Outpatient Sedation and Risks (Including Dental)

Stephanie S. Montarroyos, DO,* Alison Payson, MD,† Christie De La Vega, MD,* Anamaria Pulido, MD*

*Nicklaus Children's Hospital, Miami, FL
†Cohen Children's Medical Center, Queens, NY

PRACTICE GAPS

During the past 2 decades, outpatient sedation has been increasing in popularity among pediatric subspecialists for both invasive and noninvasive procedures outside the operating room. Clinicians should be aware of the indications for outpatient sedation, the different levels of sedation, and the current guidelines for performing a presedation assessment with risk stratification and monitoring during sedation as well as the risks associated with different sedating agents.

OBJECTIVES *After completing this article, readers should be able to:*

1. Describe the indications for outpatient sedation.
2. Define the different levels of sedation.
3. Describe how to properly assess and risk stratify a pediatric patient before outpatient sedation.
4. List the options for common pharmacologic sedating agents available for outpatient management and associated adverse effects.
5. Recognize the risks associated with outpatient sedation and recommendations for prevention of adverse events.

INTRODUCTION

Sedation is defined as "a drug-induced depression of consciousness," which occurs on a continuum ranging from minimal sedation to general anesthesia. (1) During the past 2 decades, outpatient sedation has been increasing in popularity for pediatric subspecialists for both invasive and noninvasive procedures outside the operating room. Providers have better awareness of untreated pain during painful procedures, increasing the likelihood of sedation and pain management for as simple a procedure as venipuncture. The number of procedures performed outside the operating room has also increased during the past few decades, increasing the demand for outpatient procedural sedation. Sedation can be used to help pediatric patients relax, curtail anxiety, or assist with pain control if required during painful procedures and procedures

AUTHOR DISCLOSURE: Drs Montarroyos, Payson, De La Vega, and Pulido have disclosed no financial relationships relevant to this article. This commentary does not contain a discussion of an unapproved/investigative use of a commercial product/device.

ABBREVIATIONS

AAP	American Academy of Pediatrics
ASA	American Society of Anesthesiologists
FDA	Food and Drug Administration

that require patients to remain still for extended periods. Sedation is also useful in the outpatient setting to treat infants, uncooperative patients, or patients with procedure phobia.

Outpatient sedation may be used for a variety of procedures, including radiologic imaging, auditory brainstem response testing, lumbar puncture, botulinum toxin injections, peripheral intravenous line insertion, laceration repair, incision and drainage of abscesses, gastroscopy/colonoscopy, and dental cleaning or extractions. In terms of imaging, the use of magnetic resonance imaging in place of computed tomography is becoming more popular in infants and children because it reduces exposure to ionizing radiation. However, this imaging technique takes longer to perform and requires patient immobility, thus increasing the need for sedation in patients who may be unable to cooperate. (2)

Although outpatient sedation is relatively safe, there are inherent risks associated with sedation. The most common adverse events that occur during sedation are related to airway compromise because respiratory depression is a common adverse effect from sedating medications. To mitigate adverse events associated with outpatient sedation, it is imperative to perform a presedation assessment with risk stratification of patients to determine whether the patients are appropriate candidates for sedation. It is equally important to adequately monitor the patients during sedation to ensure safety and to quickly intervene if adverse events should occur. In addition, the physician performing the procedure should not also be the practitioner performing the sedation; at least 1 of these individuals must be skilled in advanced airway management. There are a variety of sedating agents available in the outpatient setting that can be chosen based on the type of procedure and the duration for which the sedation is required.

LEVELS OF SEDATION

Various levels of sedation exist and can be chosen based on the type and duration of each procedure. Levels are classified as either minimal, moderate, or deep sedation. Different levels of sedation exist in a continuum in which the patient may easily move from 1 level to another during the same sedation. Many sedative agents require repeated dosing to achieve the desired level of sedation with titration to effect. (3) During minimal sedation, the patient is relaxed but awake with maintained consciousness and can respond appropriately to commands. (4) Minimal sedation may typically be obtained without intravenous medication administration. (5) With moderate sedation, the patient has waxing and waning consciousness but can be awakened when prompted and is able to maintain his or her own airway. (4)(5) This level of sedation usually requires a combination of sedating medications or multiple doses of a sedating medication. (5) During deep sedation, the patient is completely unconscious and unable to respond to sound or touch unless repetitive or painful. (3)(4) Airway reflexes, airway patency, and independent ventilatory function are usually retained, but they may be impaired. (3) If sedation is greater than deep, it is classified as general anesthesia in which the patient cannot be aroused even with painful stimulation and the patient loses independent ventilatory capability. (5) Clinicians must keep in mind that there is always a possibility of sedation at an unintended level greater than desired. If this occurs and the patient experiences airway compromise or loss of independent ventilatory function, the sedating physician must be prepared for this situation and have the equipment and skills necessary to intervene and provide appropriate cardiorespiratory support.

PRESEDATION ASSESSMENT

A presedation evaluation is necessary to assess for underlying medical or surgical conditions predisposing to adverse effects of sedating medications, particularly respiratory depression. (6) For this reason, emphasis should be placed on the cardiac and respiratory systems during patient consideration for outpatient sedation. Any patient with an acute respiratory infection or active asthma/reactive airway disease may be at risk for bronchospasm during sedation. (3) Any form of airway obstruction, such as a history of sleep apnea or tonsillar hypertrophy, may result in apnea or desaturation during the procedure. (3) Special attention should be given to patients with known uncorrected cardiac abnormalities because cardiac function may be impaired during sedation. If signs of heart failure, such as fatigue, difficulty feeding, or shortness of breath, are present at baseline, sedation could have devastating effects due to diffuse vasodilatation and hypotension. (3) It is recommended that all patients with known uncorrected congenital heart disease obtain an echocardiogram within 6 months of sedation. (3)

A presedation physical examination should focus on an assessment of the respiratory tract and airway anatomy with determination of the Mallampati score, a 4-level scale, which relates tongue size to pharyngeal size. (7) This score, commonly used in the operating room, ICU, or emergency department, provides an estimate of intubation difficulty, with higher scores predicting increased difficulty. (8) It has been extrapolated for use during procedural sedation; however, in pediatric patients, 1 study showed that higher Mallampati scores were not associated with increased risk of adverse sedation-related events, and multiple studies have shown

Table 1. American Society of Anesthesiologists (ASA) Classification in Pediatric Patients

ASA CLASS	DESCRIPTION
I	Normal, healthy patient
II	A patient with mild/moderate systemic disease
III	A patient with severe systemic disease
IV	A patient with severe systemic disease that is a constant threat to life
V	A moribund patient who is not expected to survive without the operation
VI	A declared brain-dead patient whose organs are being removed for donor purposes

that the Mallampati score is specific but inadequately sensitive and thus can be unreliable. (7)(9) The presence of craniofacial abnormalities, macroglossia, micrognathia, or limited range of motion in the neck should be noted as these present challenges to intubation, if required. (3)

After initial history and physical examination, the American Society of Anesthesiologists (ASA) physical status classification system should be used to determine the patient's presedation medical comorbidities and estimate sedation-related risks (Table 1). Only ASA I and II should be considered for safe, procedural sedation, with ASA I representing a normal, healthy individual and ASA II denoting a patient with mild/moderate systemic disease. (5)(10) To be classified as ASA I, the patient must have a normal BMI percentile for age and cannot have an acute illness or chronic disease history. (11) A patient with mild/moderate systemic disease is classified as ASA II. Examples of an ASA II classification include patients with asymptomatic congenital cardiac disease, well-controlled dysrhythmias, a history of asthma without an acute exacerbation, well-controlled epilepsy, non–insulin-dependent diabetes mellitus, abnormal BMI percentile for age (<5th percentile or ≥85th percentile), mild/moderate obstructive sleep apnea, an oncologic state in remission, and autism with mild limitations. (11) General anesthesia with a controlled airway should be considered for patients with ASA III to V (including patients with severe systemic disease) as well as for premature infants and infants younger than 60 weeks postconceptual age to minimize the risk of adverse events. (3)

As per the 2019 American Academy of Pediatrics (AAP) guidelines for procedural sedation, patients are also recommended to fast before receiving any level of sedation greater than minimal for elective procedures to prevent aspiration of gastric contents during the sedation process. (4) However, studies in the emergency department investigating the incidence of sedation-related adverse events based on preprocedural fasting times have shown no such association. (12)(13) When emergency procedures are required, risks and benefits of sedation may be considered based on the urgency of the procedure and ingested material. Minimum recommended fasting time for solids is 8 hours. (3) Clear liquids may be consumed up until 2 hours before sedation. (3)(4) For patients younger than 12 months, human milk may be consumed until 4 hours before sedation. (3) Formula without cereal may be consumed until 6 hours before sedation in patients 6 to 12 months of age and until 4 hours before sedation if younger than 6 months. (4)

PREPARATION AND MONITORING

Although outpatient sedation is relatively safe, there is a risk of adverse events during any sedative process, most of which are related to airway compromise. (2) To mitigate this, proper equipment setup before sedation is crucial to quickly address respiratory complications if they occur. Successful setup before outpatient sedation includes suction (for secretions or to use before intubation), oxygen and various methods for delivery of oxygen (nasal cannula and face mask if passive, bag-valve-mask ventilation with appropriately sized mask if active), endotracheal tube sized for the patient with available laryngoscope and airway adjuncts (oropharyngeal/nasopharyngeal airway) in case respiratory support with an alternative airway is necessary, intravenous access for medication/fluid delivery, and monitoring. (3) A baseline set of vital signs should be obtained, including room air oxygen saturation. Continuous physiologic monitoring of heart rate, respiratory rate, and oxygen saturation should be performed using a cardiorespiratory monitor and a pulse oximeter. (3) Blood pressure should be intermittently checked at a minimum of every 3 minutes. (3) Capnography including end-tidal carbon dioxide levels should be used to ensure adequate ventilation and respiration, especially during deep sedation. (3) Vital signs should be recorded every 5 minutes until the patient returns to their baseline level of consciousness. (3) Any persistent alteration in a patient's baseline vital signs, including bradycardia or tachycardia, bradypnea, oxygen desaturation, hypertension or hypotension, and hypercarbia, should be monitored and addressed accordingly. The 2019 AAP guidelines for procedural sedation recommend the involvement of an independent observer (independent of performing or assisting with the procedure) who is trained in airway rescue and whose only responsibility is to monitor the patient when moderate or greater sedation is provided. (2)(5) Serial observation by trained medical personnel not actively involved with the procedure allows for adequate sedation as well as prompt recognition of complications that could become serious adverse events if not effectively addressed. (6) With the introduction of these safety

practices, outpatient sedation has become relatively safe, with infrequent adverse effects and very rare accounts of death, although with any procedure or intervention, risks remain inherent. (2)

CRITERIA FOR DISCHARGE

After the procedure is completed and sedation is no longer required, the patient should be observed with continuation of monitoring until the sedative effects wear off and the patient returns to a presedation level of consciousness. (5) The patient should be able to maintain a patent airway with independent ventilation and stable cardiovascular function. The pediatric patient should also be able to maintain hydration orally without adverse effects of nausea or vomiting. This recovery process typically requires 60 to 120 minutes, at which point the patient can be discharged safely after this observation period if all the criteria are met. (3) If there is any concern for cardiovascular or respiratory compromise, inability to maintain oral hydration, or prolonged sedative effects on consciousness or pain, the provider should consider admission to the hospital for continued management.

SEDATING AGENTS

Commonly used medications for outpatient sedation include propofol, midazolam, dexmedetomidine, ketamine, pentobarbital, nitrous oxide, and fentanyl. These agents are discussed in detail, noting their differences (Table 2).

Propofol

Propofol is 1 of the most favored medications for deep sedation because it has a quick onset. (4) It is highly lipophilic, which allows the medication to cross the blood-brain barrier and produce its effects rapidly. Propofol should be used with caution in children with hypersensitivity to egg products, soy products, and glycerol. Propofol is administered intravenously with effects usually noted within less than 1 minute, lasting less than 10 minutes. (10) It provides both sedation and amnesia but does not provide pain relief, so it is most commonly used with fentanyl or ketamine if pain control is desired. (2) Propofol can cause respiratory depression; however, the combination of propofol with ketamine is less likely to be associated with respiratory depression because ketamine maintains airway reflexes. (14) Severe adverse effects, albeit rare, are increased with co-administration of propofol and ketamine (14). Propofol is also known to cause transient apnea, hypotension, pain during injection, and airway obstruction in a dose-dependent manner. (15) This medication has historically been limited to administration by anesthesiologists but has been gaining popularity among nonanesthesiologist clinicians due to its rapid onset and recovery. Recent studies have suggested that with proper education, training, and adherence to established safety guidelines, propofol is safe for administration by nonanesthesiologists completing outpatient procedures. (16)(17)(18) However, there is an association of lactic acidosis with prolonged or high-dose propofol infusion. (19)

Midazolam

Midazolam is a benzodiazepine with central nervous system depressant effects and amnestic properties that can be administered orally, intramuscularly, intranasally, or intravenously. It is the most widely studied sedative agent for outpatient procedures. (5) It is also a first-line agent for cessation of acute convulsive activity. Intranasal administration results in rapid absorption by the central nervous system, with onset of sedation within 10 minutes of administration. (5)(20) Oral administration usually provides minimal sedation within 15 to 30 minutes, and intravenous administration quickly provides adequate sedation within 5 to 15 minutes. (5) Duration of sedation ranges from 20 to 40 minutes. (5) Like any benzodiazepine, midazolam can cause respiratory depression, especially with cumulative doses, in addition to nausea, emesis, and hiccups, and erythema/edema at the injection site. Use should be avoided in patients with acute narrow-angle glaucoma and those with known hypersensitivity to benzodiazepines. Midazolam has an antidote, flumazenil, which can be given intravenously to reverse any adverse effects, such as respiratory depression, and has an onset of less than 1 minute. (5) Once flumazenil has been administered, the patient should be monitored for seizure activity because benzodiazepine reversal has been associated with lowering the seizure threshold. (21)

Dexmedetomidine

Dexmedetomidine is a central, selective α_2-adrenoreceptor agonist with hypnotic or sleep-inducing, mild analgesic, and anxiolytic properties while also preserving airway tone and respiratory drive. (22)(23) Dexmedetomidine can be given buccally, intravenously, or intranasally, with an onset of action of approximately 20 to 40 minutes and a quick recovery. (23)(24) One study in 2019 showed that buccal dexmedetomidine alone or in conjunction with midazolam provided proper sedation, with few reported adverse effects, which seems promising. However, the failure rate of sedation with buccal dexmedetomidine was 20%, prompting the need for further investigation of buccal dosing before widespread recommendation. (22) Hypotension and bradycardia are the most significant adverse effects, especially in patients with severe heart block or in patients who are

Table 2. Sedating Agents

AGENT	INDICATIONS	ROUTE	ONSET	DOSING	ADVERSE EFFECTS
Propofol	Sedation, amnesia	Intravenous	<1 min	Loading bolus dose: 1–2 mg/kg Maintenance continuous infusion: Variable, reports ranging from 130–150 μg/kg per minute with titration to effect	Airway obstruction, respiratory depression, transient apnea, laryngospasm, hypotension, localized pain during injection
Midazolam	Sedation, amnesia, anticonvulsive	Oral, intramuscular, intranasal, intravenous	Oral/intramuscular: 15–30 min Intranasal: <10 min Intravenous: 5–15 min	Oral: 0.25–0.5 mg/kg (maximum 20 mg/dose) Intramuscular: 0.05–0.15 mg/kg (maximum 10 mg total daily dose) Intranasal: 0.2–0.8 mg/kg (maximum 10 mg/dose) Intravenous: 0.025–0.1 mg/kg, may titrate to effect (maximum 6 mg total dose for infants ≥6 mo to children <6 y; maximum 10 mg total dose for children ≥6 y)	Respiratory depression, nausea, emesis, hiccups, erythema/edema at injection site
Dexmedetomidine	Sedation, hypnosis, anxiolysis, analgesia	Buccal, intranasal, intravenous	20–40 min	Buccal: Limited data available Intranasal: 1–2 μg/kg single dose Intravenous: Loading bolus dose, 0.5–2 μg/kg over 10 min; maintenance continuous infusion, 0.5–1 μg/kg per hour, titrate to effect	Hypotension, bradycardia
Ketamine	Sedation, analgesia, amnesia	Intramuscular, intravenous	Intramuscular: 3–4 min Intravenous: 1 min	Intramuscular: 4–5 mg/kg Intravenous: 1–2 mg/kg given over 30–60 sec	Nausea/vomiting, dissociation, dizziness, diplopia, dysphoria, confusion, hallucinations
Pentobarbital	Sedation, hypnosis, anticonvulsive	Oral, intramuscular, intravenous	Oral/intramuscular: 30 min Intravenous: 3–5 min	Oral: Infants, 4 mg/kg per dose (maximum 8 mg/kg total dose); children <4 y, 3–6 mg/kg; and children ≥4 y, 1.5–3 mg/kg (maximum 100 mg/dose) Intramuscular: 2–6 mg/kg (maximum 100 mg/dose) Intravenous: 1–2 mg/kg (maximum 100 mg/dose)	Airway obstruction, hypotension, laryngospasm, increased risk of apnea, respiratory depression, and cardiac depression
Nitrous oxide	Sedation, analgesia, amnesia	Inhalation	<1 min	Concentrations vary, ~30%–50% nitrous oxide with oxygen	Nausea/vomiting, diffusion hypoxia, increased intracranial pressure, hematologic and neurologic toxicity
Fentanyl	Sedation adjunct, anxiolysis, analgesia	Intranasal, intravenous	<1–2 min	Intranasal: 1.5–2 μg/kg for patients >10 kg (maximum 100 μg/dose) Intravenous: 0.5–2 μg/kg (maximum 50 μg/dose)	Pruritis, bradycardia, chest wall rigidity, respiratory depression

hypovolemic or vasoconstricted. (23) There are no absolute contraindications to dexmedetomidine.

Ketamine

Ketamine is an *N*-methyl-D-aspartate antagonist that provides both sedation and pain relief. Ketamine generally maintains normal pharyngeal and laryngeal protective reflexes; therefore, spontaneous respiration can occur. However, spontaneous respiration is not guaranteed. In addition, transient, minimal respiratory depression may occur if ketamine is given too rapidly or in high doses. Ketamine can be administered intramuscularly or intravenously, although the intravenous route is preferred because doses may be titrated to effect and recovery time is shorter. (25) For the intravenous route, effects occur within 1 minute and last approximately 10 to 20 minutes, whereas for the intramuscular route, clinical onset occurs within 3 to 4 minutes and lasts about 15 to 30 minutes. (25) This medication has amnestic properties and causes dissociation whereby the patient may be in a trancelike state with nystagmus and open eyes. (25) One study showed that a combination of nebulized low-dose ketamine and dexmedetomidine produced greater levels of sedation within 30 minutes, shorter recovery times, and better postoperative analgesia than either ketamine or dexmedetomidine used alone for outpatient pediatric dental surgical procedures. (26) The most frequently reported adverse effects include postprocedure nausea and vomiting, dizziness, diplopia, dysphoria, and confusion, but hallucinations have also been reported. (27) Laryngospasm during ketamine sedation is a rare (~0.3%) but potentially fatal complication that is not readily predicted. Anticholinergics do not decrease the risk of laryngospasm. Applying pressure to the "laryngospasm notch" (the area anterior to the mastoid process, behind the ear lobe) may reverse the spasm and is worth attempting before more invasive measures. Ketamine must be used with caution in patients with elevated intracranial or intraocular pressure, in children younger than 3 years, and when administering repeated doses within 3 hours. Its use should be avoided in patients with schizophrenia.

Pentobarbital

Pentobarbital is a barbiturate with not only sedative but also hypnotic and dose-dependent anticonvulsant properties. (28) Pentobarbital does not provide analgesia. (28) It can be administered either orally or intravenously but is most often given intravenously, potentially because the intravenous route has been more widely studied. (28)(29) Pentobarbital has a rapid onset of action, within 3 to 5 minutes, but can have a prolonged duration of approximately 90 minutes. (28) It has been associated with serious adverse effects, including airway obstruction and hypotension, with increased risk of apnea, respiratory and cardiac depression, and laryngospasm, particularly with intravenous administration. (28) Pentobarbital use is contraindicated for patients with a known hypersensitivity to barbiturates or porphyria.

Nitrous Oxide

Nitrous oxide has been used for outpatient sedation in combination with oxygen. Nitrous oxide is an odorless, colorless, inorganic gas that was reported to be the most used gaseous anesthetic in the world, used in approximately 70% of dental practices per a 2007 survey by the American Dental Association. (30)(31) Nitrous oxide's exact mechanism of action is unknown. (32) Nitrous oxide is inexpensive, has rapid onset and elimination, and provides cardiorespiratory stability; however, it does have low potency and a risk of postprocedure nausea and vomiting, diffusion hypoxia (resulting from rapid entrance of nitrous oxide into the alveoli quicker than nitrogen exits, causing gaseous dilution including oxygen), increased intracranial pressure, and hematologic/neurologic toxicity. (32) Contraindications to nitrous oxide use include recent middle ear disturbance, severe emotional disturbances, first trimester of pregnancy, treatment with bleomycin sulfate, cobalamin deficiency, pneumothorax, small-bowel obstruction, and age younger than 3 years. During inhalation induction, nitrous oxide produces rapid loss of consciousness by the concentration effect, which occurs when the concentration of gas located in lung alveoli is increased due to a large volume of gas entering pulmonary capillary blood from the alveoli. (32) Nitrous oxide has successfully been used for sedation before dental procedures, upper gastrointestinal endoscopy, fiberoptic bronchoscopy, and venipuncture. (32) Nitrous oxide has also proved beneficial in reducing chronic postsurgical pain due to its antagonist action on *N*-methyl-D-aspartate receptors. (32) One study using a fixed 50% nitrous oxide/oxygen mixture as a single agent had an approximately 90% successful sedation rate and no serious adverse events reported for patients with intellectual disability. (33) To deliver an inhaled combination of nitrous oxide with oxygen, the inhalation equipment must be able to deliver 100% and never less than 25% oxygen concentration. (6) Varying concentrations of nitrous oxide can be used to produce minimal, moderate, or deep sedation as well as general anesthesia in a dose-dependent manner. (34) To achieve minimal sedation, less than or equal to 50% concentration of nitrous oxide with the remainder as oxygen should be used without any other sedative or analgesic. (6) When combined with other sedatives/analgesics or if used in concentrations greater than 50%, there is

increased likelihood for moderate or deep sedation. (6) In contrast to the monitoring recommendations for other sedative agents, the American Academy of Pediatric Dentistry guidelines from 2009 do not require oxygen saturation monitoring for children receiving exclusively nitrous oxide for sedation in dental procedures. (32)

Fentanyl

Fentanyl is an opioid anxiolytic useful as an adjunct to sedation. It can be administered intranasally or intravenously. Fentanyl has a rapid onset and recovery, with effects seen within 1 to 2 minutes on administration and resolution in approximately 30 minutes to 1 hour. (3)(5) It is commonly given in combination with pentobarbital to provide comfort and sedation during painful procedures such as abscess incision and drainage. (4) Fentanyl may cause pruritis, bradycardia, chest wall rigidity, and respiratory depression, which persists longer than the analgesic effect. Naloxone is an opioid antidote given intranasally, intravenously, intramuscularly, or subcutaneously and is used for rapid reversal of unwanted adverse effects such as respiratory depression. (3) One should avoid fentanyl use in patients with head/chest/abdominal trauma, epistaxis (for intranasal administration), hypovolemia, or known hypersensitivity to opioids.

Chloral Hydrate

Chloral hydrate was once the standard of care for outpatient sedation. Administered orally or rectally in liquid form, chloral hydrate was 1 of the most common sedative-hypnotic medications used during the past century. (35) However, chloral hydrate has been linked to multiple deaths during procedural sedation, possibly due to its narrow therapeutic index without an antidote for toxicity. (35)(36) This medication is no longer US Food and Drug Administration (FDA) approved owing to severe adverse effects and has been discontinued in the United States since 2012; however, chloral hydrate remains available for use in countries such as Japan, Australia, England, and Switzerland. (35)(37) Multiple studies have shown an increase in the use of dexmedetomidine and a decrease in the use of chloral hydrate and pentobarbital during the past decade and a half, potentially due to a safer adverse effect profile. (2)(38)

RISKS/ADVERSE EVENTS

As previously mentioned, outpatient sedation is a relatively safe practice but not without risks. The presence of an active upper respiratory tract infection or preexisting medical conditions, including prematurity, craniofacial or anatomical airway abnormalities, asthma, developmental delay, and obstructive sleep apnea, have been shown to have a higher propensity for an adverse event, most likely due to effects on the airway. (2) Gastrointestinal or dental procedures are also more commonly associated with adverse effects. (2)

Airway obstruction was the most common adverse event, occurring in 1.55% of all sedation encounters in a study published in 2020 reporting sedation trends from 2007 to 2018. (2) Other risks of sedation include laryngospasm, transient desaturations that may or may not require ventilation, aspiration, cardiac arrest, and ultimately death, although this is significantly rare. (2)

One study analyzing adverse sedation-related events showed that the most common factor contributing to unfavorable outcomes is human error due to inadequate medical evaluation, monitoring, skills in appropriate intervention if adverse events occur, and lack of experience. (36) Death and permanent neurologic injury occurred more frequently in non–hospital-based settings, likely due to inadequate resuscitation in response to respiratory compromise. (36) Indicators of respiratory compromise were the initial clinical event in more than 80% of patients included in the study in both hospital and nonhospital environments. Pulse oximetry was positively associated with successful outcomes in contrast to unsuccessful outcomes in patients who received no physiologic monitoring during sedation. In addition, deviations in end-tidal carbon dioxide levels have been shown to be the earliest indicator of airway or respiratory compromise, before pulse oximetry shows a decreased oxygen saturation. (39) By providing proper monitoring as recommended by both the AAP and the ASA, detrimental outcomes may be predicted and prevented by timely recognition and appropriate intervention. (36)

GAINING EXPERIENCE

The Society for Pediatric Sedation offers Sedation Provider Courses that provide the basic knowledge and core competencies necessary for procedural sedation, including discussion on proper patient selection and risk assessment, monitoring, pharmacology of sedating agents, and identification and management of the most common potential adverse events. There are options for online learning as well as in-person simulation-based training. The Society for Pediatric Sedation also offers online podcasts, modules, lectures, and national conferences. (40) Providers who plan to administer outpatient sedation should be certified in Pediatric Advanced Life Support to safely intervene in the event of cardiac or respiratory compromise.

CONCLUSION

With increasing amounts of procedures performed in the outpatient setting, there is a higher demand for outpatient

sedation performed by a variety of pediatric subspecialists. Understanding the levels of sedation that exist and how to adequately assess, risk stratify, and monitor patients who safely qualify for outpatient sedation is crucial to prevent adverse events and intervene appropriately when required. Knowledge of the medication options available for use during outpatient sedation is important to determine which sedating agent will achieve the effects and length of sedation desired.

Evidence/Summary

- Various levels of sedation exist, classified as minimal, moderate, or deep sedation. (3)(4)(5) If sedation at a level greater than desired occurs and the patient experiences airway compromise or loss of independent ventilatory function, the sedating physician must be prepared to intervene and provide respiratory support appropriately.
- A presedation evaluation, including history, physical examination, and patient selection for outpatient sedation candidacy, is necessary to ensure optimal patient safety and attempt to minimize the risk of adverse events related to sedating medications (strong recommendation). (6) (Based on expert consensus per the 2019 American Academy of Pediatrics guidelines)
- There are a variety of sedative and analgesic medications available for use depending on the properties desired during sedation for outpatient procedures. It is important to understand the adverse effects of each medication to be aware of possible complications during sedation.
- Proper equipment setup and monitoring during sedation are crucial to prevent adverse events (strong recommendation). (2)(3)(5)(6) The most frequent unfavorable outcome is airway obstruction in response to human error, with greatest severity due to inadequate resuscitation. (2) Monitoring, including pulse oximetry, has been positively associated with successful outcomes, in contrast to unsuccessful outcomes in patients who received no physiologic monitoring during sedation. (36) If capnography is used, this measure has been suggested as the earliest indicator of airway or respiratory compromise before pulse oximetry detects decreased oxygen saturation. (39) (Based on research evidence as well as consensus)

QI PROJECT SUGGESTION

- Creation and implementation of an equipment checklist to ensure all the necessary equipment is available and working properly before starting the sedation.

References and teaching slides for this article can be found at https://doi.org/10.1542/pir.2022-005642.

PIR QUIZ

1. A 3-year-old patient presents for planned magnetic resonance imaging of the brain with sedation. He has a history of seizures treated with levetiracetam, with his last seizure occurring 6 months ago. He also has a history of asthma and currently is taking fluticasone twice daily. He last used albuterol 4 months ago for a viral illness. On physical examination he has normal breath sounds and a normal cardiac evaluation. His tone and strength are normal. The parents report that the child has no snoring or abnormal breathing with sleep. This patient meets which of the following American Society of Anesthesiologists classification levels?

   A. Level I.
   B. Level II.
   C. Level III.
   D. Level IV.
   E. Level V.

2. A 9-year-old girl is admitted to the hospital for severe constipation and will require peripheral intravascular access as well as a nasogastric tube for administration of intravenous fluids and high doses of an osmotic laxative. The family requests sedation. A dose of intranasal midazolam is ordered. The family wonders when the medication should begin to take effect. Which of the following best describes the expected time of onset of sedation after administration of intranasal midazolam in this patient?

   A. 1 minute.
   B. 5 minutes.
   C. 10 minutes.
   D. 15 minutes.
   E. 20 minutes.

3. A 5-year-old patient seen in the emergency department with a dislocated joint requires sedation while the joint is manipulated. Of the following, which sedative provides both sedation and moderate analgesia?

   A. Ketamine.
   B. Midazolam.
   C. Nitrous oxide.
   D. Pentobarbital.
   E. Propofol.

4. During sedation of a 6-year-old boy for a lumbar puncture the patient becomes unstable, with bradycardia and chest wall rigidity. Which of the following sedatives is most likely responsible for these adverse effects in this patient?

   A. Fentanyl.
   B. Ketamine.
   C. Midazolam.
   D. Pentobarbital.
   E. Propofol.

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5. A 4-year-old girl is undergoing sedation for magnetic resonance imaging of the leg to assess for a possible septic joint. Sedation is being provided with propofol and the patient is being appropriately monitored. A deviation in which of the following values is most likely to occur as the earliest indicator of impending respiratory compromise?

   A. Blood pressure.
   B. End-tidal carbon dioxide.
   C. Heart rate.
   D. Pulse oximetry.
   E. Respiratory rate.