

SPECIAL OPERATIONS TREATMENT

Hydrogen Cyanide (HCN)

Identification:

CAS 74-90-8

UN 1051

Synonyms include formic anannonide 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 temperatures below 78°F, hydrogen cyanide is colorless or pale blue liquid (hydrocyanic acid); at higher temperatures, it is a colorless gas. It had a faint bitter almond odor and a bitter burning taste. It is soluble in water.

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 or with gastric contents of victims who may have ingested cyanide containing materials.
 - 2. 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 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:

- A. Hydrogen cyanide acts as a cellular asphyxiant. By binding to mitochondrial cytochrome oxidase, it prevents the utilization of oxygen in cellular metabolism.
- B. Hydrogen cyanide may cause abrupt onset of profound CNS, cardiovascular, and respiratory effects, leading to death within minutes.

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.
 - 3. Hydrogen cyanide is lighter than air.
- B. **Skin/Eye Contact:** Exposure to hydrogen cyanide can cause skin and eye irritation.
 - 1. More importantly, skin or eye absorption can contribute to systemic poisoning.
 - 2. After skin exposure, onset of symptoms may be delayed.
- C. Ingestion of hydrogen cyanide solutions or cyanide salts can be rapidly fatal.

Acute Exposure:

- A. CNS
 - 1. Signs and symptoms usually develop rapidly.
 - 2. Initial symptoms are nonspecific and include:
 - a. Excitement
 - b. Dizziness
 - c. Nausea and vomiting
 - d. Headache
 - e. Weakness
 - 3. Progressive signs and symptoms may include:
 - a. Drowsiness
 - b. Tetanic spasm
 - c. Lockjaw
 - d. Convulsions
 - e. Hallucinations
 - f. Loss of consciousness
 - g. Coma
- B. **Cardiovascular**
 - 1. Abnormal heartbeat can occur in severe poisoning, resulting in:
 - a. Bradycardia
 - b. Shock
 - c. Death
 - 2. High blood pressure and a rapid heartbeat may be early transient findings.

C. Respiratory

1. As systemic poisoning begins, 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.

D. Metabolic: An anion-gap, metabolic acidosis occurs in severe poisoning from increased blood levels of lactic acid.

E. Dermal

1. Contact with liquid hydrogen cyanide causes skin irritation.
2. Dermal absorption can occur leading to systemic toxicity.

F. Ocular

1. When splashed in the eye, hydrogen cyanide can cause eye irritation and swelling.
2. Eye contact with cyanide salts has produced systemic symptoms in experimental animals.

Prehospital Management

Hot Zone

A. Rescuer Protection

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

B. Victim Removal

1. If victims can walk, lead them out of the Hot Zone to the Decontamination Zone.
2. Victims who are unable to walk may be removed on backboards or stretchers; if these are not available, carefully carry or drag victims to safety.

Decontamination Zone:

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

Speed is critical! For symptomatic victims, provide treatment with 100% O₂, and specific antidotes as needed. Treatment should be given simultaneously with decontamination procedures.

A. Rescuer Protection

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

B. ABC Reminders

1. Quickly ensure a patent airway.
2. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and backboard when feasible.

C. Victim Removal

1. If victims can walk, lead them out of the Hot Zone to the Decontamination Zone.
2. Victims who are unable to walk may be removed on backboards or stretchers; if these are not available, carefully carry or drag victims to safety.

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 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.

- E.** 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.
- C. Patients who rapidly regain consciousness and who have no other signs or symptoms may not require antidote treatment.
 - 1. Patients who remain comatose or develop shock should be treated promptly with the antidotes in the **Eli Lilly Cyanide Antidote Kit**.
- D. **In cases of ingestion:**
 - 1. **Do not induce emesis.**
 - 2. **Do not administer activated charcoal.**
 - 3. If the victim is symptomatic, immediately institute emergency life support measures, including use of a cyanide antidote kit.

Advanced Treatment:

- A. **ABC Reminders**
 - 1. Quickly ensure a patent airway
 - 2. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and backboard when feasible.
 - 3. Ensure adequate respiration, administer supplemental O₂ as needed.
 - 4. Ensure palpable pulses
 - 5. Establish IV access, if necessary, and apply cardiac monitor and pulse oximeter.
 - 6. Secure protected airway in cases of respiratory compromise.
 - a. There is no contraindication to the use of paralytic agents in this setting.
 - b. When patient condition precludes ET tube placement, perform cricothyroidotomy if equipped and trained to perform the procedure.
- B. Hydroxocobalamin (Cyanokit®)
 - 1. Administer 5 gm of Hydroxocobalamin as directed IV/IO over 15 minutes.
 - 2. See Hydroxocobalamin (Cyanokit®) for precautions.
- C. **Eli Lilly Cyanide Antidote Kit:**
 - 1. Description
 - a. This kit contains amyl nitrite, intravenous infusions of sodium nitrite and sodium thiosulfate.
 - b. Prehospital use will be confined to sodium thiosulfate.

2. Indications

- a. Treatment with cyanide antidotes should be administered to unconscious victims who have known or strongly suspected cyanide poisoning.
- b. Contact OLMC for direction.

D. Sodium Thiosulfate

1. Infuse sodium thiosulfate intravenously.
2. The usual adult dose is 50 ml of 25% solution infused over 10 to 20 minutes.
3. The average pediatric dose is 1.65 ml/kg.

E. Patients in shock or having seizures should be treated according to existing protocols.

1. These patients, or those having dysrhythmias, may be seriously acidotic; consider giving sodium bicarb, 50 mEq, with OLMC direction.

Transport to Medical Facility:

- A. Report to OLMC, and the destination hospital, the condition of the patient, treatment given, and the ETA to the destination hospital.
- B. If a cyanide containing solution 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.

Multiple Casualty (MPS or MCI):

- A. Consult with OLMC for advice regarding triage of multiple victims.
- B. Patient who have a history of significant hydrogen cyanide exposure, and all patients who have hydrogen cyanide ingestion, should be transported to a hospital for evaluation.
- C. Patients who have only brief inhalation exposure and mild or transient symptoms may be discharged from the scene after:
 1. Their names, addresses and telephone numbers are recorded, and,
 2. They are advised to seek medical care promptly if symptoms develop or recur.

Hydrogen Fluoride

Identification:

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

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

Hydrogen fluoride is a colorless, fuming liquid or gas 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. Hydrogen fluoride is a corrosive chemical that can cause immediate or delayed onset of deep tissue penetration. Absorption of fluoride ion can cause hypocalcemia, hypomagnesemia, and hyperkalemia, which may result in cardiac arrest.
- B. Victims exposed only to hydrogen fluoride gas or vapors do not pose substantial risks of secondary contamination to personnel outside the Hot Zone.
- C. Victims whose clothing or skin is contaminated with hydrogen fluoride liquid, solution or condensed vapor, can secondarily contaminate response personnel by direct contact or through off-gassing vapor.
- D. Inhalation hazards result not only from exposure to hydrogen fluoride gas but also from fumes arising from concentrated hydrogen fluoride liquid. Even fairly low airborne concentrations of hydrogen fluoride produce rapid onset of eye nose and throat irritation.
- E. Most hydrogen fluoride exposures occur by cutaneous contact with the aqueous solution. The fluoride ion, which penetrates tissues deeply, can cause both local cellular destruction and systemic toxicity.
- F. Ingestion of even a small amount of hydrofluoric acid is likely to produce systemic effects and may be fatal.
- G. Rapid decontamination is critical. Calcium containing gels, solutions and medications are used to neutralize the effects of hydrogen fluoride.

Health Effects:

- A. The toxic effects of hydrogen fluoride are due primarily to the fluoride ion, which is able to penetrate tissues and bind intracellular calcium and magnesium.
 - 1. This results in cell destruction and local bone demineralization.
 - 2. Systemic deficiency of calcium and magnesium and excess of potassium can occur.
 - 3. The adverse action of the fluoride ion may progress for several days.
- B. Hydrofluoric acid is weak compared with most other mineral acids.
 - 1. It can produce serious health effects when exposure occurs by any route.
 - 2. Effects are due to the fluoride ions' aggressive destructive penetration of tissues.

Routes of Exposure:

- A. **Inhalation**
 - 1. Inhalation hazards result not only from exposure to hydrogen fluoride gas but also from fumes arising from concentrated hydrogen fluoride liquid.
 - 2. Even low airborne concentrations of hydrogen fluoride produce rapid onset of eye nose and throat irritation.
- B. **Skin/Eye Contact**
 - 1. Most hydrogen fluoride exposures occur by cutaneous contact with the aqueous solution.
 - 2. The fluoride ion, which penetrates tissues deeply, can cause both local cellular destruction and systemic toxicity.
- C. **Ingestion:** Ingestion of even a small amount of hydrofluoric acid is likely to produce systemic effects and may be fatal.

Acute Exposure:

- A. **Respiratory**
 - 1. The toxic effects of hydrogen fluoride are due primarily to the fluoride ion, which is able to penetrate tissues and bind intracellular calcium and magnesium.
 - 2. This results in cell destruction and local bone demineralization.
 - 3. Systemic deficiency of calcium and magnesium and excess of potassium can occur.

4. The adverse effect of the fluoride ion may progress for several days.
5. Inhaled hydrogen fluoride mist or vapor affects initially the nose, throat and eyes.
6. Mild clinical effects include mucous membrane irritation and inflammation, cough and narrowing of the bronchi.
7. Severe clinical effects include almost immediate narrowing and swelling of the throat, causing upper airway obstruction.
8. Lung injury may evolve rapidly or may be delayed in onset for 12 to 36 hours.
9. Accumulation of fluid in the lungs, constriction of the bronchi and partial or complete lung collapse can occur.
10. Pulmonary effects can result even from slashes on the skin.

B. Dermal

1. Depending on the concentration and duration of exposure, skin contact may produce pain, redness of the skin, and deep slow healing burns.
2. Acid concentrations of more than 50% (including anhydrous hydrogen fluoride) cause immediate severe, throbbing pain and whitish discoloration of the skin, which usually forms blisters.
3. Hydrogen fluoride solutions from 20% to 50% may produce upon and swelling which may be delayed for to 8 hours.
4. Hydrogen fluoride solution of less than 20% cause almost no immediate pain on contact, but may cause delayed serious injury 13 to 24 hour later.

C. Ocular

1. Mild effects of hydrogen fluoride exposure include rapid onset of eye irritation.
2. More severe effects, which 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.
3. Potentially permanent clouding of the eye surface may develop immediately or after several days.

D. Gastrointestinal

1. Ingestion of hydrofluoric acid may cause corrosive injury to the mouth, throat, and esophagus.
2. Inflammation of the stomach with bleeding occurs commonly.
3. Nausea vomiting diarrhea and abdominal pain may occur.

4. Systemic effects are likely and acid-base imbalance can occur after acute ingestion.
5. Pulmonary aspiration may lead to respiratory complications.

E. Electrolyte disturbances

1. Exposure by any route may result in systemic effects, namely low levels of calcium and magnesium and high levels of potassium in the blood.
2. Low blood pressure, irregular heartbeat, involuntary muscle contraction, seizure and death may ensue.

Prehospital Management Hot Zone

A. Rescuers should be trained, and appropriately attired, before entering the Hot Zone.

1. If the proper equipment is not available, or if rescuers have not been trained to use it, assistance should be obtained from a local or regional HazMat Team or other properly equipped response organization.

B. Rescuer Protection

1. Hydrogen fluoride is corrosive to the respiratory tract and skin and is a serious systemic poison.
2. Respiratory protection: Pressure demand self-contained breathing apparatus (SCBA) is recommended in response situations that involve exposure to potentially unsafe levels of hydrogen fluoride.
3. Skin protection: Chemical protective clothing is recommended because skin exposure to either vapor or liquid may cause severe consequences.

C. ABC Reminders

1. Quickly ensure a patent airway.
2. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and backboard when feasible.

D. Victim Removal

1. If victims can walk, lead them out of the Hot Zone to the Decontamination Zone.
2. Victims who are unable to walk may be removed on backboards or stretchers; if these are not available, carefully carry or drag victims to safety.

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 Support Zone.
- B. **Rescuer Protection:** If exposure levels are determined to be safe, decontamination may be conducted by personnel wearing a lower level of protection than that worn in the Hot Zone.
- C. **ABC Reminders**
 - 1. Quickly ensure a patent airway.
 - 2. Stabilize the cervical spine with a c-collar and a backboard if trauma is suspected.
 - 3. Administer supplemental O₂.
 - 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 at least 5 minutes
 - b. Double bag contaminated clothing and personal belongings.
 - 2. Cover exposed skin with one of the following preparations:
 - a. Calcium containing slurry or gel.
 - i. **2.5 gm calcium gluconate in 100 ml of water soluble lubricant such as KY[®] Jelly, OR,**
 - ii. 1 ampule of 10% calcium gluconate per ounce of KY[®] Jelly.
 - b. Aqueous quaternary ammonium salt (Zephiran, 0.13%).
 - i. If using Zephiran concentrated solution [17%] be sure to properly dilute it by adding 30 ml [1 ounce] of concentrate to 1 gallon of water.
 - ii. Do not use on face or in eyes.
 - c. Magnesium containing solution, such as Maalox or Epsom Salts.
 - 3. 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.

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

Support Zone:

- A. Be certain that victims have been decontaminated properly. Support Zone personnel require no specialized protective gear if victims have undergone decontamination.
- B. ABC Reminders
 1. Quickly ensure a patent airway.
 2. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and backboard when feasible.
 3. Ensure adequate respiration
 - a. Administer supplemental O₂ as needed.
 - b. Apply pulse oximeter.
 4. Ensure palpable pulses.
 5. Establish IV access, if necessary.
 6. Attach cardiac monitor and observe ECG for prolonged Q-T interval or QRS duration.
- C. ALS Treatment
 1. Treat patients who have bronchospasm with albuterol, follow ***Respiratory Distress*** protocol.
 2. Treat patients who are comatose, have seizures, or ventricular dysrhythmias according to existing protocols.
 3. Secure protected airway in cases of respiratory compromise.
 - a. There is no contraindication to the use of paralytic agents in this setting.
 - b. When patient condition precludes ET tube placement, perform cricothyroidotomy.

4. Hypocalcemia (manifested by tetany and dysrhythmias) is probable after ingestion of even small amounts of hydrogen fluoride; with OLMC consultation, treat hypocalcemia with intravenous injection of a 10% solution of calcium gluconate.
5. For inhalation victims, administer 2.5% calcium gluconate by nebulizer with O₂, using:
 - a. 2.5 G of calcium gluconate in 100 ml of water, **OR**,
 - b. 25 ml of 10% calcium gluconate diluted with 100 ml of water.

D. Additional Decontamination

1. Continue flushing exposed skin for 15 minutes.
 - a. If either of the treatments recommended below is available, water flushing may be reduced to 5 minutes and the treatment should be started immediately.
 - b. **Do not inject or use Calcium Chloride for treating skin burns**, it will cause extreme pain and may further injure tissues.
2. Vigorously massage the burned areas with calcium gluconate gel.
 - a. 2.5 G in 100 ml of water-soluble lubricant, such as K-Y^a Jelly, **OR**,
 - b. 1 ampule of 10% calcium gluconate per ounce of K-Y^a Jelly).
3. Initially, the health care provider should wear rubber or latex gloves to prevent secondary contamination.
4. Continue this procedure until pain is relieved or more definitive care is rendered.
5. Some investigators recommend immersing the burned area in an iced (with ice cubes; not shaved ice) solution of a quaternary ammonium salt such as Zephiran [Zephiran, 0.13%. If using Zephiran concentrated solution (17%) be sure to properly dilute it by adding 30 ml (1 ounce) of concentrate to 1 gallon of water. Do not use on face or in eyes].
 - a. Intermittent immersion for at least 2 hours is recommended.
 - b. Care must be taken to avoid prolonged immersion because severe frostbite may result.
 - c. If immersion is not practical, soak towels with the Zephiran solution use them as compresses for the burned area.
 - i. Change compresses every 2 to 4 minutes.
 - ii. Do not use Zephiran solution on the face, particularly around the eyes, because it is irritating to sensitive tissues.
 - iii. Continue Zephiran treatment until pain is relieved or more definitive care is rendered.

6. If the eyes are still irritated, irrigate with water or Saline for 3 to 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.
7. In case of ingestion, **do not induce emesis.**
 - a. **Do Not administer activated charcoal.**
 - b. If not previously administered and the patient is alert and able to swallow give 4 to 8 ounces of water or milk.
 - c. If available, also give 2 to 4 ounces of an antacid containing magnesium (e.g., Maalox, milk of magnesia) or calcium (e.g., TUMS).

Advanced Treatment

A. ABC Reminders

1. Evaluate and support airway, breathing, and
2. Monitor heart, renal, and liver functions.
3. Hypocalcemia may cause prolonged Q-T interval and cardiac rhythm abnormalities.

B. Inhalation Exposure: Calcium gluconate may be administered to victims who have severe respiratory distress using oxygen by nebulizer and:

1. 2.5 grams of calcium gluconate in 100 ml of water, **OR**,
2. 25 ml of 10% calcium gluconate diluted in 100 ml of water.

C. Skin Contact:

1. If blisters have formed, they should be opened, drained, and debrided of necrotic tissue before treatment; early debridement may facilitate healing.
2. Two topical treatments that are generally recommended are discussed below:
 - a. Continuously massage the burned area with calcium gluconate gel (2.5 grams in 100 ml water-soluble lubricant such as K-Y^a Jelly) until the pain is relieved.
 - i. Initially, health care providers should wear rubber gloves to protect their fingers from secondary contamination.
 - ii. If some relief of pain is not obtained within 30 to 60 minutes, consider Zephiran soaks or calcium gluconate injections (see *Severe Burn*).
 - b. Some investigators recommend immersing the burned area in an iced (with ice cubes, not shaved ice) solution of a quaternary ammonium salt such as Zephiran (Zephiran 0.13%).

- i. If using Zephiran concentrated solution [17%] be sure to properly dilute it by adding 30mL [1 ounce] of concentrate to 1 gallon of water).
 - ii. Intermittent immersion for at least 2 hours is recommended.
 - iii. If pain recurs after treatment is stopped, immersion should be continued for another 2 hours.
 - iv. Total treatment of 4 to 6 hours is usually required.
 - v. If immersion is impractical, use compresses soaked with the Zephiran solution and change every 2 to 4 minutes.
- c. **Care must be taken that victims do not suffer frostbite from prolonged immersion.** Because quaternary ammonium solutions are very irritating to sensitive tissues, they should not be used on the face, particularly around the eyes or on other sensitive area.

D. Severe Burns

1. Large burns or deeply penetrating burns (i.e., from delayed treatment or exposure to hydrogen fluoride concentrations greater than 50%) may require injections of sterile aqueous calcium gluconate into and around the burned area. Authorities in industry currently recommend injections of 5% calcium gluconate solution using a small-gauge needle (30 Ga.).
 - a. Do not inject more than 0.5 ml per cm² of affected skin surface.
 - b. No local infiltration of anesthetic should be used, but in the case of severe burns, regional or general anesthesia may be considered.
2. **Do not inject Calcium Chloride to treat skin burns, it will cause extreme pain and may further injure tissues.**

E. 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.
 - a. Calcium gluconate in very small doses can be injected into the fingers.
 - b. In some cases, burr holes must be drilled in the nail or the nail must be split or removed to permit adequate contact with the sequestering agent.
 - c. Local anesthesia may be required but be aware that it may interfere with determining the adequacy of treatment.
 - d. Care must be used because multiple injections into the fingers can lead to pressure necrosis.
 - e. Patients whose skin has compromised integrity may have an increased risk of infection after multiple injections of calcium gluconate.
 - f. Consider the use of antibiotic creams such as Silvadene or Garamycin in these cases

F. Eye Contact

1. **Do not use oils, salves, or ointments for injured eyes.**
2. Do not use Zephiran or the gel form of calcium gluconate in eyes, as described for skin treatment.
3. Irrigate exposed eyes with a 1% aqueous solution of calcium gluconate (50 ml of 10% solution in 450 ml of sterile saline) using a nasal prong or Morgan Therapeutic Lens®.
 - a. Up to 500 ml over 1 to 2 hours may be used.
 - b. If calcium gluconate is not available, use normal saline for irrigation.
4. A topical anesthetic can minimize the tendency for eyelid closure and facilitate insertion of an irrigation lens.
 - a. One or two drops of Proparacaine or Tetracaine will usually provide rapid-onset ocular anesthesia for 20 minutes to an hour.
 - b. If exposure was minor, perform visual acuity testing.
 - c. In cases of substantial exposure, an ophthalmologist should be consulted immediately.

G. Ingestion Exposure

1. **Do not give emetics and do not administer activated charcoal.**
2. If the patient is conscious and alert, and treatment has not been administered previously, immediately give 4 to 12 ounces of water to dilute the acid.
3. Orally administer a one-time dose of several ounces of Mylanta, Maalox, or Milk of Magnesia; the magnesium in these products may act chemically to bind the fluoride in the stomach.
4. Consider gastric ravage using a small lumen tube.
5. Extreme throat swelling may cause airway obstruction, which may require endotracheal intubation or cricothyroidotomy.

H. Systemic Toxicity

1. Treat hypocalcemia using calcium gluconate infusions.
2. Infusions can be repeated until serum calcium, ECG, or symptoms improve.
3. Treat hypomagnesemia with 1 to 2 Gm of magnesium.

Transport to a Medical Facility:

A. If hydrofluoric acid 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 (MPS or MCI):

A. Consult with the OLMC for advice regarding triage of multiple victims.

1. 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.
2. After their names, addresses, and telephone numbers are recorded, patients may be released from the scene with follow-up instructions.

(See the reverse side of Hydrogen Fluoride-Patient Information Sheet.)

B. Triage Guidelines

1. **Inhalation Exposure:** Immediately transport to a medical facility those patients who have inhaled hydrogen fluoride and have upper respiratory irritation or other acute symptoms.
2. **Skin/Eye Contact**
 - a. All persons having of the following should be transported to a hospital as soon as possible.
 - b. Eye exposure or serious skin exposure (i.e., fingertip exposure or skin exposure greater than the total surface area of the palm).
 - c. Any evidence of burns (e.g., erythema, pain, or blisters).
 - d. Continue skin and eye irrigation or treatment during transport.
 - e. Patients who have had even mild skin or eye contact with hydrogen fluoride should be brought to the attention of a physician as soon as possible because they may have delayed pain and systemic complications.

C. Ingestion Exposure:

1. In cases of ingestion, patients should be transported to a hospital without delay.
2. Watch patients carefully because systemic effects are likely to occur.

Organophosphates

Identification:

CAS 56-38-2

UN 2783

Synonyms include a variety of trade names: Alkron, Alleron, Danthion, DNTP, DPP, Ethyl Parathion, Etilon, E-605, Stathion, Sulphos, and Thiophos.

Precautions:

A. Organophosphates are highly contaminating.

1. 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.
2. Clothing and leather goods (e.g., belts or shoes) cannot be reliably decontaminated; they should be incinerated.

B. Mild organophosphate poisoning can cause:

1. Headache
2. Nausea
3. Vomiting
4. Abdominal cramps
5. Diarrhea

C. Moderate organophosphate poisoning can result in:

1. Generalized muscle weakness and twitching.
2. Slurred speech
3. Pinpoint pupils
4. Excessive secretions
5. Shortness of breath

D. Severely poisoned patients may develop:

1. Seizures
2. Skeletal-muscle paralysis
3. Respiratory failure
4. Become comatose

E. **Treatment consists of** thorough decontamination, cardiorespiratory support, and administration of antidotes.

F. **Commercial organophosphate products may contain hydrocarbon solvents** such as xylene or toluene, which themselves can cause toxicity.

G. Organophosphates

1. At room temperature, Organophosphate is a combustible liquid that may be difficult to ignite.
2. In commercial products, organophosphate is usually dissolved in hydrocarbon solvents such as toluene or xylene, which are flammable.

H. At room temperature, organophosphates are a yellow-to-brown liquid with an odor of garlic.

1. It is often dissolved in a hydrocarbon solvent before use.
2. Organophosphate itself is not volatile.
3. It is almost insoluble in water, slightly soluble in petroleum oils, and miscible with many organic solvents.

I. Persons whose skin or clothing is contaminated with liquid or powdered organophosphate can cause secondary contamination by direct contact.

J. Because organophosphates have a low vapor pressure, significant inhalation is unlikely at ordinary temperatures.

1. However, the hydrocarbon solvents in commercial preparations can be inhaled.
2. Organophosphates are rapidly absorbed through intact skin, resulting in acute systemic toxicity.

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, including rapidly fatal systemic poisoning, can result from ingestion of organophosphates.

Health Effects:

A. Prominent manifestations of organophosphate poisoning include:

1. Abdominal cramps
2. Vomiting
3. Diarrhea
4. Pinpoint pupils
5. Excessive sweating
6. Wheezing
7. Excessive tracheo-bronchial secretions
8. Agitation
9. Seizures
10. Muscle twitching
11. Weakness

- B. Commercial pesticides may contain xylene or toluene as solvents, and some of the toxicity of pesticides may be related to these hydrocarbons.

Acute Exposure:

A. Introduction

1. Organophosphates alter cholinergic synaptic transmission at neuroeffector junctions (muscarinic effects), at skeletal myoneural junctions and autonomic ganglia (nicotinic effects), and in the CNS .
2. Signs and symptoms of poisoning vary according to age, dose, and concentration.
 - a. Muscarinic effects include: Pinpoint pupils; blurred vision; hypersecretion by salivary, lacrimal, sweat, and bronchial glands; narrowing of the bronchi; nausea, vomiting, diarrhea, and crampy abdominal pains; urinary and fecal incontinence; and slow heart rate.
 - b. Nicotinic effects include: Muscle twitching, cramping, and weakness.
3. Nicotinic stimulation can obscure certain muscarinic effects and produce rapid heart rate and high blood pressure.

B. CNS

1. CNS effects are often the earliest manifestations of poisoning in adults and constitute the major signs and symptoms in children.
2. CNS effects include: Irritability, nervousness, giddiness, fatigue, lethargy, impairment of memory, confusion, slurred speech, visual disturbance, depression, impaired gait, convulsions, loss of consciousness, coma, and respiratory depression.

C. Respiratory

1. Narrowing of the bronchi and markedly increased bronchial secretions can occur.
2. Respiratory failure results from respiratory depression coupled with paralysis of the respiratory muscles and progressive airway obstruction from bronchorrhea.
3. Pulmonary aspiration of the hydrocarbon solvent can cause inflammation of the lungs.

D. Cardiovascular

1. Most exposure victims experience bradycardia, but pulse rate may be increased initially and tachycardia is more common in very severe poisoning.
2. Irregular heartbeat may occur.

E. Gastrointestinal: Nausea, vomiting, abdominal cramps, diarrhea, and fecal incontinence are common manifestations, regardless of the exposure route.

F. Metabolic: Profuse sweating is likely to occur and may lead to profound dehydration.

G. Dermal:

1. Organophosphates are readily absorbed through the skin.
2. Dermal contact can result in systemic poisoning.

H. Ocular

1. Systemic poisoning typically causes pinpoint pupils-and spasm of the muscle of visual accommodation (i.e., ciliary muscle) leading to blurred vision and aching pain in the eye.
2. Organophosphate poisoning may still be present without pinpoint pupils, and dilation of the pupils may even be noted occasionally.
3. Eye irritation, if it occurs, is most likely caused by the hydrocarbon solvents used in commercial pesticide preparations.

I. Potential Sequelae

1. Complete recovery should occur within 10 days unless severe lack of oxygen has caused residual brain damage.
2. CNS effects such as confusion, fatigue, irritability, nervousness, and impairment of memory can occasionally last for several weeks.
3. Six to twenty-one days after acute exposure to some organophosphate compounds, onset of nerve disorders of mixed sensory-motor type may occur, peripheral nerve recovery may never be complete.
4. It is uncertain if organophosphate produces this delayed polyneuropathy.

Prehospital Management:

Hot Zone

- A. Rescuers should be trained, and appropriately attired, before entering the Hot Zone.
- B. If the proper equipment is not available, or if rescuers have not been trained in its use, assistance should be obtained from a local or regional HazMat Team, or other properly equipped response organization.
- C. **Rescuer Protection:** Organophosphate are a mild irritant and highly toxic systemic poison that is absorbed well through the skin.
- D. **Respiratory Protection:** Pressure-demand, self-contained breathing apparatus (SCBA) is recommended in response situations that involve exposure to potentially unsafe levels of organophosphates.
- E. **Skin Protection:** Chemical-protective clothing is recommended because organophosphates are rapidly absorbed through the skin and may cause systemic poisoning.
- F. **Victim Removal:**
 - 1. If victims can walk, lead them out of the Hot Zone to the Decontamination Zone.
 - 2. Victims who are unable to walk may be removed on backboards or gurneys; if these are not available, carefully carry or drag victims to safety.

Decontamination Zone:

- A. 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.
- B. **Rescuer Protection:** If exposure levels are determined to be safe, decontamination may be conducted by personnel wearing a lower level of protection than that worn in the Hot Zone.
- C. **ABC Reminders**
 - 1. Quickly ensure a patent airway.
 - 2. Stabilize the cervical spine with a collar and a backboard if trauma is suspected.
 - 3. Administer supplemental oxygen as required. Assist ventilation with a bag-valve-mask device if necessary.

Basic Decontamination:

- A. Victims who are able and cooperative may assist with their own decontamination.
- B. Remove and double-bag contaminated clothing and personal belongings.

- C. Clothing, especially leather items, is extremely difficult to decontaminate; in most cases, contaminated clothing should be incinerated as directed by hazardous materials experts.
- D. Flush exposed skin and hair with plain water for 2 to 3 minutes, then wash twice with mild soap.
 - 1. Be certain to clean under fingernails and in all skin folds.
 - 2. Rinse thoroughly with water.
 - 3. Irrigate exposed or irritated eyes with plain water or saline for 5 minutes.
 - a. Remove contact lenses if present and easily removable without additional trauma to the eye.
 - b. Continue eye irrigation during other basic care and transport.
- E. **In cases of ingestion.**
 - 1. **Do not induce emesis.**
 - 2. If the victim is alert and able to swallow, consult OLMC for activated charcoal.
- F. As soon as basic decontamination is complete, move the victim to the Support Zone.

Support Zone:

- A. Be certain that victims have been decontaminated.
- B. Victims who have undergone decontamination or have been exposed only to vapor pose no serious risks of secondary contamination to rescuers.
- C. Support Zone personnel should wear gloves for protection.

ABC Reminders:

- A. Quickly ensure a patent airway.
- B. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible.
- C. Ensure adequate respiration.
 - 1. Administer supplemental oxygen as required.
 - 2. Apply pulse oximeter.
- D. Ensure a palpable pulse.
- E. Establish intravenous access, if necessary.
- F. Attach a cardiac monitor.
- G. Airway suctioning may be required for excessive bronchial secretions.

Additional Decontamination:

- A. Continue irrigating exposed skin and eyes, as appropriate.
- B. In cases of ingestion, **do not induce emesis.**
- C. If the victim is alert and able to swallow, consult OLMC for activated charcoal (1 Gm/kg) if not given previously.

Advanced Treatment:

- A. Secure protected airway in cases of respiratory compromise.
 - 1. There is no contraindication to the use of paralytic agents in this setting.
 - 2. Both succinylcholine and vecuronium will have a significantly sustained duration of paralysis in the presence of organophosphates.
 - 3. When patient condition precludes ET tube placement, perform cricothyroidotomy if equipped and trained to perform the procedure.
- B. The initial intravenous dose of atropine in adults should be determined by the severity of symptoms. [If intravenous access can not be established, atropine may be given IM.]
 - 1. **Dosing:** [The Mark 1 AutoInjector atropine is 2 mg]
 - a. Mild poisoning, 1 mg
 - b. Moderate poisoning, 1 to 2 mg
 - c. Severe poisoning, 2 to 5 mg
 - d. In children, dosages range from 0.015 to 0.05 mg/kg
 - 2. Doses should be repeated every 15 minutes until excessive secretions and sweating have been controlled.
 - 3. In seriously poisoned patients, very large doses may be required.
 - 4. Alterations of pulse rate and pupillary size are unreliable indicators of treatment adequacy.
- C. Administer praloximine (2PAM), if profound weakness or paralysis present.
 - 1. **Dosing:**
 - a. For moderate symptoms, 1200 mg (2 amps Mark 1 injector).
 - b. For severe symptoms, 1800 mg (3 amps Mark 1 injector).
 - c. Pediatric dose: 25 to 50 mg/kg.
 - 2. **Symptom definition:**
 - a. **Moderate:** Severe weakness, inability to stand, sit up, or lift arms or legs against gravity.

- b. **Severe:** Life threatening weakness; compromise of ventilatory muscles and inadequate tidal volume.
- 3. **Caution:** When administering 2PAM intravenously, administer at rate of less than 200 mg/minute, (4 mg/minute for children).
- D. Patients who are comatose, hypotensive, or 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 (MPS or MCI)

- A. **Consult with OLMC** for advice regarding triage of multiple victims.
- B. 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.
 - 1. Others may be discharged from the scene after their names, addresses, and telephone numbers are recorded.
 - 2. They should be advised to seek medical care promptly if symptoms develop or recur.

Pralidoxime CL (Protopam[®] / 2-PAM[®])

Class:

Cholinesterase reactivator

Pharmacology and Actions:

- A. The principal action of pralidoxime is to reactivate cholinesterase which has been inactivated by an organophosphate pesticide or related compound.
- B. The drug's most critical effect is in relieving paralysis of respiratory muscles.
- C. Atropine is always required concurrently to block the effect of acetylcholine.

Indications:

- A. An antidote in the treatment of poisoning due to organophosphate pesticides and related or similar chemicals.
- B. Control of overdose by anticholinesterase drugs used in the treatment of myasthenia gravis.

Precautions:

- A. Intravenous pralidoxime administration should be done slowly, preferably by infusion.
- B. Pralidoxime is a relatively short acting drug, repeat dosing may be necessary.

Side Effects/Special Notes:

- A. The following drugs should be avoided in patients with organophosphate poisoning:
 - 1. Morphine
 - 2. Succinylcholine
- B. Pralidoxime is not indicated in the treatment of:
 - 1. Phosphorus
 - 2. Inorganic phosphates
 - 3. Organophosphates without anticholinesterase properties.