ANTIARRHYTHMICS
Adenosine, 497
Bretylium Tosylate, 498
Lidocaine, 499
Magnesium Sulfate, 500
Procainamide, 501

ANTICONVULSANTS
Diazepam, 502
Lorazepam, 503

CARDIOVASCULAR SUPPORT
Dobutamine, 504
Dopamine, 505
Epinephrine, 507
Isoproterenol, 508
Norepinephrine, 509

CHELATING AGENTS
Deferoxamine, 510
Dimercaprol (BAL), 511
Edetate Calcium Disodium, 513
Penicillamine, 515
Succimer, 517

MISCELLANEOUS
50% Dextrose, 518
Furosemide, 519
Morphine Sulfate, 520
Proparacaine Hydrochloride, 521
Sodium Bicarbonate, 522

RESPIRATORY SUPPORT
Albuterol, 523
Aminophylline, 524
Metaproterenol Sulfate, 526
Oxygen, 527

SPECIFIC PHYSIOLOGICAL ANTAGONISTS
Activated Charcoal, 529
Atropine Sulfate, 530
Calcium Gluconate, 532
Cyanide Antidote Kit, 534
Ethanol, 537
Flumazenil, 539
Methylene Blue 1%, 540
Naloxone, 541
Pralidoxime Chloride, 542
With the exception of ethanol and the chelating agents, most of these medications may be used in the prehospital setting. Prehospital use varies according to local jurisdiction. Consult your state EMS regulations and local medical control protocols for further information.

To the best of our knowledge, drug indications, dosages, and precautions contained in these protocols are correct and current as of the time of publication. The reader is urged to review standard pharmacology references and the manufacturer’s recommendations for additional details.

These protocols contain suggested treatment. Operating protocols and standing and verbal orders should be established by the local medical advisor. Consult with your medical control physician concerning local medication protocols.
Adenosine (Adenocard)

MAJOR ACTIONS
· A naturally occurring purine nucleoside that acts on the atrioventricular (AV) node to slow conduction and inhibit anterograde and retrograde reentry pathways.
· Therapeutic half-life is less than 5 sec.
· Shortens cardiac cell action potential.
· Decreases atrial contractility.
· Decreases cAMP concentration and reduces norepinephrine release.

INDICATIONS
· Conversion of paroxysmal supraventricular tachycardia to sinus rhythm.

DOSEAGE
· Adult: 6 mg rapid IV push over 1 to 3 seconds. The dose should be followed by a 20-ml saline flush. If no response is observed within 1 to 2 min, a 12-mg repeat dose may be administered. A third dose of 12 mg may be given if no conversion has occurred. Maximum dose is 30 mg.
· Pediatric: 100 μg/kg rapid IV push. Maximum single dose is 12 mg. If no response, the repeat dose is 100 to 200 μg/kg rapid IV push. Consult medical control.

PRECAUTIONS
· Continuous ECG monitoring is essential.
· Contraindicated in patients with second- or third-degree heart block, with sick sinus syndrome unless a pacemaker is in place, and with known hypersensitivity to the drug.
· In atrial fibrillation, atrial flutter, or ventricular tachycardia, adenosine will not terminate the arrhythmia but may produce a transient block which may aid in diagnosis.
· May cause flushing, hypotension, headache, chest pain, back pain, neck pain, palpitations, nausea, syncope, shortness of breath, bradycardia and a metallic taste.
· Effects of adenosine are antagonized by xanthines such as theophylline and caffeine.
· Adenosine is potentiated by dipyridamole (Persantine). Effects are prolonged in patients on carbamazepine (Tegretol).
· Transient heart blocks have been noted to occur, as well as transient (6 to 12 sec) episodes of asystole. Temporary bronchospasm and hypotension have also occurred.
· May cause coronary vasodilation in low doses and peripheral vasodilation at higher doses.
· Use with caution in pregnancy.

HOW SUPPLIED
· 2-ml/6 mg vials (3 mg/ml)
Bretylium Tosylate
(Bretylol)

MAJOR ACTIONS
- Elevates the ventricular fibrillation threshold.
- Acts as an antiarrhythmic.
- Suppresses ventricular arrhythmias, including fibrillation.
- Causes a transient rise in blood pressure and pulse, followed by adrenergic blockade, which may cause hypotension.
- Acts as a chemical defibrillator.

INDICATIONS
- Ventricular fibrillation (VF).
- Ventricular tachycardia (VT).
- Ectopic ventricular arrhythmias.
- NOTE. Should be used after other forms of therapy have failed to control the arrhythmias.

DOSAGE
- Adult: VF: 5 mg/kg rapid IV push followed by defibrillation. Then give 10 mg/kg if VF persists. Dose may be repeated at 5-min intervals up to a maximum dosage of 30 mg/kg.
- Awake patient: Dilute 5 to 10 mg/kg in 50 ml of D₅W or normal saline and give IV over 10 min.
- Pediatric: Safety and efficiency have not been established. May be recommended at initial dose of 5 mg/kg in cases in which lidocaine and defibrillation are unsuccessful in pediatric ventricular defibrillation. Consult local medical control.
- Once loading dose is given, a maintenance dose of 1 to 2 mg/min can be given as a continuous infusion.

PRECAUTIONS
- May cause hypotension. Patient should be in supine position.
- Use with caution in patients with fixed cardiac output, aortic stenosis, and pulmonary hypertension, because the drug may cause sudden, severe hypotension.
- Can cause nausea and vomiting in the conscious patient.
- Lidocaine is still considered the first-line antiarrhythmic.
- May aggravate digitalis toxicity. Contraindicated in digitalis-induced arrhythmias.
- Use with caution in patients with hepatic or renal insufficiency.

HOW SUPPLIED
- Bretylium Tosylate
- 500 mg/10 ml ampule (50 mg/ml)
Lidocaine (Xylocaine)

MAJOR ACTIONS
- Elevates fibrillation threshold by reducing myocardial excitability.
- Suppresses ventricular arrhythmias.
- Block or infiltration anesthetic agent.

INDICATIONS
- Ventricular arrhythmias, especially PVCs and ventricular tachycardia in suspected myocardial infarction or cardiac contusion.
- Recurrent or refractory ventricular fibrillation.
- Preintubation in head injuries. Minimizes rise in intracranial pressure associated with intubation.

DOSAGE
- Adult: 1 to 1.5 mg/kg IV bolus initially, with repeat bolus of 0.5 to 0.75 mg/kg every 5 to 10 minutes if needed, to a maximal total loading dose of 3 mg/kg.
- Pediatric: 1 mg/kg IV bolus.
- NOTE: Many administration methods exist for lidocaine. We believe that this method is most applicable for prehospital use. For hospital use, continuous infusion rates, and other dose regimens, consult current ACLS guidelines.

PRECAUTIONS
- Excessive doses may cause myocardial and circulatory depression.
- May cause CNS disturbances such as dizziness, disorientation, sleepiness, confusion, and seizures, as well as visual and auditory disturbances.
- May increase ventricular rate if used in the presence of atrial fibrillation.
- May cause complete A-V block.
- Contraindicated with idioventricular or escape rhythms.
- Use with caution in patients with impaired liver function, shock, conduction deficits, and pulmonary edema.

HOW SUPPLIED
- Lidocaine hydrochloride
- 100-mg/5 ml preloaded syringe (20 mg/ml) 2%
- 100-mg/10 ml preloaded syringe (10 mg/ml) 1%
- NOTE: Do not use dilution strength syringes (1 and 2 g) for IV push use.
Magnesium Sulfate

MAJOR ACTIONS
- Magnesium deficiency is associated with cardiac arrhythmias and sudden cardiac death.
- Hypomagnesemia can precipitate refractory ventricular fibrillation.
- Hypomagnesemia can inhibit the replenishment of intracellular potassium.

INDICATIONS
- Hypomagnesemia with ventricular tachycardia or ventricular fibrillation.
- Torsades de pointes.
- Hypomagnesemia caused by systemic poisoning from hydrofluoric acid or fluoride exposure.

DOSAGE
- Adult: Loading dose of 1 to 2 g (8 to 16 mEq) mixed in 50 to 100 ml of D₅W and administered IV over 5 to 60 min. Actual infusion rate depends on clinical symptoms and severity of hypomagnesemia. A maintenance infusion of 0.5 to 1 g (4 to 8 mEq)/hour should follow for up to 24 hours.
- For adult Torsades de pointes, administer 1 to 2 g IV over 1 to 2 minutes. Follow by same amount infused over 60 min.
- For pediatric doses and dosage for other hypomagnesemia conditions, refer to medical control and/or pharmacology texts.

PRECAUTIONS
- Use with caution in patients with decreased renal function.
- Maintain an adequate urine flow.
- Contraindicated in patients with known heart block, myocardial damage, respiratory depression, and renal failure.
- Weak or absent deep tendon reflexes, flaccid paralysis, hypothermia, drowsiness, hypocalcemia, hypotension, and respiratory paralysis may be seen with use.
- May cause hypokalemia. Monitor serum potassium concentration.

HOW SUPPLIED
- 10%, 12.5%, 25%, 50%; in 2-ml, 5-ml, 10-ml, 20-ml, and 30-ml ampules, vials, and prefilled syringes.
Procainamide (Pronestyl)

MAJOR ACTIONS
- Suppresses PVCs and recurrent ventricular tachycardia (VT).
- Has negative chronotropic, dromotropic, and mild negative inotropic effects.
- Causes peripheral vasodilation.

INDICATIONS
- Ventricular arrhythmias, especially PVCs and VT in suspected myocardial infarction or cardiac contusion.
- Recommended when lidocaine is contraindicated or has failed to suppress ventricular ectopy.
- Wide-complex tachycardias that cannot be distinguished from VT

DOSAGE
- Adult: 20 mg/min until arrhythmia is suppressed. Hypotension ensues, the QRS complex is widened by 50% of its original width, or a total of 17 mg/kg (1.2 g for a 70-kg patient). In urgent situations up to 30 mg/min may be administered up to a total dose of 17 mg/kg. The maintenance infusion rate is 1 to 4 mg/min.
- Pediatric: Safety and efficacy are not well established. Consult local medical control.

PRECAUTIONS
- Maintenance dose should be reduced if patient has renal insufficiency.
- Blood concentrations should be monitored in renal failure and if the patient is receiving a constant infusion of more than 3 mg/min for more than 24 hours.
- Should be avoided in patients with preexisting QT prolongation, torsades de pointes, 3-degree blocks, digitalis toxicity, and tricyclic antidepressant induced arrhythmias.
- Use with caution in patients with acute myocardial infarction, cardiac, hepatic, or renal insufficiency.
- May increase ventricular rate in atrial fibrillation and atrial flutter.
- May cause bradycardia, reflex tachycardia, hypotension, atrial-ventricular block, widened QRS, prolongation of PR or QT interval ventricular arrhythmias, seizures, and CNS depression.
- In cardiac arrest, use bolus therapy only. Consider maintenance infusion following resuscitation.
- Hypersensitivity reactions have been reported.

HOW SUPPLIED
- Procainamide hydrochloride
- 1-g/10 ml vial (100 mg/ml)
MAJOR ACTIONS
- Benzodiazepine antianxiety agent.
- Anticonvulsant. Raises seizure threshold in the motor cortex.
- Produces sedation.
- Acts as a skeletal muscle relaxant.
- Duration of action after IV anticonvulsant administration is 15 min to 1 hour.

INDICATIONS
- Patients with active seizure activity.
- Status epilepticus. Any seizure lasting longer than 5 min, or two seizures without regaining consciousness.
- Diazepam should only be administered to a patient who is actively seizing.

DOSAGE
- Adult: 2 to 10 mg in 2-mg increments by slow IV push.
- Pediatric: 0.2 mg/kg slow IV push. Maximum dose 2 to 5 mg.

PRECAUTIONS
- May cause respiratory depression and/or arrest.
- May cause hypotension and reflex tachycardia.
- Effect is intensified in patients with other CNS depressants or alcohol on board.
- Contraindicated in patients with known hypersensitivity to the drug or angle-closure glaucoma and in comatose patients.
- Use with caution in patients with psychoses, myasthenia gravis, Parkinson’s disease, impaired hepatic function, and impaired respiratory function (COPD).

HOW SUPPLIED
- 20-mg/2 ml ampule, preloaded syringes (10 mg/ml)
- 10-mg/2 ml ampule, preloaded syringes (5 mg/ml)
Lorazepam (Ativan)

MAJOR ACTIONS
- Antianxiety agent.
- Anticonvulsant with rapid onset of action.
- Depresses the CNS at the limbic and subcortical levels of the brain.
- Duration of action after IV anticonvulsant administration is 12 to 24 hours.

INDICATIONS
- As an alternative to diazepam (Valium) in patients with active seizure activity.
- As an alternative to diazepam in status epilepticus (any seizure lasting more than 5 min, or two seizures without regaining consciousness).
- Lorazepam has a prolonged duration of action relative to diazepam.
- Lorazepam should not be administered prophylactically for seizure control.

DOSAGE
- Adult: 2-mg incremental doses slow IV push. Maximum total dose 4 to 8 mg (0.1 mg/kg).

PRECAUTIONS
- May cause respiratory depression and arrest.
- Contraindicated in patients with known hypersensitivity to the drug or angle-closure glaucoma and in comatose patients.
- Use with caution in patients with psychoses, myasthenia gravis, Parkinson’s disease, impaired hepatic function, and impaired respiratory function (COPD).
- May cause hypotension and reflex tachycardia.
- Effect is intensified in patients with other CNS depressants or alcohol on board.

HOW SUPPLIED
- 2-mg/ml ampule, preloaded syringe
- 4-mg/ml ampule, preloaded syringe
Dobutamine (Dobutrex)

MAJOR ACTIONS
· A synthetic catecholamine with potent positive inotropic effects.
· Predominant beta-adrenergic agonist increases myocardial contractility and stroke volume resulting in increased cardiac output.
· May produce reflex peripheral vasodilation.

INDICATIONS
· Low cardiac output from decreased myocardial function.
· Cardiogenic shock.

DOSAGE
· Adult: Add 500 mg to 250 ml of D₂W (2000 µg/ml) and administer at 2 to 20 µg/kg/min titrated to maintain an adequate blood pressure.
· Pediatric: Same as adult.

PRECAUTIONS
· May increase myocardial oxygen demand.
· Replenish volume first when used for hypovolemia.
· Use with caution in atrial fibrillation. Increases AV conduction.
· Accurate titration is difficult without hemodynamic monitoring.
· Contains sodium bisulfite, which may trigger an allergic reaction in patients with sulfite sensitivity.
· May cause headache, tachycardia, hypertension, ventricular arrhythmias, chest pain, nausea, vomiting, and shortness of breath.
· Decreased renal and hepatic function.
· May be inactivated by alkaline solutions.

HOW SUPPLIED
· Dobutamine hydrochloride
· 250-mg (white powder)/20 ml vial. Reconstitute with 10 to 20 ml of normal saline or sterile water
Dopamine (Intropin)

MAJOR ACTIONS
• Endogenous catecholamine; metabolic precursor of norepinephrine.
• Has alpha- and beta₁-adrenergic and dopaminergic agonist properties.
• Stimulates beta₁-adrenergic receptor sites. Releases stored norepinephrine. Minimal beta₂-adrenergic effects.
• Effects are dose dependent.
• At low doses: Beta₁ effects include positive inotropic effects with increased cardiac output (increased myocardial contractility and stroke volume) and dopaminergic receptor-agonist effects, producing vasodilation in renal, mesenteric, coronary, and intracerebral vasculature.
• At high doses, alpha-adrenergic effects predominate, causing increased peripheral resistance and renal vasoconstriction.
• At higher doses actions are very similar to norepinephrine (Levophed).
• 1 to 2 µg/kg/min—causes a dilation of mesenteric and renal blood vessels.
• 2 to 10 µg/kg/min—shows beta effects on heart that usually result in increased cardiac output without increasing rate or blood pressure.
• 10 to 20 µg/kg/min—shows alpha effects that cause peripheral vasoconstriction.
• 20 to 40 µg/kg/min—the alpha effects reverse the dilation of the mesenteric and renal blood vessels.

INDICATIONS
• Hypotension without hypovolemia (especially of cardiogenic cause). Secondary use in neurogenic shock.

DOSAGE
• Adult: Mix 800 mg in 500 ml of D₅W or 400 mg in 250 ml of D₅W (1600 µg/ml). Start at 2.5 to 5 µg/kg/min and titrate to effect. A final dosage range of 5 to 20 µg/kg/min is recommended.
• Pediatric: 6 x body weight (kg) equals milligrams added to diluent to make 100 ml. Then 1 ml/min delivers 1 µg/kg/min. Start at 2 to 5 µg/kg/min and titrate to effect. Infusion may be increased to 10 to 20 µg/kg/min to improve blood pressure, perfusion, and urine output.
• NOTE: Microdrip use only. See chart for additional information on adult dosage.

PRECAUTIONS
• Contraindicated in hypovolemic shock.
• May cause tachyarrhythmias and ectopic beats.
• May be deactivated by sodium bicarbonate.
• Can increase the myocardial oxygen demand.
• May cause hypertensive crisis.
• May cause nausea and vomiting.
• Tissue infiltration may cause necrosis and sloughing.
• Therapy should not be discontinued abruptly but tapered gradually.
• Norepinephrine or dobutamine should be used if more than 20 µg/kg/min of dopamine are needed to maintain an adequate blood pressure.
• Protect from light since dopamine hydrochloride is light-sensitive.
HOW SUPPLIED

- Dopamine hydrochloride
- 200-mg/5 ml ampule, preloaded syringe (40 mg/ml)
- 400-mg/5 ml vial (80 mg/ml)

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**Dopamine Infusions (Adult)**

400 mg dopamine in 250 ml D$_2$W (concentration = 1600 µg/ml)

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*Microdrip set = 60 drops/ml

Courtesy DuPont Critical Care, Waukegan, Ill., a division of E.I. du Pont de Nemours & Co.
**MAJOR ACTIONS**
- Acts as a catecholamine with both alpha- and beta-adrenergic effects.
- Increases heart rate, contractility, AV conduction, automaticity, and myocardial irritability.
- Produces bronchodilation.
- Produces vasoconstriction and increases arterial blood pressure.
- Inhibits histamine release.

**INDICATIONS**
- Cardiac resuscitation.
- Anaphylaxis.
- Asthma attacks.
- Bronchoconstriction, bronchospasm.

**DOSAGE**
- Adult: Cardiac resuscitation: 1 mg of 1:10,000 solution IV push. Epinephrine may be given via endotracheal tube, but 2 to 2.5 times the IV dose may be required for optimal effect. Repeat every 3 to 5 min during resuscitation. Each IV dose should be followed by a 20-ml flush of IV fluid to ensure delivery to the central circulation. High-dose epinephrine, up to 5 mg or approximately 0.1 mg/kg, may be considered after the 1-mg dose has failed.
  - Anaphylaxis (with laryngeal edema or severe respiratory distress): 0.1 to 0.5 mg of 1:10,000 solution IV push; repeat in 10 min (do not exceed 0.5 mg in 10 min).
  - Allergic reaction or asthma: 0.1 to 0.5 mg of 1:1000 solution SQ.
- Pediatric: Cardiac resuscitation: 0.01 mg/kg (0.1 ml/kg of 1:10,000 solution) IV push or intraosseous (IO). Epinephrine may be given by endotracheal tube; the recommended dose is 0.1 mg/kg (0.1 ml/kg of a 1:1000 solution). Second and subsequent doses for unresponsive asystolic and pulseless arrest should be 0.1 mg/kg (0.1 ml/kg of 1:1000 solution) IV or IO. This higher dose should be administered within 3 to 5 min following the initial dose and should be repeated every 3 to 5 min during resuscitation.
  - Anaphylaxis (with laryngeal edema or severe respiratory distress): 0.01 mg/kg of 1:10,000 solution by slow IV push
  - Allergic reaction or asthma: 0.01 mg/kg of 1:1,000 solution SQ.

**PRECAUTIONS**
- Correct acidosis before administration.
- Incompatible with alkaline solutions (flush IV line after administering sodium bicarbonate).
- Contraindicated in hypertension.
- May cause supraventricular tachycardia or ventricular irritability.
- Increases myocardial oxygen demand.
- Use with caution for allergic reactions and asthma in patients over 35 years of age.

**HOW SUPPLIED**
- Epinephrine hydrochloride
- 1:10,000 1-mg/10 ml preloaded syringes (0.1 mg/ml)
- 1:1000 1-mg/1 mL ampule, preloaded syringes (1 mg/ml)
**Isoproterenol (Isuprel)**

**MAJOR ACTIONS**
- Acts as a cardiac stimulant (beta agonist, both chronotropic and inotropic).
- Improves cardiac conduction.
- Produces bronchodilation.
- Produces peripheral vasodilation.
- Increases myocardial oxygen demand.

**INDICATIONS**
- Hemodynamically unstable bradycardia that is refractory to other drug therapy (see ACLS bradycardia algorithm on p. 463).
- Refractory torsades de pointes.
- Not indicated for cardiac arrest or hypotension.

**DOSAGE**
- Adult: Mix 1 mg in 500 ml of D$_5$W (2 $\mu$g/ml) and administer as an IV drip at 2 to 10 $\mu$g/min. Titrate to heart rate of 60/min.
- Pediatric: Mix 1 mg in 500 ml of D$_5$W (2 $\mu$g/ml) and administer as an IV drip, starting at 0.1 $\mu$g/kg/min. Titrate to heart rate and blood pressure. Maximum 1 $\mu$g/kg/min.

**PRECAUTIONS**
- May be harmful at high doses.
- Increases myocardial oxygen demand which may increase infarct size.
- May cause arrhythmias. Use with caution in patients with ventricular ectopics or tachyarrhythmias.
- Use with caution in patients taking digitalis or patients with hypokalemia (patients on diuretics).
- Isuprel is a vasodilator and may cause hypotension.
- Isuprel has an additive effect with epinephrine.
- Hepatic or renal insufficiency.
- May be inactivated by alkaline solutions.

**HOW SUPPLIED**
- 1-mg/5 ml ampules, preloaded syringes (0.2 mg/ml)
- 2-mg/10 ml preloaded syringes (0.2 mg/ml)
Norepinephrine

MAJOR ACTIONS
- Endogenous catecholamine that stimulates beta₁- (heart) and beta₂ (bronchial or peripheral vasculature)-adrenergic receptors. Alpha-adrenergic receptor agonist that causes an increase in total peripheral resistance and systolic blood pressure.
- Increases force of myocardial contraction
- Dilates coronary arteries.

INDICATIONS
- Severe hypotension (systolic blood pressure below 70 torr) and a low total peripheral resistance

DOSAGE
- Adult: Mix 4 mg in 250 ml of D₅W (yielding 16 µg/ml) and administer as an IV drip. Start at 0.5 to 1 µg/min and titrate to maintain a pressure between 90 and 100 systolic. Patients with refractory shock may require 8 to 30 µg/min.
- Titrare to effect and do not allow blood pressure to rise above 110 torr systolic.
- Pediatric: Not indicated in pediatrics

PRECAUTIONS
- May induce renal and mesenteric vasoconstriction.
- May increase myocardial oxygen demand.
- Can cause severe hypertension.
- Can cause bradycardia.
- Tissue necrosis occurs if solution extravasates.
- Replace fluid volume before using.
- Alkaline solutions may inactivate norepinephrine

HOW SUPPLIED
- Norepinephrine
- 4-mg/4 ml ampules
Deferoxamine
(Desferal Mesylate)

MAJOR ACTIONS
• Chelates iron by binding ferric \((\text{Fe}^{3+})\) ions.
• Forms soluble feroxamine complex (reddish-colored), which is excreted in urine giving it a vin rosié color.
• One gram of deferoxamine binds 85 mg of iron (as ferric ions).

INDICATIONS
• Hospital therapy for acute iron intoxication.

DOSAGE

Deferoxamine Challenge Test
• Adults: 50 mg/kg (maximum dose, 2 g) IM.
• Children: 50 mg/kg (maximum dose, 1 g) IM.
  Vin rosié (reddish) urine color indicates chelatable iron present.
  False-negative tests possible.

Iron chelation dose
• IM Dose: 90 mg/kg every 8 hours until urine clears.
  Children: Maximum 1 g/dose.
  Adults: Maximum 2 g/dose.
• IV Dose: 15 mg/kg/hour IV until urine clears.
  Maximum daily dose (adults and children): 6 to 8 g.
  IV administration route preferred.
• Continue chelation until symptoms remit and/or vin rosié urine color clears.
• Monitor CBC, serum iron, and total iron binding capacity (TIBC).
  TIBC may be falsely increased in acute iron toxicity.
  Serum iron concentration may exhibit rebound effect after chelation.

PRECAUTIONS
• Adverse reactions include skin flushing, generalized erythema, urticaria, hypotension, shock, allergic reactions, anaphylactoid reactions, injection site pain, nausea, vomiting, fever, diarrhea, blurred vision.
• Maintain adequate renal output.

HOW SUPPLIED
• Parenteral sterile lyophilized powder for injection, 500 mg/ml. Reconstitute with 2 ml sterile water to yield 250 mg/ml solution. For IM use, the 250 mg/ml solution may be administered undiluted. For IV use add to 0.9% saline and administer at rate of 15 mg/kg/hr.
Dimercaprol
(British Anti-Lewisite [BAL])

MAJOR ACTIONS
- Dithiol heavy metal chelating agent: arsenic, mercury, gold.
- Developed as a treatment for arsenic-containing chemical warfare agent Lewisite.

INDICATIONS
- Hospital therapy for lead, gold, and mercury poisoning.
- Useful adjunctive therapy when used in combination with edetate calcium disodium (CaNa₂EDTA) for lead poisoning.
  - Acute lead encephalopathy or blood lead >100 μg/ml.
  - Asymptomatic patients with blood lead levels >70 μg/ml.
- Chelating agent for acute arsenic, gold, or mercury poisoning; not effective for monoalkyl mercury toxicity, alkyl lead (e.g., tetraethyl lead), or chronic elemental mercury poisoning.
- Not effective for arsine (AsH₃).

DOSAGE

Arsenic or gold poisoning (adults and children)
- 3 mg/kg deep IM every 4 hours for 2 days, six times a day for the next 2 days, and then every 6 to 12 hours for the next 7 days.
- Clinical course determines duration of therapy.
- Ensure adequate renal flow before second dose.

Mercury poisoning (adults and children)
- 5 mg/kg IM initially and then 2.5 mg/kg every 12 or 24 hours.
- Clinical course determines duration of therapy.
- Ensure adequate renal flow before second dose.

Acrodynia (mercury poisoning: infants and children)
- 3 mg/kg deep IM every 4 hours for 48 hours, every 6 hours for the next 24 hours, and then every 12 hours for 7 to 8 days.
- Clinical course determines duration of therapy.
- Ensure adequate renal flow before second dose.

Lead poisoning
- Refer to Edetate Calcium Disodium (CaNa₂EDTA) protocol in this section.

PRECAUTIONS
- Dose-related systolic blood pressure rise and tachycardia usually occurring 15 to 30 min after injection.
- Although less likely to cause essential trace metal deficiency syndromes than other chelators, will increase copper excretion.
- Causes increased urinary excretion of zinc.
- Allergic reactions: generalized pruritic, erythematous, maculopapular rash.
- Adverse reactions include nausea, vomiting, abdominal pain, diaphoresis, throat pain, chest pain, hand pain, anxiety, muscular aches and spasms, injection site pain, burning sensation in lips, mouth, and throat, red cell hemolysis in patients with glucose-6-phosphate deficiency (G-6-PD).
- Interferes with thyroid iodine accumulation.
Dimercaprol (British Anti-Lewisite [BAL])

- Toxic interaction with iron, cadmium, selenium, or uranium.
- Maintain alkaline urine to reduce likelihood of complex dissociation.
- Compound may be nephrotoxic.
- Relatively contraindicated in liver dysfunction.
- Contraindicated in patients allergic to peanuts.
- Obtain toxicological consultation.

**HOW SUPPLIED**

- For parenteral injection only: BAL in Oil 100 mg/ml with 200 mg/ml of benzyl benzoate and 700 mg/ml peanut oil
Edetate Calcium Disodium (Calcium Disodium Edetate—CaNa₂EDTA, Calcium Disodium Versenate)

MAJOR ACTIONS
- Calcium chelate of edetate disodium: chelating agent for lead and other heavy metals.

INDICATIONS
- Hospital therapy for specific heavy metal exposure.
- Used alone or in combination with dimercaprol (BAL) for lead poisoning.
- May be useful for plutonium, thorium, uranium, yttrium, chromium, manganese, nickel, zinc, and vanadium.
- Not effective for mercury, gold, or arsenic poisoning.
- Combination therapy with BAL for acute lead encephalopathy or blood lead greater than 100 µg/dl.
- Combination therapy with BAL for asymptomatic patients with blood lead levels greater than 70 µg/dl.

DOSAGE

Acute Lead Encephalopathy and/or Blood Lead >100 µg/dl with or Without Symptoms (Adults and Children)
- Dimercaprol: 4 mg/kg (450 mg/m²/day) IM every 4 hours for 5 days.
  After 4 hours and adequate urine output is established, begin Edetate Calcium Disodium 250 mg/every 4 hours (1500 mg/m²/day) for 5 days. IM and IV doses are the same. Continuous IV infusion (1 to 4 mg/ml in normal saline or D₅W) is less painful and preferred.

Symptomatic Lead Poisoning; Blood Lead >70 µg/dl (Adults and Children)
- Dimercaprol: 2.7 mg/kg (300 mg/m²/day) IM every 4 hours for 5 days.
  After 4 hours and adequate urine output is established, begin Edetate Calcium Disodium 1000 mg/m²/day continuous infusion for 5 days.
- Monitor blood lead concentrations. If blood lead decreases <50 µg/dl, BAL may be stopped.

Asymptomatic Adults With Blood Lead 56 to 69 µg/dl
- Edetate Calcium Disodium 1000 mg/m²/day continuous infusion for 5 days. Monitor blood lead concentrations.

Asymptomatic Children or Mildly Symptomatic children
- Without nausea and vomiting, blood lead >45 µg/dl should receive therapy with succimer (see Succimer protocol).
Edetate Calcium Disodium

- If adult blood lead concentration between 25-55 μg/dL, then consider:
  
  * Calcium Disodium Edetate (CaNa₂EDTA) Provocative Challenge Test adult dose:
    500 mg/m² (maximum dose 1 g) given IV over 1 hour. Collect 24-hour urine
    for lead starting with initiation of IV dose. Calculate ratio of micrograms of lead
    excreted per milligram of Edetate Calcium Disodium. If ratio is greater than 1,
    the test is positive for total body lead burden, and chelation therapy is indicated.

PRECAUTIONS

- Adverse reactions include renal tubular necrosis, proteinuria, hematuria, glycosuria,
  thrombophlebitis, IM injection site pain, anorexia, nausea, vomiting, fever, chelosis,
  tremors, headache, paresthesias, myalgias, arthralgias, rash, hypercalcemia, dysrhythmias,
  and bone marrow depression.
- May cause elevations of serum transaminases.
- Contraindicated in hepatitis.
- Maintain adequate urine output to avoid renal toxicity.
- Monitor serum electrolytes, BUN, glucose, and liver enzymes daily.

HOW SUPPLIED

- Parenteral concentrate for slow IV injection. 200 mg in 5-ml ampules; dilute with 5%
  dextrose or 0.9% sodium chloride to a concentration of 2 to 4 mg/ml (0.2% to 0.4%)
Penicillamine
(d-Penicillamine, Cuprimine, Depen, Titratabs)

MAJOR ACTIONS
- Monothiol chelating agent for copper, iron, mercury, and lead.
- Forms stable soluble complexes that are excreted in the urine.

INDICATIONS
- Hospital or outpatient therapy for heavy metal exposure
- Treatment of moderate asymptomatic lead poisoning.
- Follow-up oral chelator after treatment with edetate calcium disodium (CaNa₂EDTA)/dimercaprol (BAL)
- Used for provocative lead chelation test.
- Copper chelating agent for Wilson's disease.
- Penicillamine is used to reduce cystine excretion to prevent renal stone formation.
- Treatment of adult active rheumatoid arthritis.
- May be useful for mercury toxicity.

DOSAGE

**Moderate Asymptomatic Lead Poisoning**
- Adults: 1 to 1.5 g/day in four divided doses for 5 to 7 days.
- Pediatric: 30 to 40 mg/kg or 600 to 700 mg/m² per day in four divided doses for 5 to 7 days refer to Succimer protocol for other treatment options in children.
- Repeat courses if necessary with 1-week rest intervals in between. Continuous chelation removes trace essential metals: zinc and copper.

**Provocative Lead Chelation test**
- Administer d-Penicillamine for four doses over 24 hours. Collect 24-hour urine for lead or mercury during that time period.
- Instructions to patient:
  - Day 1: On arising, discard 1st void. Begin d-Penicillamine regimen (four doses).
  - Begin collection of 24-hour urine specimen in lab provided container.
  - Day 2: On arising save first void. Send 24-hour specimen to lab.

PRECAUTIONS
- Contraindicated in patients allergic to penicillin.
- Allergic skin reactions occur in one third of patients. Allergic reaction usually manifested by generalized pruritic, erythematous, maculopapular rash. Late (usually after 6 months of therapy)—occurring, pruritic, scaly drug rash also possible.
- Prolonged use may cause iron deficiency anemia.
- Causes increased urinary excretion of zinc and iron.
- Adverse reactions include pruritic scaly rash, proteinuria, hematuria, leukopenia, thrombocytopenia, eosinophilia, bone marrow depression, anemia, ecchymoses with skin friability at pressure sites, oral ulcers, nausea, vomiting, epigastric pain, obliterative bronchiolitis, and hepatic dysfunction.
Penicillamine (d-Penicillamine, Cuprimine, Depen, Titratabs)

- May cause elevation in serum aminotransferases.
- May promote lead absorption from GI tract.

**HOW SUPPLIED**
- Capsules of 125 and 250 mg
Succimer (Meso 2,3-Dimercaptosuccinic Acid, Chemet)

MAJOR ACTIONS
- Heavy metal chelating agent.
- Forms stable water-soluble complexes with lead.
- Increases urinary excretion of lead.
- May prove useful for mercury and arsenic chelation.
- In therapeutic doses does not deplete essential metals: calcium, iron, and magnesium.
- Structurally related to dimercaprol (BAL).

INDICATIONS
- Hospital or outpatient treatment of lead poisoning in children with blood lead concentrations >45 µg/dl.
- Currently not approved by FDA for use in adults.

DOSAGE
- Pediatric: 10 mg/kg or 350 mg/m² every 8 hours for 5 days; then reduce dose frequency to every 12 hours for an additional 14 days of treatment.
- An initial treatment course of 19 days is recommended.

▼ Succimer Dosage Regimen

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Courtesy McNair Consumer Products Co., Fort Washington, Pa
An initial treatment course of 19 days is recommended

PRECAUTIONS
- A minimum of 2 weeks between treatment courses is recommended. Repeated courses may be needed, depending on blood lead measurements.
- Concomitant administration to patients receiving CaNa₂EDTA and/or BAL is not recommended at this time. Patients who have received CaNa₂EDTA and/or BAL may receive succimer, if indicated, after a 4-week interval.
- Adverse reactions include nausea, vomiting, diarrhea, appetite loss, skin rash.
- May cause elevation in serum transaminases.
- Monitor serum transaminases at baseline and weekly during therapy.

HOW SUPPLIED
- Opaque white gelatin capsules of medicated beads of 100 mg
50% Dextrose (D_{50}W)

MAJOR ACTIONS
· Reverses hypoglycemia by providing free glucose for quick absorption and use.
· Acts as an osmotic diuretic.

INDICATIONS
· Any altered mental state or illness in a known diabetic that might be caused by hypoglycemia.
· Diagnostic tool in an unconscious patient when a reliable history is not available.
· Seizure patients, if history is not available.
· Hypothermia.
· Certain toxic exposures (see Guidelines).

DOSAGE
· Adult: 12.5 to 25 g D_{50} slow IV push. Repeat one time as needed.
· Pediatric: 0.5 to 1 g/kg D_{25} slow IV push (or D_{50} diluted 1:1) slow IV push.

PRECAUTIONS
· Draw a blood sample in a red top tube for glucose determination before administration.
· Infiltration causes tissue necrosis.
· May precipitate Wernicke’s encephalopathy in thiamine-deficient patients (alcoholics). Can be prevented with prior administration of thiamine (100 mg IV).
· Suspected intracranial hemorrhage.

HOW SUPPLIED
· 25-g/50 ml preloaded syringe (500 mg/ml)—D_{50}
· 12.5-g/50 ml preloaded syringe (250 mg/ml)—D_{25}
Furosemide (Lasix)

MAJOR ACTIONS
· Acts as a potent, rapid acting, loop diuretic that inhibits the resorption of sodium.
· Has a direct effect on the venous system, producing decreased vascular resistance and increased peripheral venous capacitance (venous pooling).
· Decreases renal vascular resistance and produces transiently increased glomerular filtration rate (GFR).
· Works in 5 to 10 minutes with maximum effect in 30 minutes.

INDICATIONS
· Used to treat acute pulmonary edema.

DOSAGE
· Adult: 0.5 to 1 mg/kg (20 to 40 mg) slow IV push as an initial dose; repeat every 30 minutes up to 2 mg/kg if indicated.
· Pediatric: 0.5 to 1 mg/kg slow IV push; repeat as needed every 30 minutes to a maximum of 2 mg/kg.

PRECAUTIONS
· May cause hypovolemia and circulatory collapse. Do not use in the presence of hypotension or if signs of hypovolemia are present.
· In children and pregnant women use by direct physician order only.
· Can cause profound diarrhea.
· Can cause hypokalemia and hyponatremia leading to cardiac arrhythmias.
· May cause an allergic reaction in patients who are sensitive to sulfonamides.
· Renal insufficiency.
· Patient should be catheterized if possible to monitor renal output.

HOW SUPPLIED
· 20-mg/2 ml ampule, preloaded syringe (10 mg/ml).
· 40-mg/4 ml ampule, preloaded syringe (10 mg/ml).
· 100-mg/10 ml ampule, preloaded syringe (10 mg/ml).