PHARMACOLOGIC BEHAVIOR MANAGEMENT FOR PEDIATRIC DENTAL TREATMENT

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Dental abnormalities, including dental caries and soft-tissue and hard-tissue anomalies, are common in children. Although the prevalence of dental caries in children has reportedly decreased over the past 5 decades, [17] [51] evidence suggests a disproportionate and alarming increase in the prevalence of caries involving primarily preschool-aged children of low socioeconomic class. [17] This subgroup is estimated to account for 25% to 50% of all carious lesions in children. This estimate is significant because children are most challenging for dentists in terms of management.

The proportion of children requiring physical restraint or pharmacologic management during delivery of dental care is estimated at 10% to 25%. [42] [73] This type of management is indicated for several important reasons, including the technical complexity of the treatment, operative safety issues, pain control, and potential psychic trauma.

Often, the dentistry required to restore carious teeth is technically complex and requires excellent patient cooperation. Even under optimal conditions with older cooperative patients, restorative techniques can be challenging for dentists when the desired outcome is excellent esthetics and freedom from discomfort.

Several aspects of delivering dental care may be dangerous for clinicians and patients. For instance, in children who are struggling and unrestrained, the injection of local anesthesia is critical and may result in injury to the eye, cheek, lip, or limbs, depending on the degree of struggling. Even if the needle is inserted into the proper tissue, struggling patients may cause significant pain and bruising around the insertion site or even breakage of the needle in the tissue. Protecting children from these adverse outcomes often requires restraint, including the limbs and head, whether mediated by a device (e.g., Papoose Board [Olympic Medical Company, Seattle, WA]), parent or other personnel, or pharmacologic agent (e.g., sedatives).

Despite careful technique, it is not always possible to obtain adequate local anesthesia for dental procedures. Two major factors causing inadequate anesthesia are (1) the pH of the tissue bed into

which the local anesthetic diffuses (i.e., it is difficult to obtain profound anesthesia for the removal of abscessed teeth) and (2) anatomic variations in nerve distribution.

The risk for inducing situational psychic trauma as a result of receiving dental care also should be considered, but the author is unaware of any large body of systematically studied and documented evidence concerning development of situational psychic trauma in children during dental procedures. The author has witnessed some children who required restraint for the removal of abscessed teeth and who, on return for routine care, display uncontrollable situational anxiety and fear despite extreme efforts to assist these children in coping with the appointment. Specific focusing on and fear of certain procedures or equipment are notable (e.g., fear of suffocation from the application of a rubber dam, needle phobia, and fear of handpiece noise and sensations).

The most common modes of pharmacologic behavior management in pediatric dental practice are oral sedation and general anesthesia. Nitrous oxide (N_2O) alone or in combination with oral sedatives is most common. [73] General anesthesia may be administered in the dental office by a qualified provider (e.g., dental or medical anesthesiologist), in an ambulatory care facility, or in a hospital.

INDICATIONS FOR PHARMACOLOGIC MANAGEMENT

Age and emotional status are primary factors in determining the need for pharmacologic management. Children may be unable to tolerate dental procedures for various reasons: they may have immature cognitive development; they may lack coping mechanisms or an inability to incorporate supportive coping strategies offered by parents or medical or dental personnel; they may have mental, emotional, or psychological inadequacies; they may have had previous negative medical or dental experiences; or they may be recipients of inappropriately conveyed situations or misleading information about procedures, such as sibling or peer exaggerations. Social, cultural, or linguistic issues may cause situational anxiety that interferes with routine delivery of care. Some children have learned inappropriate behavior patterns, such as defiance behaviors designed to obtain personal gain or advantages in social situations that are incompatible with dental treatment (Fig. 1) .

Figure 1. Facial expressions are often revealing.

In addition to age and emotional status, the type and extent of dental needs, patient health, parental concerns, and practitioner philosophy are also factors in determining the use of pharmacologic management for dental treatment. Usually, these factors are considered together, and a plan is developed to meet individualized needs of patients. For instance, a healthy child who has only one or two small carious lesions but who is extremely timid and fearful is a candidate for sedation. If this same child had extensive restorative needs, general anesthesia might be considered.

The medical status of the patient is also a consideration; by the American Academy of Pediatric Dentistry (AAPD) sedation guidelines, [25] only healthy children American Society of Anesthesiology (ASA 1) or children with certain mild to moderate systemic disorders (ASA 2) are candidates for sedation in the dental office.

SEDATION

Safety

Death caused by complications during sedation in dental offices has been reported, [10] [14] [45] but the circumstances, drugs and doses (including local anesthetics), and specialty training of the dentist are not always reported. Several such deaths have been associated with overdose of local anesthetic even if a therapeutic dose of sedative agents was used. [24] The safety of pharmacologic management of children by pediatric dentists is outstanding since the adoption of the AAPD sedation guidelines. [26] Based on survey data, [32] [33] one can extrapolate that more than 1 million children have been sedated by pediatric dentists since 1985. Despite close monitoring of all public information, the AAPD is unaware of any death in a pediatric dental office in which the practitioner explicitly followed the sedation guidelines (Rutkaukas, AAPD Executive Director, personal communication, 1999 and 2000). According to some, the number of adverse events is small and inconsequential in other settings, such as emergency rooms, where sedation may be used frequently. [55] Physicians who refer young patients to dentists for treatment should be aware of the extent of the dentist's training and compliance with sedation guidelines, including local anesthetic recommendations. One article [10] has shed some light on the relationship of adverse events and some practitioner specialties. The investigators indicated that the most common issue associated with adverse events during sedation was related to the effects of sedatives on respiration. A disproportionate number of cases (32 of 95) involved sedation or anesthesia for dental procedures. Of these, in three cases, the practitioner was a pediatric dentist, but the investigators acknowledged the limitations that data collection had on refinement of analysis and outcomes of cases, so it was impossible to determine whether these practitioners followed sedation guidelines.

Pediatricians consulted by concerned parents about the sedation of their children may wish to contact their childrens' dentists to discuss sedation including the dentist's knowledge of and adherence to the AAPD guidelines on sedation and general anesthesia.

Patient Selection for Sedation

Sedation for children during dental treatment has been used for decades, but a strong clinical science has not evolved nor paralleled the practical art of selecting patients for sedation. Traditionally, the selection of patients for sedation has rested on the experience of the practitioner in judging the behavior of the child. Certainly, many factors contribute to the decision-making process of selecting patients for sedation. These factors include, among others, degree of patient cooperation, child and doctor personality, child temperament, extent of dental needs, practitioner training and comfort with sedation techniques, parental concerns, practitioner confidence for successful outcome of other behavioral management techniques, financial issues, and state board rules and regulations. Evidence suggests that practitioners tend to use the same drug regimen regardless of the needs or behavior of the patient, [32] and the agents selected are most likely those used during the training of practitioners. [74] Only recently has a postulated scheme for the selection of agents matched the characteristics and needs of children. [72] The scheme is based on the three factors of preoperative behaviors, child temperament, and amount of dentistry to be accomplished.

Sedatives

Historically, many agents have been used to sedate children in dental offices. Typically, more than one agent is used. [73] The most popular oral sedative agents have been chloral hydrate and meperidine, [7] [12] either of which is often combined with an antiemetic, such as hydroxyzine (Vistaril). Other agents, particularly some benzodiazepines, such as midazolam (Versed), have become popular among pediatric dentists and physicians, * but their effectiveness in producing cooperative behaviors in young children during perceived painful or distressing procedures is questionable. [21]

Combinations of sedative agents with and without N_2O have been used for years.† Several popular combinations are chloral hydrate and hydroxyzine; meperidine and promethazine or hydroxyzine; and

chloral hydrate, meperidine, and hydroxyzine. Table 1 shows representative drugs, doses, and characteristics of agents often used in pediatric dentistry.

TABLE 1 -- ORALLY ADMINISTERED DRUGS AND DRUG COMBINATIONS COMMONLY USED IN PEDIATRIC DENTISTRY

Drugs	Doses (mg/kg)	Onset (Ready for Procedure)	Observable Traits	Cautions
Chloral hydrate + hydroxyzine	**Chloral hydrate (20-50)**	**45 min**	**Hyperactive; cry; sleep**	**Airway**
	Hydroxyzine (1-2)			
Chloral hydrate + hydroxyzine + meperidine	Chloral hydrate (20-40)	30-45 min	Hyperactive; euphoria; dysphoria; sleep	Airway; respiratory depression; shallow breathing; Narcan (0.01-0.1 mg/kg)
	Hydroxyzine (1-2)			
	Meperidine 1-2)			
Meperidine + hydroxyzine	Meperidine (1-3)	40-45 min	Hyperactive; euphoria; dysphoria; sleep	Airway; respiratory depression; shallow breathing; Narcan (0.01-0.1 mg/kg)
	Hydroxyzine (1-2)			
Midazolam	0.3-1.0	5-15 min	Floppy doll; slow to react; cry or struggle	Flumazenil (0.01 mg/kg)
Midazolam + hydroxyzine	Midazolam (0.3-0.75)	5-15 min	Floppy doll; slow to react; cry or struggle	Respiratory depression or shallow breathing
	Hydroxyzine (1-2)			
Diazepam	2-5 y, 5 mg	30-45 min	Cry; slow to react; relaxed; mellow	Flumazenil (0.01 mg/kg)
	6-10 y (5-10 mg)			
	11-20 y (10-15 mg)			

Several studies have indicated that, when N_2O is added to a sedative agent, the amount of disruptive behavior decreases but is not necessarily eliminated. [34] [49] [63] [76] The quantity of quiet behaviors compared with crying or struggling during sedation is approximately 70%. [49] [62] [72] [76] [77]

Routes of Administration

Oral

Administration of sedatives to children is typically oral, with elixirs. Sedatives are usually bitter, and flavoring is necessary for compliance in consuming the elixir. Despite the use of flavoring agents and coaxing, many patients refuse to drink the liquid, and practitioners often resort to oral administration of the agent by a needleless syringe or cup. Caution must be used with chloral hydrate to prevent laryngospasms. [19] Sedative agents must never be readministered if a child vomits the original solution

because of uncertainty as to the amount of drug that was initially absorbed and the possibility of overdose.

Absorption and onset of pharmacologic effects adequate for tolerance of dental surgery can be as rapid as 5 minutes (midazolam) or require 60 minutes (chloral hydrate), depending on the agent, dose, and individual. In some individuals, many drugs may significantly affect the CNS and respiratory and cardiovascular systems even if administered orally and in therapeutic doses. Practitioner intervention and monitoring may be necessary for these susceptible children, so, as required by the AAPD guidelines, the commonly used oral agents, meperidine and chloral hydrate, must never be administered outside of the treatment facility or by any individual not under the supervision of the practitioner.

Intramuscular and Submucosal

Alternative routes of administration include intramuscular and submucosal routes in children. Drugs usually are absorbed more rapidly by intramuscular and submucosal routes than by the oral route, and, if agents are administered with no aspiration or injected too quickly, an undesirable situation analogous to intravenous (IV) administration of a large drug bolus may result inadvertently. No data are available comparing the efficacy and safety of different routes of administration for dental sedation.

Intravenous

IV administration of sedatives in children is used by only a few practitioners. All states require that dentists have a permit to administer drugs by this route. Often, an oral agent or N_2O is administered first to overcome the fear associated with the insertion of the IV needle, especially in very young or extremely fearful children. Depending on the degree of fear, children may refuse initial routes of drug administration, and temporary and partial immobilization is necessary to start the IV, complicating the procedure.

The IV route is purportedly a titratable method of drug administration which assumes an endpoint. Theoretically, drugs may be added or removed by the method of administration to attain the endpoint (e.g., administration of N_2O by the inhalation route). The IV route allows the practitioner only to add or deepen sedation so as to approach the desired endpoint. Once the endpoint is reached, the drug is metabolized at variable rates; the patient begins to lighten from the endpoint; and, if additional treatment is needed, more drug is administered. Thus, IV administration of agents must be done carefully to slowly deepen sedation to a safe level or endpoint and not oversedation (Fig. 2) .

Figure 2. Typical facial expressions of level I *(A)* and level III *(B)* sedations.

Efficacy and Safety

Sedation methodology in articles spanning 3 decades has been reviewed. [70] Based on the summary data, successful outcomes can be expected in 50% to 75% of cases using therapeutic doses of agents regardless of the combinations used. Increasing the dose of sedative agents beyond conservative therapeutic doses most likely would increase success in eliminating disruptive patient responses but dramatically increase the risk for adverse events.

Sedative agents used in therapeutic doses have limitations in their ability to successfully and safely overcome some children's anxieties, fears, and uncooperative behaviors. By intentionally increasing the depth of sedation to render children more cooperative for surgery, practitioners place these children in a near-general anesthetic state. The clinician may not be properly trained or equipped to manage such a state, and practitioners, in dealing with these difficult children, should wisely seek other avenues of pharmacologic management by appropriately trained individuals, such as general anesthesists.

Working in the oral cavity or on the face may invade a patient's "personal or psychological space" so may be more stressful than procedures on other parts of the body. [6] [9] [29] Thus, deeper sedation may be required for dental treatment. Also, the dental handpiece produces a liberal water spray, thus requiring that a rubber dam or throat pack be used. Many children (and even adults) do not tolerate rubber dams well, especially if fearful.

Sedation Guidelines

Many sedation guidelines exist for various medical and dental specialties and practitioners. * Unfortunately, the terminology and implied content of guidelines are not the same. [13] The AAPD and American Academy of Pediatrics once had identical guidelines, but these now vary primarily in the area of N_2O and its use with any sedative agent. A history of these guidelines has been published. [75] The AAPD guidelines are unique in terms of their definitions of levels of sedation because of the recognition that children may not respond in the same fashion as adults when receiving dental care involving sedative regimens. For example, a 3-year-old child who has a dental appointment corresponding to nap time may fall asleep in the dental chair and not respond to verbal commands (e.g., "open your eyes") and may be difficult to awaken. Such a scenario can happen with or without sedative agents, including N_2O alone.

The AAPD guidelines recognize five levels of sedation plus general anesthesia. The first three levels include conscious sedation; level 4 is identical to deep sedation, and level 5 is general anesthesia (Table 2) (Table Not Available) . The requirements for monitors, monitoring, personnel, patient behaviors and responsiveness, and goals within each level of sedation are outlined in Table 2 (Table Not Available) .

TABLE 2 -- DEFINITIONS, CHARACTERISTICS, AND MONITORING RECOMMENDATIONS FOR LEVELS OF SEDATION AND GENERAL ANESTHESIA

(Not Available)

Adapted from Guidelines for the elective use of conscious sedation, deep sedation, and general anesthesia in pediatric patients. Pediatr Dent 21:68-73, 1999; with permission.

Patient behaviors and responsiveness were considered important elements in the development of these guidelines because of the difficulty in determining the initiation and duration of underlying reflexive responses defined by terms such as *conscious* and *deep* sedation in most guidelines. For instance, portions of the definition of conscious sedation, including the AAPD sedation guidelines, often include the statement that the patient can independently and continuously maintain a patent airway. The statement implies that swallowing, coughing, retching, and gag reflexes are intact. Such an implication can be tested only clinically because no monitors or recorders specifically and directly measure those airway reflexes, and often sedated but uncooperative children refuse to follow such clinical instructions. A sedated, quietly sleeping child with a patent airway may continue to ventilate, depending in part on tonsillar size, despite active attempts to block the airway with physical manipulation of the head. [20] The definitions of *conscious sedation*, and *deep sedation*, and *general anesthesia* of the AAPD are listed in Table 2 (Table Not Available) .

Monitoring

Many types of monitors are available for use in clinically assessing patients' conditions and functioning during sedation. [2] [66] [68] [69] [71] The monitors may be nonelectronic, such as a precordial stethoscope, or electronic, such as a pulse oximeter. The recommended use and type of monitors to assist in clinical assessment are indicated in the AAPD sedation guidelines according to the level of sedation of the patient, as listed in Table 2 (Table Not Available) . Evidence suggests that the deeper the sedation, the

more reliable the electronic monitor than clinical observation in detecting episodes of ventilation and oxygenation problems. [11] [39]

The pulse oximeter is the most commonly used monitor in pediatric dental sedation despite its shortcomings in the dental setting. [65] [67] [71] [73] Because 20% or more of all behaviors in sedated patients during the dental appointment involve crying and struggling, "false alarms" (i.e., oxygen desaturations associated with movement) may occur. The pulse oximeter relates information concerning the patient's oxygenation, albeit slightly delayed in time. The capnograph relates information about the patient's ventilation and airway blockage, so when a child seems to be sleeping after the administration of a sedative agent, it seems prudent to have available both of these monitors as a minimum. A precordial stethoscope is also a valuable instrument under these circumstances, but the sound of the dental handpiece often masks those of the breath and heart sounds during auscultation.

Sedation Protocol

The protocol for sedation varies somewhat among dental offices, but the following is a fairly typical step-by-step protocol during sedation in pediatric dental offices. The patient's medical history is reviewed on the day of the sedation to confirm that no changes have occurred since the previous visit. Consultations with the patient's physicians are done, if indicated. A physical examination, including airway assessment and determination of tonsil size, is done. Enlarged tonsils in sedated children increase the possibility of airway blockage during dentistry. [20] Patient weight and preoperative vital signs are measured, usually by a dental assistant. Clinicians can observe this interaction among the child, parent, and assistant to gain insight into the selection of an appropriate combination of agents to use for the sedation. [72] Also, compliance with oral and written preoperative instructions (e.g., nothing-by-mouth status) are determined.

The dose of the sedatives and local anesthetic is determined based on body weight (mg/kg). The sedatives are administered by the parent or clinician, and the patient is placed in a quiet room with the parent for a period consistent with the onset of the agents selected. Following the clinical onset of signs suggestive of adequate sedation, the patient is separated from the parent and placed in the dental chair, and appropriate monitors are affixed to the patient. Some pediatric dentists prefer to secure the child in a Papoose board to prevent sudden, uncontrolled movements, especially during local-anesthetic injections. Others lay the child unrestrained on the papoose board or do not use such an apparatus.

A N_2O hood, not a mask, covering only the nose is placed over the nose, and N_2O or oxygen is administered. The N_2O system is an open system in which the patient can entrain room air and dilute the concentration of N_2O as opposed to a closed system, which is standard for administering general anesthesia. The concentration of N_2O administered by the clinician usually does not exceed 50% unless the child is crying and struggling. Under these circumstances, the concentration may be briefly raised to 70% to calm the child. Occasionally, the child remains agitated and disruptive and the sedation visit is cancelled, but the patient is monitored until appropriate discharge criteria are met. If the child becomes quiet (most do so within 10 minutes), the N_2O is then reduced in concentration to 40% to 50%.

Topical and local anesthetics are administered, and a rubber dam is used to protect the airway from aerosols and water. The restorative and exodontia procedures are completed. The child is returned to the parent and monitored until discharge criteria are attained. Written and oral postoperative instructions are given. Finally, the parents are contacted in the evening to determine the patient's status.

GENERAL ANESTHESIA

General anesthesia is becoming more widely accepted as an alternative to sedation. One report [18] compared the quality of restorations and recurrent caries in children who had dental treatment under general anesthesia versus sedation. This report demonstrated superior surgical outcomes using general

anesthesia compared with sedation. Traditionally, general anesthesia was used only when the patient had a significant medical, mental, or psychological problem in conjunction with extensive caries and was nonresponsive to safe sedative regimens. The infrequent use of general anesthesia probably can be accounted for by the reluctance of most third-party payers to reimburse for general anesthesia for the purposes of restorative dentistry. [12] Oddly, relatively minor lacerations, ear-tube placement, and tonsillectomies, all of which could be performed under local anesthesia, like surgical dentistry, are covered by third-party payers. One pilot study [48] determined the societal costs for treating pediatric dental patients based on a cost-minimization model for outpatient general anesthesia versus oral sedation. The model used a Relative Based Value Scale/Unit that is based on the time and difficulty of procedures. The investigators concluded that, if a child needed more than three sedation appointments, general anesthesia offered a cost-savings alternative. In several states, politically active advocates for children have been successful in gaining legislative mandates for the coverage of young children during surgeries under general anesthesia.

SUMMARY

Sedatives are an important and necessary management technique for some children during dental procedures. Sedation can be administered safely and efficiently by competent practitioners who have special training in the use of the technique in children and who adhere to sedation guidelines.

Nonetheless, some children present with special needs, such as medically compromising conditions, or multiple carious teeth in a child who is fearful or whose family must travel a long distance for care. Sedation cannot always safely and adequately meet the needs of these children. In these cases, general anesthesia in a hospital, ambulatory care facility, or office is indicated and must be provided by an appropriately licensed and trained physician or dentist.

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