Hazards and Injuries in the Chemistry Lab

An Overview for EMS Providers

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Hazards and Injuries in the Chem Lab

- We don’t usually view college campuses as a place where we would encounter Hazmat emergencies; however, Chemistry Labs present a unique challenge to EMS providers confronted with injuries sustained from chemical substances.
Hazard Awareness
Identification of Hazardous Materials
Identification of Hazardous Materials

- Hazard Label Coding
  - Blue – Health
  - Red – Flammability
  - Yellow - Reactivity
  - White – Specific Hazard
- 0-4 Severity Scale
  - 4 Severe
  - 3 Serious
  - 2 Moderate
  - 1 Slight
  - 0 Minimal
Identification of Hazardous Materials
Identification of Hazardous Materials

- Know where Material Safety Data Sheets (MSDS) are located and how they are organized.
- Sections 3 and 4 of an MSDS presents an emergency overview, potential health effects, and first aid treatment specific to the chemical.
Types of Hazards Present in the Chem Lab

- Physical Hazards
- Pressure and Vacuum Apparatus
- Steam
- Compressed Gases
- Cryogenic (Liquid) Gases
- Radioactive Materials
- Chemical Substances
  - Acids, Bases
  - Organic Solvents
  - Oxidizing Agents
  - Reducing Agents
Physical Hazards

- Physical Hazards
- Broken glassware poses a laceration potential, but may also contaminate wounds with residual chemical substances.
- All wounds sustained from lab glassware should be thoroughly irrigated with water prior to bandaging.
Physical Hazards

- **Pressure and Vacuum Apparatus** pose the danger of explosion or implosion with high velocity fragments of glass or metal.
Physical Hazards

- Steam Burns
Compressed Gases

- **Flammables** (Propane, Acetylene, Hydrogen)
- **Simple asphyxiants** (N2, He, Argon)
- **Chemical asphyxiants** (CO, Cyanide, H2S, Phosgene)
- **Irritants/Corrosives** (Chlorine, HCl, Ammonia)
Inhaled Substances

- Symptoms will depend on specific substance – common ones include:
- CO: weakness, fatigue, nausea, flu-like symptoms
- Lightheadedness, dyspnea, coughing
- Burning, throat and eye irritation
- Bronchoconstriction
- Pulmonary Edema
Treatment for Inhalation Exposure

- Do not become a victim yourself.
- Patient should be moved to a fresh air environment.
- Oxygen provided by nonrebreather mask
- Monitor vital signs, breath sounds, and pulse oximetry. (Be aware that pulse oximetry is not reliable in cases of CO toxicity)
- Be alert for signs of pulmonary edema and systemic toxicity
- Determine the identity of the substance the patient was exposed to, and obtain a copy of the MSDS to be transported with the patient.
Cryogenic (Liquid) Gases

- Ar, He, N2, O2
- Stored at temperatures minus 240 F or lower
- Contact with cryogenic liquids to the eyes or skin can cause serious frostbite injuries. Flesh or tissues that come in contact with a cryogenically cooled material (even non-metallic materials) can stick to that material, and may tear on attempted removal.
Cryogenic (Liquid) Gases

- Cryogenic Liquids require handling with specialized personal protective equipment.
- Insulated gloves made to withstand extremely low temperatures should be worn – they should fit loosely so they can be easily thrown off if a splash occurs inside the glove.
Cryogenic (Liquid) Gases

- If exposure to a cryogenic liquid occurs, warm water should be run over the affected area. Thawed frostbitten skin will be very painful, red and swollen with a burning sensation. Bandage with bulky dressings, and seek advanced medical care.

- Liquified gases undergo a 700 x expansion from a liquid state to a gaseous state, and present an asphyxiation danger in enclosed spaces due to displacement of oxygen. One liter (quart) of liquid Nitrogen can expand to almost 25 cubic feet of gas. This can rapidly fill a small space, creating an oxygen deficient atmosphere.
Eye Injuries

Lab B

NOTICE
SAFETY GLASSES REQUIRED IN LAB
CONTACT LENSES PROHIBITED
Eye Injuries

“Eye Injuries in the workplace remain all too common, afflicting more than 700,000 Americans each year. Yet, Prevent Blindness America says 90% of these injuries can be avoided with a simple and obvious expedient: safety eyewear.”

Excerpted from Occupational Hazards Magazine / February 2005
Eye Injury from Alkali

Flush Continuously
Eye Injuries

- Corneal Opacity from an acid burn to the eye
- Use of Safety Glasses, Chemical Goggles, or Face Shields effectively prevents such injuries
- It is imperative for EMS responders to become familiar with the operation of eye washes and safety showers used in their school’s laboratories
Treatment of Eye Injuries-ANSI Standard - 2004 Revision

- The American National Standards Institute (ANSI) standard for eyewashes and safety showers (ANSI Z358.1) requires that this safety equipment have unobstructed access and be accessible within 10 seconds or less of the hazard.
To be sure plumbed units are always in proper operating condition, they should be activated on a weekly basis.

Beyond confirming that the units work, there are several reasons for regular activation:

- Sedimentation is cleared, which can clog the supply line
- Flushing stagnated water from plumbed fixtures reduces the chance of microbial hazards
- Eye injuries should be flushed with the cleanest water possible.
Treatment of Eye Injuries

- Activate eye wash
- **Wearing chemical resistant gloves**, hold eyelids of patient open, and flush eyes for at least 15 minutes
- If the person is wearing contact lenses and the lenses did not flush out from the running water, have the person remove them during the flushing process.
- Cover both eyes with a clean dressing, and do not allow the patient to touch or rub the eye.
Chemical Burn Injuries

- Clinical signs and symptoms vary depending on the route of exposure and the particular substances involved.

- Factors determining injury severity are:
  - Chemical substance, concentration, physical form, temperature, and pH
  - Route of exposure
  - Time of exposure
  - Volume of exposure
  - Surface area of the body exposed
Dermal Exposure

- Symptoms are dependent upon the specific chemical agent. Most common symptoms are:
  - Abdominal pain
  - Dyspnea
  - Seizure activity
  - Dizziness
  - Headache
  - Irritability
  - Pain, burning or itching at site of contact
  - Rash, redness, burns, or blistering
  - Un consciousness
DO NOT

- Do not become contaminated yourself – latex gloves are a very poor barrier to many chemical agents, particularly organic solvents.
- Do not try to neutralize any chemical without consulting Poison Control.
- Do not disturb blisters or remove dead skin from a chemical burn.
- Do not apply any household remedy such as ointment or salve to a chemical burn (exception is Calcium Gluconate gel for Hydrofluoric Acid burns).
Management

- Scene safety
- Personal Protective Equipment (PPE)
- Removal of patient from contaminated environment
- Removal of contaminated clothing, shoes, and jewelry from the patient. (Use chemical protective gloves)
- Surface decontamination with large volumes of water for at least 15 minutes
- Airway, ventilatory support, O2
- Monitor vital signs, pulse oximetry
Exposure to Acids and Bases

- Both acids and bases (alkalies) can be defined as caustics, which can cause significant damage on contact.
- Most acids produce a coagulation necrosis by denaturing proteins, forming a coagulum that limits the penetration of the acid.
- Bases typically produce a more severe injury known as liquefaction necrosis. This involves denaturing of proteins as well as saponification of fats, which does not limit penetration.
Common laboratory acids and bases

- **Acids**
  - Acetic Acid
  - Chromic Acid (systemic toxin)
  - Hydrofluoric Acid (systemic toxin)
  - Nitric Acid (produces characteristic yellow or orange discoloration to the skin)
  - Sulfuric Acid (dehydrates the skin leaving a black discoloration)

- **Bases (Alkalies)**
  - Ammonia
  - Ammonium Hydroxide
  - Calcium Hydroxide
  - Phenol (systemic toxin)
  - Potassium Hydroxide
  - Sodium Hydroxide
Exposure to Specific Substances

- Nitric Acid is a very powerful oxidizing agent and will react with cyanides, carbides, and metallic powders with explosive force. It will also react violently with organic compounds and may be self-igniting. Nitric acid burns tend to be quite severe.

- Organophosphates, Carbamates (These materials are commonly used to manufacture pesticides and similar classes of compounds are used to produce chemical warfare agents)

- Hydrofluoric Acid
Nitric Acid Burn
Organophosphates, Carbamates
Systemic effects from Dermal / Inhalation Exposure

- Symptoms (SLUDGE)
  - Salivation
  - Lacrimation
  - Urination
  - Defecation
  - Gastrointestinal Upset
  - Emesis
Management

- Scene Safety
- PPE
- Remove patient from substance and decontaminate (safety shower), removing contaminated clothing, shoes & jewelry. Contaminated clothing must be bagged in plastic bags for disposal.
- O2 and respiratory support
- Organophosphate exposure is treated with Atropine by ALS providers
Hydrofluoric Acid Exposure
What is Hydrofluoric Acid?

- Hydrofluoric acid, a solution of Hydrogen Fluoride gas in water, is an extremely corrosive acid that is clear and colorless with a density similar to water. It has a number of chemical, physical and toxicological properties which make handling this material especially hazardous.
Properties of Hydrofluoric Acid

- Disagreeable, pungent odor at 0.04 ppm
- Irritation of eyes and throat at 3 ppm
- Dissolves glass
- Attacks glazes, enamels, pottery, concrete, rubber, leather, many metals and organic compounds.
- Upon reaction with metals, hydrogen gas is formed.
- It must be packaged, used and stored in polyethylene, polypropylene, or Teflon containers.
Types of Exposure to HF

- Liquid Exposure (splashing or spills) Pulmonary effects can result even from splashes on the skin.

- Vapor Exposure can cause damage to the skin, eyes, and respiratory systems. HF causes severe, deeply penetrating burns to the skin, eyes, and lungs. Although concentrated acid is readily perceived by a burning sensation, more dilute solutions are often imperceptible for many hours. This potential time delay between exposure recognition and treatment can lead to insidious and difficult to treat burns.
Health Effects

The initial extent of the burn depends on the concentration, temperature, duration of contact, and quantity of the acid.

- HF is irritating to the skin, eyes, and mucous membranes, and inhalation may cause respiratory irritation or hemorrhage.
- Systemic effects can occur from all routes of exposure and may include nausea, vomiting, gastric pain, or cardiac arrhythmia.
- Symptoms may be delayed for several days, especially in the case of exposure to dilute solutions (< 20%).
- The systemic effects of HF are due to increased fluoride concentrations in the body which can change the levels of Ca, Mg, and K in the blood.
- Hypocalcemia can cause tetany, decreased myocardial contractility, and possible cardiovascular collapse while hyperkalemia may cause V Fib.
Toxicological Properties

- The toxic effects of HF are due primarily to the fluoride ion, which is able to penetrate tissues and bind intracellular calcium and magnesium. This results in cell destruction and local bone demineralization.
Dermal Exposure

- Acid concentrations of more than 50% cause immediate severe, throbbing pain and a whitish discoloration of the skin, which usually forms blisters.

- HF solutions from 20-50% may produce pain and swelling, which may be delayed up to 8 hours.

- HF solutions < 20% cause almost no immediate pain on contact but may cause delayed serious injury 12-24 hours later.

- If an individual is exposed to Hydrofluoric Acid, they must seek medical attention IMMEDIATELY, even if they do not feel pain.
Why is HF Different Than Other Acids?

- HF treatment for exposure is not limited to simply washing off the skin.
- HF is readily absorbed into the skin with deep tissue destruction.
- HF binds to the Calcium and Magnesium in the body to form insoluble salts.
  - Insoluble salts interfere with cellular metabolism causing cellular death and necrosis.
How Do We Protect Ourselves from HF Exposure?

- PPE is not a substitute for safe work practices.
- HF must ALWAYS be used in a fume hood. Eye protection with safety glasses or goggles and a face shield should be used.
- 22 mil gloves made of Neoprene, Nitrile, or Viton should be worn.
- Acid resistant apron strongly recommended
- Warning sign indicating the use of HF should be posted.
Before beginning work with HF, an exposure kit must be available and located near the lab area.

- Calcium Gluconate Gel
- 2 pairs of protective gloves
- Heavy duty polyethylene bag or container to be used for materials contaminated with HF
- MSDS
Prehospital Management

- Patients exposed only to HF gas or vapor do not pose substantial risks of secondary contamination to the rescuer. However, patients whose clothing or skin is contaminated with HF liquid, solution or condensed vapor can secondarily contaminate response personnel by direct contact.

- Rapid decontamination is critical.

- Victims who are able can assist with their own decontamination. Quickly remove and double bag contaminated clothing.
Treatment for Dermal Exposure to HF

- Use gloves resistant to HF
- Flush exposed area with large volumes of water while removing contaminated clothing
- Apply calcium gluconate gel (2.5%) topically to affected areas – when the gel dries to a film, rinse off, and reapply
Management of Respiratory Exposure

- BLS treatment includes O2 via nonrebreather face mask and monitoring for bronchoconstriction & pulmonary edema.

- Advanced airway management is essential as early as possible post exposure.
Information Resources

- ATSDR – Agency for Toxic Substances and Disease Registry provides extensive information on the Medical Management Guidelines (MMGs) for Acute Chemical Exposures
  www.atsdr.cdc.gov/mmg.html
Questions ???