TREATMENT PROTOCOLS

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Unless otherwise stated, all treatment modalities and drug dosages in this section are based on the adult patient. For pediatric patients, consult the drug protocol section and your medical advisor.

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 treatment protocols.
Inhalation Exposure

MECHANISM OF INJURY
Most hazardous material exposures are via inhalation. Inhalation exposures have five major acute life threat poisoning possibilities:
1. Hypoxia, asphyxiation
2. Direct respiratory system injury
3. Cardiovascular collapse
4. Central nervous system toxicity
5. Systemic poisoning

Examples include chlorine gas, which causes direct pulmonary injury and subsequent pulmonary edema; cyanide gas, which precipitates cardiovascular collapse; and trichloroethylene-induced CNS depression and/or cardiac arrhythmias. In general, water solubility of the material largely influences respiratory tract site and onset of symptoms. Highly water-soluble compounds such as chlorine easily react with water in the upper airway to produce rapid onset of symptoms, whereas phosgene (COCl₂) has a much lower solubility, allowing it to reach the lower respiratory tract before it reacts with the respiratory mucosa to produce irritation and possible pulmonary edema.

Remember that water solubility is only one exposure parameter to be considered when predicting health effects. Air concentration, particle size, and duration of exposure before victim evacuation must also be considered. Prolonged exposure to even relatively water-soluble substances may produce pulmonary edema; and, conversely, low water-soluble compounds may cause upper airway signs and symptoms as well. Inhaled particle size also dictates lung injury site. Particles measuring 5 to 30 μm are usually deposited in the upper airway. To reach the alveoli, particulates must measure 1 μm or less.

Fire/explosion inhalation victims should always be evaluated for carbon monoxide and/or cyanide poisoning.

SIGNS AND SYMPTOMS
Respiratory—Respiratory tract irritation, coughing, choking, hoarseness, rhinitis, laryngeal spasm, stridor, upper airway obstruction, tracheobronchitis, aspiration pneumonitis, pneumonia, alveolitis, reactive airways dysfunction syndrome (RADS) and pulmonary edema/adult respiratory distress syndrome (ARDS).

BASIC TREATMENT
• Ensure that patient is decontaminated. Remove all clothing, shoes, and jewelry. Wash the patient with soap and water
• Ensure an open airway and support respirations if necessary.
• Aggressive airway management may be necessary.
• Administer oxygen by nonrebreather mask at 10 to 15 L/min.
• Monitor for pulmonary edema/ARDS and treat if necessary (refer to pulmonary edema protocol in this section).

ADVANCED TREATMENT
• Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious, has severe pulmonary edema, or is in respiratory arrest. Early intubation at the first sign of upper airway obstruction may be necessary.
• Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
• Administer 100% oxygen if carbon monoxide poisoning suspected. Hyperbaric oxygen therapy should be considered if CNS or cardiac symptoms are present and/or the carboxyhemoglobin concentration is greater than 30%.
• Start an IV with D5W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
• Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in this section).

SPECIAL CONSIDERATIONS
• Systemic toxicity may result from inhalation exposure. Refer to specific guidelines for chemical(s) in question for more detailed information.
• Hospitalized patients may require the following baseline laboratory studies: CBC, platelet count, coagulation profile, serum electrolytes, BUN, creatinine, glucose, anion gap, baseline biochemistry panel to include serum aminotransferases (ALT and AST), alkaline phosphatase, lactate dehydrogenase, calcium, phosphorous, and magnesium. Additional useful tests, depending on the history of the exposure, include blood cyanide concentration, ethanol, heavy metal(s), and specific poison determinations.
• Measurement of arterial blood gases (ABGs) with measured carboxyhemoglobin, methemoglobin, and percent oxygen saturation determinations are necessary.
• Baseline chest radiograph.
• Measurement of peak flow rates (PFRs) may be helpful.
• Positive end-expiratory pressure (PEEP)–assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome.
• Some products may cause early olfactory fatigue and therefore have poor warning properties.
• Refer to decontamination protocol in this section.
MECHANISM OF INJURY
Although inhalation exposures occur most frequently, the balance of most hazardous material exposures are via the dermal or ocular route. Dermal exposures have three major acute life threat poisoning possibilities:
1. Local skin irritation, blistering, chemical burns, irritant dermatitis, allergic dermatitis, and allergic reactions.
2. Systemic absorption resulting in cardiovascular collapse pulmonary toxicity, systemic toxicity and metabolic acidosis.
3. Central nervous system toxicity, seizures, altered level of consciousness, and coma.

Examples include corrosive dermal injury, ranging from irritation to chemical burns; organophosphate dermal exposure poisoning that produces cardiovascular collapse; or hydrofluoric acid, which causes local burns or systemic fluorosis, hypocalcemia, and hypomagnesemia. Concentration of product, duration of exposure, and skin surface disruption influence rate of absorption and magnitude/expression of symptoms.

SIGNS AND SYMPTOMS
Skin—Irritation, redness, vesicle formation, rash, partial- and full-thickness burns.
Some chemicals may cause burns as deep as and including bone.

BASIC TREATMENT
• Ensure that patient is decontaminated. Remove all clothing, shoes, and jewelry. Wash the patient with soap and water.
• Ensure an open airway and support respirations if necessary.
• Check for singed nasal hair, presence of carbon particles, or oral burns.
• Administer oxygen at 10 to 15 L/min by nonrebreather mask.
• Assess and treat any other injuries.
• Estimate body surface area (BSA) of the burn:
  Rule of Nines: BSA is divided into 11 areas of 9% each plus the perineum at 1%; or use
  Lund and Browder chart: BSA map that corrects for age.
• Cover burned areas with dry sterile dressings.
• Maintain body temperature with blankets. Do not apply external heat.
• Evaluate for systemic toxicity and, if substance is known, treat by specific guideline.

ADVANCED TREATMENT
• Consider orotracheal or nasotracheal intubation at earliest indicated moment if signs of stridor or respiratory distress are present.
• Start an IV of lactated Ringer's or normal saline at TKO rate.
• Depending on the surface area of the burn and the hemodynamic state of the patient, administer fluids according to the Parkland formula (4ml/kg/% BSA burn), administering ½ of the estimated IV fluid volume required during the first 8 hours. Consult medical control. See chemical burn protocol in this section.

SPECIAL CONSIDERATIONS
• Systemic toxicity may result from dermal exposure. Refer to chemical burn protocol and specific guidelines for chemical(s) in question for more detailed information.
Dermal Exposure

- Hospitalized patients may require the following baseline laboratory studies: CBC, platelet count, coagulation profile, serum electrolytes, BUN, creatinine, glucose, anion gap, baseline biochemistry panel to include serum aminotransferases (ALT and AST), alkaline phosphatase, lactic dehydrogenase, calcium, phosphorous, and magnesium. Additional useful tests, depending on the history of exposure, include blood cyanide concentration, ethanol, heavy metal(s), and specific poison determinations.
- Measurement of arterial blood gases (ABGs) with measured carboxyhemoglobin, methemoglobin, and percent oxygen saturation determinations may be necessary.
- Baseline chest radiograph.
- Positive end-expiratory pressure (PEEP)-assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome (ARDS).
- Ascertain identification of specific poison. Refer to appropriate guideline.
- Refer to decontamination protocol in this section.
Ingestion Exposure

MECHANISM OF INJURY
Ingestion exposures have six major acute life threat poisoning possibilities:
1. Cardiovascular collapse
2. Pulmonary toxicity
3. Central nervous system toxicity
4. Gastrointestinal tract injury
5. Metabolic poisoning effects
6. Systemic toxicity
   Examples include sodium hydroxide ingestion, which causes GI hemorrhage and ulceration with subsequent stricture formation; potassium cyanide ingestion, which produces cardiovascular collapse; or ethylene glycol ingestion, which induces CNS depression and/or cardiac arrhythmias, metabolic acidosis, and renal failure. Symptoms may be delayed, depending on the rate of absorption of the poison.

SIGNS AND SYMPTOMS
Gastrointestinal—Nausea, vomiting, drooling, intestinal obstruction, abdominal pain, hemorrhage, ulceration, perforation, and diarrhea.

BASIC TREATMENT
· Ensure that patient is decontaminated. Remove all clothing, shoes, and jewelry. Wash the patient with soap and water.
· Ensure an open airway and support respirations if necessary.
· For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a good gag reflex, and does not drool. Administer activated charcoal (refer to activated charcoal protocol in Section Four).
· Do not use emetics. Toxic effects from many compounds may be delayed, depending on rate of GI absorption. GI absorption rate may be influenced by a variety of factors, including time of last meal, amount ingested, and lipid solubility of the compound. Since it takes sometimes 30 minutes or more for syrup of ipecac to work, vomiting may begin about the time the patient begins to experience symptoms such as loss of consciousness, gag reflex, and/or seizures.

ADVANCED TREATMENT
· Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious, has severe pulmonary edema, or is in respiratory arrest. Early intubation at the first sign of upper airway obstruction may be necessary.
· Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
· Administer 100% oxygen if carbon monoxide poisoning is suspected. Hyperbaric oxygen therapy should be considered if CNS or cardiac symptoms are present and/or the carboxyhemoglobin concentration is greater than 30%.
· Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in this section).
· Start an IV with D5W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
· Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in this section).
Ingestion Exposure

- In-hospital gastric lavage may be useful in some ingestion situations. If indicated, gastric lavage should be instituted within the first 4 hours after ingestion, preferably in the first hour after ingestion. Usual contraindications include ingestions of strong corrosives, hemorrhage with coagulation abnormalities, and relatively nontoxic ingestions.

**Technique of gastric lavage**

1. Orogastic tube selection
   a. Use a large-bore orogastric tube (nasogastric tubes except for GI decompression are not indicated). Appropriate sizes are: Adult—30 to 40 French; child—16 to 28 French.

2. Orogastic tube placement
   a. If the patient is unconscious, endotracheal or nasotracheal intubation to protect the airway is indicated before passage of the orogastric tube.
   b. Conscious patients with intact gag reflex may be lavaged without airway intubation. These patients require continuous observation to prevent aspiration.
   c. Maintain the patient in the head-down left lateral decubitus position to prevent aspiration.
   d. Once the tube is passed, continuous patient monitoring is required. To confirm tube placement, use a stethoscope to listen over the stomach for the sound of air as it is instilled via syringe into the orogastric tube. If the patient is endotracheally intubated and resistance to orogastric tube passage is encountered, cautious deflation of the endotracheal tube cuff may be required for orogastric tube passage. Reinflate the endotracheal cuff once the orogastric tube is passed.
   e. Abdominal or chest radiograph may be necessary to confirm tube placement.

3. Gastric lavage technique
   a. Gastric lavage is best accomplished with warmed saline to prevent hypothermia. The appropriate lavage fluid dose aliquot is: Adult—200 to 250 ml; child: 50 to 100 ml.
   b. Leave aliquot in place for about 30 to 60 seconds. Allow gravity to drain. Repeat until clear or at least approximately 2 L have been used in the adult.
   c. Once the lavage is complete, leave tube in place for administration of activated charcoal or multiple-dose activated charcoal dose and cathartics (refer to activated charcoal protocol in Section Four).

**SPECIAL CONSIDERATIONS**

- Gastric lavage should be considered an in-hospital technique.
- Systemic poisoning may result from ingestion exposure. Refer to specific guidelines for chemicals in question for more detailed information.
- Hospitalized patients may require the following baseline laboratory studies: CBC, platelet count, coagulation profile, serum electrolytes, BUN, creatinine, glucose, anion gap, baseline biochemistry panel, including serum aminotransferases (ALT and AST), alkaline phosphatase, lactic dehydrogenase, calcium, phosphorous, and magnesium. Additional useful tests, depending on the history of ingestion include blood cyanide concentration, ethanol, osmolar gap, ethylene glycol, methanol, heavy metal(s), and ingestion-specific poison determinations.
- Measurement of ABGs with measured carboxyhemoglobin, methemoglobin and percent oxygen saturation determinations may also be necessary.
- Baseline chest radiograph.
### Hazardous Materials Absorbed by Activated Charcoal

<table>
<thead>
<tr>
<th>Alcohol</th>
<th>Mercuric chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>Nicotine</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Oxalates</td>
</tr>
<tr>
<td>Camphor</td>
<td>Parathion</td>
</tr>
<tr>
<td>Chlordane</td>
<td>Phenolphthalein</td>
</tr>
<tr>
<td>2,4-Dichlorophenoxyacetic acid (2,4-D)</td>
<td>Phosphorus</td>
</tr>
<tr>
<td>Hexachlorophene</td>
<td>Potassium</td>
</tr>
<tr>
<td>Iodine</td>
<td>Selenium</td>
</tr>
<tr>
<td>Kerosene</td>
<td>Silver</td>
</tr>
<tr>
<td>Malathion</td>
<td>Strychnine</td>
</tr>
</tbody>
</table>

### Hazardous Materials Not Well Absorbed by Activated Charcoal

<table>
<thead>
<tr>
<th>Alkali</th>
<th>Lithium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boric Acid</td>
<td>N-Methyl carbamate</td>
</tr>
<tr>
<td>Cyanide</td>
<td>Potassium hydroxide</td>
</tr>
<tr>
<td>DDT</td>
<td>Sodium hydroxide</td>
</tr>
<tr>
<td>Ferrous sulfate</td>
<td>Sodium metasilicate</td>
</tr>
<tr>
<td>Mineral acids</td>
<td></td>
</tr>
</tbody>
</table>


- Positive end-expiratory pressure (PEEP)–assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome (ARDS).
- Ascertain identification of specific poison. Refer to appropriate guideline.
The most recent advanced cardiac life support (ACLS) algorithms, published by the American Medical Association, have been reprinted in this section to guide emergency cardiac management decisions (Figs. III-1 to III-11). Specific information for chemically induced pulmonary edema and shock conditions can be found in the pulmonary edema and shock protocols found in this section.

Specific treatment protocols should be established by local medical control.
Universal Algorithm for Adult Emergency Cardiac Care

Assess responsiveness

Responsive
- Observe
- Treat as indicated

Not responsive
- Activate EMS
- Call for defibrillator
- Assess breathing (open the airway, look, listen, and feel)

Breathing
- Place in rescue position if no trauma

Not breathing
- Give 2 slow breaths
- Assess circulation

Pulse

Oxygen
- IV
- Cardiac monitor
- Vital signs

History
- Physical examination
- 12-lead ECG

Suspected cause?

Hypotension/shock
Acute pulmonary edema
Go to p. 468

Acute MI
Go to p. 470

Arrhythmia

Too slow
Go to p. 463

Too fast
Go to p. 464

Ventricular fibrillation/tachycardia (VF/VT) present on monitor/defibrillator?

No

Yes

VF/VT
Go to p. 460

Intubate
- Confirm tube placement
- Confirm ventilations
- Determine rhythm and cause

Electrical activity?

Yes

No

Pulseless electrical activity (PEA)
Go to p. 461

Asystole
Go to p. 462

Adapted from JAMA 268 2199-2275. 1992 Copyright 1992, American Medical Association
Ventricular Fibrillation/ Pulseless Ventricular Tachycardia Algorithm (VF/VT)

- ABCs
- Perform CPR until defibrillator attached\(^b\)
- VF/VT present on defibrillator

Defibrillate up to 3 times if needed for persistent VF/VT (200 J, 200-300 J, 360 J)

Rhythm after the first 3 shocks\(^h\)

#### Persistent or recurrent VF/VT

- Continue CPR
- Intubate at once
- Obtain IV access

#### Return of spontaneous circulation

- Assess vital signs
- Support airway
- Support breathing
- Provide medications appropriate for blood pressure, heart rate, and rhythm

#### PEA

Go to p. 461

#### Asystole

Go to p. 462

---

**Class I** definitely helpful
**Class IIa**: acceptable, probably helpful
**Class IIb**: acceptable, possibly helpful
**Class III**: not indicated, may be harmful

(a) Precordial thump is a Class IIb action in witnessed arrest, no pulse, and no defibrillator immediately available.
(b) Hypothermic cardiac arrest is treated differently after this point. See section on hypothermia.
(c) The recommended dose of epinephrine is 1 mg IV push every 3-5 min. If this approach fails, several Class IIb dosing regimens can be considered:
   - Intermediate epinephrine 2-5 mg IV push, every 3-5 min
   - Escalating: epinephrine 1 mg-3 mg-5 mg IV push, 3 min apart
   - High: epinephrine 0.1 mg/kg IV push, every 3-5 min

(d) **Sodium bicarbonate** (1 mEq/kg) is Class I if patient has known preexisting hyperkalemia

(e) Multiple sequenced shocks (200, 200-300 J, 360 J) are acceptable here (Class I), especially when medications are delayed.

(f) Medications:
   - Lidocaine 1.5 mg/kg IV push. Repeat in 3-5 min to total loading dose of 3 mg/kg; then use
   - Bretylium 5 mg/kg IV push. Repeat in 5 min at 10 mg/kg
   - Magnesium sulfate 1-2 g IV in torsades de pointes or suspected hypomagnesemic state or severe refractory VF
   - Procainamide 30 mg/min in refractory VF (maximum total 17 mg/kg)

(g) **Sodium bicarbonate** (1 mEq/kg IV):
   - Class IIa
     - If known preexisting bicarbonate-responsive acidosis
     - If overdose with tricyclic antidepressants
     - To alkalize the urine in drug overdoses
   - Class IIb
     - If intubated and continued long arrest interval
     - Upon return of spontaneous circulation after long arrest interval
   - Class III
     - Hypoxic lactic acidosis

---

Pulseless Electrical Activity (PEA) Algorithm
(Electromechanical Dissociation [EMD])

Includes: • Electromechanical dissociation (EMD)
  • Pseudo-EMD
  • Idioventricular escape rhythms
  • Ventricular escape rhythms
  • Bradyasystolic rhythms
  • Postdefibrillation idioventricular rhythms

- Continue CPR
- Intubate at once
- Obtain IV access
- Assess blood flow using Doppler ultrasound

Consider possible causes
(parentheses = possible therapies and treatments)
• Hypovolemia (volume infusion)
• Hypoxia (ventilation)
• Cardiac tamponade (pericardiocentesis)
• Tension pneumothorax (needle decompression)
• Hypothermia (see hypothermia algorithm)
• Massive pulmonary embolism (surgery, thrombolitics)
• Drug overdoses such as tricyclics, digitalis, beta-blockers, calcium channel blockers
• Hyperkalemia
• Acidosis
• Massive acute myocardial infarction (go to p. 470)

- **Epinephrine** 1 mg IV push, repeat every 3-5 min
- If absolute bradycardia (<60 beats/min) or relative bradycardia, give atropine 1 mg IV
- Repeat every 3-5 min to a total of 0.04 mg/kg

Class I: definitely helpful
Class IIa: acceptable, probably helpful
Class IIb: acceptable, possibly helpful
Class III: not indicated, may be harmful

(a) **Sodium bicarbonate** 1 mEq/kg is Class I if patient has known preexisting hyperkalemia.
(b) **Sodium bicarbonate** (1 mEq/kg):
  Class IIa
  • If known preexisting bicarbonate-responsive acidosis
  • If overdose with tricyclic antidepressants
  • To alkalinate the urine in drug overdoses

Class IIb
• If intubated and long arrest interval
• Upon return of spontaneous circulation after long arrest interval

Class III
• Hypoxic lactic acidosis
(c) The recommended dose of epinephrine is 1 mg IV push every 3-5 min. If this approach fails, several Class IIb dosing regimens can be considered:
  • Intermediate: epinephrine 2-5 mg IV push, every 3-5 min
  • Escalating: epinephrine 1 mg-3 mg-5 mg IV push, 3 min apart
  • High: epinephrine 0.1 mg/kg IV push, every 3-5 min
(d) Shorter atropine dosing intervals are possibly helpful in cardiac arrest (Class IIb).

Adapted from JAMA 268. 2199-2275, 1992. Copyright 1992, American Medical Association
Asystole Treatment Algorithm

- Continue CPR
- Intubate at once
- Obtain IV access
- Confirm asystole in more than one lead

Consider possible causes
- Hypoxia
- Hyperkalemia
- Hypokalemia
- Preexisting acidosis
- Drug overdose
- Hypothermia

Consider immediate transcutaneous pacing (TCP)

- Epinephrine 1 mg IV push repeat every 3-5 min
- Atropine 1 mg IV repeat every 3-5 min up to a total of 0.04 mg/kg

Consider termination of efforts

Class I: definitely helpful
Class IIa: acceptable, probably helpful
Class IIb: acceptable, possibly helpful
Class III: not indicated, may be harmful

(a) TCP is a Class IIb intervention. Lack of success may be due to delays in pacing. To be effective TCP must be performed early, simultaneously with drugs. Evidence does not support routine use of TCP for asystole.

(b) The recommended dose of epinephrine is 1 mg IV push every 3-5 min. If this approach fails, several Class IIb dosing regimens can be considered:
- Intermediate: epinephrine 2-5 mg IV push, every 3-5 min
- Escalating: epinephrine 1 mg-3 mg-5 mg IV push, 3 min apart
- High: epinephrine 0.1 mg/kg IV push, every 3-5 min

(c) Sodium bicarbonate 1 mEq/kg is Class I if patient has known preexisting hyperkalemia.

(d) Shorter atropine dosing intervals are Class IIb in asystolic arrest.

(e) Sodium bicarbonate 1 mEq/kg.

Class IIa
- if known preexisting bicarbonate-responsive acidosis
- if overdose with tricyclic antidepressants
- to alkalinate the urine in drug overdoses

Class IIb
- if intubated and continued long arrest interval
- upon return of spontaneous circulation after long arrest interval

Class III
- hypoxic lactic acidosis

(f) If patient remains in asystole or other agonal rhythms after successful intubation and initial medications and no reversible causes are identified, consider termination of resuscitative efforts by a physician. Consider interval since arrest.

Bradycardia Algorithm
(Patient is not in cardiac arrest)

(a) Serious signs or symptoms must be related to the slow rate. Clinical manifestations include:
- symptoms (chest pain, shortness of breath, decreased level of consciousness)
- signs (low BP, shock, pulmonary congestion, CHF, acute MI).

(b) Do not delay TCP while awaiting IV access or for atropine to take effect if patient is symptomatic.

(c) Denervated transplanted hearts will not respond to atropine. Go at once to pacing, catecholamine infusion, or both.

(d) Atropine should be given in repeat doses in 3-5 min up to total of 0.04 mg/kg. Consider shorter dosing intervals in severe clinical conditions. It has been suggested that atropine should be used with caution at atrioventricular (AV) block at the His-Purkinje level (type II AV block and new third-degree block with wide QRS complexes) (Class IIb).

(e) Never treat third-degree heart block plus ventricular escape beats with lidocaine.

(f) Isoproterenol should be used, if at all, with extreme caution. At low doses it is Class IIb (possibly helpful); at higher doses it is Class III (harmful).

(g) Verify patient tolerance and mechanical capture. Use analgesia and sedation as needed.

Tachycardia Algorithm

- Assess ABCs
- Secure airway
- Administer oxygen
- Start IV
- Attach monitor, pulse oximeter, and automatic blood pressure
- Assess vital signs
- Review history
- Perform physical examination
- Order 12-lead ECG
- Order portable chest roentgenogram

If ventricular rate >150 beats/min
- Prepare for immediate cardioversion (go to p. ###)
- May give brief trial of medications based on arrhythmia
- Immediate cardioversion is seldom needed for heart rates <150 beats/min

No or borderline

- Atrial fibrillation
  - Atrial flutter
  - Consider
    - Diltiazem
    - Beta-blockers
    - Verapamil
    - Digoxin
    - Procainamide
    - Quinidine
    - Anticoagulants

- Paroxysmal supraventricular tachycardia (PSVT)
  - Vagal maneuvers
  - Adenosine
    - 6 mg, rapid IV push over 1-3 sec
    - 1-2 min

- Wide-complex tachycardia of uncertain type
  - Lidocaine
    - 1-1.5 mg/kg IV push
    - Every 5-10 min

- Ventricular tachycardia (VT)
  - Lidocaine
    - 1-1.5 mg/kg IV push
    - Every 5-10 min

- Complex width?
  - Adenosine
    - 12 mg, rapid IV push over 1-3 sec (may repeat once in 1-2 min)
(a) Unstable condition must be related to the tachycardia. Signs and symptoms may include chest pain, shortness of breath, decreased level of consciousness, low blood pressure (BP), shock, pulmonary congestion, congestive heart failure, acute myocardial infarction.

(b) Carotid sinus pressure is contraindicated in patients with carotid bruits; avoid ice water immersion in patients with ischemic heart disease.

(c) If the wide-complex tachycardia is known with certainty to be PSVT and BP is normal/elevated, sequence can include verapamil.
Electrical Cardioversion Algorithm
(Patient is not in cardiac arrest)

**Tachycardia**
With serious signs and symptoms related to the tachycardia

If ventricular rate is >150 beats/min, prepare for IMMEDIATE CARDIOVERSION. May give brief trial of medications based on specific arrhythmias. Immediate cardioversion is generally not needed for rates <150 beats/min.

**Check**
- Oxygen saturation
- Suction device
- IV line
- Intubation equipment

**Premedicate whenever possible**

**Synchronized cardioversion**
- VT
- PSVT
- Atrial fibrillation
- Atrial flutter

(a) Effective regimens have included a sedative (eg, **diazepam, midazolam, barbiturates, etomidate, ketamine, methohexital**) with or without an analgesic agent (eg, **fentanyl, morphine, meperidine**). Many experts recommend anesthesia if service is readily available.

(b) Note possible need to resynchronize after each cardioversion.

(c) If delays in synchronization occur and clinical conditions are critical, go to immediate unsynchronized shocks.

(d) Treat polymorphic VT (irregular form and rate) like VF: 200 J, 200-300 J, 360 J.

(e) PSVT and atrial flutter often respond to lower energy levels (start with 50 J).

Hypotension/Shock/Acute Pulmonary Edema Algorithm

Clinical signs of hypoperfusion, congestive heart failure, acute pulmonary edema
- Assess ABCs
- Secure airway
- Administer oxygen
- Start IV
- Attach monitor, pulse oximeter, automatic blood pressure
- Assess vital signs
- Review history
- Perform physical examination
- Order 12-lead ECG
- Order portable chest roentgenogram

What is the nature of the problem?

Volume problem
- Administer
  - Fluids
  - Blood transfusions
  - Cause-specific interventions
  - Consider vasopressors, if indicated

Systolic BP <70 mm Hg
- Consider Norepinephrine 0.5-30 μg/min IV or Dopamine 5-20 μg/kg/min

Systolic BP 70-100 mm Hg
- Dopamine 2.5-20 μg/kg/min IV (Add norepinephrine if dopamine is >20 μg/kg/min)

Systolic BP >100 mm Hg and diastolic BP normal
- Dobutamine 2.0-20 μg/kg/min IV

Rate problem
- Too slow
  Go to p. 463
- Too fast
  Go to p. 464

Diastolic BP >110 mm Hg
- Nitroglycerin start 10-20 μg/min IV (use if ischemia persists and BP remains elevated. Titrate to effect) and/or
- Nitroprusside 0.1-5.0 μg/kg/min IV

What is the blood pressure (BP)?

a for more information, see pages 463 and 464.
Consider further actions especially if the patient is in acute pulmonary edema

First-line actions
- **Furosemide** IV 0-5.0 mg/kg
- **Morphine** IV 1-3 mg
- **Nitroglycerin** SL
- **Oxygen**/intubate PRN

Second-line actions
- **Nitroglycerin** IV if BP >100 mm Hg
- **Nitroprusside** IV if BP >100 mm Hg
- **Dopamine** if BP <100 mm Hg
- **Dobutamine** if BP >100 mm Hg
- Positive end-expiratory pressure (PEEP)
- Continuous positive airway pressure (CPAP)

Third-line actions
- **Amrinone** 0.75 mg/kg then 5-15 μg/kg/min (if other drugs fail)
- **Aminophylline** 5 mg/kg (if wheezing)
- **Thrombolytic** therapy (if not in shock)
- **Digoxin** (if atrial fibrillation, supraventricular tachycardias)
- Angioplasty (if drugs fail)
- Intra-aortic balloon pump (bridge to surgery)
- Surgical interventions (valves, coronary artery bypass grafts, heart transplant)

(a) Base management after this point on invasive hemodynamic monitoring if possible.
(b) Fluid bolus of 250-500 mL normal saline should be tried. If no response, consider sympathomimetics.
(c) Move to **dopamine** and stop **norepinephrine** when BP improves.
(d) Add **dopamine** when BP improves. Avoid **dobutamine** when systolic BP <100 mm Hg.

Adapted from JAMA 268: 2199-2275, 1992 Copyright 1992, American Medical Association
Acute Myocardial Infarction Algorithm
Recommendations for early management of patients with chest pain and possible AMI

**COMMUNITY**
Community emphasis on "Call First, Call Fast, Call 911"

**EMS SYSTEM**
EMS system approach that should address
- Oxygen-IV-cardiac monitor-vital signs
- Nitroglycerin
- Pain relief with narcotics
- Notification of emergency department
- Rapid transport to emergency department
- Prehospital screening for thrombolytic therapy*
- 12-lead ECG, computer analysis, transmission to emergency department*
- Initiation of thrombolytic therapy*

**EMERGENCY DEPARTMENT**
"Door-to-drug" team protocol approach
- Rapid triage of patients with chest pain
- Clinical decision maker established (emergency physician, cardiologist, or other)

**Assessment**
Immediate:
- Vital signs with automatic BP
- Oxygen saturation
- Start IV
- 12-lead ECG (MD review)
- Brief, targeted history and physical
- Decide on eligibility for thrombolytic therapy

Soon:
- Chest x-ray
- Blood studies (electrolytes, enzymes, coagulation studies)

**Treatments to consider if there is evidence of coronary thrombosis plus no reasons for exclusion:** (some but not all may be appropriate)
- Oxygen at 4 L/min
- Nitroglycerin SL, paste or spray (if systolic blood pressure >90 mm Hg)
- Morphine IV
- Aspirin PO
- Thrombolytic agents
- Nitroglycerin IV (limit systolic BP drop to 10% if normotensive; 30% drop if hypertensive; never drop below 90 mm Hg systolic)
- Beta-blockers IV
- Heparin IV
- Routine lidocaine administration is NOT recommended for all patients with AMI
- Magnesium sulfate IV
- Percutaneous transluminal coronary angioplasty

30-60 min to thrombolytic therapy

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§For information on the National Heart Attack Alert Program, contact the National Institutes of Health Information Center, P.O. Box 30105, Bethesda, Md 20824-0105

*Optional guidelines*

**Bradycardia Decision Tree**

**Pediatric Advanced Life Support**

- Assess ABCs
- Secure airway
- Administer 100% oxygen
- Start IV or intraosseous (IO) access
- Assess vital signs

**Severe cardiorespiratory compromise?**
- Poor perfusion
- Hypotension
- Respiratory difficulty

**No**
- Observe
- Support ABCs
- Consider transfer or transport to ALS facility

**Yes**
- Perform chest compression if despite oxygenation and ventilation:
  - Heart rate <80/min in an infant
  - Heart rate <60/min in a child

**Epinephrine**
- IV/IO: 0.01 mg/kg (1:10 000)
- Endotracheal (ET): 0.1 mg/kg (1:1000)
- Repeat every 3-5 min at the same dose

**Atropine 0.02 mg/kg**
- Minimum dose: 0.1 mg
- Maximum single dose:
  - 0.5 mg for child
  - 1.0 mg for adolescent
- May be repeated once

*Special conditions may apply in the presence of severe hypothermia*

If asystole develops, see p. 462