

Benzene and Related Compounds

SUBSTANCE IDENTIFICATION

Colorless liquids with an aromatic odor. Used in the manufacture of pharmaceuticals, dyes, textiles, varnishes, lacquers, solvents, degreasers, and many other compounds. Found in gasoline (0.8%), coal tar distillates, cigarette smoke, and petroleum naphtha.

ROUTES OF EXPOSURE

Skin and eye contact

Inhalation

Ingestion

Skin absorption

TARGET ORGANS

Primary

Skin

Eyes

Central nervous system

Cardiovascular system

Respiratory system

Hepatic

Renal

Blood

Secondary

Gastrointestinal system

LIFE THREAT

Arrhythmias, respiratory failure, pulmonary edema, CNS depression, liver and kidney damage.

SIGNS AND SYMPTOMS BY SYSTEM

Cardiovascular: Tachyarrhythmias, especially ventricular fibrillation and cardiovascular collapse.

Respiratory: Upper respiratory tract irritation, cough, hoarseness, dyspnea, tachypnea, substernal chest pain, bronchospasm, acute pulmonary edema, and respiratory failure.

CNS: Headache, drowsiness, dizziness, depression, decreased judgement, loss of balance, tinnitus, confusion, weakness, tremors, poor coordination, neurobehavioral changes, seizures, initial transient euphoria followed by CNS depression, and visual disturbances.

Gastrointestinal: Nausea, vomiting, stomach pain, and excessive salivation may be present.

Eye: Chemical conjunctivitis and corneal damage.

Skin: Drying and cracking of the skin (defatting, irritant dermatitis).

Kidney: Renal failure.

Hepatic: Liver toxicity.

Blood: Bone marrow suppression, aplastic anemia, and leukemia (acute myelogenous leukemia (AML)).

Other: Human carcinogenic risk with benzene (AML).

SYMPTOM ONSET FOR ACUTE EXPOSURE

Immediate

Pulmonary edema possibly delayed

Bone marrow symptoms delayed

CO-EXPOSURE CONCERNS

Other hydrocarbon solvents

Other bone marrow poisons

THERMAL DECOMPOSITION PRODUCTS INCLUDE

Carbon dioxide

Carbon monoxide

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE

Blood disorders

Kidney disorders

Liver 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 respiratory arrest.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias as 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, reticulocyte count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Arterial blood gases (ABG), 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.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS

- Avoid epinephrine and related beta agonists (unless patient is in cardiac arrest or has reactive airways disease refractory to other treatment) because of the possible irritable condition of the myocardium. Use of these medications may lead to ventricular fibrillation.
- Chronic or high-dose, acute exposure victims require participation in a medical surveillance program.

Halogenated Aliphatic Hydrocarbons and Related Compounds

SUBSTANCE IDENTIFICATION

Waxy, amber-colored solids with a mild turpentine odor. Colorless or white volatile liquids, with a penetrating odor, that yields heavy vapors. Used as solvents, cleaners, degreasing agents, paint removers, fumigants, and refrigerants.

ROUTE OF EXPOSURE

Skin and eye contact

Inhalation

Ingestion

Skin absorption

TARGET ORGANS

Primary

Skin

Eyes

Central nervous system

Cardiovascular system

Respiratory system

Secondary

Gastrointestinal system

Hepatic

Renal

LIFE THREAT

CNS depression, respiratory arrest, and circulatory collapse

SIGNS AND SYMPTOMS BY SYSTEM

Cardiovascular: Vasodilation (centrally mediated) leading to hypotension. Cardiovascular collapse, ventricular arrhythmias, and fibrillation.

Respiratory: Lung and mucous membrane irritation, dyspnea, tachypnea, signs of pulmonary edema, hypoxia, and respiratory arrest.

CNS: Headache, CNS depression, drowsiness, dizziness, confusion, vertigo, fatigue, lethargy, seizures, coma, visual disturbances, and numbness in hands and feet (pares-thesias).

Gastrointestinal: Nausea, vomiting, diarrhea, and abdominal cramps.

Eye: Chemical conjunctivitis and corneal damage.

Skin: Irritant dermatitis and chemical burns.

Renal: Kidney damage may occur.

Hepatic: Liver damage (hepatotoxicity) and hepatorenal syndrome.

Other: Methylene chloride is metabolized in the body to carbon monoxide. Prolonged exposure in nonsmokers may produce carboxyhemoglobin concentrations in the 3% to 10% range. These concentrations may produce cardiovascular compromise in individuals with preexisting lung and/or cardiovascular disease. Some products can cross

the placental membrane. Trichloroethylene, tetrachloroethylene, 1,2 dichloroethane, dichloromethane, tetrachloroethylene, and trichloromethane are suspected human carcinogens (other compounds may be added or deleted as further research data become available).

SYMPTOM ONSET FOR ACUTE EXPOSURE

Immediate

Pulmonary edema possibly delayed

Neurobehavioral changes possibly delayed

CO-EXPOSURE CONCERNS

Ethanol

Other organic solvents

THERMAL DECOMPOSITION PRODUCTS INCLUDE

Carbon dioxide

Carbon monoxide

Chlorine

Hydrogen bromide

Hydrogen chloride

Hydrogen iodide

Hydrogen fluoride

Phosgene

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE

Central nervous system disorders

Liver disorders

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).
- 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 sterile dressings after decontamination (refer to chemical burn protocol in Section Three).

ADVANCED TREATMENT

- Consider orotracheal or nasotracheal intubation for airway control in the unconscious patient.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias as necessary (refer to cardiac protocol in Section Three).
- Start an IV with D₅W TKO. Use lactated Ringer's if signs of hypovolemia are present.
- 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 with a normal fluid volume. Watch for signs of cardiac irritability and 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 (ALT and AST), calcium, phosphorus, and magnesium. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Monitor carboxyhemoglobin (CO) blood concentrations in cases of methylene chloride (refer to carbon monoxide guideline 89).
- 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

- Dichloromethane (synonyms: methylene chloride and methylene dichloride) is decomposed by heat to phosgene and is metabolized in the body to carbon monoxide

(example of lethal synthesis). Refer to appropriate guidelines (carbon monoxide, 89; phosgene, 101) for additional information.

- Avoid epinephrine and related beta agonists (unless patient is in cardiac arrest or has reactive airways disease refractory to other treatment) because of the possible irritable condition of the myocardium. Use of these medications may lead to ventricular fibrillation.
- Organic brain dysfunction known as the psycho-organic syndrome of solvents has been described in cases of chronic exposure. Neuroencephalopathy (dementia) may occur as a sequelae of severe exposures. Permanent neurobehavioral changes may result. This syndrome is usually documented with neurobehavioral testing.

Chlorinated Fluorocarbons (CFCs) and Related Compounds

SUBSTANCE IDENTIFICATION

Colorless liquids or gases with fruitlike or etherlike odor. Some gases are odorless and a odorant is occasionally added. Used as propellants, solvents, polymer intermediates for dechlorination of chemicals, refrigerants (Freons) and fire extinguishing agents (Halon) and in the manufacturing process of many products. When heated, many of these products decompose to phosgene.

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

LIFE THREAT

Asphyxiation. Products demonstrate anesthetic properties at high concentrations. Cardiac arrhythmias.

SIGNS AND SYMPTOMS BY SYSTEM

Cardiovascular: Cardiovascular collapse and arrhythmias. May aggravate preexisting cardiac problem. May increase myocardial effects of catecholamines.

Respiratory: Narcotic effect may depress respirations. Irritation of the respiratory tract and, possibly, pulmonary edema.

CNS: Excitation, headache, disorientation, dizziness, weakness, and seizures. CNS depression and coma due to anesthetic effect or hypoxia. Neurobehavioral changes.

Gastrointestinal: Nausea, vomiting, excessive salivation, and abdominal cramps.

Eye: Irritation and lacrimation

Skin: Mild skin irritation and possible frostbite as a result of freezing effect of gas expansion.

SYMPTOM ONSET FOR ACUTE EXPOSURE

Immediate

Respiratory and cardiovascular symptoms possibly delayed

Neurobehavioral changes possibly delayed

CO-EXPOSURE CONCERNS

Other halogenated hydrocarbons

Other chlorinated fluorocarbons

Hydrocarbon solvents

THERMAL DECOMPOSITION PRODUCTS INCLUDE**Halon**

Carbonyl halides

Hydrogen bromide

Hydrogen fluoride

Halogen acids

Free halogens

Freon

Carbon dioxide

Carbon monoxide

Carbonyl halides

Chlorine

Phosgene

Hydrochloric acid

Hydrofluoric acid

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE

CNS disorders

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 as needed.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Minimize physical activity and provide a quiet atmosphere.
- 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. 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).
- Treat frostbite with rapid rewarming techniques (refer to frostbite protocol in Section Three).

ADVANCED TREATMENT

- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest.
- 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. 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.
- Obtain toxicological consultation if necessary.

SPECIAL CONSIDERATIONS

- Avoid epinephrine and related beta agonists (unless patient is in cardiac arrest or has reactive airways disease refractory to other treatment) because of the possible irritable condition of the myocardium. Use of these medications may lead to ventricular fibrillation.

Carbon Tetrachloride and Related Compounds

SUBSTANCE IDENTIFICATION

Waxy, amber-colored solid with a mild turpentine odor. Colorless or white volatile liquid that yields heavy vapors. Sweet, aromatic odor resembling that of chloroform.

Used in solvents, cleaners, and fumigants, refrigerants, metal degreasers, and semiconductor production.

ROUTE OF EXPOSURE

Skin and eye contact

Inhalation

Ingestion

Skin absorption

TARGET ORGANS

Primary

Skin

Eyes

Central nervous system

Cardiovascular system

Respiratory system

Secondary

Gastrointestinal system

Hepatic

Renal

Metabolism

LIFE THREAT

CNS depression, respiratory arrest, and circulatory collapse.

SIGNS AND SYMPTOMS BY SYSTEM

Cardiovascular: Cardiovascular collapse, hypotension, ventricular arrhythmias and ventricular fibrillation. Possible hypertension.

Respiratory: Dyspnea, tachypnea, irritation to the lungs and mucous membranes, epistaxis, pulmonary edema, and respiratory arrest.

CNS: CNS depression, coma, headache, drowsiness, dizziness, confusion, and seizures, visual disturbances, and neurobehavioral changes.

Gastrointestinal: Nausea, vomiting, anorexia, diarrhea, and abdominal cramps.

Eye: Chemical conjunctivitis.

Skin: Irritant dermatitis, flushing, and chemical burns.

Renal: Kidney damage.

Hepatic: Jaundice and liver damage, including hepatitis.

Metabolism: Metabolic acidosis.

Other: Some products present a human carcinogenic risk.

SYMPTOM ONSET FOR ACUTE EXPOSURE

Immediate

Pulmonary edema possibly delayed

Hepatotoxicity possibly delayed

CO-EXPOSURE CONCERNS

Alcohols

Acetone

Chlorinated solvents

Sympathomimetic agents

THERMAL DECOMPOSITION PRODUCTS INCLUDE

Carbon dioxide

Carbon monoxide

Chlorine

Hydrogen chloride

Phosgene

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE

Central nervous system disorders

Alcoholism

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).
- 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 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.
- 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 if patient is hypotensive with a normal fluid volume. Watch for signs of myocardial irritability and 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, platelet count coagulation profile, 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 the anion gap may be helpful. Arterial blood gases (ABG), 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.
- Hyperbaric oxygen therapy may be beneficial in treating hepatotoxicity.
- *N*-acetylcysteine (NAC) therapy has been suggested as a possible therapeutic agent to prevent hepatotoxicity.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS

- Avoid epinephrine and related beta agonists (unless patient is in cardiac arrest or has reactive airways disease refractory to other treatment) because of the possible irritable condition of the myocardium. Use of these medications may lead to ventricular fibrillation.

Lower Alcohols (1-3 Carbons) and Related Compounds

SUBSTANCE IDENTIFICATION

Found as colorless liquids with the odor of rubbing alcohol. Used as solvents, disinfectants, and sanitizers. Chemical intermediates in the manufacturing process of cleaning and decreasing agents, rubber products, adhesives, and cosmetics. Also found in rubbing alcohol, skin lotions, and antifreeze preparations.

ROUTES OF EXPOSURE

Skin and eye contact

Inhalation

Ingestion

TARGET ORGANS

Primary

Skin

Eyes

Central nervous system

Cardiovascular system

Respiratory system

Hepatic

Metabolism

Secondary

Gastrointestinal system

Renal

LIFE THREAT

CNS depression leading to coma and respiratory arrest. Cardiac arrhythmias.

SIGNS AND SYMPTOMS BY SYSTEM

Cardiovascular: Cardiovascular collapse, hypotension, arrhythmias, and bradycardia.

Respiratory: Upper airway mucosa irritation, respiratory depression and arrest, and risk of aspiration pneumonia.

CNS: Headache, dizziness, drowsiness, confusion, incoordination, CNS depression, and coma. CNS depression with isopropanol may be more profound and long lasting than that seen with ethanol.

Gastrointestinal: Nausea, vomiting (hematemesis), gastritis, diarrhea, and stomach pain.

Eye: Chemical conjunctivitis.

Skin: Contact dermatitis.

Renal: Kidney damage.

Hepatic: Liver damage.

Metabolism: Anion gap metabolic acidosis and hypoglycemia.

Other: Hypothermia may be associated with coma.

SYMPTOM ONSET FOR ACUTE EXPOSURE

Immediate

Hypoglycemia possibly delayed

CO-EXPOSURE CONCERNS

Acetone and other ketones

Aromatic hydrocarbons

Other hydrocarbon solvents

Other alcohols

THERMAL DECOMPOSITION PRODUCTS INCLUDE

Carbon dioxide

Carbon monoxide

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE

Respiratory system disorders

Eye disorders

Liver disorders

Blood 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 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.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with lactated Ringer's to support vital signs. Watch for signs of fluid overload.
- Monitor for signs of hypoglycemia (decreased LOC, tachycardia, pallor, dilated pupils, diaphoresis, and/or a reading on a dextrose strip or glucometer of less than 50 mg/dl) and administer 50% dextrose if necessary (refer to 50% dextrose protocol in Section Four).
- For hypotension with signs of hypovolemia, administer fluid cautiously. Consider vasopressors for hypotension with a normal fluid volume (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 MANAGEMENT

- 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.
- Determine methanol, ethanol, or isopropanol serum concentrations.
- 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.
- Hemodialysis may be beneficial in cases of severe poisoning.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS

Refer to guideline 31 for methanol poisoning.