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Emergency drugs

Daniel A. Haas, DDS, PhD, FRCD(C)*

Department of Clinical Sciences, Discipline of Anesthesia, Faculty of Dentistry, University of Toronto, 124 Edward Street, Toronto, Ontario, M5G 1G6, Canada
Department of Pharmacology, Faculty of Medicine, University of Toronto, Toronto, Ontario, M5S 1A8, Canada
Department of Dentistry, Sunnybrook and Women's College Health Sciences Centre, Toronto, Ontario, M4N 3M5, Canada

Dentists must be prepared to manage medical emergencies that may arise in practice. This need is supported by surveys that have shown that dental office emergencies are not uncommon, with syncope being the most frequent event cited [1]. When syncope is excluded, it is estimated that an average of one other medical emergency arises approximately every 4 years in practice [2]. Therefore, dentists should be ready to manage these events. Preparation focuses primarily on prevention but should also include the presence of specific equipment and emergency drugs.

There are numerous proposals for lists of drugs that a dentist should have readily available for the management of medical emergencies [3–11]. These suggested lists share similarities but they are not identical. These recommendations can differ from what is actually found in dental practice [12]. Ultimately it is the individual dentist's own decision as to which drugs are appropriate for his or her particular practice. This article reviews the drugs that should be considered for this purpose.

Basic principles

The dentist's role in the handling of any medical emergency begins with prevention by following basic principles, such as conducting a thorough medical history with appropriate alterations to dental treatment as necessary [13]. It is usually considered essential that the dentist be trained and

* Department of Clinical Sciences, Discipline of Anesthesia, University of Toronto, 124 Edward Street, Toronto, Ontario, M5G 1G6, Canada.
E-mail address: daniel.haas@utoronto.ca (D.A. Haas).

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competent in basic life support (BLS), or cardiopulmonary resuscitation (CPR) [7]. This provides the dentist with the skills to manage most medical emergencies, starting with the assessment, and if necessary, the treatment of airway, breathing, and circulation (the ABCs of CPR). In most cases, only after these basics are addressed should the dentist consider the use of emergency drugs. Nevertheless, acknowledging the importance of prevention and competency in BLS, a core group of drugs must be readily accessible.

There are many potential emergencies and protocols to follow. Ideally, a dentist should be aware of all of them; yet, the reality is that when the emergency first develops, the precise diagnosis may not be clear. Without a diagnosis, how can one formulate a treatment plan? This problem can be circumvented by following the key principle that the most important aspect of nearly all medical emergencies in the dental office is to prevent or correct insufficient oxygenation of the brain and heart. On a simple level, if a patient has lost consciousness, it is a result of lack of oxygenated blood in the brain. If a patient is having an episode of acute angina pectoris, it is a result of relative lack of oxygenated blood to specific sites in cardiac muscle. The management of all medical emergencies occurring in a dental office should include ensuring that oxygenated blood is being delivered to the brain and heart. Beginning with an ABC approach is always prudent, particularly if the diagnosis is not clear. Furthermore, an ABC approach should always be considered before the administration of a drug.

Drugs that should be promptly available to the dentist can be divided into two categories. The first category represents those drugs that may be considered essential. These drugs are summarized in Table 1. The second category contains drugs that are also helpful and should be considered as part of the emergency kit. These supplementary drugs are summarized in Table 2. The precise composition of the drug kit can vary as the presence of the drugs in this latter group may depend on the nature of the dental practice. Those with training in Advanced Cardiac Life Support would also have additional drugs, including vasopressin, amiodarone, lidocaine, norepinephrine, verapamil, adenosine, procainamide, magnesium, and others [14]. This latter group is not discussed in this article.

Dentists who are trained to administer general anesthesia or intravenous sedation would be expected to have additional drugs commensurate with the modality practiced. These dentists would be expected to have a patent intravenous line in place and therefore drug administration could use this route, which may be considered ideal. It may be assumed that dentists without advanced training in anesthesia or sedation may not be proficient in venipuncture. In this case the intramuscular route of administration, which can include the intralingual injection, would be appropriate. The intralingual intramuscular injection should provide a more rapid onset of action compared with the more traditional sites, although not as rapid as intravenous. This article assumes the intramuscular route is the one most likely to be used.

Table 1
Essential emergency drugs

Drug	Indication	Initial adult dose
Oxygen	Almost any medical emergency	100%: inhalation
Epinephrine	Anaphylaxis	0.1 mg IV or 0.3–0.5 mg IM
	Asthma unresponsive to albuterol	0.1 mg IV or 0.3–0.5 mg IM
	Cardiac arrest	1 mg IV
Nitroglycerin	Pain of angina	0.3–0.4 mg sublingual
Antihistamine	Allergic reactions	
(diphenhydramine or		25–50 mg IV, IM
chlorpheniramine)		10–20 mg IV, IM
Albuterol	Asthmatic bronchospasm	2 sprays (180 μg–200 μg) inhalation
Aspirin	Myocardial infarction	160 mg–325 mg
Pediatric doses (approximate, not to exceed the adult doses listed above)		
Epinephrine = 0.01 mg/kg		
Diphenhydramine = 1 mg/kg		
Albuterol = 1 spray (90–100 μg)		

Essential drugs

Oxygen

Oxygen is indicated for every emergency except hyperventilation. Understanding the basic pharmacology of oxygen resides in knowledge of the oxyhemoglobin dissociation curve. Room air contains 20.9% oxygen, and this

Table 2
Supplementary emergency drugs

Drug	Indication	Initial adult dose
Glucagon	Hypoglycemia in unconscious patient	1 mg IM
Atropine	Clinically significant bradycardia	0.5 mg IV or IM
Ephedrine	Clinically significant hypotension	5 mg IV, or 10–25 mg IM
Hydrocortisone	Adrenal insufficiency Recurrent anaphylaxis	100 mg IV or IM
Morphine or	Angina-like pain unresponsive	Titrate 2 mg IV, 5 mg IM
nitrous oxide	to nitroglycerin	~35%, inhalation
Naloxone	Reversal of opioid overdose	0.1 mg IV or 0.4 mg IM
Lorazepam or	Status epilepticus	4 mg IM or IV
midazolam		5 mg IM or IV
Flumazenil	Benzodiazepine overdose	0.1 mg IV

The final composition of the supplementary emergency drugs depends on the individual dentist's needs and the nature of the practice. The drugs listed above should be considered. Dental offices that provide conscious sedation, deep sedation or general anaesthesia require additional drugs.

normally results in oxyhemoglobin saturation approximating 98%. At this level the curve is stable. When mouth to mask or mouth to mouth ventilation is carried out as part of basic CPR, the exhaled carbon dioxide results in a reduction in the amount of oxygen delivered, to a level approximating 16%. Therefore, the patient is immediately at a disadvantage even when being ventilated adequately. As oxyhemoglobin saturation starts to decrease to less than 90%, the sigmoid shape of this curve results in a progressively more rapid decrease. Cardiac compressions carried out as part of CPR are meant to simulate cardiac output. Even when these compressions are being done ideally, they achieve only approximately 25–30% of the normal cardiac output [14]. This puts the patient at a further disadvantage. If cardiac arrest has been present for a period of time, acidosis may begin that will shift the oxyhemoglobin dissociation curve to the right. This results in a lower oxyhemoglobin saturation for a given partial pressure of oxygen being delivered to the lung alveoli. This further decreases the amount of oxygen available to be delivered to the tissues.

The accumulation of these facts points to the need to improve oxygen delivery by whatever means are available. This should be done with a clear full-face mask for the spontaneously breathing patient and a bag-valve-mask device for the apneic patient. Therefore whenever possible, with the exception of the patient who is hyperventilating, oxygen should be administered. For the management of a medical emergency it should not be withheld for the patient with chronic obstructive lung disease, even though they may be dependent on low oxygen levels to breathe if they are chronic carbon dioxide retainers. Short-term administration of oxygen to get them through the emergency should not depress their drive to breathe.

Oxygen should be available in a portable source, ideally in an ''E''-size cylinder that holds more than 600 liters. This should allow for more than enough oxygen to be available for the patient until resolution of the event or transfer to a hospital. If the typical adult has a minute volume of 6 liters per minute, then this flow rate should be given as a minimum. If the patient is conscious, or unconscious yet spontaneously breathing, oxygen should be delivered by a full-face mask; a flow rate of 6–10 liters per minute is appropriate for most adults [15]. If the patient is unconscious and apneic, it should be delivered by a bag-valve-mask device with which a flow rate of 10–15 liters per minute is appropriate [15]. A positive pressure device may be used in adults, provided that the flow rate does not exceed 35 liters per minute.

Epinephrine

Epinephrine is the drug of choice for the emergency treatment of anaphylaxis and asthma that does not respond to its drug of first choice, albuterol. Epinephrine also is indicated for the management of cardiac arrest, but in the dental office setting, it may not be as likely to be given, because

intravenous access may not be available. Its administration intramuscularly is not as likely to be effective in this latter emergency, in which adequate oxygenation and early defibrillation is most important for the cardiac arrest dysrhythmias with the best prognoses, namely ventricular fibrillation or pulseless ventricular tachycardia [16].

Epinephrine, an endogenous catecholamine, is an agonist at all adrenoceptors. When considering its use in emergencies, the effects on the cardiovascular and respiratory systems are most important.

The actions on the heart are mediated primarily by the stimulation of β-1 receptors. This results in an increase in heart rate, force of contraction and automaticity. The combination of increased rate and stroke volume leads to an increase in cardiac output. In turn, this should lead to improved perfusion. This increase in cardiac output may be required to reverse the hypotension that can accompany anaphylaxis. Increased myocardial automaticity can predispose to dysrhythmias in a beating heart, but may be advantageous during cardiac arrest. Myocardial oxygen requirement increases as a result of the greater work of the heart. This can be an adverse effect, particularly in the compromised heart in which an increased demand for oxygen in the presence of diminished supply may predispose to ischemia, with subsequent angina or infarction.

The effects on the vasculature are primarily caused by either α-1 stimulation that induces constriction mainly in skin and mucous membranes, or β-2 effects that include vasodilatation of the blood vessels predominantly in skeletal muscle. The increased peripheral vasoconstriction is beneficial during management of a cardiac arrest [14].

The effects on the respiratory system are also of importance. The stimulation of β-2 receptors causes bronchorelaxation. This is beneficial in the emergency treatment of a bronchoconstriction as found during an acute asthmatic attack when bronchorelaxation cannot be induced by a β-2 agonist alone. This action is also required in the management of anaphylaxis.

As a drug, epinephrine has a rapid onset and short duration of action, usually 5–10 minutes when given intravenously. For emergency purposes, epinephrine is available in two formulations. It is prepared as 1:1,000, which equals 1 mg per mL, for intramuscular, including intralingual, injections. More than one ampule or prefilled syringe should be present, as multiple administrations may be necessary. It also is available as 1:10,000, which equals 1 mg per 10 mL, for intravenous injection. Autoinjector systems are also available for intramuscular use (such as the EpiPen) that provide one dose of 0.3 mg as 0.3 ml of 1:1,000, or the pediatric formulation that is one dose of 0.15 mg as 0.3 ml of 1:2,000.

Initial doses for the management of anaphylaxis are 0.3–0.5 mg intramuscularly or 0.1 mg intravenously [7,16–18]. These doses should be repeated as necessary until resolution of the event. Similar doses should be considered in asthmatic bronchospasm that is unresponsive to a beta-2 agonist, such as albuterol. Dose in cardiac arrest is 1 mg intravenously.

Intramuscular administration during cardiac arrest has not been studied, but would seem to be unlikely to render significant effect.

Epinephrine is clearly a highly beneficial drug in these emergencies. Concurrently, however, it can be a drug with a high risk if given to a patient with ischemic heart disease. Nevertheless, it is the primary drug needed to reverse the life-threatening signs and symptoms of anaphylaxis or persistent asthmatic bronchospasm.

Nitroglycerin

This drug is indicated for acute angina or myocardial infarction. It is characterized by a rapid onset of action. Its primary mechanism of action is through vasodilation, which results in a decrease in venous return to the heart and therefore a reduction in the work of cardiac muscle. In turn, this reduces myocardial oxygen consumption. Given that angina pectoris arises from an imbalance in the supply and demand of oxygen in the heart, this action is beneficial.

Nitroglycerin presents little in the way of adverse reactions. Because it decreases blood pressure, it should not be administered if systolic blood pressure is less than 90 mm Hg. It may lead to headache if given to a patient with chest pain of noncardiac origin.

For emergency purposes it is available as 0.3-, 0.4-, or 0.6-mg sublingual tablets or a 0.4-mg sublingual spray. One important point to be aware of is that the tablets have a short shelf life of approximately 3 months once the bottle has been opened and the tablets have been exposed to air or light. The spray has the advantage of having a shelf life that corresponds to that listed on the bottle. Therefore, if a patient uses his or her own nitroglycerin, there is a possibility of the drug being inactive. This supports the need for the dentist to always have a fresh supply available. With signs of angina pectoris, 0.3 or 0.4 mg should be administered sublingually. Relief of pain should occur within minutes. If necessary, this dose can be repeated twice more in 5-minute intervals provided that systolic blood pressure remains above 90 mm Hg.

Injectable antihistamine

An antihistamine is indicated for the management of allergic reactions. Whereas mild non-life-threatening allergic reactions may be managed by oral administration, life-threatening reactions necessitate parenteral administration. Antihistamines may be classified as those that block either H-1 or H-2 histamine receptors. Whereas a case can be made for the use of both classes of drugs [19], the H-1 antagonist is commonly considered the first line antihistamine [6,18]. The H-1 antagonist therefore would be the more essential of the two. These drugs block the action of histamine at the H-1 receptor; they do not inhibit the release of histamine.

Two injectable agents may be considered, either diphenhydramine (Benadryl) or chlorpheniramine. Parenteral diphenhydramine is available

as either a 10 or a 50 mg per mL solution. Parenteral chlorpheniramine is available as a 10 mg per mL solution. They may be administered as part of the management of anaphylaxis or as the sole management of less severe allergic reactions, particularly those with primarily dermatologic signs and symptoms such as urticaria. Recommended doses for adults are 25–50 mg of diphenhydramine or 10–20 mg of chlorpheniramine.

Albuterol

A selective β-2 agonist such as albuterol (Ventolin) is the first choice for management of bronchospasm. When administered by an inhaler, it provides selective bronchodilation with minimal systemic cardiovascular effects. It has a peak effect in 30–60 minutes, with a duration effect of 4–6 hours. Other inhalational selective β-2 agonists could also be considered for emergency management of an acute asthmatic attack. Examples include metaproterenol (Alupent) or terbutaline (Brethaire, Bricanyl).

Albuterol is available as a metered dose inhaler that provides 90 or 100 micrograms of drug per administration. Adult dose is 180 to 200 micrograms, which is two sprays, to be repeated as necessary. Pediatric dose is 90 to 100 micrograms, or one spray, repeated as necessary.

Aspirin

Aspirin is one of the more newly recognized life-saving drugs, as it has been shown to reduce overall mortality from acute myocardial infarction [20,21]. This drug is well known in dentistry. Aspirin blocks the cyclooxygenase enzymes, leading to a reduction in prostaglandins, prostacyclins, and thromboxanes. Thromboxanes potently constrict arteries and promote platelet aggregation. Aspirin's role as a drug in medical emergencies is derived from this inhibition of thromboxane, as it inhibits platelet aggregation.

The purpose of its administration during an acute myocardial infarction is to prevent the progression from cardiac ischemia to injury to infarction. There is a brief period of time early on during a myocardial infarction during which aspirin can show this benefit. For emergency use there are few contraindications. These would include known hypersensitivity to aspirin, severe asthma, or history of significant gastric bleeding.

Aspirin is available as 81-, 162.5-, 325-, 500-, or 650-mg tablets. The lowest effective dose is not known with certainty, but a minimum of 162 mg should be given immediately to any patient with pain suggestive of acute myocardial infarction.

Oral carbohydrate

An oral carbohydrate source, such as fruit juice or nondiet soft drink, should be readily available. Whereas this is not a drug, and perhaps should not be included in this list, it should be considered essential. If this sugar

source is kept in a refrigerator it may not be appreciated that it is a key part of the emergency equipment. Therefore, consideration should be given to making this part of the emergency kit. Its use is indicated in the management of hypoglycemia in conscious patients.

Supplementary drugs

In addition to the six drugs discussed above, several other drugs should be considered as part of an emergency kit, as shown in Table 2.

Glucagon

The presence of this drug allows intramuscular management of hypoglycemia in an unconscious patient. The ideal management of severe hypoglycemia in a diabetic emergency is the intravenous administration of 50% dextrose. Glucagon is indicated if an intravenous line is not in place and venipuncture is not expected to be accomplished, as may often be the case in a dental office. It has actions that oppose insulin and its administration raises plasma glucose. Its anti-hypoglycemic effect occurs within 15 minutes if given intramuscularly. Its duration of action is approximately 90 minutes. Adverse effects are not expected.

The dose for an adult is 1 mg. If the patient weighs less than 20 kg, the recommended dose is 0.5 mg. Glucagon is available as a 1-mg formulation that requires reconstitution with its diluent immediately before use.

Atropine

This antimuscarinic, anticholinergic drug is indicated for the management of hypotension that is accompanied by bradycardia. By blocking cardiac muscarinic receptors, atropine will increase heart rate. Hypotension is normally accompanied by a reflex increase in heart rate. If hypotension is accompanied by a slow heart rate, correction of this bradycardia may resolve the low blood pressure. Conversely, one should be concerned about too great an increase in heart rate in patients with ischemic heart disease. Similarly, there should be concern with any patient in whom anticholinergic effects may be problematic, such as those patients with acute narrow angle glaucoma, prostatic hypertrophy, or urinary retention. It has a rapid onset and short duration of action.

The dose recommended is 0.5 mg initially, followed by increments as necessary until reaching a maximum of 3 mg. Paradoxically, doses of less than 0.4 mg have been associated with induction of bradycardia, likely caused by atropine's central nervous system's actions. Atropine is available in numerous strengths, ranging from 50 micrograms per mL to 1 mg per mL. A concentration approximating 0.5 mg per mL would be suitable for emergency purposes.

Ephedrine

This drug is a vasopressor that may be used to manage significant hypotension. Ephedrine is a sympathomimetic that directly and indirectly leads to stimulation of all adrenoceptors. It has similar cardiovascular actions as epinephrine, except that ephedrine is less potent and has a prolonged duration of action, lasting from 60–90 minutes. That α and β receptors are stimulated is an advantage over other commonly recommended vasopressors such as phenylephrine or methoxamine, which are selective α-1 agonists. These latter agents are effective provided adequate intravenous fluids are being coadministered, a situation that may not occur in the dental office. The β-1 stimulation causes an increase in heart rate and stroke volume, thereby increasing cardiac output, which in turn should help maintain perfusion. The result is an improvement in blood pressure and perfusion, thereby improving tissue oxygenation, one of the primary goals in the handling of any medical emergency. Similar precautions as noted with epinephrine administration should be considered when given to a patient with ischemic heart disease.

For the treatment of severe hypotension, it is ideally administered in 5-mg increments intravenously. Intramuscularly it should be given in a dose of 10–25 mg. It is formulated as either a 25- or 50-mg per mL solution.

Corticosteroid

Administration of a corticosteroid such as hydrocortisone may be indicated for the prevention of recurrent anaphylaxis. Hydrocortisone may also play a role in the management of an adrenal crisis. Corticosteroids provide membrane-stabilizing effects, reduce leukotriene formation, and reduce histamine release from mast cells. These actions are therefore beneficial in allergic reactions. The notable drawback to their use in emergencies is their slow onset of action, that approaches 1 hour even when administered intravenously. This is the reason these drugs are not considered essential, as they are of minimal benefit in the acute phase of the emergency. There is low likelihood of an adverse response with one dose.

The prototype for this group is hydrocortisone (Solu-Cortef) that may be administered in a dose of 100 mg as part of the management of these emergencies.

Morphine

Morphine is indicated for the management of severe pain that occurs with a myocardial infarction. ACLS recommendations list morphine as the analgesic of choice for this purpose [14]. It has the beneficial effects of being an excellent analgesic and having good mood-altering properties to help manage the stress that accompanies this event. This reduction in pain and stress should minimize endogenous epinephrine release. Morphine increases venous capacitance and therefore decreases systemic vascular resistance that reduces preload, a beneficial effect during a myocardial infarction, as it reduces the work of the

heart. In turn, less oxygen is needed. It can be used if systolic blood pressure is more than 90 mm Hg and the patient is not hypovolemic.

The dose involves titration in 1–3-mg increments intravenously until pain relief is accomplished. This should be guided by a decrease in blood pressure and respiratory depression. Extreme caution should be used in the elderly. If an intravenous line is not in place, consideration can be given to administering morphine in a dose of approximately 5 mg intramuscularly. Again, lower doses need to be considered for the older patient. As a narcotic, it requires separate storage and recording, consistent with legal regulations.

Naloxone

If morphine is included in the emergency kit or opioids are used as part of a sedation regimen, then naloxone (Narcan) should also be present for the emergency management of inadvertent overdose. Naloxone is an antagonist at all opioid receptors, and therefore blocks all of the actions of morphine or any other opioid. Following intravenous administration, it has an onset of action of 1–2 minutes and a peak effect in 5–15 minutes. Its duration of action depends on the extent of the overdose it is reversing, and may range from 5–45 minutes. Naloxone must be used cautiously, as there is the potential for significant adverse effects. Particular concern should be given to patients with cardiac irritability, as this may be worsened and result in alterations in blood pressure, ventricular tachycardia, or ventricular fibrillation. Its short duration of action necessitates appropriate monitoring beyond its termination of effect.

Doses ideally should be titrated slowly in 0.1-mg increments to effect. It is formulated as either a 0.02-, 0.4-, or 1.0-mg per mL solution.

Nitrous oxide

Nitrous oxide is a reasonable second choice if morphine is not available to manage pain from a myocardial infarction. Its good analgesic and anxiolytic effects are advantageous to the patient having an acute myocardial infarction. As with morphine, this reduction in pain and stress should minimize endogenous epinephrine release. Nitrous oxide's effects on the cardiovascular system are negligible, although it is a mild myocardial depressant and mild sympathomimetic. It lacks morphine's beneficial effects on the cardiovascular system.

For management of pain associated with a myocardial infarction, it should be administered with oxygen, in a concentration approximating 35%, or titrated to effect.

Injectable benzodiazepine

The management of seizures that are prolonged or recurrent, also known as status epilepticus, may require administration of a benzodiazepine. All benzodiazepines share the effects of anxiolysis, sedation, anterograde amnesia, skeletal muscle relaxation, and an anticonvulsant action. It is this latter

action that makes benzodiazepines valuable drugs during emergencies. Diazepam is often listed as the drug of choice for status epilepticus. This, however, should be administered intravenously, as the onset of action following intramuscular administration is unpredictable. In most dental practices, it would not be realistic to assume that the dentist could achieve venipuncture in a patient having an active seizure. This leads to the need for a water-soluble agent such as midazolam or lorazepam. Lorazepam has been reported as the drug of choice for status epilepticus [22] and can be administered intramuscularly. Midazolam, however, is another alternative that is water-soluble and could be considered. Sedation would be an expected side effect and patients should be appropriately monitored.

Adult doses to consider for lorazepam are 4 mg intramuscularly, or midazolam 5 mg intramuscularly. If an intravenous line is in place, these drugs should be slowly titrated to effect.

Flumazenil

Flumazenil (Romazicon) should be part of the emergency kit when oral or parenteral sedation is used [23]. This specific antagonist to the benzodiazepine receptor reverses benzodiazepine-induced unconsciousness, sedation, and amnesia. The duration of action is dose-dependent and dependent on the dose and specific agonist being reversed. As with naloxone, the potential for resedation requires that whenever this agent is used to reverse overdose, the patient should be monitored in recovery beyond the duration of action of flumazenil. There should be caution if the patient has a seizure disorder treated by benzodiazepines.

Dosage is 0.1 to 0.2 mg intravenously, incrementally. The total dose usually does not exceed 1.0 mg. Its effectiveness when given intramuscularly has not been established.

Drug use for specific emergencies

It is beyond the scope of this article to provide a detailed rationale and description of each treatment protocol or algorithm to be followed. The following is a synopsis of specific emergencies that incorporate the drugs discussed above. The etiologies and recognition are not discussed, but may be found in other excellent sources [6,7]. The management of all emergencies shares the need to assess and treat the ABCs as necessary and administration of oxygen (except for hyperventilation). One must also consider if and when to call for help and activate the local emergency medical system.

Syncope

No drugs other than oxygen are required to manage this most common emergency seen in dentistry [1]. As it is a transient period of unconsciousness, it is truly an emergency as the airway may be obstructed. The management

includes positioning the patient to maximize blood flow to the brain by laying the patient supine with the legs slightly elevated. Attention to the ABCs must be carried out to ensure an open airway. Oxygen should be administered. The initial steps of the management of all unresponsive patients should begin with this protocol. When recovered, offering the patient a source of oral glucose should be considered.

Anaphylaxis

The drugs to be considered for this emergency are summarized in Table 3. Anaphylaxis is a severe allergic reaction [18,24]. It can be life-threatening if it manifests as any combination of bronchospasm, laryngeal edema, or hypotension. Each one of these three signs can be life-threatening on their own. When found in combination, and in particular, when these signs develop rapidly, the level of concern must be heightened. Timing is an important factor. With anaphylaxis to the penicillin family, 96% of all deaths occurred within the first hour.

Once anaphylaxis is apparent, one should follow basic principles and administer epinephrine. This should be an initial dose of 0.1 mg intravenously or 0.3–0.5 mg intramuscularly, repeated as necessary. Once stable, either diphenhydramine in a dose of 25–50 mg or chlorpheniramine in a dose of 10–20 mg may be given intramuscularly. If available, hydrocortisone in a dose of 100 mg may be given. Oxygen should be administered throughout.

For less severe allergic reactions, particularly when there are no signs of airway compromise, diphenhydramine or chlorpheniramine may be administered alone.

Bronchospasm (acute asthma)

Albuterol, epinephrine, and oxygen may be required for this emergency. The drug of first choice is the β-2 agonist, such as albuterol, although

Table 3
Drugs grouped by emergency

Emergency	Essential drugs	Supplementary drugs
Allergy/anaphylaxis	Epinephrine Diphenhydramine or chlorpheniramine	Hydrocortisone
Asthma	Albuterol Epinephrine	
Angina/myocardial infarction	Nitroglycerin Aspirin	Morphine Nitrous oxide
Hypotension		Atropine Ephedrine
Diabetic hypoglycemia	Oral carbohydrate	Glucagon
Status epilepticus		Lorazepam or midazolam

The above table assumes that oxygen is being administered and that intravenous access is not necessarily available.

metaproterenol and terbutaline also can be considered. An adult should receive two sprays; a young child should receive one spray. This should be repeated as necessary. If there is no response then epinephrine should be administered in the same dosage as described for anaphylaxis.

Cardiac arrest

This is managed consistent with the principles of BLS, or ACLS if appropriately trained individuals are present. If there is skill at using a bag-valve-mask device, then 100% oxygen should be administered. If available, an automated external defibrillator can be used. It has been stated that even without electrocardiogram (ECG) monitoring, 1 mg epinephrine can be administered, as it is indicated for all pulseless rhythms [3]. The fundamental aspect in its management is rapid defibrillation and ventilation.

Angina/myocardial infarction

Nitroglycerin, oxygen, and aspirin may be required for these emergencies. If available, morphine or nitrous oxide is indicated if myocardial infarction is diagnosed. Management of angina pectoris depends on whether or not there is a positive history of ischemic heart disease. The algorithm is summarized in Table 4. Those patients who are known angina patients should be administered sublingual nitroglycerin and may take their own. Oxygen should be administered. Relief should result within minutes following nitroglycerin administration. If no relief ensues, a second dose should be given. A fresh supply of nitroglycerin should be used for the second dose to rule out ineffectiveness caused by deterioration of the drug, which may occur if the patient had opened the bottle more than 3 months ago and exposed the drug to air or light. Therefore, the dentist should use the fresh supply from the emergency kit. The steps outlined in Table 4 should be followed. If there is no relief after three administrations, a diagnosis of myocardial infarction should be assumed and the patient transferred and managed accordingly.

Table 4
Management of angina pectoris/myocardial infarction

Ischemic heart disease history: positive	Ischemic heart disease history: negative
ABCs and O_2	ABCs and O_2
	Call 911 (assume myocardial infarction)
Nitroglycerin	Nitroglycerin
If no relief after 3–5 minutes:	If no relief after 3–5 minutes:
Repeat	Repeat
If no relief after 3–5 minutes:	If no relief after 3–5 minutes:
Repeat	Repeat
If no relief after 3–5 minutes:	If no relief after 3–5 minutes:
Call 911 (assume myocardial infarction)	Call 911 (assume myocardial infarction)
Aspirin 162 or 325 mg	Aspirin 162 or 325 mg
Morphine 2 mg IV or 5 mg IM or N_2O:O_2	Morphine 2 mg IV or 5 mg IM or N_2O:O_2

If there is no history of ischemic heart disease, the protocol is the same, except that the emergency medical system should be called immediately, as the patient needs to be transferred and assessed in hospital.

Hypotension

If the patient is symptomatic and the blood pressure has dropped significantly from baseline, hypotension may be assumed. The management begins with the syncope protocol as described above. One should then reassess blood pressure and perfusion. The ideal management at this point is the administration of intravenous fluids, but that is not realistic in most dental offices where venipuncture may not be likely. If a drug is to be used, atropine at 0.5 mg can be considered if heart rate is less than 60 beats per minute. Otherwise, ephedrine may be considered in doses ranging from 5–25 mg. As described above, these agents should be used cautiously.

Diabetic emergencies

The management of emergencies associated with diabetes is summarized in Table 5. Hypoglycemia and hyperglycemia are serious and can be fatal if left untreated. With that in mind, hypoglycemia is often considered the more serious because of the rapidity of onset of signs. If the patient is conscious, the treatment is easy. The hypoglycemic patient should be given an oral source of carbohydrate, such as a fruit juice or nondiet soft drink. The hyperglycemic patient should be given insulin if the dose is known, as provided by an accompanying caregiver for example. If not, the patient should be transferred to hospital. The unconscious hypoglycemic patient is best managed with basic ABCs, followed by oxygen and 50% dextrose if an intravenous line is in place. If not, glucagon can be administered intramuscularly in a dose of 1 mg.

Seizures

Management should begin with the protection of the patient. If status epilepticus develops, as determined by seizures that are prolonged or

Table 5
Management of diabetic emergencies

Hypoglycemia	Hyperglycemia
If conscious	If conscious
Oral carbohydrates	Hospitalize
If unconscious	If unconscious
ABCs	ABCs
Oxygen	Oxygen
Call 911	Call 911
50% dextrose IV or	
1 mg glucagon IM	

repeated, then an injectable benzodiazepine can be administered. Either lorazepam at 4 mg or midazolam at 5 mg may be given intramuscularly if a patent intravenous line is not present. If given, one should continue to monitor for deep sedation and the potential loss of protective reflexes.

Summary

There is universal agreement that dentists require emergency drugs to be readily available. Opinions differ as to the specific drugs that should comprise an emergency kit. This article has provided one opinion. Oxygen, epinephrine, nitroglycerin, injectable diphenhydramine or chlorpheniramine, albuterol, and aspirin should be readily available in a dental office. Other drugs such as glucagon, atropine, ephedrine, hydrocortisone, morphine or nitrous oxide, naloxone, midazolam or lorazepam, and flumazenil should also be considered.

There are differences in the level of training of dentists in the management of medical emergencies [25]. Therefore the final decision should be made by the individual dentist who is in the best position to determine the appropriateness of these agents for the particular practice. Despite the best efforts at prevention, emergencies may still arise. Plans to manage these events are needed and there is the possibility that the drugs discussed above may be required. Their presence may save a life.

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