



## HYDROFLUORIC ACID

### I. PURPOSE

This guideline is designed to facilitate rapid assessment and treatment, clarify areas perceived as unclear in Poisindex, and encourage consistencies for Hydrofluoric Acid (HF) exposure management.

### II. BACKGROUND

Hydrofluoric Acid (HF) is found extensively in industry and sometimes in the home. Uses include glass etching, semiconductor manufacturing, rust removal, dyes, plastics, germicides, tanning, solvents, fireproofing, pottery glazing, photography and as a laboratory reagent.

### III. PHARMACOLOGY / TOXICOLOGY

- A) Hydrogen fluoride (HF) is a skin and respiratory irritant. It is a relatively weak inorganic acid and toxic effects result primarily from the highly reactive fluoride ion. HF may lead to a spectrum of injury from superficial burns to dermal necrosis.
- B) HF penetrates tissues deeply, where the highly cytotoxic fluoride ion is released and cellular destruction occurs.
- C) The fluoride ion readily binds with calcium and may cause systemic hypocalcemia.
- D) Severity and rapidity of onset of symptoms depends on the concentration, duration of exposure, and penetrability of the exposed tissue. Pain may be delayed. **EXPOSURE SYMPTOMS**
- E) **DERMATOLOGICAL and MUSCULOSKELETAL**

Destruction of tissue proceeds under toughened coagulated skin so that ulcers extend deeply, heal slowly, and leave a scar. After a delay of 1-12 hours, progressive redness, swelling, skin blanching, and pain is noted. **The pain is progressive and unrelenting.** Severe deep-tissue destruction may occur, including full-thickness skin loss.

- 1) Dermal exposure with more than 1% total body surface area to a 50% or greater solution, dermal exposure greater than 5% total body surface area to any solution, or inhalation of greater than 60% solution places the patient at risk for local and systemic toxicity.
- 2) Concentrations less than 20%: Erythema and pain may be delayed up to 24 hours, often not reported until tissue damage is extreme. Studies have shown 7% HF produced symptoms in one to several hours, 12% HF less than one hour and 14.5% HF immediately.
- 3) Concentrations 20% to 50%: While symptoms (erythema and pain) may develop quickly, they may also be delayed up to 8 hours. Again, sometimes not reported until tissue damage is extreme.
- 4) Concentrations greater than 50%: Usually result in immediate burning, erythema, and tissue damage.

## CASE MANAGEMENT GUIDELINE: . . . HYDROFLUORIC ACID

- F) OCULAR
  - 1) Ocular exposure can result in severe ocular damage with concentration greater than 0.5%. Fume exposure commonly causes eye irritation and ocular injury. Signs and symptoms may be delayed.
  - 2) Corneal erosion, progressive vascularization and corneal stroma scarring, corneal opacification has been reported. Like alkali burns, damage continues to progress over the first 24 hours.
- G) SYSTEMIC / INGESTION: Ingestion, inhalation and extensive dermal burns may cause fluoride systemic toxicity, which occasionally may be manifested by hypocalcemia, hypomagnesemia, pulmonary edema, metabolic acidosis, ventricular arrhythmias and death.
- H) RESPIRATORY: Inhalation may result in dyspnea, bronchospasm, chemical pneumonitis, pulmonary edema, tracheobronchitis, airway obstruction secondary to laryngeal edema, and chemical burns.
- I) GASTROINTESTINAL: Ingestion may result in vomiting and abdominal pain, painful necrotic lesions, hemorrhagic gastritis, and pancreatitis. Rectal administration has caused acute colitis with perforation.
- J) ACID-BASE: Metabolic acidosis with severe poisoning.
- K) FLUID-ELECTROLYTE: Hypocalcemia and hypomagnesemia may develop after inhalation, dermal or oral exposure.
- L) CARDIOVASCULAR: QT prolongation, ventricular arrhythmias, and cardiac arrest secondary to hypocalcemia and hypomagnesemia. Histologic myocardial damage has been described in fatal exposures

## IV. TREATMENT

- A) Charcoal or induction of emesis is of no value.
- B) For ingestions administer a fluoride-binding substance such as milk, chewable calcium carbonate tablets, or milk of magnesia. Irrigate mouth with copious amounts of milk or water. If a large ingestion, or suicidal gesture, without spontaneous emesis and the patient refuses to drink, consider lavage with milk or a 10% calcium solution.
- C) All ocular exposures must be irrigated promptly with tepid milk, saline, or water for at least 30 minutes. Careful examination for eye damage, in a HCF, is required for all ocular exposures; dilute solutions may result in delayed signs and symptoms.
- D) After inhalation exposures, if cough or difficulty in breathing develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. Administer 100% humidified O<sub>2</sub> with assisted ventilation as required. Consider PEEP if pulmonary edema ensues. Signs and symptoms of pulmonary edema may be delayed up to 24 hours.
- E) Dermal: wash exposed area with copious amounts of water, then soak in a solution of Epsom salts (magnesium sulfate) or use calcium gel. The gel is massaged into the affected area until the pain has subsided for 15 minutes. It must have access to the burn, so cloth or thick necrotic coagulum should be removed. Immediate topical use of calcium or magnesium may prevent deep burns.

CASE MANAGEMENT GUIDELINE:... HYDROFLUORIC ACID

- 1) Recipe(s) for Calcium Gel
    - a. Method 1 with CALCIUM GLUCONATE POWDER
      1. Add 3.5 grams of calcium gluconate USP to a 5-ounce tube of water-soluble surgical lubricant, such as K-Y Jelly<sup>(R)</sup>.
    - b. Method 2 with CALCIUM CARBONATE TABLETS
      2. Triturating ten (10-grain) tablets into a fine powder and adding to 20 milliliters of a water-soluble lubricant gel, such as K-Y Jelly<sup>(R)</sup> (Chick & Borah, 1990).
      3. Another method is to gradually add the calcium carbonate powder to K-Y Jelly<sup>(R)</sup> until a spreadable gel is produced.
  - 2) Directions
    - a. Mix materials thoroughly
    - b. Apply to exposed area following decontamination and apply an occlusive dressing
    - c. The injured hand may be placed in a surgeon's glove to keep the gel in contact with the exposed surface.
    - d. Reapply gel every four hours
- F) **Intra-arterial:** Injection of calcium by the intra-arterial route may be helpful for burns involving several digits or under fingernails. Infuse 20 mL of 10% calcium gluconate, **not calcium chloride**, diluted in 250 mL D5W via the radial or brachial artery proximal to the injury over 3-4 hours. Intra-arterial infusion should be continued until pain does not recur. Note: consult with toxicologist before recommendation to HCF.
- G) Nebulized inhalation and ocular administration of 2.5% calcium gluconate solution remain of unproven efficacy.
- H) Correct systemic hypocalcemia with IV administration of Calcium Gluconate; 0.1 to 0.2 mL/kg up to 10 mL/dose of a 10% solution; repeat as necessary.
- I) Correct systemic hypomagnesemia with IV administration of magnesium sulfate; 2 grams in adults, 25 to 50mg/kg in children, diluted to less than 10 mg/mL.

V. LABORATORY MONITORING

- A) Obtain serum electrolytes including serial plasma calcium, magnesium, and potassium levels during therapy.
- B) Obtain arterial blood gases and Chest X-Ray in symptomatic patients.
- C) Monitor EKG continuously for signs of hypocalcemia (prolonged QT interval).



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Date

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