

Toxicology Clinics-Bench to Bedside Painful Foot

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A 32 years old mechanic presented to the Emergency Department complaining of severe foot pain four hours after contact with a chemical in the garage. What chemical exposure likely caused this injury? (Figure 1)



Figure 1: Clinical presentation

Answer: Hydrofluoric Acid

What Is Hydrofluoric Acid?

Hydrofluoric Acid (HF) is widely used in industrial settings and household cleaning products such as rust removers. Dermal exposure can cause significant delayed effects, and life-threatening systemic effects can occur through any route of exposure.

How Does It Act?

Fluoride ions bind directly with calcium and magnesium and disrupt potassium channels causing cell dysfunction and death. Ventricular dysrhythmias occur secondary to hypocalcemia, hyperkalemia and hypomagnesemia, and acidosis.

How to Assess The Risk?

This can look complex due to different routes and concentrations. The following are some simple rules before we talk specifics:

- Any dermal/ocular injury can cause severe pain out of proportion
- Inhalation can cause pulmonary injury
- Ingestion of >100 ml low concentration HF (6%) can cause life-threatening toxicity
- Ingestion of any volume of higher concentrations of HF can cause life-threatening toxicity

What Are The Specific Dermal Exposures At Risk of Life-Threatening Toxicity?

- 100% HF solution to 2.5% body surface area
- 70% HF solution to 8% body surface area
- 23% HF solution to 11% body surface area
- Domestic HF is usually between 5 – 12%.
- Industrial HF is more concentrated.

What Are The Clinical Features?

Dermal Exposure:

- If concentrations of <50% are in contact with the skin, there is often a delay in pain by several hours. The lower the concentration, the greater the delay. Patients often present at night or the next day following exposure.
- Deep pain without any erythema or blistering is typical
- Pallor, blanching, blistering, or tissue loss often appears hours or days later.
- The pain usually lasts 24-36 hours.

Inhalation:

- Immediate mucosal irritation followed by delayed dyspnoea, cough, and wheeze.
- Non-cardiac pulmonary edema can occur in severe cases.

Ingestion:

- < 20% HF is minimally corrosive
- Vomiting, throat pain, dysphagia, and abdominal pain.
- Cardiac arrest from systemic fluorosis can occur without warning 30 minutes to 6 hours post-ingestion.

Systemic Fluorosis:

- Hypocalcemia and hypomagnesemia manifest as tetany and QT prolongation.
- Ventricular dysrhythmias and cardiac arrest.

What Are The Supportive Cares?

- Administer oral and parenteral analgesia; this is often required until calcium treatment is given.
- Do not give local anesthetic for pain relief because pain is used as a marker of adequate calcium delivery.

What are the investigations?

- Serial ECGs every 2 hours in anyone with the potential to develop systemic fluorosis. The degree of QT prolongation is a useful biomarker of hypocalcemia.
- Serum ionized calcium and magnesium. Measure at presentation every 4 hours in patients who may develop systemic fluorosis until cardiac monitoring ceases.

How to Treat This Patient?

- For dermal exposure, remove clothing and copiously irrigate with water or saline
- Be careful to avoid secondary exposure to health care providers
- Apply topical calcium gel directly to the affected area(s)
- Hand burns can be placed in a glove containing calcium slurry
- Local injection of dilute calcium gluconate and intravascular administration of calcium have also been described. However, extreme caution should be exercised if considering these therapies.
- For potentially life-threatening ingestions, a nasogastric tube can be inserted to aspirate GI contents and administer calcium or magnesium salts.
- Obtain EKG and institute cardiac monitoring.
- Aggressively treat hypocalcemia and hypomagnesemia.

How to Manage This Patient?

- Patients with intentional ingestions, extensive burns, or signs of systemic toxicity should be admitted to an intensive care setting.
- Only asymptomatic patients with mild dermal exposure controlled with analgesics, and no additional symptoms, are candidates for discharge.

Reference:

1. Kirkpatrick JR, Burd DAR. An algorithmic approach to the treatment of hydrofluoric acid burns. Burns 1995; 21:495-499.