R7DHRE Hazardous Materials Guideline: Hydrofluoric Acid

Region VII Disaster Health Response Ecosystem

REGION VII DISASTER HEALTH RESPONSE ECOSYSTEM (R7DHRE)

CHEMICAL SPECIALTY TEAM

Call Your Poison Center for Immediate Assistance: 1-800-222-1222

Hazardous Materials Guideline: Hydrofluoric Acid

This document is intended as a supplement for discussion with your local poison center or toxicologist.

1.0 BACKGROUND

1.1 Description: **Hydrogen fluoride is a highly corrosive, colorless, fuming liquid or gas with a strong, irritating odor and is a serious systemic poison.** Hydrogen fluoride is commonly used for rust removal, glass or metal etching, and oil refining.

1.2 Mechanism of Injury: Hydrogen fluoride has two distinct mechanisms for toxicity. These include the local corrosive effects from being an acid and the systemic effects from the fluoride ion. The fluoride ion complexes with calcium and magnesium, causing hypocalcemia, hypomagnesemia, tissue destruction, hyperkalemia and systemic toxicity. The fluoride ion can produce serious health effects, including death, by any route of exposure.

1.3 Routes of Exposure: **Dermal, Ingestion, Inhalation, Ocular.**

2.0 PROVIDER SAFETY

2.1 Personal Protective Equipment (PPE) – Decontamination Team: Personnel decontaminating patients must wear **full-body chemical-resistant clothing and respiratory protection**. Respiratory protection may consist of either:

2.1.1 A positive pressure air or oxygen source, such as an air-line respirator or a Self-Contained Breathing Apparatus (SCBA) or

2.1.2 A filtered air respirator (including Powered Air Purifying Respirators (PAPRs)) with filters capable of adsorbing hydrogen fluoride.

2.1.3 The use of a positive pressure air or oxygen source is preferred if there is doubt as to the use of a positive pressure air or oxygen source is preferred over a filtered air respirator if there is doubt as to the identity of the chemical in question, or there may be exposure to a level of hydrogen fluoride which can overwhelm the filter's ability to remove the chemical from the inspired air.

2.2 Personal Protective Equipment (PPE) – Treatment Team: Personnel treating patients who have been adequately decontaminated need no additional PPE other than **universal precautions** since there is no serious risk of secondary contamination.

2.2.1 The vomit from persons who have ingested hydrofluoric acid is hazardous because it may off-gas acid vapors or contaminate those coming in contact with the vomit. Prepare treatment areas for rapid clean up in case the patient vomits.

2.3 Patient Decontamination:

2.3.1 Persons exposed to only **hydrogen fluoride gas** and have **no skin irritation, no eye irritation, dry skin, AND dry clothes generally do not need decontamination**. These patients do not pose a significant risk of secondary contamination.

2.3.2 Persons contaminated with **liquid hydrofluoric acid solutions** do **pose a risk of secondary contamination** from off-gassing of hydrogen fluoride vapors and direct contact with the chemical.

2.3.3 Remove contact lenses if it can be done without additional trauma to the eye. **Irrigate eyes for a minimum of 15 minutes**. Continue irrigation until eye pH is neutral (7 to 8).

2.3.4 Remove ALL clothing and jewelry. Double bag clothing and jewelry to prevent off-gassing.

2.3.5 **Rapid decontamination is critical because of hydrogen fluoride's rapid skin penetration.** Decontamination is best **accomplished by irrigation** with **copious amounts of water**. Wash skin and hair with plain water for a minimum of 5 minutes and then wash twice with soap & water after washing with plain water. Washing with water alone (for a longer period of time) is acceptable if soap is not available. **Neutralization with a base is NOT recommended**. Skin pH can be checked to assure that all of the acid has been removed.

2.3.6 Watch for hypothermia in children and the elderly, when decontamination is done with un-heated water, or during cold weather.

3.0 SIGNS & SYMPTOMS

3.1 Severity of symptoms will depend upon the concentration of the hydrogen fluoride to which the person is exposed and the duration of exposure.

3.2 Inhalation: **Irritation of the eyes, nose, throat and upper airway**; lacrimation and rhinorrhea; coughing, bronchoconstriction, wheezing; shortness of breath. **Severe exposures can cause burns of the upper airway leading to upper airway obstructions, damage to the alveoli leading to pulmonary edema, decreased oxygenation and systemic hypoxia, and hemoptysis and bronchopneumonia**. Lung injury may evolve rapidly or may be delayed in onset for 12 to 36 hours. Pulmonary effects can result even from splashes on the skin.

3.3 Dermal: The surface area of the burn is not predictive of its effects. Pain, redness of the skin, blistering and deep burns.

3.3.1 **Acid concentrations of >50%** cause immediate severe, throbbing pain, a whitish skin discoloration and blisters.

3.3.2 **Acid concentrations of 20-50%** produce pain and swelling, which may be delayed up to 8 hours.

3.3.3 **Acid concentrations of <20%:** cause almost no immediate pain on contact but may cause delayed serious injury 12 to 24 hours later.

3.4 Ocular: **Mild effects**: rapid onset of eye irritation. **Severe effects**: sloughing of the eye surface, swelling, clouding of the eye surface, prolonged or permanent visual defects, blindness, or total eye destruction. Severe effects may result from even minor hydrofluoric acid splashes.

3.5 Ingestion: Corrosive injury to the mouth, throat, and esophagus. Stomach inflammation and bleeding occurs commonly. Nausea, vomiting, diarrhea, and abdominal pain. Systemic effects are likely. Acid-base imbalances can occur after acute ingestion.

3.6 Systemic: Symptoms may occur from any route of exposure and can be delayed for several days, especially after exposure to dilute solutions of hydrogen fluoride (< 20%). **Hypocalcemia should be considered a risk in all instances of inhalation or ingestion and whenever skin burns exceed 25 square inches** (an area about the size of the palm). **Absorption of substantial amounts of hydrogen fluoride by any route may be fatal.**

3.6.1 Symptoms: Nausea, vomiting, gastric pain, pulmonary edema, cardiac arrhythmias, hypomagnesemia.

3.6.2 Hypocalcemia: Tetany, decreased myocardial contractility, arrhythmias, CV collapse.

3.6.3 Hyperkalemia: Arrhythmias and ventricular fibrillation.

4.0 DIAGNOSTICS

4.1 Immediate and frequent testing of serum calcium, magnesium, and potassium are indicated.

4.1.1 Severe hypocalcemia, hypomagnesemia should be anticipated, and repletion should begin as soon as possible.

4.1.2 Severe hyperkalemia may occur in the setting of a severe systemic exposure.

4.2 Close ECG monitoring of QT and QRS intervals.

4.3 Any diagnostic evaluation of irritation and burns should be based on sign and symptoms of irritation or corrosive effects.

5.0 TREATMENT

5.1 General: Follow standard Basic and Advanced Life Support Guidelines. **Monitor ECG** for prolonged Q-T interval or QRS duration (caused by hypocalcemia or hyperkalemia).

5.2 *Systemic*: **Check calcium, magnesium and potassium levels frequently** (hourly or more often). Replace calcium and magnesium until serum calcium / magnesium levels, ECG, or symptoms improve. Treat hyperkalemia with standard therapies.

5.3 Inhalation: **Maintain the patient's airway as necessary.** Endotracheal intubation should be performed under direct visualization because of edema and potential damage to the oropharynx. Cricothyroidotomy may be considered. **Support oxygenation and ventilation as necessary**. Use standard treatments for pulmonary edema and bronchospasm. Consider the use of **PEEP and bronchodilators**. Corticosteroids can be considered.

5.3.1 A suggested, but unproven, therapy for patients who have severe respiratory distress is nebulized calcium gluconate, 2.5% solution (2.5 g of calcium gluconate in 100 mL of water is made by adding 25 mL of 10% calcium gluconate to 75 mL of water for inhalation).

5.4 Dermal: Decontamination should occur as soon as possible. After thorough decontamination, the following options may be considered for visualized burns or areas with pain out of proportion to exam.

Topical Calcium Gluconate Gel. Treatment of skin burns begins with topical calcium gluconate gel. Mix calcium gluconate 2.5 g in 100 mL water-soluble lubricant or 1 ampule of 10% calcium gluconate per ounce water-soluble lubricant. Apply every 4 to 6 hours until pain is relieved. Some sources recommend applying the gel 4 to 6 times daily for 3 to 4 days as definitive treatment.

Alternative preparations:

a. Mix 3.5 g of USP calcium gluconate with 5 ounces of a water-soluble gel such as K-Y Jelly and apply to the affected area.

b. Triturate (10) 10-grain calcium carbonate tablets (i.e., Tums) to a fine powder. Add 20 mL of a water-soluble gel like K-Y Jelly. This forms a 32.5% slurry suitable for applying to the affected area.

5.4.1 **Dermal Infiltration of Aqueous Calcium Gluconate**. If some relief of pain is not obtained within 30 to 60 minutes with topical calcium gel, consider injections of sterile aqueous calcium gluconate into and around the burned area. Subungual burns often do not respond to immersion treatment. Care must be used because multiple injections into the fingers can lead to pressure necrosis. It may be necessary to split or remove the nail. The recommended dose is to inject up to 0.5 mL of 10% calcium gluconate solution per cm2 of affected skin surface using a small-gauge needle. Injection may not be feasible in the case of burns to the fingers; in such cases, intra-arterial infusion may be considered. **Do not use calcium chloride for dermal infiltration due to potential for tissue necrosis.**

5.4.2 **Intra-Arterial Aqueous Calcium Gluconate**. Intra-arterial calcium gluconate has been found to be effective for the treatment of burned digits and upper extremities. The radial artery is preferred, but the brachial artery can be used if there is incomplete anastomotic flow between the radial and ulnar circulations. The initial dosage is 10 mL of 10% calcium gluconate diluted with 40 mL D5W given intra- arterially over 4 hours. If pain is unrelieved, 20% concentrations have been used. After the first dose, the infusion can be stopped, but the line should be maintained so that further doses can be infused if pain recurs. Once the patient has been pain-free for 4 hours, the catheter can be removed. Although anesthesia can be used, it is not recommended since it invalidates the pain relief which is a titration endpoint for effective treatment. **Do not use calcium chloride for intra-arterial infusion due to potential for tissue necrosis.**

5.4.3 The intense pain of hydrogen fluoride burns should not be suppressed with local anesthetics because the degree of pain is an indicator of treatment efficacy. Do not use calcium chloride as it will increase pain and cause more tissue injury.

5.4.4 A burn specialist or plastic surgeon should be consulted early in the treatment of fluoride burns. The treatments for hand burns require expert assistance; consult a poison center, medical toxicologist, or hand surgeon.

5.5 Ocular: **Irrigate eyes to a neutral pH**. The pH of the conjunctiva should be checked every 30 minutes for 2 hours after irrigation is stopped to ensure that the measured pH is that of the tissue and not the irrigating fluid. Perform a thorough eye exam: test visual acuity and perform fluorescein and slit lamp examinations. Consultation with an ophthalmologist is indicated.

5.6 Ingestion:

5.6.1 This is a life-threatening event with > 90% mortality and must be treated aggressively.

5.6.2 Immediately transport all victims to hospital via rescue squad.

5.6.3 **Do NOT give activated charcoal, induce emesis, or attempt to neutralize the ingested hydrofluoric acid.**

5.6.4 Consider dilution by giving 2 to 4 ounces of milk or water orally ONLY to patients who are conscious, able to swallow, and are able to protect their airway. **If available, also give 2 to 4 ounces of an antacid containing either magnesium or calcium**. Endoscopic evaluation may be necessary.

5.6.5 Ionized calcium should be followed every 30 minutes; supplemental IV calcium should be given to keep calcium levels within the normal range.

5.6.6 All patients who ingested HF should be in an ICU for 24 hours with frequent monitoring of calcium and electrolytes, and continuous ECG monitoring.

Initial author: Edward Bottei, MD, FACMT; revised by Dan McCabe, MD and the R7DHRE Chemical Specialty Team