An Evidence-Based Approach To Pediatric Procedural Sedation

Abstract

Children present a unique challenge when it comes to procedural sedation in the emergency department. For pediatric patients, sedation may be required to facilitate cooperation during a procedure that would not typically require sedation in an adult patient. The amnestic, anxiolytic, and analgesic properties of procedural sedation agents must be weighed against their potential side-effect profiles. The ideal agent should have a favorable safety profile, be quick and easy to administer, provide adequate length and depth of sedation, and result in a relatively rapid return to baseline. An evidence-based evaluation of various agents of procedural sedation is presented in this review.

Case Presentation

A 3-year-old girl with a history of reactive airway disease is brought into the ED by her father. She has sustained a fall that resulted in a small frontal hematoma and a deep, jagged chin laceration. The father states that there was no loss of consciousness and no vomiting at the time of the event, which was 1 hour prior to her arrival to the ED. The father is concerned about her head injury and also inquires about the repair of the cut. Your examination reveals a very anxious child with a chin laceration that is fairly deep and may require extensive repair. You begin to consider sedation. You inquire about her last meal, and the father states that she had a light dinner about 4
hours prior to their arrival. He asks about the relevance of her last meal. You begin to explain that his child may need sedation and try to answer all of his questions. Which sedative will you use? What are the side effects? How long will it last? Is it absolutely necessary? Does it matter that she sustained a head trauma earlier today? Will she need an IV prior to the procedure? How long will it take for her to return to her normal self?

**Introduction**

Historically, pain and anxiety in the pediatric population has been undermanaged. Some of the reasons for the undertreatment of pain can be attributed to children’s inability to quantify or qualify their pain. Other factors are attributed to the unfamiliarity of medical personnel with the different available agents for pain management and fear of their adverse side effects.1-4

Nonpharmacologic interventions should always be considered when approaching a child who requires a diagnostic or therapeutic procedure. The developmental stage of the child should always be considered when choosing a proper pharmacologic or nonpharmacologic intervention. A child’s perception of pain is influenced by age, cognitive level, and past experiences of painful episodes. It is also very important to remember that a child’s reactions are often based on the reaction of his or her parents. Involving the parents can ease their concerns and help calm the patient.5

**Critical Appraisal Of The Literature**

An extensive literature search was performed in the PubMed database using multiple combinations of the search terms procedural sedation, conscious sedation, pediatric analgesia, pediatrics, emergency department, and side effects. All relevant articles were selected, reviewed, and included in the bibliography. Over 125 articles were reviewed, 68 of which are cited in this article. Emphasis was placed on reviewing the most recent reports, studies, and guidelines.

**Definitions**

_Procedural sedation_ is defined as the use of pharmacological and nonpharmacological means to depress the central nervous system, thus reducing a patient’s anxiety and irritability, enabling intervention or treatment to be carried out.6,7 In 2001, the Joint Commission issued the following terminology: (1) minimal sedation, (2) moderate sedation/analgesia, (3) deep sedation/analgesia, and (4) general anesthesia.8,9

**Analgesia:**
- Pain is relieved without intentionally producing a sedated state.
- Altered mental status may be a secondary effect of medications administered for analgesia.

**Minimal Sedation:**
- The patient responds normally to verbal commands, although cognitive function and coordination may be impaired.
- Ventilatory functions are unaffected.
- Cardiovascular functions are unaffected.

**Moderate Sedation:**
- The patient responds purposefully to verbal commands either alone or with minimal stimulation.
- The patient maintains airway and adequate ventilation without intervention.
- Cardiovascular function is maintained.

**Deep Sedation:**
- The patient cannot be easily aroused but responds purposefully to noxious stimulation.
- The patient may require assistance to maintain airway and adequate ventilation.
- Cardiovascular function is usually maintained.

**Dissociative Sedation:**
- The patient is in a trance-like cataleptic state in which they experience profound analgesia and amnesia but retain airway protective reflexes, spontaneous respirations, and cardiopulmonary stability.10
- Ketamine is the only approved pharmacologic agent used for procedural sedation that produces this state.

**General Anesthesia:**
- The patient cannot be aroused.
- The patient often requires assistance to maintain airway and positive pressure ventilation.
- Cardiovascular function may be impaired.

**Goals Of Sedation**

The medication selected for each procedure should meet the following goals8:
- Guard the patient’s safety and welfare
- Minimize physical discomfort and pain
- Control anxiety, minimize psychological trauma, and maximize the potential for amnesia
- Control behavior and/or movement to allow the safe completion of the procedure
- Ensure safe discharge

Knowledge of each drug’s time of onset, peak response, and duration of action is essential.
Emergency Department Presedation
Evaluation And Preparation

All presedation evaluations should begin with a detailed history, including previous medical problems, surgeries requiring anesthesia, allergies, use of the medications, family history, and type and time of the most recent oral intake. The physical examination should focus on heart and lung auscultation as well as evaluation for any conditions that may interfere with endotracheal intubation, if necessary. Patients should be assigned an American Society of Anesthesiologists (ASA) Physical Status Classification. (See Table 1.) Patients who are in ASA classes I or II are frequently considered appropriate candidates for minimal, moderate, or deep sedation. Children in ASA classes III or IV, children with special needs, or those with anatomic airway abnormalities or extreme tonsillar hypertrophy present issues that require additional and individual consideration, particularly for moderate and deep sedation.8,11

Presedation assessments are a Joint Commission requirement, and most institutions have a specific form to facilitate consistent documentation.12 (See Appendix A, page 10.)

Preoperative Fasting

Agents used for sedation are thought to have the potential to impair protective airway reflexes, particularly during deep sedation, and impairment of those reflexes may result in regurgitation and pulmonary aspiration. Before sedation, the emergency clinician needs to evaluate prior food and fluid intake.8

The ASA has issued consensus-based guidelines for preoperative fasting; however, they are limited to “healthy patients” undergoing “elective procedures,” effectively excluding emergency department (ED) patients. These guidelines stipulate at least 2 hours of fasting for clear liquids, at least 4 hours for breast milk, and at least 6 hours for solids, cow’s milk, and infant formula.13,14

In separate guidelines for procedural sedation and analgesia, the ASA states, “The literature does not provide sufficient evidence to test the hypothesis that preprocedure fasting results in a decreased incidence of adverse outcomes in patients undergoing either moderate or deep sedation.” Given this lack of sufficient evidence, the ASA used task force consensus to conclude that, “In urgent, emergent, or other situations in which gastric emptying is impaired, the potential for pulmonary aspiration of gastric contents must be considered in determining: (1) the target level of sedation, (2) whether the procedure should be delayed, or (3) whether the trachea should be protected by intubation.”15

Most of the current understanding of aspiration risk with procedural sedation and analgesia is less likely than commonly believed. Thus, there is insufficient evidence to support the position that fasting guidelines crafted for operative anesthesia should be extrapolated to sedation practice.13,16 In fact, recent literature comparing patients with different preprocedural fasting times found no significant difference in the incidence of adverse events between the groups.17

Although each institution may have its own standard for procedural sedation regarding nil per os (NPO, or nothing by mouth) status, a 4-step assessment is recommended before each sedation to stratify aspiration risk:14

1. Assess the patient’s risk. Patients with 1 or more of the following are at higher risk.
   • Possibility of a difficult airway
   • Conditions predisposing to esophageal reflux (ie, elevated intracranial pressure, gastritis)
   • Extremes of age (ie, < 6 months or > 70 years)
   • Severe systemic disease with functional limitation (ASA class ≥ 3)
   • Other clinical conditions that may increase aspiration risk (ie, altered mental status)

2. Assess the timing and nature of recent oral intake.
   • Nothing
   • Clear liquids only
   • Light snack
   • Heavier snack or meal

3. Assess the urgency of the procedure.
   • Emergency (ie, cardioversion, reduction of an angulated fracture)
   • Urgent (ie, care of dirty wound or laceration, incision and drainage, or fracture reduction)

Table 1. American Society of Anesthesiologists Patient Classifications

<table>
<thead>
<tr>
<th>Patient Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Normally healthy patient</td>
</tr>
<tr>
<td>Class II</td>
<td>A patient with mild systemic disease (ie, mild asthma)</td>
</tr>
<tr>
<td>Class III</td>
<td>A patient with severe systemic disease (ie, moderate-to-severe asthma)</td>
</tr>
<tr>
<td>Class IV</td>
<td>A patient with severe, systemic disease that is a constant threat to life (ie, severe bronchopulmonary dysplasia, advanced cardiac disease)</td>
</tr>
<tr>
<td>Class V</td>
<td>A moribund patient who is not expected to survive without the operation (ie, septic shock, severe trauma)</td>
</tr>
</tbody>
</table>

Adapted from The Lancet, Vol. 367, by Baruch Krauss and Steven M. Green, “Procedural Sedation and Analgesia in Children,” page 766, Copyright 2006, with permission from Elsevier.
clip-on devices are prone to displacement and may produce artificial data.\(^8\)

It is also important to note that pulse oximetry is not a substitute for monitoring ventilation, as there is a variable lag time between the onset of hypventilation or apnea and a change in oxygen saturation. For this reason, capnography has been used increasingly more often to monitor ventilation. Increases in end-tidal carbon dioxide (ETCO\(_2\)) can be detected in patients with respiratory depression before hypoxemia is noted, particularly in those who are receiving supplemental oxygen. ETCO\(_2\) has also been shown to detect hypoventilation much more reliably than by medical staff observation alone.\(^{19,20}\)

### Vascular Access

Intravenous (IV) access is not mandatory in procedural sedation, especially for lighter levels of sedation or when the agent can be administered via other routes. If the procedure is performed without an IV catheter, equipment and personnel capable of establishing vascular access should be immediately available. If the patient is anticipated to need multiple doses of medication or if they are a higher-risk patient, an IV catheter should be placed prior to the procedure.

Patients receiving deep sedation should have an IV catheter in place for administration of multiple doses of medication or for resuscitation, if needed.

### Discharge Criteria

Monitoring should continue until the patient meets criteria for safe discharge.\(^{18}\) These criteria include:

- Airway patency and stable cardiovascular function
- Easy arousability with intact protective reflexes
- Ability to talk (if age appropriate)
- Ability to sit up unaided (if age appropriate)
- Adequate hydration, with management of any nausea or vomiting
- Appropriate management of any continued pain
- Caregiver understanding of possible complications and discharge instructions

Young infants or children who are handicapped should return to the level of responsiveness observed before sedation. In a prospective study of 1367 ED sedation events after which the child was discharged, adverse effects occurred in 14% and occurred within 25 minutes of the last medication dose. This study suggests that children who have not experienced a serious adverse reaction to sedation can be safely discharged after 30 minutes of observation.\(^{21}\)
**Analgesic Medications**

Proper use of analgesic medication can decrease the need for sedation. There are a variety of choices, from topical to systemic. A summary of the following agents for procedural sedation is included in Table 2, page 9.

**Topical Agents**

**LET: Lidocaine 4%, epinephrine 0.1%, tetracaine 0.5%**

- **Uses:**
  - Small laceration repair (< 5 cm)
  - Provides adequate anesthesia for closure in 75% to 90% of scalp and facial lacerations
  - Less effective on extremity or truncal wounds

- **Route:** Topical; available as an aqueous solution or gel (gel is easier to use)

- **Dose/duration:** 1 to 3 mL applied to an open wound for 20 to 30 minutes

- **Contraindications/side effects:**
  - Adverse effects are rare
    - A systematic review of 23 randomized controlled trials reported no complications
    - Toxic effects can be: cardiovascular, central nervous system, methemoglobinemia
  - Use with caution on mucous membranes (potential of excessive absorption)
  - LET is contraindicated in patients with allergy to amide or ester local anesthetics
  - Epinephrine causes local vasoconstriction, which slows systemic absorption and metabolism of the anesthetics

- **Comments:**
  - Having standing triage orders may expedite pain control and laceration repair
  - If local anesthesia with LET alone is inadequate, LET can still reduce the pain of the lidocaine injection

**EMLA: Lidocaine 2.5% and prilocaine 2.5% in a cream base**

- **Uses:**
  - Venous or arterial punctures
  - Placement of IV catheters
  - Accessing subcutaneous drug reservoirs
  - Lumbar punctures
  - Laceration repair

- **Route:** Topical

- **Dose/duration:**
  - 1 to 2 g of EMLA cream should be applied per 10 cm
  - Requires approximately 1 hour to achieve peak affect

- **Effects last up to 2 hours after removal of cream**

- **Contraindications/side effects:**
  - Conditions requiring rapid treatment
  - Known allergies to lidocaine or prilocaine
  - Predisposition to methemoglobinemia (G6PD)
  - Avoid use in infants < 3 months of age

- **Comments:** Having standing triage orders may expedite pain control and laceration repair

**Lidocaine**

- **Uses:** Lidocaine is the most commonly used anesthetic for local infiltration.

- **Route:** For repair of wounds that require precise anatomic alignment, a regional block may be preferable to infiltration of local anesthetic because local infiltration may distort important skin landmarks.

- **Dose/duration:** Usually given as a 1% solution (10 mg/mL). Dosage should not exceed:
  - Lidocaine without epinephrine – 5 mg/kg (0.5 mL/kg)
  - Lidocaine with epinephrine – 7 mg/kg (0.7 mL/kg)

- **Contraindications/side effects:** In the past, injection of epinephrine with local anesthetic in certain areas such as face, nose, ear, digit, or penis was discouraged as it was thought to have the potential to cause ischemic complications. There is no convincing evidence of the harm of such use.

- **Comments:** Buffering of lidocaine with sodium bicarbonate decreases the pain of injection, especially when using lidocaine with epinephrine, and it may shorten the time to anesthetic effect. Lidocaine can be buffered by adding 1 part of 1 mEq/mL of sodium bicarbonate to 9 to 10 parts of 1% lidocaine or 1% lidocaine with epinephrine.

**Systemic Agents**

**Nonopioids**

**Acetaminophen (APAP, Paracetamol)**

Acetaminophen is a safe choice for treatment of pediatric pain. The acetaminophen dose is 15 mg/kg every 4 hours. The maximum daily dose for children < 2 years old is 60 mg/kg/day; for children 2 to 12 years old, the maximum daily dose is 75 mg/kg/day, not to exceed 3750 mg/day.

**Ibuprofen**

Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID) used to control mild to moderate pain, and it can be used in children > 6 months old. The mechanism of action is inhibition of prostaglandins. Ibuprofen is metabolized in the liver and excreted in urine. The dose for pain reduction is 10 mg/kg every 6 to 8 hours, with a maximum daily dose of 40 mg/kg.
Clinical Pathway For Choosing The Proper Sedation Agent

- **Goal of procedure**
  - Motion control
    - Sedative, dissociative agents
  - Anxiolysis
    - Sedative, dissociative agents
  - Sedation
    - Sedative, dissociative agents
  - Analgesia
    - Opioids, dissociative agents
  - Amnesia
    - Opioids, dissociative agents, or sedatives

- **Type of procedure**
  - Not painful (ie, diagnostic imaging)
  - Minimally painful (ie, minor trauma, instrumentation, vascular access)
  - Painful (ie, minor trauma, instrumentation, vascular access [central])

- **Sedation**
  - Midazolam
  - Propofol
  - Nitrous oxide
  - Topical local anesthesia
  - Midazolam
  - Ketamine
  - Fentanyl + midazolam
  - Propofol

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lipophilic agent, the drug accumulates with repeated
and/or prolonged administration.\textsuperscript{37-39} Chest wall
rigidity is a known side effect of fentanyl, but it has
been shown to occur with higher doses in preterm
and term neonates. The treatment for rigid chest
syndrome is respiratory support (which may require
intubation and chemically induced paralysis) and
use of an opioid reversal agent such as naloxone.\textsuperscript{40,41}
Typically, fentanyl is administered intravenously,
but an effective intranasal or nebulized route is also
available.\textsuperscript{42-43} Dosing of fentanyl is 1 to 2 mcg/kg/dose (max 100 mcg).

**Sedative/Hypnotic Agents**

**Midazolam**
Midazolam is a short-acting benzodiazepine with
a rapid onset of action. It provides sedation, anxi-
olysis, and amnesia. Midazolam can be admin-
istered via multiple routes.\textsuperscript{12} It is important to
remember that this class of agents does not have
direct analgesic properties and can be given in
conjunction with opioids for analgesia. When this
is done, however, caution must be used because
the risks of hypoxia and apnea are much greater
than when either agent is used alone.\textsuperscript{44} Midazolam
is often preferred over other longer-acting benzo-
diazepines. The time to peak effect is 2 to 3 min-
utes, and duration is approximately 45 minutes
to 1 hour via the IV route. Other available routes
include IM, oral, intranasal, and rectal. The onset
of action via the oral route is 15 to 30 minutes,\textsuperscript{3}
but it has been noted that oral midazolam can lead
to unreliable concentrations in serum and clinical
effect due to first-pass hepatic metabolism.\textsuperscript{45-47} The
intranasal route has an onset of action within 10
to 20 minutes, but it can be irritating to the nasal
mucosa.\textsuperscript{48,49} Midazolam can be used for effective
moderate-to-deep sedation through careful IV ti-
tration. Paradoxical reactions, characterized by in-
consolable crying, combativeness, disorientation,
agitation, and restlessness have been reported in
1% to 15% of children receiving midazolam.\textsuperscript{50} One
study involving 706 patients showed an incidence
of 3.4% in patients between 6 months and 6 years
of age within 3 to 6 minutes of midazolam admin-
istration. Other side effects noted were desatura-
tion (4.6%), apnea (2.8%), hypotension (2.7%), and
hiccups (1%-2%).\textsuperscript{50} It is important to remember to
monitor the patient closely during administration
of midazolam, especially if it is given in conjunc-
tion with opioids. Recommended dosing:
- Oral: Infants and children: 0.25 to 0.5 mg/kg
  (max 20 mg)
- Intranasal: 0.2 to 0.5 mg/kg
- IV:
  - 6 months old to 5 years old: 0.05 to 0.1 mg/
    kg (max 6 mg)
  - > 5 years old: 0.25 to 0.5 mg/kg (max 10 mg)
  - > 12 years old: 0.5 to 1.0 mg/kg (max 20 mg)

**Barbiturates**
Barbiturates are often used in the pediatric ED for
children who require sedation to undergo a diagnost-
ic imaging study.\textsuperscript{53} Barbiturates are relatively safe,
especially if used alone. Major side effects are hypo-
tension and respiratory depression with apnea. The
potential for airway compromise increases when used
in combination with other sedatives and/or opiates.

**Methohexital**
Methohexital is a very short-acting agent. Onset of
action is 30 to 60 seconds, and the duration of the
effect is only 5 to 10 minutes.\textsuperscript{52}

**Thiopental**
Thiopental is a short-acting drug. The onset of action
is 30 to 60 seconds, and the duration of effect is 15
minutes. Thiopental decreases intracranial pressure
and may be useful in patients in whom increased in-
tracranial pressure is a concern.\textsuperscript{53} It is generally used
rectally for procedural sedation in children.

**Pentobarbital**
Pentobarbital is an effective sedative for radiologic
procedures. When the drug is given intravenously,
the onset of action is approximately 3 to 5 minutes
and the duration of action is 30 to 45 minutes. The
onset of action is slower with oral or rectal admin-
istration. In a prospective study of 55 patients, the
mean intubation time of pentobarbital was 6 min-
utes and duration of sedation averaged 86 minutes.\textsuperscript{54}
Recommended dosing:
- Oral:
  - < 4 years old: 1.5 to 3 mg/kg (max 100 mg)
  - > 4 years old: 3 to 6 mg/kg (max 100 mg)
- IV:
  - 1 to 6 mg/kg; titrate with 1 to 2 mg/kg every
    3 to 5 minutes
  - IM: 2 to 6 mg/kg (max 100 mg)

**Propofol**
Propofol is a nonopioid, nonbarbiturate seda-
tive hypnotic that has traditionally been used
by anesthesiologists as an induction agent for
general anesthesia. When used intravenously, it
has an immediate clinical effect, and, if used with
an opioid for analgesia, it can provide effective
sedation for painful procedures, and has a quick
recovery time of 5 to 15 minutes. Propofol has
antiemetic as well as euphoric properties.\textsuperscript{55,56} If
consistent with hospital guidelines and protocols,
the clinician using propofol in the ED must re-
member to use proper monitoring, capnography,
and pulse oximetry.\textsuperscript{57} Propofol is contraindi-

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in any patient with known or suspected allergy to propofol, eggs, or soy products. The most serious adverse effect of propofol is potent respiratory depression and apnea. Hypotension is also one of the side effects, but it seems to be transient and of little clinical importance in healthy patients. Propofol dosing is 1 mg/kg (repeat dose 0.5 mg/kg).

**Ketamine**

Ketamine has been a popular dissociative agent among emergency clinicians for years. Ketamine works by disconnecting the thalamocortical and limbic systems, resulting in a trance-like state characterized by amnesia, analgesia, and sedation. Ketamine provides effective sedation and anxiolysis for very painful procedures while maintaining airway patency and cardiac function. Although previous guidelines advised against use of ketamine in children 3 to 12 months of age, a recent meta-analysis demonstrated that the previous concerns for higher risks of airway compromise are anecdotal. Current absolute age contraindications for ketamine include infants < 3 months old. Previous data recommended against the use of ketamine in patients with suspected increased intracranial pressure; however, new evidence suggests that the increase in intracranial pressure due to ketamine is minimal and that it can be safely used in patients with acute traumatic brain injury. There is also some evidence to suggest that ketamine’s cerebral vasodilatory effect may help with cerebral perfusion. In patients with known structural barriers to cerebrospinal fluid flow, alternative agents are preferred.

Ketamine is known to increase risk of laryngospasm during procedures with major stimulation of the oropharynx (ie, endoscopy), but it can be safely used for minor oropharyngeal procedures (ie, intraoral laceration repairs). Accumulation of secretions in the posterior pharynx should be avoided. Previously, ketamine was often administered with other medications. Coadministration of an anticholinergic (atropine) and benzodiazepine (midazolam) have been proven to be unnecessary. Coadministration of an antiemetic (ie, ondansetron) has been shown to decrease the rate of emesis in children by 8%. Because of this modest effect, the administration of ondansetron is in no way mandatory, but it may have beneficial effects in adolescents, in whom the rate of emesis is higher.

Ketamine’s side effects include: laryngospasm (which is usually resolved with bag-valve mask ventilation), apnea (rare, transient), respiratory depression, tachycardia, hypertension, emesis, emergence reactions, nystagmus, and muscle rigidity. Ketamine is contraindicated in patients with psychosis.

Ketamine’s dissociative effects take place at a certain threshold rather than on a dose-response continuum. Once the state has been reached, additional medication does not enhance the effect, nor are the adverse events heightened as long as one stays within the standard dosing range. Ketamine can be administered via either the IV or the IM route; both have been proven to be of equal safety. The IM route of ketamine administration is associated with a higher rate of vomiting. The IV route is preferred for longer procedures, as the patient may require repeat dosing. IV ketamine should be given over 30 to 60 seconds to avoid transient respiratory depression. IM ketamine doses need to be slightly higher to achieve the same state. Recommended dosing:

- **IV**: Loading dose of 1.5 to 2 mg/kg; repeated doses of 0.5 to 1.0 mg/kg, as needed
- **IM**: Loading dose of 4 to 5 mg/kg; repeated doses are half the loading dose, as needed

**Inhaled Nitrous Oxide**

Inhaled nitrous oxide provides mild analgesia, sedation, amnesia, and anxiolysis. It is commonly dispensed at concentrations between 30% and 70%, with oxygen composing the remainder of the mixture. Often, nitrous oxide may need to be combined with a more potent analgesic (ie, opioid, regional anesthesia) to produce adequate procedural conditions. It can be delivered through a demand-valve mask in a child who is able to cooperate (usually older than 4 years of age). This method of delivery also ensures that, if the patient becomes somnolent, the mask will fall from the patient’s face and gas delivery will stop. Continuous delivery systems are available but have variable success and result in more frequent emesis. Nitrous oxide has a rapid onset (30-60 sec), with a maximum effect after 5 minutes and rapid recovery with discontinuation of inhalation. Hemodynamic stability, protective airway reflexes, and spontaneous respirations are usually preserved. Some of the adverse effects of nitrous oxide are nausea, dizziness, voice change, euphoria, and laughter. Contraindications to nitrous oxide include nausea and vomiting, trapped gas (eg, bowel obstruction, pneumothorax, middle ear infection), and pregnancy. A scavenging system must be in place to ensure compliance with occupational safety regulations.
Table 2. Dosing, Onset, And Duration Of Procedural Sedation Medications

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosing</th>
<th>Onset</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analgesia</strong></td>
<td></td>
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</tr>
<tr>
<td>LET (lidocaine 4%, epinephrine 0.1%, tetracaine 0.5%)</td>
<td>Topical: 1-3 mL to wound</td>
<td>20-30 min</td>
<td>1 h</td>
</tr>
<tr>
<td>EMLA (lidocaine 2.5% and prilocaine 2.5%)</td>
<td>Topical: 1-2 g/10 cm²</td>
<td>60 min</td>
<td>2 h</td>
</tr>
<tr>
<td>Lidocaine 1%</td>
<td>Local: max – 5 mg/kg or 0.5 mL/kg</td>
<td>5-30 min</td>
<td>2 h</td>
</tr>
<tr>
<td>Lidocaine 1% + epinephrine</td>
<td>Local: max – 7 mg/kg or 0.7 mL/kg</td>
<td>5-30 min</td>
<td>2-3 h</td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>PO/PR: 15 mg/kg</td>
<td>10-60 min</td>
<td>4 h</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>PO: 10 mg/kg</td>
<td>1-2 h</td>
<td>6 h</td>
</tr>
<tr>
<td><strong>Ketorolac</strong></td>
<td>Children 2-16 y: x 1 dose</td>
<td>IV: 1-3 min</td>
<td>6 h</td>
</tr>
<tr>
<td></td>
<td>IV: 0.5 mg/kg (max 15 mg)</td>
<td>IV: 30-45 min</td>
<td></td>
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<tr>
<td></td>
<td>IM: 1 mg/kg (max 30 mg)</td>
<td>IM: 30-45 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Children &gt; 16 y or &gt; 50 kg</td>
<td>IV: 1-3 min</td>
<td>6 h</td>
</tr>
<tr>
<td></td>
<td>IV: 30 mg q8h (max 120 mg/day)</td>
<td>IM: 60 mg x 1 dose, then 30 mg q6h (max 120 mg/day)</td>
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</tr>
<tr>
<td><strong>Morphine Sulfate</strong></td>
<td>IV: 0.05-0.2 mg/kg (max 15 mg)</td>
<td>5-10 min</td>
<td>2-4 h</td>
</tr>
<tr>
<td><strong>Fentanyl Citrate</strong></td>
<td>IV: 1-2 mcg/kg (max 100 mcg/dose)</td>
<td>2-3 min</td>
<td>30-60 min</td>
</tr>
<tr>
<td><strong>Sedation</strong></td>
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<tr>
<td>Midazolam</td>
<td>PO: infants and children</td>
<td>15-30 min</td>
<td>60-90 min</td>
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<td></td>
<td>0.25-0.5 mg/kg (max 20 mg)</td>
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<td></td>
<td>Intranasal: 0.2-0.5 mg/kg</td>
<td>10-15 min</td>
<td>60 min</td>
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<td></td>
<td>2-3 min</td>
<td></td>
<td>45-60 min</td>
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<td></td>
<td>IV:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 mo-5 y: 0.05-0.1 mg/kg (max 6 mg)</td>
<td>45-60 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6-12 y: 0.025-0.05 mg/kg (max 10 mg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 12 y: 2.5-5 mg (max 10 mg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IM: 0.05-0.15 mg/kg (max 10 mg)</td>
<td>10-20 min</td>
<td>60-120 min</td>
</tr>
<tr>
<td>Pentobarbital</td>
<td>PO/PR: (&lt; 4 y) 1.5-3 mg/kg (max 100 mg)</td>
<td>15-60 min</td>
<td>60-240 min</td>
</tr>
<tr>
<td></td>
<td>PO/PR: (&gt; 4 y) 3-6 mg/kg (max 100 mg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-6 mg/kg (titrate 1-2 mg/kg q3-5min)</td>
<td>3-5 min</td>
<td>15-45 min</td>
</tr>
<tr>
<td></td>
<td>IM: 2-6 mg/kg (max 100 mg)</td>
<td>10-15 min</td>
<td>60-120 min</td>
</tr>
<tr>
<td>Propofol</td>
<td>IV: 1 mg/kg (repeat dose 0.5 mg/kg)</td>
<td>&lt; 1 min</td>
<td>5-15 min</td>
</tr>
<tr>
<td><strong>Dissociative Agents</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketamine</td>
<td>IV: 1.5-2 mg/kg (slowly over 1 min); may repeat 0.5-1.0 mg/kg dose q10min, as needed</td>
<td>1 min</td>
<td>Lasts 15 min</td>
</tr>
<tr>
<td></td>
<td>IM: 4-5 mg/kg; may repeat 2-4 mg/kg q10min, as needed</td>
<td>3-5 min</td>
<td>Recovery: 60 min</td>
</tr>
<tr>
<td><strong>Inhalation Drug</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>Preset mixture with at least 30% oxygen self-administered by demand-valve mask. Continuous-flow nasal mask if uncooperative</td>
<td>&lt; 5 min</td>
<td>&lt; 5 min after discontinuation</td>
</tr>
</tbody>
</table>

Abbreviations: IM, intramuscular; IV, intravenous; PO, by mouth; PR, per rectum; q, every.

Table courtesy of Inna Elikashvili, DO.
Appendix A. Sample Procedural Sedation Preparation Checklist

Emergency Department
Procedural Sedation and Analgesia
Physician Checklist

Pre-Procedure Assessment
- Past medical history (note history of OSA)
- Prior problems with sedation/anesthesia
- Allergies to food or medications
- Procedure
- Cardiorespiratory reserve: no or mild impairment / moderate impairment / significant impairment
- Difficult airway features: none / mild concern / significant concern
- Last oral intake (see fasting grid on reverse)
- Weight (kg)

Difficult Airway Features
- Difficult Laryngoscopy: Look externally, Evaluate 3-3-2 rule, Mallampati score, Obstruction, Neck Mobility
- Difficult BVM Ventilation: Beard, Obese, No teeth, Elderly, Sleep Apnea / Snoring
- Difficult LMA: Restricted mouth opening, Obstruction, Distorted airway, Stiff lungs or c-spine
- Difficult Cricothyrotomy: Surgery, Hematoma, Obesity, Radiation distortion or other deformity, Tumor

Is this patient a good candidate for ED procedural sedation and analgesia?
The less cardiorespiratory reserve, the more difficult airway features, and the less urgent the procedure, the more likely the patient should not receive ED-based PSA. If not a candidate for ED PSA consider these alternatives:
- Regional or local anesthetic
- PSA or GA in the operating room
- Endotracheal intubation in ED

Pre-procedure Preparation
- Informed consent for PSA and procedure
- Personnel: 1 procedural physician, 1 PSA provider, 1 RN
- Place patient on telemetry monitoring
- Place patient on EtCO2/O2 nasal cannula
- Ensure RN ready to chart RN PSA flowsheet
- Prepare for endotracheal intubation
- Select and draw up PSA agent(s) [see reverse] [prepare double the amount predicted to be used]
- Reversal agent(s) vial at bedside
- Paralytic agent [succ. or rocuronium] vial at bedside

Airway Equipment
- Ambu bag connected to oxygen: Size: approximate nasal bridge, malar eminences, alveolar ridge / err larger
- Laryngoscopy handles - verify power: At least two
- Suction - verify function
- Laryngoscopy blades - verify bulbs: Curved and straight / One size larger, one size smaller
- Oral airways: Size: Angle of mouth to tragus of ear (usually 80, 90, or 100 mm in adults)
- Nasal airways: Size: Tip of nose to tragus of ear (usually 26 Fr/6.5 mm, 28/7, or 30/7.5 in adults)
- Colorimetric capnometer: To be used if continuous not available or not functioning
- Endotracheal tubes - verify cuffs: Variety of sizes
- ETT stylet
- ETT securing device: Tape if no device available
- Gum elastic bougie
- LMA with lubricant and syringe
- Difficult airway equipment: Cricothyrotomy tools / video laryngoscope / optical stylet / fiberoptic scope

Definition of PSA: PSA is being performed when, in a non-intubated patient, benzodiazepines and opioids are used in combination in sufficient doses to depress level of consciousness, or when ketamine is used in dissociative dose (≥1 mg/kg IV), or when propofol or etomidate is used in any dose. Use of barbiturates to facilitate painless procedures (e.g. imaging studies) is also considered PSA.

Used courtesy of Reuben Strayer, MD and Mount Sinai School of Medicine.
<table>
<thead>
<tr>
<th>Agent</th>
<th>Dose*</th>
<th>Contraindications</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propofol</td>
<td>0.5-1 mg/kg IV, then 0.5 mg/kg q1-2 min prn</td>
<td>Egg or soy allergy</td>
<td>Preferred for shorter procedures and where muscle relaxation is of benefit; avoid if hypotension is a concern</td>
</tr>
<tr>
<td>Ketamine</td>
<td>1-2 mg/kg IV over 30-60 sec or 4-5 mg/kg IM, repeat half dose prn</td>
<td>Absolute: age &lt; 3 months, schizophrenia</td>
<td>Preferred for longer procedures; avoid if hypertension/ tachycardia is a concern; have midazolam available to manage emergence distress; muscle tone is preserved or increased; post-procedure emesis may be mitigated by prophylactic ondansetron</td>
</tr>
<tr>
<td>Etomidate</td>
<td>0.1-0.15 mg/kg IV, then 0.05 mg/kg q2-3 min prn</td>
<td>Intra-procedure myoclonus or hypertonicity, as well as post-procedure emesis, are common</td>
<td></td>
</tr>
<tr>
<td>Fentanyl</td>
<td>1-2 mcg/kg IV, then 1 mcg/kg q3-5 min prn</td>
<td>Pregnancy, allergy to benzyl alcohol</td>
<td>Comparatively delayed onset of action; do not re-dose too quickly</td>
</tr>
<tr>
<td>Midazolam</td>
<td>0.05 mg/kg IV, then 0.5 mg/kg q3-5 min prn</td>
<td>Pregnancy, porphyria</td>
<td>Use for painless procedures where analgesia is not needed</td>
</tr>
<tr>
<td>Pentobarbital</td>
<td>1 mg/kg IV, then 1 mg/kg q3-5 min prn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reversal Agent</td>
<td>Dose*</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Naloxone</td>
<td>0.01-0.1 mg/kg IV or IM (typical adult dose 0.4 mg), max 2 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flumazenil</td>
<td>0.01 mg/kg IV (typical adult dose 0.2 mg) over 20 seconds, max 1 mg</td>
<td></td>
<td>Only use in benzodiazepine naïve patient</td>
</tr>
</tbody>
</table>

*All doses should be reduced in the elderly and in patients with marginal hemodynamics*

### Post-procedure Assessment

- **Adverse events**: none / hypoxia (< 90%) / airway compromise / vomiting / hypotension / cardiac arrest / other: ____________
- **Interventions taken**: none / bag valve mask / LMA / ETT / reversal agent / hypotension Rx / admission for PSA / other: ____________
- **Adequacy of PSA**: nondistressed / mild distress / severe distress
- **Procedure**: successful / unsuccessful
- **MD or RN at bedside until patient responds to voice**
- **Telemetry, ETCO₂, SpO₂ monitoring until patient responding to questions appropriately**
- **If reversal agent used, observation two hours after answering questions appropriately**
- **Mental status and ambulation at baseline at time of discharge**

### Fasting Grid

**Standard risk patient**

<table>
<thead>
<tr>
<th>Oral intake in the prior 3 hours</th>
<th>Emergent Procedure</th>
<th>Urgent Procedure</th>
<th>Semi-urgent procedure</th>
<th>Non-urgent procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing</td>
<td>All levels of sedation</td>
<td>All levels of sedation</td>
<td>All levels of sedation</td>
<td>All levels of sedation</td>
</tr>
<tr>
<td>Clear liquids only</td>
<td>All levels of sedation</td>
<td>All levels of sedation</td>
<td>Up to and including brief deep sedation</td>
<td>Up to and including extended moderate sedation</td>
</tr>
<tr>
<td>Light snack</td>
<td>All levels of sedation</td>
<td>Up to and including brief deep sedation</td>
<td>Up to and including dissociative sedation</td>
<td>Minimal sedation only</td>
</tr>
<tr>
<td>Heavier snack or meal</td>
<td>All levels of sedation</td>
<td>Up to and including extended moderate sedation</td>
<td>Minimal sedation only</td>
<td>Minimal sedation only</td>
</tr>
</tbody>
</table>

**Higher-risk patient**

<table>
<thead>
<tr>
<th>Oral intake in the prior 3 hours</th>
<th>Emergent Procedure</th>
<th>Urgent Procedure</th>
<th>Semi-urgent procedure</th>
<th>Non-urgent procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing</td>
<td>All levels of sedation</td>
<td>All levels of sedation</td>
<td>All levels of sedation</td>
<td>All levels of sedation</td>
</tr>
<tr>
<td>Clear liquids only</td>
<td>All levels of sedation</td>
<td>Up to and including brief deep sedation</td>
<td>Minimal sedation only</td>
<td>Minimal sedation only</td>
</tr>
<tr>
<td>Light snack</td>
<td>All levels of sedation</td>
<td>Minimal sedation only</td>
<td>Minimal sedation only</td>
<td>Minimal sedation only</td>
</tr>
<tr>
<td>Heavier snack or meal</td>
<td>All levels of sedation</td>
<td>Minimal sedation only</td>
<td>Minimal sedation only</td>
<td>Minimal sedation only</td>
</tr>
</tbody>
</table>

- **Minimal sedation only** → Dissociative sedation; brief or intermediate-length moderate sedation → Extended moderate sedation → Brief deep sedation → Intermediate or extended-length deep sedation → Brief: < 10 min Intermediate: 10-20 min Extended: > 20 min

### Additional Comments

**MD Name** | **Sign** | **Date/Time**


**Green, Roback et al**: Fastening and Emergency Department Procedural Sedation and Analgesia: A Consensus-Based Clinical Practice Advisory. Ann Emerg Med. 2007;49:454-461. [For definitions, see "figure footnotes" on page 458 of original article]

Used courtesy of Reuben Strayer, MD and Mount Sinai School of Medicine.
1. “There is no reason to call a child life specialist. We are going to have to sedate this child.” A child life specialist can be extremely helpful in calming the child and alleviating the anxiety of the parent. Sedation may still be necessary in certain cases, but a child life specialist should always be involved to help aid in the process.

2. “The ED is too busy to wait for the LET to work.” Waiting for the LET to take effect can diminish the need for local infiltration of lidocaine, especially for smaller lacerations, and can significantly diminish the pain and anxiety associated with laceration repair.

3. “I have done many sedations. I can handle doing the sedation and the procedure itself.” There should be a separate, dedicated provider (medical doctor or certified registered nurse anesthetist) for the procedural sedation, along with a nurse or a respiratory therapist to properly record vitals and administer the medication.

4. “The nurse cannot find an ETCO₂, so we’ll just use the pulse oximeter.” ETCO₂ has been shown to be more effective at demonstrating decrease in ventilation and should be used during sedations. The room should also be prepared with other equipment in case resuscitation or an advanced airway is necessary.

5. “NPO status is very important and cannot be ignored, even if the procedure is emergent.” When evaluating a patient for an emergent sedation, NPO status needs to be addressed in the following manner: First, assess the patient’s baseline risk factors. Second, access the timing and nature of recent oral intake. Third, access the urgency of the procedure. Fourth, determine the prudent limit of targeted depth and length of procedural sedation and analgesia. When it is necessary to perform an emergent procedure, one should proceed regardless of the patient’s NPO status.

6. “This patient previously received analgesics and makes a poor candidate for sedation.” Previously receiving analgesics is not a contraindication to procedural sedation as long as proper monitoring, equipment, and drug doses are used.

7. “I used propofol, but I didn’t know this child had an egg allergy.” Propofol is contraindicated in any patient with known or suspected allergy to propofol, eggs, or soy products. Proper history and physical examination should be obtained in all patients prior to proceeding with the procedural sedation. An allergy history is especially important.

8. “This child needs a CT scan. I’m going to use ketamine since I’m very comfortable with that medication.” Ketamine is not an ideal medication for radiographic imaging since the child may still move quite a lot. Pentobarbital may be a more preferable choice, since its onset of action is quick and the duration of sedation is short.

9. “The child’s initial IM ketamine dose wore off prior to the orthopedic surgeon being done with the procedure.” Although an IV catheter is not necessary with all procedural sedations, it must be anticipated if more than 1 dose will need to be administered or if the case may present other difficulties. If more sedation is required, an IV can be placed after the initial sedation, although it is preferable before.

10. “It’s the middle of the night. Since this child is now sleeping, I’m fairly certain there is no need to wait for the sedation medication to wear off.” Although it can be difficult to assess, the patient should always be observed to return to baseline status. The parents should be encouraged to wake the child up for an evaluation prior to being discharged from the ED.
Summary

A pediatric patient requiring a complicated or painful procedure can present a challenge to an emergency clinician. Patient and parental anxiety may interfere with appropriate evaluation and repair. Incorporating child life specialists can drastically reduce the anxiety of both the child and parent. In instances when distraction and analgesia are insufficient, procedural sedation can provide the necessary level of sedation. There are many different agents available for procedural sedation. Choosing the right agent requires anticipation of the duration of the procedure, familiarity with the side-effect profile of the medication, proper equipment, and appropriate staffing.

Case Conclusion

After performing a complete history and physical exam of the child, you concluded that her minor head trauma did not meet criteria for any head imaging, but you decided to sedate her for the laceration repair, selecting ketamine. You explained to her father that you thought the repair would have a better cosmetic outcome if his daughter was still during the procedure. By the time the evaluation and set-up was complete, it was about 6 hours after the child’s last meal. The child was taken into a room and hooked up to a monitor, pulse oximeter, and capnometry. All equipment for an advanced airway appropriate for the child was set up in advance, and proper consent was obtained. Another physician was in charge of the laceration repair, while you monitored the patient during sedation. An IM dose of ketamine was administered with the father in the room. When the patient reached a dissociated state, the laceration was successfully repaired. The child was observed until she returned to her baseline. Proper follow-up was established.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study, such as the type of study and the number of patients in the study will be included in bold type following the references, where available. The most informative references cited in this paper, as determined by the author, will be noted by an asterisk (*) next to the number of the reference.


28. Cordoni A, Cordoni LE. Eutectic mixture of local anesthetics reduces pain during intravenous catheterization. (79 patients)


60. Mayberg TS, Lam AM, Matta BF, et al. Ketamine does not increase cerebral blood flow velocity or intracranial pressure...


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1. Equipment required to ensure safe procedural sedation includes:
   a. Oxygen and bag-valve mask system for positive pressure ventilation
   b. Suction catheter and apparatus
   c. Defibrillator
   d. Emergency cart with appropriate medications
   e. All of the above

2. Capnography is not recommended if pulse-oximetry is available.
   a. True
   b. False

3. Adequate analgesia can decrease the need for sedation.
   a. True
   b. False

4. Topical analgesics provide minimal pain relief and should not be used.
   a. True
   b. False

5. Midazolam is available via:
   a. IV route only
   b. IV and IM routes only
   c. IV and PO routes only
   d. IV, IM, PO, PR and intranasal routes

6. An agent that is often used for procedural sedation during a diagnostic radiographic test in the ED is:
   a. Ketamine
   b. Midazolam
   c. Pentobarbital
   d. Morphine

7. What is a side effect commonly seen in patients on ketamine?
   a. Abdominal pain
   b. Nystagmus
   c. Hypotension
   d. Decreased salivary secretions

8. Which of the following is an appropriate dose of IM ketamine versus IV ketamine?
   a. IM dose same as IV dose
   b. IM dose lower than IV dose
   c. IM dose higher than IV dose
   d. Ketamine cannot be administered IM

9. Nitrous oxide (NO) is commonly dispensed at concentrations of:
   a. NO 10% and O₂ 90%
   b. NO 50% and O₂ 50%
   c. NO 75% and O₂ 25%
   d. NO 90% and O₂ 10%
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