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SUMMARY

Acids, alkalis, and organic compounds are commonly encountered in home and industry. Chemicals can enter the body through absorption, ingestion, inhalation, or as part of combined mechanisms. Severity of injury results from the composition, concentration, temperature, amount, and duration of contact with the agent. Immediate removal of the chemical, to include removal of contaminated clothing, brushing away any particles, and aggressive water irrigation are critical to decreasing the severity of injury.

RECOMMENDATIONS

- **Level 1**
 - None
- **Level 2**
 - Decontamination of chemical exposure to the skin:
 - Brush away all visible particles
 - Remove all contaminated clothing
 - Begin irrigation with water at the scene for up to 30 minutes if patient stable
 - Protect patient from hypothermia
 - Protect patient privacy
 - Hydrofluoric acid binds with calcium and magnesium in the bloodstream.
 - Topical calcium can be applied acutely to reduce pain.
 - Monitor with telemetry for up to 48 hours in intensive care unit to identify dysrhythmias and monitor serum electrolytes.
 - Consider intravenous calcium replacement for marked hypocalcemia, arrhythmias, or hemodynamic instability.
- **Level 3**
 - Lithium exposures should be irrigated with mineral oil to remove remaining lithium ions prior to cleaning with water.

INTRODUCTION

The mechanism of action for burns resulting from chemical exposure to the skin is related to the characteristics of the chemical itself. The pH of the chemical initiates degradation of skin and underlying tissues. Specific chemical composition and temperature, route of exposure, and duration of contact all serve to confound injury severity. Prompt and appropriate decontamination is essential (1). Common chemicals leading to cutaneous burns include battery acid, bleach, detergents, drain cleaners, fertilizers, hair relaxers, metal cleaners and rust removers, paint thinners and removers, pesticides, sanitizers and disinfectants, swimming pool chemicals, toilet bowl cleaners, and wet cement. Identifying the nature of the chemical exposure is essential to guiding treatment and determining prognosis.

Large chemical burns can require significant fluid resuscitation due to the depth of injury and should be treated similarly to thermal burns. Chemical burns differ from thermal burns in that the presence of the chemical causes

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Supported by multiple, prospective randomized clinical trials or strong prospective, non-randomized evidence if randomized testing is inappropriate.
- **Level 2:** Supported by prospective data or a preponderance of strong retrospective evidence.
- **Level 3:** Supported by retrospective data or expert opinion.

DISCLAIMER: These guidelines were prepared by the Department of Surgical Education, Orlando Regional Medical Center. They are intended as a general statement regarding appropriate patient care practices based on the medical literature and clinical expertise at the time of development. They should not be considered protocol or policy nor are intended to replace clinical judgment or dictate care of individual patients.

ongoing tissue damage until the tissue is decontaminated. Topical antibiotic ointment and sterile dressings should be applied and changed daily. Chemical burn injuries should be evaluated daily and plans for surgical debridement and split-thickness autografting initiated. Full-thickness chemical burn injuries are frequently apparent at the time of initial presentation due to the rapidity of the chemical in causing tissue destruction.

Alkalis

Alkalis (pH > 7) destroy skin and underlying tissue through liquefactive necrosis and protein denaturation resulting in deep penetration of the chemical. They are known to cause more devastating tissue destruction when compared to acid compounds. Alkalis include lye and caustic sodas, wet cement, and oven, drain, and industrial cleaners (1).

Lithium hydroxide exposures have become common with the advent of vape cigarettes and increased production of electronic vehicles such as electronic bicycles. Water irrigation for lithium battery exposure may lead to an exothermic reaction producing further injury to the tissues. Decontamination with mineral oil is recommended to thoroughly clean away all remaining lithium prior to contact with water (2,3).

Acids

Acids (pH <7) break down skin and tissue through coagulation necrosis and protein precipitation resulting in a thick eschar. This eschar is felt to limit deeper penetration of the chemical. Similar to alkalis, acids are found in many home and industrial cleaning products (1).

Hydrofluoric acid

Hydrofluoric acid is a corrosive inorganic acid used in industrial cleaning, etching, mining and semiconductor manufacturing. Hydrofluoric acid binds with serum calcium and magnesium potentially leading to critical hypocalcemia, hypomagnesemia, and hyperkalemia with significant hemodynamic effects. Burns caused by exposure to hydrofluoric acid may appear pale or bright red and may not blister initially. Inhalation of hydrofluoric acid can cause severe pulmonary injury. Patients often report severe pain incongruent with the initial presentation.

Treatment of hydrofluoric acid exposure differs significantly from that of other acids. Following water irrigation, calcium replacement is essential and should begin with topical calcium application using 2.5% calcium gluconate gel. If the commercial gel is unavailable, mix 3.5 g of calcium gluconate powder with 140 g (5 oz) of water-soluble surgical lubricant. The calcium gel should be massaged into the affected tissue for 30-60 minutes. For hand exposures, the gel can be placed inside a surgical glove that is then placed on the patient's hand. Healthcare providers should wear gloves and avoid contact with the calcium gel (6). Topical magnesium hydroxide antacid is an alternative, but less effective, option. If pain persists despite topical calcium treatment, 5 percent calcium gluconate (0.5 mL per square cm of wound area) may be injected intradermally directly into and around the affected areas. For severe exposures and uncontrolled pain, intra-arterial infusions of calcium gluconate may be required for up to 72 hours following exposure (1,3,5,6). Simultaneously, IV calcium replacement should be performed based on serum levels which may need to be measured as frequently as every hour during the first 24-48 hours (1,3,5,6).

Telemetry and critical care monitoring are indicated for exposures greater than 25 cm² due to the risk of QTc prolongation, ventricular dysrhythmia, hypocalcemia, hyperkalemia, and hypomagnesemia. IV calcium monitoring and replacement may continue up to 48 hours, when fluoride ions stabilize.

Organic Compounds

Organic compounds function as solvents causing damage by "melting" the skin and fat. Once absorbed, damage may extend to the kidneys and liver. Harmful organic compounds include phenols, creosote, and petroleum products (1).

Elemental Metals

Elemental sodium, potassium, magnesium, phosphorous, lithium, cesium, and certain reactive metal compounds (e.g., titanium tetrachloride) combust or release hazardous byproducts when exposed to water (6). When present, the metal fragments must be removed with forceps and placed in mineral oil. Surgical debridement may be necessary to remove embedded metal. These fragments can spontaneously combust, and either saline-soaked or mineral oil dressings should be placed over the burned tissue to avoid exposure to air. White phosphorus, from military munitions, can be visualized using UV light.

DECONTAMINATION

All personnel should don personnel protective equipment (PPE) including gown, gloves, mask and eye protection before encountering patients with chemical exposure. Patients with suspected or known chemical burns should be decontaminated outside of the emergency department before being brought inside for treatment. Lifesaving interventions (i.e., endotracheal intubation) should be performed outside the emergency department prior to decontamination (6). Contaminated clothing and jewelry should be removed and safely disposed of. Any obvious chemical products must be removed or brushed away to avoid exothermic reaction. Any attempts to neutralize chemicals (such as with baking soda) may result in heat generation and worsening injury. Other than lithium exposure, large-volume low-pressure warm water irrigation is the safest method of burn decontamination. Irrigation should begin at the scene and may continue for 30 minutes as long as the patient remains stable. Alkali burns typically require longer irrigation times than acid burns. Patients should be monitored for hypothermia and active rewarming initiated early. Patient privacy should be always protected. Test strips may be useful to follow the progress of acid/alkali decontamination during acute management (skin pH is normally close to 5.5). Skin pH should be checked 5-10 minutes following cessation of irrigation to avoid measuring the pH of the irrigation fluid. If the skin pH has not reached the target goal, irrigation should be continued (1,6).

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