Two categories of pediatric emergency can occur during sedation. Anesthesia associated problems usually are airway related and lead to hypoxia and cascade to bradycardia and potentially death. Examples of these include drug/dose problems, unintended sedation level changes, allergic reactions to the agents used, laryngospasm and loss of protective reflexes. Non-anesthesia emergencies can occur at anytime and are not related to the sedative or anesthetic agents. These may occur concurrently or separately and can include airway obstruction, allergic reactions, seizures and hypoglycemia. It is important for the practitioner to be able to identify and intervene early in the event to be able to manage the emergency and stabilize the patient before further progression.

Though there are many reported numbers for the incidence of emergencies during sedation and anesthesia, they may be unreliable.\textsuperscript{1, 2, 3} There is no central reporting agency in dentistry for incidences of morbidity or simple complications which don’t affect the outcome of the sedation. Mortality numbers are difficult to obtain other than in insurance company closed case analyses and there exists only estimates of the number of outpatient sedations given in a specific time period. In addition, some practitioners do not recognize problems or may choose to ignore them because they believe they are too minor to record such as temporary loss of protective reflexes as the patient drifts between sedation levels. Practices are inconsistent in their delivery and monitoring making data recovery difficult.

In general, the pediatric heart and lungs are generally free of disease unless it is congenital. The second most common disease affecting children is asthma and is the most common cause of admission for the pediatric patient. It affects approximately 11-15% of children and is now considered a lifelong disease. It is important to understand the severity of the asthma pre and post treatment and the medications used because of the impact they may have on the emergency treatment. Acquired infections of the airway in children require a 6 week healing period before sedation or general anesthesia should be done. Understanding allergic versus infectious etiology is key to treatment and prevention of medical emergencies.

This article is by no means a complete discourse on pediatric emergency management and will only focus on respiratory, cardiovascular, and sedative and local anesthetic drug overdose related emergencies. Other pediatric emergencies will be covered in a future article. The reader is well advised to do...
additional research on pediatric diseases and emergency management of patients and take appropriate continuing education courses. Topics such as foreign body obstruction and complications of the routes of administration are covered in courses such as Pediatric Advanced Life Support by the American Heart Association and the American Academy of Pediatrics.

Response to Emergencies
The concept of “rescue”, as proposed by Cote states that the purpose of all emergency treatment is to manage and stabilize the patient until help arrives. Using local emergency services alone and waiting for their response is not adequate rescue. Know and understand if the emergency responders are EMTs or Paramedics. The office must have the resources and training necessary to perform rescue from unintended sedation level changes, i.e. overdose, as well as other categories of emergencies. The chances for a successful outcome decrease with the distance and time from an emergency facility.

Learning to rescue alone is not adequate emergency preparation. Prevention of the emergency through guidelines, understanding drug dosages and pharmacology, with potential interactions, and knowing your patient and his or her medical history will mediate the risks involved. Documenting sedation incidents in the office and reviewing those with staff and other practitioners allow us to learn from experience and modify our delivery, monitoring and especially our response, be it as simple as a using a neck and shoulder roll or one more involved such as drug dose change. It is recommended that during sedations, children are maintained at the minimal or moderate level to maintain their protective reflexes and their airways patent.

By following guidelines, we are able to minimize but not totally eliminate risk. NPO guidelines may leave our patients at risk for hypovolemia especially if they perspire profusely while in a medical immobilization device. The triad of hypovolemia, hypoxia and hypercarbia lowers seizure threshold, increases myocardial irritability and may hinder or prevent resuscitation efforts. In addition, certain sedation medications such as chloral hydrate may increase myocardial irritability and may negate the use of epinephrine during emergency care.

Emergency Kit
The emergency kit for pediatric patients must be adequate to maintain a patent airway and stabilize the child at the level of sedation achieved as well as treat any concurrent emergencies until either help arrives or the patient emerges and recovers. This implies that if the patient drops to a level deeper than anticipated, the doctor must be able to monitor and maintain the patient at the unintended level and have the training, equipment and staff to do so. The emergency kit must also
contain equipment and supplies to respond to other basic pediatric office emergencies and first aid. An appropriate list is available in the AAP/AAPD Guidelines for Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures\(^4\) (chart 1). The kit must contain specific equipment and sizes for pediatric resuscitation including face masks, advanced airway devices and equipment for IV and IO access. The kit must be placed in an identified and easily reached area and the components must be clearly marked and labeled. Response must be organized and practiced with individual roles assigned to each member of the response team (chart 2).

Oxygen is always the first drug of choice. Room air has 21% oxygen content. Oxygen, as a supplement in emergency situations, should be delivered at 100% with the assistance of an appropriately sized pediatric self-inflating bag valve mask system. A mobile E-sized tank is capable of delivering 10 liters/minute of oxygen for 60 minutes and may be used in areas not plumbed with oxygen. Alternative oxygen delivery methods may be available but must meet the requirements of access and transportability. Without modification, the standard N2O/O2 delivery unit is not capable of delivering positive pressure oxygen because of an overload pop-off valve in the system. The standard reservoir bag does not substitute for a self-inflating bag valve mask though the unit may be used to supply oxygen to the BVM.

Masks used in resuscitation should be transparent with a form fitting inflatable collar which should also be checked on a regular basis. A variety of different sizes should be available and should fit comfortably between the nasal bridge and the chin. A 5cc syringe without needle should be kept with the masks to deflate or inflate the collar.

Advanced airway devices for managing airways during emergencies include nasal and oral airways, endotracheal tubes (ETT) and appropriate placement equipment. A valuable adjunct for airway management is the laryngeal mask airway (LMA) which may substitute for intubation in compromised airways. It is recommended that experience be gained in this technique. The inflatable collar may block regurgitated stomach contents from entering the airway. Various sizes for pediatric patients must be available.

Correct size oral airways are measured externally from the tragus to the commissure of the lips. Nasal airways are measured externally from the tragus to the corner of the nares.

Automated Electronic Defibrillators (AED) are a conundrum in pediatric emergency care but states are increasingly mandating their presence in dental offices. Short of aiding the staff in resuscitating the doctor, they have little purpose in pediatric practices as a first line resuscitation...
device. Most cardiac problems are not due to disease or congenital issues but instead to hypoxia leading to a transient tachycardia with the child succumbing to a fatal bradycardia. Performing defibrillation on a hypoxic heart will not revive it nor correct an arrhythmia.

**Routes of Administration of Emergency Drugs**

It is recognized that the optimum route of administration of all emergency medications is intravascularly or intraosseously, although alternate means are available. Submucosal delivery in the area distal and superior to the maxillary molar in the region of the pterygoid plexus or intramuscularly into the nearest exposed muscle mass (gluteal or deltoid) may be used when there is optimum circulation. Because the dental practitioner is most comfortable in the oral cavity, the submucosal site mentioned is recommended for drugs that may be given intramuscularly due to the high vascularity of the area. This also avoids the possibility of swelling and airway obstruction if administered in the floor of the mouth or the tongue. Diazepam, because of its ethylene glycol base, is not appropriate for intramuscular or submucosal administration except in extreme cases.

**Paradigm of Emergency Care**

The paradigm of emergency care should involve a system or method of treatment that guides our thoughts and actions.

Prior to the 2012 revision of the American Heart Association’s Pediatric Advanced Life Support (PALS) course, the mnemonic of PABCD where P is position, A is airway, B is breathing, C is circulation, and D is drugs was used. As with the concept of rescue, the absence of prevention in the thought process leads us to a situation which may be preventable. Therefore, a paradigm of PPABCD, where the first P is prevention, PABC are the same, and the D is definitive treatment (realizing not all emergencies require drug intervention) can be considered. The mnemonic has been recently revised again to stress the increased focus on circulation. The key to success is not to progress to the next letter if the prior letter is not stabilized i.e. do not attempt breathing if the airway is not stabilized.

**Emergencies of the Respiratory System**

The most common emergency during pediatric sedations is hypoxia. It may be caused by airway obstruction, drug overdose, local anesthesia overdose or unintended sedation level, all of which may lead to reduced respiratory rate and volume. When respiratory and/or cardiac rates reach 2/3 of pretreatment rates, good quality CPR should begin including bag valve mask (BVM) intervention. Survival rates after hypoxia and cardiac arrest are 3-17% therefore, early recognition and management are crucial. The early signs of hypoxia are restlessness and agitation, transient increase in heart
rate then decrease, and irregular breathing patterns. The various sounds of respiratory problems may be summarized as follows:

### Respiratory Problems

- **Gurgling**: fluid or foreign body in the upper airway
- **Snoring**: tongue/soft palate/tonsil obstruction
- **Crowing**: large tongue, vocal cord paralysis or swelling, croup, epiglottitis, foreign body, allergic reaction with edema, laryngospasm
- **Wheezing**: bronchospasm or partial obstruction of the lower airway on expiration

The treatment of hypoxia, regardless of cause, is as follows:

### Hypoxia

<table>
<thead>
<tr>
<th>P (Prevention)</th>
<th>Neck roll.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loose medical immobilization device.</td>
</tr>
<tr>
<td></td>
<td>Know sedation level and drug interactions.</td>
</tr>
<tr>
<td></td>
<td>Rubber dam carefully placed on single side-not cross arch.</td>
</tr>
<tr>
<td></td>
<td>Suction readily available.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P (Position)</th>
<th>Supine with head tilt.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monitor and assess airway and breathing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A (Airway)</th>
<th>Assess patency.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Position tongue forward- no blind sweeps.</td>
</tr>
<tr>
<td></td>
<td>Place appropriately sized nasal airway measured from OPA: tragus to corner of the mouth.</td>
</tr>
<tr>
<td></td>
<td>100% O2 by nasal or full face mask.</td>
</tr>
<tr>
<td></td>
<td>LMA or intubate if airway does not open.</td>
</tr>
<tr>
<td></td>
<td>Monitor and reassess.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B (Breathing)</th>
<th>Assess respirations.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self vs. assisted.</td>
</tr>
<tr>
<td></td>
<td>Adequate volume and speed.</td>
</tr>
<tr>
<td></td>
<td>Assist as necessary with positive pressure 100% O2 by Bag Valve Mask (BVM).</td>
</tr>
<tr>
<td></td>
<td>Monitor and reassess.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C (Circulation)</th>
<th>Assess perfusion by peripheral/carotid pulses.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Begin CPR.</td>
</tr>
<tr>
<td></td>
<td>Monitor and reassess.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D (Definitive)</th>
<th>Determine cause and treat with appropriate drug.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Activate 911 and transport to emergency facility.</td>
</tr>
</tbody>
</table>

Asthma is the most common cause for admission to hospitals in the pediatric population. Bronchospasm, the end result of asthma, may also be caused by allergies, reactive airway disease following infection or pneumonia, and mechanical or chemical irritation. The most common signs are congestion, wheezing, dyspnea, confusion or agitation and tachypnea and tachycardia. Because the pediatric patient has limited oxygen reserves, intervention must be immediate. The heart will tire quickly and hypoxia, hypovolemia and hypercarbia will ensue quickly with lactic acidosis leading to an irreversible condition.

The treatment of bronchospasm is as follows:

### Bronchospasm

<table>
<thead>
<tr>
<th>P (Prevention)</th>
<th>History</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chromalin/steroid/puffer handy</td>
</tr>
<tr>
<td></td>
<td>Decrease anxiety/ supplement with O₂</td>
</tr>
<tr>
<td></td>
<td>Avoid narcotics (histamine releasers)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P (Position)</th>
<th>Partially reclining</th>
</tr>
</thead>
</table>

| A (Airway) | 2-4 puffs of albuterol inhaler q 2 minutes for 2 doses |

<table>
<thead>
<tr>
<th>B (Breathing)</th>
<th>Assist as necessary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bag/valve/mask if needed</td>
</tr>
<tr>
<td></td>
<td>Prepare to intubate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C (Circulation)</th>
<th>Monitor and CPR as needed</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>D (Definitive)</th>
<th>If bronchospasm resolves, continue treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If fails to resolve, notify EMS</td>
</tr>
</tbody>
</table>

Laryngospasm may be caused by aspiration of a foreign body, depth of sedation with partial loss of protective reflexes or post viral syndrome with reactive airway disease.

With time, the situation progresses and is harder to reverse without drug intervention. The treatment of laryngospasm is as follows:
Sedation and Medical Emergencies in the Pediatric Patient
by David L. Rothman, D.D.S.

Laryngospasm

P (Prevention)  History of infection
Use of rubber dam and high capacity suction
P (Position)  Supine with head tilt and shoulder roll
A (Airway)  Check for foreign body/vomitus
Place appropriate length oral airway
B (Breathing)  100% O₂ through BVM
Constant mild to moderate pressure- not burst
Drugs prn
Succinylcholine 2-4mg IM with atropine .04mg
Be prepared to ventilate for up to 30 min.
C (Circulation)  Monitor for peripheral pulses
CPR prn
D (Definitive)  EMS activation and transport

Abnormal Cardiac Rhythm and Pulses
Arrhythmias and dysrhythmias may have many causes but the most common include an undiagnosed congenital defect, hypoxia, effects of circulating catecholamines on a sensitized myocardium, drug effects and vagal stimulation. The end result of the arrhythmia is poor perfusion, lowered blood pressure, and the shunting of blood from the peripheral circulation to maintain perfusion of the blood rich group. The Pediatric Advanced Life Support Course (PALS) provides excellent training in the management of this problem. Because arrhythmias have the potential to become fatal, rapid identification and treatment are imperative.

Arrhythmias

P (Prevention)  Know patient
Know drug, its interactions and its effects
P (Position)  Supine with neck and shoulder roll
A (Airway)  Maintain patency
Nasal or oral airway as needed
100 % O₂
B (Breathing)  Monitor and assist as needed with bag valve mask
Begin CPR if needed
C (Circulation)  Monitor and assist as needed
Begin CPR if needed
D (Definitive)  Notify EMS and prepare for transport

Sedation Drug Overdose

Despite the practitioner’s best efforts in predicting patient response to a dose of sedative medication, there is always the chance of hyper or hyporeactions to the drug such that the patient slips into a deeper level of sedation than intended. The practitioner must be prepared to respond appropriately and maintain and protect the airway if loss of protective reflexes occurs.

The response to sedation drug overdose is as follows:

Sedation Drug Overdose

P (Prevention)  Know drug dose, interactions and effect
Know drug metabolism and half life
Identify levels of sedation and responsiveness
P (Position)  Supine with neck and shoulder roll
A (Airway)  100% O₂
Oral airway or intubate if needed to guarantee patency
Monitor and reassess
B (Breathing)  Assist with BVM as needed
Monitor and reassess
C (Circulation)  Monitor and assist with CPR if necessary
D (Definitive)  STOP dental procedure
Start IV (required for deep sedation or GA)
Monitor appropriate vital signs
Reversal agents if appropriate
Naloxone 0.01 mg/kg IM q5m to max 1mg.
Flumazenil 0.2mg IV q1m to max 1 mg.
Monitor and assess level of sedation

Local Anesthesia Overdose

The administration of local anesthesia concurrently with sedative medications constitutes polypharmacy and requires additional caution because of the risk of potentiation and fatal arrhythmias secondary to lidocaine or epinephrine overdose. Because its presence decreases the rate of anesthetic absorption, there is no reason for not using local anesthetic with vasoconstrictor during sedation of ASA 1 or 2 patients. In the case of
overdose, increasing CNS depression leads to the paradox of increasing CNS stimulation, agitation and talkativeness. The patient exhibits seizures until the blood level falls. Management of this emergency involves stabilizing the patient and monitoring until blood levels fall.

**Local Anesthesia Overdose**

| P (Prevention) | Follow current local anesthesia guidelines and doses not exceeding 4mg/kg for commercially available drugs |
| P (Position) | Supine in the unresponsive, sedated patient |
| A (Airway) | Usually adequately maintained |
| B (Breathing) | Usually maintained |
| C (Circulation) | Usually adequately maintained |
| D (Definitive) | EMS activation and transport |

**Conclusion**

The successful treatment outcome of an in-office emergency of a pediatric patient during sedation is dependent upon rapid identification of a problem and immediate intervention. The emergency situation always takes precedence over the dental procedure. Using recommended monitors and monitoring techniques, early identification of critical events is possible. The practitioner is advised to always be suspicious of changes in the child’s responses. With a well-trained doctor and office staff, practiced in emergency response, the likelihood of mortality or severe disability decreases for the child. Continuous training for all staff members is recommended.

**Chart 1**

**Emergency Medications and Equipment**

1. oxygen;
2. ammonia spirits;
3. glucose (50%);
4. atropine;
5. diazepam;
6. epinephrine;
7. lidocaine (cardiac);
8. diphenhydramine hydrochloride;
9. hydrocortisone;
10. pharmacologic antagonists (as appropriate) nalozone hydrochloride flumazenil.

**Airway management equipment**

1. nasal and oral airways and clear masks of assorted pediatric and adult sizes;
2. portable oxygen delivery system capable of delivering bag and mask ventilation greater than 90% at 10 L/min flow for at least 60 minutes (e.g. “E” cylinder);
3. self-inflating breathing bag and reservoir with masks that will accommodate children and adults of all sizes.
4. Deep sedation and general anesthesia: assorted pediatric endotracheal tubes, laryngoscopes with straight and curved blades, Magill forceps

**Intravenous equipment for deep sedation and general anesthesia**

1. gloves,
2. alcohol wipes,
3. tourniquets,
4. sterile gauze pads,
5. tape;
6. intravenous solutions and equipment for administration appropriate to the patient population being treated
   a. intravenous catheters (22, 24 gauge)
   b. intravenous administration set (tubing) (microdrip 60 drops/mL)
   c. intravenous fluids
   d. assorted needles for drug aspiration and administration
   e. appropriately sized syringes
### Chart 2

**Team member 1**
- Initiates emergency care
  - Treat patient/ Basic Life Support
  - Activates office emergency protocol
- Remains with patient

**Team member 2**
- Brings supplies/emergency kit
  - Medications/O2 tank
- Assists 1

**Team member 3**
- Crowd control
- Notifies emergency backup service on instructions from 1
- Meets EMS and escorts in
- Maintains records
- Assists as needed

### References


The ADSA Pediatric Sedation Review Course in Las Vegas is a two day course reviewing topics related to the safe and effective sedation of children. It is specifically designed for both pediatric dentists as well as non-pediatric dentists who sedate children during dental procedures.

The course reviews the unique anatomical and physiological aspects of pediatric patients of concern during procedural sedation as well as the pharmacological aspects of the various agents used in this population. Alternative methods of patient management will be reviewed as well as a thorough discussion of patient monitoring necessary during sedation procedures.

The course will feature a thorough discussion of sedative techniques for special populations of children including those with developmental disabilities and medical challenges. The course will conclude with a thorough discussion of management of emergencies seen during procedural sedation of children.

**Friday, March 4, 2016**

8:00  Introduction  
Dr. David Rothman - Chair

8:15  Definition of a Pediatric Patient  
Dr. David Rothman

9:15  Physiology  
Dr. David Rothman

10:15  Break

10:30  Nitrous Oxide  
Dr. Robert Bosack

11:00  Local Anesthesia  
Dr. Joseph Giovannitti

12:00  Lunch

1:00  Drugs & Drug Regimens  
Dr. Ronald Kosinski

2:00  Alternatives - IV Sedation/GA Options

3:00  Break

3:15  Monitoring  
Dr. Ernie Luce

3:45  Non-Pharmacologic Behavior Management  
Dr. David Rothman

**Saturday, March 5, 2016**

8:00  Treating Disabled Patients  
Dr. David Rothman

9:00  Human Simulation  
Dr. Ronald Kosinski

10:00  Break

10:15  Medical Emergencies

12:00  Lunch

1:00  Children with Medical Challenges  
Dr. David Rothman

2:45  Break

3:00  Pediatric Sedation for the Autistic Patient  
Dr. Ronald Kosinski

ADSA Meetings 2016

Speakers & Topics Subject to Change