Warfarin, Hydroxycoumarin, Indandione, and Related Compounds

SUBSTANCE IDENTIFICATION
Colorless, odorless solids. Used as solids, pellets, dusts, and solutions. Used as rodenticides. A variety of products are on the market. Warfarin is the anticoagulant drug Coumadin.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Eyes
Cardiovascular system
Hepatic
Secondary
Skin
Central nervous system
Respiratory system
Gastrointestinal system
Renal

LIFE THREAT
Impairs the clotting ability of the blood and causes internal hemorrhage.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia and hypotension.
Respiratory: Mild tachypnea.
CNS: Possibly paralysis or other signs of cerebral vascular accident caused by cerebral hemorrhage.
Gastrointestinal: Hematemesis, epistaxis, and bleeding gums. Bloody or tar-like stools.
Eye: Chemical conjunctivitis.
Skin: Ecchymosis at knees, elbows, and buttocks.
Renal: Kidney damage.
Hepatic: Liver damage.
Other: Some products may present a human teratogenic risk. Symptoms usually result from repeated exposures. Newer products, the so-called “superwarfarins” (indandiones), may cause symptoms after a single exposure.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Delayed, maximum anticoagulation effect usually reached in 36 to 72 hours.
THERMAL DECOMPOSITION PRODUCTS INCLUDE
Acrid smoke and fumes
Carbon dioxide
Carbon monoxide

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Blood disorders/bleeding tendencies

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- Rinse patient with warm water, 30° C/86° F, if possible.
- Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest.
- Start an IV with lactated Ringer’s TKO.
- For hypotension with signs of hypovolemia, administer fluid cautiously. Watch for signs of fluid overload (refer to shock protocol in Section Three).
• Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS
• Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (AST and ALT), lactic dehydrogenase (LDH), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
• Monitor clotting parameters, including prothrombin and partial thromboplastin times.
• Administration of vitamin K₁ (Aquamyphyton) may be beneficial.
  - Adult dosage: 5 to 10 mg IM
  - Pediatric dosage: 1 to 5 mg IM
• In severe poisoning cases with hemorrhage, vitamin K₁ may be given IV (IV use has increased risk of anaphylaxis):
  - Adult dosage: 10 mg IV
  - Pediatric dosage: 5 mg IV

Do not use vitamin K₃ (Synkavite).

Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS
• Use caution with invasive therapeutic measures. Intubation may cause upper airway hemorrhage.
• Persons on tricyclic antidepressants, dilantin, MAO inhibitors, erythromycin, tetracycline, sulfa drugs, and thyroid supplements may have an augmented response.
Arsenic and Related Compounds

SUBSTANCE IDENTIFICATION
A silver-grey, crystalline, solid or black and yellow amorphous form. Used in the manufacture of glass, metallurgy, alloys, and electrical and semiconductor devices. Also used in the manufacture of many commercial products, including insecticides, herbicides, desiccants, and wood preservatives.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Skin
Eyes
Respiratory system
Hepatic
Renal
Blood
Secondary
Central nervous system
Cardiovascular system
Gastrointestinal system

LIFE THREAT
Heavy metal toxicity. Vomiting with GI bleeding. CNS depression, pulmonary edema, and cardiac arrest.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Hypovolemic shock and circulatory collapse. Tachycardia and ventricular arrhythmias. QT interval prolongation and T wave changes.
Respiratory: Respiratory tract irritation, depression, and pulmonary edema.
CNS: Headache, vertigo, delirium, syncope, CNS depression, muscle cramps, coma, and seizures. Peripheral neuropathy with chronic exposure.
Gastrointestinal: Burning pain, nausea, vomiting, and bloody diarrhea. GI bleeding with hematemesis and hematochezia. Intense thirst, garlic-type breath odor.
Eye: Chemical conjunctivitis, corneal damage.
Skin: Dermatitis and burns. Cyanosis and cold extremities.
Renal: Kidney damage and hemoglobinuria.
Hepatic: Liver damage.
Blood: Anemia, low white blood cell count (leukopenia), decreased platelet count (thrombocytopenia), bone marrow suppression (pancytopenia), and increased bone marrow vascularity.
Other: Some products may present a human carcinogenic or teratogenic risk. Arsenic in contact with acid or acid mist may produce arsine gas.
SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms (blood, hepatic, renal) possibly delayed

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Metal oxide fumes
Arsenic trioxide

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Respiratory system disorders
Nervous system disorders
Liver disorders
Kidney disorders

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient's clothing, jewelry, and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- Rinse patient with warm water, 30°C/86°F, if possible.
- Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Remove victim from contact with the material.
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- Treat seizures if necessary (refer to seizure protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool.
Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).

**ADVANCED TREATMENT**

- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with D₃W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of pulmonary edema.
- Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
- For hypotension with signs of hypovolemia, administer fluid cautiously. Consider vasopressors for hypotension with a normal fluid volume. Watch for signs of fluid overload (refer to shock protocol in Section Three).
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

**INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS**

- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, coagulation profile, and baseline biochemical profile, including serum aminotransferases (AST and ALT), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Blood and urine arsenic determinations should be done. Treatment should not be delayed in the symptomatic patient, since results may take several days to obtain.
- 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.
- Closely monitor hydration state and urinary output and maintain if necessary.
- Urine alkalinization and chelation therapy with BAL or D-penicillamine may be beneficial in symptomatic patients. Therapy should be guided by patient presentation and renal test values.
- Hemodialysis may be required in cases of acute renal failure.
- Obtain toxicological consultation as necessary.
SUBSTANCE IDENTIFICATION
Found as a colorless gas that may have a garlic-type odor. Arsine may be found wherever hydrogen is generated in the presence of arsenic. Arsine is formed by the action of a weak acid on arsenic-containing iron or other nonferrous metals. Used in the electronics industry in doping gas mixtures for semiconductors and in organic synthesis. Most common type of exposure is during cleaning of tanks and tank cars.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation

TARGET ORGANS
Primary
Cardiovascular system
Hepatic
Renal
Blood
Secondary
Skin
Eyes
Central nervous system
Respiratory system
Gastrointestinal system

LIFE THREAT
Intravascular hemolysis, pulmonary edema, and acute renal failure. Latent period of 2 to 24 hours may precede jaundice and renal failure. Exposure may cause cardiac and respiratory arrest.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia, ventricular arrhythmias, and hypotension.
Respiratory: Dyspnea and pulmonary edema. Respiratory tract irritation.
CNS: Headache, dizziness, paresthesia, delirium, and coma.
Gastrointestinal: Nausea, vomiting, and abdominal pain.
Eye: Chemical conjunctivitis, corneal damage. Red staining of the conjunctiva.
Skin: Dermatitis and burns. Bronzing of the skin and jaundice.
Renal: Red or bronze-colored urine. Painless hematuria leading to renal damage or acute renal failure.
Hepatic: Liver damage with jaundice.
Blood: Intravascular hemolysis, anemia, bone marrow depression. Decreased erythrocyte glutathione (GSH) reported.
Other: Some products may present a human carcinogen or teratogenic risk. Can be fatal or cause severe injuries at concentrations below the odor threshold (0.5 ppm)

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms possibly delayed for minutes to hours
CO-EXPOSURE CONCERNS
Chlorine
Fluorine
Nitric acid
Nitrogen trifluoride

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Arsenic trioxide
Arsine generation from gallium arsenide

MEDICAL CONDITIONS COMMONLY AGGRAVATED BY EXPOSURE
Kidney disease
Congenital deficiency of reduced erythrocyte glutathione (GSH)
Anemia

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- If any concurrent liquid or solid contamination exists:
  - Gently brush away dry particles and blot excess liquids with absorbent material.
  - Rinse patient with warm water, 30°C/86°F, if possible.
  - Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
ADVANCED TREATMENT

- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with lactated Ringer’s. Titrate flow to maintain urine output. Watch for signs of pulmonary edema.
- Treat hypotension with fluid administration. Vasopressors should only be used if fluid administration cannot maintain an adequate blood pressure (refer to shock protocol in Section Three).
- Administer furosemide (Lasix) (refer to furosemide protocol in Section Four).
- Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
- Administer 1 to 2 amps (adult dose) of sodium bicarbonate IV push, BY DIRECT PHYSICIAN ORDER. This will alkalinize the urine and prevent hemoglobin precipitation and acute renal failure (refer to sodium bicarbonate protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).
- Cover skin burns with dry sterile dressings after decontamination (refer to chemical burn protocol in Section Three).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS

- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, coagulation profile, blood and urine arsenic concentrations, and baseline biochemical profile, including serum aminotransferases (AST and ALT), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- 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.
- Hemodialysis may be beneficial in the severely poisoned patient.
- Obtain toxicological consultation as necessary.
Barium and Related Compounds

SUBSTANCE IDENTIFICATION
Found in a white or yellowish metal powder that will evolve gas. Contained in rodenticides, alloys, paints, soap, paper, rubber, ceramics, glass, depilatories of animal hair, and fireworks. Also found in x-ray contrast (barium sulfate) media, textile industry, and steel hardening procedures. Also used in spark plugs and engine rod bearings and in gas removal from vacuum tubes during manufacturing.

ROUTES OF EXPOSURE
Skin and eye exposure
Inhalation
Ingestion

TARGET ORGANS
Primary
Skin
Eyes
Central nervous system
Cardiovascular system
Respiratory system
Secondary
Gastrointestinal system
Renal
Metabolism

LIFE THREAT
Cardiac arrhythmias leading to cardiac arrest and respiratory arrest caused by hypokalemia and muscle paralysis.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Ventricular arrhythmias with PVCs leading to bradycardia, episodes of ventricular tachycardia, ventricular fibrillation, and asystole. Vasoconstriction and transient hypertension. Hypotension caused by fluid loss from vomiting and diarrhea.
Respiratory: Failure due to respiratory muscle paralysis. A corrosive action that may cause irritation and bronchial pneumonia.
CNS: Dizziness, tinnitus, muscle spasms, and seizures followed by coma and paralysis.
Gastrointestinal: Severe gastroenteritis causing cramp-type pain, nausea, vomiting, and bloody diarrhea. Excessive salivation
Eye: Chemical conjunctivitis and severe burns with corneal damage possible. Dilated pupils may be present.
Skin: May be alkaline in solution and cause severe skin burns.
Renal: Kidney damage.
Metabolism: Hypokalemia.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms possibly delayed
CO-EXPOSURE CONCERNS
Other metals
THERMAL DECOMPOSITION PRODUCTS INCLUDE
Oxides
Barium hydride
MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Respiratory disorders
Cardiac dysrhythmias
Low serum potassium
DECONTAMINATION
• Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
• Delay entry until trained personnel and proper protective equipment are available.
• Remove patient from contaminated area.
• Quickly remove and isolate patient’s clothing, jewelry, and shoes.
• Gently brush away dry particles and blot excess liquids with absorbent material.
• Rinse patient with warm water, 30° C/86° F, if possible.
• Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
• Refer to decontamination protocol in Section Three.
IMMEDIATE FIRST AID
• Ensure that adequate decontamination has been carried out.
• If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
• Immediately flush contaminated eyes with gently flowing water.
• Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
• Keep victim quiet and maintain normal body temperature.
• Obtain medical attention.
BASIC TREATMENT
• Establish a patent airway. Suction if necessary.
• Watch for signs of respiratory insufficiency and assist ventilations if necessary.
• Administer oxygen by nonrebreather mask at 10 to 15 L/min.
• Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
• Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
• For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
• Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool (refer to ingestion protocol in Section Three).
• Do not attempt to neutralize because of exothermic reaction.
• Cover skin burns with dry sterile dressings after decontamination (refer to chemical burn protocol in Section Three).
ADVANCED TREATMENT

- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with lactated Ringer’s TKO. Watch for signs of fluid overload.
- For hypotension with signs of hypovolemia, administer fluid cautiously. Watch for signs of fluid overload (refer to shock protocol in Section Three).
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS

- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (AST and ALT), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Serum potassium should be monitored and hypokalemia treated if necessary.
- Forced diuresis and hemodialysis may be beneficial in the severely poisoned patient.
- Obtain toxicological consultation as necessary.
Beryllium and Related Compounds

SUBSTANCE IDENTIFICATION
A hard, light, grayish-white metal. May exist as fume (beryllium oxide), respirable dust, metal or alloy. Used in the manufacture of electrical components, chemicals, ceramics, and x-ray tubes. Beryllium is also added to many alloys to increase strength and corrosion resistance.

ROUTE OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion

TARGET ORGANS
Primary
Skin
Eyes
Respiratory system
Secondary
Central nervous system
Cardiovascular system
Gastrointestinal system
Hepatic
Renal

LIFE THREAT
Acute beryllium pneumonitis and pulmonary edema.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia.
Respiratory: Irritation of respiratory tract. Epistaxis, feeling of facial fullness with pain, nonproductive cough, dyspnea, and pulmonary edema. Chest pain or tightness of the chest may be present. Berylliosis (chronic beryllium disease).
CNS: Weakness, dizziness, and fatigue. Seizures.
Gastrointestinal: Irritation of the mucous membranes.
Eye: Chemical conjunctivitis, corneal damage, and severe burns.
Skin: Dermatitis. If solid beryllium is implanted under broken or abraded skin, lesions with central nonhealing areas may result. Cyanosis may be present.
Renal: Kidney dysfunction.
Hepatic: Liver damage.
Other: Some products may present a human carcinogen risk.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms possibly delayed

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Beryllium oxide fumes
Hydrogen chloride
Hydrogen
Beryllium and Related Compounds

Nitrogen oxides
Sulfur dioxide

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
Pulmonary disorders
Cardiac disorders
Skin disorders
Liver disorders
Kidney disorders

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient's clothing, jewelry, and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- Rinse patient with warm water, 30°C/86°F, if possible.
- Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest.
Beryllium and Related Compounds

- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- 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 Section Three).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS
- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (AST and ALT), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required. Beryllium blood concentrations not helpful in management.
- 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.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS
- Beryllium lymphocyte transformation test useful in assessing risk of developing lung fibrosis (Berylliosis) from beryllium exposure.
Cadmium and Related Compounds

**SUBSTANCE IDENTIFICATION**
Odorless, white, metallic solid. Found as a powder, pure sticks, ingots, slabs, or crystals. Used in various silver and copper alloys; in rustproofing; in the production of phosphors, paints, pigments, and batteries; and in various metallurgical processes, including metal electroplating. Also a by-product of zinc-smelting operations. May be released from welding cadmium-containing objects or soldering (copper, lead, tin, zinc, and silver solder) and brazing with rods or wire containing cadmium.

**ROUTES OF EXPOSURE**
Skin and eye contact
Inhalation
Ingestion

**TARGET ORGANS**
*Primary*
Skin
Eyes
Cardiovascular system
Respiratory system
Renal
*Secondary*
Central nervous system
Gastrointestinal system
Hepatic
Metabolism

**LIFE THREAT**
Respiratory irritant that can cause pulmonary edema.

**SIGNS AND SYMPTOMS BY SYSTEM**
*Cardiovascular:* Tachycardia and arrhythmias.
*Respiratory:* Respiratory tract irritation. Productive cough, stridor, dyspncea, tachypnea, and noncardiac chest pain. Cadmium fume pneumonitis, acute pulmonary edema (sometimes hemorrhagic), and pulmonary fibrosis.
*CNS:* Headache, weakness, vertigo, and metallic taste in the mouth. CNS depression to coma. Seizures are rare. Muscle cramps may be present.
*Gastrointestinal:* Nausea, vomiting, hemorrhagic gastritis, and diarrhea. Abdominal cramps and increased salivation.
*Eye:* Chemical conjunctivitis.
*Skin:* Dermatitis.
*Renal:* Kidney damage.
*Hepatic:* Liver damage.
*Metabolism:* Metabolic acidosis. Altered calcium metabolism.
*Other:* Fever. Some products may present a human carcinogenic risk.
SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms possibly delayed for days

CO-EXPOSURE CONCERNS
Metals capable of causing a metal fume fever-type syndrome.
Cigarette smoking (cigarette smoking increases normal cadmium intake)

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Cadmium oxides
Sulfur dioxide

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Respiratory disorders
Kidney disorders

DECONTAMINATION
\cdot Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
\cdot Delay entry until trained personnel and proper protective equipment are available.
\cdot Remove patient from contaminated area.
\cdot Quickly remove and isolate patient’s clothing, jewelry, and shoes.
\cdot Gently brush away dry particles and blot excess liquids with absorbent material.
\cdot Rinse patient with warm water, 30° C/86° F, if possible.
\cdot Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
\cdot Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
\cdot Ensure that adequate decontamination has been carried out.
\cdot If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
\cdot Immediately flush contaminated eyes with gently flowing water.
\cdot Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
\cdot Keep victim quiet and maintain normal body temperature.
\cdot Obtain medical attention.

BASIC TREATMENT
\cdot Establish a patent airway. Suction if necessary
\cdot Watch for signs of respiratory insufficiency and assist ventilations if necessary.
\cdot Administer oxygen by nonrebreather mask at 10 to 15 L/min.
\cdot Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
\cdot Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
\cdot For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
\cdot Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not
drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).

**ADVANCED TREATMENT**
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in severe pulmonary edema.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- 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 Section Three).
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

**INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS**
- Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Blood and urine cadmium concentrations may be obtained. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Urinary cadmium concentrations provide an indication of recent cadmium exposure and body burden. Beta₂ microglobulin determination in urine may be increased in acute cadmium induced nephropathy.
- Serum cadmium concentrations range from 0.0005 to 0.002 mg/L, with blood cadmium averaging 0.004 mg/L in nonexposed workers to 0.009 mg/L in asymptomatic individuals exposed to cadmium fumes. Urine cadmium concentrations over 0.005 mg/L may indicate excessive exposure.
- 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.
- There are no effective chelating agents. Calcium and vitamin D therapy have proven useful in cases of severe bone loss.
- Obtain toxicological consultation as necessary.

**SPECIAL CONSIDERATIONS**
- Cadmium has a half-life in humans of 25 to 30 years.
Cobalt and Related Compounds

SUBSTANCE IDENTIFICATION
Silvery gray-to-silver, bluish-white, odorless solid, or found in solution form. Used in the manufacture of cobalt-bearing alloys, permanent magnets, lacquers, paint driers, cutting materials, and wear-resistant materials, in the production of inks, enamels, glazes, glass/ceramic pigments, and catalysts; and in the synthesis of heating fuels and as a catalyst in hydrocarbon production. Pyrophoric cobalt is a black powder that burns in contact with air.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Skin
Eyes
Cardiovascular system
Respiratory system
Blood
Secondary
Central nervous system
Gastrointestinal system
Renal
Metabolism

LIFE THREAT
Respiratory irritant that may cause pulmonary edema and fibrosis.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia, arrhythmias, and hypotension.
CNS: CNS depression.
Gastrointestinal: Nausea, vomiting, diarrhea, abdominal cramps, and pancreatitis.
Eye: Chemical conjunctivitis and corneal damage.
Skin: Irritant or allergic dermatitis.
Renal: Hematuria and kidney damage.
Metabolism: Metabolic acidosis. Hypothyroidism.
Blood: Coagulation abnormalities.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms possibly delayed for days
CO-EXPOSURE CONCERNS
Nickel
Chromium

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Cardiovascular disorders
Respiratory disorders
Skin disorders

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient's clothing, jewelry, and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- Rinse patient with warm water, 30° C/86° F, if possible.
- Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in severe pulmonary edema.
Cobalt and Related Compounds

- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- 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 Section Three).
- For hypotension with signs of hypovolemia, administer fluids cautiously. Consider vasopressors if hypotensive without signs of hypovolemia (refer to shock protocol in Section Three).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS

- Useful initial laboratory studies include complete blood count, coagulation profile, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (ALT and AST), amylase, calcium, phosphorus, magnesium, and thyroid profile. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- 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.
- Bronchospastic symptoms should be treated with an inhalation medication regime similar to that used for reactive airways disease. Inhaled corticosteroids may be of value in severe bronchospasm.
- Products may cause acidosis; hyperventilation and sodium bicarbonate may be beneficial. Bicarbonate therapy should be guided by patient presentation, ABG determination, and serum electrolyte considerations.
- Obtain toxicological consultation if necessary.
Copper and Related Compounds

SUBSTANCE IDENTIFICATION
Reddish, lustrous, odorless metal. Found as solids, dusts, or mists. May be found in paint pigments, coloring agents, electroplating baths, wood preservation, and textile treatments. Also used in the manufacture of copper wire, rod, piping, and tubing. Product can be liberated from production and application of insecticides, germicides, and fungicides. Also produced during mining and refining of copper ore. Elemental copper is an essential enzyme co-factor.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion

TARGET ORGANS
Primary
Skin
Eyes
Respiratory system
Renal
Hepatic
Blood
Secondary
Central nervous system
Cardiovascular system
Gastrointestinal system

LIFE THREAT

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia, weak pulse, and hypotension.
CNS: Headache, fatigue, and coma.
Gastrointestinal: Nausea, vomiting (blue-green emesis), abdominal pain, hemorrhagic gastritis, and diarrhea. Metallic taste in the mouth.
Eye: Chemical conjunctivitis, corneal ulceration, and palpebral edema.
Skin: Irritant dermatitis. Skin may be pale, cool, and clammy. Greenish discoloration of the skin and hair possible.
Renal: Kidney damage, hematuria, oliguria, increased BUN, and acute tubular necrosis.
Hepatic: Liver damage.
Blood: Hemolytic anemia.
Other: Exposure may cause metal fume fever: a self-limited, flu-type illness with symptoms of metallic taste, fever, chills, aches, chest tightness, and cough.
SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Symptoms possibly delayed 48 hours

CO-EXPOSURE CONCERNS
Other metals

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Copper fumes
Metal oxides
Carbon monoxide
Carbon dioxide

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Wilson's disease (an autosomal recessive genetic condition resulting in excess copper storage in the body).

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- Rinse patient with warm water, 30° C/86° F, if possible.
- Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).
ADVANCED TREATMENT
• Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious.
• Start an IV with lactated Ringer’s TKO. Watch for signs of fluid overload.
• For hypotension with signs of hypovolemia, administer fluid cautiously. Consider vasopressors if hypotensive with a normal fluid volume. Watch for signs of fluid overload (refer to shock protocol in Section Three).
• Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS
• Useful initial laboratory studies include complete blood count, coagulation profile, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including bilirubin, serum aminotransferases (ALT and AST), calcium, phosphorus, magnesium, serum or blood copper. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
• Normal serum copper concentrations vary widely and range up to 1.09 mg/L in men and 1.2 mg/L in women. Copper concentrations may double in pregnancy. Blood copper concentrations average 0.89 mg/L in both men and women. Blood copper measurements correlate more closely with acute poisoning. Blood concentrations greater than 3 mg/L may be indicative of toxicity.
• Chelating agents (BAL, D-penicillamine) may be beneficial in symptomatic patients. Therapy should be guided by patient presentation and laboratory values.
• Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS
• Copper sulfate is a strong emetic. This emetic action may limit toxicity in mild-to-moderate ingestions.
• Metal fume fever, also termed “Monday Morning Fever,” may develop from exposure to copper fumes. Symptoms include: metallic taste, dry cough, shortness of breath, diaphoresis, fever, chills, fatigue, and myalgia. Symptoms usually begin 4 to 12 hours after exposure, are self-limited, usually remit during the work week, and re-appear with exposure after the weekend. This is most likely an immune-mediated problem related to occupational exposures.