Dithiocarbamates and Related Compounds

SUBSTANCE IDENTIFICATION
White, yellowish, grayish, or black powder or crystals with a characteristic odor. Available as a wettable powder, dust, aqueous suspension. Also found in mixtures with other fungicides (mixtures, oil dispersible). Used as fungicides, seed disinfectants, insecticides, animal repellents, and soil sterilants and in soap and antiseptic sprays and rubber manufacturing.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

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

LIFE THREAT
Hypotension and respiratory failure.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Cardiovascular collapse and hypotension.
Respiratory: Upper respiratory tract irritation with cough. Respiratory paralysis.
CNS: Headache, weakness, lethargy, dizziness, ataxia, confusion, drowsiness, and coma. Suppression of deep tendon reflexes, flaccid paralysis, and weakness/numbness of the extremities. Cerebral edema may occur with exposure to some products. Late development of peripheral neuropathy.
Gastrointestinal: Nausea, vomiting, diarrhea. Ingestion may cause GI tract necrosis.
Eye: Conjunctivitis, lacrimation, and corneal damage.
Skin: Allergic and contact dermatitis, pruritus, and photosensitivity.
Renal: Kidney damage.
Hepatic: Liver damage.
Blood: Low white count (leukopenia) and abnormality in red blood cell size (anisocytosis).
Metabolism: Thyroid dysfunction
Other: Some products may present human mutagenic or teratogenic risk. Some may
Dithiocarbamates and Related Compounds

present a carcinogenic risk from metabolites. Many of these products are carbamates; however, exposure does not lead to cholinergic findings (SLUDGE syndrome).

NOTE: Some of these products may be mixed with a hydrocarbon solvent as a vehicle. Toxicity may result from the solvent.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Possible delay of cerebral edema
Peripheral neuropathy delayed

CO-EXPOSURE CONCERNS
Alcohol: May cause disulfiram (Antabuse)-like reaction

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Carbon dioxide
Carbon disulfide
Carbon monoxide
Sulfur dioxide

MEDICAL PROBLEMS POSSIBLY AGGRAVATED BY EXPOSURE
Respiratory system disorders
Skin disorders
Thyroid 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).
· 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 severe respiratory distress patient.
- Hyperventilate if signs of cerebral edema are present.
- 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.
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- 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).
- 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, thyroid function, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS
- Ascertaining identity of the solvent involved and refer to appropriate guideline.
- These compounds may be metabolized to carbon disulfide, hydrogen sulfide, dimethylamine, methylisothiocyanate, and ethylene thiourea. These metabolites contribute to the clinical picture seen with these compounds.
- Fields treated with dithiocarbamate may demonstrate high air concentrations of carbon disulfide, hydrogen sulfide, and methylisocyanate.
- Disulfiram (Antabuse) is a dithiocarbamate. Consumption of alcohol may cause a disulfiram-like reaction.
Monofluoroacetate and Related Compounds

SUBSTANCE IDENTIFICATION
A white, water-soluble, odorless solid. Usually found in a water solution with a black warning color. Used as a rodenticide. Has been misused for predator elimination, or mixed with a black dye added to grain rodent baits.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

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

LIFE THREAT
Ventricular arrhythmias and seizures.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Sinus bradycardia with frequent ventricular ectopy (may be multifocal in nature), ventricular tachycardia, ventricular fibrillation, hypotension, and cardiac arrest.
Respiratory: Respiratory depression.
CNS: Excitation, apprehension, auditory disturbances, carpopedal spasm, and paresthesia of the face and nose. Seizures with periods of CNS depression, coma, and death.
Gastrointestinal: Nausea, vomiting, diarrhea, excessive salivation.
Eye: Chemical conjunctivitis and blurred vision.
Skin: Irritation. Cyanosis.
Hepatic: Liver damage.
Renal: Kidney damage.
Other: Extremely toxic compounds that prevent the conversion of citrate to isocitrate in the Krebs cycle. Hypocalcemia.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Symptoms possibly delayed 30 minutes to 3 hours

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Fluorides
Carbon oxides
MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Cardiovascular disorders
Neurological 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.
- 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.
- 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.
- 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, thyroid function, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.

- If hypocalcemia is present, calcium gluconate should be administered. Therapy should be guided by patient presentation and serum calcium levels.

- Obtain toxicological consultation as necessary.
Organotins and Related Compounds

SUBSTANCE IDENTIFICATION
Colorless-to-yellow liquids or solids with a weak odor. Used as fungicides, bactericides, pesticides, wood preservatives, and corrosion inhibitors.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion

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

LIFE THREAT
Respiratory failure, pulmonary edema, and cerebral edema.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Cardiovascular collapse and arrhythmias.
Respiratory: Respiratory tract irritation, respiratory failure, and pulmonary edema.
CNS: Headache, dizziness, visual disturbances, tinnitus, cerebral edema, muscle weakness, flaccid muscle paralysis, seizures, and coma. Neurobehavioral changes.
Gastrointestinal: Nausea, vomiting, diarrhea, GI tract hemorrhage and peritonitis may occur.
Eye: Conjunctivitis, lacrimation, corneal damage, conjunctival edema, and photophobia.
Skin: Irritation, dermatitis, and chemical burns.
Hepatic: Liver damage.
Renal: Glucose in the urine (glycosuria).
Metabolism: Inhibitors of oxidative phosphorylation, Hyperglycemia.
Other: Some of these products may be mixed with a hydrocarbon solvent as a vehicle. Toxicity may result from the solvent. Trialkytn compounds have the highest toxicity

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Cerebral and pulmonary edema possibly delayed

CO-EXPOSURE CONCERNS
Hydrocarbon solvents
THERMAL DECOMPOSITION PRODUCTS INCLUDE
Irritating fumes
Organic acid vapors
Tin oxides

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Respiratory system 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 materials.
- 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 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).
- 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).
- 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 or in severe respiratory distress.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Hyperventilation may reduce intracranial pressure.
- 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.
- 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 CONSIDERATION
- 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. 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.
- Osmotic diuretics and/or hyperventilation may be useful in treating cerebral edema.
- In animal studies, chelators such as BAL or d-Penicillamine have demonstrated no therapeutic benefit in removing organotin compounds.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS
- Ascertain identity of the solvent involved and refer to appropriate guideline.
- Oral exposures result in relatively more severe toxicity.
Paraquat and Related Compounds

SUBSTANCE IDENTIFICATION
Paraquat is a colorless-to-yellow solid with a mild, ammonia-like odor, but may be found in (0.5% to 20%) solutions and sprays. Used as a herbicide, desiccant, defoliation agent, and redox indicator. Products are extremely toxic.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

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

LIFE THREAT
Paraquat and diquat are poisons that target multiple organ systems. Death results from pulmonary edema, cardiac damage, circulatory collapse, and cerebral hemorrhages/infarctions.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Cardiovascular collapse, hypotension, and arrhythmias.
Respiratory: Irritation of the mucous membranes. Coughing, dyspnea, epistaxis, and pulmonary edema followed by a late development of pulmonary fibrosis. Diquat does not cause fibrosis.
CNS: Headache, lethargy, CNS depression, and coma. Diquat may cause brainstem hemorrhage and infarction.
Gastrointestinal: Burning pain in mouth, pharynx, esophagus, and abdomen. Likely to produce burns or ulceration of the mouth, pharynx, esophagus, and stomach. Nausea, profuse, bloody vomiting (hematemesis), paralytic ileus, and diarrhea with bloody stools. Pancreatic damage.
Eye: Chemical conjunctivitis and severe eye injury resembling corrosive injuries. Corneal scarring possible.
Skin: Irritation, dryness, erythema, blistering, ulceration, and nail changes (transverse ridging, furrowing). Irritant or contact dermatitis. Exposure to paraquat solutions may cause skin burns. Cyanosis and sometimes jaundice
Renal: Renal failure.
Hepatic: Liver damage.
Other: Fever.

**SYMPTOM ONSET FOR ACUTE EXPOSURE**

Immediate

Some symptoms possibly delayed

Pulmonary fibrosis may occur 2 to 14 days after exposure

**THERMAL DECOMPOSITION PRODUCTS INCLUDE**

Carbon monoxide

Hydrogen chloride

Nitrogen oxides

Sulfur oxides

**MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE**

Eye disorders

Respiratory system disorders

Cardiovascular 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 a 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. Do not use supplemental oxygen in cases of paraquat or diquat exposure.
- 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.
Paraquat and Related Compounds

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 Fullers’ Earth, 7% bentonite USP or activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four). Do not delay GI decontamination.

- 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.

- Positive-pressure ventilation techniques with a bag-valve-mask device, (without supplemental oxygen in cases of paraquat or diquat exposure) 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 fluid cautiously. Consider vasopressors for hypotension with a normal fluid volume. Watch for signs of pulmonary edema (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, magnesium, and plasma paraquat/diquat concentrations. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required. Plasma paraquat concentrations are useful in predicting prognosis.

- Rapid Dithionite Test: to detect urinary paraquat/diquat:

  Add 5 ml 1% sodium dithionite (sodium hydrosulfate) in sodium hydroxide (1N) to 10 ml urine. Wait 60 seconds.

  Use positive and negative controls: dark blue color = paraquat or diquat; green color = diquat.

  The vividness of the color approximates the paraquat/diquat concentration. This is a semi-quantitative test.

- 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.

- Administer Fullers’ Earth or 7% bentonite USP:

  Adult dosage: 100 to 150 g via lavage tube

  Pediatric Dosage: 1 to 2 g/kg

- If above not available, use activated charcoal (refer to activated charcoal protocol in Section Four).
· Do not delay GI decontamination.
· Charcoal hemoperfusion within the first 2 hours of ingestion may be useful.
· Obtain toxicological consultation as necessary.

**SPECIAL CONSIDERATIONS**

· Oxygen enhances paraquat pulmonary toxicity. Although diquat does not cause pulmonary fibrosis, oxygen promotes the formation of superoxide ($O_2^-$) radicals that may cause multiorgan damage. Avoid supplemental oxygen administration with either paraquat or diquat poisoning unless the patient shows signs of severe cyanosis, respiratory compromise, or respiratory or cardiac arrest.
· Paraquat is actively transported into the lungs even after oral ingestion, causing pulmonary edema and irreversible fibrosis.
· Two phases of paraquat pulmonary toxicity:
  - Phase I: Types I and II pulmonary epithelial cells destroyed, causing alveolitis
  - Phase II: Intraalveolar and interalveolar fibrosis
Pentachlorophenol and Related Compounds

SUBSTANCE IDENTIFICATION
Found as a dark grey or light brown solid with a phenolic odor. Used as an emulsifiable concentrate, pellets, pills, and in solution forms. Used in making pesticides, fungicides, and herbicides and as a wood preservative. Compounds may be contaminated with polychlorinated dibenzodioxins and dibenzofurans.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

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

LIFE THREAT
Respiratory and circulatory collapse. Severe increase in body temperature (hyperthermia).

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Initially, blood pressure increase followed by hypotension Ventricular arrhythmias and tachycardia.
Respiratory: Sneezing, respiratory tract irritation, deep breathing followed by dyspnea, decreased rate, and arrest. Bronchitis is a common symptom. Pulmonary edema may occur secondary to massive inhalation exposures.
CNS: CNS excitation followed by depression, coma, and seizures. Extreme fatigue, headache, dizziness, incoordination, and weakness. Cerebral edema.
Gastrointestinal: Nausea, vomiting, diarrhea, and abdominal pains.
Eye: Chemical conjunctivitis, dilated pupils, and opacification of the cornea.
Skin: Dermatitis, chloracne, diaphoresis, and chemical burns.
Renal: Kidney damage. Renal output increased, then decreased.
Hepatic: Liver damage.
Metabolism: Metabolic acidosis. Uncouplers of oxidative phosphorylation.
Other: Exposure may alter metabolism and cause severe hyperthermia. Response personnel should be warned against overheating, since the toxicity of these products may be exaggerated by high-temperature environments.
NOTE: Some of these products may be mixed with a hydrocarbon solvent as a vehicle. Toxicity may result from the solvent.

**SYMPTOM ONSET FOR ACUTE EXPOSURE**

Immediate
Some symptoms possibly delayed

**CO-EXPOSURE CONCERNS**

Polychlorinated dibenzodioxins
Polychlorinated dibenzofurans
High-temperature environments

**THERMAL DECOMPOSITION PRODUCTS INCLUDE**

Carbon dioxide
Carbon monoxide
Chlorine
Chlorinated hydrocarbons
Chlorinated phenols
Hydrogen chloride
Phosgene

**MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE**

Kidney disorders
Liver 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 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).

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).

Cover skin burns with dry sterile dressings after decontamination (refer to chemical burn protocol in Section Three).

Rapid body cooling may be necessary in case of hyperthermia. Use of salicylates is contraindicated.

**ADVANCED TREATMENT**

Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in severe respiratory distress.

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 to treat dehydration. Watch for signs of fluid overload, cerebral edema, and 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, and baseline biochemical profile, including serum aminotransferases (AST and ALT), serum alkaline phosphatase, lactate dehydrogenase (LDH), calcium, phosphorous 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.

Products may cause acidosis; hyperventilation and sodium bicarbonate may be beneficial. Bicarbonate therapy should be guided by patient presentation, ABG determination, and serum electrolytes considerations.

Obtain toxicological consultation as necessary.

**SPECIAL CONSIDERATIONS**

Ascertain identity of the solvent involved and refer to appropriate guideline.

Atropine is contraindicated.
Glyphosate (Roundup) and Related Compounds

SUBSTANCE IDENTIFICATION
Colorless or white, odorless crystals. Also found in water-based solution form with a 15% surfactant (polyoxyethyleneamine) to aid in emulsification of the herbicide. This surfactant adds to the toxicity of the mixture. Used as an organic herbicide in the form of the mono(isopropylammonium) salt. Used in forestry, agriculture, and general weed-killing

ROUTE OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion

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

LIFE THREAT
Hypotension, cardiac arrhythmias, and pulmonary edema.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Cardiovascular collapse with hypotension. Ventricular arrhythmias and bradycardia.
Respiratory: Irritation of the upper airway. Pulmonary edema.
CNS: Ataxia, vertigo, incoordination, stupor, and coma.
Gastrointestinal: Nausea, vomiting, diarrhea, abdominal pain, pharyngitis, and erosions of GI tract mucosa.
Eye: Chemical conjunctivitis.
Skin: Dermatitis and chemical burns.
Renal: Kidney damage.
Hepatic: Liver damage.
Metabolism: Metabolic acidosis.
Blood: May cause red blood cell hemolysis.
Other: May cause hypothermia or hyperthermia.

SYMPTOM ONSET FOR ACUTE EXPOSURES
Immediate
Some symptoms possibly delayed
CO-EXPOSURE CONCERNS
Polyoxyethyleneamine
THERMAL DECOMPOSITION PRODUCTS INCLUDE
Carbon dioxide
Carbon monoxide
Nitrogen oxides
Phosphorus oxides
MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Anemia
Respiratory disorders (COPD)
Cardiovascular 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).
Monitor body temperature and treat if necessary.
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.
Positive-pressure ventilation techniques with a bag-valve-mask-device may be beneficial.
Start an IV with lactated Ringer's TKO. Titrate to maintain adequate urine flow. Watch for signs of fluid overload and pulmonary edema.
Monitor and treat cardiac arrhythmias if necessary (refer to cardiac protocol in Section Three).
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 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, 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.
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.
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.
Monitor for myoglobinuria. If present, maintain adequate hydration state and urine output. Diuretics and urinary alkalization may be required in severe cases.
Obtain toxicological consultation as necessary.
Strychnine and Related Compounds

SUBSTANCE IDENTIFICATION
Colorless, odorless solid. Found as grains, crystals, or powders. Used as a rodenticide and in veterinary products. Also found as a common adulterant of many street drugs.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion

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

LIFE THREAT
Convulsions leading to acidosis and diaphragmatic spasm causing respiratory arrest.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia and hypertension followed by cardiovascular collapse.
Respiratory: Hypoxemia and respiratory arrest secondary to convulsions.
CNS: Stiffness of face and neck. Restlessness, hyperexcitability, hyperreflexia, and muscle cramps. Mild sensory stimulus may produce violent paroxysmal convulsions. Body typically arches in hyperextension (opisthotonos): legs are adducted and extended, arms are rigidly extended, fists are tightly clenched, and the jaw is rigidly clamped. Patients are usually conscious and oriented during the convulsive episode.
Gastrointestinal: Occasional vomiting.
Eye: Chemical conjunctivitis.
Skin: Cyanosis and diaphoresis.
Renal: Kidney damage secondary to acidosis, rhabdomyolysis, and myoglobinuria.
Hepatic: Liver damage secondary to acidosis.
Metabolism: Lactic acidosis.
Other: Hyperthermia.

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Symptoms possibly delayed 15 to 30 minutes

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Carbon dioxide
Carbon monoxide
Nitrogen oxides
Sulfur dioxide

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 until medical treatment is obtained.
- 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.
- Anticipate convulsions 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. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).
- Use rapid cooling measures to treat hyperthermia.

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest.
- 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 fluid overload.
- For hypotension with signs of hypovolemia, administer fluid cautiously. Consider va-
Strychnine and Related Compounds

Soppressors for hypotension with a normal fluid volume. Watch for signs of fluid overload (refer to shock protocol in Section Three).

- Treat convulsions 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.
- Monitor for myoglobinuria. If present, maintain adequate hydration state and urinary output. Diuretic therapy may be necessary. Avoid alkalinization therapies, since this will delay excretion of strychnine.
- If convulsions are not controlled by diazepam, paralyzing agents (succinylcholine) may be needed.
- Acid diuresis is of questionable benefit and not indicated if myoglobinuria is present.
- Obtain toxicological consultation as necessary.

**SPECIAL CONSIDERATIONS**

- Very slight stimuli may cause convulsions; try to keep all external stimuli to a minimum.
Thiabendazoles and Related Compounds

SUBSTANCE IDENTIFICATION
A white, odorless solid. Formed as wettable powders, flowable suspension, thermal fumigation tablets, dusts, and 40% solutions. Used as systemic fungicides and in paint manufacturing. Thiabendazole (Mintezol) is used as a prescription anthelmintic.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

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

LIFE THREAT
Cardiovascular collapse and respiratory tract irritation

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Bradycardia, hypotension, and cardiovascular collapse.
Respiratory: Respiratory tract irritation, wheezing, and hypersensitivity reaction possible.
CNS: Headache, drowsiness, giddiness, tinnitus, numbness, muscle incoordination, vertigo, hyperexcitability, seizures, and CNS depression.
Gastrointestinal: Epigastric distress, salivation, anorexia, nausea, vomiting, and diarrhea.
Eye: Conjunctivitis.
Skin: Allergic dermatitis, erythema multiforma, and Stevens-Johnson syndrome (severe toxic cutaneous reaction with mucosal erosions).
Renal: Involuntary urination.
Hepatic: Liver damage.
Metabolism: Hyperglycemia.
Blood: Low white blood cell count (leukopenia).
Other: Some products have a carbamate structure but do not cause cholinesterase inhibitory effects.
NOTE: Some of these products may be mixed with a hydrocarbon solvent as a vehicle. Toxicity may result from the solvent.

**SYMPTOM ONSET FOR ACUTE EXPOSURE**

Immediate

Some symptoms possibly delayed

**THERMAL DECOMPOSITION PRODUCTS INCLUDE**

- n-butylisocyanate
- Hydrogen sulfide
- Sulfides
- Sulfur oxides

**MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE**

- Allergic reactions
- Asthma
- Dermatitis

**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 severe respiratory distress.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with D$_5$W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
- 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).
- 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.
- 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.
- Obtain toxicological consultation as necessary.

**SPECIAL CONSIDERATIONS**
- Ascertain identity of the solvent involved and refer to appropriate guideline.
- Acute toxicity problems are usually related to allergic dermatitis and hypersensitivity reactions.
- Thiabendazole has been reported to inhibit theophylline metabolism.