ACLS Drugs, Cardioversion, Defibrillation and Pacing

Drug/Therapy	Indications/Precautions	Adult Dosage
ACE Inhibitors (Angiotensin-Converting Enzyme Inhibitors)	**Indications** ACE inhibitors reduce mortality and improve LV dysfunction in post-AMI patients. They help prevent adverse LV remodeling, delay progression of heart failure, and decrease sudden death and recurrent MI. They are of greatest benefit in patients with the following conditions: • Suspected MI and ST-segment elevation in 2 or more anterior precordial leads. • Hypertension. • Clinical heart failure without hypotension in patients not responding to digitalis or diuretics. • Clinical signs of AMI with LV dysfunction. • LV ejection fraction <40%.	**Approach**: ACE inhibitor therapy should start with low-dose oral administration (with possible IV doses for some preparations) and increase steadily to achieve a full dose within 24 to 48 hours.
Enalapril		**Enalapril (IV = Enalaprilat)** • PO: Start with a single dose of 2.5 mg. Titrate to 20 mg PO BID. • IV: 1.25 mg IV initial dose over 5 minutes, then 1.25 to 5 mg IV every 6 hours.
Captopril		**Captopril** • Start with a single dose of 6.25 mg PO. • Advance to 25 mg TID and then to 50 mg TID as tolerated.
Lisinopril	**Precautions/Contraindications for all ACE inhibitors** • ***Contraindicated*** in pregnancy (may cause fetal injury or death). • Contraindicated in angioedema. • Hypersensitivity to ACE inhibitors. • Reduce dose in renal failure (creatinine >3 mg/dL). Avoid in bilateral renal artery stenosis.	**Lisinopril, AMI Dose** • 5 mg within 24 hours of onset of symptoms, then • 5 mg given after 24 hours, then • 10 mg given after 48 hours, then • 10 mg once daily for 6 weeks
Ramipril	• Avoid hypotension, especially following initial dose and in relative volume depletion. • Generally not started in ED but within first 24 hours after fibrinolytic therapy has been completed and blood pressure has stabilized.	**Ramipril** Start with a single dose of 2.5 mg PO. Titrate to 5 mg PO BID as tolerated.

Drug/Therapy	Indications/Precautions	Adult Dosage
Adenosine	**Indications** • First drug for most forms of narrow-complex PSVT. Effective in terminating those due to reentry involving AV node or sinus node. • Does *not* convert atrial fibrillation, atrial flutter, or VT. **Precautions** • Transient side effects include flushing, chest pain or tightness, brief periods of asystole or bradycardia, ventricular ectopy. • Less effective in patients taking theophyllines; avoid in patients receiving dipyridamole. • If administered for wide-complex tachycardia/VT, may cause deterioration (including hypotension). • Transient periods of sinus bradycardia and ventricular ectopy are common after termination of SVT. • Contraindication: Poison/drug-induced tachycardia.	**IV Rapid Push** • Place patient in mild reverse Trendelenburg position before administration of drug. • Initial bolus of 6 mg given *rapidly* over 1 to 3 seconds followed by normal saline bolus of 20 mL; then elevate the extremity. • Repeat dose of 12 mg in 1 to 2 minutes if needed. • A third dose of 12 mg may be given in 1 to 2 minutes if needed. **Injection Technique** • Record rhythm strip during administration. • Draw up adenosine dose and flush in 2 separate syringes. • Attach both syringes to the IV injection port closest to patient. • Clamp IV tubing above injection port. • Push IV adenosine *as quickly as possible* (1 to 3 seconds). • While maintaining pressure on adenosine plunger, push normal saline flush *as rapidly as possible* after adenosine. • Unclamp IV tubing.
Amiodarone	**Indications** Used in a wide variety of atrial and ventricular tachyarrhythmias and for rate control of rapid atrial arrhythmias in patients with impaired LV function when digoxin has proven ineffective. **Recommended for** • Treatment of shock-refractory VF/pulseless VT. • Treatment of polymorphic VT and wide-complex tachycardia of uncertain origin. • Control of hemodynamically stable VT when cardioversion is unsuccessful. Particularly useful in the presence of LV dysfunction. • Use as adjunct to electrical cardioversion of SVT, PSVT. • Acceptable for termination of ectopic or multifocal atrial tachycardia with preserved LV function. • May be used for rate control in treatment of atrial fibrillation or flutter when other therapies ineffective. **Precautions** • May produce vasodilation and hypotension. • May also have negative inotropic effects. • May prolong QT interval. Be aware of compatibility and interaction with other drugs administered.	**Cardiac Arrest** 300 mg IV push (2000 Guidelines recommend dilution to 20 to 30 mL D_5W). Consider additional 150 mg IV push in 3 to 5 minutes. (Maximum cumulative dose: 2.2 g IV/24 hours.) **Wide-Complex Tachycardia (Stable)** *Maximum cumulative dose:* 2.2 g IV/24 hours. May be administered as follows: • *Rapid infusion:* 150 mg IV over first 10 minutes (15 mg/min). May repeat rapid infusion (150 mg IV) every 10 minutes as needed. • *Slow infusion:* 360 mg IV over 6 hours (1 mg/min). • *Maintenance infusion:* 540 mg IV over 18 hours (0.5 mg/min). **Precautions** • When multiple doses are administered, cumulative doses >2.2 g/24 hours are associated with significant hypotension in clinical trials. • Do not routinely administer with other drugs that prolong QT interval (eg, procainamide). • Terminal elimination is extremely long (half-life lasts up to 40 days).
Amrinone (*Now* Inamrinone)	**Indications** Severe congestive heart failure refractory to diuretics, vasodilators, and conventional inotropic agents. **Precautions** • Do not mix with dextrose solutions or other drugs. • May cause tachyarrhythmias, hypotension, or thrombocytopenia. • Can increase myocardial ischemia.	**IV Loading Dose and Infusion** • 0.75 mg/kg, given over 10 to 15 minutes. • Follow with infusion of 5 to 15 µg/kg per minute titrated to clinical effect. • Optimal use requires hemodynamic monitoring.

Drug/Therapy	Indications/Precautions	Adult Dosage
Aspirin • 160 mg, 325 mg tablets • Chewable tablets more effective in some trials	**Indications** • Administer to all patients with ACS, particularly reperfusion candidates, unless hypersensitive to aspirin. • Blocks formation of thromboxane A_2, which causes platelets to aggregate, arteries to constrict. This reduces overall AMI mortality, reinfarction, nonfatal stroke. • Any person with symptoms ("pressure," "heavy weight," "squeezing," "crushing") suggestive of ischemic pain **Precautions** • Relatively contraindicated in patients with active ulcer disease or asthma. • Contraindicated in patients with known hypersensitivity to aspirin.	• 160 mg to 325 mg tablet taken as soon as possible (chewing is preferable to swallowing) and then daily. • May use rectal suppository for patients who cannot take PO. • Give within minutes of arrival. • Higher doses (1000 mg) interfere with prostacyclin production and may limit positive benefits.
Atropine Sulfate Can be given via tracheal tube	**Indications** • First drug for symptomatic sinus bradycardia (Class I). • May be beneficial in presence of AV block at the nodal level (Class IIa) or ventricular asystole. **Will not be effective when infranodal (Mobitz type II) block is suspected (Class IIb).** • Second drug (after epinephrine or vasopressin) for asystole or bradycardic pulseless electrical activity (Class IIb). **Precautions** • Use with caution in presence of myocardial ischemia and hypoxia. Increases myocardial oxygen demand. • Avoid in hypothermic bradycardia. • Will not be effective for infranodal (type II) AV block and new third-degree block with wide QRS complexes. (In these patients may cause paradoxical slowing. Be prepared to pace or give catecholamines.)	**Asystole or Pulseless Electrical Activity** • 1 mg IV push. • Repeat every 3 to 5 minutes (if asystole persists) to a maximum dose of 0.03 to 0.04 mg/kg. **Bradycardia** • 0.5 to 1 mg IV every 3 to 5 minutes as needed, not to exceed total dose of 0.04 mg/kg. • Use shorter dosing interval (3 minutes) and higher doses (0.04 mg/kg) in severe clinical conditions. **Tracheal Administration** 2 to 3 mg diluted in 10 mL normal saline.
***β*-Blockers** **Metoprolol** **Atenolol** **Propranolol** **Esmolol** **Labetalol**	**Indications** • Administer to all patients with suspected myocardial infarction and unstable angina in the absence of complications. These are effective antianginal agents and can reduce incidence of VF. • Useful as an adjunctive agent with fibrinolytic therapy. May reduce nonfatal reinfarction and recurrent ischemia. • To convert to normal sinus rhythm or to slow ventricular response (or both) in supraventricular tachyarrhythmias (PSVT, atrial fibrillation, or atrial flutter). β-Blockers are second-line agents after adenosine, diltiazem, or digitalis derivative. • To reduce myocardial ischemia and damage in AMI patients with elevated heart rate, blood pressure, or both. • For emergency antihypertensive therapy for hemorrhagic and acute ischemic stroke. **Precautions** Concurrent IV administration with IV calcium channel blocking agents like verapamil or diltiazem can cause severe hypotension. • Avoid in bronchospastic diseases, cardiac failure, or severe abnormalities in cardiac conduction. • Monitor cardiac and pulmonary status during administration. • May cause myocardial depression. • Contraindicated in presence of HR <60 bpm, systolic BP <100 mm Hg, severe LV failure, hypoperfusion, or second- or third-degree AV block.	**Metoprolol** • Initial IV dose: 5 mg slow IV at 5-minute intervals to a total of 15 mg. • Oral regimen to follow IV dose: 50 mg BID for 24 hours, then increase to 100 mg BID. **Atenolol** • 5 mg slow IV (over 5 minutes). • Wait 10 minutes, then give second dose of 5 mg slow IV (over 5 minutes). • In 10 minutes, if tolerated well, may start 50 mg PO; then give 50 mg PO twice a day. **Propranolol** • Total dose: 0.1 mg/kg by slow IV push, divided into 3 equal doses at 2- to 3-minute intervals. Do not exceed 1 mg/min. • Repeat after 2 minutes if necessary. **Esmolol** • 0.5 mg/kg over 1 minute, followed by continuous infusion at 0.05 mg/kg per minute (maximum: 0.3 mg/kg per minute). • Titrate to effect. Esmolol has a short half-life (2 to 9 minutes). **Labetalol** • 10 mg labetalol IV push over 1 to 2 minutes. • May repeat or double labetalol every 10 minutes to a maximum dose of 150 mg, *or* give initial dose as a bolus, then start labetalol infusion at 2 to 8 mg/min.

Drug/Therapy	Indications/Precautions	Adult Dosage
Calcium Chloride 100 mg/mL in 10 mL vial (total = 1 g; a 10% solution)	**Indications** • Known or suspected hyperkalemia (eg, renal failure). • Hypocalcemia (eg, after multiple blood transfusions). • As an antidote for toxic effects (hypotension and arrhythmias) from calcium channel blocker overdose or β-adrenergic blocker overdose. • May be used prophylactically before IV calcium channel blockers to prevent hypotension. **Precautions** • Do not use routinely in cardiac arrest. • Do not mix with sodium bicarbonate.	**IV Slow Push** • 8 to16 mg/kg (usually 5 to 10 mL) IV for hyperkalemia and calcium channel blocker overdose. May be repeated as needed. • 2 to 4 mg/kg (usually 2 mL) IV for prophylaxis before IV calcium channel blockers.
Cardioversion (Synchronized) Administered via remote defibrillation electrodes or handheld paddles from a defibrillator/monitor Place defibrillator/monitor in synchronized (sync) mode Sync mode delivers energy just after the R wave	**Indications** • All tachycardias (rate >150 bpm) with serious signs and symptoms related to the tachycardia. • May give brief trial of medications based on specific arrhythmias. **Precautions** • In critical conditions go to immediate unsynchronized shocks. • Urgent cardioversion is generally not needed if heart rate is ≤150 bpm. • Reactivation of sync mode is required after each attempted cardioversion (defibrillators/cardioverters default to unsynchronized mode). • Prepare to defibrillate immediately if cardioversion causes VF. • Synchronized cardioversion cannot be performed unless the patient is connected to monitor leads; lead select switch must be on lead I, II, or III and not on "paddles." • Contraindication: Poison/drug-induced tachycardia.	**Technique** • See electrical cardioversion algorithm, page 160. • Premedicate whenever possible. • Engage sync mode before each attempt. • Look for sync markers on the R wave. • "Clear" the patient before each shock. • Deliver monophasic shocks in the following sequence: 100 J, 200 J, 300 J, 360 J.* Use this sequence for each of the following: — VT† — PSVT‡ — Atrial flutter‡ — Atrial fibrillation †Treat polymorphic VT (irregular form and rate) with same currents used for VF: 200 J, 200 to 300 J, 360 J. ‡PSVT and atrial flutter often respond to lower energy levels; start with 50 J. • Press "charge" button, "clear" the patient, and press both "shock" buttons simultaneously. *Biphasic waveforms using lower energy are acceptable if documented to be clinically equivalent or superior to reports of monophasic shock success.
Defibrillation Attempt Use conventional monitor/defibrillator Use automated or shock advisory defibrillator Administer shocks via remote adhesive electrodes or handheld paddles	**Indications** First intervention for VF or pulseless VT (Class I). **Precautions** • Always "clear" the patient before discharging a defibrillation shock. • Do not delay defibrillation for VF/VT. • Asystole should not be routinely shocked. • Treat VF/VT in hypothermic cardiac arrest with up to 3 shocks. Repeat shocks for VF/VT only after core temperature rises above 30°C. • If patient in VF/VT has an automatic implantable cardioverter defibrillator (AICD), perform external defibrillation per BLS guidelines. If AICD is delivering shocks, wait 30 to 60 seconds for completion of cycle. • If patient has implanted pacemaker, place paddles and pads several inches from the pacing generator.	**Adult Monophasic Defibrillation Energy Levels*** • 200 J, first shock. • 200 to 300 J, second shock. • 360 J, third shock. • If these shocks fail to convert VF/VT, continue at 360 J for future shocks. • If VF recurs, shock again at the last successful energy level. *Biphasic devices shock at lower energy levels (approximately 150 J). In some clinical settings, initial and repeated shocks at these lower energy levels are acceptable.

Drug/Therapy	Indications/Precautions	Adult Dosage
Digibind (Digoxin-Specific Antibody Therapy) 40 mg vial (each vial binds about 0.6 mg digoxin)	**Indications** Digoxin toxicity with the following: • Life-threatening arrhythmias. • Shock or congestive heart failure. • Hyperkalemia (potassium level >5 mEq/L). • Steady-state serum levels >10 to 15 ng/mL for symptomatic patients. **Precautions** • Serum digoxin levels rise after digibind therapy and should not be used to guide continuing therapy.	**Chronic Intoxication** 3 to 5 vials may be effective. **Acute Overdose** • IV dose varies according to amount of digoxin ingested. • Average dose is 10 vials (400 mg); may require up to 20 vials (800 mg). • See package insert for details.
Digoxin 0.25 mg/mL or 0.1 mg/mL supplied in 1 or 2 mL ampule (totals = 0.1 to 0.5 mg)	**Indications** • To slow ventricular response in atrial fibrillation or atrial flutter. • Alternative drug for PSVT. **Precautions** • Toxic effects are common and are frequently associated with serious arrhythmias. • Avoid electrical cardioversion if patient is receiving digoxin unless condition is life threatening; use lower current settings (10 to 20 J).	**IV Infusion** • Loading doses of 10 to 15 μg/kg lean body weight provide therapeutic effect with minimum risk of toxic effects. • Maintenance dose is affected by body size and renal function.
Diltiazem	**Indications** • To control ventricular rate in atrial fibrillation and atrial flutter. May terminate re-entrant arrhythmias that require AV nodal conduction for their continuation. • Use after adenosine to treat refractory PSVT in patients with narrow QRS complex and adequate blood pressure. **Precautions** • Do not use calcium channel blockers for wide-QRS tachycardias of uncertain origin or for poison/drug-induced tachycardia. • Avoid calcium channel blockers in patients with Wolff-Parkinson-White syndrome plus rapid atrial fibrillation or flutter, in patients with sick sinus syndrome, or in patients with AV block without a pacemaker. • Expect blood pressure drop resulting from peripheral vasodilation (greater drop with verapamil than with diltiazem). • Avoid in patients receiving oral β-blockers. • Concurrent IV administration with IV β-blockers can cause severe hypotension.	**Acute Rate Control** • 15 to 20 mg (0.25 mg/kg) IV over 2 minutes. • May repeat in 15 minutes at 20 to 25 mg (0.35 mg/kg) over 2 minutes. **Maintenance Infusion** 5 to 15 mg/h, titrated to heart rate.
Disopyramide ***(IV dose not approved for use in United States)***	**Indications** Useful for treatment of a wide variety of arrhythmias. It prolongs the effective refractory period, similar to procainamide. **Precautions/Contraindications** Must be infused relatively slowly. It has potent anticholinergic, negative inotropic, and hypotensive effects that limit its use.	**IV Dose** 2 mg/kg over 10 minutes, followed by continuous infusion of 0.4 mg/kg per hour.

Drug/Therapy	Indications/Precautions	Adult Dosage
Dobutamine *IV infusion* 70 to 100 mm Hg and *no* signs of shock. Dilute 250 mg (20 mL) in 250 mL normal saline or D_5W	**Indications** Consider for pump problems (congestive heart failure, pulmonary congestion) with systolic blood pressure of **Precautions** • Avoid with systolic blood pressure <100 mm Hg *and* signs of shock. • May cause tachyarrhythmias, fluctuations in blood pressure, headache, and nausea. • Contraindication: Suspected or known poison/drug-induced shock. • Do not mix with sodium bicarbonate.	**IV Infusion** • Usual infusion rate is 2 to 20 µg/kg per minute. • Titrate so heart rate does not increase by >10% of baseline. • Hemodynamic monitoring is recommended for optimal use.
Dofetilide ***(Not approved for use in United States)***	**Indications** Treatment of atrial fibrillation. **Precautions/Contraindications** Adverse effects include QT prolongation, which can be associated with torsades de pointes. This complication is most likely to occur in patients with a history of congestive heart failure. Its use is limited by its need to be infused relatively slowly, which may be impractical under emergent conditions.	**IV Infusion Dose** Single infusion of 8 µg/kg over 30 minutes.
Dopamine *IV infusion* Mix 400 to 800 mg in 250 mL normal saline, lactated Ringer's solution, or D_5W	**Indications** • Second drug for symptomatic bradycardia (after atropine). • Use for hypotension (systolic blood pressure ≤70 to 100 mm Hg) with signs and symptoms of shock. **Precautions** • May use in patients with hypovolemia but only after volume replacement. • Use with caution in cardiogenic shock with accompanying congestive heart failure. • May cause tachyarrhythmias, excessive vasoconstriction. • Taper slowly. • Do not mix with sodium bicarbonate.	**Continuous Infusions (titrate to patient response)** **Low Dose** 1 to 5 µg/kg per minute. **Moderate Dose** 5 to 10 µg/kg per minute ("cardiac doses"). **High Dose** 10 to 20 µg/kg per minute ("vasopressor doses").
Epinephrine **Note:** Available in 1:10 000 and 1:1000 concentrations.	**Indications** • **Cardiac arrest:** VF, pulseless VT, asystole, pulseless electrical activity. • **Symptomatic bradycardia:** After atropine, dopamine, and transcutaneous pacing. • **Severe hypotension.** • **Anaphylaxis, severe allergic reactions:** Combine with large fluid volumes, corticosteroids, antihistamines. **Precautions** • Raising blood pressure and increasing heart rate may cause myocardial ischemia, angina, and increased myocardial oxygen demand. • High doses do not improve survival or neurologic outcome and may contribute to postresuscitation myocardial dysfunction. • Higher doses *may* be required to treat poison/drug-induced shock.	**Cardiac Arrest** • **IV Dose:** 1 mg (10 mL of 1:10 000 solution) administered every 3 to 5 minutes during resuscitation. Follow each dose with 20 mL IV flush. • **Higher Dose:** Higher doses (up to 0.2 mg/kg) may be used if 1-mg dose fails. • **Continuous Infusion:** Add 30 mg epinephrine (30 mL of 1:1000 solution) to 250 mL normal saline or 5% dextrose in water; run at 100 mL/h and titrate to response. • **Tracheal Route** 2 to 2.5 mg diluted in 10 mL normal saline. **Profound Bradycardia or Hypotension** 2 to 10 µg/min infusion (add 1 mg of 1:1000 to 500 mL normal saline; infuse at 1 to 5 mL/min).

Drug/Therapy	Indications/Precautions	Adult Dosage
Fibrinolytic Agents	**Indications**	
Alteplase, recombinant *(Activase)*; tissue plasminogen activator (tPA) 50 and 100 mg vials reconstituted with sterile water to 1 mg/mL	*For AMI in Adults* • ST elevation (≥1 mm in ≥2 contiguous leads) or new or presumably new LBBB; strongly suspicious for injury (BBB obscuring ST analysis). • In context of signs and symptoms of AMI. • Time from onset of symptoms <12 hours. *For Acute Ischemic Stroke* (Alteplase is the only fibrinolytic agent approved for acute ischemic stroke.) • Sudden onset of focal neurologic deficits or alterations in consciousness (eg, language abnormality, motor arm, facial droop). • Absence of intracerebral or subarachnoid hemorrhage or mass effect on CT scan. • Absence of variable or rapidly improving neurologic deficits. • Alteplase can be started in <3 hours from symptom onset. • See Case 10.	**Alteplase, recombinant (tPA)** Recommended total dose is based on patient's weight. For AMI the total dose should not exceed 100 mg; for acute ischemic stroke the total dose should not exceed 90 mg. Note that there are 2 approved dose regimens for AMI patients, and a *different* regimen for acute ischemic stroke. *For AMI:* • Accelerated infusion (1.5 hours) — Give 15 mg IV bolus. — Then 0.75 mg/kg over next 30 minutes (not to exceed 50 mg). — Then 0.50 mg/kg over next 60 minutes (not to exceed 35 mg). • 3-hour infusion — Give 60 mg in first hour (initial 6 to 10 mg is given as a bolus). — Then 20 mg/h for 2 additional hours. *For Acute Ischemic Stroke:* • Give 0.9 mg/kg (maximum 90 mg) infused over 60 minutes. • Give 10% of the total dose as an initial IV bolus over 1 minute. • Give the remaining 90% over the next 60 minutes.
For all 5 agents, use 2 peripheral IV lines, *one line exclusively for fibrinolytic administration.*	**Precautions** Specific exclusion criteria: • Active internal bleeding (except menses) within 21 days. • History of cerebrovascular, intracranial, or intraspinal event within 3 months (stroke, arteriovenous malformation, neoplasm, aneurysm, recent trauma, recent surgery). • Major surgery or serious trauma within 14 days. • Aortic dissection. • Severe, uncontrolled hypertension. • Known bleeding disorders. • Prolonged CPR with evidence of thoracic trauma. • Lumbar puncture within 7 days. • Recent arterial puncture at non-compressible site. • During the first 24 hours of fibrinolytic therapy for ischemic stroke, do not administer aspirin or heparin.	
Anistreplase *(Eminase)*; anisoylated plasminogen streptokinase activator complex (APSAC) Reconstitute 30 U in 50 mL sterile water or D_5W		**Anistreplase (APSAC)** 30 IU IV over 2 to 5 minutes.
Reteplase, recombinant *(Retavase)* 10-U vials reconstituted with sterile water to 1 U/mL		**Reteplase, recombinant** • Give first 10-U IV bolus over 2 minutes. • 30 minutes later give second 10-U IV bolus over 2 minutes. (Give NS flush before and after each bolus.)
Streptokinase *(Streptase)* Reconstitute to 1 mg/mL	**Adjuvant Therapy for AMI** • 160 to 325 mg aspirin chewed as soon as possible. • Begin heparin immediately and continue for 48 hours if alteplase or Retavase is used.	**Streptokinase** 1.5 million IU in a 1-hour infusion.
Tenecteplase *(TNKase)*		**Tenecteplase** • Bolus: 30 to 50 mg
Flecainide ***(IV form not approved for use in United States)***	**Indications** • Treatment of ventricular arrhythmias. • Treatment of supraventricular arrhythmias in patients without coronary artery disease. • Effective for termination of atrial flutter and fibrillation, ectopic atrial tachycardia, AV nodal reentrant tachycardia, and supraventricular tachycardias associated with an accessory pathway. **Precautions/Contraindications** Should be avoided in patients with impaired LV function because it has significant negative inotropic effects. ***Must be infused slowly.*** Adverse effects include bradycardia, hypotension, and neurologic symptoms such as oral paresthesias and visual blurring.	**IV Dose** Administered at 2 mg/kg body weight at 10 mg/min. ***Must be infused slowly.***

Drug/Therapy	Indications/Precautions	Adult Dosage
Flumazenil	**Indications** Reverse respiratory depression and sedative effects from pure benzodiazepine overdose. **Precautions** • Effects may not outlast effect of benzodiazepines. • Monitor for recurrent respiratory depression. • Do not use in suspected tricyclic overdose. • Do not use in seizure-prone patients. • Do not use in unknown drug overdose or mixed drug overdose with drugs known to cause seizures (tricyclic antidepressants, cocaine, amphetamines, etc)	**First Dose** 0.2 mg IV over 15 seconds. **Second Dose** 0.3 mg IV over 30 seconds. If no adequate response, give third dose. **Third Dose** 0.5 mg IV given over 30 seconds. If no adequate response, repeat once every minute until adequate response or a total of 3 mg is given.
Furosemide	**Indications** • For adjuvant therapy of acute pulmonary edema in patients with systolic blood pressure >90 to 100 mm Hg (without signs and symptoms of shock). • Hypertensive emergencies. • Increased intracranial pressure. **Precautions** • Dehydration, hypovolemia, hypotension, hypokalemia, or other electrolyte imbalance may occur.	**IV Infusion** • 0.5 to 1 mg/kg given over 1 to 2 minutes. • If no response, double dose to 2 mg/kg, slowly over 1 to 2 minutes.
Glucagon Powdered in 1 and 10 mg vials Reconstitute with provided solution	**Indications** Adjuvant treatment of toxic effects of calcium channel blocker or β-blocker. **Precautions** • Do not mix with saline. • May cause vomiting, hyperglycemia.	**IV Infusion** 1 to 5 mg over 2 to 5 minutes.
Glycoprotein IIb/IIIa Inhibitors	**Indications** These drugs inhibit the integrin glycoprotein IIb/IIIa receptor in the membrane of platelets, inhibiting platelet aggregation. Indicated for acute coronary syndromes *without* ST-segment elevation. **Precautions/Contraindications** Active internal bleeding or bleeding disorder in past 30 days, history of intracranial hemorrhage, or other bleeding, surgical procedure or trauma within 1 month, platelet count <150 000/mm^3, hypersensitivity and concomitant use of another GP IIb/IIIa inhibitor.	**Note: Check package insert for current indications, doses, and duration of therapy.** Optimal duration of therapy has not been established.
Abciximab (ReoPro®)	**Abciximab Indications** FDA-approved for patients with non–Q-wave MI or unstable angina with planned PCI within 24 hours. **Precautions/Contraindications** Must use with heparin. Binds irreversibly with platelets. Platelet function recovery requires 48 hours (regeneration). Readministration may cause hypersensitivity reaction.	**Abciximab Dose** • *Acute coronary syndromes with planned PCI within 24 hours:* 0.25 mg/kg IV bolus (10 to 60 minutes before procedure), then 0.125 μg/kg per minute IV infusion. • *PCI only:* 0.25 mg/kg IV bolus, then 10 μg/min IV infusion.
Eptifibitide (Integrilin®)	**Eptifibitide Indications** Non–Q-wave MI, unstable angina managed medically, and unstable angina/non–Q-wave MI patients undergoing PCI. **Actions/Precautions** Platelet function recovers within 4 to 8 hours after discontinuation.	**Eptifibitide Dose** • *Acute coronary syndromes:* 180 μg/kg IV bolus, then 2 μg/kg per minute IV infusion. • *PCI:* 135 μg/kg IV bolus, then begin 0.5 μg/kg per minute IV infusion, then repeat bolus in 10 minutes.
Tirofiban (Aggrastat®)	**Tirofiban Indications** Non–Q-wave MI, unstable angina managed medically, and unstable angina/non–Q-wave MI patients undergoing PCI. **Actions/Precautions** Platelet function recovers within 4 to 8 hours after discontinuation.	**Tirofiban Dose** *Acute coronary syndromes or PCI:* 0.4 μg/kg per minute IV for 30 minutes, then 0.1 μg/kg per minute IV infusion.

Drug/Therapy	Indications/Precautions	Adult Dosage
Heparin **Unfractionated (UFH)** Concentrations range from 1000 to 40 000 IU/mL	**Indications** • Adjuvant therapy in AMI. • Begin heparin with fibrin-specific lytics (eg, alteplase). **Precautions** • Same contraindications as for fibrinolytic therapy: active bleeding; recent intracranial, intraspinal, or eye surgery; severe hypertension; bleeding disorders; gastrointestinal bleeding. • Doses and laboratory targets appropriate when used with fibrinolytic therapy. • Heparin reversal: ***Protamine*** 25 mg IV infusion over 10 minutes or longer. (Calculate dose as 1 mg protamine per 100 IU of heparin remaining in patient; heparin plasma half-life is 60 minutes.) • Do not use if platelet count is or falls below <100 000 or with history of heparin-induced thrombocytopenia. For these patients consider direct antithrombins: — ***Desirudin:*** 0.1 mg/kg IV bolus, followed by infusion of 0.1 mg/kg per hour for 72 hours. — ***Leprudin:*** 0.4 mg/kg IV bolus, followed by infusion of 0.15 mg/kg per hour for 72 hours.	**IV Infusion** • Initial bolus 60 IU/kg (maximum bolus: 4000 IU). • Continue12 IU/kg per hour (maximum: 1000 IU/hour for patients >70 kg) (round to the nearest 50 IU). • Adjust to maintain activated partial thromboplastin time (aPTT) 1.5 to 2 times the control values for 48 hours or until angiography. • Target range for aPTT after first 24 hours is between 50 and 70 seconds (may vary with laboratory). • Check aPTT at 6, 12, 18, and 24 hours. • Follow institutional heparin protocol.
Heparin **Low Molecular Weight (LMWH)** **Dalteparin** (Fragmin®) and **Enoxaparin** (Lovenox®) **Nadroparin** (Fraxiparine®) ***(Not available in United States)***	**Indications** For use in acute coronary syndromes, specifically patients with non–Q-wave MI/unstable angina. These drugs inhibit thrombin generation by factor Xa inhibition and also inhibit thrombin indirectly by formation of a complex with antithrombin III. These drugs are **not** neutralized by heparin-binding proteins. **Precautions** • Hemorrhage may complicate any therapy with LMWH. Contraindicated in presence of hypersensitivity to heparin or pork products or history of sensitivity to drug. Use **enoxaparin** with extreme caution, if at all, in patients with heparin-induced thrombocytopenia. • Contraindicated if platelet count <100 000. For these patients consider these direct antithrombins: — ***Desirudin:*** 0.1 mg/kg IV bolus, followed by infusion of 0.1 mg/kg per hour for 72 hours. — ***Leprudin:*** 0.4 mg/kg IV bolus, followed by infusion of 0.15 mg/kg per hour for 72 hours.	**Subcutaneous Dose for Dalteparin and Enoxaparin** 1 mg/kg BID SC for 2 to 8 days, administered with aspirin.
Ibutilide	**Indications** Treatment of supraventricular arrhythmias, including atrial fibrillation and atrial flutter. Because it has such a short duration of action, it is most effective for the conversion of atrial fibrillation or flutter of relatively brief duration. **Precautions/Contraindications** Ventricular arrhythmias develop in approximately 2% to 5% of patients (polymorphic ventricular tachycardia, including torsades de pointes, may be observed). *Monitor ECG continuously for arrhythmias during administration and for 4 to 6 hours after administration, with defibrillator nearby.* Patients with significantly impaired LV function are at highest risk for arrhythmias.	**Dose for Adults ≥60 kg:** 1 mg (10 mL) administered IV (diluted or undiluted) over 10 minutes. A second dose may be administered at the same rate 10 minutes later. **Dose for Adults <60 kg:** 0.01 mg/kg initial IV dose.
Inamrinone *See* Amrinone		

Drug/Therapy	Indications/Precautions	Adult Dosage
Isoproterenol *IV infusion* Mix 1 mg in 250 mL normal saline, lactated Ringer's solution, or D_5W	**Indications** • Use cautiously as *temporizing* measure if *external pacer is not available* for treatment of symptomatic bradycardia. • Refractory torsades de pointes unresponsive to magnesium sulfate. • *Temporary* control of bradycardia in heart transplant patients (denervated heart unresponsive to atropine). • Poisoning from β-adrenergic blockers. **Precautions** • Do not use for treatment of cardiac arrest. • Increases myocardial oxygen requirements, which may increase myocardial ischemia. • Do not give with epinephrine; can cause VF/VT. • Do not administer to patients with poison/drug-induced shock (exception: β-adrenergic blocker poisoning). • Higher doses are Class III (harmful) except for β-adrenergic blocker poisoning.	**IV Infusion** • Infuse at 2 to 10 µg/min. • Titrate to adequate heart rate. • In torsades de pointes titrate to increase heart rate until VT is suppressed.
Lidocaine Can be given via tracheal tube	**Indications** • Cardiac arrest from VF/VT. • Stable VT, wide-complex tachycardias of uncertain type, wide-complex PSVT (Indeterminate). **Precautions** • *Prophylactic* use in AMI patients is *not* recommended. • Reduce maintenance dose (not loading dose) in presence of impaired liver function or left ventricular dysfunction. • Discontinue infusion immediately if signs of toxicity develop.	**Cardiac Arrest From VF/VT** • Initial dose: 1 to 1.5 mg/kg IV. • For refractory VF may give additional 0.5 to 0.75 mg/kg IV push, repeat in 5 to 10 minutes; maximum total dose: 3 mg/kg. • A single dose of 1.5 mg/kg IV in cardiac arrest is acceptable. • Tracheal administration: 2 to 4 mg/kg. **Perfusing Arrhythmia** For stable VT, wide-complex tachycardia of uncertain type, significant ectopy, use as follows: • 1 to 1.5 mg/kg IV push. • Repeat 0.5 to 0.75 mg/kg every 5 to 10 minutes; maximum total dose: 3 mg/kg. **Maintenance Infusion** 1 to 4 mg/min (30 to 50 µg/kg per minute).
Magnesium Sulfate	**Indications** • Recommended for use in cardiac arrest only if torsades de pointes or suspected hypomagnesemia is present. • Refractory VF (after lidocaine). • Torsades de pointes with a pulse. • Life-threatening ventricular arrhythmias due to digitalis toxicity. • Prophylactic administration in hospitalized patients with AMI is not recommended. **Precautions** • Occasional fall in blood pressure with rapid administration. • Use with caution if renal failure is present.	**Cardiac Arrest (for hypomagnesemia or torsades de pointes)** 1 to 2 g (2 to 4 mL of a 50% solution) diluted in 10 mL of D_5W IV push. **Torsades de Pointes (not in cardiac arrest)** • Loading dose of 1 to 2 g mixed in 50 to 100 mL of D_5W, over 5 to 60 minutes IV. • Follow with 0.5 to 1 g/h IV (titrate dose to control the torsades). **Acute Myocardial Infarction (if indicated)** • Loading dose of 1 to 2 g, mixed in 50 to 100 mL of D_5W, over 5 to 60 minutes IV. • Follow with 0.5 to 1 g/h IV for up to 24 hours.
Mannitol Strengths: 5%, 10%, 15%, 20%, and 25%	**Indications** Increased intracranial pressure in management of neurologic emergencies. **Precautions** • Monitor fluid status and serum osmolality (not to exceed 310 mOsm/kg). • Caution in renal failure because fluid overload may result.	**IV Infusion** • Administer 0.5 to 1 g/kg over 5 to 10 minutes. • Additional doses of 0.25 to 2 g/kg can be given every 4 to 6 hours as needed. • Use with support of oxygenation and ventilation.

Drug/Therapy	Indications/Precautions	Adult Dosage
Morphine Sulfate	**Indications** • Chest pain with ACS unresponsive to nitrates. • Acute cardiogenic pulmonary edema (if blood pressure is adequate). **Precautions** • Administer slowly and titrate to effect. • May compromise respiration; therefore, use with caution in the compromised respiratory state of acute pulmonary edema. • Causes hypotension in volume-depleted patients. • Reverse, if needed, with naloxone (0.4 to 2 mg IV).	**IV Infusion** 2 to 4 mg IV (over 1 to 5 minutes) every 5 to 30 minutes.
Naloxone Hydrochloride	**Indications** Respiratory and neurologic depression due to opiate intoxication unresponsive to O_2 and hyperventilation. **Precautions** • May cause opiate withdrawal. • Effects may not outlast effects of narcotics. • Monitor for recurrent respiratory depression. • Rare anaphylactic reactions have been reported.	**IV Infusion** • 0.4 to 2 mg every 2 minutes. • Use higher doses for complete narcotic reversal. • Can administer up to 10 mg over short period (<10 minutes). • In suspected opiate-addicted patients, titrate dose until ventilations adequate. Begin with 0.2 mg every 2 minutes × 3 doses, then 1.4 mg IV push.
Nitroglycerin Available in IV form, sublingual tablets, and aerosol spray	**Indications** • Initial antianginal for suspected ischemic pain. • For initial 24 to 48 hours in patients with *AMI and CHF*, large anterior wall infarction, persistent or recurrent ischemia, or hypertension. • Continued use (beyond 48 hours) for patients with recurrent angina or persistent pulmonary congestion. • Hypertensive urgency with ACS. **Precautions/Contraindications** • With evidence of AMI, limit systolic blood pressure drop to 10% if patient is normotensive, 30% drop if hypertensive, and avoid drop below 90 mm Hg. • Do not mix with other drugs. • Patient should sit or lie down when receiving this medication. • Do not shake aerosol spray because this affects metered dose. • Contraindications — Hypotension — Severe bradycardia or severe tachycardia — RV infarction — Viagra within 24 hours	**IV Infusion** • IV bolus: 12.5 to 25 µg. • Infuse at 10 to 20 µg/min. • Route of choice for emergencies. • Use appropriate IV sets provided by pharmaceutical companies. • Titrate to effect. **Sublingual Route** 1 tablet (0.3 to 0.4 mg); repeat every 5 minutes. **Aerosol Spray** Spray for 0.5 to 1 second at 5-minute intervals (provides 0.4 mg per dose).

Drug/Therapy	Indications/Precautions	Adult Dosage
Nitroprusside (Sodium Nitroprusside) Mix 50 or 100 mg in 250 mL D_5W only	**Indications** • Hypertensive crisis. • To reduce afterload in heart failure and acute pulmonary edema. • To reduce afterload in acute mitral or aortic valve regurgitation. **Precautions** • Light-sensitive; therefore, wrap drug reservoir in aluminum foil. • May cause hypotension, thiocyanate toxicity, and CO_2 retention. • May reverse hypoxic pulmonary vasoconstriction in patients with pulmonary disease, exacerbating intrapulmonary shunting, resulting in hypoxemia. • Other side effects include headaches, nausea, vomiting, and abdominal cramps.	**IV Infusion** • Begin at 0.1 μg/kg per minute and titrate upward every 3 to 5 minutes to desired effect (up to 5 μg/kg per minute). • Use with an infusion pump; use hemodynamic monitoring for optimal safety. • Action occurs within 1 to 2 minutes. • Cover drug reservoir and tubing with opaque material.
Norepinephrine Mix 4 mg in 250 mL of D_5W or 5% dextrose in normal saline Avoid dilution in normal saline alone	**Indications** • For severe cardiogenic shock and hemodynamically significant hypotension (systolic blood pressure <70 mm Hg) with low total peripheral resistance. • This is an agent of last resort for management of ischemic heart disease and shock. **Precautions** • Increases myocardial oxygen requirements because it raises blood pressure and heart rate. • May induce arrhythmias. Use with caution in patients with acute ischemia; monitor cardiac output. • Extravasation causes tissue necrosis. • If extravasation occurs, administer phentolamine 5 to 10 mg in 10 to 15 mL saline solution, infiltrated into area.	**IV Infusion (Only Route)** • 0.5 to 1 μg/min titrated to improve blood pressure (up to 30 μg/min). • Do not administer in same IV line as alkaline solutions. • Poison/drug-induced hypotension may require higher doses to achieve adequate perfusion.
Oxygen Delivered from portable tanks or installed, wall-mounted sources through delivery devices	**Indications** • Any suspected cardiopulmonary emergency, especially (but *not* limited to) complaints of shortness of breath and suspected ischemic chest pain. • **Note:** Pulse oximetry provides a useful method of titrating oxygen administration to maintain physiologic oxygen saturation (see precautions). **Precautions** • Observe closely when using with pulmonary patients known to be dependent on hypoxic respiratory drive (very rare). • Pulse oximetry inaccurate in low cardiac output states or with vasoconstriction.	

Device	Flow Rate	O_2 (%)
Nasal prongs	1-6 L/min	24-44
Venturi mask	4-8 L/min	24-40
Partial rebreather mask	6-10 L/min	35-60
Bag-mask	15 L/min	up to 100

Drug/Therapy	Indications/Precautions	Adult Dosage
Procainamide	**Indications** • Useful for treatment of a wide variety of arrhythmias. • May use for treatment of PSVT uncontrolled by adenosine and vagal maneuvers if blood pressure stable. • Stable wide-complex tachycardia of unknown origin. • Atrial fibrillation with rapid rate in Wolff-Parkinson-White syndrome. **Precautions** • If cardiac or renal dysfunction is present, reduce maximum total dose to 12 mg/kg and maintenance infusion to 1 to 2 mg/min. • Proarrhythmic, especially in setting of AMI, hypokalemia, or hypomagnesemia. • May induce hypotension in patients with impaired LV function. • Use with caution with other drugs that prolong QT interval (eg, amiodarone, sotalol).	**Recurrent VF/VT** • 20 mg/min IV infusion (maximum total dose: 17 mg/kg). • In urgent situations, up to 50 mg/min may be administered to total dose of 17 mg/kg. **Other Indications** • 20 mg/min IV infusion until one of the following occurs: — Arrhythmia suppression. — Hypotension. — QRS widens by >50%. — Total dose of 17 mg/kg is given. **Maintenance Infusion** 1 to 4 mg/min.
Propafenone ***(IV form not approved for use in United States)***	**Indications** Antiarrhythmic agent used for treatment of ventricular arrhythmias and supraventricular arrhythmias. **Precautions/Contraindications** • Significant negative inotropic effects. *Must be infused slowly.* May increase mortality in patients who have had MI so should be avoided when coronary artery disease is suspected. • Increased plasma concentrations can develop if taken with cimetidine. Digoxin and warfarin levels increase when these drugs are taken with propafenone. • Reported side effects include bradycardia, hypotension, and gastrointestinal upset.	**IV Dose** 1 to 2 mg/kg body weight at 10 mg/min. ***Must be infused slowly.***
Sodium Bicarbonate	**Indications** Specific indications for bicarbonate use are as follows: • **Class I** if known preexisting hyperkalemia. • **Class IIa** if known preexisting bicarbonate-responsive acidosis (eg, diabetic ketoacidosis) or overdose (eg, tricyclic antidepressant overdose, cocaine, diphenhydramine) to alkalinize urine in aspirin or other overdose. • **Class IIb** if prolonged resuscitation with effective ventilation; upon return of spontaneous circulation after long arrest interval. • **Class III** (not useful or effective) in hypercarbic acidosis (eg, cardiac arrest and CPR without intubation). **Precautions** • Adequate ventilation and CPR, notbicarbonate, are the major “buffer agents” in cardiac arrest. • Not recommended for routine use in cardiac arrest patients.	**IV Infusion** • 1 mEq/kg IV bolus. • Repeat half this dose every 10 minutes thereafter. • If rapidly available, use arterial blood gas analysis to guide bicarbonate therapy (calculated base deficits or bicarbonate concentration). **Blood Gas Interpretation** An acute change in $Paco_2$ of 1 mm Hg is associated with an increase or decrease in pH of 0.008 U (relative to normal $Paco_2$ of 40 mm Hg and normal pH of 7.4).

Drug/Therapy	Indications/Precautions	Adult Dosage

Sotalol

(IV form not approved for use in United States)

Indications

In the United States, oral form is approved for treatment of ventricular and atrial arrhythmias. Outside the United States, used for treatment of supraventricular arrhythmias and ventricular arrhythmias in patients without structural heart disease.

Precautions/Contraindications

- Should be avoided in patients with poor perfusion, because of significant negative inotropic effects. ***Must be infused slowly***.
- Adverse effects include bradycardia, hypotension, and arrhythmias (torsades de pointes).
- Use with caution with other drugs that prolong QT interval (eg, procainamide, amiodarone).

Dose

Administered as 1 to 1.5 mg/kg body weight, then infused at rate of 10 mg/min. ***Must be infused slowly***.

Thrombolytic Agents

See Fibrinolytic Agents

Transcutaneous Pacing

External pacemakers have either *fixed* rates (nondemand or asynchronous mode) or *demand* rates (range: 30 to 180 bpm).

Current outputs range from 0 to 200 mA.

Indications

- Class I for hemodynamically unstable bradycardia (eg, blood pressure changes, altered mental status, angina, pulmonary edema).
- Class I for pacing readiness in setting of AMI, as follows:
  - — Symptomatic sinus node dysfunction.
  - — Type II second-degree heart block.
  - — Third-degree heart block.
  - — New left, right, or alternating BBB or bifascicular block.
- Class IIa for bradycardia with symptomatic ventricular escape rhythms.
- Class IIa for overdrive pacing of tachycardias refractory to drug therapy or electrical cardioversion.
- Class IIb for bradyasystolic cardiac arrest. Not routinely recommended. If used, use early.

Precautions

- Contraindicated in severe hypothermia or prolonged bradyasystolic cardiac arrest.
- Conscious patients may require analgesia for discomfort.
- Avoid using carotid pulse to confirm mechanical capture. Electrical stimulation causes muscular jerking that may mimic carotid pulse.

Technique

- Place pacing electrodes on chest per package instructions.
- Turn the pacer ON.
- Set demand rate to approximately 80 bpm.
- Set current (mA) output as follows:
  - — *Bradycardia:* Increase milliamperes from minimum setting until consistent capture is achieved (characterized by a widening QRS and a broad T wave after each pacer spike). Then add 2 mA for safety margin.
  - — *Asystole:* Begin at full output (mA). If capture occurs, slowly decrease output until capture is lost (threshold). Then add 2 mA for safety margin.

Vasopressin

Indications

- May be used as an alternative pressor to epinephrine in the treatment of adult shock-refractory VF (Class IIb).
- May be useful for hemodynamic support in vasodilatory shock (eg, septic shock).

Precautions/Contraindications

- Potent peripheral vasoconstrictor. Increased peripheral vascular resistance may provoke cardiac ischemia and angina.
- Not recommended for responsive patients with coronary artery disease.

IV, IO, and TT Doses for Cardiac Arrest:

40 U IV push × 1 is the only route recommended in the AHA *ECC Guidelines 2000.*

Drug/Therapy	Indications/Precautions	Adult Dosage
Verapamil	**Indications** • Alternative drug (after adenosine) to terminate PSVT with narrow QRS complex and adequate blood pressure and *preserved LV function.* • May control ventricular response in patients with atrial fibrillation, flutter, or multifocal atrial tachycardia. **Precautions** • Give *only* to patients with narrow-complex PSVT or arrhythmias known to be of supraventricular origin. Do not use calcium channel blockers for wide-QRS tachycardias of uncertain origin. • Avoid calcium channel blockers in patients with Wolff-Parkinson-White syndrome and atrial fibrillation, sick sinus syndrome, or second- or third-degree AV block without pacemaker. • Expect blood pressure drop caused by peripheral vasodilation. IV calcium is an antagonist that may restore blood pressure in toxic cases. • May decrease myocardial contractility and may exacerbate CHF in patients with LV dysfunction. • Concurrent IV administration with IV β-blockers may produce severe hypotension. • Use with extreme caution in patients receiving oral β-blockers.	**IV Infusion** • 2.5 to 5 mg IV bolus over 2 minutes. • Second dose: 5 to 10 mg, if needed, in 15 to 30 minutes. Maximum dose: 20 mg. • Alternative: 5 mg bolus every 15 minutes to total dose of 30 mg. • Older patients: Administer over 3 minutes.