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Pediatric Sedation: A Comprehensive Review

Painful procedures are common in the acute care setting, and failing to mange a child's anxiety and pain may have long-term consequences. Being familiar with a diversity of non-pharmacologic and pharmacologic alternatives is critical.

— Ann M. Dietrich, MD, Editor

Introduction

Children may require painful procedures while in the acute care setting. Non-pharmacologic techniques and pharmacologic agents are important to reduce the anxiety and pain associated with necessary procedures. Non-pharmacologic techniques used to provide distraction and reduce anxiety are a cornerstone of pediatric procedural sedation. Although these techniques often do not totally eliminate the need for medication, their importance should not be underestimated. Effective strategies include taking time to prepare the child for the procedure, being mindful of the type of language used to describe the procedure to the child, providing the child's parent or caregiver with specific instructions as to how they can be a helpful, reassuring presence during the procedure, and offering distraction activities. Options for these activities range from very simple (blowing bubbles or looking at a picture book) to very high-tech (virtual reality software), but all of them can significantly improve a child's experience during an emergency department (ED) procedure.[1]

A variety of topical and non-pharmacologic analgesic measures are available for children, including topical anesthetics, devices producing vibratory and cold stimuli, and (for infants) oral sucrose solutions and breastfeeding.[2]

A diversity of routes of administration for medications allow for selection of not only the medication, but the way it is administered based on the goals of the sedation. Intranasal administration of medication can be an excellent alternative to parenteral sedation for procedures. It is effective, quick, low-risk, and well-tolerated.[3]

When providing parenteral procedural sedation, preparation is critical. This includes a comprehensive history and physical exam prior to sedating the child, cardiorespiratory monitoring (including capnography) in place during the procedure, and availability of all necessary resuscitative medications and equipment at the bedside.[4]

Procedural sedation should not be delayed based on fasting time. There is no convincing evidence that a longer fasting time decreases the risk of adverse events with procedural sedation, or that a shorter fasting time increases the risk of adverse events.[5]

Agents should be selected based on the attributes of the agent and the goals for the procedural sedation. Be mindful of whether the agent of choice provides

EXECUTIVE SUMMARY

- Procedural sedation should not be delayed based on fasting time. There is no convincing evidence that a longer fasting time decreases the risk of adverse events with procedural sedation, or that a shorter fasting time increases the risk of adverse events.
- For children who are verbal and able to engage in conversation, provide a simple explanation of what procedure will be performed and why. If possible, allow them to see and touch the types of equipment that will be used for the procedure.
- Topical anesthetic creams can be very useful for vascular access, such as intravenous (IV) starts and accessing indwelling ports, as well as for procedures such as lumbar punctures, abscess incision and drainage, and laceration repairs.
- The intranasal route has several advantages:
  – It allows children to avoid the traumatic experience of IV placement or intramuscular (IM) injection.
  – It can be given to children who are nauseated/vomiting and to those who would spit out oral medication.
  – First-pass metabolism is bypassed, leading to faster and more predictable absorption as compared to oral medications.
  – The nasal mucosa are highly vascularized and provide a wide surface area for drug absorption, which allows the medications to work quickly and well.
- Ketamine was given a Level A recommendation in the American College of Emergency Physicians policy statement for both safety and efficacy in providing procedural sedation for children in the emergency department. It is best suited for children 6 months to 15 years old.

analgesia. If analgesia is necessary, choose an alternate agent or add analgesic therapy as appropriate. Be aware that combination therapy, particularly with opioids combined with benzodiazepines, is associated with an increased risk of respiratory depression, hemodynamic instability, and other adverse events.[3]

The vast majority of adverse events related to procedural sedation in pediatric patients occur during the procedure itself. Children who have received sedation or analgesia for an ED procedure and do not have an adverse event during the procedure can be discharged safely after a 30-minute observation period following the last dose of medication, provided they otherwise meet discharge criteria. These criteria include: all vital signs are within acceptable limits, patient maintains airway patency unassisted, patient is awake or easily aroused, patient is able to speak (if age-appropriate), patient is able to sit up unassisted and ambulate short distances with minimal assistance (if age-appropriate), and patient tolerates oral intake with no subsequent vomiting.[6]

Non-Pharmacologic Anxiolysis

For children, procedural sedation often is necessary not because the procedure in question is significantly painful, but because an anxious child who does not understand what is being done to them will be simply unable to cooperate, even with a procedure that does not cause significant physical pain. While anxiolytic medications and procedural sedation are important tools for addressing this, these techniques increase ED length of stay, require an increased use of resources (physical resources, such as monitored beds, as well as time and attention from ED physicians and staff), and carry a small, but not negligible, risk of adverse events. Fortunately, there are a number of very effective non-pharmacologic techniques that can be used to reduce anxiety or simply provide distraction for children undergoing procedures in the ED. Although these techniques cannot entirely eliminate the need for procedural sedation (particularly for long, complex, or painful procedures), they can reduce the amount and intensity of sedation that is required, make the entire ED experience significantly less traumatic for the child, and improve parent satisfaction. The importance of non-pharmacologic techniques for managing pain and anxiety in pediatric patients undergoing ED procedures should not be underestimated.[1-3,7]

A Certified Child Life Specialist (CCLS) is a valuable addition to the care team in any ED that cares for pediatric patients. CCLSs are pediatric health professionals who have been educated and clinically trained in the developmental impact of illness and injury. They provide evidence-based and developmentally appropriate interventions to reduce fear, anxiety, and pain. These interventions include preparation, education, and therapeutic play. However, even in departments that do not have a CCLS on staff, the care team can use the general principles behind these techniques to mitigate anxiety for children undergoing procedures. Which of these techniques are appropriate, and how effective they will be, depends on multiple factors, including the age and developmental stage of the child, the availability of support staff, the ability of the parent(s) or caregiver(s) to be effective participants, and the type of procedure that must be performed.[8]

Preparation

For children who are verbal and able to engage in conversation, provide a simple explanation of what procedure will be performed and why. If possible, allow them to see and touch the types of equipment that will be used for the procedure. (Examples of this include allowing a child with a laceration that needs to be stapled to use a skin stapler on a doll, stuffed animal, or a piece of paper or cloth, or allowing a child with a wound that needs to be irrigated to squirt liquid into a basin from a saline flush or irrigation bottle.) During this process, encourage children to ask questions and to verbalize their feelings and fears.

Make every effort to use language that is clear and honest, but also

age-appropriate and non-threatening (the term that child life specialists use for this is "soft language"). For example, an intravenous line (IV) can be described as a "medicine straw that goes in with a quick poke," sutures can be described as "special strings to fix your cut," a splint or cast can be described as "a hard bandage to help your bones heal and get strong," and "sedation" can be described as "sleepy medicine to help you feel calm and relaxed."[8]

Having parents in the room for procedures can be extremely helpful, but if parents are anxious or emotional themselves, their children will pick up on those feelings and be more anxious as a result. Although parents should be given the option to stay if possible, they also should be given the option to leave if they feel they will not be able to provide a calm, reassuring presence for their child during the procedure. This should not be presented as a failure on their part; by recognizing their limitations and opting to leave the room, they are doing the most helpful thing they can for their child under the circumstances, and should be commended.

Parents who do elect to stay for the procedure typically benefit from being given a specific task. Do not assume that parents will help restrain their children for procedures. Many parents, especially parents of small children, will be perfectly able and willing to help with this, but others will not. Again, this should not be presented as a failure on the parents' part; they can be very helpful simply by sitting or standing where their child can see them, talking to their child, and helping provide distraction (reading to their child, playing music or videos on their phone, etc.).

Distraction

Several methods for distraction of children during procedures have been studied and found to be potentially effective. Unsurprisingly, those that are highly immersive, novel, and engaging (such as virtual reality software) perform better in research studies than lower-tech options such as books and music. However, any distraction that engages the child is better than no distraction at all, and the optimal distraction technique will depend on the specific personality and interests of the child in question and the resources available. If they are old enough to do so, children should be allowed to choose from among a few options for procedural distraction (even if the options are very limited, they will appreciate being allowed to choose from a selection of picture books or TV channels).[1-3,8]

Potential distraction techniques include:

- books (a story read by a parent or staff member, or simply looking at pictures);
- music;
- television, movies, internet videos;
- analog games (finding various objects in a complex picture, memory or matching games, etc.);
- blowing bubbles;
- video games on a phone or tablet;
- virtual reality software, either interactive (e.g., playing a virtual reality game) or immersive (e.g., going to a virtual beach during a procedure).

Topical Analgesia

Minimizing pain and discomfort, even from routine ED interventions such as IV starts, can prevent an ED visit from becoming a frightening or traumatic experience for a child, increase cooperation, and improve rapport with children and parents. Fortunately, various noninvasive, and often non-pharmacologic, measures are available to accomplish this.

Topical Anesthetic Creams

Topical anesthetic creams can be very useful for vascular access, such as IV starts and accessing indwelling ports, as well as for procedures such as lumbar punctures, abscess incision and drainage, and laceration repairs. They are also painless to administer. The main drawback is the time to onset of action, which is 20 minutes at minimum.[2]

For Use on Intact Skin.

- Liposomal lidocaine 4% (LMX and generics) generally works in 20-30 minutes (although some preparations take longer). The advantages of liposomal lidocaine include "needle-free" administration, a short onset of action, and minimal vasoactive properties. Liposomal lidocaine is not associated with methemoglobinemia, which is a systemic side effect of lidocaine-prilocaine.

In children, liposomal lidocaine has been found to be as effective as lidocaine–prilocaine for reducing pain from venipuncture and intravenous cannulation, and to be as effective as buffered lidocaine injection.[9]

- Eutectic mixture of local anesthetics with lidocaine 2.5% and prilocaine 2.5% (EMLA and generics) will reach a depth of 3 mm after 60 minutes and 5 mm in 120 minutes. Analgesia increases for up to three hours under occlusive dressing and persists for one to two hours after cream is removed.[10]
- Lidocaine and tetracaine patches. Twenty to 30 minutes is needed for a lidocaine and tetracaine patch with a self-heating system to be effective.[11]
- For a simple incision and drainage or quick laceration repair, topical anesthetic may be sufficient and allow children to avoid the unpleasant experience of an injection. For a more complex procedure that will involve manipulation of deeper structures (for example, drainage of a large, loculated abscess), additional anesthesia will need to be provided by injection.
- For lumbar punctures, effective topical anesthesia can reduce the pain associated with needle insertion and withdrawal during lumbar puncture in newborns.[16]

Use of local anesthetics is also associated with an increased success rate.[17]

Agents for Laceration Repair

LET (lidocaine, epinephrine, and tetracaine) is a topical combination of anesthetic and vasoconstrictor in gel or liquid form containing lidocaine 4%, epinephrine 0.1%, and tetracaine 0.5%. It is safe to use in children older than 2 years of age and can be applied to simple nonmucosal lacerations. It also may be used for complex or deeper lacerations requiring supplemental subcutaneous anesthetic administration application.

LET should be placed on an open wound and covered with an occlusive dressing, or a cotton ball soaked with LET solution should be placed into the wound and allowed to soak in for 20-30 minutes until the wound edges are blanched.

Needle-Free Injected Lidocaine

Sold under the brand name J-Tip, a needle-free injection system uses pressurized gas to forcibly propel lidocaine across the skin without puncturing it, creating an area of anesthesia the size of an eraser. It works in about one to three minutes. A study comparing J-Tip to topical lidocaine for infant lumbar punctures found similar pain scores but improved first-pass success with the J-Tip. The device does make a loud "popping" sound when it deploys, which can be frightening for some children, and patients have reported some discomfort associated with the device.[2,18]

Oral Sucrose

A 24% oral sucrose solution (Sweet-Ease) has been shown to be effective for procedures such as IV starts, lumbar punctures, and injections/vaccinations in infants younger than 6 months of age. The dosing is 1 mL to 2 mL placed in the buccal mucosa or on a pacifier, which can be repeated as needed during the procedure.[2]

Breastfeeding

Breastfeeding also has been shown to reduce pain associated with procedures such as IV starts, lumbar punctures, and injections/vaccinations in infants. However, not all mothers/infants will be able to do this (some infants are very easily distracted while breastfeeding, and getting them to maintain a latch during a procedure can be difficult).[2]

Parental Contact

In addition to providing distraction and reducing anxiety, there is evidence that being held, talked to, or caressed by a parent during a procedure can have an actual analgesic effect for young children.[2]

Vibratory Distraction Device

These devices work based on the "gate theory" of pain; pain fibers cannot transmit a painful stimulus if they are simultaneously being stimulated by vibration and cold.

The devices consist of a plastic body (often shaped like a bee or lady bug) and detachable wings (these are essentially small, wing-shaped ice packs; disposable and non-disposable models are available). The wings should be frozen solid in the freezer prior to using the device. After the wings are removed from the freezer, they are attached to the device, and the device is turned on, causing it to vibrate. The device should be placed about 5 cm proximal to where the procedure is being done, and left in place for about one minute prior to the procedure.[3,19]

Studies indicate that this device shows no benefit in infants, but does show benefit in older children (ages 3-18 years) undergoing venipuncture. Part of the effect may be due to the distraction provided by the device.[2,19]

Sedation Levels

Identifying the depth of sedation that is needed for the procedure assists with selection of the route and agent that would be best in the individual situation.

Minimal: This is also referred to as anxiolysis. The patient remains awake but relaxed, and is able to interact.

Moderate: This is also known as conscious sedation. With moderate sedation, the patient has depressed consciousness but responds to verbal requests or reacts to touch. The patient's breathing remains intact, and no support is needed.

Deep: The patient cannot be aroused easily but will respond to repeated or painful stimuli. The breathing may be impaired and may need to be supported.

Dissociative: This produces a trance-like state in which the patient remains awake but is unaware of the pain and retains no memory of the event. The patient is able to follow commands, and the airway reflexes remain intact.

Non-Parenteral Medication for Procedures

Intranasal medications (*see Table 1*) or oral medications are appropriate for analgesia/anxiolysis when sedation is the goal.

Advantages of Intranasal Route

The intranasal route has several advantages:

- It allows children to avoid the traumatic experience of IV placement or IM injection.
- It can be given to children who are nauseated/vomiting, and to those who would spit out oral medication.
- First-pass metabolism is bypassed, leading to faster and more predictable absorption as compared to oral medications.
- The nasal mucosa are highly vascularized and provide a wide surface area for drug absorption, which allows the medications to work quickly and well. For example, the available data indicate that intranasal fentanyl works as well and as quickly as parenteral morphine in pediatric patients.[3,12]

Indications. Intranasal sedation is an excellent choice for procedures that are relatively quick (15 minutes or less), and for which perfect cooperation and motion control are not essential. Examples include simple laceration repair (local anesthesia also usually will be required), X-rays of skeletal deformities/suspected fractures, longer imaging studies (computed tomography, magnetic resonance imaging, and ultrasound), lumbar punctures, joint dislocations, injuries due to animal bites (typically associated with high levels of anxiety), abscess incision and drainage, burn debridement or dressing, casting (if any cast molding is needed), and foreign body removal.[12]

Technique

- Divide the dose between both nares to maximize the available surface area for drug distribution.
- A "drip method" also can be used for giving intranasal medication, but this requires a compliant child. A nasal atomizer is the preferred method.
- The most commonly available brand of nasal atomizer has 0.1 mL of "dead space"; 0.1 mL of the drug being administered will be lost. Plan accordingly by drawing up an additional 0.1 mL of medication.
- The inferior turbinate is the portion of the nasal fossa that serves as the main site for systemic drug entry because of its high surface area and vascularization. (*See Figure 1.*)
- To administer intranasal medication, place the patient into a "sniffing position," with the patient's neck slightly extended and the nose and chin aligned in a horizontal plane. Place the mucosal atomization cushion in the naris, aim

Table 1. Selection of an Intranasal Agent[12,13]		
Primary Goal: Sedation/ Anxiolysis • Patient is not in pain prior to the procedure, the procedure is not significantly painful, and the primary purpose of sedation is to reduce anxiety/agitation (e.g., laceration repair)	**Midazolam** • 0.3 mg/kg to 0.5 mg/kg • Use the concentrated formulation (5 mg/mL). • Maximum dose/volume is 10 mg (2 mL; 1 mL per naris), but ideal volume is 0.25 mL to 0.3 mL per naris • This is approximately the dose for a 20-kg child, so a good rule of thumb is that you "graduate" from intranasal midazolam when you graduate from kindergarten. • Intranasal midazolam can cause a sensation of irritation/burning when administered.	**Dexmedetomidine** • Initial dose is 2.5 mcg/kg. Can give an additional 1 mcg/kg if needed. • Typical concentration is 100 mcg/mL, so it can be effectively used in children up to 80 kg (adult size). • Has a longer duration of action (30+ minutes) than other agents, but this can be useful for some procedures (ultrasound, echocardiogram, laceration repair)
Primary Goal: Analgesia • Patient is in pain prior to the procedure, and the procedure will exacerbate their pain (e.g., manipulating a fractured limb for imaging or splinting) • Intranasal fentanyl is a safe and effective method of pain management for children.[14] • Intranasal fentanyl and ketamine had similar pain reduction in children with moderate to severe pain from extremity injury. More minor adverse events were associated with ketamine.[15]	**Fentanyl** • 1.5 mcg/kg to 2 mcg/kg • Most formulations are concentrated at 50 mcg/mL. • Maximum dose/volume is 100 mcg (2 mL; 1 mL per naris), but ideal volume is 80 mcg (1.6 mL; 0.8 mL per naris). • This is approximately the dose for a 40-kg child, so a good rule of thumb is that you are finished with intranasal fentanyl in the fourth or fifth grade.	**Ketamine** • Analgesic intranasal dosing is 1 mg/kg to 1.5 mg/kg. • Typical onset of action is 15 minutes (if it has not worked by then, it is unlikely to work at all, and you should move on to another agent). • It is not advisable to try to use intranasal ketamine to achieve sedation; the intranasal volumes required to achieve the necessary serum drug levels are not practical. Intranasal ketamine is best used as an opioid-sparing analgesic, and sedating doses of ketamine should be administered intramuscularly or intravenously.

toward the pinna of the ear, and shoot the drug into the nasal fossa as fast as possible (the speed is necessary to atomize the solution).[12,13]

Oral Midazolam

For a child who is not vomiting and who is cooperative with taking an oral medication, oral midazolam can provide anxiolysis and sedation while avoiding the mild to moderate irritation associated with intranasal medications. The anxiolytic dosing for oral midazolam is 0.3 mg/kg to 0.5 mg/kg, with a maximum dose of 20 mg. Onset of action is 10 minutes with a peak effect at 53 minutes.

Nitrous Oxide

Nitrous oxide is a weak dissociative anesthetic that provides a rapid, reliable change in the depth of analgesia and sedation with a rapid recovery. When necessary, additional effective analgesia often can be achieved using local lidocaine or regional nerve blocks. Nitrous oxide is desirable for patients who require more anxiolysis than pain control. An example of a procedure for which nitrous oxide would be a reasonable option is reduction of forearm fractures. Studies have shown that for forearm fractures, nitrous oxide sedation in conjunction with a hematoma block was as effective as IV ketamine and midazolam and involved a faster recovery time.[20]

Dosing: Nitrous oxide is administered by nebulizer via a gas system, usually 50% nitrous oxide as a baseline dose.

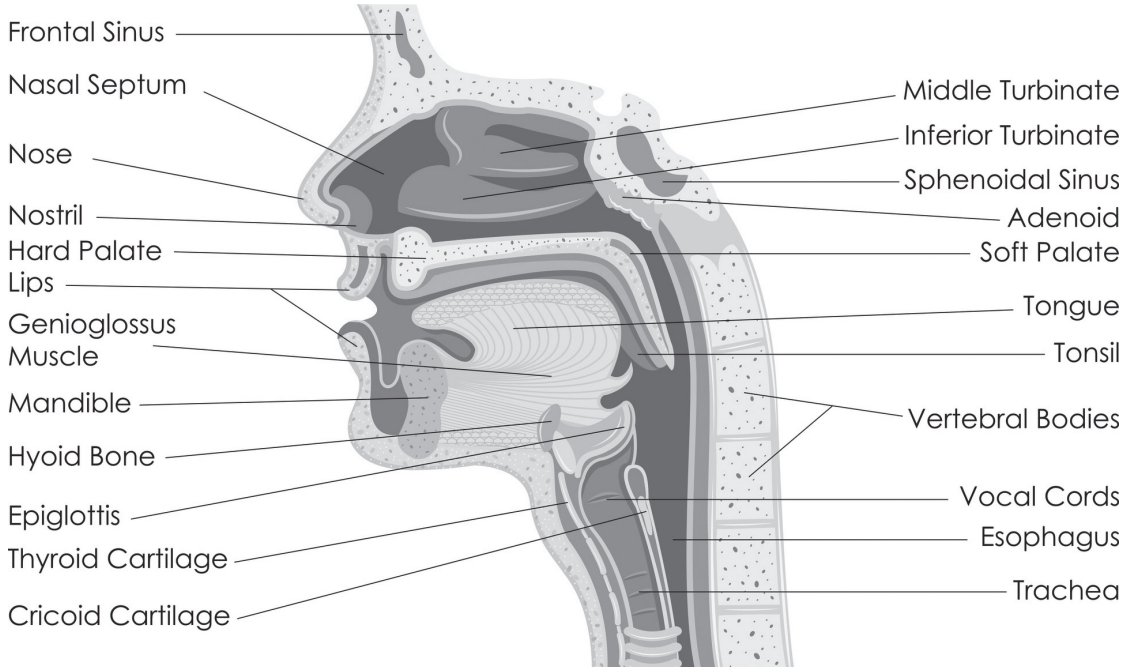
Time of onset: Approximately three to five minutes.

Recovery: Approximately three to five minutes.[21]

Parenteral Procedural Sedation

Indications. Given the variety of non-parenteral options available for pediatric procedural sedation in children, it is optimal to choose one of these if possible; this will be faster, lower-risk, and less demanding of the department's resources. However, there are scenarios where parenteral sedation is optimal to allow for procedure completion. The main determining factor is time; if you are not reasonably confident that you can perform the procedure in 15 minutes or less, parenteral sedation is indicated. Another important factor is the degree of sedation and motion control needed to perform the procedure

Figure 1. Nasal Anatomy



Source: Getty Images

properly. A simple abscess incision and drainage or repair of a laceration requiring only a few sutures usually can be done with good cosmetic and functional outcome with minimal sedation. However, for other procedures, such as repair of a complex facial laceration, excellent motion control is required to ensure a good outcome. This also is an indication for parenteral sedation.

Preparation

History and Physical Exam. As with any procedure requiring sedation or anesthesia, it is ideal to obtain a thorough history and physical exam before the patient is sedated.

Specific elements to target in the history include:

- Does the patient have any previous history of sedation or anesthesia?
- Did the patient have any problems with these previous experiences?
- Is there a family history of adverse anesthesia reactions?
- Does the patient have a history of cardiac or respiratory pathology, and if so, how severe? In the case of asthma/reactive airway disease, has the child ever required hospitalization? Did any of their previous hospitalizations involve intensive care unit admissions or intubations? If so, how recently? When was the last time the patient required systemic steroids?
- Does the patient have any current upper respiratory infections or respiratory symptoms?

Essentially, physicians need to examine these children as if they are preparing to intubate them (although it is hoped that will not be necessary). Specific elements to target in the physical exam include:

- Facial and neck anatomy (look for micrognathia, short neck, neck masses, etc.);
- Oral anatomy and Mallampati score;
- Dental exam. Look for loose/missing teeth. If the child has orthodontia (braces, retainers, expanders, etc.), specifically ask if it is removable, and remove it if possible.
- Evaluate for any current upper respiratory infection symptoms (nasal congestion, rhinorrhea, etc.);
- Cardiac and respiratory exams.

Establish ASA class. American Society of Anesthesiologists Physical Status Classification:

Class I: Normal healthy patient;

Class II: Patient with mild systemic disease;

Class III: Patient with severe systemic disease;

Class IV: Patient with severe systemic disease that is a constant life threat;

Class V: Moribund patient, not expected to survive without the procedure.

Only patients who fall under the categories of Classes I and II are considered appropriate patients for procedural sedation (PSA).

Note that there are no specific findings on the history or physical exam that are absolute contraindications to performing procedural sedation in the ED. By definition, these are not elective procedures, and providers should not expect ideal conditions. Whether to proceed with procedural sedation is a matter of individual clinical judgment, clinician comfort, and available resources. However, these findings should inform the sedation plan, and, if relevant, can help guide decisions such as whether to involve a consultant or transfer the patient to a tertiary care center.

Fasting Time. Procedural sedation should not be delayed based on fasting time. This is in accordance with guidelines set forth by the American College of Emergency Physicians.[25] Numerous studies of the subject have found no evidence that prolonged fasting time reduces aspiration or emesis, and

Table 2. Selection of an Agent[22]

Medication	Dose	Effects	Time of Onset	Duration of Action	Other Considerations
Ketamine	1 mg/kg to 2 mg/kg IV initially. May give repeat doses of 0.5 mg/kg to 1 mg/kg every 5-10 minutes as needed to achieve desired level of sedation Ketamine IM: 4-5 mg/kg IM	• Provides analgesia, sedation, and amnesia in one single agent • No loss of protective reflexes	**IV:** 1-2 minutes **IM:** 4-5 minutes	**IV:** approximately 30-60 min **IM:** approximately 25 min	Ketamine was given a Level A* recommendation in the ACEP policy statement for both safety and efficacy in providing PSA for children in the ED.[4] It is best suited for children 6 months to 15 years old. **Adverse Events** • Vomiting, emergence reaction, laryngospasm/apnea (rare) **Absolute Contraindications** • Age < 3 months, known or suspected psychosis
Etomidate	0.1 mg/kg to 0.3 mg/kg IV initial dose, can give repeat doses of 0.05 mg/kg IV every 3-5 minutes, maximum total dose 0.6 mg/kg IV	No analgesic properties	< 1 minute	5-15 minutes	**Special Considerations** • Patients generally maintain hemodynamic stability, making it a good choice in patients whose cardiovascular status is unknown **Adverse Events** • Vomiting, pain at the injection site, transient non-epileptiform myoclonus **Relative Contraindications** • Severe illness (such as sepsis) **Absolute Contraindications** • Adrenal insufficiency (acquired or congenital)
Propofol	1 mg/kg IV loading dose, then 0.5 mg/kg/hr infusion or 0.5 mg/kg repeat IV bolus dosing (wait at least 3-5 minutes between repeat doses to assess effect)	No analgesic properties	< 1 minute	15-30 minutes	**Special Considerations** • Antiemetic properties **Adverse Events** • Respiratory depression, oversedation (can produce general anesthesia with repeat dosing) • Hypotension **Relative Contraindications** • Avoid with egg or soy allergies, avoid in patients with cardiac compromise **Absolute Contraindications** • Porphyria

IV = intravenous; IM = intramuscular; ACEP = American College of Emergency Physicians; PSA = procedural sedation; ED = emergency department
* American College of Emergency Physicians Level A Recommendation: Generally accepted principles for patient care that reflect a high degree of clinical certainty (eg, based on evidence from one or more Class of Evidence I or multiple Class of Evidence II studies).

(continued)

aspiration during procedural sedation is a rare event in any case.[5]

Equipment

The vast majority of procedural sedations do not involve any major adverse cardiac or respiratory events. However, it is essential to have a plan in place to deal with these events, and to have all necessary equipment at the bedside.

• If the department has a designated resuscitation or procedure room, move the patient there, if possible.

• Monitoring: Electrocardiography, pulse oximetry, blood pressure cuff, and

Table 2. Selection of an Agent[22] (*continued*)

Medication	Dose	Effects	Time of Onset	Duration of Action	Other Considerations
Dexmedetomidine	1 mcg/kg to 3 mcg/kg IV loading dose (over 10 minutes), followed by 0.5 mcg/kg to 1 mcg/kg per hour continuous infusion. Children < 5 years old may require higher maintenance infusion rates than older children	Modest sedative and anxiolytic effects May have a role in sedation of children with neurologic impairment[23,24]	5-10 minutes	30-70 minutes	**Special Considerations** • Minimal respiratory depression **Adverse Events** • Bradycardia, hypotension, laryngospasm (rare) **Relative Contraindications** • Dehydration, reduced cardiac output • Should be avoided in patients receiving medications that act on the atrioventricular (AV) node or with cardiac conduction abnormalities unless guidance from an expert in pediatric cardiac anesthesiology is available
Fentanyl	1 mcg/kg to 2 mcg/kg IV initial dose. Repeat dosing 0.5 mcg/kg to 1 mcg/kg IV every 3-5 minutes	Analgesic effects	1-5 minutes	30-60 minutes after last dose	**Adverse Events** • Hypotension, respiratory depression, chest wall rigidity (especially with rapid IV infusion)
Midazolam	**6 months-5 years:** 0.05 mg/kg to 0.1 mg/kg, maximum single dose 2 mg **6-12 years:** 0.025mg/kg to 0.05 mg/kg, maximum single dose 2 mg **Older than 12 years:** 1 mg to 2 mg IV Can give repeat dosing starting 2-5 minutes after initial dose, titrating to desired level of sedation **6 months-5 years:** 0.2 mg/kg/dose, max total dose 6 mg **6-12 years:** 0.1 mg/kg/dose, max total dose 6 mg **Older than 12 years:** 1 mg/dose to 2 mg/dose, max total dose 10 mg	No analgesic effects	1-3 minutes	15-60 minutes, depending on total dose administered	**Special Considerations** • Has excellent amnestic and anxiolytic effects • Usually does not produce full immobility, so best used for procedures that do not require this • Flumazenil can reverse effects, but should be avoided in patients with seizure disorders or chronic benzodiazepine use **Adverse Events** • Respiratory depression (especially when combined with opioid medications) • Can cause a paradoxical reaction, producing hyperactivity, aggression, or inconsolable crying

IV = intravenous

end tidal CO_2. Monitoring equipment should be hooked up and turned on prior to starting the procedure.

• Oxygen via nasal cannula (connected and turned on).

• Suction (connected and turned on).

• Airway equipment:

- oral airway and nasal trumpet in appropriate sizes;

- bag valve mask in appropriate size (connected and turned on);

- laryngoscope in appropriate size (it is at the clinician's discretion whether to use video or direct laryngoscopy for first pass, but if video laryngoscopy is available in the department, both video and direct laryngoscopes should be at the bedside for the procedure);

- endotracheal tubes (at least two; one in the size you anticipate being appropriate for the patient, and one that is 0.5-1 size smaller);

- adjuncts for a difficult airway: bougie, LMA in appropriate size, scalpel.

• Medications:

- extra doses of sedation and analgesia;

- anti-emetics;

- reversal agents (e.g., flumazenil and naloxone);

- IV fluids;

- paralytic (for intubation);

- resuscitation drugs (this can be simplified by having a "code cart" in the room or outside the door).

Agent Selection

An agent should be selected based on the goals of the procedure and type of procedure (*see Table 3*) with agents listed in Table 2. Agents should be selected based on goals for the procedure and type and duration of the procedure. As noted in Table 2, many popular agents for procedural sedation have no analgesic effect. For procedures that are not significantly painful, this is not a problem. For painful procedures such as complex fracture reduction, an agent with analgesic properties (such as ketamine) is needed or the sedative should be combined with an opioid analgesic (such as fentanyl). However, combination therapy is associated with an increased risk of respiratory depression, hemodynamic instability, and other adverse events, so if using combination therapy, it is especially important to use the lowest effective doses, monitor the patient closely, and have appropriate rescue/resuscitation equipment available during the procedure.

Table 3. Selecting an Agent Based on Goal or Type of Procedure

Goal	Type of Agent
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	**Agents**
Not painful (i.e., diagnostic imaging)	• Midazolam • Propofol
Minimally painful (i.e., minor trauma, instrumentation, vascular access)	• Nitrous oxide • Topical local anesthesia • Midazolam
Painful (i.e., minor trauma, instrumentation, vascular access [central])	• Ketamine • Fentanyl + midazolam • Propofol

Adapted from: Elikashvili I, Vella AD. An evidence-based approach to pediatric procedural sedation. *Emerg Med Pract* 2012;9:1-16.

Post-Sedation Monitoring

The vast majority of adverse events related to procedural sedation in pediatric patients occur during the procedure itself. Children who have received sedation or analgesia for an ED procedure and do not have an adverse event during the procedure can safely be discharged after a 30-minute observation period following the last dose of medication, provided they otherwise meet discharge criteria. ACEP recommends (Level C) that no universally applicable, evidence-based set of clinical indicators for discharge has been established. Emergency physicians, in conjunction with their institutions, should develop criteria for safe discharge.[26] Post-sedation discharge criteria are as follows[6]:

• All vital signs within acceptable limits;

• Maintaining airway patency unassisted;

• Awake or easily aroused;

• Able to talk (if age-appropriate);

• Able to sit up unassisted and ambulate short distances with minimal assistance (if age-appropriate);

• Has tolerated oral intake with no subsequent nausea or vomiting.

Conclusion

Children experience anxiety and pain, especially with procedures in the acute care setting. It is important for clinicians to identify and manage these aspects of patient care. Agents should be selected based on the clinical goals (sedating for an imaging study, immobilization, and pain control, etc.). An understanding of effective alternatives and routes will optimize the child's emergency department experience.

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CME/CE Questions

1. What is the role of non-pharmacologic techniques for managing anxiety in pediatric procedural sedation?
   a. They are essentially useless because children lack the intellectual maturity to understand the procedure being performed. The only option for reducing their anxiety is medication.
   b. If used effectively, they can entirely eliminate the need for medication, even for complex and painful procedures.
   c. They are only effective if a certified Child Life Specialist is available to perform them.
   d. Although they may not entirely eliminate the need for medication, they can reduce the amount and intensity of pharmacologic sedation that is needed, as well as improving the patient experience of the procedure.
2. Which of the following is true regarding talking to children about upcoming procedures (provided they are verbal and able to engage in conversation)?
   a. Explaining upcoming procedures to children will only upset them further; it is best to simply perform the procedure as quickly as possible with no explanation.
   b. Children benefit from maximal honesty; it is best to describe the procedure to them in detail, including pointing out which parts of the procedure are expected to be particularly painful.
   c. If possible, you should take time to prepare children for upcoming procedures, including allowing them to see/touch/use the equipment that will be used for the procedure (if this can be done in a safe and practical way).
   d. It is important to use the same explanations as you would for adults.

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CME/CE Objectives

Upon completion of this educational activity, participants should be able to:

- discuss conditions that should increase suspicion for traumatic injuries;
- describe the various modalities used to identify different traumatic conditions;
- cite methods of quickly stabilizing and managing patients; and
- identify possible complications that may occur with traumatic injuries.

3. Which of the following statements about having parents remain in the room for procedures is true?
   a. Parents should be required to remain in the room for all procedures and should be expected to assist with restraining their children.
   b. Having parents in the room for procedures only creates unnecessary distractions for the clinician, so parents should be required to leave.
   c. Parents who choose to stay in the room for procedures benefit from being given a specific task.
   d. Because parental presence can reduce anxiety and pain during the procedure, parents who choose to leave the room for a procedure should be informed that they are increasing their child's pain and anxiety.
4. Which of the following are effective distraction techniques for children undergoing procedures in the emergency department?
   a. Picture books
   b. Blowing bubble
   c. Watching a movie
   d. All of the above
5. Which patient would be the best candidate for procedural anxiolysis with oral midazolam?
   a. A 13-month-old with a scalp laceration who screams and cries whenever she is approached by medical staff, and whose parents report that she hates taking oral medication under any circumstances
   b. A 7-year-old with a simple facial laceration who is very anxious about "getting stitches," but is receptive to the idea of taking medication to help him feel less anxious
   c. A 10-year-old with a comminuted distal radius fracture that is expected to be very difficult to reduce
   d. A 16-year-old who fell while intoxicated with alcohol, sustaining an ankle fracture, and is now still intoxicated and vomiting repeatedly
6. Which of the following statements about intranasal procedural sedation is *false*?
   a. Because first-pass metabolism is bypassed and the nasal mucosa are highly vascularized, the time of onset is very quick.
   b. It allows children to avoid the traumatic experience of an intravenous placement or intramuscular injection.
   c. Because there is essentially no limit on the volume of liquid that can be atomized into the nares, intranasal sedation is an option for children of all sizes.
   d. Because of the limits on the volume of medication that can be absorbed by the nasal mucosa, it is a good idea to divide your dose between both nares to maximize absorption.
7. A 3-year-old patient has a complex facial laceration. You think that parenteral sedation will be necessary to achieve optimal repair. When you walk into the room to obtain consent for sedation from her parents, they say the child ate a chocolate chip cookie and drank from a juice box about an hour ago. What is the appropriate next step?
   a. No change in plans is necessary; proceed with sedation and laceration repair.
   b. Proceed with laceration repair, but obtain written acknowledgement from the parents that their daughter is at increased risk of aspiration and vomiting because she ate and drank shortly before the procedure.
   c. Wait until the patient has had no oral intake for at least two hours before performing the procedure.
   d. Wait until the patient has had no oral intake for at least eight hours before performing the procedure.
8. A 6-year-old boy with congenital adrenal insufficiency and an anaphylactic allergy to eggs has a displaced mid-shaft humerus fracture that requires reduction under parenteral conscious sedation. Which agent(s) is/are appropriate for sedation in this patient?
   a. Etomidate alone
   b. Etomidate and fentanyl
   c. Ketamine alone
   d. Propofol and fentanyl

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