Rectal

Narcotics

The opioid class of drugs includes morphine, fentanyl, meperidine and diamorphine (available in Europe). This medication class continues to be the gold standard for acute pain control. Hemodynamic compromise and pruritis are histamine-induced adverse effects that occur to a greater degree with morphine than with synthetic fentanyl. Rapidly administered large doses of fentanyl (usually greater than 5 µg/kg) may cause chest wall rigidity. Naloxone can reverse many of the adverse effects of narcotics but chest wall rigidity may necessitate paralysis and intubation. Narcotics are contraindicated in patients with hypersensitivity and severe respiratory depression.

Fentanyl

Fentanyl is a commonly used synthetic opioid that has a rapid onset, a short duration, is reversible, and is 50 to 100 times more potent than morphine. The main benefit over

other narcotics is the comparatively minimal histamine release and limited cardiovascular side effects. It has been incorporated into a lollipop that is nonthreatening and easy to administer. However, this form has been found to cause significant vomiting and pruritis, and is not recommended for procedural sedation.

Diamorphine

Diamorphine is rapidly and well absorbed (lipophilic), has a low irritancy and has twice the potency of morphine with a similar duration of action.

Fentanyl and midazolam

Many emergency physicians combine these two agents to achieve analgesia, sedation, anxiolysis, amnesia and muscle relaxation. The drawback is a higher incidence of respiratory depression because the agents are synergistic.

OTHERS

Meperidine, promethazine and chlorpromazine (intramuscular)

The combination of **meperidine, promethazine, and chlorpromazine** (also called demerol, phenergan and thorazine (DPT); lytic cocktail; paediatric cocktail; dethergan; kiddie cocktail; cardiac catheterization cocktail; or Demerol compound) provides analgesia and sedation, and is antiemetic. However, it has a delayed onset of action, lasts up to several hours, has a high failure rate for sedation in paediatrics and carries a risk of respiratory depression and/or arrest at even less than recommended doses. For these reasons, this triad of medications is no longer recommended.

Chlorpromazine

Although some physicians have used chlorpromazine in isolation to sedate children, the risk of hypotension, dystonic reactions, reduction of seizure threshold and prolonged lethargy make it unacceptable given the available alternatives.

Ketamine

As a nonbarbiturate phencyclidine derivative that provides dissociative sedation, analgesia and amnesia, ketamine is a popular choice for many ED procedures. It has cardiostimulatory effects that make it ideal for patients in whom hemodynamic compromise must be avoided. It may be administered orally, with 16% bioavailability compared with 93% when given intravenously or intramuscularly. It may be of benefit to asthmatic patients by reducing bronchospasm.

The primary adverse effects of ketamine are 'emergence phenomena'. These are perceptual disturbances such as alterations in mood, vivid or unpleasant dreams, and hallucinations during or after emergence from sedation. Addition of midazolam may reduce these adverse perceptual effects, although studies have not supported this theory (4).

Ketamine may cause excessive salivation, which can be avoided by pretreatment with 0.01 mg/kg to 0.02 mg/kg of atropine or 0.005 mg/kg to 0.01 mg/kg of glycopyrrolate. Laryngospasm and increased systemic, intracranial and intraocular pressures have also been described with ketamine; therefore, it is contraindicated in patients with these conditions.

Propofol (2,6-diisopropyl phenol)

Propofol is becoming a popular choice for short emergency procedures in children. This nonopioid, nonbarbiturate sedative hypnotic has anticonvulsant properties, an amnestic effect, and lowers intracranial pressure. It may, however, cause apnea, hypotension and reduced cardiac output, and should be used only by physicians who are comfortable managing these potential complications. Infusions must only be used on a short term basis (less than several hours) because long term use has been associated with serious adverse events. Health Canada has stated that "propofol is contraindicated for the sedation of children 18 years or younger receiving intensive care" (5). Propofol lacks analgesic effect and is commonly combined with an opioid such as fentanyl. Propofol has been found to 'burn' with injection. This can be avoided by injecting up to 1 mL of 1% lidocaine before or with it.

Propofol is contraindicated in patients with egg or soybean allergy, known hypersensitivity or disordered fat metabolism.

Etomidate

An imidazole derivative, etomidate was recently shown to be useful in many emergency procedures (6). Its lack of clinically significant hemodynamic alterations and its minimal side effects give rise to interest in exploring this agent

TABLE 3
Reversal agents

Agent	Dose (route)	Onset/duration	Comments
Naloxone	1-100 µg/kg every 1-2 min (IV, IM, ET)	1-3 min/ 15-120 min	Low dose maintains analgesia
Flumazenil	0.01-0.02 mg/kg every 1-2 min (IV)	1-2 min/ 20-120 min	May induce seizures

ET Endotracheal; IN Intranasal; IM Intramuscular; IV Intravenous; PO Oral; PR Rectal

TABLE 4
Discharge criteria

Patent airway and adequate oxygenation
Stable vital signs (back to baseline)
Awake or easily aroused
Return to a presedation level of responsiveness:
Able to sit up with assistance if age-appropriate
Follow age-appropriate commands
Return to baseline verbal ability
Able to tolerate an oral challenge
Accompanied by a responsible adult who can observe the child closely for the next eight hours

for use in procedural sedation. While etomidate is known to cause suppression of the adrenal gland, these effects are transient and thought to have little if any clinical consequence. Not yet available in Canada, except in special circumstances, etomidate has been used successfully for years in the United States.

Nitrous oxide

As the only inhalational anesthetic available to most EDs, nitrous oxide provides anxiolysis and mild analgesia. It is combined with oxygen (usually 50%) and requires a scavenging system. It is usually delivered using a 'demand valve' and consequently requires a cooperative patient. Nitrous oxide is contraindicated in patients with a pneumothorax or closed air spaces such as a bowel obstruction.

REVERSAL AGENTS

Reversal of sedation or analgesia should be weighed carefully to balance the benefits against the possible risks. Many advocate supportive care while awaiting the respiratory depressant's effect to abate (Table 3).

POST SEDATION MONITORING AND DISCHARGE CRITERIA

Once the procedure is completed, the patient enters a high-risk period in which there is minimal stimulation with continuing sedation and/or analgesia. Monitoring during this time is critical and a patient must not be discharged until consistent, predefined criteria have been met (Table 4). Patients should be observed for at least two hours if reversal agents have been administered.

CASE 1

Suturing a two-year-old child can be challenging. A good agent to use in this situation would be ketamine. The intravenous route has the advantage of being titratable and predictable, but even starting an intravenous drip may prove to be a challenge of its own. Oral ketamine is less predictable but will be well tolerated by some children. For the most difficult child, a one-time intramuscular shot will adequately sedate him for enough time to repair most simple lacerations.

CASE 2

Fracture reductions are an excellent example of when propofol is the ideal agent. With its rapid onset of action and short duration, propofol provides excellent sedation and muscle relaxation that facilitates the manipulation of fractures. Because it does not have analgesic properties, propofol must be used in conjunction with a short acting opiate such as fentanyl. Appropriate monitoring by personnel who are prepared to deal with potential transient respiratory depression and hypotension are mandatory. Ketamine would be another good choice for this scenario. While it will take longer to act and subsequently wear off, it provides analgesia and sedation, and causes less cardiorespiratory depression.

CASE 3

Sedation of an infant may be required for cooperation with radiological investigations such as computed tomography. For these patients, rectal thiopental works very well. It has a relatively quick onset and does not impair the neurological status of the patient for a prolonged period of time. Again, it must be used with appropriate monitoring, and physicians must be aware of and prepared for any potential respiratory depression.

SUMMARY

Oligoanalgesia and anxiety-provoking events within the paediatric ED population are problems that have short and long term negative consequences for patients, parents and health care workers. Procedural sedation is one method that employs dynamic medication titration to reduce these problems. Knowledge of the indications, pharmacology and approach to procedural sedation in the paediatric ED population often results in a more successful outcome for the child undergoing a potentially painful or anxiety-provoking experience. However, it is important for the health care worker(s) involved to be aware of and prepared for adverse events that may arise during and after the sedation experience.

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