Hazardous Materials

DECONTAMINATION ZONE

Note: All victims suspected of ingestion or significant exposure to **hydrogen cyanide** solution **require decontamination**. Others may be transferred immediately to the Support Zone.

A. Decontamination

1. Victims who are able and cooperative may assist with their own decontamination.
   a. **Rapidly remove contaminated clothing** while flushing exposed skin and hair with plain water for 2 to 3 minutes.
   b. Then wash twice with mild soap.
   c. Rinse thoroughly with water.
   d. Double bag contaminated clothing and personal belongings.

2. Irrigate exposed or irritated eyes with plain water or saline for 5 minutes.
   a. Continue eye irrigation during other basic care or transport.
   b. Remove contact lenses if present and easily removable without additional trauma to the eye.

B. Transfer to Support Zone as soon as decontamination is complete.

Hydrogen Cyanide – 70.020

IDENTIFICATION

CAS 74-90-8
UN 1051

Synonyms include formic anammonide and formonitrile. Aqueous solutions are referred to as hydrocyanic acid and prussic acid.

Hydrogen cyanide is very volatile, producing potentially lethal concentrations at room temperature. At temperature below 78°F, hydrogen cyanide is colorless or pale blue liquid (hydrocyanic acid); at higher temperatures, it is a colorless gas. It has a faint bitter almond odor and a bitter burning taste. It is soluble in water. **Hydrogen cyanide is lighter than air.**

PRECAUTIONS

A. Persons whose clothing or skin is contaminated with cyanide containing solutions can secondarily contaminate personnel by direct contact or through off-gassing vapor.
   1. Avoid dermal contact with cyanide-contaminated victims and their bodily fluids.
   2. **Take special care with victims who may have ingested cyanide, as cyanide salts dissolve in the stomach and react with hydrochloric acid to produce hydrogen cyanide gas. Transport patients in vehicles with windows opened and/or good ventilation. These patients who meet *Death in the Field* criteria should be considered a Hot Zone.**
   3. Victims exposed only to hydrogen cyanide gas do not pose contamination risks to rescuers.

B. Hydrogen cyanide is a volatile flammable liquid at room temperature; as a gas, it is flammable and potentially explosive.

C. Hydrogen cyanide is absorbed well by inhalation and can produce death within minutes.
   1. Substantial absorption can occur through intact skin if vapor concentration is high.
   2. Exposure by any route may cause systemic effects.

HEALTH EFFECTS

HCN is classified a systemic (chemical) asphyxiant. Cyanides interfere with the intracellular utilization of oxygen resulting in cellular dysfunction and cell death. Effects are most profound and first evidenced in the CNS and cardiovascular system. Initial symptoms may include CNS excitation and cardiovascular compensation followed by depression/collapse of both systems.

ROUTES OF EXPOSURE

A. Inhalation
   1. Hydrogen cyanide is readily absorbed from the lungs; symptoms of poisoning begin within seconds to minutes.
   2. *The odor of cyanide does not provide adequate warning of hazardous concentrations.* ***Perception of the odor is a genetic trait (20% to 40% of the general population cannot detect hydrogen cyanide); also, rapid olfactory fatigue can occur.***

B. Skin/Eye Contact: Exposure to hydrogen cyanide can cause skin and eye irritation and can contribute to systemic poisoning with delayed symptoms.

C. Ingestion of hydrogen cyanide solutions or cyanide salts can be rapidly fatal

SIGNS AND SYMPTOMS

A. Signs and symptoms usually develop rapidly. Initial symptoms are nonspecific and include excitement, dizziness, n/v, HA and weakness.
B. Progressive signs and symptoms may include: Drowsiness, tetanic spasm, convulsions, hallucinations and loss of consciousness.
C. Cardiovascular – Can cause various life-threatening dysrhythmias.
D. Respiratory
    1. Victims may complain of shortness of breath and chest tightness.
    2. Pulmonary findings may include rapid breathing and increased depth of respiration.
    3. As poisoning progresses, respirations become slow and gasping; cyanosis may be present, and pulmonary edema may develop.

RESCUER PROTECTION

A. Respiratory protection: Pressure demand self-contained breathing apparatus (SCBA) is recommended in response situations that involve exposure to potentially unsafe levels of hydrogen cyanide.
B. Skin protection: Chemical protective clothing is recommended because both hydrogen cyanide vapor and liquid can be absorbed through the skin to produce systemic toxicity.

DECONTAMINATION ZONE

A. Refer to Decontamination page.
B. Transfer to Support Zone as soon as decontamination is complete.

SUPPORT ZONE

A. Be certain that victims have been decontaminated properly. Additional decontamination may be required for exposed skin and eyes.
B. Decontaminated victims or those exposed only to vapor, pose no serious risks of secondary contamination to rescuers. In these cases, Support Zone personnel require no specialized protective gear.

TREATMENT

Patients who rapidly regain consciousness and who have no other signs or symptoms may not require antidote treatment. Patients who remain comatose or develop shock should be treated promptly with the antidotes per OLMC direction. In cases of ingestion—**emesis and activated charcoal are *contraindicated***.

A. High flow oxygen, establish IV access, apply cardiac monitor and secure protected airway following Airway Management protocol.
B. If Cyanide Toxicity is suspected based on findings (soot in mouth, nose or oropharynx, know exposure) and patient is comatose, in cardiac or respiratory arrest, or has persistent hypotension despite fluid resuscitation:
    1. Administer Hydroxocobalamin (CYANOKIT®) 5 g IV or IO over 15 minutes. Repeat once if needed. For cardiac arrest, hydroxocobalamin should be administered as a rapid fluid bolus.
    2. If Hydroxocobalamin (CYANOKIT®) is not available, then administer Sodium Thiosulfate 50 ml of 25% solution over 10-20 minutes. Pediatric dose is 1.65 ml/kg.

3. Do NOT administer Hydroxocobalamin (CYANOKIT®) and Sodium Thiosulfate to the same patient.
4. Treat other presenting symptoms per appropriate protocol.
5. Initiate emergent transport to appropriate facility.
6. Patients in shock or having seizures should be treated according to existing protocols. These patients may be seriously acidotic; consider giving sodium bicarbonate 50 mEq, with OLMC direction.

C. **MULTI-CASUALTY TRIAGE -** Patients who have only brief inhalation exposure and mild or transient symptoms may be discharged.

Hydrogen Fluoride – 70.030

IDENTIFICATION
CAS 7664-39-3
UN 1052 (Anhydrous)
UN 1790 (Solution)

Synonyms include fluoric acid, hydro fluoride, hydrofluoric acid, and fluorine monohydride.

Hydrogen fluoride is a colorless, corrosive fuming liquid or gas (boiling temperature 67°F) with a strong irritating odor. It is usually shipped in cylinders as a compressed gas. Hydrogen fluoride readily dissolves in water to form colorless hydrofluoric acid solutions. Dilute solutions are indistinguishable from water. It is present in a variety of over-the-counter products at concentrations of 6% to 12%.

PRECAUTIONS
A. Victims whose clothing or skin is contaminated with HF liquid, solution or condensed vapor, can secondarily contaminate response personnel by direct contact or through off-gassing vapor.
B. Inhalation hazards result not only from HF gas but also from fumes arising from concentrated hydrogen fluoride liquid **or from the patient's bodily fluids.**
C. Rapid flushing of exposed areas with water is critical. HF is water-soluble.

HEALTH EFFECTS
The toxic effects of hydrogen fluoride are due primarily to the fluoride ion. The fluoride ion combines with endogenous calcium and magnesium to form insoluble calcium fluoride and magnesium fluoride.
A. This results in cell destruction and local bone demineralization.
B. Life threatening hypocalcemia, hypomagnesemia, and hyperkalemia can occur.
C. The adverse action of the fluoride ion may progress for several days.

ACUTE EXPOSURE
A. **Respiratory**—Due to HF's water solubility, effects of exposure generally occur in the upper airway including the glottis. However, people incapacitated in large clouds of HF can have severe deep lung injury.
    1. **Mild effects**— mucous membrane irritation, cough and narrowing of the bronchi.
    2. **Severe effects**:
        a. Almost immediate narrowing and swelling of the throat, causing upper airway obstruction.
        b. Lung injury may evolve rapidly or may be delayed in onset for 12 to 36 hours.
        c. Pulmonary edema and constriction of the bronchi. Partial or complete lung collapse can occur.
        d. Pulmonary effects can result even from splashes on the skin.
B. **Dermal**—Depending on the concentration and duration of exposure, skin contact may produce pain, redness of the skin, and deep, slow healing burns with symptoms delayed up to 24 hours. HF can penetrate tissues deeply, causing both local cellular destruction and systemic toxicity.

C. **Ocular**
   1. **Mild effects**— Rapid onset of eye irritation.
   2. **More severe effects**— May result from even minor hydrofluoric acid splash include, sloughing of the surface of the eye, swelling of the structures of the eye, and cell death due to lack of blood supply. Potentially permanent clouding of the eye surface may develop immediately or after several days.

D. **Gastrointestinal**
   1. A small amount of ingested HF is likely to produce systemic effects including acid-base imbalance and may be fatal.
   2. Ingestion of hydrofluoric acid may cause corrosive injury to the mouth, throat and esophagus as well as inflammation and bleeding of the stomach.
   3. Nausea, vomiting, diarrhea, and abdominal pain may occur.

E. **Electrolyte disturbances**—Exposure by any route may result in systemic effects: Hypocalcemia and/or hypomagnesemia and/or hyperkalemia.

PREHOSPITAL MANAGEMENT

HOT ZONE

Rescuer Protection

A. SCBA is recommended in response situations that involve exposure to potentially unsafe levels of hydrogen fluoride.
B. Skin protection: Chemical protective clothing, i.e. level A or level B, is recommended because skin exposure to either vapor or liquid may cause severe consequences.

DECONTAMINATION ZONE

A. Victims exposed only to hydrogen fluoride gas or vapor who have no skin or eye irritation do not need decontamination, they may be transferred immediately to the Treatment Area.
B. Rescuer Protection: If exposure levels are determined to be safe, personnel wearing a lower level of protection than that worn in the Hot Zone may conduct decontamination.
C. ABC Reminders:
   1. Quickly ensure a patent airway— anticipate airway edema.
   2. Stabilize the cervical spine with a c-collar and a backboard if trauma is suspected.
   3. Administer supplemental O_2.
   4. Assist ventilation with a bag-valve-mask device if necessary.
D. Basic decontamination:
   1. Victims who are able and cooperative may assist with their own decontamination
      a. **RAPIDLY REMOVE CONTAMINATED CLOTHING** while flushing exposed skin and hair with plain water for 15 minutes.
      b. If treatment recommended below is available, water flushing may be reduced to 5 minutes and the treatment should be started immediately.
         - Calcium gluconate 3 g mixed with 5 oz water soluble lubricant and applied to burn.
      c. Double bag contaminated clothing and personal belongings.
   2. Irrigate exposed or irritated eyes with plain water or saline or 5 minutes.
      a. Continue eye irrigation during other basic care or transport.

b. Remove contact lenses if present and easily removable without additional trauma to the eye.

3. In case of ingestion, **do not induce emesis or administer activated charcoal.**
   a. Victims who are conscious and able to swallow should be given 4 to 8 ounces of water or milk.
   b. If available, also give 2 to 4 ounces of an antacid containing magnesium (e.g., Maalox, Milk of Magnesia) or calcium (e.g., TUMS).
4. As soon as basic decontamination is complete, move the victim to the Treatment Area.

TREATMENT

Be certain that victims have been decontaminated properly. Treatment Area personnel require no specialized protective gear if victims have undergone decontamination.

A. ABCs, C-spine (prn), Pulse Oximetry, and ECG to obtain baseline QT interval (may be of benefit for this).
B. Treat patients who are symptomatic per existing protocols.
C. Observe for signs of hypocalcemia and contact OLMC regarding treatment with Calcium Gluconate.
   1. ECG—prolonged Q-T interval or QRS or ventricular dysrhythmias.
   2. Other—Muscular tetany. This is probable after ingestion of even small amounts of HF.
D. **For inhalation victims**.
   1. Administer 2.5% calcium gluconate by nebulizer. Mix 1cc of 10% Calcium Gluconate with 3ccs of Normal Saline into the nebulizer.
   2. If wheezes are present, consider use of Albuterol per Respiratory Distress protocol.
E. **Minor Burns**.
   1. Initially, the health care provider should wear rubber or latex gloves to prevent secondary contamination.
   2. Calcium gluconate 3 g mixed with 5 oz water soluble lubricant and applied to burn.
   3. Continue this procedure until pain is relieved or more definitive care is rendered.
F. **Hand Exposure**
   1. Subungual (under the nail) burns often do not respond to immersion treatment. The treatment for hand burns requires expert assistance; consult with OLMC.
   2. Treatment of hand exposures can be accomplished by placing calcium gluconate gel into an exam glove and placing the glove on the affected hand.
G. **Optical Exposure**—Irrigate exposed eyes with a 1% aqueous solution of calcium gluconate (10 ml of 10% solution in 90 ml of sterile saline in Buretrol) using a nasal cannula.
   1. Up to 500 ml over 1 to 2 hours may be used.
   2. If calcium gluconate is not available, use normal saline for irrigation.

MULTI-CASUALTY TRIAGE

Consult with the OLMC for advice regarding triage of multiple victims. Persons who have had only minor or brief exposure to hydrogen fluoride gas or vapor and are initially asymptomatic are not likely to develop complications. See Multiple Toxic Exposure Protocol.

Organophosphates – 70.040

IDENTIFICATION

CAS 56-38-2
UN 2783

Synonyms include Alkron, Alleron, Danthion, DNTP, DPP, Ethyl Parathion, Etilon, E-605, Stathion, Sulphos, and Thiophos.

The term organophosphate (OP) is generally understood to mean an organic derivative of phosphoric or similar acids. There are many different OPs and they differ to some extent in their properties. Many OPs inhibit an enzyme known as acetylcholinesterase. This is a class effect of OPs, but not all OPs (e.g. glyphosate) demonstrate this effect. Inhibitors of acetylcholinesterase affect certain nerve junctions in animals, as well as parasympathetic effector sites (the heart, lungs, stomach, intestines, urinary bladder, prostate, eyes and salivary glands). By inhibiting the enzyme acetylcholinesterase, OPs prevent the nerve junction from functioning properly.

PRECAUTIONS

A. Organophosphates are highly contaminating.
B. Victims whose skin or clothing is contaminated with liquid or powdered organophosphate can secondarily contaminate response personnel by direct contact or off gassing of solvent vapor.
C. Clothing and leather goods (e.g., belts or shoes) cannot be reliably decontaminated; they should be incinerated.
A. Special care should be taken to avoid contact with the vomitus of a patient who has ingested organophosphate.

PHYSICAL PROPERTIES

A. At room temperature, organophosphate are powders or combustible liquids.
B. Organophosphates are almost insoluble in water, slightly soluble in petroleum oils, and miscible with many organic solvents. Accordingly, most commercial products contain hydrocarbon solvents.
C. Organophosphates have low vapor pressures; thus significant inhalation is unlikely at normal temperatures (Exception: Dichlorvos (a.k.a. DDVP and Vapona) when in a poorly ventilated confined space). However, the hydrocarbon solvents remain volatile and flammable, as well as possessing toxic properties.

ROUTES OF EXPOSURE

A. Inhalation:
    1. Toxic inhalation of organophosphate vapor is unlikely at ordinary temperatures because of its low volatility, but toxic effects can occur after inhalation of organophosphate sprays or dusts.
    2. The hydrocarbon solvents (most commonly toluene and xylene) used to dissolve organophosphate are more volatile than organophosphate itself, and toxicity can result from inhalation of solvent vapor as well.
B. Skin/Eye Contact—Organophosphates are rapidly absorbed through intact skin or eyes, contributing to systemic toxicity.
C. Ingestion—Acute toxic effects. May be rapidly fatal.

Organophosphates – 70.040

HEALTH EFFECTS

A. Introduction:
   1. Organophosphates are known as cholinesterase inhibitors. Normally, the neurotransmitter acetylcholine (ACh) is broken down by acetylcholinesterase (AChE). Organophosphates inhibit the activity of AChE and thus ACh is not broken down. The resulting accumulation of ACh overstimulates ACh receptors (aka cholinergic receptors) within the central and peripheral nervous systems. The toxic effects of organophosphates result from this overstimulation of ACh receptors. There are two types of ACh receptors, muscarinic and nicotinic.
   2. Signs and symptoms of poisoning vary according to age, dose, and concentration:
      a. **CNS effects**—Irritability, nervousness, giddiness, fatigue, lethargy, impairment of memory, confusion, slurred speech, visual disturbance, depression, impaired gait, convulsions, loss of consciousness, coma, and respiratory depression. CNS effects can be some of the earliest symptoms.
      b. **PNS Effects**—Nicotinic and muscarinic stimulation can provide opposing effects. In general, nicotinic signs and symptoms predominate early in organophosphate poisoning, while muscarinic signs and symptoms predominate later.
         i. **Muscarinic effects**— **SLUDGE** (Salivation, Lacrimation, Urination, Defecation, Gastroenteritis, Emesis), or **DUMBELS** (Diarrhea, Urination, Miosis, Bradycardia, Bronchorrhea, Bronchospasm, Emesis, Lacrimation, Salivation, Secretion, Sweating).
         ii. Nicotinic effects— **MTWHF** (Mydriasis, Tachycardia, Weakness, Hypertension, Hyperglycemia, Fasciculations, Flaccidity).

PREHOSPITAL MANAGEMENT

- **HOT ZONE**

A. Respiratory Protection: SCBA is recommended in response situations that involve exposure to potentially unsafe levels of organophosphates.
B. Skin Protection: Chemical-protective clothing is recommended because organophosphates are rapidly absorbed through the skin and may cause systemic poisoning.

- **DECONTAMINATION ZONE**
  All victims suspected of organophosphate ingestion, or substantial exposure to aerosolized organophosphates, or who have skin or eye exposure to liquid or powdered organophosphates require thorough decontamination.

BASIC DECONTAMINATION

Follow Decontamination General Guidelines. Then, move the victim to the Treatment Area upon completion.

SIGNS AND SYMPTOMS

A. Mild poisoning HA, n/v, abdominal cramps, and diarrhea.
B. Moderate poisoning: Generalized muscle weakness and twitching, slurred speech, pinpoint pupils, excessive secretions, and shortness of breath.

C. Severe poisoning: Seizures, skeletal-muscle paralysis, respiratory failure, and coma.

TREATMENT

A. Secure protected airway in cases of respiratory compromise per Airway Management protocol.
B. There is no contra-indication to the use of paralytic agents is in this setting, however both ***succinylcholine and vecuronium will have a significantly sustained duration of paralysis in the presence of organophosphates***.
C. The initial intravenous dose of atropine in adults should be determined by the severity of symptoms. In seriously poisoned patients, very large doses may be required. Alterations of pulse rate and pupillary size are unreliable indicators of treatment adequacy. **Atropine works *only* to correct muscarinic effects.**
    1. In mild to moderate poisonings (e.g. headache, mild bronchorrhea, nausea, vomiting, diarrhea but normal mentation), administer atropine 1-2 mg IV/IO/IM every 3-5 minutes until symptoms improve.
    2. For severe poisoning (e.g. altered mental status, unconsciousness, seizures), administer atropine 3-5 mg IV/IO/IM every 3-5 minutes until symptoms begin to improve.
    3. Treat seizures per seizure protocol.

D. Administer pralidoxime (2-PAM), if profound weakness or paralysis present.
    1. Moderate symptoms—1,200 mg (two Mark 1 injectors or one Duodote).
    2. Severe symptoms—1,800 mg (three Mark 1 injectors or three Duodote injectors).

    CAUTION: When administering 2-PAM intravenously, administer at rate of less than 200 mg/minute, (4 mg/minute for children).

    Note: The* Mark 1 auto-Injector *atropine is 2 mg. The 2-Pam auto-injector is 600 mg pralidoxime. The Duodote Auto-Injector is atropine 2.1 mg/0.7 mL and pralidoxime chloride 600 mg/2 mL.

E. Patients who are comatose, hypotensive, have seizures or cardiac dysrhythmias should be treated according to ALS protocols.

TRANSPORT TO MEDICAL FACILITY

A. Report to OLMC, and the receiving medical facility, the condition *of* the patient, treatment given, and estimated time of arrival at the medical facility.

B. If organophosphate has been ingested:
    1. Prepare the ambulance in case the victim vomits toxic material.
    2. Prepare several towels (or other absorbent material) and open plastic bags to quickly clean up and isolate vomitus.

MULTI-CASUALTY TRIAGE

Patients who have histories or evidence suggesting substantial exposure and all persons who have ingested organophosphate should be transported to a medical facility for evaluation.

A. Others may be discharged from the scene after their names, addresses, and telephone numbers are recorded.
B. They should be advised to seek medical care promptly if symptoms develop or recur.

PEDIATRIC PATIENTS:
Atropine: In children, dose is 0.05 mg/kg IV/IO.
Pralidoxime: Pediatric dose: 25 to 50 mg/kg and must be given slowly via IV (4 mg/min.)