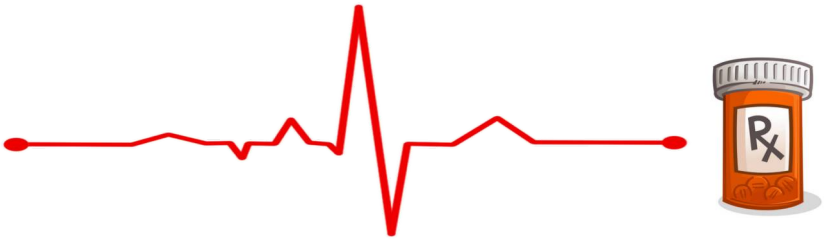
Medication Reference for the EMS Professional

2018



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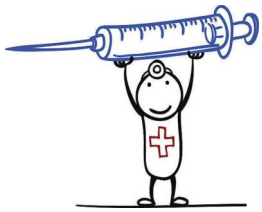

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INTRODUCTION

1. This document provides general, introductory guidelines for prehospital emergency care providers in Pennsylvania.

2. Medical Command physicians, other EMS systems, and in-hospital providers may appropriately use/order dosages that are outside the recommended ranges listed in this document or in the state protocol.

3. Always know and follow *your* local protocols.

4. Always use closed-loop communication. We are expected to question—and we may ultimately refuse—any order that we believe to be harmful to our patients.

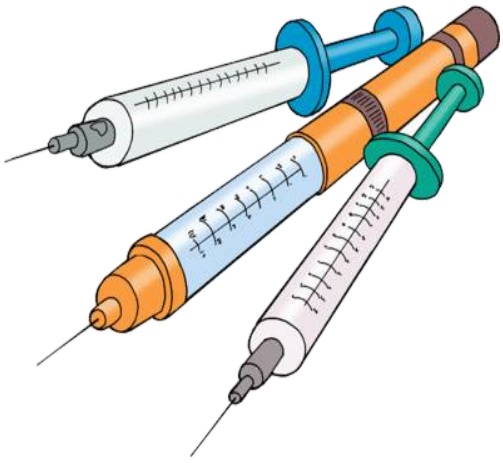
5. No protocol or reference document can replace proper clinical judgment, critical thinking, and common sense. YOU ARE ULTIMATELY RESPONSIBLE FOR PROVIDING THE OPTIMAL CARE FOR YOUR PATIENT!

6. The IV medications in this document may also be administered via intraosseous access.

7. Generally, the weight-based pediatric dosages (often calculated with a length-based, color-coded resuscitation tape) should not exceed the maximum adult dosage.

8. Make appropriate dosage adjustments for the elderly and for medically compromised patients. These patients will often require lower dosages than those that are listed.

9. Abbreviations:
   - ET = via endotracheal tube
   - IM = intramuscular
   - IN = intranasal
   - IO = via intraosseous access
   - IVP = IV push
   - IVPB = IV piggyback (secondary IV infusion)
   - PO = by mouth
   - PR = rectally
   - SQ = subcutaneous



Acetaminophen (Tylenol)

Classification

Analgesic, antipyretic

Therapeutic Effects

- Pain reliever
- Fever reducer

Indications

- Musculoskeletal pain (including pain associated with trauma)
- Fever (including fever associated with seizures)

Contraindications

- Hypersensitivity to acetaminophen

Side Effects

Other: nausea, headache, rash

Adult Dosing

650 mg PO

Pediatric Dosing

- 15 mg/kg PO or PR (via suppository)
- Should not be administered to patients who are < 3 months of age

Notes & Precautions

- Acetaminophen (APAP) is generally not administered to patients with a fever until the temperature exceeds 38°C/100.4°F.
- It should also not be administered to patients who have received a dose within the past 4 hours.
- Administer with caution to patients with hepatic or renal dysfunction, chronic malnutrition, and chronic alcohol abuse.
- Do not exceed 4 g/day from all sources for patients who are 12 years of age and older.
- Do not exceed 75 mg/kg/day from all sources for children who are less than 12 years of age.
- Many commonly prescribed and OTC cold/cough/fever medications contain APAP. All potential sources of the medication should be considered prior to its administration to avoid acetaminophen toxicity.
- Overdoses are treated with acetylcysteine (usually in the IV form).
- IV acetaminophen is sometimes administered to hospital inpatients.

Common medications that contain acetaminophen:

Endocet	Lortab	Roxicet	
Excedrin	Norco	Tramadol	
Fioricet	Percocet	Vicodin	

Activated Charcoal (Actidose, Insta-Char, SuperChar)

Classification	Chemical adsorbent
Therapeutic Effects	Porous surface of carbon molecule adsorbs toxins and inhibits GI absorption
Indications	Oral ingestion of certain drugs or chemicals that leads to overdose or poisoning
Contraindications	♦ Ingestion of caustic or corrosive substances, such as acids or strong alkalis ♦ Bleeding or perforation of GI tract ♦ Ingestion of cyanide, heavy metals, petroleum distillates, ferrous sulfate, alcohols (charcoal will not be effective)
Side Effects	**Gastrointestinal:** nausea, vomiting, constipation, abdominal pain, diarrhea
Adult Dosing	1 g/kg PO or via naso-/orogastric tube (50 g and 75 g are typical doses)
Pediatric Dosing	Same as adult dosing
Notes & Precautions	♦ Activated charcoal is often supplied with sorbitol, a hypertonic sugar that acts as a laxative. ♦ It is supplied in bottles or tubes as a suspension that must be shaken vigorously prior to administration. Because the contents may consolidate in the bottle before use, the container is sometimes kneaded to distribute the medication throughout the liquid. ♦ Sometimes activated charcoal is supplied in powdered form (25 g/tablespoon) that must be mixed with water before administration. ♦ Oral administration should only be attempted in patients who are able to drink directly from the bottle through a straw without assistance, nausea, or vomiting. Patients with an altered level of consciousness or the potential for airway compromise should *not* be given activated charcoal orally. ♦ It is most effective when administered within 30 minutes of the poison's ingestion. It may be effective within 60 minutes for certain substances that slow GI motility, such as anticholinergics. ♦ It is generally not utilized in acetaminophen overdoses, as it may interfere with acetylcysteine, the specific antidote for acetaminophen toxicity. ♦ Milk may decrease the effectiveness of charcoal. ♦ Activated charcoal should never be given in combination with syrup of ipecac. ♦ Adsorption refers to the ability of harmful substance to bind to the exterior structure of the charcoal without chemically reacting with it.

Adenosine (Adenocard)

Classification

Antidysrhythmic, endogenous nucleoside

Therapeutic Effects

- Depresses automaticity in the SA node
- Slows conduction through the AV node
- May interrupt reentry pathways in the AV node

Indications

SVT unresponsive to vagal maneuvers

Contraindications

- Hypersensitivity to adenosine
- 2nd or 3rd degree AV (heart) block
- History of sick sinus syndrome
- Diagnosis of Wolff-Parkinson-White Syndrome because of the risk of unstable tachycardia or cardiac arrest
- Relatively contraindicated in patients with asthma or COPD who are short of breath/wheezing because of the increased risk of bronchospasm

Side Effects

Cardiovascular: chest discomfort, palpitations, hypotension, transient asystole, escape rhythms, heart block, bradycardia
Respiratory: shortness of breath, bronchoconstriction, wheezing
Neurological: dizziness, lightheadedness, headache, tingling, numbness, blurred vision
Other: flushed skin, diaphoresis, nausea, metallic taste in mouth

Adult Dosing

- 6 mg rapid IVP; if no response within 2 min, administer 12 mg rapid IVP
- The 12 mg dose can be repeated in some systems

Pediatric Dosing

- 0.1 mg/kg rapid IVP
- If no response within 2 min, administer 0.2 mg/kg rapid IVP

Notes & Precautions

- Because its half-life is < 10 s, administer adenosine over 1-3 s via IV access in the antecubital fossa. Raise the patient's arm during the medication push, and immediately follow it with a rapid 20 mL NSS flush from a syringe. Warn the patient of the impending discomfort, and elevate his head 30-45° before administration.
- It is generally not effective in converting atrial flutter or atrial fibrillation.
- In some systems, a rapid trial of adenosine may be given to certain unstable tachycardias before synchronized cardioversion.
- Adenosine is sometimes used to treat stable, wide-complex, regular tachcardias of unknown etiology.
- The patient's use of caffeine, theophylline, or methylxanthines may render adenosine less effective, so larger doses might be necessary.
- The patient's use of dipyramidole (Persantine) or carabamazepine (Tegretol)—or administration via central venous access—may potentiate the effects of adenosine, so longer periods of asystole may occur.

Albuterol (Proventil, Ventolin, ProAir)

Classification

Bronchodilator; short-acting beta-2 agonist

Therapeutic Effects

Relaxes bronchial smooth muscle by stimulating beta-2 adrenergic receptors

Indications

Reversible bronchospasm associated with:

- Asthma or COPD (emphysema and chronic bronchitis)
- Allergic reaction/anaphylaxis
- Toxic inhalation
- Near drowning

Contraindications

Hypersensitivity to albuterol

Side Effects

Cardiovascular: palpitations, tachycardia, dysrhythmias, hypertension
Gastrointestinal: nausea, vomiting
Neurological: headache, dizziness, diaphoresis, tremors, nervousness, hyperactivity

Adult Dosing

- 2.5 mg in 3 mL NSS nebulized with an O_2 flow rate of 6-8 L/min, repeated as indicated
- 1-2 puffs can be also be administered by inhaler (usually 90 mcg/inhalation)

Pediatric Dosing

- Nebulizer: same as adult dosing
- Inhaler: MDIs are not recommended for children < 4 years old. The inhaler dosing for older children is generally the same as it is for adults.

Notes & Precautions

- Albuterol is administered in prehospital care via hand-held, mask, and in-line nebulizers.
- Delivering albuterol with an O_2 flow rate of >10 L/min only evaporates the albuterol faster without adding any therapeutic benefit.
- Instruct the patient to breathe normally for a minute or two and then to inhale slowly and deeply. He should hold the albuterol in his lungs for several seconds after every 5-10 breaths, if possible.
- Spacers should be strongly considered with the use of MDIs to enhance the medication delivery for pediatric and compromised adult patients.
- It may be mixed and nebulized with 500 mcg of ipratropium bromide.
- Adverse effects are usually dose-related, and they occur more frequently when albuterol is used in conjunction with other sympathetic agonists.
- It may be supplied in a 0.083% solution (2.5 mg/3 mL) or less commonly in a 0.5% solution (5 mg/mL) that must be diluted.
- "HFA" is the chemical name for the propellant in the inhaler.
- Albuterol is not usually indicated for patients with acute decompensated heart failure (CHF). It is sometimes administered, however, when the bronchospasm can be attributed to a concurrent diagnosis of COPD or asthma.

Amiodarone (Cordarone, Pacerone)

Classification

Antidysrhythmic

Therapeutic Effects

- Mechanism of action affects sodium, potassium, and calcium channels
- Has alpha- and beta-blocking properties
- Prolongs both the cardiac action potential and the refractory period
- May increase coronary perfusion and reduce PVR

Indications

- Persistent or recurrent ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT)
- VT or wide-complex tachycardia of unknown etiology (with a pulse)
- Post-cardioversion of VT
- Post-ROSC prophylaxis

Contraindications

- Hypersensitivity to amiodarone
- Pulmonary edema or signs of acute heart failure
- Hypotension or cardiogenic shock
- Bradycardia or 2nd/3rd-degree AV (heart) block
- Concurrent use of procainamide or other drugs that prolong the QT interval

Side Effects

Cardiovascular: hypotension, bradycardia, AV conduction abnormalities, prolonged QT interval

Other: headache, dizziness, flushing, abnormal salivation

Adult Dosing

Cardiac arrest: 300 mg IVP with a repeat dose of 150 mg in 10 min if indicated (dilute both doses in 20-30 mL NSS/D_5W before administration)

Wide-complex tachycardia:

- Loading dose: 150 mg (mixed in 100 mL D_5W/NSS) over 10 min, repeated as indicated
- Maintenance infusion: 1 mg/min (mix 100 mg in 100 mL D_5W/NSS)

Post-ROSC Prophylaxis:

- If any bolus was administered during CPR, only initiate the 1 mg/min maintenance infusion.
- If **no** bolus was administered during CPR, infuse a 150 mg/10 min loading dose followed by the 1 mg/min maintenance infusion.

Pediatric Dosing

Cardiac arrest: 5 mg/kg IVP (dilute in 20 mL NSS before administration)

Wide-complex tachycardia/Post-ROSC: 5 mg/kg infused over 20-60 min

Notes & Precautions

- Use an in-line filter for all infusions when one is available.
- Amiodarone may be used for certain SVTs after standard therapies fail.
- Its half-life may be as long as several weeks.
- Use caution in patients with renal or hepatic dysfunction and in pregnant patients.

Ammonia Inhalants

Classification

Aromatic ammonia spirit, respiratory stimulant

Therapeutic Effects

Irritates the peripheral sensory receptors of the nasal septum to cause reflex stimulation of the respiratory and vasomotor centers

Indications

Syncope and the prevention of syncope

Contraindications

- Hypersensitivity to ammonia
- Altered mental status possibly caused by:
  - Respiratory distress
  - Cardiac symptoms
  - Neurologic deficits
  - Trauma

Side Effects

Respiratory: bronchospasm, wheezing, airway irritation, pulmonary edema, laryngospasm, stridor, cough

Adult Dosing

Hold one inhalant 4 inches from the nostrils, and wave it back and forth 1-2 times.

Pediatric Dosing

Not recommended for pediatric use

Notes & Precautions

- Repeat doses should not be required. Instead, place the pre-syncopal patient in a supine position and maintain his alertness with continuous verbal and physical stimuli.
- Inhalants are supplied in single-dose, breakable ampules that are wrapped in a paper or cotton sleeve.
- Use caution in patients with a history of respiratory problems because ammonia inhalants may cause bronchospasm.
- Use caution in all patients when an ALS mechanism or concern exists. Treat with the appropriate protocol instead.
- Syncope may indicate a significant underlying illness or injury.
- Ammonia inhalants should not be used as a diagnostic tool to differentiate patients with a true altered level of consciousness from those who are faking unresponsiveness.
- Store away from direct heat and light.

Aspirin

Classification

Antiplatelet, antiaggregant, antithrombotic

Therapeutic Effects

Inhibits platelet aggregation and vasoconstriction by inhibiting thromboxane A_2 production

Indications

- Chest discomfort of suspected myocardial origin
- Acute coronary syndromes (ACS)

Contraindications

Absolute:
- Hypersensitivity to aspirin

Relative:
- Active or recent history of GI bleeding
- Bleeding disorders
- Thrombocytopenia
- Nasal polyps

Side Effects

Gastrointestinal: nausea, epigastric pain
Other: bleeding, tinnitus, wheezing

Adult Dosing

324 mg PO (chewed and swallowed)

Pediatric Dosing

Not used in prehospital emergency care

Notes & Precautions

- The standard abbreviation for aspirin is ASA (acetylsalicylic acid).
- Even if the patient has already taken her daily dose of ASA, a full 324 mg dose should still be administered for suspected ACS.
- It is sometimes indicated in the hospital for ischemic strokes that cannot be treated with fibrinolytic therapy.
- Aspirin administration, even in doses as low as 162 mg, significantly decreases mortality for MI patients.
- Despite most relative contraindications, a single dose of aspirin is considered to be a safe and therapeutic treatment for ACS.
- Although some EMS systems list several contraindications to the administration of aspirin, the only absolute contraindication is a true hypersensivity to the medication.
- Emergency Medical Dispatchers may have directed the potential ACS patient to self-administer aspirin prior to the ambulance arrival.
- Other classifications of aspirin include: analgesic, antipyretic, and NSAID (non-steroidal anti-inflammatory drug).
- It is not recommended in pediatric patients due to the increased risk of developing Reye's Syndrome.
- AIA (aspirin-induced asthma), also known as AERD (aspirin-exacerbated respiratory disease) or Samter's Triad, is a hypersensitivity reaction to aspirin that involves nasal polyps, rhinosinusitis, and asthma.

Atropine Sulfate

Classification

Anticholinergic, vagolytic, parasympatholytic, sympathomimetic, parasympathetic blocker

Therapeutic Effects

- Inhibits parasympathetic stimulation by blocking acetylcholine receptors in target organs
- Decreases vagal tone, resulting in increased heart rate, increased SA node automaticity, and accelerated AV conduction
- Dilates bronchioles and decreases respiratory tract secretions

Indications

- Hemodynamically unstable bradycardia
- Organophosphate/carbamate/nerve agent poisoning

Contraindications

- Hypersensitivity to the medication
- Narrow-angle glaucoma (when other treatments are available)

Side Effects

Cardiovascular: tachycardia, increased myocardial O_2 demand
Respiratory: dry mucous plugs may develop in lungs
Gastrointestinal: dry mouth, thirst, difficulty swallowing
Neurological: dizziness, headache, drowsiness, restlessness, confusion, photophobia, blurred vision, pupillary dilation, seizures, glaucoma may worsen
Other: flushed, hot, dry skin

Adult Dosing

Unstable Bradycardia:
0.5 mg rapid IVP, repeated every 3-5 min to a max of 3 mg

Organophosphate and Carbamate Poisoning:
- 2-6 mg IM initial dose, depending on the symptom severity
- 2-6 mg IVP every 5-15 min (no max dose) until signs/symptoms are reversed (proper atropinization is evident)

Pediatric Dosing

Unstable Bradycardia:
- 0.02 mg/kg rapid IVP; may repeat once in 5 min

Organophosphate and Carbamate Poisoning:
- 0.25-6 mg IM initial dose, depending on the patient's body mass and the symptom severity
- 0.05 mg/kg IVP initial dose; double the dose every 5 min until signs/symptoms are reversed (proper atropinization is evident)

******CONTINUED ON NEXT PAGE******

Atropine Sulfate (*continued*)

Notes & Precautions

- Bradycardia may worsen if atropine is administered slowly or in doses of less than 0.5 mg in adults.
- Atropine will not be effective in treating infranodal (Mobitz II or wide-complex 3rd degree AV) blocks. In fact, it may further decrease the heart rate in a Mobitz II. It is also unlikely to be effective in hypothermic patients with bradycardia.
- Use it with caution in patients with suspected myocardial ischemia or ACS, as the increase in heart rate may accelerate the development or extend the area of myocardial injury secondary to the increased myocardial O_2 demand.
- Epinephrine is the first IV medication choice for pediatric patients with unstable bradycardia. Atropine is only used when increased vagal tone or primary AV blocks are present and when epinephrine is ineffective.
- Atropine should be not used in neonates.
- Organophosphates and carbamates are found in pesticide products, such as flea and tick collars, ant and roach sprays/traps, and bug bombs.

Signs of proper atropinization:

- Shortness and breath and wheezing decrease
- Heart rate, BP, SpO_2, tidal volume, and BVM compliance improve
- Skin and visible secretions dry
- Level of consciousness may improve

Mnemonic for signs of excess atropine administration:

- *Red* as a beet (flushing)
- *Dry* as a bone (dry mouth and skin)
- *Hot* as a pistol (hyperthermia)
- *Blind* as a bat (blurred vision and dilated pupils)
- *Mad* as a hatter (confusion and delirium)

Benzocaine (Hurricane Spray)

Classification	Local topical anesthetic of the ester type
Therapeutic Effects	Temporary pain relief
Indications	♦ First degree burns (such as a sunburn) ♦ Insect bites and stings ♦ Minor lacerations and abrasions ♦ Anesthesia of airway structures prior to nasotracheal intubation
Contraindications	♦ Hypersensitivity to benzocaine or any ester-type anesthetic ♦ Infection or sores at site of application (relative)
Side Effects	**Cardiovascular:** bradycardia, hypotension **Neurological:** dizziness, drowsiness, paresthesia, restlessness, headache **Other:** nausea, diaphoresis, tinnitus, urticarial, rash
Adult Dosing	Spray or use applicator to apply directly to area
Pediatric Dosing	Same as adult dosing
Notes & Precautions	♦ Benzocaine is administered for external topical use only. ♦ It is supplied in multiple application mechanisms and concentrations. Anesthetic sprays are supplied in 5% and 20% concentrations. ♦ The onset of action is generally 1 minute, and the duration of action is often between 15-20 minutes. ♦ It is minimally absorbed into the systemic circulation, so side effects are rare. ♦ It should be stored in a temperature range of 59-86 degrees Fahrenheit.

Calcium Chloride

Classification	Electrolyte
Therapeutic Effects	♦ Aids in the transmission of nerve impulses ♦ Increases contractility of cardiac, skeletal, and smooth muscles ♦ Helps to maintain cell membrane and capillary permeability ♦ Is a component of the blood coagulation process
Indications	♦ Known or suspected hyperkalemia ♦ Known or suspected calcium channel blocker overdose ♦ Crush syndrome and/or associated compartment syndrome
Contraindications	♦ Digitalis toxicity ♦ Ongoing ventricular fibrillation (VF) ♦ Hypercalcemia
Side Effects	Burning sensation at injection site
Adult Dosing	1 g IVP over 3-5 min (more quickly during cardiac arrest)
Pediatric Dosing	20 mg/kg (0.2 mL/kg of a 10% solution) IVP over 3-5 min (more quickly during cardiac arrest)
Notes & Precautions	♦ Calcium chloride (CaCl) is usually supplied in a 10% solution that yields a concentration of 100 mg/mL. ♦ Repeat doses are used in some systems for the indications above. ♦ CaCl should be administered through a larger vein to minimize irritation to the vessel. ♦ IV patency should be continuously reassessed, as infiltration of CaCl will cause tissue necrosis. ♦ CaCl will precipitate with sodium bicarbonate. Use separate IV lines to administer each medication, if possible. If only one IV line is available, be sure to flush the tubing copiously before and after each medication is pushed. ♦ In some systems, doses as low as 2-4 mg/kg may be given prior to calcium channel blocker (verapamil or diltiazem) administration to prevent hypotension. ♦ CaCl is sometimes used to treat magnesium toxicity in pregnant women who are receiving an IV infusion of the medication. ♦ Administer CaCl with extreme caution, if at all, to patients who are taking digitalis, as doing so may precipitate digitalis toxicity. Consider administering smaller doses more slowly.

Captopril (Capoten)

Classification

Angiotensin-converting enzyme (ACE) inhibitor

Therapeutic Effects

- Lowers blood pressure
- Decreases both preload and afterload primarily by dilating the arterioles

Indications

Acute decompensated heart failure (CHF)

Contraindications

- Hypersensitivity to captopril or any other ACE inhibitor
- History of angioedema related to previous ACE inhibitor treatment
- Hereditary or idiopathic angioedema
- Pregnancy

Side Effects

Cardiovascular: angioedema, hypotension
Other: abdominal pain, cough, syncope

Adult Dosing

25 mg SL

Pediatric Dosing

Not recommended for prehospital emergency care

Notes & Precautions

- The onset of action may occur within 5 minutes, and the time to peak effect is approximately one hour.
- Use with caution in patients with renal dysfunction.
- Significant hypotension may result in patients who are hyponatremic or hypovolemic (e.g., for those patients who take diuretics).
- Captopril interrupts the renin-angiotensin-aldosterone system (RAAS) by blocking the conversion of angiotensin I to angiotensin II.

Common ACE Inhibitors (names frequently end in "-pril"):

benzapril	fosinapril	peridopril	ramipril
enalapril	lisinopril	quinapril	tandolapril

Dextrose 5% in Water (D_5W)

Classification	Hypotonic crystalloid solution; dextrose solution
Therapeutic Effects	♦ Provides a modest sugar source for cellular metabolism ♦ Provides free water for intravenous infusion
Indications	Dilution of IV infusion/push medications
Contraindications	It should not be mixed with certain medications, such as diazepam (Valium) and phenytoin (Dilantin), because of the likelihood of precipitation.
Side Effects	None when used in the manner listed above
Adult Dosing	It is generally used in prehospital emergency care only for mixing medications that are administered via IV infusion. It is not utilized for a KVO infusion or for a bolus in hypovolemic patients. The infusion rate is determined by the medication that is added to it.
Pediatric Dosing	Same as adult
Notes & Precautions	♦ D_5W is supplied in 25-1000 mL bags, although the 100 mL and 250 mL ones are the most commonly used sizes in ambulances. ♦ Because D_5W is a hypotonic crystalloid solution, its water content will begin to leave the intravascular space within 10-20 minutes. ♦ Dextrose 5% is sometimes premixed with: 0.9% NaCl solution (D_5NS) 0.45% NaCl solution (D_5-½NS) 0.225% NaCl solution (D_5-¼NS) Lactated Ringer's Solution (D_5LR) These solutions are rarely used for prehospital emergency care and are most often utilized during interfacility transfers or for long-term care when patients require a constant infusion of both water and glucose.

Dextrose 50%/25%/10% in Water

Classification

Hyperglycemic agent, carbohydrate

Therapeutic Effects

Increases blood glucose level

Indications

- Known blood glucose level of < 60 mg/dL when oral glucose cannot be administered
- *Suspected* hypoglycemia when blood glucose level is not available:
  1. Altered level of consciousness, coma, or seizure of unknown etiology
  2. Acute or chronic alcohol intoxication with altered mental status

Contraindications

- Known hypoglycemia: None
- Suspected hypoglycemia:
  1. Suspected intracranial hemorrhage with unknown blood glucose level
  2. New onset CVA signs/symptoms with unknown blood glucose level in a non-diabetic patient

Side Effects

A feeling of warmth or pain at injection site, phlebitis

Adult Dosing

25 g IV push/infusion over several minutes (see Notes below)

Pediatric Dosing

0.5 g/kg of $D_{25}W$/$D_{12.5}W$/$D_{10}W$ IV over several minutes (see Notes below)

Notes & Precautions

- Never withhold dextrose from a patient who needs it.
- In some EMS protocols, only 12.5 g of dextrose is administered to adults, and this dose will usually achieve a normal blood glucose level.
- Dextrose may be administered in any concentration to adults. To administer 25 g of dextrose, administer 50 mL of $D_{50}W$ slow IVP or infuse 250 mL of $D_{10}W$ over several minutes.
- The pediatric dose of 0.5 g/kg is equivalent to the following volumes :
  1. $D_{25}W$ (for all pediatric patients except neonates): 2 mL/kg
  2. $D_{12.5}W$ (used primarily for neonates): 4 mL/kg
  3. $D_{10}W$: (for any pediatric patient): 5 mL/kg
- To make $D_{25}W$ with a pre-filled $D_{50}W$ syringe, discard 25 mL of the original solution and replace it with 25 mL of NSS. Gently invert (but do not shake) the syringe several times to mix the medication.
- To make $D_{10}W$ with a pre-filled $D_{50}W$ syringe, discard 40 mL of the original solution and replace it with 40 mL of NSS.
- Dextrose in all concentrations is very irritating to the veins, so use the largest, most proximal vein available for IV access. If the medication leaks into the surrounding tissues, ulcers and necrosis (tissue death) will occur. Such tissue damage is a frequent cause of liability for EMS providers.
- Continuously reassess the IV site patency, and immediately discontinue the dextrose administration if patency cannot be confirmed. Pull back on the syringe plunger every 5-10 mL of the medication push. Blood should easily be aspirated into the extension tubing to confirm patency.
- $D_{50}W$ should ideally be diluted when administered via IO access.

Diazepam (Valium)

Classification

Benzodiazepine

Therapeutic Effects

- Suppresses seizure activity in the brain (anticonvulsant)
- Acts as a sedative-hypnotic by stimulating the GABA receptor
- Promotes muscle relaxation by inhibiting spinal motor reflex pathways
- Provides anxiolysis

Indications

- Generalized seizures
- Procedural sedation (such as for synchronized cardioversion, transcutaneous pacing, and post-intubation management)
- Agitated behavior or severe anxiety
- Vertigo
- Delirium tremens (from alcohol withdrawal)

Contraindications

- Hypersensitivity to diazepam
- Acute narrow-angle glaucoma

Side Effects

Cardiovascular: hypotension, bradycardia
Respiratory: ventilatory depression
Neurological: dizziness, ataxia, fatigue, drowsiness, amnesia

Adult Dosing

Generalized seizures/procedural sedation/agitated behavior:

- 0.1 mg/kg (up to 10 mg) IVP at 5 mg/min (sometimes faster in urgent situations); this dose may be repeated every 5 min to a total of 0.3 mg/kg
- Only one dose is used for synchronized cardioversion.
- Although the IM route is authorized for patients with agitated behavior, it is not preferred (administer another benzodiazepine if it's available).

Vertigo: 5 mg IVP over 1 min

Severe anxiety: 2 mg IVP over 1 min; repeat as indicated

Pediatric Dosing

Generalized seizures:

- 0.3 mg/kg (up to 5 mg) IVP at 5 mg/min; may be repeated once in 5 min
- 0.5 mg/kg (up to 10 mg) PR (rectally) may be administered if vascular access is unavailable (it should be diluted to total volume of 5 mL); this dose may be repeated once in 5 min

Procedural sedation:

- 0.1 mg/kg (up to 5 mg) IVP at 5 mg/min; this dose may be repeated every 5 min to a total of 0.3 mg/kg
- Only one dose is used for synchronized cardioversion.
- Although the IM route is authorized for patients with agitated behavior, it is not preferred (administer another benzodiazepine if it's available).

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Diazepam (Valium)—*continued*

Notes & Precautions

- Use caution in patients with hypotension or signs/symptoms of shock.
- Use caution in patients with hepatic or renal dysfunction.
- Diazepam administered during seizure activity may further depress the ventilatory drive during the post-ictal phase, so be prepared to assist the patient's breathing.
- Alcoholic beverages, antihistamines, opioids, tricyclic antidepressants, and other CNS depressants may potentiate diazepam.
- Like other benzodiazepines, it has no analgesic properties.
- Diazepam commonly causes phlebitis near the injection site. Larger veins, such as those in the antecubital fossa, are preferred.
- Diazepam (Diastat gel) can be administered rectally by both medical and non-medical personnel for pediatric patients with seizures.
- Diazepam can be administered IM via auto-injector for some patients with nerve agent exposure. Refer to local protocols for specific dosing information.
- Diazepam may precipitate when administered with D_5W and is incompatible with many IV medications. Only administer with NSS or LR infusions, and flush the IV tubing well between medication administrations.
- The effects of benzodiazepines can be reversed with flumazenil (Romazicon). However, this medication should not be administered to patients with a history of chronic benzodiazepine use because status epilepticus may result. Generally, flumazenil is not utilized in prehospital emergency care.
- Some EMS systems use diazepam as a muscle relaxant for orthopedic emergencies.
- Diazepam was the top-selling pharmaceutical between 1969-1982.

Diltiazem (Cardizem)

Classification

Calcium channel blocker

Therapeutic Effects

- Inhibits influx of calcium ions during depolarization of vascular smooth muscle and cardiac cells
- Slows AV nodal conduction time and prolongs AV nodal refractory period
- Interrupts reentry pathways in AV node
- Dilates coronary and peripheral arteries, improves coronary perfusion, and decreases peripheral vascular resistance by relaxing vascular smooth muscle

Indications

Rate control for stable, narrow-complex tachycardias, such as:

- Atrial fibrillation/flutter and atrial tachycardia
- SVT (generally after vagal maneuvers and adenosine were ineffective)

Contraindications

- Hypersensitivity to diltiazem
- Sick sinus syndrome
- 2nd or 3rd degree AV (heart) block (or any extreme bradycardia)
- Wolff-Parksinson-White Syndrome
- Hypotension or signs of shock
- Ventricular tachycardia or wide-complex tachycardia of unknown etiology

Side Effects

Cardiovascular: bradycardia, heart blocks, hypotension, CHF
Gastrointestinal: nausea, vomiting
Neurological: dizziness, syncope, headache

Adult Dosing

- 0.25 mg/kg (up to 20 mg) IVP over 2 min
- If the first dose is ineffective, 0.35 mg/kg (up to 25 mg) IVP over 2 min may be administered 15 min after the initial dose.
- A maintenance infusion of 5-15 mg/h, titrated to heart rate, may be initiated.

Pediatric Dosing

Not indicated for prehospital emergency care

Notes & Precautions

- Reduce the dose for elderly patients. Many of these patients respond to doses as low as 10 mg.
- Maintenance infusions are rarely necessary in prehospital emergency care because of diltiazem's duration of action (usually > 1 hour).
- Severe hypotension and heart failure may result if diltiazem is administered to patients who are taking oral beta blockers, calcium channel blockers, or digitalis. Medical Command consultation is strongly recommended.
- Diltiazem vials should be kept unrefrigerated for no longer than one month.
- Furosemide will precipitate if mixed with diltiazem. Flush the IV tubing well if both medications must be administered via the same site.
- Many patients take diltiazem PO on a daily basis for stable angina, hypertension, or heart rate control with chronic atrial fibrillation.
- Use caution in patients with hepatic or renal dysfunction.

Diphenhydramine (Benadryl)

Classification

Antihistamine

Therapeutic Effects

- Competes with histamine for H_1 receptor sites
- Reverses histamine-induced bronchospasm, bronchosecretions, vasodilation, and increased capillary permeability
- Relaxes non-vascular smooth muscle

Indications

- Allergic reaction/anaphylaxis
- Dystonic (extrapyramidal) reactions, often from the use of phenothiazines or phenothiazine-like medications

Contraindications

- Hypersensitivity to diphenhydramine
- Acute asthma exacerbation
- Pregnant or nursing women (relative contraindication)
- Narrow-angle glaucoma (relative contraindication)

Side Effects

Cardiovascular: palpitations, tachycardia, hypotension
Respiratory: formation of dry mucous plugs in lower airway
Neurological: drowsiness, confusion, blurred vision, decreased coordination
Other: dry mouth, urinary retention

Adult Dosing

50 mg IVP over 2 min (may also be administered IM)

Pediatric Dosing

1 mg/kg IVP over 2 min (may also be administered IM)

Notes & Precautions

- In some EMS systems, the doses above are sometimes repeated.
- Diphenhydramine has an anticholinergic (atropine-like) effect on the body. For this reason, it should not be administered to patients with asthma exacerbations because it causes the formation of dry mucous plugs in the lower airways (which increase airway resistance).
- Diphenhydramine is a CNS depressant, and it may potentiate other antihistamines, alcoholic beverages, narcotics, and sedatives.

Typical dystonic reactions to phenothiazine-like medications:

- Buccolingual crisis: facial spasms that may include tongue protrusion, difficulty swallowing, and the sensation of a "thick tongue"
- Oculogyric crisis: involuntary gyration of the eyes
- Akathisia: an ability to remain still or the inability to sit in general; the patient may stand, stare, and shuffle without any apparent purpose
- Torticollis (neck spasms) and muscle spasms involving other body parts

Examples of phenothiazines or phenothiazine-like medications:

Compazine	Mellaril	Phenergan	Thorazine
Haldol	Navane	Stelazine	Triavil

Dobutamine (Dobutrex)

Classification	Inotropic agent; beta-1 agonist
Therapeutic Effects	Increases inotropy (contractility) and AV conduction
Indications	♦ Congestive heart failure (acute decompensated heart failure) ♦ Cardiogenic shock
Contraindications	♦ Hypersensitivity to dobutamine ♦ Hypovolemia
Side Effects	**Cardiovascular:** palpitations, tachycardia, PVCs, hypertension, chest discomfort **Neurological:** nervousness, headache **Other:** leg cramps
Adult Dosing	Generally start the IV infusion at 5 mcg/kg/min; increase by an additional 5 mcg/kg/min every 10 min as indicated to a maximum of 20 mcg/kg/min (See *Notes* below)
Pediatric Dosing	Not recommended for prehospital use
Notes & Precautions	♦ Dobutamine is mixed in either D_5W or NSS. Mix 200 mg in 250 mL for an 800 mcg/mL concentration. Premixed solutions are available. ♦ Dopamine is the preferred medication in prehospital care for patients in cardiogenic shock. ♦ Dobutamine may be used for patients with acute decompensated heart failure (CHF) and hypotension. ♦ Slight alpha-1/beta-2 adrenergic effects might be present, however they (as well as tachycardia) are considered to be side effects. The absence of these effects is desirable so as to minimize the increase in myocardial O_2 demand. ♦ Concurrent use of tricyclic antidepressants may promote prolonged hypertension.

Dopamine (Intropin)

Classification

Adrenergic agonist, sympathomimetic, catecholamine, inotropic agent

Therapeutic Effects

Low Dose (1-4 mcg/kg/min):

- Dilates renal and mesenteric arteries by stimulating dopamine receptors
- May reduce BP due to vasodilation

Moderate Dose (5-10 mcg/kg/min):

- Increases inotropy (cardiac contractility) and chronotropy (heart rate)
- Increases cardiac output and BP by stimulating beta-1 receptors

High Dose (10-20 mcg/kg/min):

- Causes vasoconstriction by stimulating alpha receptors
- Increases BP by activating both alpha and beta receptors
- Alpha-1 effects are most prominent in this dosing range

Indications

- Cardiogenic shock
- Distributive (vasodilatory) shock)
- Hemodynamically unstable bradycardia

Contraindications

- Hypersensitivity to dopamine
- Hypotension secondary to heat stroke

Side Effects

Cardiovascular: tachycardia, palpitations, hypertension, chest discomfort, ventricular irritability, vasoconstriction

Other: dyspnea, nausea, vomiting

Adult Dosing

Generally start the IV infusion at 5 mcg/kg/min; increase by an additional 5 mcg/kg/min every 10 min as indicated to a maximum of 20 mcg/kg/min (See *Notes* below)

Pediatric Dosing

Same as adult

Notes & Precautions

- Titrate the infusion to achieve signs of adequate perfusion (in addition to a target BP, if appropriate).
- Dopamine can be mixed in either D_5W or NSS. A common prehospital method is to mix 200 mg in 250 mL for an 800 mcg/mL concentration. Premixed solutions are available in 800, 1600, and 3200 mcg/mL concentrations. The higher concentrations are used in the hospital for fluid-restricted adults, but more dilute concentrations are safer for prehospital use.
- Do not mix IV push medications in the same IV tubing as a dopamine infusion. Sodium bicarbonate, in particular, will decrease the effectiveness of dopamine.
- Dopamine infusions should not be abruptly discontinued because the BP will decrease rapidly. Gradually taper the infusion before stopping it.

Enalapril (Enalaprilat, Vasotec)

Classification

Angiotensin-converting enzyme (ACE) inhibitor

Therapeutic Effects

- Lowers blood pressure
- Decreases both preload and afterload primarily by dilating the arterioles

Indications

Acute decompensated heart failure (CHF)

Contraindications

- Hypersensitivity to enalapril or any other ACE inhibitor
- History of angioedema related to previous ACE inhibitor treatment
- Hereditary or idiopathic angioedema
- Pregnancy

Side Effects

Cardiovascular: angioedema, hypotension
Other: abdominal pain, cough, dizziness, syncope

Adult Dosing

0.625-1.25 mg IVP over 5 min

Pediatric Dosing

Not recommended for prehospital emergency care

Notes & Precautions

- The onset of action may occur within 1-2 minutes, and the time to peak effect is approximately 30 minutes.
- Use with caution in patients with renal dysfunction.
- Significant hypotension may result in patients who are hyponatremic or hypovolemic (e.g., for those patients who take diuretics).
- Enalapril interrupts the renin-angiotensin-aldosterone system (RAAS) by blocking the conversion of angiotensin I to angiotensin II.
- It is a second-generation ACE inhibitor, and it is associated with fewer side effects than captopril.

Common ACE Inhibitors (names frequently end in "-pril"):

benzapril	fosinapril	peridopril	ramipril
captopril	lisinopril	quinapril	tandolapril

Epinephrine (Adrenaline)

Classification

Adrenergic agonist, sympathomimetic, catecholamine

Therapeutic Effects

- Improves cardiac output by acting on beta-1 receptors to increase chronotropy (heart rate), inotropy (contractility), and dromotropy (conduction velocity), and automaticity
- Relaxes bronchial smooth muscle by acting on beta-2 receptors
- Increases BP by acting on the alpha-1 receptor to promote vasoconstriction
- May increase coronary and cerebral perfusion during CPR

Indications

- Cardiac arrest
- Hypotension post-ROSC
- Allergic reaction/anaphylaxis
- Unstable bradycardia
- Asthma/COPD/bronchospasm
- Distributive shock
- Croup/stridor/upper airway edema

Contraindications

None when used for the indications above

Side Effects

Cardiovascular: palpitations, tachycardia, chest discomfort, hypertension, ectopy, increased myocardial O_2 demand, ventricular fibrillation
Gastrointestinal: nausea, vomiting
Neurological: anxiety, restlessness, headache, dizziness, tremors, seizures

Adult Dosing

Cardiac arrest: 1 mg (1:10,000) IVP every 3-5 min

Hypotension post-ROSC/unstable bradycardia/distributive shock:
10-20 mcg IVP every 2 min (or an IV infusion starting at 5-10 mcg/min)

Allergic reaction/anaphylaxis/asthma/COPD/bronchospasm:
0.3 mg (1:1000) IM (may be repeated for some indications in 5-15 min)

Pediatric Dosing

Cardiac arrest/unstable bradcardia:
0.01 mg/kg (1:10,000) IVP every 3-5 min OR 0.1 mg/kg ET (see Notes below)

Hypotension post-ROSC:
10 mcg IVP every 2 min (lower doses may be effective)

Allergic reaction/anaphylaxis/asthma:
0.01 mg/kg (1:1000) IM (may sometimes be repeated in 5-15 min)

Croup/stridor/upper airway edema (NOT from epiglottitis):
0.5 mL 2.25% racemic epinephrine mixed with 2 mL NSS and nebulized OR
5 mg (1:1000) epinephrine nebulized (if racemic epi is unavailable)

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Epinephrine (Adrenaline)—*continued*

Notes & Precautions

- The 1:10,000 concentration is now more commonly referenced as 0.1 mg/mL, and the 1:1000 concentration is 1 mg/mL.
- To prepare push dose (10 mcg/mL) epinephrine, mix 1 mL of 1:10,000 epinephrine with 9 mL of NSS.
- To prepare an epinephrine infusion, mix 1 mg of 1:1000 epinephrine in a 250 or 500 mL bag of D_5W/NSS. The PA EMS Protocol mandates that this infusion be administered by an electronic pump.
- For neonatal resuscitation, 1 mL/kg of 1:10,000 epinephrine may be administered via tracheal tube when vascular access in unavailable. Follow the medication injection with a 2 mL NSS flush. This dose may be repeated once in 3-5 min.
- For cardiac arrest/unstable bradycardia in pediatric patients who are 1 month of age and older, 0.1 mL/kg of 1:1000 epinephrine may be administered via tracheal tube when vascular access is unavailable. Follow the medication injection with a 5 mL NSS flush. This dose may be repeated every 3-5 min until vascular access can be established.
- Use caution when administering epinephrine to pregnant women, patients over 40 years of age, and people diagnosed with hypertension or cardiovascular disease.
- Sodium bicarbonate decreases the effectiveness of epinephrine. Administer a copious NSS flush and wait at least 1 minute after each medication push.
- In some EMS systems, significantly higher doses of IV epinephrine are sometimes administered to profoundly hypotensive patients with anaphylaxis.
- Physicians and dentists use epinephrine in combination with local anesthetics (such as lidocaine) to anesthetize tissue. The epinephrine causes localized vasoconstriction which results in less bleeding and prolonged anesthesia.

Etomidate (Amidate)

Classification	Sedative-hypnotic, general anesthetic
Therapeutic Effects	♦ Short-acting medication that provides CNS sedation and general anesthesia
Indications	♦ Sedation-assisted intubation (SAI) ♦ Procedural sedation
Contraindications	Hypersensitivity to etomidate
Side Effects	**Cardiovascular:** bradycardia, tachycardia, hypotension, hypertension **Respiratory:** hypoventilation, apnea (usually of short duration) **Other:** nausea, vomiting, pain at injection site, myoclonus
Adult Dosing	0.3 mg/kg (up to 30 mg) IVP over 30-60 seconds
Pediatric Dosing	Same as adult
Notes & Precautions	♦ Etomidate's onset of action is 30-60 seconds, and the time to peak effect is about 1 min. Its duration of action is usually about 5 min for the dose listed above, however it can be longer in geriatric patients. ♦ It is believed to decrease the activity of the RAS (reticular activating system) in the brainstem, and it affects the GABA receptors. ♦ Etomidate does not provide any analgesia. ♦ It is not recommended for use in children less than 10 years of age. ♦ The loss of the eyelash reflex indicates that the patient has obtained a therapeutic level of sedation. ♦ Etomidate is an imidazole compound. It is *not* a benzodiazepine, an opioid, a barbiturate, or a neuromuscular blocking agent (paralytic). ♦ Adverse effects, especially with regard to heart rate and BP, are uncommon. ♦ When hypotension does occur, it is usually associated with rapid administration or hypovolemia. ♦ The most common side effects are pain on injection, myoclonus during sedation, and nausea/vomiting during the recovery phase. ♦ Myoclonic movements are involuntary muscle spasms in the neck, chest, and extremities that should not be confused with seizure activity. ♦ Etomidate decreases cerebral perfusion, cerebral oxygen demand, and ICP. ♦ Etomidate administration has been proven to decrease the serum cortisol level, and it should be used with caution in sepsis patients. The most significant cortisol decrease was associated with repeated IV boluses or continuous infusions.

Fentanyl (Sublimaze)

Classification

Synthetic narcotic analgesic, opioid

Therapeutic Effects

- Acts directly on CNS opioid receptors to relieve pain
- Decreases myocardial O_2 demand
- Alleviates anxiety

Indications

Relief of pain associated with:

- Musculoskeletal injuries
- Burns
- Suspected acute coronary syndromes (ACS)
- Analgesia during transcutaneous pacing and after intubation
- Kidney stones and certain other medical conditions with physician guidance

Contraindications

- Hypersensitivity to fentanyl
- Hypotension or severe hypovolemia
- Severe respiratory depression (consider etiology)

Side Effects

Cardiovascular: hypotension, bradycardia, tachycardia
Respiratory: hypoventilation
Gastrointestinal: nausea, vomiting
Neurological: altered level of consciousness

Adult Dosing

- 1 mcg/kg IVP (up to 100 mcg) over 3 min (may also be given IN/IM)
- May repeat with 0.5 mcg/kg every 5 min to a total of 3 mcg/kg

Pediatric Dosing

Same as adult

Notes & Precautions

- The onset of action for IV fentanyl is < 1 min, and its analgesic duration of action is approximately 30-60 min.
- Fentanyl is approximately 100 times more potent than morphine (50 mcg of fentanyl has the approximate analgesic effect of 5 mg of morphine). Use caution with elderly patients. Reduce the dose for patients > 65 years old. "Start low and go slow."
- Fentanyl has fewer side effects than morphine because it is not associated with any significant histamine release. Therefore, side effects such as itching, nausea, vomiting, and hypotension are less common.
- Some systems use higher single doses of fentanyl (3 mcg/kg) as an adjunct to induction during RSI.
- Muscle and chest wall rigidity may occur after larger single doses (> 3 mcg/kg) are administered rapidly.
- Some patients self-administer fentanyl via transdermal patches (Duragesic).
- Fentanyl lozenges (Actiq) are used for buccal administration in both military and civilian settings.

Furosemide (Lasix)

Classification	Loop diuretic
Therapeutic Effects	Decreases preload by increasing urine output; some slight preload reduction may also stem from vasodilation and venous pooling
Indications	Acute decompensated heart failure (CHF) with intravascular volume overload
Contraindications	♦ Hypersensitivity to furosemide ♦ Dehydration or hypovolemia ♦ Hypotension
Side Effects	**Cardiovascular:** hypotension, syncope, dehydration, dysrhythmia **Gastrointestinal:** nausea, vomiting, diarrhea **Neurological:** confusion, headache, blurred vision, tinnitus, hearing loss **Other:** electrolyte imbalances, metabolic alkalosis
Adult Dosing	40-100 mg (0.5-1 mg/kg) IVP over at least 2 min
Pediatric Dosing	Not recommended for prehospital use
Notes & Precautions	♦ Because a patient's intravascular volume status is difficult to establish in the prehospital environment, furosemide administration is rare. ♦ Repeat doses, although sometimes necessary during in-hospital care, are generally not administered in the prehospital environment. ♦ The slight reduction in peripheral vascular resistance may begin within 5 minutes, and the diuresis usually begins within 15-20 minutes. ♦ Rapid administration may damage the eighth cranial nerve, which may result in tinnitus and/or permanent hearing loss. ♦ Furosemide, when administered to patients with COPD or pneumonia, may worsen the dyspnea that is associated with these conditions. ♦ It will precipitate when mixed with diltiazem. Flush the IV tubing well if both medications must be administered via the same site. ♦ Furosemide is a sulfonamide derivative (such medications are used as antibiotics). Patients with a hypersensitivity to sulfonamides such as penicillin may also experience a hypersensitivity to furosemide when it's administered on a regular basis. Sulfonamide allergies, therefore, should not be considered to be a contraindication for single bolus doses in emergencies. ♦ Furosemide acts by inhibiting the reabsorption of sodium and chloride in the Loop of Henle as well as in the proximal and distal tubules. ♦ Because furosemide enhances the excretion of many ions, to include sodium, chloride, potassium, calcium, magnesium, and hydrogen, it should generally not be given in combination with other diuretics. Severe hypovolemia and electrolyte imbalances may result. ♦ Use caution with pregnant patients. Furosemide should only be used in immediately life-threatening situations.

Glucagon

Classification	Hyperglycemic agent, hormone
Therapeutic Effects	Increases blood glucose level by: ♦ Glycogenolysis: the conversion of hepatic glycogen to glucose ♦ Gluconeogenesis: new glucose creation from breakdown of proteins and fats
Indications	Known or suspected hypoglycemia when oral or IV dextrose cannot be administered
Contraindications	Hypersensitivity to glucagon
Side Effects	**Cardiovascular:** tachycardia, hypotension **Gastrointestinal:** nausea, vomiting
Adult Dosing	1 mg IM/IN
Pediatric Dosing	♦ 0.5 mg IM/IN for patients who weigh < 20 kg ♦ 1 mg IM/IN for patients who weigh ≥ 20 kg
Notes & Precautions	♦ Glucagon is supplied in powdered form to prolong its shelf life. It is often distributed in a package with two vials. The diluent (liquid) is removed from one of them with a syringe, and it's injected into the vial with the powdered medication. After the vial is gently swirled to mix the two components, the glucagon solution should be administered immediately. ♦ The diluent in some two-vial packages contains glycerin, and it is rarely associated with adverse reactions. ♦ If a diluent is not provided, then the glucagon powder may be reconstituted with sterile water. Concentrations of > 1 mg/mL should not be used. ♦ Glucagon may precipitate with NSS, so it should only be mixed with that solution for IM/IN administration if no other diluent is available. However, it should *not* be mixed with NSS for IV administration. ♦ If the initial dose of glucagon does not therapeutically increase the blood glucose level, it is preferable to administer IO/IV dextrose instead of a second dose of glucagon. ♦ IV glucagon is sometimes used to treat unstable bradycardia secondary to beta blocker or calcium channel blocker overdose. It increases heart rate and cardiac contractility independent of the beta adrenergic receptors. The initial dose is generally 0.05 mg/kg (up to 5 mg) IVP over 3-5 min. ♦ IV glucagon can also be used to treat esophageal and lower airway obstructions because it relaxes smooth muscle. ♦ Glucagon requires sufficient hepatic glycogen stores to function, so it is unlikely to effectively treat hypoglycemia associated with starvation, prolonged fasting, adrenal insufficiency, and prolonged physical exertion without adequate carbohydrate intake. ♦ Be prepared for the patient to vomit whenever glucagon is used (especially when larger IV doses are administered).

Hydroxocobalamin (Cyanokit)

Classification	Antidote
Therapeutic Effects	Converts cyanide to cyanocobalamin (Vitamin B12) so it can be safely excreted in urine
Indications	Known or suspected cyanide poisoning
Contraindications	Hypersensitivity to hydroxocobalamin
Side Effects	**Cardiovascular:** hypertension **Integumentary:** erythema, rash, infusion site reaction **Other:** red-colored urine, nausea, headache
Adult Dosing	♦ 5 g IV infused over 15 min ♦ A second 5 g dose may be administered over 15-120 min, depending on the severity of the poisoning and the patient's clinical response to the first dose
Pediatric Dosing	♦ 70 mg/kg (up to 5 g) IV infused over 15 min ♦ The safety of a repeat dose has not been established
Notes & Precautions	♦ Hydroxocobalamin is supplied in a 250 mL glass vial that contains 5 g of red, freeze-dried powder. A double-sided spike is provided to allow 200 mL of NSS to be injected into the vial (up to the fill line printed on the label) to reconstitute the powder. Although NSS is preferred, LR and D_5W may also be used if NSS if not readily available (the diluent is not included in the package). ♦ The vial should be gently swirled or inverted (but never shaken) for 1 min to mix the medication prior to administration. It should be used within 6 hours after it was mixed. ♦ A vented IV administration set is also provided in the package. As with any IV infusion from a glass vial, an open vent is required for the medication to flow. ♦ Hydroxocobalamin is not compatible in the same IV line with sodium thiosulfate or sodium nitrite, medications that are also used as cyanide antidotes. The safety of co-administering those medications with hydroxocobalamin has not been established, so they should be administered in a separate IV line if they are used at all. ♦ Red-colored urine is observed in all patients, and it may continue to be observed for several weeks following administration.

Ipratropium Bromide (Atrovent)

Classification	Anticholinergic
Therapeutic Effects	♦ Bronchodilator ♦ Inhibits mucus secretion
Indications	Bronchospasm associated with: ♦ COPD (emphysema and chronic bronchitis) ♦ Asthma ♦ Allergic reaction/anaphylaxis ♦ Toxic inhalation ♦ Near drowning
Contraindications	♦ Hypersensitivity to ipratropium ♦ Narrow-angle glaucoma (relative)
Side Effects	**Cardiovascular:** palpitations, chest discomfort **Neurological:** headache, dizziness, nervousness, tremors, insomnia **Other:** nausea, GI distress, mouth and throat dryness and irritation, coughing
Adult Dosing	500 mcg nebulized (in combination with albuterol), repeated as indicated
Pediatric Dosing	Same as adult dosing
Notes & Precautions	♦ In prehospital emergency care, ipratropium is nebulized in combination with albuterol with an oxygen flow rate of 6-8 L/min. The trade name of this premixed solution is DuoNeb. The same combination is also available via metered-dose inhaler with the trade name of Combivent. ♦ Ipratropium is not significantly absorbed into the systemic circulation, nor does it appear to cross the blood-brain barrier, so it does not exert significant systemic anticholinergic effects that might otherwise be anticipated. ♦ It should be used with caution in patients with prostatic hypertrophy.

Ketamine Hydrochloride (Ketalar)

Classification

Dissociative general anesthetic

Therapeutic Effects

- Produces dissociative analgesia (including general anesthesia)
- Bronchodilation with minimal or no ventilatory depression

Indications

- Chemical restraint of patients with excited delirium
- To facilitate endotracheal intubation
- Non-narcotic analgesia

Contraindications

- Hypersensitivity to ketamine

Side Effects

Cardiovascular: tachycardia, hypertension
Neurological: nystagmus, diplopia, emergence reaction (see below)
Other: hypersalivation, vomiting, laryngospasm

Adult Dosing

Excited delirium/endotracheal intubation (IV dose):

- 2 mg/kg IVP over 1 min or 4 mg/kg IM
- It may also be administered intranasally in some systems

Pediatric Dosing

Same as adult dosing

Notes & Precautions

- The onset of action is 30-60 seconds (IV) and 3-5 min (IM). The duration of action is 10-15 min (IV) and 20-30 min (IM).
- Ketamine is available in a number of concentrations, but the optimal one for IM use is 100 mg/mL. This concentration should be diluted with NSS before IV administration.
- Administering midazolam with ketamine is recommended to prevent emergence reactions involving delirium, hallucinations, excitation, and irrational behavior after ketamine administration. These reactions are known to occur more commonly in adults.
- Ketamine's bronchodilatory effect makes it the optimal medication to facilitate the intubation of patients with asthma or COPD.
- Because of ketamine's sympathomimetic effect, it is also the optimal medication to facilitate the intubation of patients with shock or hypotension.
- Because of its sympathomimetic effect, however, ketamine should be used with caution in patients with ACS, CHF, aneurysms (aortic and cerebral), penetrating eye injury, and increased ICP (especially those with head injury and intracranial hemorrhage).
- In some EMS systems, ketamine is used in lower doses (0.1-0.25 mg/kg) for analgesia, either as an adjunct to or in place of opioid medications.
- Ketamine produces excessive oral secretions which require frequent suctioning. Atropine 0.5 mg may be considered to help dry the secretions.
- Ketamine is a phencyclidine derivative.

Lactated Ringer's Solution (LR)

Classification

Isotonic crystalloid solution

Therapeutic Effects

Replaces water and electrolytes

Indications

Hypovolemia

Contraindications

Large volumes of LR should not be administered to patients with:

- Acute decompensated heart failure (CHF)
- Renal failure
- Metabolic alkalosis

Side Effects

Pulmonary edema (when large volumes are infused too quickly)

Adult Dosing

Controlled hemorrhage *without* shock:

- 100-200 mL/h

Controlled hemorrhage with shock/non-hemorrhagic shock:

- 10-20 mL/kg; titrate to achieve signs of adequate perfusion

Uncontrolled hemorrhage with shock:

- Infuse at a "wide open" rate with frequent reassessment until minimum signs of adequate perfusion are achieved (permissive hypotension)

Pediatric Dosing

Controlled hemorrhage with shock/non-hemorrhagic shock:

- 20 mL/kg; repeat as indicated

Uncontrolled hemorrhage with shock:

- Infuse at a "wide open" rate with frequent reassessment until minimum signs of adequate perfusion are achieved

Notes & Precautions

- Excessive fluid resuscitation in patients with uncontrolled hemorrhage may lead to increased bleeding and to the disruption of both the clotting process and the blood's oxygen-carrying capability. Therefore, fluid resuscitation should be titrated to achieve minimum signs of adequate perfusion (improvement in mentation, peripheral pulses, and skin color/temperature with a systolic BP of 70-90 mmHg).
- Patients with both hemorrhagic shock and a severe head injury may require enough LR to achieve a systolic BP $\geq$ 110 mmHg.
- The elderly and the very ill may develop new onset pulmonary edema with smaller infusion volumes. Use caution, and reassess more frequently.
- Although a 10-20 mL/kg bolus is a common adult dose, perfusion often improves with smaller volumes. Reassess after each 250-500 mL is administered, and adjust the flow rate as necessary.
- Infusions of larger volumes may lead to hypothermia, particularly in pediatric and elderly patients, so administer warmed fluid when indicated.
- Only ~20-25% of LR will remain in the vascular space after one hour.
- LR is not compatible with some blood products, such as packed RBCs.
- Hartmann's Solution is functionally equivalent to LR.
- LR contains sodium, potassium, calcium, chloride, and lactate (a buffer).

Lidocaine (Xylocaine)

Classification

Antidysrhythmic, amide local anesthetic

Therapeutic Effects

- Decreases ventricular irritability
- Raises the fibrillatory threshold
- Decreases conduction through ischemic tissue
- Produces local anesthesia

Indications

- Persistent or recurrent ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT)
- VT/regular wide-complex tachycardia of unknown etiology (with a pulse)
- Ventricular ectopy (malignant PVCs)
- Post-cardioversion of VT
- Post-Return of Spontaneous Circulation (ROSC) prophylaxis
- Analgesia prior to intraosseous infusion

Contraindications

- Hypersensitivity to lidocaine or other amide-type anesthetics
- 2nd or 3rd degree AV (heart) blocks
- Bradycardia
- Wolff-Parkinson-White (WPW) Syndrome

Side Effects

Cardiovascular: bradycardia, hypotension, cardiac arrest
Gastrointestinal: nausea, vomiting
Neurological: dizziness, drowsiness, paresthesia, seizures, restlessness, disorientation, slurred speech

Adult Dosing

For all indications *except* analgesia prior to IO infusion:

- 1.5 mg/kg IVP at 50 mg/min; repeat as indicated with 0.75 mg/kg every 5 min to a total maximum dose of 3 mg/kg
- When used during cardiac arrest, lidocaine is administered more quickly (over several seconds).
- Frequent ectopy and brief runs of VT may respond to lower initial doses.
- A maintenance infusion of 1-4 mg/min should be initiated after the loading dose is given (see *Notes* below for dosing and preparation instructions).

Analgesia prior to IO infusion:

- 0.5 mg/kg (up to 40 mg) of 1% or 2% lidocaine is pushed *very slowly*

Pediatric Dosing

For all indications *except* analgesia prior to IO infusion:

- 1 mg/kg IVP over 2 min (over several seconds during cardiac arrest)
- The same dose may be repeated in 5-15 min, depending on the protocol
- Maintenance infusion: 20-50 mcg/kg/min IV

Analgesia prior to IO infusion: Same as adult

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Lidocaine (Xylocaine)—*continued*

Notes & Precautions

- To prepare a lidocaine infusion, mix 100 mg of lidocaine in 100 mL of D_5W or NSS (for a 1 mg/mL concentration). The infusion rate in mg/min should be rounded up to the nearest whole number higher than the total dose pushed in mg/kg. For example, a single 1.5 mg/kg loading dose would be followed with a 2 mg/min maintenance infusion.
- Reduce the dose of the maintenance infusion by half for patients with hepatic, renal, or left ventricular dysfunction.
- Some sources list infranodal blocks as a contraindication for lidocaine. Infranodal blocks include bundle branch blocks and fascicular blocks.
- The definition of malignant PVCs include those which are frequent (> 6/min), multifocal, coupled, and those involved in the R-on-T phenomenon.
- Lidocaine is rarely given, if at all, for frequent unifocal PVCs despite the traditional definition of malignant PVCs.
- In some systems, IV lidocaine is administered several minutes before the first intubation attempt to blunt the rise in ICP for certain at-risk patients.
- Lidocaine is available in 1%, 2%, 4%, and higher concentrations and is packaged for IV push, IV infusion, and inhalation. It is also available as a jelly and a transdermal patch (Lidoderm) for topical use.
- Sensitivities and allergies are extremely rare.
- Local anesthetics act on nerve cells by blocking the transmission of electrical impulses across the cell membranes.
- Other amide local anesthetics include mepivacaine, articaine, prilocaine, and bupivacaine.
- Lidocaine is routinely used in combination with epinephrine for local anesthesia during dental procedures.
- Concurrent use with beta blockers may cause lidocaine toxicity.
- Lidocaine may be potentiated when used currently with phenytoin, procainamide, or propranolol.

Lorazepam (Ativan)

Classification

Benzodiazepine

Therapeutic Effects

- Suppresses seizure activity in the brain (anticonvulsant)
- Acts as a sedative-hypnotic by stimulating the GABA receptor
- Promotes muscle relaxation by inhibiting spinal motor reflex pathways
- Provides anxiolysis

Indications

- Generalized seizures
- Procedural sedation (such as for synchronized cardioversion, transcutaneous pacing, and post-intubation management)
- Agitated behavior or severe anxiety
- Vertigo

Contraindications

- Hypersensitivity to lorazepam
- Acute narrow-angle glaucoma

Side Effects

Cardiovascular: hypotension, bradycardia
Respiratory: ventilatory depression
Neurological: dizziness, ataxia, fatigue, drowsiness, amnesia

Adult Dosing

Generalized seizures/procedural sedation/agitated behavior:

- 2 mg IVP over 1 min; this dose may be repeated once in 5 min
- Only one dose is used for synchronized cardioversion
- It may also be administered IN/IM for seizures and agitated behavior

Vertigo: 1 mg IVP over 1 min

Severe anxiety: 0.5-1 mg IVP over 1 min; repeat as indicated

Pediatric Dosing

Generalized seizures/procedural sedation/agitated behavior:

- 0.1 mg/kg (up to 2 mg) IV over 1 min; this dose may be repeated once in 5 min
- Only one dose is used for synchronized cardioversion
- It may also be administered IN/IM for seizures and agitated behavior

Notes & Precautions

- Use caution in patients with hypotension or signs/symptoms of shock.
- Alcoholic beverages, antihistamines, opioids, tricyclic antidepressants, and other CNS depressants may potentiate lorazepam.
- Lorazepam administered during seizure activity may further depress the ventilatory drive during the post-ictal phase, so be prepared to assist the patient's breathing.
- Like other benzodiazepines, it has no analgesic properties.
- Dilute the 2 mg/mL concentration from the container with an additional mL of NSS before IV administration. The medication should *not* be diluted prior to IM or IN administration.
- Lorazepam has a 3 month shelf life when it's not refrigerated.

Magnesium Sulfate ($MgSO_4$)

Classification

Electrolyte, antidysrhythmic

Therapeutic Effects

- Critical electrolyte that participates in many metabolic cellular reactions
- Smooth muscle relaxation (e.g., blood vessels, bronchioles, uterus)

Indications

- Seizures associated with eclampsia
- Torsades de Pointes
- Known hypomagnesemia

Contraindications

- Third degree AV block
- Known hypocalcemia

Side Effects

Cardiovascular: bradycardia, dysrhythmias, hypotension, flushing, diaphoresis
Neurological: CNS depression, sedation, muscle weakness
Other: diarrhea, hypocalcemia, ventilatory depression

Adult Dosing

Seizures associated with eclampsia: 1 g/min IVP (up to 4 g), with each gram diluted in NSS to a total volume of 10 mL

Torsades de Pointes (with pulses):

- Loading dose: 2 g mixed in 100 mL D_5W/NSS and infused over 5 min
- Maintenance infusion: 0.5-1 g/hour IV infusion

Torsades de Pointes/suspected hypomagnesemia (both with cardiac arrest):
2 g slow IVP diluted in NSS to a total volume of 10 mL

Pediatric Dosing

Torsades de Pointes (cardiac arrest):
25-50 mg/kg (up to 2 g) slow IVP (diluted in NSS to a total volume of 10 mL)

Notes & Precautions

- In some systems, magnesium sulfate 2 g (25-50 mg/kg in pediatric patients), mixed in 100 mL D_5W/NSS, is infused over 10-20 min to treat severe bronchospasm that responds poorly to inhaled bronchodilators.
- Although $MgSO_4$ is the preferred treatment for stable Torsades, unstable Torsades should first be defibrillated. $MgSO_4$ should be administered for shock-refractory Torsades or for post-conversion prophylaxis.
- Use caution in patients with hypotension, severe bradycardia, renal dysfunction, and concurrent use of other CNS depressants.
- Hypomagnesemia is often diagnosed in patients with chronic alcohol abuse, malnutrition, or a prolonged QT interval.
- It can be considered for dysrhythmias associated with a TCA overdose.
- It is also used in some systems for preeclampsia and to suppress labor (especially when complications are expected).
- Magnesium sulfate may be used to treat preeclampsia or eclampsia for several weeks after delivery.
- Calcium chloride or calcium gluconate should be administered to treat magnesium sulfate toxicity.

Methylprednisolone Sodium Succinate (Solu-Medrol)

Classification	Corticosteroid, glucocorticoid, anti-inflammatory
Therapeutic Effects	♦ Decrease inflammation and immune system response
Indications	♦ Asthma ♦ COPD (emphysema and chronic bronchitis) ♦ Allergic reaction/anaphylaxis
Contraindications	♦ Hypersensitivity to methylprednisolone sodium succinate or any product component ♦ Not administered to premature infants because the preparation contains benzyl alcohol
Side Effects	**Cardiovascular:** fluid retention, pulmonary edema, hypertension, tachycardia **Gastrointestinal:** abdominal distention, nausea, vomiting, hiccups **Other:** increased blood glucose level, headache, vertigo, malaise
Adult Dosing	125 mg IVP over 2 min (also IM, but his route is not preferred)
Pediatric Dosing	2 mg/kg IVP over 2 min (also IM, but this route is not preferred)
Notes & Precautions	♦ The onset of action occurs after more than one hour, so this medication is not a first-line treatment for any of the indications above. ♦ It is supplied in the Act-O-Vial system. The powder must be reconstituted and gently swirled (not shaken) before administration. ♦ Use with caution in patients with renal or hepatic dysfunction, CHF, hypertension, diabetes, and seizures. ♦ It supplements the naturally occurring hormone cortisol, which is produced in the adrenal cortex. ♦ It decreases the formation, release, and activity of histamine and other inflammatory mediators. ♦ It precipitates with subsequent administration of calcium gluconate.

Midazolam (Versed)

Classification

Benzodiazepine

Therapeutic Effects

- Suppresses seizure activity in the brain (anticonvulsant)
- Acts as a sedative-hypnotic by stimulating the GABA receptor
- Promotes muscle relaxation by inhibiting spinal motor reflex pathways
- Provides anxiolysis
- Provides anterograde amnesia
-

Indications

- Generalized seizures
- Procedural sedation (such as for synchronized cardioversion, transcutaneous pacing, and post-intubation management)
- Agitated behavior or severe anxiety
- Vertigo

Contraindications

- Hypersensitivity to midazolam
- Acute narrow-angle glaucoma

Side Effects

Cardiovascular: hypotension, bradycardia, tachycardia
Respiratory: ventilatory depression
Neurological: dizziness, ataxia, fatigue, drowsiness, headache
Other: nausea, vomiting

Adult Dosing

Generalized seizures/procedural sedation/agitated behavior:

- 0.05 mg/kg (up to 5 mg) slow IVP; this dose may be repeated once in 5 min
- Only one dose is used for synchronized cardioversion
- It may also be administered IM/IN for seizures and agitated behavior (the IM dose for seizures is always 5 mg)

Vertigo: 1 mg slow IVP

Severe anxiety: 1 mg slow IVP; repeat as indicated

Pediatric Dosing

Generalized seizures:

- 0.1 mg/kg (up to 2 mg) slow IVP or IN; this dose may be repeated once in 5 min
- Alternatively: 0.15 mg/kg IM/PR; this dose may be repeated once in 5 min

Procedural sedation/agitated behavior:

- 0.05 mg/kg (up to 2 mg) slow IVP; this dose may be repeated once in 5 min
- Only one dose is used for synchronized cardioversion
- It may also be administered IM/IN for agitated behavior

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Midazolam (Versed)—*continued*

Notes & Precautions

- Use caution in patients with hypotension or signs/symptoms of shock.
- Alcoholic beverages, antihistamines, opioids, tricyclic antidepressants, and other CNS depressants may potentiate midazolam.
- Midazolam administered during seizure activity may further depress the ventilatory drive during the post-ictal phase, so be prepared to assist the patient's breathing.
- Like other benzodiazepines, it has no analgesic properties.
- The effects of benzodiazepines can be reversed with flumazenil (Romazicon). However, this medication should not be administered to patients with a history of benzodiazepine dependence because status epilepticus may result. Generally, flumazenil is not utilized in prehospital emergency care.
- Midazolam, like other benzodiazepines, may cause paradoxical agitation in pediatric patients.
- Use a large muscle for IM injections, such as the lateral thigh or the gluteus maximus. The deltoid may be considered for injection volumes of no more than 1 mL. Always use the 5 mg/mL concentration for IM or IN administration.
- Midazolam is a preferred benzodiazepine for IM injection because of its quicker onset of action and time to peak effect when compared to lorazepam and diazepam.
- Midazolam is sometimes diluted to a 1 mg/mL concentration (or less) prior to IV administration.
- Anterograde amnesia corresponds to the degree of drowsiness.

Morphine Sulfate

Classification

Narcotic analgesic, opioid

Therapeutic Effects

- Acts directly on CNS opioid receptors to relieve pain
- Decreases myocardial O_2 demand
- Alleviates anxiety

Indications

Relief of pain associated with:

- Musculoskeletal injuries
- Burns
- Suspected acute coronary syndromes (ACS)
- Analgesia during transcutaneous pacing and after intubation
- Kidney stones and certain other medical conditions with physician guidance

Contraindications

- Hypersensitivity to morphine
- Hypotension or severe hypovolemia
- Severe respiratory depression (consider etiology)

Side Effects

Cardiovascular: hypotension, bradycardia, tachycardia
Respiratory: hypoventilation
Neurological: altered level of consciousness, headache, dizziness, confusion
Gastrointestinal: nausea, vomiting
Other: itching, skin redness

Adult Dosing

- 0.1 mg/kg (up to 10 mg) IVP over 3 min
- Repeat every 5 min up to a total maximum of 20 mg (depending on protocol/orders)
- May also be given IM in some circumstances

Pediatric Dosing

- 0.1 mg/kg (up to 5 mg) IVP over 3 min
- Repeat every 5 min up to a total maximum of 0.2 mg/kg (depending on protocol/orders)

Notes & Precautions

- Larger doses may be required for burns and other mechanisms that cause severe pain.
- In some systems, the 5 mg/mL or 10 mg/mL concentrations of morphine are diluted to make titration easier in the prehospital environment.
- In smaller doses morphine does not usually exert major effects on the cardiovascular system. Due to the release of histamine, it may slightly reduce preload through peripheral vasodilation (decrease in both venous return and peripheral vascular resistance).
- Morphine sulfate is no longer a recommended treatment for CHF (acute decompensated heart failure) because it's associated with increased mortality.

Naloxone (Narcan)

Classification

Opioid antagonist

Therapeutic Effects

- Competitively blocks various opioid receptor sites
- Reverses ventilatory depression, sedation, and pupillary effects of opioids

Indications

Ventilatory depression and altered level of consciousness (ALOC) associated with suspected opioid overdose

Contraindications

Hypersensitivity to naloxone

Side Effects

Note: the side effects listed primarily result from opioid withdrawal
Cardiovascular: hypertension, tachycardia, hypotension
Other: nausea, vomiting, tremors, diaphoresis, dyspnea

Adult Dosing

- Initial dose of 0.4 mg IV (or 2 mg IN/IM)
- An initial IV dose of 2 mg is acceptable for patients with both ventilatory depression and signs of poor perfusion (hypotension, weak peripheral pulse)
- Repeat IV doses of 1.6-2 mg every 2-4 min as needed to a total of 4.4 mg
- The IN/IM dose of 2 mg may be repeated once in 2-4 min

Pediatric Dosing

- First dose: 0.1 mg/kg (up to 0.4 mg) IV/IN/IM
- Second and third doses: 0.1 mg/kg (up to 2 mg) IV/IN/IM
- An initial dose of 2 mg via any route is acceptable for patients with both ventilatory depression and signs of poor perfusion (hypotension, weak peripheral pulse). The repeat dose would also be 2 mg.
- Repeat doses may be administered 2-4 min after the previous one

Notes & Precautions

- The goal of administration is the return of adequate spontaneous breathing.
- Patients must be adequately ventilated before naloxone is administered.
- Although the IV and IN routes are preferred for the initial dose, repeat doses may be administered IM and SQ to extend the therapeutic effect.
- Some opioids may require larger doses of naloxone than those listed above.
- The dosing regimen listed above reflects current PA State EMS Protocols. Many EMS systems utilize lower repeat doses which are often more appropriate for certain patients.
- Naloxone should be administered before intubating patients with suspected opioid overdose.
- If no response is noted after multiple doses of naloxone have been administered, the etiology of the altered level of consciousness should be questioned and a different treatment strategy should be considered.

Common Opioids

Codeine	Heroin	Nubain	Talwin
Darvocet/Darvon	Lomotil	Oxycontin/MS-Contin	Tramadol
Demerol	Methadone	Percocet/Percodan	Vicodin
Dilaudid	Norco	Stadol	

Nitroglycerin (Nitrostat, Nitrolingual, Nitro-Bid)

Classification

Vasodilator

Therapeutic Effects

- Dilates coronary arteries, peripheral veins, and arterioles
- Reduces preload and afterload (decreases myocardial workload/O_2 demand)

Indications

- Chest discomfort of suspected cardiac origin
- ACS (acute coronary syndromes)
- Acute decompensated heart failure (CHF)

Contraindications

- Hypotension (systolic BP ≤ 100) or hypovolemia
- Erectile dysfunction medication taken within the past 24-48 hours
- Significant bradycardia
- Head trauma or cerebral hemorrhage

Side Effects

Cardiovascular: hypotension, tachycardia, palpitations
Neurological: headache, dizziness, syncope, increased ICP
Other: flushed skin, sublingual burning sensation, dry mouth, nausea, vomiting

Adult Dosing

Chest discomfort/ACS: 0.4 mg SL every 3-5 min, repeated as indicated with no maximum dose

Acute decompensated heart failure (CHF): initial dose is 0.4 mg SL, repeated every 3-5 min as indicated based on the following systolic BP scale:

> 180: 1.2 mg (three 0.4 mg doses)
140-180: 0.8 mg (two 0.4 mg doses)
100-140: 0.4 mg

Alternatively: 5-200 mcg/min IV infusion (based on BP) or 1-2" of paste;
Do not decrease the systolic BP by > 25% when administered by any route

Pediatric Dosing

Not recommended for pediatric use

Notes & Precautions

- Nitroglycerin (NTG) is available in the following forms: tablet, spray, paste, transdermal patch, and glass bottle for IV use.
- The 0.4 mg dose is also described as 1/150 gr. The 0.3 mg dose is 1/200 gr.
- Do not shake nitroglycerin spray, as doing so might alter the metered dose.
- Remove transdermal patches from hypotensive patients and from those who require defibrillation, synchronized cardioversion, or transcutaneous pacing.
- In most patients, adverse effects are both transient and self-limited.
- Concurrent use of other vasodilators may potentiate NTG.
- Do NOT administer NTG to patients who have taken Viagra/Revatio (sildenafil) or Levitra (vardenafil) in the last 24 hours or Cialis (tadalafil) in the last 48 hours in order to prevent potentially fatal hypotension.
- Revatio is used for pulmonary hypertension.
- Use caution when administering NTG to patients with a suspected right ventricular MI. IV access must be established before or simultaneously with NTG administration. Prepare to administer an NSS bolus, if needed.

Nitrous Oxide (Nitronox)

Classification

Analgesic, anxiolytic, anesthetic gas

Therapeutic Effects

- Depresses CNS to relieve pain and to reduce anxiety
- Increases cerebral perfusion secondary to vasodilation
- Increases oxygen tension in blood

Indications

- Musculoskeletal pain
- Burns
- Chest discomfort of suspected cardiac origin
- Severe anxiety
- Multisystem trauma when patients are awake

Contraindications

- Hypersensitivity to nitrous oxide
- Alcohol or other drug intoxication
- Patients cannot follow commands or self-administer medication
- Head injury
- COPD
- Thoracic injury (including possible pneumothorax)
- Suspected bowel obstruction
- Suspected otitis/air embolism/decompression sickness

Side Effects

Neurological: altered level of consciousness, dizziness/lightheadedness, headache, hallucinations

Other: nausea, vomiting, increased pulmonary vascular resistance

Adult Dosing

A blended mixture of 50% nitrous oxide and 50% oxygen is self-administered via modified demand valve until pain/anxiety is relieved, adverse effects are experienced, or the patient drops the administration device.

Pediatric Dosing

Same as adult dosing

Notes & Precautions

- It should only be used in a well-ventilated area.
- The duration of action is brief (less than 5 minutes) after the gas administration is discontinued.
- It diffuses into closed air spaces easily, and therefore it may precipitate the rupture of pre-existing blebs or bowel obstructions. It also may increase the size of an existing pneumothorax.
- Documentation should include the start and end times of the gas administration in addition to all other pertinent medication administration and reassessment information.
- Nitrous oxide may potentiate the effect of other CNS depressants.

Normal Saline (0.9% NaCl Solution, NSS)

Classification

Isotonic crystalloid solution

Therapeutic Effects

Replaces water and electrolytes

Indications

- Hypovolemia
- KVO infusion
- Mixed with medications for infusion

Contraindications

Large volumes of NSS should not be administered to patients with acute decompensated heart failure (CHF) or renal failure.

Side Effects

Pulmonary edema (when large volumes are infused too quickly)

Adult Dosing

Controlled hemorrhage *without* shock:

- 100-200 mL/h

Controlled hemorrhage with shock/non-hemorrhagic shock:

- 10-20 mL/kg; titrate to achieve signs of adequate perfusion

Uncontrolled hemorrhage with shock:

- Infuse at a "wide open" rate with frequent reassessment until minimum signs of adequate perfusion are achieved (permissive hypotension)

Pediatric Dosing

Controlled hemorrhage with shock/non-hemorrhagic shock:

- 20 mL/kg; repeat as indicated

Uncontrolled hemorrhage with shock:

- Infuse at a "wide open" rate with frequent reassessment until minimum signs of adequate perfusion are achieved

Notes & Precautions

- NSS is a universal IV fluid that can be used in any emergency.
- Excessive fluid resuscitation may lead to increased bleeding and to the disruption of the clotting process. In addition, the blood's oxygen-carrying capability may be diminished. Therefore, fluid resuscitation in patients with uncontrolled hemorrhage and shock should be titrated to achieve minimum signs of adequate perfusion (improvement in mentation, peripheral pulses, and skin color/temperature plus a systolic BP of 70-90 mmHg).
- Patients with both hemorrhagic shock and a severe head injury may require enough NSS to achieve a systolic BP $\geq$ 110 mmHg.
- Use caution with the elderly and the very ill, as they may develop new onset pulmonary edema with smaller infusion volumes. Reassess more frequently.
- Although a 10-20 mL/kg bolus is a common adult dose, perfusion often improves with smaller volumes. Reassess after each 250-500 mL is administered, and adjust the flow rate as necessary.
- Infusions of larger volumes may lead to hypothermia, particularly in pediatric and elderly patients.
- Only ~25% of NSS will remain in the vascular space after one hour.
- Saline solutions are available in other concentrations, such as 0.45%, 3%, 5%. Hypertonic saline is used to treat hyponatremia and cerebral edema.

Normosol (Normosol-R)

Classification

Isotonic crystalloid solution

Therapeutic Effects

Replaces water and electrolytes

Indications

Hypovolemia

Contraindications

Large volumes of Normosol should not be administered to patients with acute decompensated heart failure (CHF) or renal failure.

Side Effects

Pulmonary edema (when large volumes are infused too quickly)

Adult Dosing

Controlled hemorrhage *without* shock:

- 100-200 mL/h

Controlled hemorrhage with shock/non-hemorrhagic shock:

- 10-20 mL/kg; titrate to achieve signs of adequate perfusion

Uncontrolled hemorrhage with shock:

- Infuse at a "wide open" rate with frequent reassessment until minimum signs of adequate perfusion are achieved (permissive hypotension)

Pediatric Dosing

Controlled hemorrhage with shock/non-hemorrhagic shock:

- 20 mL/kg; repeat as indicated

Uncontrolled hemorrhage with shock:

- Infuse at a "wide open" rate with frequent reassessment until minimum signs of adequate perfusion are achieved

Notes & Precautions

- Excessive fluid resuscitation may lead to increased bleeding and to the disruption of the clotting process. In addition, the blood's oxygen-carrying capability may be diminished. Therefore, fluid resuscitation in patients with uncontrolled hemorrhage and shock should be titrated to achieve minimum signs of adequate perfusion (improvement in mentation, peripheral pulses, and skin color/temperature plus a systolic BP of 70-90 mmHg).
- Patients with both hemorrhagic shock and a severe head injury may require enough Normosol to achieve a systolic BP $\geq$ 110 mmHg.
- Use caution with the elderly and the very ill, as they may develop new onset pulmonary edema with smaller infusion volumes. Reassess more frequently.
- Although a 10-20 mL/kg bolus is a common adult dose, perfusion often improves with smaller volumes. Reassess after each 250-500 mL is administered, and adjust the flow rate as necessary.
- Infusions of larger volumes may lead to hypothermia, particularly in pediatric and elderly patients.
- Only ~25% of Normosol will remain in the vascular space after one hour.
- Normosol contains sodium, potassium, magnesium, chloride, acetate (a buffer), and gluconate (a buffer).
- Plasma-Lyte A/Plasma-Lyte 148 is a functionally equivalent solution.
- Some forms of Normosol contain dextrose and are hypertonic.

Ondansetron (Zofran)

Classification	Antiemetic, serotonin antagonist
Therapeutic Effects	Decreases nausea and vomiting by blocking certain serotonin receptor sites on both central chemoreceptors and peripheral vagus nerve terminals
Indications	Prevention and/or treatment of nausea and vomiting
Contraindications	♦ Hypersensitivity to ondansetron ♦ Pregnancy (relative) ♦ Lactating or breastfeeding mothers (relative)
Side Effects	**Cardiovascular:** chest discomfort, hypotension **Gastrointestinal:** abdominal pain **Neurological:** headache, fatigue, weakness
Adult Dosing	4 mg IVP over 2 min (may also be given IM or by oral dissolving tablet)
Pediatric Dosing	0.15 mg/kg IV over 2 min in children > 6 months of age
Notes & Precautions	♦ Use caution with children less than 4 years old. Do not administer to infants who are ≤ 6 months of age. ♦ Use caution in patients with a history of renal or hepatic dysfunction (or in patients who use ondansetron regularly). The maximum total IV or PO dose for these patients should be 8 mg. ♦ In emergency care ondansetron is rarely contraindicated. ♦ Ondansetron is not routinely effective in treating nausea and vomiting associated with motion sickness. ♦ Some patients also take oral ondansetron on a daily basis.

Oxygen

Classification

Gas

Therapeutic Effects

Reacts with glucose in the mitochondria to produce a usable form of energy (ATP) that is essential for normal cellular function

Indications

- Suspected or confirmed hypoxia
- Increased oxygen demand

Contraindications

No significant contraindications exist during short-term, prehospital emergency care when oxygen (O_2) is used within appropriate guidelines.

Side Effects

- Generally, there are no significant side effects when O_2 is appropriately administered during short-term, prehospital emergency care.
- Serious complications may result, however, when *inappropriately* high concentrations are delivered to ACS, CVA, COPD, and post-ROSC patients.

Adult Dosing (General Guidelines)

Device	O_2 Flow Rate (L/min)	O_2 Concentration (FiO_2)
Nasal cannula	2-6	24-44%
Non-rebreather mask (NRB)	10-15	60-80%
BVM with reservoir	10-15	90-99%
Oxymask	1-40	24-90%
Tracheostomy mask	2-15	24-60%
Venturi mask	2-15	24-60%
Pocket mask	10-15	up to 60%
Simple facemask	5-10	35-50%
Demand valve/FROPVD	N/A	up to 100%

Pediatric Dosing

- Similar to the adult dosing
- Consider blow-by delivery and/or modified devices for small children.
- NRB and BVM flow rates of as little as 6-8 L/min often provides high O_2 concentrations for smaller children.

Notes & Precautions

- Never withhold oxygen from a patient who needs it!
- Generally, titrate the O_2 flow rate for most patients to achieve an SpO_2 of 94-99% in order to avoid complications relating to hyperoxia. The optimal SpO_2 for some patients with COPD may be as low as 88-92%.
- In cases of carbon monoxide or cyanide exposure, administer the highest possible O_2 concentration since pulse oximetry will be unreliable.
- Oxygen administration is not routinely used in the initial resuscitation of newborns because of the toxic risks to certain cells, to include retrolental fibroplasia (usually associated with long-term O_2 therapy). When it is administered, however, the flow rate should be carefully titrated to achieve the SpO_2 target as specified in current AHA guidelines.
- Avoid excessive O_2 administration in patients with a paraquat (an herbicide) exposure because it will worsen toxicity.

Oxytocin (Pitocin)

Classification	Synthetic hormone
Therapeutic Effects	♦ Initiates uterine contractions ♦ Decreases bleeding from uterine vessels
Indications	♦ Postpartum hemorrhage after the placenta is delivered
Contraindications	Hypersensitivity to oxytocin
Side Effects	**Cardiovascular:** hypertension, hypotension, water retention, dysrhythmias **Neurological:** seizures, coma, subarachnoid bleeding **Other:** uterine spasm or rupture, nausea, vomiting
Adult Dosing	♦ Add 10-20 units of oxytocin to 1 L of NSS and infuse at a "wide open" rate; titrate the infusion in response to the uterine contractions and bleeding severity ♦ Alternatively, in some systems, oxytocin 10 units IM is administered after the placenta is delivered
Pediatric Dosing	Not indicated
Notes & Precautions	♦ Prehospital use of oxytocin is limited to the control of postpartum hemorrhage. During hospital care it is sometimes used to initiate the labor process, however it should not be used in prehospital care prior to the delivery of either the child or the placenta. ♦ Be sure that another fetus is not expected to be delivered before oxytocin is administered. ♦ It should be used in conjunction with fundal massage for post-partum hemorrhage. ♦ Evaluate the fundus every 5 minutes during and after oxytocin administration. ♦ Naturally occurring oxytocin is secreted from the posterior pituitary gland as the mother breast-feeds the infant. This process may naturally contribute to the control of post-partum hemorrhage.

Pralidoxime Chloride (2-PAM, Protopam)

Classification

Cholinesterase reactivator

Therapeutic Effects

- Reactivates the enzyme acetylcholinesterase, which allows acetylcholine to be metabolized in order to decrease the excessive parasympathetic stimulation caused by the pesticide or nerve agent
- Relieves paralysis of the muscles of breathing

Indications

- Pesticide (organophosphate) poisoning
- Nerve agent exposure

Contraindications

Hypersensitivity to pralidoxime

Side Effects

Cardiovascular: tachycardia, hypertension
Respiratory: hyperventilation, laryngospasm
Neurological: dizziness, drowsiness, headache, blurred vision, diplopia
Other: muscle rigidity or weakness, nausea, pain at injection site

Adult Dosing

- 600-1800 mg IM (usually via autoinjector), based on symptom severity
- Alternatively, in some systems, 1-2 g is mixed in 100 mL NSS/D_5W and is infused over 15-30 min

Pediatric Dosing

- 600-1800 mg IM (usually via autoinjector), based on symptom severity
- Alternatively, in some systems, 20-50 mg/kg (up to 2 g) is mixed in 100 mL NSS/D_5W and is infused over 15-30 min

Notes & Precautions

- Pralidoxime chloride is most often administered in conjunction with atropine during prehospital emergency care via autoinjector (in products such as DuoDote or the Mark 1 Kit).
- The Mark 1 kit requires pralidoxime and atropine to be administered via two different autoinjectors, however the DuoDote injector mixes both mediations into one solution.
- The autoinjectors are administered IM in the lateral thigh.
- An alternative method of delivering the medication is to dilute it to a total volume of 20 mL with NSS and to administer it IV push over 5-10 min.
- It is not recommended for carbamate poisoning.

Sodium Bicarbonate

Classification

Alkalinizing agent

Therapeutic Effects

- Increases blood pH
- Lowers serum potassium level

Indications

- Hyperkalemia
- Tricyclic antidepressant overdose
- Crush syndrome
- Certain cases of metabolic acidosis

Contraindications

Metabolic or respiratory alkalosis

Side Effects

Respiratory: pulmonary edema
Other: metabolic alkalosis, hypernatremia, hyperosmolarity, paradoxical acidosis

Adult Dosing

1 mEq/kg slow IVP (more quickly during cardiac arrest)

Pediatric Dosing

Same as adult dosing

Notes & Precautions

- In some systems, the initial doses listed above can either be doubled or repeated.
- Sodium bicarbonate ($NaHCO_3$) will precipitate when mixed with calcium chloride. Use separate IV lines to administer each medication, if possible. If only one IV line is available, be sure to flush the tubing copiously before and after each medication is pushed.
- Catecholamines, such as epinephrine and dopamine, will be significantly less effective when administered in proximity to sodium bicarbonate.
- Adequate alveolar ventilation is the primary treatment for the acidosis associated with cardiac arrest. Sodium bicarbonate should only be administered during cardiac arrest with adequate CPR and ventilation in progress.
- Hyperkalemia is often present in cardiac arrest patients who undergo hemodialysis, so sodium bicarbonate may be indicated sooner in these patients.
- Sodium bicarbonate is sometimes used to treat toxic exposure to cocaine, phenobarbital, salicylates, methanol, ethylene glycol, and several other substances.
- Arterial blood gas analysis may more accurately determine the appropriate dosage of sodium bicarbonate in patients with metabolic acidosis.

Sodium Thiosulfate

Classification	Cyanide antidote
Therapeutic Effects	Converts cyanide to thiocyanate, which is both relatively nontoxic and readily excreted in the urine
Indications	♦ Suspected cyanide poisoning ♦ Suspected hydrogen sulfide poisoning
Contraindications	None during prehospital emergency care
Side Effects	**Cardiovascular:** hypotension **Gastrointestinal:** nausea, vomiting **Neurological:** headache, disorientation **Other:** prolonged bleeding time, salty taste in mouth, warm sensation in body
Adult Dosing	12.5 g (50 mL) IVP over 1-2 min
Pediatric Dosing	1.6 mL/kg (up to 12.5 g/50 mL) IVP over 1-2 min
Notes & Precautions	♦ Cyanide inhibits cellular respiration and prevents the utilization of oxygen in cellular metabolism. ATP production will markedly decrease, and acidosis will quickly develop. Cyanide poisoning will cause death in seconds to minutes. ♦ Cyanide is often found in plating shops, battery shops, and in many industrial settings. It is also found in rodenticides and in the seeds/pits of fruits such as cherries, apples, and peaches. ♦ Alternative uses for sodium thiosulfate include the prevention of cyanide toxicity when sodium nitroprusside is administered as well as the prevention of nephrotoxicity when Cisplatin (a chemotherapy drug) is administered. ♦ Cyanide antidote kits may be found at industrial sites where cyanide is present. The kit will usually include three components: ▪ Amyl nitrite: it is inhaled for 15-30 seconds and is administered with supplemental O_2. The inhalation may be repeated every 30 seconds. It may convert hemoglobin to methemoglobin. ▪ Sodium nitrite: 300 mg IVP over 2-4 min is administered in order to convert hemoglobin to methemoglobin, which binds to the cyanide and allows aerobic metabolism to resume. ▪ Sodium thiosulfate is generally administered after sodium nitrite.

Succinylcholine (Anectine, Quelicin)

Classification	Depolarizing neuromuscular blocking agent
Therapeutic Effects	Competitively binds to receptors to block the action of acetylcholine at the neuromuscular junction
Indications	Muscle paralysis used to facilitate endotracheal intubation
Contraindications	♦ Hypersensitivity to succinylcholine ♦ Personal or family history of malignant hyperthermia ♦ Neuromuscular diseases, such as Guillain-Barré Syndrome, Multiple Sclerosis ♦ Burns, crush injuries, or severe trauma greater than 24 hours old ♦ CVA (3 days to 6 months post-event) ♦ Hyperkalemia ♦ Pseudocholinesterase deficiency (a genetic disorder) ♦ Narrow-angle glaucoma ♦ Penetrating eye injury
Side Effects	**Cardiovascular:** bradycardia, hypotension, dysrhythmias, cardiac arrest **Neurological:** increased intracranial pressure, increased intraocular pressure **Other:** hyperkalemia, increased intragastric pressure, malignant hyperthermia
Adult Dosing	1.5 mg/kg IVP
Pediatric Dosing	2 mg/kg IVP
Notes & Precautions	♦ The onset of action with the doses above is 45-60 seconds, and the duration of action is 5-8 min. ♦ Repeat doses should not be administered because of an increased risk of bradycardia and asystole. ♦ Succinylcholine does not provide any sedation, analgesia, or amnesia. ♦ All neuromuscular blocking agents will cause apnea, so ventilatory support and monitoring are mandatory. ♦ Succinylcholine will NOT stop neuronal seizure activity. It only briefly terminates skeletal muscle contractions. ♦ Premedication with atropine is recommended in pediatric patients to prevent bradycardia. ♦ Succinylcholine is used in reduced doses as a muscle relaxant prior to electroconvulsive therapy, and it's the medication of choice for terminating persistent laryngospasm.

Terbutaline (Brethine, Brethaire, Bricanyl)

Classification	Bronchodilator, sympathetic agonist
Therapeutic Effects	Relaxes bronchial smooth muscle via beta-2 adrenergic receptors
Indications	Bronchospasm associated with: ♦ Asthma ♦ COPD (includes emphysema and chronic bronchitis)
Contraindications	♦ Hypersensitivity/allergy to the medication ♦ Significant tachycardias, especially those caused by digitalis toxicity
Side Effects	**Cardiovascular:** tachycardia, palpitations, chest discomfort, hypertension, dysrhythmias **Gastrointestinal:** nausea, vomiting **Neurological:** nervousness, tremors, dizziness, headache
Adult Dosing	♦ 0.25 mg SQ; may repeat once in 15-30 min ♦ MDI: one or two 200 mcg inhalations
Pediatric Dosing	Generally not used in the prehospital environment
Notes & Precautions	♦ Some EMS systems use terbutaline to delay or to weaken uterine contractions when a prolapsed cord or other emergencies occur. ♦ Use with caution in elderly patients or in patients with hypertension or cardiovascular disease. ♦ Adverse effects are usually transient and are dose-related. ♦ Adverse effects may occur more frequently when terbutaline is used in conjunction with other beta-agonists. ♦ The concurrent use of MAO inhibitors or tricylic antidepressants may potentiate tachydysrhythmias.

APPENDIX A: Notes on O_2 Delivery Devices

Non-rebreather mask:

- Set the flow rate to 15 L/min, and inflate the reservoir with oxygen by holding closed the one-way valve at the top of the reservoir.
- Place the mask on the patient's face, and seal the perimeter of the mask by using the metal strip across the bridge of the nose. Tighten the elastic strap around the head.
- Confirm that all valves on the mask open and close as the patient inhales and exhales.
- If the "one-size-fits-some" mask seals on the face and the valves open and close, decrease the oxygen flow until the reservoir only partially deflates on inspiration. Do not allow it to deflate by more than about 1/3 of its total volume.
- High minute volumes may cause the reservoir to deflate even when the flow rate is 15 L/min. In these cases, increase the oxygen flow rate by as much as necessary to keep the reservoir inflated.

Nasal cannula:

- Flow is delivered by two prongs that rest in the patient's nostrils. (Note that the $EtCO_2$ nasal cannula instead delivers O_2 via small holes between the prongs. The prongs themselves are only used for CO_2 sampling.)
- The tubing is placed over the ears and is secured with the slip-loop under the patient's chin.
- It is used for patients who require lower concentrations of oxygen and for those who cannot tolerate a mask because they feel suffocated. Also consider using an OxyMask with these patients.
- Despite the traditional flow rate of 2-6 L/min for emergency care, nasal cannulas are sometimes used with flow rates as high as 15 L/min for CPR and for the support of oxygenation during sedation-assisted and rapid sequence intubation.

Blow-by oxygen:

- Blow-by oxygen isn't just for children; it is for any patient who cannot tolerate other O_2 delivery devices.
- Blow-by oxygen delivery is often used for children who are afraid of the oxygen mask. Allow a parent to assist with the administration. Consider using a paper cup connected to oxygen supply tubing or another commercially available pediatric device (such as the rubber teddy bear that delivers oxygen).
- Blow-by oxygen is also administered to infants from oxygen supply tubing held in a cupped hand. The oxygen flow is aimed across the child's face.

FROPBDs and demand valves:

- FROPBDs (also known as FROPVDs) and demand valves should not be used for EMS provider-assisted ventilations. Although some systems allow them to be used for that purpose, the devices do not allow the user to appreciate the lung compliance and will very often cause gastric distention and regurgitation. These devices are more appropriately utilized as patient-controlled breathing devices.
- FROPBDs (**F**low-**R**estricted, **O**xygen-**P**owered **B**reathing **D**evices) are similar to the classic demand valve, however they limit the maximum pressure to 60 cm H_2O. Note that inflation pressures as low as 25-30 cm H_2O may cause gastric insufflation.
- Demand valves are most appropriately used to provide close to 100% oxygen to a patient who is already breathing adequately but who needs short-term oxygen therapy (such as a firefighter during a rehab session). The patient's own inspiratory flow creates a negative pressure that automatically triggers the demand valve to provide 100% oxygen without the use of a separate button to initiate the process.
- Use caution with patients who are exhausted or who have a decreased ability to initiate a strong inspiratory flow to avoid fatigue and possible hypoventilation.

APPENDIX A: Notes on O_2 Delivery Devices

OxyMask:

- Benefits of this device include the elimination of CO_2 rebreathing and an improved ability to communicate with the patient.
- It also allows for suctioning without removing the mask and feels less claustrophobic to the patient.

Bag-valve mask:

- Generally, adult BVMs will deliver 90+% O_2 with only 10 L/min. Using a flow rate of 25 L/min does not deliver significantly more oxygen to the patient, it only empties the cylinder 2.5x faster!
- For patients who need a lower oxygen concentration to avoid an SpO_2 of 100%, such as intubated post-ROSC or CVA patients, flow rates as little as 2-4 L/min may be necessary to maintain an SpO_2 between 94-99%.
- It is generally recommended to use a PEEP valve at 5 cm H_2O when ventilating most patients. Certain patients, such as those in acute decompensated heart failure (CHF), may require pressures of 10+ cm H_2O in order to maintain proper oxygenation.

Oxygen cylinder reference:

- The shaded areas show the minutes remaining at the various cylinder pressures and flow rates.

"D" Cylinder (holds approx. 415 L at 2000 psi)											
	Flow Rate (L/min)										
Cylinder Pressure (psi)		2	3	4	5	6	8	10	12	15	25
	600	32	21	16	12	10	8	6	5	4	2
	800	48	32	24	19	16	12	9	8	6	3
	1000	64	42	32	25	21	16	12	10	8	5
	1200	80	53	40	32	26	20	16	13	10	6
	1400	96	64	48	38	32	24	19	16	12	7
	1600	112	74	56	44	37	28	22	18	14	8
	1800	128	85	64	51	42	32	25	21	17	9
	2000	144	96	72	57	48	36	28	24	19	11

"E" Cylinder (holds approx. 680 L at 2000 psi)											
	Flow Rate (L/min)										
Cylinder Pressure (psi)		2	3	4	5	6	8	10	12	15	25
	600	56	37	28	22	18	14	11	9	7	4
	800	84	56	42	33	28	21	16	14	11	6
	1000	112	74	56	44	37	28	22	18	14	8
	1200	140	93	70	56	46	35	28	23	18	11
	1400	168	112	84	67	56	42	33	28	22	13
	1600	196	130	98	78	65	49	39	32	26	15
	1800	224	149	112	89	74	56	44	37	29	17
	2000	252	168	126	100	84	63	50	42	33	20

APPENDIX B: Mixing Push-Dose (10 mcg/mL) Epinephrine

	Method	Pros	Cons
1.	• Expel all but 1 mL of epi from a prefilled 0.1 mg/mL syringe • Add 9 mL of NSS to the syringe from the IV tubing • Gently invert it 6-8 times to mix the new concentration	• Quickest and simplest method • Already has its own cap	• Wasteful: a single prefilled 0.1 mg/mL syringe only makes one push-dose syringe (instead of 6-8 with Methods 2 and 3 below) • The push-dose epi is now in an incorrectly labeled container
2.	• Inject 1 mL of epi from a prefilled 0.1 mg/mL syringe into an empty 10 mL syringe • Add 9 mL of NSS to the 10 mL syringe from the IV tubing • Gently invert the push-dose syringe 6-8 times • Cap the prefilled syringe, and save it for additional use	• Only takes about 20 seconds longer than Method #1 • Efficient: one prefilled epi syringe can make 6-8 of the 10 mL push-dose syringes	• Must acquire a syringe cap from a flush or another source
3.	• Add 1 mg of epi (1 mg/mL concentration) to a 100 mL bag of NSS/D_5W • The bag now contains a 10 mcg/mL concentration, so multiple syringes can be filled from it	• Works well when prefilled 0.1 mg/mL syringes are unavailable or in short supply • Allows for the use of any size of syringe (1-20 mL) if 10 mL syringes are unavailable • Efficient: medications are only mixed once	• Are there any? Hospitals sometimes mix the medication in this manner.

Notes:

A. Concentration equivalents: 0.1 mg/mL = 1:10,000, 1 mg/mL = 1:1000, and 10 mcg/mL = 1:100,000.
B. Using prefilled normal saline flush syringes to mix medications is potentially unsafe and is not recommended by the FDA, the ISMP (Institute for Safe Medication Practices), or the device manufacturers.
C. Needles and Luer transfer devices may be used to transfer epi from a prefilled syringe to a new syringe.
D. Although the cap can be reused, always use a new syringe when filling with or mixing push-dose epi.
E. Always use an adhesive label or a permanent marker to identify a push-dose epi syringe. If a Sharpie is used to write directly on the syringe barrel or IV bag, the ink will not smear if it's allowed to dry for 15 seconds before being touched. The writing can be removed at any time with alcohol swab.
F. Always be sure that the syringe is capped when it's not being used. Individually packaged sterile caps are made for this purpose, but caps from prefilled syringes (medication or flush) can also be used.