This article continues the theme of the September 2003 *Journal*: Managing Medical and Behavioral Changes in Children.

Emergency Medicine in Pediatric Dentistry: Preparation and Management

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ABSTRACT

Medical emergencies can and do occur in the practice of dentistry. Although most emergencies take place in adults, serious problems can also develop in younger patients. The contemporary dentist must be prepared to manage expeditiously and effectively those few problems that do arise. Basic life support (as necessary) is all that is required to manage many emergency situations, with the addition of specific drug therapy in some others. Preparation of the office and staff includes basic life support (annually), pediatric advanced life support, development of an emergency team, consideration for emergency medical services, and the availability of emergency drugs and equipment with the ability to use these items effectively. As with the adult patient, effective management of pain (local anesthesia) and anxiety (behavioral management, conscious sedation) will minimize the development of medical emergencies.

Medical emergencies can and do occur in the practice of dentistry. Most medical emergencies develop when the patient, commonly an adult, is fearful or has inadequate pain control. The most common emergencies noted in adult dental patients include syncope (less than 50 percent), non-life-threatening allergy, acute anginal episodes, postural hypotension, seizures, acute asthmatic attacks, and hyperventilation.[1]

In the pediatric patient, the most common emergency situations seen in dentistry are associated with drug administration, most often local anesthetics and/or central nervous system depressants used for sedation. It is this author's firm belief that the most likely scenario for a serious drug-related emer-

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gency developing in dentistry is the following: a younger, lighter-weight child receiving multiple quadrants of dental treatment in the office of a younger, less-experienced, nonpediatric dentist (i.e., general practitioner).[2]

All dental practices must be prepared to manage potentially life-threatening emergencies, be the patient a child or adult. The following sections review the preparation of the dental office and staff to successfully manage medical emergencies that might arise in younger patients in the dental office.

The definitions of victims by age[3] are as follows:

Infant: < 1 year

Child: 1 to 8 years

Adult: ≥ 8 years

Preparation

The following four assets are critical in preparing the office and staff to recognize and effectively manage medical emergencies:

- The ability to properly perform basic life support;
- A functioning dental office emergency team;
- Access to emergency assistance; and
- The availability of emergency drugs and equipment.

Basic Life Support

Basic life support (or cardiopulmonary resuscitation) is the single most important step in preparation of the office and staff to successfully manage medical emergencies. BLS for health care providers is defined as: **P**osition, **A**irway, **B**reathing, **C**irculation, and **D**efibrillation. Most states mandate BLS certification for licensure to practice as a dentist. The majority of states also require BLS certification for dental hygienists, and some mandate certification for dental assistants.

Figure 1. Mouth-to-mask ventilation.

Figure 2. Head tilt-chin lift.

California has mandated BLS for licensure for many years. However, possession of a valid CPR card is no guarantee that BLS can be adequately performed. In an unpublished study of entering postdoctoral students (residents in endodontics, periodontology, prosthodontics, pediatric dentistry, oral and maxillofacial surgery, orthodontics, and general practice) at the USC School of Dentistry, 30 students "challenged" the BLS-recertification course that is mandatory for them. All had been certified in BLS at the health care provider level within the previous six months.[4] The challenge consisted of completing a 25-question written examination with a grade of 80 percent or better, and demonstrating "adequate" performance at one-person BLS on an adult victim. Only four of the students successfully challenged the course (13 percent). Most were unable to perform "adequate" one-person CPR on an adult victim for one minute.

Recertification in BLS is recommended annually (in most venues, CPR cards have a two-year expiry date). BLS instructors should be brought into the dental office, with mannequins placed in the dental chair and on the floor in the reception room. It should be mandatory for all office personnel to participate in this training. For health care providers, rescue breathing should be taught as mouth-to-mask ventilation, not mouth-to-mouth (**Figure 1**).

The importance of BLS as preparation for managing medical emergencies in children is highlighted by the fact that the primary etiology of cardiac arrest in children is airway problems, usually airway obstruction or respiratory arrest (as might occur with overly deep "conscious" sedation). The young child's heart is normally healthy. Coronary artery disease is essentially nonexistent in this age group. However, the healthy young heart will cease beating when deprived of oxygen for a prolonged period. At the moment a pediatric cardiac arrest occurs, there is no residual oxygen remaining in the victim's blood (all available oxygen has been utilized by the dying cells). Acidosis and cellular (biological) death develop rapidly. U.S. survival rates from out-of-hospital cardiac arrest in pediatric patients is from 3 percent to 17 percent, and survivors are often neurologically devastated.[5,6] By contrast, cardiac arrest in adults usually develops secondary to advanced coronary artery disease. At the moment the adult heart goes into arrest, there remains a reservoir of oxygen in the blood and tissues that will be utilized before cellular death occurs.

The very basic step of airway management (head tilt-chin lift) is critically important in saving the life of a child.

Pediatric Advanced Life Support

Because children are different from adults, the author recommends that the dentist and staff in offices where significant numbers of younger patients are treated successfully complete a course in pediatric advanced life support.[7]

Similar to BLS, PALS stresses basic and advanced life support techniques for younger patients. Offered through organizations such as hospitals, pediatric dental societies, and private educational providers, the course outline is presented in the **box on this page**.

PEDO

PEDO is the acronym for Pediatric Emergencies in the Dental Office, a didactic and clinical course in emergency medicine designed for the entire staff of the pediatric dental office. Sponsored by the American Academy of Pediatric Dentistry, the course provides in-depth, hands-on training in the prevention and management of specific emergency situations that arise more commonly in children.[a]

Emergency Team

The dental office emergency team consists of three individuals, each assigned specific tasks to perform, as outlined in **Table 1**.

All members of the office emergency team should be interchangeable. Although the proper and effective management of the emergency situation is ultimately the dentist's responsibility, emergency management may be performed by any trained individual under supervision of the dentist.

Access to Emergency Medical Services

Assistance in managing an emergency should be sought as soon as the treating doctor "feels" it is needed, and a "feeling" it is indeed. Emergency medical services should be sought if the dentist does not know what is happening; knows, but does not like, what is happening; or ever feels uncomfortable with the situation. The dentist should seek help as soon as possible in these situations.

In virtually all situations, the most practical course for getting help is to activate the EMS system by calling 911. In an emergency, the ultimate responsibility of the treating dentist is to keep the victim alive until he or she recovers or help arrives on scene to take over management of the situation. Though exceptions may exist, in most areas of California, EMS can be expected to arrive on scene within five to 10 minutes.

Box

Pediatric Advanced Life Support

Course Outline

- The Chain of Survival and Emergency Medical Services for Children*
- Basic Life Support for the PALS Health Care Provider*
- Airway, Ventilation, and Management of Respiratory Distress and Failure*
- Fluid Therapy and Medications for Shock and Cardiac Arrest
- Vascular Access*
- Rhythm Disturbances
- Postarrest Stabilization and Transport
- Trauma Resuscitation and Spinal Immobilization
- Children with Special Health Care Needs*
- Toxicology*
- Neonatal Resuscitation
- Rapid Sequence Intubation
- Sedation Issues for the PALS Provider*
- Coping with Death and Dying
- Ethical and Legal Aspects of CPR in Children*

**Denotes subjects of special interest to dentists treating children*

Table 1

Office emergency team

Team member	Responsibilities
Member #1 (first person on scene of emergency)	1. Remain with victim 2. Activate office emergency system 3. Basic life support as necessary
Member #2	1. Bring emergency equipment* to scene
Member #3 (and other members of the dental office staff)	1. Assist as necessary a. Activate emergency medical services b. Meet and escort EMS to office c. Assist with basic life support d. Prepare emergency drugs for administration e. Monitor and record vital signs

*Emergency equipment includes oxygen supply, emergency drugs, and, when appropriate, an automated external defibrillator

Emergency Drugs and Equipment

Every dental office must have emergency drugs and equipment, as listed in **Tables 2 through 4**. Minor modifications are necessary in offices where children are treated (colored rows in **Tables 2 and 4**).

In offices where central nervous system depressant drugs are employed for conscious sedation, antidotal drugs that are available for specific sedative agents must be included in the emergency drug kit (**Table 3**). If benzodiazepines are used (e.g., diazepam, midazolam, triazolam), flumazenil must be available. Where opioids are employed, naloxone must be included in the emergency drug kit. Single doses of these drugs may be ineffective when administered to manage overdosage resulting from orally administered or long-acting benzodiazepines and opioids.

Table 2

Recommended Dental Office Emergency Drugs

Drug	Indication	Availability	Recommended for kit
Epinephrine (Adrenalin)	Anaphylaxis	1:1000 (adult) (0.3 mg/dose)	1 preloaded syringe and 3 x 1 mL ampules of 1:1,000
Epinephrine (Adrenalin)	Anaphylaxis	1:2,000 (pediatric) (0.15 mg/dose)	1 preloaded syringe and 3 x 1 mL ampules of 1:1,000
Diphenhydramine (Benadryl)	Allergic reactions	50 mg/mL	2-3 x 1 mL ampules of 50 mg/mL
Oxygen	All emergencies	"E" cylinder + delivery devices	Minimum 1, preferable 2, "E" cylinders
Albuterol (Proventil, Ventolin)	Bronchospasm	Metered aerosol inhaler	1 aerosol inhaler
Sugar	Hypoglycemia	Orange juice, "insta-glucose"	12-ounce bottle of orange juice and/or 1 tube of "insta-glucose"
Aspirin	Suspected myocardial infarction	325 mg tablets	1-2 sealed tablets
Nitroglycerin	Angina pectoris	Metered spray	1 Nitrolingual pumpspray

Table 3

Antidotal Drugs

Drug	Indication	Availability	Recommended for kit
Flumazenil (Romazicon)	Benzodiazepine antagonist	0.1 mg/mL	1 x 10mL multidose vial
Naloxone (Nascan)	Opioid antagonist	0.4 mg/mL	2 x 1 mL ampule of 0.4 mg/mL

Basic Management

As described above, basic management of all medical emergencies follows the **PABCD** acronym, (positioning, airway, breathing, circulation, and definitive care [in the BLS acronym, D is defibrillation]).

It is first necessary to determine if the patient is conscious or unconscious. Unconsciousness is defined as the lack of response to sensory stimulation (e.g., lack of response to the "shake and shout" maneuver).[9]

Position

As the most common cause of loss of consciousness is hypotension, all unconscious patients are placed, at least initially, in a supine position with their feet elevated slightly. This position provides an increase in cerebral blood flow with a minimum of interference with respiratory efforts.[10] Conscious people experiencing a medical emergency are placed in whatever position they find most comfortable. As an example, most people in acute respiratory distress (e.g., acute asthmatic bronchospasm) automatically assume an upright position to improve ventilation.

Airway and Breathing

In the unconscious person, the head tilt-chin lift maneuver must be performed (**Figure 2**) followed by an assessment of ventilation ("look, listen, feel").

An important point to remember: Seeing the victim's chest moving does not guarantee that he or she is actually breathing (exchanging air), but simply that he or she is *trying* to breath. Hearing and feeling the exchange of air against the rescuers cheek is the only indication of successful ventilation.

In the absence of spontaneous respiratory efforts (e.g., chest not moving), controlled ventilation must be performed as expeditiously as possible. With

Table 4

Suggested Dental Office Emergency Equipment

Device	Availability	Recommended for kit
Automated external defibrillator	Many	1 AED (pediatric AEDs are available)[8]
Face masks	Various sizes for children and adults	Several pediatric masks and adult mask
Dispoable syringes and needles	2 mL syringe with 20-gauge needle	2-3 sterile, disposable syringes
Spacer for bronchodilator inhaler	Various manufacturers	1 "spacer"

a full face mask and positive pressure oxygen, the patient older than 8 is ventilated at a rate of one breath every five seconds, whereas a rate of one breath every three seconds is used for the infant and child victim.[11] Each individual ventilation should cease when the chest is seen to rise, as overventilation leads to gastric distension and regurgitation.

Circulation

In pediatric medical emergencies, it is likely that a palpable pulse will be present, especially in situations in which the airway and breathing are adequately and rapidly assessed and supported.

Remember: Airway problems (e.g., obstruction, apnea) are the most common cause of cardiac arrest in infants and children.

Palpation of the carotid artery pulse is preferred in children 1 year or older and adults, whereas the brachial pulse is preferred in infants younger than 1 year. In the absence of a palpable pulse, chest compression must be commenced, and EMS summoned immediately.

Definitive Care

Following assessment and implementation of the required steps of BLS, the dentist must seek to determine the cause of the problem (i.e., make a diagnosis). Where a diagnosis is possible and appropriate treatment available, it should be undertaken. If a diagnosis is made but appropriate treatment is not available or if the cause of the problem remains unknown, EMS should be sought immediately. Definitive management of several common pediatric emergencies follows.

Specific Emergencies

Acute Bronchospasm (Asthmatic Attack)

Recognition: Conscious patient in acute respiratory distress, demonstrating wheezing, supraclavicular and intercostal retraction.

P: Position comfortably — usually upright

A, B, C: Assessed as adequate (Victim is conscious and able to speak.)

D: (1) Administer bronchodilator. If patient's inhaler is available, allow him or her to use it. If the patient is younger and the parent or guardian is available, bring him or her into the treatment room to assist in administration of bronchodilator. Many younger children require the use of a spacer to obtain adequate relief with the inhaler.

(2) Administer oxygen, via facemask or nasal canula at a flow rate of 3 to 5 liters per minute.

(3) Summon EMS if parent or guardian of the patient suggests it, or if the episode of bronchospasm does not terminate following two adequate doses of the bronchodilator.

Generalized Tonic-Clonic Seizure ("Grand Mal" Seizure)

Recognition: Period of muscle rigidity (about 20 seconds) followed by alternating muscle contraction and relaxation lasting for about one to two minutes.

P: Position supine.

A, B, C: Assessed as adequate (respiratory and cardiovascular stimulation usually occur during seizure).

D: (1) Protect victim from injury. Keep victim in the dental chair; gently hold onto arms and legs, preventing uncontrolled movements, but do not hold so tight as to prevent limited movement.

(2) If parent or guardian is available, bring him or her into the treatment room to assist in assessment of victim.

(3) Summon EMS if parent or guardian of patient suggests it, or if the seizure continues for more than two minutes.

Remember: Do not place anything between the teeth of a convulsing person.

Most generalized tonic-clonic seizures will stop within one minute and almost always within two minutes (thus the recommendation to seek EMS with prolonged seizure activity). At the termination of the seizure, P, A, B, C, D must be reassessed, as follows:

P: Position supine.

A, B, C: Assessed and managed as needed. In most (but not all) post-seizure situations, **A** must be managed, but **B** and **C** are assessed as adequate.

D: With help from the parent or guardian, try to communicate with the patient, who is likely in a state similar to a deep physiologic sleep. Following a generalized tonic-clonic seizure, the

victim is quite disoriented. As the parent or guardian has seen this and done this before, allow him or her to talk with the patient to reorient the patient to both space and time.

Remember: Most morbidity and mortality associated with seizures occurs in the postseizure period because the rescuer does not do enough for the victim (P, A, B, C)

Sedation Overdose

Recognition: Lack of response to sensory stimulation.

Consider. An overdose of sedation is general anesthesia. Effective management of a patient receiving general anesthesia is predicated on airway management and breathing. Therefore, this should not represent an emergency in the office of a doctor who is trained to administer general anesthesia to children or adults.

P: Position supine.

A, B, C: Assessed and managed as necessary. In most cases, **A** alone is required; whereas **A** and **B** will be needed in a few situations. **C** will generally be present if **A** and **B** are properly assessed and managed.

D: (1) Monitor patient, using pulse oximeter[b] (and blood pressure and heart rate/rhythm).

(2) Stimulate patient periodically (verbally and/or squeezing the trapezius muscle) seeking response.

3) Antidotal therapy: If sedative drugs were administered parenterally, and intravenous access is available, administer flumazenil IV in a dose of 0.2 mg (2 mL) in 15 seconds waiting 45 seconds to evaluate recovery where benzodiazepines were administered. If recovery is not adequate at one minute, an additional dose of 0.2 mg may be administered. Repeat every minute until recovery occurs or a dose of 1.0 mg has been delivered. Titrate naloxone IV at 0.1 mg. (0.25 mL) per minute to a dose of 1.0 mg if an opioid was administered. Naloxone may be administered intramuscularly, in a dosage of 0.01 mg/kg every two to three minutes until the patient is responsive.

Remember: Specific antidotal therapy may not be effective following the oral administration of central nervous system depressants; and antidotal therapy should be administered intravenously, if possible. Naloxone may be administered intramuscularly.

> Basic life support (as necessary) is all that is required to manage many emergency situations, with the addition of specific drug therapy in some others.

Local Anesthetic Overdose

A true overdose of local anesthetic should be always preventable.[2]

Recognition. Generalized tonic-clonic seizure or unconsciousness, generally developing five to 40 minutes after local anesthetic administration.

P: Position supine.

A, B, C: Assessed and administered as needed.

D: (1) Generalized tonic-clonic seizure — follow protocol for seizures (above). With proper airway management and ventilation, a local anesthetic-induced seizure often ceases in less than one minute. In the absence of an adequate airway and ventilation, carbon dioxide is retained, the patient becomes acidotic, and the seizure threshold of the local anesthetic decreases, leading to more prolonged and more intense seizure.[13]

(2) Unconsciousness — the basic protocol for management of the unconscious patient is followed when a local anesthetic overdose manifests itself as loss of consciousness. Proper management of airway and breathing, as needed, will minimize occurrence of cardiac arrest. As the cerebral concentration of the local anesthetic decreases (through redistribution of the drug out of the brain) consciousness returns.

(3) Summon EMS if consciousness is not restored in two minutes or if the patient is not breathing.

Final comments

Medical emergencies can and do occur in the practice of dentistry. Although most emergencies take place in adults, serious problems can also develop in younger patients. The contemporary dentist must be prepared to manage expeditiously and effectively those few problems that do arise. Basic life support (as necessary) is all that is required to manage many emergency situations, with the addition of specific drug therapy in some others. Preparation of the office and staff includes basic life support (annually), pediatric advanced life support, development of an emergency team, consideration for emergency medical services, and the availability of emergency drugs and equipment with the ability to use these items effectively. As with the adult patient, effective management of pain (local anesthesia) and anxiety (behavioral management, conscious sedation) will minimize the development of medical emergencies. CDA

Notes / a. PEDO — contact the American Academy of Pediatric Dentistry for dates of future PEDO courses. www.aapd.org, 800.544.2174.

b. The doctor using oral sedation (in children younger than 13) or parenteral (intramuscular or intravenous) sedation must have a pulse oximeter in the dental office, as per the Dental Practice Act, Part 3, California Code of Regulations.

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