

## HYDROFLUORIC ACID

### Dermal Exposure

#### Background:

Hydrofluoric acid (HF) is a relatively weak acid because the hydrogen and fluoride create a tightly bound molecule. HF readily penetrates the skin and mucous membranes because of its tight binding (uncharged). In the tissue, the fluoride portion will avidly bind to divalent cations such as calcium and magnesium, causing deep tissue destruction. The deep tissue destruction causes the severe unrelenting pain experienced by affected patients. Severity and timing of effects depends on the concentration, duration of exposure, and penetrability of the exposed tissue; pain may be delayed. Life threatening systemic toxicity may follow dermal exposure with minimal external tissue damage.

#### Incubation Period:

Timing of pain following dermal exposure to HF will vary according to concentration. Generally:

- 1) < 20 percent concentration - erythema and pain may be delayed for 24 hours and often is not reported until significant tissue injury has occurred.
- 2) 20 to 50 percent concentration - erythema and pain may be delayed for 8 hours and often is not reported until tissue injury has occurred.
- 3) >50 percent concentration - may produce immediate pain and erythema, rapid destruction of tissues and acute systemic toxicity.

#### Signs/Symptoms:

- 1) Airway: Upper airway and mucosal irritation may occur from fumes.
- 2) Cardiovascular: Hypocalcemia and hypomagnesemia are associated with prolonged QTc and ventricular dysrhythmias, such as torsades de pointes, ventricular tachycardia and ventricular fibrillation.
- 3) Pulmonary: Dyspnea, bronchospasm chemical pneumonitis, pulmonary edema (possibly hemorrhagic), tracheobronchitis, upper airway obstruction, chemical burns (larynx, trachea and bronchi) and ARDS may occur following severe inhalational exposure.
- 4) Metabolic: Hypocalcemia, hypomagnesemia, hyperkalemia and acidosis.
- 5) Dermal: A hallmark of dermal exposure to low concentrations of HF is pain that is out of proportion to the physical examination. Severe pain may be obvious, while only erythema of the exposed skin is observed. More severe burns may exhibit erythema, central blanching with peripheral erythema, swelling, vesiculation, serous crusting, ulceration, blue-gray discoloration and necrosis.
- 6) Eyes: Pain, conjunctival injection, corneal abrasion and corneal ulceration may be seen initially with a strong liquid exposure. Progressive corneal vascularization, scarring and corneal opacification may occur in a delayed fashion.

#### Laboratory and Diagnostic Testing:

Low concentration exposures or late presenting patients may need pain control and antidotal treatment only. In patients with exposure to higher concentrations, or who are chronically ill or symptomatic, consider a calcium level, magnesium level, chem-7, EKG, and monitoring for dysrhythmias.

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**Treatment:**

**Decontamination:**

Remove all exposed clothing and jewelry and irrigate all exposed areas with copious amounts of water for 30 minutes (acute exposures).

**Enhanced Elimination:**

No methods of enhanced elimination are available for HF burns.

**Antidotal Therapy:**

- 1) Topical calcium and parenteral calcium are the mainstays of treatment of dermal burns.
- 2) Calcium gel: Apply and massage gel into the affected area. Any coagulum that is present must be removed prior to gel application so that the antidote may penetrate the area. There are two methods of making gel in the ED if calcium gluconate or carbonate gel is not available from the pharmacy:
  - a) Calcium gluconate: Add 3.5 grams of calcium gluconate powder to a 5-ounce tube of water-soluble surgical lubricant, such as K-Y Jelly. Calcium chloride is not recommended due to its potential for irritation.
  - b) Calcium carbonate: 32.5 percent slurry used for treatment of hand or finger burns can be prepared by grinding ten (10-grain) tablets into a fine powder and adding to 20 milliliters of a water-soluble lubricant gel, such as K-Y Jelly. Alternatively, calcium carbonate powder can be added to K-Y Jelly until a spreadable gel is produced.
- 3) Local infiltration: Consider local infiltration with calcium gluconate if higher concentration HF exposure results in immediate tissue damage or erythema and pain persist following adequate irrigation. Infiltrate each square centimeter of the affected (painful) skin and subcutaneous tissue with about 0.5 milliliter of 10 percent calcium gluconate using a 30-gauge needle. Repeat as needed to control pain. This procedure is generally not recommended for fingers or toes due to potential for tissue injury from increased pressure (compartment syndrome).
- 4) Intravenous: Regional intravenous infusion of calcium gluconate, using a technique similar to the Bier block, is an option for HF burns of the forearm, hand or digits **and** topical or local infiltration therapy has failed.
  - a) Insert an IV into the dorsum of the affected hand. Exsanguinate the superficial veins by raising the arm for 5 minutes or applying an esmarch bandage. When exsanguination is complete, inflate a blood pressure cuff to just above the systolic blood pressure to prevent the arm from refilling with blood. Lower the arm or remove the bandage. Infuse 10 to 20 mL of 10 percent calcium gluconate solution diluted to 30 to 40 mL with 0.9 percent saline solution. Maintain ischemia 25 to 30 minutes; then sequentially release the blood pressure cuff over 5 minutes. IV therapy is considered successful if there is absence of pain and tenderness during the hour following treatment.
- 5) Intra-arterial infusion: This technique is an option for treatment of digit burns and topical therapy has failed.
  - a) Following satisfactory placement of the arterial line, a dilute preparation of calcium gluconate (10 mL of a 10 percent solution mixed in 40 to 50 mL 5 percent dextrose **or** 20 mL of a 10 percent solution mixed in a 250 cc of 5 percent dextrose) is infused with a pump apparatus into the catheter over 4 hours. If pain recurs in 4 hours, repeat calcium infusion one time. Perform frequent neurovascular checks of the hand during and after the procedure.

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**Supportive Care:**

- 1) Pain control: Administer NSAIDS and narcotics as needed to control pain.
- 2) Electrolytes: Treat hypocalcemia, hypomagnesemia and hyperkalemia as necessary.
- 3) Cardiac effects: Mainly due to the above, treat electrolyte imbalances with calcium gluconate or calcium chloride IV push. Correct hyperkalemia emergently with insulin, dextrose and sodium bicarbonate. Consider administration of magnesium sulfate.

**Disposition:**

Admit patients with high concentration exposures and cardio-respiratory signs/symptoms to the ICU and observe with continuous EKG monitoring.

Patients who need invasive procedures such as arterial administration of calcium gluconate should be admitted to a monitored setting with frequent neurovascular checks.

Patients who have adequate pain control after irrigation and/or antidotal treatment may be discharged home with close follow up.