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Conscious Sedation in the Pediatric Population

Special Considerations

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During the last 10 years, the number of procedures performed in areas outside of the operating room has increased markedly. Because of this rapid increase, the use of nurse-monitored sedation in these patients has also increased substantially. To provide guidelines for the use of various types of sedation in the pediatric population, in 1985 the American Academy of Pediatrics (AAP) published "Guidelines for the Elective Use of Conscious Sedation, Deep Sedation, and General Anesthesia in Pediatric Patients."[1] These guidelines were revised and retitled in 1992 to reflect current trends in sedative use as well as monitoring needs for the child both during and after receiving sedation.[2]

Children are not little adults. They are physiologically, psychologically, and emotionally different. For these very reasons, the term *conscious sedation* (CS) may not always reflect the level of sedation required for the pediatric patient.[14] Conversely, the term *deep sedation,* as defined by the American Academy of Pediatrics, includes the "inability to maintain a patent airway independently," which may also be somewhat rigid for what actually occurs in this population.[2] Deep sedation may be necessary for certain procedures that children must undergo, such as permanent pacemaker implantation or radiofrequency catheter ablation. The nurse caring for children receiving sedation must be cognizant of the differences between children and adults and incorporate them into the individual patient's plan of care.

There is scant nursing literature that deals specifically with CS or deep sedation in the pediatric population. Today's practicing nurses find themselves in situations in which they are responsible for the prescribed administration of these agents as well as for patient monitoring. The intent of this article is to assist the nurse in providing safe, quality care to those pediatric patients receiving sedative agents.

Reviewed in this article are the fundamental differences in children, including the psychologic/developmental aspects, anatomic/physiologic differences, and pathologic/pharmacologic differences. The recommendations of the American Academy of Pediatrics are discussed as well as specific procedures requiring the use of sedation in children. Routes of administration and specific agents will be reviewed in addition to potential complications. The nursing implications of caring for children who receive sedation and the associated nursing care are also presented.

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Fundamental Differences in Children

Psychologic/Developmental

Because the child is both cognitively and emotionally immature, his or her response to and understanding of medical procedures will vary. The child also has underdeveloped communication skills, which makes nonverbal communication between the nurse and the child extremely important. Additionally, the child is not alone; generally there is a family attached. The child's care should be family centered, because everything that affects the child affects the family, and vice versa.[12] Preprocedural preparation of the child undergoing a procedure requiring the use of sedation should begin with an assessment of the child's level of understanding to ensure that the level of teaching is congruent with the patient's age and intellectual abilities. Patient and family education is generally most successful when information is presented briefly, simply, and repeatedly. Explanations should be honest and factual to promote trust in the nurse/patient relationship. Any written information is an effective adjunct.

The response of the child and family to illness varies.[38] Age and intellectual maturity are less important than the child's conception of illness in predicting the child's level of adjustment before hospitalization.[10] Parents generally react to their child's illness with disbelief followed by anger, guilt, fear, frustration, and anxiety, depending on the severity of the illness.[47] The nurse caring for the patient and family must take all of these issues into account when explaining the type of sedative agent to be used, as well as the patient's response to said agent. For example, if ketamine is to be used in a child undergoing an invasive procedure, the potential for hallucinations in the recovery period should be explained during the preprocedural educational session. The nurse can relieve some anxiety for the patient and family by explaining how the sedation agent works, as well as what the family might expect during recovery, both immediately following the procedure and when the child returns home.

Anatomic/Physiologic

The anatomic and physiologic differences in children include, but are not limited to, the following systems: respiratory, cardiovascular, fluid and electrolytes, and thermoregulation. These differences are pivotal in caring for children receiving agents that are likely to affect their overall hemodynamic status. The baseline vital signs of a child differ somewhat from those of an adult. Both the heart and respiratory rates are faster, and the blood pressure is lower. Smaller changes in the vital signs of a child are more significant than in the adult. The nurse caring for a child must be aware of not only these normal parameters (Table 1) but also of what is normal for a specific child's condition, such as a child with cyanotic heart disease.

Every component of the respiratory system is immature in the child. The airway of the infant and child is smaller than that of the adult.[4] Any agent that may produce laryngospasm or bronchospasm can result in airway obstruction in the younger child owing to the underdevelopment of the supporting cartilage and airway muscles prior to school age. Precautionary measures should be made *prior* to administering sedative agents in this age group. Intubation of the pediatric patient can be complicated by the more anterior and cephalad larynx. Also, the smallest portion of the larnyx is at the level of the cricoid cartilage, limiting the size of an endotracheal tube that may be used until the child is approximately 8 years of age.[4] Although the use of CS or deep sedation precludes the use of endotracheal intubation, complications can arise that necessitate intubation. The health care professionals caring for these children must be cognizant of these differences, especially when administering agents that produce central respiratory depression.

The primary difference between a child's cardiovascular system and an adult's cardiovascular system is a faster heart rate. A child's stroke volume is smaller, and thus cardiac output is directly proportional to heart rate. If the child's heart rate exceeds 220 beats per minute, stroke volume and cardiac output usually fall secondary to compromised ventricular diastolic filling time and decreased coronary artery perfusion.[4] Bradycardia has a similar effect; when it is persistent or profound, it is commonly a result of acidosis, hypoxemia, severe hypotension, or tissue hypoxia.[21] The child exhibits signs similar to the adult of decreased cardiac output and

Table 1. NORMAL VITAL SIGN PARAMETERS IN CHILDREN

Age	Respiratory Rates *(bpm)	Heart Rates (awake) †(bpm)	Heart Rates (sleeping) †(bpm)	Blood Pressure (systolic) (mmHg)	Blood Pressure (diastolic) (mmHg)
Newborn	35	100–180	80–160	60–90	20–60
Infant	30–60	80–160	75–160	87–105	53–66
Toddler	24–40	80–160	60–90	95–105	53–66
School-age	18–30	65–110	50–90	97–112	57–71
Adolescent	12–16	55–90	40–90	112–128	66–80

* *bpm*, breaths per minute; † *bpm*, beats per minute; *mmHg*, millimeters of mercury.
Data from Curley MAQ, Smith JB, Moloney-Harmon PA: Critical Care Nursing of Infants and Children. Philadelphia, WB Saunders, 1996.

poor systemic perfusion, including tachycardia, pallor, cool skin, and decreased urine output. Hypotension in the child is a *late* sign of decreased perfusion.

Fluid and electrolyte differences in the child are important. Owing to the child's higher metabolic rate and greater insensible and evaporative water losses, the child has a larger daily fluid requirement per kilogram of body weight. The absolute amount of fluid that the child requires is small, so that excess fluid administration should be minimized, especially when flushing or diluting medications. Electrolytes can play an important role in the child's overall status. Infants in particular are very sensitive to changes in glucose, especially during periods of high stress. Dehydration can be manifested by hypernatremia. Patients undergoing procedures requiring sedation who have previously taken diuretics can be prone to hypokalemia; this condition can lead to cardiac dysrhythmias if this is not recognized prior to sedative administration.

Thermoregulation is also an important factor in the care of the sedated child. The large surface area-to-volume ratios in the infant and young child lead to greater heat loss to the environment, when compared with adults. This heat loss can be prevented by maintaining a neutral thermal environment and frequently (or even constantly) monitoring the child's temperature during the procedure. Temperature extremes can alter the child's metabolic activity. Specifically, hypothermia reduces blood flow, and hyperthermia increases metabolic requirements.

Pathologic/Pharmacologic

Chronic illness often is seen in patients undergoing procedures requiring CS. The psychosocial and developmental needs of chronically ill children are not disease specific.[39] The medically compromised child, as well as the chronically ill child, may be sensitized to the medical or dental environment.[20] This may result in poor cooperation secondary to fear of the unknown or a history of traumatic experiences.

There are five specific variables that can be used to determine the level and duration of agents used. Children differ from their adult counterparts in each of these variables, primarily because of the child's increased cardiac output. The first variable to consider when choosing a sedative agent for the child is the dosage and formulation of the drug. The dosage should not only be weight dependent, but also age and disease dependent.[11] The available drug formulation will influence its concentration, and, in some cases, its route of administration.

Secondly, understanding the uptake and absorption of the drug is extremely important when caring for children. The third variable influencing the level and duration of sedation in the child is the concentration and distribution of the sedative within the body. In the pediatric patient, there is a greater competition for the protein binding sites, which means that there is more "free drug" available.[11] This may increase the risk of toxicity. Neonates specifically have decreased plasma protein concentration owing to their increased extracellular volume to total body water ratio.[11]

The fourth variable is the specific action of the drug at the targeted receptor site. Neonates again have a higher tendency to become toxic to sedative agents.[11] Finally, the fifth variable is drug metabolism and excretion.

Younger children have an increased sensitivity to pharmacologic agents and are more prone to toxicity[11] because of their immature metabolism and excretion systems. The child with an impaired renal system, liver dysfunction, or congestive heart failure will neither metabolize nor excrete sedative agents in the same way as a healthy child.

Recommendations of the AAP

The "Guidelines for Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures" purports to provide guidelines for health care professionals caring for sedated children.[2] The recommendations provided therein are summarized and paraphrased only here. The goals of sedation in the pediatric patient are similar to those of the adult; they include guarding the patient's welfare and safety, minimizing physical pain and discomfort, maximizing amnesia, providing analgesia to reduce negative psychological responses, controlling the patient's behavior, and returning the patient to a state that makes safe discharge possible.[2] Of utmost importance is documentation, which includes the time before, during, and after the child receives sedation.

The AAP publication contains specific guidelines regarding the level of sedation, both conscious and deep. The personnel administering the sedation, support personnel, monitoring, and documentation are discussed for each. Special considerations, such as the use of nitrous oxide, local anesthetics, and magnetic resonance imaging also are addressed.[2]

Vade and colleagues[45] used these guidelines to evaluate the safety of patients receiving chloral hydrate for specific radiologic procedures. The study demonstrated that proper monitoring could result in early recognition and management of complications, but also that, despite careful preprocedural screening, some patients do experience untoward reactions.[45]

In 1996, another study evaluated the helpfulness of these guidelines in 126 pediatric patients who received a variety of sedative agents while undergoing a variety of procedures.[27] The authors concluded that an organized approach to sedation management in the child, such as that recommended by the aforementioned AAP publication, is critical to the safety of pediatric patients.[27]

Procedures Requiring Sedation in Children

Children must undergo various procedures that require sedation. Coté[15] states that the following issues must be taken into account prior to sedative administration for a procedure: the type of procedure planned (i.e., painful or not painful), the duration of the procedure, the underlying medical condition of the child, the need for anxiolysis or narcosis, and experience with alternative routes or techniques of administration. Some of the procedures requiring sedation in children include urologic procedures, cardiovascular or pulmonary procedures, radiologic procedures, dental procedures, gastrointestinal procedures, and instances of emergency or trauma. Additionally, sedation is necessary in certain intensive care unit (ICU) situations. A synopsis of specific procedures can be found in Table 2.

Specific agents have been used in a variety of settings with success, whereas some others have not. Most of the agents used to sedate children have not been approved by the Food and Drug Administration (FDA) for use in the pediatric population; this generally means that the studies required for FDA labeling (i.e. double-blind, randomized studies) were not carried out.[15] This has not hindered pediatric practitioners from using these agents in children, however.

Routes and Agents Used for Sedation in Children

The onset and duration of action of each sedative agent varies according to the route of administration. This requires specific knowledge of each agent's distribution and elimination half-life. The *distribution half-life* of a pharmacologic agent is the time it takes the agent to be distributed from the blood to the peripheral tissues.[40] The *elimination half-life* is the time it takes for 50% of the drug to be eliminated from the body. The latter term is very important when one is providing discharge teaching to the child's primary caregiv-

Table 2. COMMON PROCEDURES POTENTIALLY REQUIRING SEDATION IN CHILDREN

	Procedure
Urologic	Vesicoureterogram, ultrasonography, intravenous pyelogram (IVP)
Cardiovascular	Echocardiography, cardiac catheterization/electrophysiology study, interventional catheterization (including stent/coil placement and radiofrequency ablation), device placement (including pacemakers and implantable defibrillators), are elective cardioversion
Radiologic	CT scan, magnetic resonance imaging, radiotherapy, stereotactic radiosurgery, bone/gallium scans, electroencephalogram (EEG), visual/auditory evoked response testing
GI	Endoscopy, colonoscopy, esophagogastroduodenoscopy (EGD), small bowel biopsy
Respiratory	Transbronchial biopsy (via nasal approach), chest-tube placement
Dental	Extractions, minor oral surgery, impressions/cleaning, crowning, fillings
ER/Trauma	Closed fracture reductions, skeletal survey, sexual abuse examinations, laceration suturing (minor and complex), maxillofacial injuries
Other	Lumbar punctures, bone marrow aspiration, complex dressing changes, incision and drainage of abscess, foreign body extraction, tracheostomy, burn care

ers. The commonly used routes of medication administration in children include oral, nasal, rectal, intramuscular, and intravenous. Local anesthetics can provide an effective adjunct to sedative agents in specific instances. Combinations of routes as well as agents are also common in the pediatric population.

Oral Administration

Oral sedative administration has the major advantage of ease of delivery and greater acceptance by the child.[34] No special equipment or skills are necessary for oral administration. In certain cases, dosage modification is necessary to account for varied gastrointestinal absorption. A disadvantage to oral administration is the risk of aspiration.

Agents that can be administered orally in children include chloral hydrate,[19, 30] diazepam,[34] midazolam,[24] and ketamine.[44] Recent studies have shown that chloral hydrate may not be as safe as was once thought owing to its long elimination half-life and potential to lead to airway obstruction postdischarge.[7, 45] To administer midazolam orally, the intravenous form must be mixed with a diluent. Such diluents include apple juice[15] or, in this author's experience, a small amount of acetominophen or Kool-aid. When administering midazolam in this way, the oral dosage calculation is higher because less of it is absorbed by the gastrointestinal tract; however, the level of sedation is thought to be similiar to intravenous administration. Midazolam also can be administered sublinguinally.[25]

Nasal Administration

Nasal administration of sedatives has the distinct advantage of providing more reliable absorption than oral administration, because it is absorbed across the nasal mucosa.[34] The major disadvantages are that it may cause sneezing, a large volume may be swallowed (producing a longer distribution half-life), and nasal congestion may hinder its absorption. Children may be less enthusiastic about this route of administration. The most common agent administered intranasally in children is midazolam.[25, 28, 42] It is administered similarly to any other nose drop. This route generally results in a quicker onset of action than the traditional oral route but again is less preferable to the patient.[25, 26]

Rectal Administration

Rectal administration of sedative agents is being used with increasing frequency owing to its low incidence of adverse effects. Similar to both oral and nasal administration, there is no need for painful intramuscular injections. This route is generally well tolerated by children when compared with oral administration and has the advantage of less residual, unabsorbed drug.[34] The risk of aspiration is alleviated when compared to oral or nasal administration. The disadvantage is that absorption is

decreased with fecal impaction or diarrhea. Agents that can be administered rectally include methohexital,[24] diazepam,[34] midazolam,[37, 46] and ketamine.[46]

Intramuscular Administration

Intramuscular injection is the least desirable route of sedative administration in the pediatric population. A "shot" is the first verbalized fear in nearly all children who come in contact with the health care environment. Intramuscular injections have the distinct advantage of avoiding the difficulty of establishing venous access in the uncooperative patient, which has been virtually eliminated with the introduction of topical anesthetic agents. It does, however, result in most of the drug being directly delivered to the patient,[34] and it has a longer duration of action. The disadvantages include pain, the need for repeated injections for longer sedation, and a delayed onset of action. Agents that can be administered by intramuscular injection include midazolam,[33,37] ketamine,[33] morphine,[34] meperidine,[34] and DPT/lytic cocktail, a combination of meperidine, promethazine, and chlorpromazine.[35, 41] Although DPT/lytic cocktail has been used for some time, the AAP has issued a statement cautioning its use.[3] The combination of agents that comprise the lytic cocktail often fails to produce therapeutic results and has a high rate of serious adverse effects, including respiratory depression and death.[3]

Intravenous Administration

The most reliable and controllable method of sedative administration is the intravenous route.[34] It provides the quickest onset of action and allows both boluses and continuous infusions; however, the duration of action is shorter compared with intramuscular administration. Intravenous administration has the disadvantage of requiring intravenous access, which can be difficult in chronically ill children. Specific agents include diazepam, midazolam,[23] ketamine,[18, 29, 43] morphine, meperidine, fentanyl,[32] and propofol.[29]

The most common route of sedative administration varies from practitioner to practitioner. When caring for pediatric patients, the goal is to administer the agent in a way that is not threatening or painful for the child, but will produce appropriate sedation for the procedure being performed. In most cases, oral is the preferred route of administration in the younger child, specifically from toddler age to adolescents. Infants are less traumatized by the rectal and nasal routes, whereas the intramuscular route is the least desirable for all age groups. If there is existing venous access, this route is preferred because it is reliable and controllable. It provides a quicker onset and shorter duration of action. Again, the route chosen must take into account not only the procedure being performed but also the duration of that procedure.

Local Anesthetics

One of the major advances in caring for children was the development of a topical anesthetic known as eutetic mixture of local anesthetics (EMLA) cream.[13, 49] It can be placed on the skin to anesthetize an area prior to a painful procedure such as intravenous line placement.[17] It has revolutionalized the practice of pediatrics because it allows painful procedures to become pain free and thus more tolerable for the child. It is important when using topical anesthetics to prevent the child from touching the anesthetic and then the mouth or eyes. If the agent comes in contact with a mucous membrane, it can be more readily absorbed. EMLA cream can be applied prior to intramuscular injections and intravenous catheter placement to decrease pain at the injection or insertion site. For intravenous line placement, several sites should be anesthetized.

Other local anesthetics can be used as adjuncts to sedative agents to compliment sedation and analgesia. The dosage of sedative agents can be decreased when one is using local anesthetics. Caution should be exercised when using certain local anesthetics during certain procedures, which may affect the results and subsequent outcome of the investigation. Buckles et al[8] evaluated the use of local lidocaine during cardiac electrophysiologic (EP) testing in pediatric patients and found decreased inducibility of ventricular dysrhythmias secondary to therapeutic serum concentrations of lidocaine obtained during the procedure. The dosage and concentration of lidocaine was reduced and the study re-

peated; inducibility was not affected with the new formulation.[9] It should also be noted that the use of local anesthetic agents is not without adverse effects; overdose can result in seizures, cardiovascular depression,[15] or even death.[16]

Combinations

Many agents and routes of administration are routinely used in combination with each other. This is particularly so in children because premedication is often warranted prior to the procedure to reduce anxiety. Various combinations have been reported in children, including fentanyl and diazepam[32] and ketamine and midazolam.[22] Combinations of sedative agents should be used with caution owing to their cumulative effects. Specifically, respiratory arrest has been reported with the use of midazolam and fentanyl in a child.[48] Because of its popularity as an agent for premedication, midazolam frequently is used in combination with other sedative agents.

Specific Agents

Specific agents that are used in the pediatric population are summarized in Table 3. The dosages, routes of administration, onset of action, duration of action, and nursing implications are also provided.

Postprocedure Care

The AAP has specified that certain discharge criteria should be met before the child who has received sedation can be released from the treatment area or treatment facility.[2] These criteria can be found in Table 4. The nurse caring for children who have received sedation must do everything to ensure their safety. Discharge teaching is pivotal before releasing these patients to someone else's care. Coté[14] reports three deaths that occurred postdischarge (in an automobile on the way home) that might have been prevented with specific discharge information regarding any residual effects of the drug and the importance of maintaining good head position to avoid airway obstruction.

The child who receives CS or deep sedation must be monitored appropriately following the procedure. Vital signs should be assessed frequently and recorded. Proper equipment (e.g., oxygen, an Ambu bag, and suctioning devices) must be readily available. Additionally, there must be access to emergency equipment in the event of adverse reactions (e.g., apnea or aspiration). More and more, pulse oximetry and heart rate and rhythm monitoring are being used routinely in the pediatric population during recovery from sedation.

Complications

Overdosage or untoward reactions to the procedure or medication may occur at any time. The patient's quality of respirations, pulse intensity, heart rate and rhythm, blood pressure, and oxygen saturation must be assessed and documented every 5 minutes. Without careful titration and control of maintenance flow rates, the patient can progress rapidly beyond the optimal state of CS to a state of deep sedation or from a state of deep sedation to general anesthesia.[36] The complications of sedative agents can affect any bodily system but usually manifest themselves in the respiratory or cardiovascular system.

Respiratory

Respiratory depression is the most serious adverse effect of sedative agents, primarily owing to the fact that cardiovascular compromise is often secondary to respiratory compromise. The main cause of oxygen desaturation is obstruction of the child's upper airway caused by relaxation of the pharyngeal muscles. Repositioning of the child's head and neck, using the head tilt/chin lift manuever, immediately corrects this mechanical problem. The child may require manual or mechanical ventilatory assistance if this maneuver is not successful.

Cardiovascular

The most common adverse effect of sedative agents to the cardiovascular system is secondary to respiratory depression and oxygen desaturation. Specific agents may affect the child's cardiac output (e.g., propofol decreases cardiac output by decreasing systemic

Table 3. COMMONLY USED SEDATION/REVERSAL AGENTS IN CHILDREN

Drug	Route	Dosage	Onset	Duration	Nursing Implications
MORPHINE SULFATE	IV IM	0.1–0.3 mg/kg 0.1–0.3 mg/kg Max: 10 mg	1–2 min 20–60 min	3–4 hr 4–5 hr	May cause respiratory depression, hypotension, and nausea and vomiting; causes histamine release; delayed absorption with IM administration; rectal administration not recommended; reduce dosage in critically ill patients.
MEPERIDINE	IV IM	1.0–3.0 mg/kg 1.0–3.0 mg/kg Max: 100 mg	1–3 min 15–30 min	1–3 hr 3–4 hr	May cause respiratory depression, more nausea and vomiting than morphine sulfate; rectal administration not recommended owing to delayed absorption; use IM administration with caution as medicine may peak (~90 min) after procedure has been completed; reduce dosage in critically ill patients.
FENTANYL	Transmucosal IV	5–20 μg/kg 0.5–3 μg/kg Max: 4–5 μg/kg	15–20 min 1–5 min	90–240 min 30–60 min	Respiratory depression, chest wall/glottic rigidity; respiratory depression can last longer than drug effects; cut dosage into thirds for <6 mon of age; slowly titrate at 0.5–1.0 μg/kg/dose; fentanyl oralet for transmucosal administration (only agent approved for pediatric use); 100 times more potent than morphine.
DIAZEPAM	Oral IV PR	0.1–0.3 mg/kg 0.1–0.3 mg/kg 0.2–0.3 mg/kg Max: 10 mg	30–60 min 2–5 min 30–60 min	2–8 hr 2–4 hr 2–6 hr	IM/IV administration is very painful; IM is poorly absorbed; PR administration: Add meds and 5 mL of air into 10- to 20-mL syringe; attach to 8– to 12–Fr lubricated feeding tube. Fill catheter to tip, insert into rectum, inject and remove as unit; infusion 1–3 mg/kg/hr; oral taste unpleasant; resedation possible 6–8 hr. post oral administration.
MIDAZOLAM	Oral IV IM PR Nasal	0.5–0.75 mg/kg 0.05–0.15 mg/kg 0.05–0.15 mg/kg 0.5–0.75 mg/kg 0.2–0.5 mg/kg Max: 4 mg total	20–30 min 3–5 min 5–10 min 10–20 min 5–10 min	45 min 1–2 hr 1–6 hr 45 min 20–40 min	Caution with narcotics and in patients on erythromycin (prolonged effects); may potentiate adverse effects of opioids (respiratory distress); decrease dose with compromised renal function; Oral: Mix IV preparation with Kool-aid, apple juice, or acetaminophen, has foul taste.
KETAMINE	Oral IV IM PR	6–10 mg/kg 1–3 mg/kg 2–10 mg/kg 5–10 mg/kg Max: 100 mg (IV)	15–45 min 1–2 min 5 min <4 min	1–2 hr 15 min 15–30 min 15–30 min	Laryngospasm, vomiting, dysphoria, hallucinations; co-administration of benzodiazepines or narcotics may reduce hallucinations; if suction required, suction oral cavity only; increases HR, BP, intracranial and intraocular pressure; increased secretions may require antisialagogue administration.

METHOHEXITAL	PR	20–30 mg/kg of 10% solution Max: 500 mg	6–11 min	20–60 min	May cause involuntary muscle movement, hiccoughs, or respiratory irregularity; hypotension; less rectal irritation when mixed with lower concentration solutions.
CHLORAL HYDRATE	Oral PR	20–75 mg/kg 20–75 mg/kg Max: 100 mg/kg or 1 gm	40–60 min 40–60 min	4–8 hr 4–8 hr	Prolonged sedation, caution with liver disease; bitter taste; increased incidence of nausea and vomiting; 30% failure rate.
PROPOFOL	IV (Cont inf)	50–200 μg/kg/min	40 sec	3–8 min	CV and respiratory depression; decreased BP and SVR; use prior administration of lidocaine (0.5–1.0 mg/kg) to decrease pain of administration or use large vein when administering.
DPT (LYTIC COCKTAIL) concentrate: meperidine— 25 mg/mL promethazine— 6.5 mg/mL chlorpromazine— 6.5 mg/mL	IM	.02–0.2 mL/kg	20–30 min	5–20 hr	Chlorpromazine may affect inducibility of certain cardiac arrhythmias; may use up to 4 mL in two divided doses as upper dosage limit. DO NOT ADMINISTER IV.
EMLA Eutectic mixture of local anesthetics (lidocaine and prilocaine)	Topical	Dependant on surface area - use smallest possible surface area	30–60 min	2–4 hr	Keep away from eyes and other mucous membranes; apply over site and cover with occlusive dressing.
NALOXONE	IV ET	.01–0.1 mg/kg Max: 2 mg	2–3 min	30–40 min	May repeat every 3–5 min, short half-life, can give IM, intraosseous, or subcutaneous.
FLUMAZENIL	IV Dose - 5–10 μg/kg over 15 sec, repeat q 1 min to total of 1 mg	0.2 mg x 1, then 0.1 mg every 1 min to maximum of 1 mg. Repeat every 20 min to maximum of 3 mg/hr Max: ≤3 mg/hr	1–2 min	30–60 min	Does not reverse respiratory depression.

IV, intravenous; *min,* minutes; *BP,* blood pressure; *IM,* intramuscular; hr, hours; SVR, systemic vascular resistance; *mg,* milligrams; μg, micrograms; *ET,* endotracheal; *kg,* kilogram; *sec,* seconds; *max,* maximum dose; *mL,* milliliters; *PR,* per rectum.

Data from Coté CJ: Sedation for the pediatric patient: A review. Pediatr Clin North Am 41:31, 1994; and Motoyama EK, Davis PJ (eds): Smith's Anesthesia for Infants and Children, ed 6. St. Louis, Mosby-Year Book, 1995; and Saccheti A, Schafermeyer R, Gerardi M: Pediatric analgesia and sedation. Ann Emerg Med 23:1994.

Table 4. RECOMMENDED DISCHARGE CRITERIA

1. Cardiovascular function and airway patency are satisfactory and stable.
2. The patient is easily arousable, and protective reflexes are intact.
3. The patient can talk (if age appropriate).
4. The patient can sit up unaided (if age appropriate).
5. For a very young or handicapped child, incapable of the usually expected responses, the presedation level of responsiveness or a level as close as possible to the normal level for that child should be achieved.
6. The state of hydration is adequate.

Data from American Academy of Pediatrics, Committee on Drugs: Guidelines for monitoring and management of patients during and after sedation for diagnostic and therapeutic procedures. Pediatrics 89:1110, 1992; with permission.

vascular resistance, whereas ketamine increases cardiac output by increasing heart rate due to enhanced automaticity). Adverse cardiac events have been reported in children with cyanotic heart disease.[45] Several deaths occurred with the use of the combination agents, meperidine, promethazine, and thorazine or DPT, in these children. It is recommended that these patients routinely receive supplemental oxygen during sedation-requiring procedures.[15]

Reverse Reactions

Several sedative agents are sometimes known to produce agitation rather than sedation. The signs of reverse reaction in the child include agitation, hyperactivity, combativeness, and involuntary movement. The undesired effects of ketamine, such as hallucinations, can be minimized by the coadministration of benzodiazepines. It is also helpful to provide a quiet, dark, and stimulus-free environment during ketamine emergence and to avoid its use in certain patients, specifically children over 10 years of age or those with a history of psychiatric disorders.[33]

Management

Many complications of sedative agents can be avoided with vigilant attention to the patient. In the event of major complications, appropriate supportive measures must be undertaken. The nurse should remain cognizant of his or her limitations and use anesthesiology-trained personnel when appropriate. Supportive measures may include, but are not limited to, maintenance of a patent airway (using head tilt/chin lift), ventilatory support, artificial airway placement, and basic or advanced pediatric life support manuevers.

Nursing Implications

Before the Procedure

The responsibilities of the nurse begin before any procedure in which sedatives will be administered. First and foremost, the nurse must be aware of the institution's policy regarding his or her responsibilities for the child receiving CS or deep sedation. Numerous nursing and medical organizations have published recommendations for the monitoring of patients receiving IVCS.[2,5,6] The American Association of Operating Room Nurses (AORN) recommends that the nurse managing the care of these patients should have no other responsibilities during the procedure, thus ensuring that the patient is always attended and constantly monitored.[6]

The nurse must be responsible for having adequate knowledge of any sedative agents that will be used during the procedure, including the drug's mechanism of action, onset and duration, potential adverse effects, and last but not least, appropriate reversal agents. It is preferable that this information be obtained in a formal educational program provided by experts in the pharmacology of sedative agents. The AAP's general guidelines include identifying a responsible person to care for the child before admission and after discharge, having the necessary facilities to provide safe sedation (including appropriate equipment and personnel for emergencies), identifying back-up emergency services, and having on-site equipment for all ages and sizes of children.[2] Before the patient arrives in the procedure room/area, the nurse must have all monitoring equipment available and in working order. Emergency equipment also must be available because an adverse event may occur at any time. The nurse should be

able to provide basic and advanced pediatric life support. The cross-training of personnel from the adult population to the pediatric population is undesirable; however, the minimal competency requirement of any such personnel should be successful completion of a pediatric advanced life support course.

The nurse caring for the child receiving sedative agents must evaluate the child's and family's readiness to learn prior to any preprocedural education. The child's psychologic and developmental status should determine which age-appropriate teaching should ensue. Pederson and Harbaugh[31] explored the experiences of 24 pediatric patients undergoing cardiac catheterization. The most common themes emerging from their data were anticipatory anxiety, pain, invasion of privacy, and being comforted. These data also revealed a lack of knowledge as well as misconceptions regarding the procedure itself. If painful interventions are necessary in the child's care, he or she should be made aware of this. One should never, ever lie to a child regarding pain. The child should be informed that he or she might awaken (CS) during the procedure or sleep throughout (deep sedation). The parents or primary caregivers should be given an estimate of the procedure's duration and where they should wait during their child's procedure.

The nurse should be cognizant of the child's physical status as well as health history. In accordance with the AAP, documentation before the administration of any sedative agent should include informed consent, preprocedural education, provision of emergency phone numbers for postdischarge caregiver concerns, dietary precautions (i.e., NPO status), name and phone number of primary care physician, and a copy of any prescriptions given to the responsible party.[2] A comprehensive health evaluation also must be included in the documentation, including any current medications, allergies (drug or otherwise), possibility of pregnancy, history of smoking, and history of substance or alcohol abuse.[36] The health evaluation should include the patient's age and weight, a review of systems, baseline vital signs, a physical examination, and an American Society of Anesthesiologists' (ASA) physical status classification evaluation. Another important component of the overall health evaluation includes a history of apnea or other respiratory problems, any previous adverse effects with sedative agents, and the presence of a chronic health condition. After obtaining this baseline assessment, the nurse should develop a plan of care that is specific to the individual child and family.

During the Procedure

In addition to mechanical monitoring, the nurse should assess the patient continuously for any adverse reactions or complications of the sedative agents. Dosages for reversal agents should be calculated and readily available (see Table 3). The nurse should constantly evaluate the patient for any overt physical signs of pain, including muscle rigidity, tearing of the eyes, distorted facial features, groaning, agitation, and increases in respiratory rate, heart rate, or blood pressure.[36] The child's head position should be monitored constantly to prevent unnecessary airway obstruction. Documentation during the procedure should include the patient's level of consciousness, heart rate and rhythm, blood pressure, respiratory rate, oxygen saturation, and medications administered, including the agent's name, route of administration, site of administration, dosage, and patient response. Additionally, any inspired concentration of oxygen should be specified. The duration of administration should be documented, as well as how the dosage was calculated (i.e., mg/kg) and any adverse reactions.

After the Procedure

The patient may or may not be discharged from the treatment or procedure area. He or she may be admitted to an observation unit or inpatient area. Regardless of where the child recovers, the nurse has distinct responsibilities for ensuring the patient's safe return to his or her presedation state. The following parameters should be assessed frequently: level of consciousness, vital signs, and patency of the child's airway. If the child is cared for by a different nurse, the sedation nurse must exchange information regarding the child's sedation, including any adverse effects or events. Specifically, knowing the use of any reversal agents is critical because the half-life of the sedative agent may exceed that of

its antagonist; these patients should be monitored for several hours longer than the patient who does not receive a reversal agent.

The child should not be discharged until urination has occurred and there is no nausea or vomiting. Once the child is awake and alert, fluids may be offered. Children typically will gulp fluids at this time, leading to intractable nausea and vomiting in some cases. The nurse should provide frequent sips at this time to avoid gastrointestinal upset; this technique also should be explained to the parents or primary caregivers. Positioning the child on one side or the other can help decrease the risk of aspiration.

When it has been determined that the child is fit for discharge, the nurse must provide verbal and written discharge instructions to the responsible party. Documentation after the procedure should contain the time and condition of the child at discharge and that specific, recognized discharge criteria have been met.[2] The written instructions should be signed by the responsible party, indicating that the content is understood. A copy should be placed in the child's hospital record. The discharge instructions should include the following: when the child should make a complete recovery from the medication (based on the agent's duration of action and elimination half-life), when it is permissible to allow solid foods, any adverse effects of the medication that would require reporting to the physician, the name and telephone number of the physician contact (i.e., the primary care provider or subspecialist), any procedural discharge instructions (i.e., cardiac catheterization site care), review of any prescribed medications and prescriptions, activity restrictions, and a follow-up appointment, if applicable.

Additionally, Coté[14] stresses the importance of an additional person to accompany the responsible person and the child home in the car, one who can constantly monitor the child (especially the airway) with no other responsibilities (like driving). This cannot be overstressed because several children have died on the way home in the back seat of a car owing to airway obstruction.[14] This should be mandatory when the sedative agents used have a long elimination half-life.

SUMMARY

The child requiring sedation has unique needs. The nurse caring for pediatric patients must have adequate knowledge to incorporate the physical, emotional, and psychological differences between children and adults into the child's overall plan of care. Because of these differences, sedation of the child presents a challenge. The nurse must continue to assess his or her knowledge of all facets of sedative agents and monitoring principles in the pediatric population to provide safe, effective, quality care to children and their families.

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