

# **Medical Emergencies in the Dental Office**

## **The Basics**

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Medical emergencies can and do occur in the dental office. Data obtained from dentists in independent surveys by Fast<sup>1</sup> and Malamed<sup>2</sup> vividly demonstrate that the dental office environment is not immune to the occurrence of potentially life-threatening situations (Table 1). In a 10-year period, more than 30,000 emergencies were reported by the more than 4,000 dentists surveyed. The nature of the emergencies varied significantly, from the usually benign (syncope) to the catastrophic (cardiac arrest and anaphylaxis).

It is the author's belief that the overwhelming majority of emergencies encountered were precipitated by the increased stress that is so often present in the patient in the dental environment. Increased stress can result from fear and anxiety or inadequate pain control.

That stress is associated with an increased occurrence of emergency situations was confirmed by Matsuura, who reported that 77.8 percent of life-threatening systemic complications in the dental office developed either during or immediately following local anesthetic administration or during dental treatment (Table 2a)<sup>3</sup>. Getting a local anesthetic injection or a "shot," to use patients' vernacular, is always rated by patients as one of the most traumatic aspects of dental care. When emergencies arose during dental treatment, 38.9 percent developed during the extraction of teeth, while 26.9 percent occurred during pulpal extirpation \_ two procedures where adequate pain control is frequently difficult to obtain (Table 2b).

It is important that all members of the dental office staff be trained to promptly recognize and efficiently manage emergency situations. Unfortunately, when emergencies occur, it is not always possible to easily determine the precise nature of the problem. For example, a patient may state that he or she is having difficulty breathing, not that he or she is suffering from an asthmatic attack or hyperventilation; or the initial complaint may be a "tightness in my chest," not "I am suffering an anginal attack" or a myocardial infraction. Patients may likewise state simply that they "don't feel well." Specific management becomes more difficult at those times.

Table 1

<b>REPORTED INCIDENCE OF EMERGENCY SITUATIONS BY PRIVATE PRACTICE DENTISTS DURING A 10-YEAR PERIOD<sup>1,2</sup></b>	
Syncope, vasodepressor	5,407
Mild allergic reaction	2,583
Angina pectoris	2,552
Postural hypotension	2,475
Seizures	2,195
Asthmatic attack (bronchospasm)	1,392
Hyperventilation	1,326
Epinephrine reaction	913
Insulin shock & hypoglycemia	890
Cardia arrest	331
Anaphylactic reation	304
Myocardial infarction	289
Local anethetic overdose	204
Acute pulmonary edema (heart failure)	141
Diabetic coma	109
Cerebrovascular accident	68
Adrenal insufficiency	25
Throid storm	4
<b>Total</b>	<b>30,602</b>

The recognition and management of emergency situations will, of necessity, be based upon commonly presenting clinical signs and symptoms. Five categories are noted, including:

- Altered consciousness;
- Convulsions;
- Respiratory distress;
- Drug-related emergencies; and
- Chest pain

Figure 1

Recognition

- Altered consciousness
- Convulsions
- Respiratory distress
- Drug-related emergencies
- Chest Pain

**Position**

- Unconscious...supine, feet elevated
- Conscious...comfortably

**Airway**

- Assess and manage, if needed

**Breathing**

- Assess and manage, if needed

**Circulation**

- Assess and manage, if needed

**Definitive Care**

- EMS
- Drugs

**Table 2a**

<b>Time of Occurrence of Reported Systemic Complications<sup>3</sup></b>	
<i>Just before treatment</i>	<b>1.5%</b>
<i>During/after local anesthesia</i>	<b>54.9%</b>
<i>During treatment</i>	<b>22.0%</b>
<i>After treatment</i>	<b>15.2%</b>
<i>After leaving dental office</i>	<b>5.5%</b>

**Table 2b**

<b>Type of Dental Treatment During Occurrence of Complications<sup>1</sup></b>	
<i>Tooth extraction</i>	<b>38.9%</b>
<i>Pulp extirpation</i>	<b>26.9%</b>
<i>Unknown</i>	<b>12.3%</b>
<i>Other treatment</i>	<b>9.0%</b>

<i>Preparation</i>	<b>7.3%</b>
<i>Filling</i>	<b>2.3%</b>
<i>Incisions</i>	<b>1.7%</b>
<i>Apicoectomy</i>	<b>0.7%</b>
<i>Removal of fillings</i>	<b>0.7%</b>
<i>Alveolar plastics</i>	<b>0.3%</b>

## **Preparation For Medical Emergencies**

**Prior to discussing the management of emergency situations, it is necessary to briefly review the steps needed to fully prepare the dental office and staff so emergencies can be managed efficiently and effectively. These steps include: basic life support training, an office emergency response team, access to emergency medical services, and emergency drugs and equipment.**

**Basic life support (cardiopulmonary resuscitation): all employees of the dental office should be required to receive training in BLS, at least annually. The recommended minimal level of training for all dental health professionals is the BLS health care provider course, which provides certification in one- and two-person CPR; infant, child and adult obstructed airway management; and BLS. Included in health care provider level training is the use of a face mask for ventilation, an extremely important technique for the dental health professional. It is strongly suggested that BLS training be done in the dental office, with the "victim" (mannequin) in the dental chair.**

**An in-office emergency response team, consisting of not less than two people, preferably three. Member 1 (the first person to reach the emergency) stays with the victim, administers BLS as required and activates the in-office emergency team ("help!"). Member 2 brings the emergency drug kit and portable oxygen cylinder to the scene of the emergency, while Member 3 reports to the scene of the emergency to assist as necessary. This might include preparing drugs for administration, activating emergency medical services, monitoring vital signs, and meeting the EMS team in front of the building and escorting them to the scene of the emergency. In the small office, Member 2 functions as member 3 on arrival at the emergency scene. It is important that all members of the emergency response team be able to perform all of these tasks.**

**Seeking medical assistance: Knowledge of whom to contact when assistance is needed in an emergency is essential. The use of community emergency medical services (e.g., 911) is taken for granted in most communities in California. Additionally, a well-trained (in emergency medicine) medical or dental health professional located nearby may also be utilized. As soon as the dentist believes that**

assistance is needed, the EMS system in the office should be activated without hesitation. It is better to seek help sooner than to wait too long.

An emergency kit containing drugs and equipment is mandatory. The emergency drug kit should be prepared by the dentist and be consistent with the dentist's training in emergency medicine. The emergency kit should not include any drugs or equipment that the dentist is not trained to use. "Complexity in a time of adversity breeds chaos." Critical drugs and equipment recommended as a "bare bones" minimum in all dental offices include:

**Epinephrine 1:1,000.** One preloaded syringe (two dose, 1:1,000), 0.3 mg/dose. Suggested: three to four 1 ml. ampules of 1:1,000 epinephrine. In offices where children are treated, one preloaded epinephrine syringe 1:2,000, 0.15 mg/dose is recommended.

**Histamine-blocker.** Either diphenhydramine (benadryl) 50 mg/ml or chlorpheniramine (Chlortrimaton) 10 mg/ml. Also suggested are two to three 1 ml. ampules (preloaded syringes are not recommended).

**Oxygen.** Suggested is a minimum of one "E" cylinder of oxygen.

**Nitroglycerin.** Nitrolingual spray 0.4 mg/metered dose spray. One spray bottle is suggested.

**Bronchodilator.** Albuterol metered inhaler (Proventil, Ventolin). One inhaler is suggested.

**Antihypoglycemic.** Orange juice or nondiet cola beverages are suggested.

**Oxygen delivery system.** A positive pressure/demand valve: Full face mask permitting delivery of 100 percent oxygen if used properly. Requires training (available in BLS healthcare provider course, ACLS, or hands-on emergency medicine courses). Bag valve/mask device: Full face mask permitting delivery of 21 percent oxygen (ambient air) or enriched oxygen, if an oxygen tube from an E cylinder is attached (25 percent or 90 percent oxygen). Requires training as with positive pressure mask (above).

**High volume suction and aspirator tips or tonsillar suction.**

**Syringes.** Two to three 2-ml. plastic, disposable syringes (18- or 20-gauge needle is attached).

**Tourniquets.** Minimum one, up to three.

**Magill intubation forceps.** Permit easy retrieval of small objects from the oral cavity and pharynx.

Emergency drug kits can be prepared by the dentist and individualized to meet the training and expertise of the dentist and staff, or commercial emergency drug kits can be purchased. In a recent survey of emergency preparedness of dental offices (n = 2302) 86.3 percent had an emergency drug kit available in the dental office. Of these, 50.5 percent purchased commercial drug kits, 11.5 percent modified a commercial kit and 38.0 percent designed their own emergency drug kit. In 1973, the American Dental Association addressed the question of emergency drugs and equipment and included the following statement concerning commercial kits:

*"None of these kits is compatible with the needs of all practitioners, and their promotion is sometimes misleading. All dentists must be prepared to diagnose and treat expeditiously life-threatening emergencies that may arise in their practices. The best way to accomplish this objective is by taking continuing education courses on the subject of emergencies to remain informed on current practices recommended for handling emergencies in the office. A false sense of security may be engendered by the purchase of a kit if the purchaser presumes that it will fulfill all the needs of an emergency situation. The most important factors in the effective treatment of emergencies are the knowledge, judgment and preparedness of the dentist. ....Since emergency kits should be individualized to meet the special needs and capabilities of each clinician, no stereotyped kit can be approved by the Council on Dental Therapeutics. Practitioners are encouraged to assemble their own individual kit that will be safe and effective in their hands or to purchase a kit that contains drugs that they are fully trained to administer."*

Though made more than 20 years ago, this statement is as true today as it was then.

## Management of Emergency Situations

Successful management of all emergency situations is predicated upon prompt recognition and effective management. A well-defined series of steps should be followed in rendering emergency care in all situations. These steps, illustrated in Figure 1, are, in order: recognition, position, airway, breathing, circulation and definitive care.

### *Recognition*

Recognition of an emergency situation is based upon the clinical signs and symptoms presented by the victim. Signs are visual clues, such as convulsion, cyanosis and diaphoresis (excessive sweating), while symptoms are more subjective, for example: "I feel very jittery" or "I can't breathe." Often times, it may be possible to arrive at a rather definitive diagnosis through signs and symptoms. For example, a patient with a prior history of asthma may simply state that he or she is experiencing an asthmatic attack, or an anginal patient may state that the substernal discomfort he or she is experiencing is angina. At other

times, however, a definitive diagnosis may not be as easy to discern, such as when the patient simply says "I'm dizzy" or "I don't feel good." Initial emergency management will, therefore, frequently be based upon sometimes vague clinical signs and symptoms. Five categories are described using this system:

n Altered consciousness, defined as a conscious patient acting strangely (altered consciousness) or a lack of response to sensory stimulation, e.g., "shake and shout" (unconsciousness).

- Convulsions, defined as generalized skeletal muscle contraction and relaxation.
- Respiratory distress, defined as a conscious patient experiencing difficulty in breathing.
- Drug-related emergencies, defined as any emergency situation arising during or shortly after the administration of a drug.
- Chest pain, defined as a subjective feeling of pressure, heaviness, tightness, burning or a constricting feeling in the "chest" area.

Once an emergency is recognized, any dental care or other treatment should immediately be halted and attention directed to the problem.

### *Positioning*

Positioning during a medical emergency will be based upon whether the victim retains consciousness.

The unconscious patient should immediately be placed into a supine (horizontal) position with his or her feet elevated slightly (10 degrees). This increases the return of blood from the legs and feet to the chest and heart and provides for an increase in blood flow to the cerebral vasculature. Since a drop in blood pressure is the single most common cause of loss of consciousness in human, this step, by itself, is often all that is needed to terminate a transient episode of syncope or postural (orthostatic) hypotension.

Positioning of the conscious patient during an emergency situation will be based upon the comfort of the patient. It is safe to say that a conscious patient who is speaking has a patent airway, is breathing, and has at least a minimally adequate blood pressure. Given this, the comfort of the patient is paramount. Asthmatics and others experiencing difficulties in breathing will almost always be more comfortable sitting or standing up because of improved pulmonary vital capacity. Patients experiencing chest pain also feel more comfortable in an upright position.

### *Airway*

The patency of the patient's airway must be assessed. In the conscious patient, one who is able to respond verbally to commands or questions,

the airway is maintained and does not require assistance. However, once consciousness is lost, skeletal muscle tone decreases leading to airway obstruction in more than 80 percent of unconscious people. Airway management, through the head tilt-chin lift technique is required in the unconscious patient.

### ***Breathing***

The presence or absence of spontaneous respiratory efforts must be assessed next. If present, their effectiveness must also be considered. In the conscious patient who is able to speak, breathing is usually adequate. Speech is the process of air being expelled from the lungs through the vocal apparatus. In the choking victim, a person who has aspirated food or some other object, consciousness will be present initially, the victim will be making violent efforts at getting air into their lungs and will be unable to speak. In this situation, the rescuer should identify him- or herself as being trained to manage the problem and proceed to administer the abdominal thrust (Heimlich maneuver).

In the unconscious patient, it is possible that spontaneous respiratory efforts will be present and adequate, present and shallow, or absent. In addition to assessing the presence of spontaneous ventilation ("look"), it is also essential to determine if the airway is patent and the patient is exchanging air adequately ("listen and feel"). The "look, listen and feel" technique is used to assess ventilatory efforts. With the rescuer's ear placed one inch from the victim's mouth and nose, the rescuer, still maintaining head tilt-chain lift, looks at the victim's chest to determine if the victim is trying to breathe. The rising and falling of the chest indicate the presence of spontaneous respiratory efforts. Of equal, if not greater, importance is the "listen and feel" component. If the airway is patent and if spontaneous ventilatory efforts are present, the rescuer should feel and hear each breath against his or her ear and cheek. Thus, it is significant that the rescuer keep an ear one inch (and not farther) from the victim's mouth and nose.

In the absence of spontaneous efforts, rescue breathing via a mouth-to-mask apparatus, bag-valve-mask device ("Ambu bag"), or positive pressure oxygen mask must be initiated with two full and complete ventilations, with the victim's chest rising with each breath. Mouth-to-mouth ventilation can also be employed, but it is difficult to imagine any dental health professional wanting to perform mouth to mouth ventilation on a patient during a typical dental procedure. Ventilation with a mask is more esthetic and sanitary. Education in ventilation with mask can be obtained through the American Heart Association or American Red Cross Healthcare Provider courses or through continuing dental education courses sponsored by dental schools or societies.

In the presence of spontaneous respiratory efforts, it is critical to assess whether air is actually being exchanged. When exchanged air is felt and heard by the rescuer, it is necessary only to maintain head tilt-chin lift to



provide a patent airway for the victim, permitting him or her to breathe. When respiratory efforts are present but air is not felt, the airway must be repositioned and evaluated again.

Oxygen may be administered to the patient once it becomes available.

### *Circulation*

Following successful completion of airway and breathing, circulatory function is assessed. In the conscious patient, it is obvious that circulatory function is at least adequate. Blood pressure will be high enough to provide adequate blood flow to the cerebral circulation, thus permitting the patient to retain consciousness.

With the unconscious patient, it is necessary to palpate a central artery to assess circulatory function. In adults and children, the carotid artery is palpated for not longer than 10 seconds while head tilt is maintained. As soon as the pulse is detected, the rescuer can proceed to the next step in management. When, however, no pulse is palpable in this 10 second period, it is necessary to quickly perform two important functions: call for help and have EMS (911) activated, and initiate closed chest cardiac compressions.

### *Definitive Management*

Position, airway, breathing and circulation, the steps of basic life support, are employed to ensure oxygenation of the victim's blood and that blood is circulating to the brain. In many of the psychogenically induced emergencies encountered in dentistry, the victim recovers within seconds to minutes of these steps being successfully completed (e.g., vasodepressor syncope [common faint]).

However other situations exist in which additional management will be necessary for the patient to recover from the emergency situation.

Definite management consists of those steps required to bring the victim back to the state of normalcy that existed prior to the emergency occurring. Definitive management of a medical emergency in the dental situation may entail either one or both of the following steps: activation of emergency medical services or the administration of drugs.

### **Types of Emergencies**

#### *Altered Consciousness*

#### **Vasodepressor Syncope (common faint)**

**Typical scenario: Adolescent male fearful of injections sitting slightly reclined in the chair of a female doctor, about to receive an intraoral**

**injection of local anesthetic. As the injection is delivered he appears pale, diaphoretic and slumps in the chair, nonresponsive.**

**Management: Recognition: Patient does not respond to "shake and shout" technique. Position: Supine with feet elevated slightly. Airway: head tilt-chin lift must be done. Breathing: "Look, listen and feel" indicates that satisfactory respiration is present. Circulation: Palpation of carotid pulse. Pulse is present, rate of 25/minute. Definitive management: Oxygen, aromatic ammonia (if available). Aromatic ammonia vaporole is crushed in fingers and held beneath nose of victim.**

**Likely outcome: Patient regains consciousness within 10-15 seconds of positioning and airway management.**

**Need for EMS: Unlikely.**

**Drugs required: Oxygen, aromatic ammonia (optional).**

**Dental care: Terminated, patient escorted home by adult companion following recovery since it takes almost 24 hours for the body to fully recover from an episode of vasodepressor syncope.**

### **Hypoglycemia**

**Typical scenario: 35-year-old male with a history of Type 1 diabetes (insulin-dependent diabetes mellitus) scheduled for an early morning appointment for root planning and curetage. Patient awakens late and after taking insulin injection leaves for dental appointment without eating breakfast. Seated in dental chair one hour later, the patient becomes diaphoretic, cold, exhibits a slight tremor of the extremities, and becomes mentally disoriented. Is unable to respond rationally to questions from the dentist.**

**Management: Recognition of hypoglycemia: Diabetic patient appears cold, sweaty, shay and mentally disoriented. Position: Comfortable, most likely somewhat elevated. Airway: OK, not necessary to maintain. Breathing: OK, not necessary to ventilate. Circulation: Palpation of carotid pulse, pulse is present. Definitive management: "Sugar" orally, orange juice or cola beverage containing sugar, about 4 ounces are administered. Oxygen may be administered.**

**Likely outcome: Patient rapidly (within about five to 10 minutes) returns to a normal level of CNS function.**

**Need for EMS: Unlikely.**

**Drugs required: "Sugar," oxygen.**

**Dental care: May continue if both doctor and patient consent.**

## ***Convulsions***

### **Generalized Tonic-Clonic Seizures**

**(GTCS, Grand Mal Seizure)**

**Typical scenario:** Epileptic with history of fairly well-controlled grand mal seizures who is also a dental phobic is about to receive a local anesthetic injection when he arches his back and becomes rigid for about 10 seconds (tonic phase of seizure). He then begins to exhibit alternating muscle contractions and relaxations (clonic phase of the seizure).

**Management during tonic-clonic seizure:** Recognition of seizure: Patient arches his back becoming rigid, followed by a period of alternating muscle contraction and relaxation. Position: Supine with feet elevated slightly. Airway: Head tilt-chin lift may be performed but is not always necessary. Breathing: "Look, listen and feel" determines that satisfactory respiration is present. Circulation: palpation of carotid pulse, a strong pulse is present, rate of 110/minute. Definitive management: Activate EMS immediately. Protect the victim's arms and legs from injury during the seizure by gently holding them and allowing movement within limits. Do not restrain the patient from moving at all, as this increases the likelihood of injury. *Do not attempt to place anything into the mouth of the seizing victim.* Seizures usually terminate spontaneously within two to five minutes.

**Management during the post-seizure phase:** Recognition: patient stops convulsing and becomes immobile and non-responsive. Position: Supine with feet elevated slightly in dental chair: supine on left side if on floor. Airway: Head tilt-chin lift are usually necessary, if snoring is present. Breathing: Spontaneous ventilation is usually present. Snoring may be heard if the airway is not adequately maintained. Reposition the airway if snoring develops. Circulation: Palpation of carotid pulse, pulse is present. Definitive management: The postseizure patient is usually deeply "asleep" (hard to arouse, normal physiologic sleep). Talk to patient in an effort to orient him to space (tell him where he is) and time (what day it is). Tell him that he had a seizure, is in the dental office and that everything is OK. If parent or guardian of patient is present, have that person talk to patient.

**Likely outcome:** Post-seizure patient slowly becomes oriented to space and time. Hospitalization by EMS usually occurs when patient is not oriented to space and time. Most epileptic patients will be able to leave the office in the custody of an adult guardian without the need for hospitalization. Patients suffering first seizures will almost always require a period of hospitalization.

**Need for EMS:** Epileptic patient: determine the need for EMS prior to first treatment of patient. In many cases, this step will not be necessary.

However, in a patient who has no history of prior seizure activity and in the epileptic patient where a seizure lasts for more than five minutes or where the seizure ends but recurs before the patient fully recovers (both are examples of status epilepticus, a life-threatening situation), emergency care should be sought immediately.

**Drugs required:** Oxygen, usually during the postseizure phase. Intravenous anticonvulsants administered by EMS if the status epilepticus develops.

**Dental care:** Terminated.

### *Respiratory Distress*

#### **Bronchospasm**

**Typical Scenario:** A 15-year-old female asthmatic is to receive a local anesthetic injection. During the injection, she abruptly sits up, grabbing at her neck and begins to breathe with deep respirations.

**Management:** Recognition of bronchospasm: dyspnea (difficulty breathing), wheezing, use of accessory muscles of respiration (neck, back, abdominal), diaphoresis, cyanosis of mucous membranes (if severe). **Position:** Comfortable, most likely upright. **Airway:** OK, not necessary to maintain. **Breathing:** OK, wheezing usually present, but it is not necessary to ventilate. **Circulation:** Palpation of carotid pulse, pulse is present. **Definitive management:** Hand patient bronchodilator and have her self-administer her usual dose (usually one to two inhalations/dose). Oxygen may be administered. Patient should be removed from stressful environment, i.e., operatory, if possible.

**Likely outcome:** Bronchospasm is relieved shortly (approximately 15 seconds) following the administration of the appropriate dose of bronchodilator. Permit patient to medicate herself a second time, if necessary.

**Need for EMS:** Not if bronchospasm is relieved with one to two doses. When two doses of bronchodilator fail to alleviate bronchospasm (status asthmaticus) or when asthmatic patient requests medical assistance, EMS should be activated immediately.

**Drugs required:** Bronchodilator, oxygen.

**Dental care:** May proceed if both doctor and patient consent.

### *Drug-related Emergencies*

#### **Allergy, Non-Life-Threatening**

**Typical Scenario:** A 26-year-old female with mitral valve prolapse with regurgitation enters office 45 minutes after taking 3 grams of amoxicillin. She is flushed, has small skin eruptions, and complains to the receptionist of itching so severe that "my skin feels like it is burning." There is no prior history of any adverse drug reaction.

**Management: Recognition of allergy:** Allergy is recognized by the presence of a skin reaction consisting of urticaria, pruritis and erythema (itching, hives and rash). More severe allergic reactions may involve stimulation of exocrine glands, producing watery eyes, a running nose and gastrointestinal upset (cramping); respiratory involvement consisting of bronchospasm, noted by difficulty breathing and wheezing; and/or cardiovascular involvement, manifested by vasodilation which, if severe, may lead to hypotension and the loss of consciousness. An allergic reaction is considered life-threatening when it involves either breathing and/or the cardiovascular system (the anaphylactic reaction). **Position:** Comfortable, as patient is conscious. **Airway and breathing:** Assess by asking patient if she has any difficulty breathing. If the dentist is trained, he or she should auscultate (listen to) the patient's lungs and listen for wheezing. In absence of respiratory difficulty, ventilatory assistance is not necessary. **Circulation:** Monitor blood pressure and heart rate to determine if cardiovascular system is affected, vasodilation produces hypotension and tachycardia. Can also speak with patient to determine her mental status. In presence of hypotension, patient will feel "faint," "lightheaded," "dizzy." In absence of CVS involvement, patient may be maintained in comfortable position. **Definitive management:** Oxygen may be administered, however it is important to manage the signs and symptoms of allergy immediately and aggressively. In the situation described of a systemic skin reaction the following is recommended:

- Administer histamine-blocker (diphenhydramine 50mg) IM (mid-deltoid or vastus lateralis) or IV.
- Observe patient for at least one hour to ensure that signs & symptoms resolve and do not become increasingly severe (respiratory and/or CVS involvement).
- Prescribe oral histamine-blocker for three days following consultation with patient's physician.

**Likely outcome:** Skin discomfort resolves within five minutes following intravenous histamine-blocker, within 10 to 30 minutes after IM histamine-blocker. Following observation for one hour, oral histamine-blockers are required to maintain relief from the pruritis and to prevent a relapse, which could occur up to 72 hours later.

**Need for EMS:** Unlikely; however, if in the opinion of the treating dentist it is felt to be prudent, then EMS or other emergency personnel should be summoned.

**Drugs required: Histamine-blocker, oxygen.**

**Dental care: Postponed. Prior to further treatment, an evaluation of the allergic response should be made and appropriate alternative drugs administered at subsequent dental visits.**

### **Allergy, Life-Threatening**

**Typical scenario: A 36-year-old male with known latex allergy is to receive a local anesthetic injection in the dental office prior to restorative treatment. Vinyl gloves are used by the doctor assistant. Within seconds of the administration of the local anesthetic, 2 percent lidocaine+epinephrine 1:100,000, the patient complains of severe difficulty breathing and lightheadedness. Within a minute, he becomes unresponsive.**

**Management: Recognition of allergy: More severe allergic reactions may involve stimulation of exocrine glands, producing watery eyes, a running nose and GI upset (cramping; respiratory involvement consisting of bronchospasm, noted by difficulty breathing and wheezing; and/or cardiovascular involvement, manifested by vasodilation which, if severe, may lead to hypotension and the loss of consciousness. An allergic reaction is**

#### **Medical Emergencies in the Dental Office**

**considered life-threatening when it involves either breathing and/or the cardiovascular system (the anaphylactic reaction). Position: Supine with feet elevated slightly. Airway and breathing: Head tilt-chin lift is necessary to maintain airway, followed by look, listen and feel to assess respiratory efforts are noted (look) and wheezing is heard (listen).**

**Circulation: The carotid pulse must be palpated. It is present, but is noted to be weak and rapid. The blood pressure is 80/40.**

**Definitive management: Emergency medical services is activated immediately. Oxygen may be administered as soon as available, but epinephrine must be administered immediately. The preloaded syringe provides an adult dose of 0.3 mg (0.3 ml) of a 1:1,000 concentration. It should be administered in the vastus lateralis or mid-deltoid, or sublingually into the floor of the mouth. Continue to administer BLS, as needed, and to monitor the patient. Epinephrine, 0.3 mg., is administered every five minutes as needed during the anaphylactic reaction. A histamine-blocker, such as diphenhydramine 50 mg., is administered IM following recovery of the patient; blood pressure increases, wheezing is replaced by normal breath sounds, and consciousness returns.**

**Likely outcome: BLS and epinephrine are essential for survival if anaphylaxis occurs. Multiple doses of epinephrine, given at five minute intervals, may be required to reverse the severe allergic reaction. Epinephrine must be administered in anaphylaxis without hesitation if the victim is to have a chance of survival. The histamine-blocker is**

administered, following clinical recovery of the patient, to minimize a recurrence of the cardiovascular and/or respiratory allergy and to help alleviate pruritis, if present. Histamine-blockers should never be administered in lieu of epinephrine during anaphylaxis.

**Need for EMS: Essential.** Upon arrival, an IV drip will be started and additional drugs, such as histamine-blockers and corticosteroids, will be administered. The anaphylactic victim will usually be hospitalized for a variable length of time to ensure complete recovery.

**Drugs required: Epinephrine, histamine-blocker, oxygen.**

**Dental care: Postponed.**

### **Local Anesthetic Overdose**

**Typical scenario:** Well-behaved 5-year-old male receives four cartridges of 3 percent mepivacaine for restorative dentistry in four quadrants. Ten minutes into the dental procedure, the patient becomes rigid for several seconds, then convulses for about 15 seconds. Several minutes later a second seizure occurs, lasting for 10 seconds.

**Management:** Recognition of local anesthetic overdose: generalized tonic-clonic seizure activity. **Position:** supine with feet elevated slightly. **Airway:** head tilt-chin lift necessary. **Breathing:** Look, listen and feel, spontaneous respiratory efforts observed with adequate exchange. **Circulation:** Palpation of carotid pulse, pulse is present, rapid and strong..

**Definitive management:** EMS is summoned immediately and BLS maintained. Protection of the seizing victim during the tonic-clonic phase is essential, with BLS being critical in the post-seizure period. The administration of oxygen is considered extremely important during the management of local anesthetic-induced seizures. If available, an IV line should be obtained and an intravenous anticonvulsant, such as diazepam or midazolam, titrated until the seizure is terminated.

**Likely outcome:** Local anesthetic-induced seizures will continue until the plasma level of the anesthetic agent in the cerebral circulation falls below the seizure threshold for that drug. As cerebral blood levels of local anesthetics rapidly decline (several minutes), local anesthetic-induced seizures will not be of long duration provided that the victim's ventilation is adequate. Acidosis, secondary to the retention of carbon dioxide and the production of lactic acid, lowers the local anesthetic seizure threshold, thereby prolonging the seizure. Adequate airway management with full and effective ventilation is of paramount importance to the full and complete recovery from local anesthetic-induced seizures.

**Need for EMS: Yes**

**Drugs required: Oxygen. Anticonvulsant administration is recommended only if the seizure continues or if repetitive seizures occur and if the doctor is knowledgeable in venipuncture, IV drug administration and the management of an unconscious, apneic patient.**

**Dental care: Terminated.**

### ***Chest Pain***

#### **Angina Pectoris**

**Typical scenario: Male, aged 55, with history of stable angina pectoris, complains of chest "pain" during the administration of an intraoral local anesthetic.**

**Management: Recognition of anginal pectoris: Patient, with a known history of angina, is familiar with clinical signs and symptoms. Frequently described as a tightness, heaviness, constricting or a burning sensation, in the substernal region. Position: Comfortable, most likely somewhat elevated. Airway and breathing: OK, not necessary to maintain. Circulation: Patient is conscious. Palpation of carotid pulse, pulse is present. Definitive management: Oxygen may be administered, but the anginal patient will want his nitroglycerin. Use the patient's own nitroglycerin initially, permitting the patient to dose himself. Anginal pain subsides within one to two minutes. If the episode does not terminate, use the translingual nitroglycerin spray from the emergency kit. Administering the same dose.**

**Likely outcome: signs and symptoms of angina rapidly resolve with administration of nitroglycerin and do not return.**

**Need for EMS: Unlikely, unless patient requests medical assistance.**

**Drugs required: Nitroglycerin, oxygen**

**Dental care: May continue if both patient and doctor consent. Determine the cause of the anginal episode before recommencing the dental care. Treatment modification may be made in order to prevent repeat anginal episodes.**

#### **Myocardial Infarction**

**Typical scenario: Middle-aged male with no prior history of cardiovascular problems complains of a crushing sensation in his chest during dental treatment. He also describes a "tingling" sensation running down his left arm toward his fingers. He is quite concerned, is breathing rapidly, is diaphoretic and his facial color has changed somewhat, appearing almost ashen-gray.**



**Management: Recognition of myocardial infarction: chest "pain" occurring in the absence of a previous history should be considered as serious, potentially myocardial infarction. In addition, if a patient with an anginal history ever states that his or her discomfort is worse than usual, or if two doses of nitroglycerin fail to alleviate the discomfort, or if the "anginal" pain is relieved by nitroglycerin administration but returns, EMS should be summoned immediately. Position: Comfortable, most likely somewhat elevated. Airway and breathing: OK, not necessary to maintain circulation: Palpation of carotid pulse, pulse is present, but may be irregular. Definitive management: Activate EMS immediately, stating that a suspected myocardial infarction is in progress. Oxygen should be administered. Nitroglycerin, two translingual sprays, may be administered to determine if the episode is anginal or a myocardial infarction. Symptomatic management is indicated. For example, if the patient feels cold, blankets should be applied. Have the victim chew one aspirin tablet (81 mg or 325 mg) and permit it to dissolve in his mouth and be absorbed transmucosally. It should not be swallowed. Recent studies have demonstrated that ASA has a thrombolytic effect that is extremely beneficial during MI. To manage the pain of an MI administer, if available, 3.5 liters per minute nitrous oxide and 6.5 lpm oxygen. Monitor and record vital signs. Prepare (psychologically) to manage cardiac arrest.**

**Likely outcome: Hopefully emergency care arrives while the patient maintains consciousness. An IV will be established, the EKG monitored and appropriate drugs administered to stabilize the patient, who will then be transferred to a hospital for definitive management. Most deaths from myocardial infarction occur during the initial two hours following coronary occlusion and are due to ventricular dysrhythmias (ventricular fibrillation, ventricular tachycardia). Dental office personnel must be prepared to manage this occurrence should the patient lose consciousness, cease breathing and have no palpable carotid pulse.**

**Need for EMS: Essential.**

**Drugs required: Oxygen, nitroglycerin, aspirin.**

**Dental treatment: Terminated.**

## **REFERENCES**

- 1. Fast TB, Martin MD and Ellis TM, Emergency preparedness: a survey of dental practitioners. *J Amer Dent Assoc* 112:499-501, 1986.**
- 2. Malamed SF, Managing medical emergencies. *J Amer Dent Assoc* 124:40-53, 1993.**

3. Matsuura H, Analysis of systemic complications and deaths during dental treatment in Japan. *Anesth Prog* 36:219-228, 1990.
4. Pallasch TJ, This emergency kit belongs in your office. *Dental Management*, Aug 1976, pp 43-5.
5. Malamed SF, Handbook of medical emergencies in the dental office, 4 ed 1993, CV Mosby Co, St. Louis.
6. Council on Dental Therapeutics, Emergency kits. *J Amer Dent Assoc* 87:909,1973.

## **EMERGENCY MEDICINE: Beyond The Basics**

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### **ABSTRACT**

*Medical emergencies can arise in the dental office. Preparedness for these emergencies is predicated on an ability to rapidly recognize a problem and to effectively institute prompt and proper management. In all emergency situations, management is based on implementation of basic life support, as needed. The author describes the appropriate management to two common emergency situations: allergy and chest pain.*

**Medical emergencies can, and do, happen in the practice of dentistry. I have used that statement at the start of hundreds of lectures and numerous papers on the subject of emergency medicine as it relates to the practice of dentistry. Surveys have validated the truth of this statement, as have published case reports in the dental literature.<sup>1-8</sup>**

**It is inconceivable that a dentist or any member of a dental office staff would deign to treat the health care needs of another human being without having both the knowledge and the ability to manage any foreseeable emergency or complication that might arise as a result of**

their treatment or coincident with it. Yet, in many parts of the United States and many other countries, very few dentists have the necessary knowledge of basic life support and emergency preparedness.

In the preceding article,<sup>2,9</sup> I have reviewed the essentials—the basics—of emergency preparedness and management of emergency situations in the dental environment. Preparedness for medical emergencies is predicated on an ability to rapidly recognize a problem and to effectively institute prompt and proper management. In all emergency situations, management is based on implementation of basic life support, or BLS, as needed. The box "Preparation for Medical Emergencies" presents a summary of the steps recommended for emergency preparation.

Basic life support position, airway, breathing and circulation, a sequence abbreviated as P,A,B,C—is provided, as needed, to ensure that the victim's brain is receiving an adequate supply of well-oxygenated blood. Only the necessary steps are provided:

- ☐ P alone in many situations;
- ☐ P + A when airway maintenance is necessary (as in vasodepressor syncope, or common faint);
- ☐ P + A + B when the victim is apneic;
- ☐ P + A + B + C in the unlikely event of cardiac arrest.

## **PREPARATION FOR MEDICAL EMERGENCIES**

### **PROVISION OF BASIC LIFE SUPPORT, OR BLS**

**How:** Completion of Healthcare Provider course offered by the American Heart Association or Professional Rescuer course offered by the American Red Cross

**When and where:** Annually, in dental office

**Who:** All office personnel should be certified

**What must be acquired:** Ability to ventilate with a mask

### **Responsibilities of In-office emergency Team**

#### **Member No. 1**

**Stay with victim**

**Administer BLS as necessary**

**Activate in-office emergency response**

#### **Member No. 2**

**Obtain emergency drug kit and oxygen cylinder and bring to site of emergency**

**Member No. 3**

**Assist as necessary:**

- **Activate emergency medical service, or EMS**
- **Assist with two-person cardiopulmonary resuscitation, or CPR**
- **Prepare emergency drugs**
- **Monitor vital signs**
- **Meet EMS and escort to office (hold elevator for immediate use)**

#### **OBTAINING EMERGENCY ASSISTANCE**

**When: As soon as it is thought necessary—DO NOT HESITATE**

**Who: Emergency medical services (reached by calling 9-1-1 or other appropriate number); nearby medical or dental professional if he or she is well-trained in emergency management (for instance, an oral and maxillofacial surgeon)**

#### **EMERGENCY DRUGS AND EQUIPMENT TO HAVE AVAILABLE**

**Injectable drugs**

**Epinephrine 1:1,000 preloaded syringe + 2 x 1-milliliter ampules**

**Histamine blocker (for example, diphenhydramine 50 mg/mL) 2 x 1-mL ampules**

**Noninjectable drugs**

**Vasodilator (nitroglycerin spray [Nitrolingual spray, Rorer Pharmaceuticals])**

**Bronchodilator (for example, albuterol [Proventil, Schering; Ventolin, Glaxo])**

**Antihypoglycemic agent (for example, orange juice, soft drinks)**

**Oxygen (E"-cylinder + delivery system)**

## **Emergency Equipment**

**Oxygen delivery system**

**Pocket mask (to provide 16 percent oxygen)**

**Bag-valve-mask device (to provide 21 percent oxygen)**

**Positive pressure/demand valve (to provide 100 percent oxygen)**

**Plastic, disposable syringes: 2 x 2 mL with 18- or 20-gauge needle**

**Magill intubation forceps**

**Tourniquets (minimum of two)**

***Based on information from Malamed<sup>2</sup> and Fisher.<sup>11</sup>***

**Sometimes the BLS formula is augmented by D, which stands for definitive care. This entails diagnosis of the problem and its treatment. In the dental office environment, this will entail possible drug administration and/or activation of emergency medical services (by calling 9-1-1 or another appropriate number).**

**In this article, I will describe two common emergency situations: allergy and chest pain. The discussion will be in considerably greater detail than provided in the previous article so that the reader may more fully appreciate the reasoning behind the indicated steps in the management of these problems.**

## **Allergy**

**Allergic reactions are among the more common emergencies seen in dentistry. A survey of 4,309 dentists in North America reported a total of 30,602 emergency situations, including 2,583 reports of "mild" allergy and 304 of anaphylaxis<sup>2</sup>.**

**Allergy may be defined as a hypersensitive state acquired through exposure to a particular allergen, re-exposure to which produces a heightened capacity to react.<sup>10</sup> An allergic reaction therefore represents an exaggerated response to a substance—an allergen—it considers foreign to the body. The box "Common Allergens in Dentistry" lists allergens commonly encountered in dentistry.**

**On exposure to an allergen, cell walls of previously sensitized tissue mast cells and circulating basophils are lysed, releasing into the tissues the chemical mediators of allergy (Box, "Chemical Mediators of Allergy"), the foremost among which is histamine. The intensity and location of an allergic reaction will correspond to the site(s) of release of**

these mediators, the rate at which they are released and the quantities released.

## Common Allergens In Dentistry

### Antibiotics

- Penicillins\*
- Cephalosporins
- Tetracyclines
- Sulfonamides\*

### Analgesics

- Acetylsalicylic acid (aspirin)\*
- Nonsteroidal anti-inflammatory drugs

### Local Anesthetics

- Esters\*
- Procaine
- Propoxycaine
- Benzocaine
- Tetracaine

### Preservatives

- Parabens (methylparaben)\*
- Bisulfites, metabisulfites\*

### Other Allergens

- Acrylic monomer (methyl methacrylate)
- Latex\*

\*Common allergen

When viewed as an emergency, two major categories of allergy may be discerned: the delayed-onset, mild, non-life-threatening reaction and a more acute, life-threatening systemic allergic reaction termed "anaphylaxis." Mild allergy occurs more commonly than systemic life-threatening allergy—and happily so, for the latter reaction represents one of the most frightening emergency situations faced by health professionals.

Delayed reactions—localized. Allergic skin reactions appearing a considerable time after antigenic exposure (60 minutes or more) that do not progress may be considered as non-life-threatening. These include a mild, localized skin reaction or localized mucous membrane reaction after application of topical anesthetics such as benzocaine. Virtually all

allergic reactions to benzocaine are localized to the area of drug application. As benzocaine is not water-soluble, it is not absorbed into the cardiovascular system, minimizing the risk of a systemic allergic reaction's developing after its application.<sup>11</sup>

Diagnostic clues to the presence of an allergic skin reaction include hives, itching, edema and flushed skin.

#### *Management of delayed onset, localized allergic skin reaction*

**P**—Position the victim comfortably. An upright or erect position is usually preferred.

**A, B and C**—These are assessed but need not be implemented in this conscious patient.

**D**—Definitive care for the localized allergic skin reaction is the administration of an oral histamine blocker for 3 days (for example, diphenhydramine hydrochloride administered four times a day in doses of 50 milligrams for 3 days). A 3-day regimen is recommended, as the half-life of some of the chemical mediators of allergy is quite long. The symptom of itching will usually be alleviated within an hour after the initial histamine-blocker dose, but a continuing regimen is necessary to completely resolve the allergic reaction.

**Delayed reactions \_systemic.** An allergic skin reaction may also be systemic. This is likely after exposure to an allergen (such as penicillin, shellfish or peanuts) that is ingested and absorbed into the cardiovascular system of a previously sensitized person, provoking histamine release from multiple sites throughout the body. In a typical scenario, patients requiring antibiotic prophylaxis appear in the dental office 45 minutes after ingesting their penicillin dose. They appear flushed, exhibit hives and complain of intense itching all over their bodies.

#### *Management of delayed onset, systemic allergic skin reaction*

**P**—Position the victim comfortably. An upright or erect position is usually preferred.

**A, B and C**—These are assessed but need not be implemented in this conscious patient.

**D**—Definitive care for this systemic allergic skin reaction also involves histamine-blocker administration, after the clinician determines that the allergic response does not yet involve either the respiratory or cardiovascular, or CV, systems.

The clinician may determine the patient's respiratory or CV system involvement simply by speaking with him or her. Allergic respiratory involvement is noted by bronchospasm, a narrowing of the lumen of bronchioles, leading to a significant increase in the work of breathing. If the patient is able to breathe normally and comfortably, bronchospasm is not present. An additional clue to bronchospasm may be the presence of audible wheezing. Vasodilation occurs with cardiovascular involvement, leading to a drop in blood pressure, or hypotension, producing alterations in consciousness—dizziness, feeling of faintness, or loss of consciousness—if significant. The clinician may monitor the blood pressure (and compare it to pretreatment baseline vital signs, if available) and/or ask the patient how he or she feels.

If the allergic response involves either breathing or the CV system, it is deemed life-threatening and requires aggressive management. Management of this response will be addressed in the next section.

Where only skin is involved, but the reaction is systemic, definitive management is predicated on making the patient comfortable and minimizing the risk of the reaction's progressing to involve the respiratory or cardiovascular systems. Histamine blockers, such as diphenhydramine and chlorpheniramine, are the drugs of choice. However, owing to the greater degree of involvement produced by significantly increased levels of histamine (and other mediator) release, the oral route cannot be recommended. If available, intravenous administration of a histamine blocker is recommended. Relief (of itching) would occur within a period ranging from seconds to a few minutes. If the intravenous, or IV, route is unavailable, parenteral administration via the intramuscular route is preferred, using either the vastus lateralis (anterior and lateral thigh) or mid-deltoid sites.

Onset of action (relief of itching) would be noted within 10 minutes, with maximal effect developing within 30 minutes. Onset after oral administration is too slow (30 minutes, with peak effect in about 1 hour), given the severe nature of this response. If the dentist is uncomfortable administering an intramuscular, or IM, injection in this situation, outside assistance should be sought—from, for instance, emergency medical services, or EMS (by calling 9-1-1 or the appropriate number in the specific community), or an oral and maxillofacial surgeon—to administer the drug.

The dentist should permit the histamine blocker to work and then observe the patient for at least 1 hour before allowing him or her to leave the office. The patient should be allowed to leave only if the itching has resolved (the skin response will remain for several hours to days). The patient should not leave the office unescorted or operate a motor vehicle if a parenteral histamine blocker has been administered. Because histamine blockers are central nervous system, or CNS, depressants, sedation may occur, lessening the patient's ability to drive or perform tasks safely. A prescription for oral histamine blockers to be



taken for 3 days should be given to the patient on discharge from the office. (Examples of such drugs could include diphenhydramine, 50mg capsules, to be taken four times a day for 3 days, and chlorpheniramine, 4 mg, to be taken three to four times a day.)

**Immediate reactions.** Allergic reactions that develop within minutes of exposure to an allergen are more likely to become life-threatening, involving either the respiratory and/or cardiovascular systems. Anaphylaxis is acutely life-threatening, requiring immediate and aggressive management if the victim is to survive. Anaphylaxis is also termed "anaphylactic shock."

Anaphylaxis can result in death. In the United States, annual rates of death associated with anaphylaxis are approximately as follows,<sup>12</sup> according to cause:

- ❑ 500 people from penicillin anaphylaxis, most often after parenteral administration;
- ❑ 100 from stings of Hymenoptera (bees, wasps, yellow jackets, hornets);
- ❑ 25 from anaphylactic reaction to radiopaque contrast media used in angiography.

In addition, a number of deaths recently have been attributed to latex anaphylaxis among medical personnel and patients.<sup>13,14</sup>

The figure below presents the usual progression of the anaphylactic reaction. Deviations from this pattern are common, often involving only skin and respiratory systems, or skin and cardiovascular systems or the respiratory or cardiovascular systems alone.

Recognition and management must be immediate and aggressive. Death in anaphylaxis occurs where epinephrine is not administered or its administration is delayed. Survival is based on the prompt administration of epinephrine.

**Skin**

**Urticaria, pruritis, erythema, edema**



**Exocrine Glands, Intestinal Smooth Muscle**

**Tearing, increased serous nasal secretions, intestinal cramping, nausea**



## Respiratory System

### Bronchospasm



## Cardiovascular System

### Vasodilation (hypotension)

#### ***Management of immediate onset, systemic allergic reactions (anaphylaxis)***

**P**—Position the victim appropriately. An upright or erect position is usually preferred if the victim is conscious and respiratory distress is the primary component of the anaphylactic response. Where a significant cardiovascular response, such as hypotension, is present, the supine position with feet elevated 10 degrees is preferred to optimize cerebral perfusion.

**A, B and C**—These are assessed and implemented, as needed.

**D**—Definitive care in anaphylaxis consists of two phases, the acute phase (while the patient's life remains in jeopardy) and the recovery phase.

#### ***Acute phase management***

- Administration of epinephrine (Adrenalin) 1:1,000 in a dose of 0.3 mg IM every 5 minutes until recovery occurs (see below);
- immediate activation of EMS;
- administration of oxygen by means of nasal hood or face mask at a flow of 5 to 6 liters per minute, or L/min.

#### ***Recovery phase management***

- IM administration of histamine blocker;
- stabilization of patient by EMS personnel;
- establishment of intravenous access;
- administration of appropriate drugs: additional histamine blocker (IV); corticosteroid (IV);
- transportation to hospital for definitive care.

After attending to P,A,B,C and activating EMS, the dentist must administer epinephrine every 5 minutes until recovery. Recovery is

based on a reversal of the respiratory signs and symptoms (such as dyspnea and wheezing, labored breathing) and the cardiovascular signs and symptoms (such as hypotension).

Epinephrine is the most critical drug in management of anaphylaxis, as it reverses the two most life-threatening components of the reaction: vasodilation and bronchospasm.

Epinephrine has vasoconstricting and bronchodilating properties. The drug, in a dose of 0.3 mg (0.3 mL of a 1:1,000 concentration) is administered IM into the vastus lateralis or mid-deltoid muscle or, if appropriate, into the base of the tongue (sublingually) or the body of the tongue (intralingually). Fortunately, epinephrine has a rapid onset of action (if the blood pressure has not fallen), its clinical actions developing within several minutes. After epinephrine administration, BLS (P,A,B,C) is continued as needed, vital signs are monitored and, if necessary, epinephrine is readministered every 5 minutes. At 5 minutes, if hypotension or respiratory distress remains, epinephrine is readministered. This process is continued until all respiratory and cardiovascular signs and symptoms have been relieved. In most instances, multiple doses of epinephrine will be required as the "usual" therapeutic dose of epinephrine in anaphylaxis is 1.0 mg.<sup>8</sup> As epinephrine is a very potent drug and can produce adverse responses secondary to its potent CV system actions (in other words, the victim can survive the anaphylactic reaction only to succumb to epinephrine's excessive CV effects), epinephrine is administered to adults in increments of 0.3 mg until the desired clinical action is achieved.

After recovery (assuming emergency medical technicians have not yet arrived), it is important that a histamine blocker be administered. Administered IM, the histamine blocker serves two important functions: relief from the intense pruritis (itching) that usually accompanies anaphylaxis; minimizing the likelihood of a recurrence of the acute symptoms of anaphylaxis, as the short clinical duration of epinephrine leads to a reversal of its actions (vasoconstriction and bronchodilation) in approximately 10 minutes. A dose of 1 mL of histamine blocker is given to the adult patient (emergency drug dosages are presented in Table 1).

*On arrival of EMS personnel, IV access will be established and additional drugs administered. These will include additional histamine blockers and corticosteroids. After being stabilized, the patient will be transported to a hospital for definitive management. In many instances, a period of 2 to 3 days' hospitalization will be required for full recovery.*

## **Chest Pain**

Like allergy, chest pain is a clinical symptom commonly observed in dental office emergency situations, accounting for 2,552 reported cases

of angina pectoris and 289 cases of myocardial infarction in a dental office survey I conducted in 1992.<sup>2</sup>

Though many causes of chest pain exist, two occur most frequently: angina pectoris and acute myocardial infarction. There are also many recorded instances of noncardiac chest pain that are mistaken for true cardiac causes of pain.

Table 1

Dosages of injectable emergency drugs			
Patient	Age Range	Dose (mL)	Epinephrine 1:1,000 (mL)
Adult	> 9 years	1.0	0.3
Child	1 through 8 years	0.5	0.15
Infant	<1 year	0.25	0.075

Noncardiac vs. cardiac chest pain. Pain developing in the left sternal region is frequently thought by the sufferer to be of cardiac origin. Such pain is usually transitory and not associated with a cardiac etiology. In most such instances, the chest pain is a product of either gas, acute indigestion or skeletal muscle strain. It is important, however, to be able to distinguish between noncardiac and true cardiogenic pain. The box "Cardiac vs. Noncardiac Chest Pain" contrasts these two types of chest pain.

Cardiac VS. Noncardiac Chest Pain	
Cardiac Chest Pain	Noncardiac Chest Pain
• Sharp, knifelike	• Dull
• Stabbing sensation	• Aching
• Aggravated by movement	• Heaviness, oppressive feeling
• Present only with breathing	• Present at all times
• Localized (patient can point to one spot)	• Generalized (occurs over an area)

Angina pectoris vs. myocardial infarction. Angina pectoris is defined as a transient chest pain produced by exertion, emotion or stress, and is relieved by either rest or the administration of nitrates.<sup>15</sup> Acute anginal episodes develop when the myocardium needs more oxygen than the coronary arteries are able to provide. In the first six of the common etiologies of angina presented in the box "Etiology of Acute Anginal Episodes," the heart's workload is increased, while in the last three

etiologies the amount of oxygen carried by the blood is diminished. Increased cardiac workload or decreased oxygen delivery to the myocardium produces an imbalance in the amount of oxygen required by the myocardium and the amount it is receiving. In this situation, ischemic cardiac pain develops and will persist until the imbalance is rectified. Once the acute anginal episode is terminated, the myocardium returns to a normal state of functioning. No permanent damage occurs.

ETIOLOGY OF ACUTE ANGINAL EPISODES
Physical activity
Hot, humid environment
Cold weather
Emotional stress (argument, anxiety or sexual excitement)
Caffeine ingestion
Fever, anemia or thyrotoxicosis
Cigarette smoking
Smog
High altitudes

The most common cause of a myocardial infarction is the formation of a blood clot (thrombus) in a coronary artery. Blood flow through the artery is curtailed, leading to an acute ischemic event that is similar, initially, to angina except that it is of considerably greater duration. Ischemic myocardium ceases to function normally (in a coordinated, synchronized manner), which results in the development of acute dysrhythmias and impaired cardiac function (decreased cardiac output, hypotension). Unless the thrombus is removed and the myocardium revascularized promptly, myocardial death will occur. Most survivors of myocardial infarction will demonstrate diminished cardiac function as a result of the permanent damage done to their heart.

**Angina pectoris.** Most anginal patients have what is termed "stable" angina. There is a constancy to their angina: frequency, type and location of discomfort and response to nitroglycerin.<sup>16</sup> Patients with angina should be contacted before each appointment and reminded to have nitroglycerin available during their dental treatment. In a dental care environment, anginal episodes may be produced by anxiety or sudden, unexpected pain, both of which cause an increase in cardiac workload. Prevention of anginal episodes is best achieved through adequate local anesthesia and the recognition and management of dental fears.

In response to fear or pain, cardiac workload increases and an acute anginal episode develops. The patient with a history of angina will usually stop the doctor and say, "I am having an anginal attack."

*Management of angina pectoris*

**P—Position the victim comfortably. An upright or erect position is usually preferred by the patient experiencing anginal pains.**

**A, B and C—These are assessed but need not be implemented in this conscious patient.**

**D—Definitive care of an acute anginal episode involves relieving the imbalance between myocardial oxygen need and myocardial oxygen delivery.**

**Permit the patient to administer a dose of his or her nitroglycerin, which most frequently is in the form of sublingual tablets. A dose may be from one to four tablets. Placed under the tongue, nitroglycerin is rapidly absorbed into the CV system, providing relief of anginal pain in 1 to 2 minutes.**

**Oxygen may also be administered, but virtually all anginal patients, given a choice between oxygen and nitroglycerin, prefer nitroglycerin because it acts more quickly to relieve their discomfort. Administer oxygen via nasal hood or face mask at a flow rate of about 5 to 6 L/min.**

**Permit the patient to recover. After recovery, dental care may be continued, provided that both the patient and the doctor agree that it is appropriate. Before recommencing treatment, determine why the episode occurred and take steps to prevent it from recurring.**

***Possible patient responses to nitroglycerin administration.* There are a number of possible responses to the administration of nitroglycerin.**

- As described above, the most common response is for the anginal discomfort to be quickly relieved (1 to 2 minutes).**
  
- It is also possible for the patient's sublingual nitroglycerin tablets to fail to alleviate the discomfort. This is not an uncommon problem, as the shelf life of an opened bottle of nitroglycerin tablets is quite short (3 to 4 months in a nonairtight container) and patients normally have multiple open bottles of nitroglycerin available (in their office, home, car, coat pocket or pants). When a patient's dose of medication fails to relieve his or her discomfort within 2 minutes, a second dose of nitroglycerin is administered, this time using the metered aerosol spray from the dental office emergency kit. If the discomfort is alleviated in this way, the patient should be instructed to procure a new supply of nitroglycerin as quickly as possible.**
  
- Nitroglycerin fails to alleviate the discomfort and a subsequent dose of the metered aerosol spray likewise fails to provide relief. EMS should be summoned promptly, as there is an increased likelihood that the problem at hand is myocardial infarction, not angina.**

- The nitroglycerin dose alleviates the discomfort in 1 to 2 minutes, but the discomfort returns. In this situation, the likelihood is also great that the cause of the chest discomfort is not angina but is a myocardial infarction (see below).

Chest pain, no previous history of angina. In this scenario, a presumably healthy patient with no history of cardiac problems complains of chest discomfort during a dental procedure. A significant difference between this patient and the patient known to have angina is the degree of panic expressed by this patient, who is convinced that he or she is having a heart attack.

Even though it is most likely that this episode is produced by either acute anxiety or is an anginal attack (induced by the patient's acute anxiety), the possibility does exist that a myocardial infarction might be occurring. As there is no history of cardiac disease and because the patient is extremely apprehensive about his or her condition, it is prudent to activate EMS as soon as is possible.

#### *Management of first episode of chest pain*

**P**—Position the victim comfortably. An upright or erect position is usually preferred by the conscious patient complaining of chest pain.

**A, B and C**—These are assessed but need not be implemented in this conscious patient.

**D**—Definitive care of an initial episode of chest pain involves activating EMS and attempting to treat the most likely cause of the problem, as outlined below in steps 1 through 6.

**Note:** Steps 1 through 3 are considered the minimum acceptable treatment for this patient.

1. Activate EMS immediately.

2. Administer oxygen using a nasal cannula, nasal hood or face mask at a flow of 5 to 6 L/min.

3. Monitor and record vital signs (blood pressure, heart rate and rhythm, respiratory rate).

4. Administer nitroglycerin translingually (a dose of 2 sprays on the tongue). Nitroglycerin is the drug of choice in the definitive management of anginal discomfort. The overwhelming likelihood in this situation is that the cause of the discomfort is angina, not a myocardial infarction. Administration of nitroglycerin and the patient's response aid in definitive diagnosis of the problem.

5. Administer analgesic if discomfort is not alleviated (see following section on myocardial infarction for discussion).

6. Administer aspirin (81 mg) if discomfort is not alleviated (see following section on myocardial infarction for discussion).

*On arrival of EMS personnel, the patient will be monitored (by means of vital signs and an echocardiogram), IV access established and additional drugs administered (these might include oxygen and intravenous analgesics, if the pain has not ceased). The patient will usually be transported to a hospital for a more complete evaluation to determine the cause of the chest pain.*

**Myocardial infarction. Myocardial infarction, or MI, is a clinical syndrome stemming from a deficient coronary arterial blood supply to a region of myocardium that results in cellular death and necrosis. The syndrome is usually characterized by severe and prolonged substernal pain similar to, but more intense and of longer duration than that of angina pectoris.**

In most cases, myocardial infarction is not precipitated by the dental care but is simply the clinical manifestation of a blood clot forming in a coronary artery that is already partially obstructed with atherosclerotic plaque. Emotional stress is felt to be a precipitating factor in some cases.<sup>17</sup> Patient activity at the onset of clinical signs and symptoms of myocardial infarction are presented in Table 2.<sup>18</sup>

Table 2

PATIENT ACTIVITY AT THE ONSET OF CLINICAL SIGNS AND SYMPTOMS OF MYOCARDIAL INFARCTION, OR MI.*	
Activity	Percentage of Patients Engaged In Activity At Onset of MI
At rest	51
Modest or usual exertion	18
Physical exertion	13
Sleep	8
Surgical procedure	6
Other	4

\*Based on data from Alpert and Braunwald.<sup>18</sup>

Myocardial ischemia ensues, leading to the onset of clinical signs and symptoms. Pain is experienced in 80 percent of MIs. The pain builds rapidly to maximal intensity, lasting for prolonged periods (30 minutes to several hours) if unmanaged. The pain is usually described as a pressing or crushing sensation, like a deep ache within the chest. Rarely is the pain described as sharp or stabbing. It is located over the middle



to upper one-third of the sternum and, much less commonly, over the lower third of the epigastrium.

Unfortunately, when the pain of acute MI occurs in the epigastrium and is associated with nausea and vomiting, the clinical picture may easily be confused with that of acute gastritis, cholecystitis or peptic ulcer. Rest does not reduce the pain, nor does the use of nitroglycerin. The pain of myocardial infarction is most effectively relieved through the administration of opioids such as morphine. Radiation of pain occurs throughout the same pattern as that of angina.

The patient with acute myocardial infarction may appear to be in acute distress. A cold sweat is usually present, and the patient feels quite weak. The patient appears apprehensive and expresses an intense fear of impending doom. Although "intense fear of impending doom" may appear to the reader to be an overly dramatic and silly statement, rest assured that many victims of MI do indeed report this feeling. In contrast to anginal patients who lie, sit or stand still, realizing that any activity will increase the discomfort of angina, patients with acute myocardial infarction are often restless, moving about in a futile attempt to find a comfortable position for themselves. They may clutch at the chest with a fist—the Levine sign (a sign of ischemic pain first brought to widespread recognition by cardiologist Dr. Samuel A. Levine). Dyspnea is usually present, with the patient complaining that the crushing pressure on the chest prevents normal breathing. Respiratory movements do not intensify the painful sensation. Nausea and vomiting frequently occur, especially if the pain is severe.

In the absence of definitive signs and symptoms of allergy (wheezing, skin reaction), it is imperative that epinephrine not be administered. If there is any doubt as to the etiology of respiratory distress, epinephrine should not be administered. Given to a patient suffering an acute MI, epinephrine could severely aggravate the symptoms.

Probably the most threatening feature of the early post-infarction period (the first 1 to 2 hours) is the development of cardiac dysrhythmias. Most patients—95 percent of those experiencing MIs—exhibit abnormalities in heart rhythm. They are significant in that they may produce alterations in the normal sequence of atrial and ventricular contraction, leading to diminished cardiac output, and/or they may produce an aberrant focus of electrical depolarization in the myocardium. They also may adversely affect the ventricular rate, producing one of the following:

- ❑ bradycardia, or slow heart rate;
- ❑ ventricular tachycardia, or an extremely rapid contraction rate with insufficient time for ventricular filling (a rhythm that might be cardiac arrest);
- ❑ ventricular fibrillation, or irregular, uncoordinated, ineffective contraction of individual muscle bundles (a form of cardiac arrest);
- ❑ asystole, or complete absence of contractions (a form of cardiac

arrest).

Death occurring in the early postinfarction period, although it may be produced by the infarction of a large mass of myocardium, is normally the result of an acute dysrhythmia.

Myocardial infarction and cardiac arrest are not the same. Cardiac arrest is a potential complication of a myocardial infarction, and it can occur without myocardial infarction.

A patient with a history of stable angina will know when his or her pain is not anginal. An episode of chest pain in a patient with no history of cardiovascular disease should always be considered a myocardial infarction and managed as such initially. In addition, any patient receiving nitroglycerin for chest pain where the pain is resolved and then returns (while the patient is still in the dental office) should be managed as though it, too, were a myocardial infarction.

#### *Management of myocardial infarction*

**P**—Position the victim comfortably. As the patient suffering an acute MI is conscious and complaining of severe discomfort in the chest (and/or other areas), the upright or erect position is usually preferred.

**A, B and C**—These are assessed and need not be implemented in this conscious patient.

**D**—Definitive care of a suspected acute myocardial infarction victim involves several important basic steps and a number of additional steps:

1. Activate EMS immediately.
2. Administer oxygen via nasal cannula, nasal hood or face mask at a flow of 5 to 6 L/min.
3. Monitor and record vital signs every 5 minutes (blood pressure, heart rate and rhythm).

These steps increase the delivery of oxygen in the patient's blood to the cells in the body. The brain will receive additional oxygen, perhaps alleviating some of the feeling of lightheadedness or nausea that might be present. Mucous membranes "pink up," and the cyanotic hue disappears. Oxygen, however, is not an analgesic drug. The pain the patient is experiencing becomes progressively more intense and may seriously compromise him or her. Therefore, in the absence of emergency medical technicians, there are several additional steps that could—indeed, should—be considered in the prehospital management of this patient.

**4. Manage the pain.** Traditionally, as recommended in advanced cardiac life support, or ACLS, venous access is obtained and 2 to 5 mg of morphine sulfate is administered every 5 to 30 minutes.<sup>20</sup> In the absence of ACLS, nitrous oxide and oxygen serve as an excellent alternative. It is estimated that 35 percent of dental practices in the United States have N<sub>2</sub>O-O<sub>2</sub> available. In many countries, and in areas of the United States, emergency medical services employ a premixed combination of either 35 percent or 40 percent nitrous oxide with 60 percent or 65 percent oxygen in lieu of opioids in management of acute chest pain.<sup>21</sup> Termed Entonox in Europe and Dolonox in the United States, nitrous oxide in a 35 or 40 percent concentration is as analgesic as 2 to 5 mg of morphine, sedates a very apprehensive patient and provides a 60 to 65 percent concentration of oxygen. Do not titrate the N<sub>2</sub>O-O<sub>2</sub> ; simply deliver a flow of 3.5 to 4.0 L/min. of N<sub>2</sub>O and a flow of 6.0 to 6.5 L/min. of O<sub>2</sub>. In most cases, this treatment will alleviate the pain entirely, and in others will provide at least some degree of pain relief.

**5. Begin fibrinolytic therapy.** Ischemic myocardium does not die quickly. A window of 5 to 6 hours exists between the occlusion of the coronary artery and cellular death of the involved, injured myocardium. Once the patient is in the hospital environment, several procedures are available that can revascularize the area of affected myocardium. These procedures, described below, must be initiated before the myocardium dies if the victim is to survive the MI with little or no permanent myocardial damage.

Recently added to prehospital protocols for management of suspected MIs is fibrinolytic therapy. One aspirin (acetylsalicylic acid, or ASA), in a dose of as little as 81 mg, has been shown conclusively to inhibit platelet aggregation and to start the process of fibrinolysis.<sup>22</sup> The aspirin should be chewed, permitting it to dissolve in the mouth and be absorbed through the oral mucous membrane (similar to nitroglycerin). Administered in this manner, it produces a clinical effect within 20 minutes. If swallowed, the ASA will also be effective; however, its onset will be delayed considerably.

**6. Prepare for complications.** Most deaths from myocardial infarction occur within the first 2 hours of coronary artery obstruction. The cause of death in almost all cases is the onset of an acute dysrhythmia, the most common of which is ventricular fibrillation. Cardiac arrest—the absence of a palpable pulse—occurs when the heart, which is a pump, is no longer able to provide a cardiac output adequate to maintain consciousness or adequate tissue perfusion. The victim becomes unconscious and is not responsive to the "shake and shout" technique.

Ventricular fibrillation, or VF, is the primary dysrhythmia noted in approximately 90 percent of all cardiac arrests in adults. It is a dysrhythmia in which the individual muscle bundles contract independently of each other as opposed to the normal regular, coordinated and synchronized contraction of myocardial fibers. Little or

no cardiac output is present. In humans, VF is 15 times more frequent during the first hour after the onset of signs and symptoms of acute MI than during the following 12 hours.<sup>19</sup>

Because VF is such a frequently occurring dysrhythmia and is reversible if treated promptly, the automatic external defibrillator, or AED, has assumed increasing importance in the prehospital management of cardiac arrest victims.<sup>23</sup>

Defibrillation delivers an electrical shock to the myocardium, depolarizing all myocardial cells simultaneously, with the expectation that after the shock the cells will return to a normal synchronized state of function, or normal sinus rhythm. The 1992 American Heart Association guidelines for basic and advanced cardiac life support recognized this fact and stated, "Instructors [and] students ... must recognize that defibrillation is the single most important intervention in adult ECC (emergency cardiac care). Defibrillation, however, is ineffective without an adequate airway and effective ventilation."<sup>24</sup> Additionally, "the AHA considers early defibrillation the standard of care in the community. Failure of emergency personnel to have a defibrillator available during a cardiac arrest is difficult to defend."<sup>24</sup>

Though these numbers are approximations, the success rate of prompt defibrillation is such that when delivered to a cardiac arrest victim within 1 minute of collapse, the procedure is 90 percent successful in re-establishing a functional rhythm and palpable pulse.<sup>25</sup> Delivered in 2 minutes, defibrillation is 80 percent successful, with a 10 percent decrease in expectation of success for every minute defibrillation is delayed. If defibrillation is delivered after 10 minutes, there is minimal expectation of survival (this in spite of the effective delivery of P,A,B,C). Because of this, AEDs are now found on airplanes (as of January 1, 1997, all airplanes operated by American Airlines have an AED on board), health clubs, apartment buildings, factories and public buses (in Phoenix as of July 1, 1997).

At present, basic life support consists of P,A,B,C. With the realization of the importance of defibrillation and the availability of AEDs, it is expected that basic life support for health care professionals will be changed in the not-too-distant future to include D, for defibrillation.

*On arrival of EMS personnel*, the conscious myocardial infarction victim will be monitored with an electrocardiograph, venous access obtained and, if indicated, appropriate drug therapy instituted. Drugs administered might include morphine sulfate for pain relief, lidocaine for management of certain ventricular dysrhythmias or atropine for bradycardias. The patient will be stabilized and transported to the hospital for diagnosis and definitive management.

Once the patient is in the hospital and a definitive diagnosis of myocardial infarction has been made—and if the time since infarction is

still within the 5- to 6-hour window—revascularization procedures may be attempted. The two most commonly employed are fibrinolytic therapy, using streptokinase and urokinase; and primary balloon angioplasty, involving catheterization of the obstructed coronary vessel and inflation of a balloon that forces the lumen open.<sup>26, 27</sup> Though not without their own risk, these procedures—if performed before myocardial death—can lead to reperfusion of the injured myocardium and subsequent recovery from the MI with little or no permanent myocardial damage.

## **CONCLUSION**

Basic preparation of the office for all emergency situations is critical to the successful management of allergy and chest pain. The acute, life-threatening allergic reaction, anaphylaxis, is the one emergency situation in which the administration of a drug, epinephrine, frequently represents the difference between a successful outcome and a fatality. Its prompt administration is essential, as is the activation of EMS and basic life support. The much more common mild allergic skin reaction is easily managed with the oral and/or parenteral (IM, IV) administration of histamine-blocking drugs. The need for emergency assistance in this situation is rare.

Drug administration is less critical with anginal pain and myocardial infarction, the implementation of the steps of basic life support (P,A,B,C) often being the only steps necessary for complete management. Whenever chest pain occurs for the first time or if an anginal patient suggests it, EMS should be summoned immediately. In the typical acute anginal episode, the administration of nitroglycerin represents definitive management, EMS not being required.

Allergy and chest pain are two common emergency situations that arise in the dental office environment. Both of these conditions, though they usually are readily recognized and easily managed without significant sequelae, may prove to be situations that can lead to morbidity and—in more serious situations—death.

## **REFERENCES**

1. Fast TB, Martin MD, Ellis TM. Emergency preparedness: a survey of dental practitioners. *JADA* 1986,112:499-501.
2. Malamed SF. Managing medical emergencies. *JADA* 1993;124(8):40-53.
3. Matsuura H. Analysis of systemic complications and deaths during dental treatment in Japan. *Anesth Prog* 1990,36:219-28.

4. Papa LJ. Bilateral stroke in a healthy 41-year-old man. *Hosp Pract* 1994;29(5):125-6.
5. Cutino SR. Vasovagal syncope associated with seizure activity. *Gen Dent* 1994;42(4): 342-3.
6. Kharbanda OP, Varshney P, Dutta U. Accidental swallowing of a gold cast crown during orthodontic tooth separation. *J Clin Pediatr Dent* 1995;19(4):289-92.
7. Young EB, Saso MA, Pulver E. Acute chest pain during dental treatment a case report. *J Can Dent Assoc* 1990;56(5):437-40.
8. Gortzak BA, Abraham-Inpijn L. Pain-induced hypertensive episode in the dental office. *Gen Dent* 1995;43(3):274-6.
9. Malamed SF. Back to basics: emergency medicine in dentistry. *CDA J* 1997;25(4):285-94.
10. Malamed SF. *Medical emergencies in the dental office*. 4th ed. St. Louis: Mosby 1993.
11. Fisher AA. Topical medicaments which are common sensitizers. *Ann Allergy* 1982; 49(2):97-100.
12. Stafford CT. Life-threatening allergic reactions. Anticipating and preparing are the best defenses. *Postgrad Med* 1989;86(1):235-42, 245.
13. Huang SW. Latex allergy: a new threat to patients and health professionals [editorial]. *J Formos Med Assoc* 1996;95(5):361-3.
14. Ebo DG, Stevens WJ, De Clerck LS. Latex anaphylaxis. *Acta Clin Belg* 1995;50(2):87-93.
15. *Mosby's medical and nursing dictionary*. St. Louis: Mosby-Year Book 1983.
16. Angst DM, Bensinger DA. Angina. In: *Cardiopulmonary emergencies*. Springhouse, Pa.: Springhouse; 1991.
17. Jenkins CD. Recent evidence supporting psychologic and social risk factors for coronary disease. *N Engl J Med* 1976;294:1033.
18. Alpert JS, Braunwald E. Pathological and clinical manifestations of acute myocardial infarction. In: Braunwald E, ed. *Heart disease, a textbook of cardiovascular medicine*. Philadelphia: Saunders Co., 1980.
19. Pantridge JF, Webb SW, Adgey AA. Arrhythmias in the first hours of acute myocardial infarction. *Prog Cardiovasc Dis* 1981; 23(4):265-78.

20. **Todres D. The role of morphine in acute myocardial infarction. Am Heart J 1971;81: 566-70.**
21. **Thompson PL, Lown B. Nitrous oxide as an analgesic in acute myocardial infarction. JAMA 1976;235:924.**
22. **Eisenberg MJ, Topal EJ. Prehospital administration of aspirin in patients with unstable angina and acute myocardial infarction. Arch Intern Med 1996;156(14):1506-10.**
23. **Cummins RO, White RD, Pepe PK. Ventricular fibrillation, automatic external defibrillators, and the United States Food and Drug Administration: confrontation without comprehension. Ann Emerg Med 1995;26(5): 621-31.**
24. **American Heart Association Emergency Cardiac Care Committee and Subcommittees. Guidelines for cardiopulmonary resuscitation and emergency cardiac care. III: Adult advanced cardiac life support. JAMA 1992,268: 2199-234.**
25. **O'Hearn P. Early defibrillation: lessons learned. J Cardiovasc Nurs 1996;10(4):24-36.**
26. **Ludlam CA, Bennett B, Fox KA, Lowe GD, Reid AW. Guidelines for the use of thrombolytic therapy. Haemostasis and Thrombosis Task Force of the British Committee for Standards in Haematology. Blood Coagul Fibrinolysis 1995;6(3):273-85.**
27. **Grech ED, Ramedale DR. Primary coronary angioplasty in acute myocardial infarction. Postgrad Med J 1996;72(847):269-73.**