INTRODUCTION

For more than 90 years, office-based anesthesia has been a part of the history, training, and practice of oral and maxillofacial surgery (OMFS).1,2 There may be a significant component of fear, anxiety, and pain that should be alleviated in order to carry out procedures comfortably for patients.

Every oral surgeon should recognize that medical emergencies may transpire during the course of practice and office-based anesthesia. These emergencies could be connected to surgical management, anesthesia administration, or patient risk factors.3 Medical emergencies can easily evolve into a life-threatening emergency without prompt recognition and treatment. It is for this reason emergency medications should be present and available in the oral surgery office.

Oral surgeons who use advanced anesthesia, like moderate sedation, in addition to deep sedation/general anesthesia must be skilled in diagnosis and management of emergencies, which may result from their usage.4 Resuscitative equipment (Box 1), oxygen, and other resuscitative medications should be accessible for immediate use.5,6

This list is a suggested list of the core emergency drugs and a of suggested emergency medications for those doing advanced anesthesia. Always check with your state dental board for the mandatory emergency medications you must have in your office.7

CORE EMERGENCY DRUGS

Oxygen

Oxygen is used for the treatment of hypoxemia, which is common in numerous medical emergencies.8 This underlines the significance and need for a supplemental oxygen delivery system.9 Multiple routes are available for delivery. The oral surgery office should also be equipped with a bag-valve mask with full face mask to allow for positive-pressure ventilation.10

Nitroglycerin

Nitroglycerin is used for relief of acute chest pain with history of angina, or undiagnosed angina with symptoms of myocardial infarction. It is an antianginal that stimulates cyclic guanosine monophosphate production, which relaxes vascular smooth muscle specifically in the coronary arteries.
in the presence of an anjinal attack. The usual dose of nitroglycerin is 1 sublingual (0.4 mg) tablet or 1 spray (0.4 mg) from a nitroglycerin spray atomizer every 5 minutes. Common side effects are headaches, dizziness, and flushing. Nitroglycerin is contraindicated for patients with hypotension and should not be given to patients taking medication for erectile dysfunction, such as sildenafil (Viagra), tadalafil (Cialis), and vardenafil ( Levitra) because of risk of severe hypotension, tachycardia, and cardiovascular collapse.11,12

**Epinephrine 1:1000**

Epinephrine 1:1000 is used for anaphylaxis, for bronchospasm, and as a cardiac stimulant during cardiac arrest. It is a sympathomimetic drug that activates alpha- and beta-adrenergic receptors. It increases heart rate and myocardial contractility. It also causes vasoconstriction and bronchial dilation and stabilizes mast cells. For anaphylaxis, the adult dose of epinephrine is 0.3 mg (1:1000), and the children’s dose is 0.15 mg (1:2000) intramuscular (IM) via autoinjector for anaphylaxis. An IM preparation can also be made by drawing up 0.3 mL from a vial of 1 mg/mL (1:1000) into a syringe for use for adults with anaphylaxis (Fig. 1). The epinephrine 1:10,000 concentration is designed for intravenous (IV) administration. Caution should be used, as it may cause tachydyrhythmias. It also decreases placental blood flow and may induce premature labor.14,15

**Albuterol**

Albuterol is used for bronchospasm and wheezing secondary to an acute asthmatic episode. It is a bronchodilator that stimulates beta-2 adrenergic receptors, causing bronchodilation. Albuterol is available in a metered-dose inhaler and can be used 2 to 3 times every 1 or 3 minutes as needed.16

**Aromatic Ammonia**

Aromatic ammonia is used for syncope/fainting/loss of consciousness. It is a respiratory stimulant, and when crushed, releases a noxious odor that stimulates the respiratory and vasomotor centers of the medulla. Return to consciousness is typically achieved by placing patients in the Trendelenburg position, with administration of oxygen and by using aromatic ammonia.17

**Diphenhydramine**

Diphenhydramine is used for allergic reactions/anaphylaxis. It is an antihistamine that antagonizes histamine at the H-1 receptor. It causes sedation and has an anticholinergic effect. Diphenhydramine can be given 50 mg IM or IV.18

**Glucose (Dextrose 50%)**

Glucose (dextrose 50%) is used to increase glucose levels in hypoglycemic states. Simple sources may be used, such as orange juice, cola, or granulated sugar, in conscious patients. The oral formulation should not be given to unconscious patients because of risk of aspiration. If patients are unable to swallow, IV access should be obtained, and dextrose 50% in water can be given or by IM injection of glucagon.19

**Emergency Medications for Advanced Anesthesia**

The American Association of Oral and Maxillofacial Surgeons Committee on Anesthesia recommends that the oral surgery office maintain supplies of the following medications: vasopressors,
corticosteroids, bronchodilators, muscle relaxants, narcotic antagonists, benzodiazepine antagonists, antihistamines, antiarrhythmics, anticholinergics, coronary artery vasodilators, antihypertensives, and drugs for treatment of malignant hyperthermia.  

**VASOPRESSORS**

**Ephedrine**

Ephedrine is an adrenergic agonist used to manage moderate to severe hypotension when patients are also bradycardic. Ephedrine displays both alpha-1 and beta-1 adrenergic agonism. Ephedrine causes increased peripheral vascular resistance, positive cardiac chronotropy, and positive cardiac inotropy. Ephedrine can be prepared by diluting a 50-mg/mL vial in 9 mL of saline to make a 5-mg/mL solution. Typical dosing is a 5-mg bolus titrated to the desired effect.

**Phenylephrine**

Phenylephrine is an adrenergic agonist used to manage hypotension when patients have tachycardia or normal heart rate. Phenylephrine is a selective alpha-1 agonist, which results in peripheral vasoconstriction and increased blood pressure. Reflex bradycardia typically accompanies administration. Phenylephrine can be prepared by diluting a 10-mg/mL vial in 9 mL of saline; 9 mL of this solution can be discarded, and an additional 9 mL of saline can be added to create a 0.1-mg/mL solution. Alternatively, the 10-mg/mL vial can be added to a 100-mL bag of saline to also obtain the desired 0.1-mg/mL solution (Fig. 2). Typical dosing is 0.1 mg/mL titrated to the desired effect.

**CORTICOSTEROID**

*Dexamethasone*

Dexamethasone is a synthetic adrenal corticosteroid used as an antiemetic and for treatment of severe allergies, pruritus, asthma, bronchospasm, and postoperative edema. It can provide membrane-stabilizing effects, reduce leukotriene formation, and reduce histamine release from mast cells. There is a slow onset of action. A typical dose is 4 to 12 mg IV. Caution should be used for patients with preexisting infection, peptic ulcer, or hyperglycemia.

**Hydrocortisone**

Hydrocortisone is a corticosteroid with similar indications and anti-inflammatory properties as dexamethasone. It is the preferred corticosteroid for management of acute adrenal insufficiency. The typical dose is 125 mg.

**MUSCLE RELAXANTS**

*Succinylcholine*

Succinylcholine is a depolarizing neuromuscular blocker used for management of laryngospasm after other methods have proved unsuccessful. It helps relax the vocal cords and causes general muscle paralysis. It binds directly to postsynaptic acetylcholine receptor endplates, leading to fasciculations followed by muscular paralysis. It has a very rapid onset (45–60 seconds) and short duration of action (4–6 minutes). A typical dose is 0.1 to 0.2 mg/kg or 20 mg IV to break the spasm. It will require ventilation support. There is a lack of fade in train-of-four response. It should not be used whenever hyperkalemia is possible, such as muscular dystrophy or other myotonias, in muscle denervation, cerebral palsy, multiple sclerosis, or burn patients. An increase in potassium from succinylcholine use in hyperkalemic conditions may lead to cardiac arrest. It is a trigger for malignant hyperthermia and can result in prolonged paralysis in patients with pseudocholinesterase deficiency. It has a shelf life of 2 weeks.

*Dantrolene*

Dantrolene is used for the treatment of malignant hyperthermia crisis. It is required in any clinic that uses known triggers like sevoflurane, isoflurane, desflurane, and succinylcholine. It interferes
with calcium release from the sarcoplasmic reticulum and leads to muscle relaxation. Triggering agents should be discontinued. The patient should be hyperventilated with 100% oxygen at a 10-L/min flow rate, and then sodium bicarbonate administered, the patient cooled, and diuretics (furosemide) administered. The initial dose is a bolus of 2.5 mg/kg with increments up to 10 mg/kg administered via a large-bore IV catheter. It is formulated in 20 mg per bottle of powder, which needs to be reconstituted in 60 mL sterile water. The Malignant Hyperthermia Association of the United States recommends 36 vials be kept on site if a triggering agent is stocked in the clinic.21

**Ryanodex**

Ryanodex is an alternative to the conventional dantrolene sodium formulation, used for the treatment of malignant hyperthermia. It is a ryanodine receptor 1 antagonist. Each vial contains 250 mg of dantrolene and is reconstituted in 5 mL of sterile water to allow rapid administration.21

**Rocuronium**

Rocuronium is a nondepolarizing muscle relaxant. It works by competing for cholinergic receptor at the motor endplate. It has a rapid onset (dose dependent 45–120 seconds) with intermediate duration of action (30–90 minutes). When used in high concentration, it may be considered a substitute for succinylcholine to break laryngospasm. A typical dose is 0.6 to 1.2 mg/kg; a higher dose of 1.2 mg/kg will decrease the onset of action to 45 to 60 seconds. It may require prolonged ventilation support. It does not depend on plasma cholinesterase for metabolism. Local anesthetics will increase the duration of neuromuscular block. It has a shelf life of 12 weeks.21

**Sugammadex**

Sugammadex is used for reversal of neuromuscular blockade from rocuronium. It is a modified gamma cyclodextrin that encapsulates the rocuronium molecule. Unlike neostigmine, it does not inhibit acetylcholinesterase, and cholinergic effects are not seen; therefore, an antimuscarinic agent (atropine or glycopyrrolate) is not needed. It will reverse deep induced paralysis in 2.9 minutes versus neostigmine at 48.8 minutes. Reversal of moderate block (appearance of second twitch in train-of-four stimulation) with rocuronium is 2 mg/kg. For deep block (no twitches in train-of-four stimulation), a dose of 4 mg/kg is used. For immediate reversal, use 16 mg/kg. Sugammadex may make hormonal contraception less effective for up to 7 days.21

**Anticonvulsant**

Most seizures are transient and managed by protection of the patient’s head with cushioning and removing sharp objects from around the patient’s area. Status epilepticus and prolonged or recurrent seizure require anticonvulsant therapy, such as benzodiazepines. They act on the inhibitory neurotransmitter GABA, the limbic system, the hypothalamus, and the thalamus to produce sedation, an antianxiety effect, and skeletal muscle relaxation. Diazepam at a dosage of 10 mg is acceptable if the IV line is intact. However, if a line is lost during a tonic-clonic convulsion, lorazepam 4 mg is the drug of choice, as it is long acting and allows IM administration. Lorazepam also can be used for management of acute withdrawal symptoms. Midazolam 5 mg may also be used, as it allows for IM administration.25–27

**REVERSAL AGENTS**

**Naloxone**

Naloxone is used for the management of opioid overdose with unintended respiratory depression. It is an antagonist for all opioid receptor subtypes. It will reverse all effects of opioids, including analgesia, respiratory depression, and chest wall rigidity. Because of its onset of action of 1 to 2 minutes, it is unsuitable for management of desaturation secondary to opioid-induced chest wall rigidity. Succinylcholine is the first-line agent for this. After administration of Naloxone, patients should be monitored in office for 1 hour to rule out re-sedation. A typical dose is 0.1-mg increments
titrated to effect with a maximum of 0.8 mg. Formulation is usually 0.4 mg/mL in a 1-mL vial, which can be diluted with normal saline in a 10-cc syringe for a 0.1-mg/mL solution. Caution should be used, as use may result in significant release of catecholamines resulting hypertension, seizures, ventricular tachycardia, ventricular fibrillation, or fluid shift triggering pulmonary edema.28

**Flumazenil**

Flumazenil is used for management of benzodiazepine overdose, resulting in unconsciousness in planned moderate sedation, postoperative drowsiness, central nervous system depression, respiratory depression, or emergence delirium. It reverses the sedation, anxiolysis, amnesia, muscle relaxation, and anticonvulsant effects of benzodiazepines by inhibiting GABA receptors. Patients should be monitored in office for at least 1 hour to rule out re-sedation. A typical dose is 0.1 to 0.2 mg titrated to effect. It should not be given to patients with a seizure disorder managed by benzodiazepines.28

**Anticholinergics**

Anticholinergics is used for management of hemodynamically significant bradycardia, dizziness or motion sickness-related symptoms, and increased salivation. The target of anticholinergic medications is muscarinic receptors. When activated, these receptors cause parasympathetic effects on specific organs. The primary anticholinergic medications are atropine, glycopyrrolate, and scopolamine. Atropine has the fastest onset and blocks vagal stimulation to the heart, allowing for unopposed sympathetic stimulation. This makes it the drug of choice for hemodynamically unstable bradycardia with a typical dose of 0.5 mg IV titrated to effect. It also can be used in smaller doses of 0.01 mg/kg to counteract the hyperalvation effect of ketamine during procedural sedation. It should not be given to patients with ischemic heart disease, acute narrow-angle glaucoma, prostatic hypertrophy, urinary retention, acute hemorrhage, or hyperthyroidism. Physostigmine, a cholinesterase inhibitor, can reverse anticholinergic syndrome (emergence delirium) encountered with use of scopolamine, benzodiazepines, or diphenhydramine.21

**ANTIHYPERTENSIVE AGENTS**

**Esmolol**

Esmolol is a beta-1 selective antagonist with a very short duration of action. It decreases the force and rate of heart contractions. A typical dose is 20 mg titrated to effect. The duration of action is under 20 minutes. It can be used for management of hypermetabolic state. Caution should be used with patients with asthma and chronic obstructive pulmonary disease.21

**Labetalol**

Labetalol is a selective alpha-1 blocker and nonselective beta-blocker. It has intrinsic sympathetic activity and will not decrease resting cardiac function as much as esmolol. It lowers blood pressure by blockade of alpha-1 receptors in vascular smooth muscle and beta-1 receptor in the heart. The dosage is 20 mg titrated to effect. Duration of action is 2 to 18 hours. Caution should be used in patients with asthma, bradycardia, and congestive heart failure. Any patient given antihypertensive should be assessed carefully before discharge for risk of orthostatic hypotension.21

**Hydralazine**

Hydralazine is a direct-acting smooth muscle relaxant used to treat hypertension. It acts as a vasodilator to decrease peripheral resistance and lowers the blood pressure and decreases afterload. It can cause reflex sympathetic stimulation, which increases the heart rate and cardiac output. A typical dose 5 mg IV titrated up to 25 mg. Onset is 5 minutes with a duration 2 hours. It can be used for patients with asthma and can cause flushing, hypotension, headache, and nausea/vomiting. It should not be given to patients with tachycardia, coronary artery disease, constrictive pericarditis, lupus, pulmonary hypertension, high-output heart failure (thyrotoxicosis), dissection aortic aneurysm, or porphyria.29

**ANTIARRHYTHMIC**

**Amiodarone**

Amiodarone is used for the treatment of ventricular fibrillation, pulseless ventricular tachycardia refractory to defibrillation and epinephrine administration, and stable ventricular tachycardia. It is also used for Wolff-Parkinson-White syndrome with reentry phenomenon. It works by blocking potassium channels by slowing down conduction in the atrioventricular (AV) node and increasing threshold for ventricular fibrillation. In cardiac arrest algorithm, it is given as a 300-mg bolus. It should not be given with other antiarrhythmics or beta-blockers, as it may cause sinus arrest.30

**Adenosine**

Adenosine is used for the treatment of paroxysmal supraventricular tachycardia. It works by slowing
conduction in the AV node and interrupting the reentry pathways. A typical dose is 6 mg push. It has a very rapid onset and may cause transient sinus bradycardia or asystole with administration. It may also cause chest pain, hypotension, flushing, and bronchospasm. It should not be given to patients with asthma or those taking dipyridamole or theophylline.31

**DIURETICS**

**Furosemide (Lasix)**

Furosemide (Lasix) is used to treat fluid buildup due to congestive heart failure, acute pulmonary edema, acute decompensated heart failure, and resistant hypertension. It is also used to prevent kidney injury during malignant hyperthermia. It is a loop diuretic that works on the thick ascending limb of loop of Henle. A dose is typically 0.5 to 1 mg/kg IV over 1 to 2 minutes for acute pulmonary edema and hypertensive crisis. Onset of action is 5 minutes after IV administration, and duration is 2 hours. Oral administration of Lasix will “last 6 hours,” hence the name. It should not be used in patients with lupus, liver disease, renal impairment, and sulfa allergies. It can cause electrolyte imbalance, hypotension, and ototoxicity.21

**Antiemetics**

Antiemetics are used for treatment of nausea and vomiting after procedural sedation. It is important to know the known risk factors, like younger age, female sex, nonsmoker, and history of postoperative nausea vomiting. Also, high risks are obesity, gastroesophageal reflux disease, gastroparesis, and diabetes. It is important to limit known triggers like N2O, fentanyl, and etomidate.21

**Ondansetron**

Ondansetron is used to prevent nausea and vomiting after procedural sedation. It is a 5-HT3 receptor antagonist that acts on both peripheral vagal nerve terminals and central chemoreceptor trigger zone of the area postrema in the medulla. Dose is usually 4 mg IV. It is associated with prolonged QT interval, which may lead to torsades de pointes. It should not be given to patients with congenital long QT syndrome and congestive heart failure.21

**Metoclopramide**

Metoclopramide is used to prevent nausea and vomiting after procedural sedation. It is a dopamine D2 receptor antagonist that acts on the chemoreceptor trigger zone in the central nervous system. The dose is 10 mg. It can cause movement disorders like tardive dyskinesia. It should not be used in patients with Parkinson disease. It can also trigger neuroleptic malignant syndrome (NMS), characterized by high fever, confusion, rigid muscles, and autonomic imbalance. The management for NMS is stopping the offending agent, rapid cooling, dantrolene, and benzodiazepines.21 One may also consider supplementing with additional known antiemetics like Decadron, propofol, and scopolamine transdermal patch.

**SUMMARY**

Anxiety control and patient comfort are integral parts of the OMFS practice. Knowledge of emergency drugs is part of a safe anesthesia practice, which includes proper patient selection, anesthesia technique, drug regimen, monitoring, and emergency preparedness.

This article focuses on describing many of the characteristics and properties of drugs that are helpful in the treatment of anesthetic emergencies in the OMFS office. This list should not be considered mandatory or all-inclusive.

Any OMFS office should be prepared to deal with emergencies. The provider should be cognizant of the drugs discussed in this article. Knowledge of the indication and appropriate use of the drugs described provides a sound basis for the management of adversity that may arise during sedation or anesthesia in an outpatient OMFS office.

**CLINICS CARE POINTS**

- A list of core emergency drugs includes oxygen, nitroglycerin, aspirin, epinephrine, albuterol, aromatic ammonium, diphenhydramine, and glucose.
- American Association of Oral and Maxillofacial Surgeons Anesthesia committee recommends the oral surgery office maintain supplies of the following medications: vasoressors, corticosteroids, bronchodilators, muscle relaxants, narcotic antagonists, benzodiazepine antagonists, antihistamines, antiarrhythmic, anticholinergics, coronary artery vasodilators, antihypertensives, and drugs for treatment of malignant hyperthermia.
- Triggers for malignant hyperthermia include sevoflurane, isoflurane, desflurane, and succinylcholine.
- Malignant hyperthermia can be treated with dantrolene or Ryanodex.
- Sugammadex can reverse neuromuscular blockade of Rocuronium.
- Naloxone can reverse overdose of fentanyl.
- Flumazenil can reverse overdose of versed.
- Physostigmine can reverse anticholinergic syndrome (emergence delirium) from use of glycopyrrolate.
- Basic life support, advanced cardiovascular life support, and pediatric advanced life support algorithms and guidelines should be routinely reviewed and readily available.

DISCLOSURE
The authors have nothing to disclose.

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