



Occupational Toxicity: Management of Workplace Exposures

As emergency physicians expand their role into caring for workplace injuries, they will be confronted by unusual chemical exposures. Usually there are manifested by unique pulmonary and dermatologic manifestations. The lecturer will teach the recognition of such disorders, as well as the unique antidotal interventions required.

- Become familiar with workplace exposures that require special knowledge to prevent untoward outcomes.
- Recognize the unique workplace “rashes,” such as chrome holes or hydrofluoric burns, and know their “antidotes.”
- Discuss the various causes of occupational reactive airway disease, including metal fume fever and chlorine exposures.
- Realize the systemic danger that accompanies potentially lethal gas exposures, including arsine, carbon disulfide, phosgene, phosphine, and cadmium fumes.

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FACULTY

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Occupational Toxicology

Management of Workplace Exposures

The 1999 ACEP Scientific Assembly, Las Vegas

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Course Description

As emergency physicians expand their role into caring for workplace injuries, they will be confronted by unusual chemical exposures. Usually these are manifested by unique pulmonary and dermatologic manifestations. The lecturer will teach the recognition of such disorders, as well as the unique aspects of decision-making, diagnostic testing and interventions required.

Objectives

- Become familiar with workplace exposures that require special knowledge to prevent untoward outcomes.
- Recognize the unique workplace "rashes," such as hydrofluoric acid, and know their treatments.
- Become familiar with the resources available to assist in decision-making.
- Discuss the various causes of occupational lung disease.
- Realize the systemic danger that accompanies potentially lethal gas exposures.
- Learn the most useful antidotal and supportive therapies required in toxic occupational exposures.

Special Rules of Occupational Toxicology

- **What is the Difference between hazard and risk?**

Hazard is the tiger in the cage at the zoo.

Risk is you inside the cage with the tiger.

DEFINITION of a Hazardous Chemical

"Any substance which jumps out of its container when something goes wrong and hurts or harms the things it touches."

LUDWIG BRENNER'S Former hazmat specialist with the national transportation safety board

- **The cause and effect from a workplace exposure is never clear cut.**

A patient's toxic exposure is the sum total and interaction with all exposures in the world of toxicology: workplace exposures, hobbies, environmental exposures, food, water, indoor air, medications, health food supplements, performance enhancers

- **The DOSE makes the POISON**

The dose is the total amount of chemical absorbed by the patient during an exposure

It can be estimated from various information available

It depends mostly on the concentration of the chemical

AND duration of the exposure

Other factors: route of exposure, absorption characteristics of the chemical (e.g. lipid soluble chemicals tend to be more readily absorbed by the skin) and the site of the exposure (e.g. enclosed space versus outdoors)

Dose-response relationship varies as a function of time

The same dose administered over a longer duration will cause less severe effects than if administered over a shorter period of time.

Higher concentrations over a shorter duration is more likely to produce adverse health effects than lower concentrations over longer exposure periods.

Duration of exposure may be limited by *warning properties*

- **You are a public health physician. Sentinel Health Event**

Disease suggestive of chemical hazard

Recognition and action will *PREVENT*:

Further exposure to patient

Additional patient exposures

Environmental and Workplace exposures need further investigation. Others are at RISK!

- **If the patient does not already have a lawyer, They Will!**

Legal Issues predominate in occupational exposure issues. Document carefully.

- **The public wants zero risk from chemical exposure. Psychologic harm from a chemical exposure is Harm.**

Rules of Recognizing Occupational Poisonings

- The Most Important Question to Ask:
 “What Do You Do for a Living?”
 - Recognizing occupational exposures requires some detective work
Clues to the Presence of Chemical Exposures in the Workplace
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Type of work

Chemical manufacturing plant operator
Hazardous waste site crew
Pipeline
Agricultural work
Transportation of hazardous chemicals
(cropduster pilot)

Type of Incident

Fire
Explosion
Ruptured tank
Spills
Enclosed space accidents
Structural collapse

Findings at the Incident

Vapor clouds
Dead animals, insects or fish
Multiple people with similar complaints
Rescue from enclosed spaces

Chemical odors

Patient Findings

Unexplained unconsciousness in otherwise healthy person
Unexplained cardiac arrest in otherwise healthy person
Strong odors on clothes, skin or breath
Unidentified liquids or particulates on skin or clothing
Chemical burns
Irritation of the eyes, mucous membranes or skin
Methemoglobinemia

- **Know the Common Presentations of Occupational Exposures**
 - Contact and allergic dermatitis
 - Mucous membrane irritation
 - Occupational asthma
 - Odor intolerance/ Solvent syndrome
 - Multiple chemical sensitivities
 - Systemic effects

- Know the Toxic Syndromes from Acute Occupational Exposures

| Toxic Syndrome | Common Signs and Symptoms | Examples |
|--------------------------------|--|---|
| Chemical burns | Painful, burning skin, mucous membrane irritation, Systemic toxic effects | Acid or alkaline corrosives, hydrofluoric acid, phenol, hydrocarbon solvents |
| Irritant gas syndrome | Mucous membrane irritation, coughing, dyspnea, acute bronchospasm, pulmonary edema, noncardiogenic | Ammonia, chlorine, isocyanates, acrolein, sulfur dioxide, hydrogen chloride |
| Acute solvent syndrome | Mucous membrane irritation, headache, lightheadedness, dizziness, nausea, chest tightness, dyspnea, dysrhythmias, lethargy, confusion, coma | Xylene, toluene, benzene, isocyanates, methyl bromide, methylene chloride, aliphatic hydrocarbons |
| Methemoglobinemia | Cyanosis unresponsive to oxygen therapy Headache, lightheadedness, dizziness, nausea, chest tightness, dyspnea, dysrhythmias | Aniline, nitrogen oxides, amyl nitrite, chlorates, dinitrophenol |
| Acetylcholinesterase poisoning | Pinpoint pupils and eye pain, dyspnea, bronchospasm, pulmonary edema, muscle weakness, coma, seizures, tachycardia or bradycardia, diaphoresis, salivation, lacrimation, vomiting, diarrhea, abdominal cramps, | Nerve agents: sarin, soman, tabun, VX, organophosphate and carbamate insecticides |
| Metabolic Poisoning | Early or low level exposure: nausea, vomiting, headache, dizziness Coma, seizures, syncope, Dysrhythmias, hypotension, Metabolic acidosis 'Knocked down' - cardiac arrest | Cyanide, hydrogen sulfide, azides, phosphine, carbon monoxide |
| Delayed toxic effects | Pulmonary edema, noncardiogenic Hepatic injury Renal injury | Arsine, chlorine, ethylene oxide, methyl bromide, nitrogen oxides, phosgene, phosphine carbon tet, 2-nitropropane cadmium |
| Psychogenic illness | Headache, faintness, dizziness, nausea, chest tightness, weakness, extremity numbness, dyspnea or hyperventilation, mucous membrane irritation | Often indistinguishable from many serious toxic exposures |

- **KNOW the BAD ONES**

Dermal Toxins to Fear

- Aniline dyes
- Arsenic
- Benzene
- Hydrofluoric Acid
- Mercury Compounds
- Organic Solvents
- Organophosphate Insecticides
- Phosphorus
- Phenols

Inhalation Toxins to Fear

Irritants

- Phosgene/ Oxides of Nitrogen
- Hydrogen Fluoride
- Chlorine/Ammonia/Acrolein

Systemic Poisons

- Hydrogen sulfide/ Hydrogen cyanide
- Hydrocarbon Solvents/ Carbon disulfide
- Organophosphate Insecticides
- Arsine/phosphine
- Heavy metals/ Arsenic, mercury, lead, cadmium, etc.

Rules of Protection from Occupational Toxins

- Know the ways to become ill from a chemical exposure
 - Touch the BAD stuff
 - Breath the BAD air

Personal Protective Equipment



EYE protection

RESPIRATORY protection

SKIN protection

Rules of Information Retrieval

- **Very Important Questions to ask**

How can this exposure affect me or my department?

What is the name of the suspected chemical?

Does this chemical pose a risk of secondary contamination?

What is the dose?

What is the clinical significance of the estimated dose?

What are the anticipated toxic effects of the chemical?

Is there a specific treatment or antidote?

Are there delayed or long-term effects?

What is the dose and the clinical significance of the estimated dose?

Data from the patient:

Concentration

Time of Exposure

Warning properties can be clues to the extent of exposure

Concentration at which a chemical's odor can be detected or irritant symptoms occur

Caution: Do not rely on detection of odors alone in order to estimate the potential exposure.

Some toxins have a detectable odor or cause irritant symptoms only after exposure to extremely high concentrations that may cause other serious toxic effects (e.g. phosgene)

Hydrogen sulfide will cause olfactory nerve paralysis as air concentrations rise to lethal levels.

- **There are lots of numbers out there. What do they mean?**

Understanding Regulatory Toxicology

Sources of Knowledge for Toxic Effects from Chemical Exposure

Chemical Structure

Physiologic Rationale

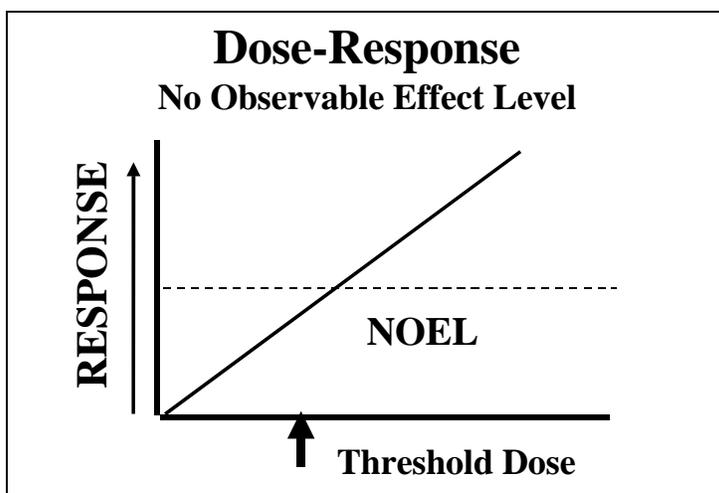
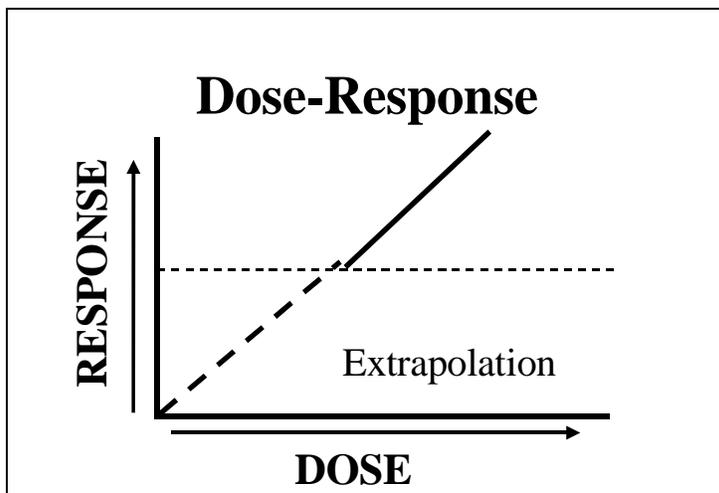
Animal Studies

Human Volunteer Studies

Case Reports of Accidents and Exposures

Epidemiologic Studies of Exposed Populations

Randomized Controlled Trials



Workplace Exposure Terms Used to Estimate Chemical Exposure

PEL: Permissible exposure level (OSHA). An 8-hour time weighted average (TWA) chemical concentration in air that cannot be exceeded. Same as threshold limit value (TLV-TWA) used by the American Congress of Governmental Industrial Hygienists (ACGIH).

Ceiling Limit: A chemical's airborne concentration that can never be exceeded.

IDLH: Immediately Dangerous to Life and Health. A chemical's concentration that poses immediate threat to life, or causes irreversible or delayed effects, or compromises ability to escape the environment.

STEL: Short Term Exposure Level - A 15 minute TWA that should not be exceeded at any time during the work day.

What are the anticipated toxic effects of the chemical?

Despite published research, the human health risks of many chemicals remain uncertain.

The reliability of hazard information varies among the many resources.

Potential toxic effects should be anticipated from those chemicals with little or no documented toxicity.

Resources for Health Risk Information

Material Safety Data Sheets

Material Safety Data Sheets (MSDS) are a good source for chemical identification, but information regarding human health effects is often incomplete or inaccurate. Inert ingredients listed on the MSDS may actually be toxic to humans, even though they are inert when the products are used as intended. Regional poison centers and medical toxicologists are often the most reliable resources for up-to-date human health risk information and specific treatment recommendations.

Computer Data Bases and Internet Connections (a few examples)

Poisindex/Tomes

Hazardous Substance Data Bank (HSDB)

Chemical Hazard Response Information System (CHRIS)

Toxicology Data Network (TOXNET)

National Library of Medicine (Medline)

ATSDR Web Site: <http://atsdr1.atsdr.cdc.gov:8080/atsdrhomr.html>

EPA Home Page: <http://www.epa.gov/epahome/>

TOXICON: Medical Toxicology Online: <http://toxicon.uh.uic.edu/toxicon/>

Vermont SIRI MSDS Collection: <http://hazard.com/msds>

Reference Texts

Agency for Toxic Substance and Disease Registry. *Managing Hazardous Materials Incidents. Volume 3, Medical Management Guidelines for Acute Chemical Exposures.* 1994.

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Goldfrank, Flomenbaum, Lewin, et al: Goldfrank's Toxicologic Emergencies. Appleton and Lange, 1999.

Haddad, Winchester and Shannon: Clinical Management of Poisoning and Drug Overdose, Saunders Company, 1998.

Klaassen CD: Casarett and Doull's Toxicology: The Basic Science of Poisons. MacMillan, 1996

Rom WN: Environmental and Occupational Medicine. Little, Brown and Company, 1992

Sullivan JB and Krieger GR: Hazardous Materials Toxicology: Clinical Principles of Environmental Health. Williams and Wilkins, 1992

Agencies with Telephone Hotlines

Regional Poison Centers

County and State Health Departments

Agency for Toxic Substances and Disease Registry (ATSDR) 1-404-639-0615

Chemical Transportation Emergency Center (CHEMTREC) 1-800-424-9300

Environmental Protection Agency (EPA) - Contact regional office

Clues and Information from the Laboratory Evaluation

- Perform a focused laboratory evaluation
- Monitoring vs Acute Exposure evaluation
 - Problem: Never have baseline measurements in acute exposures
- Measuring toxin vs toxin's effect
 - Pesticide Metabolite in Urine
 - Acetylcholinesterase Activity
- Biologic Markers

Rules for Treating Occupational Poisoning

General Concepts of Treatment

- Take Corrective Action to Prevent Further Exposure
- Medical Treatment with Proven Therapies for Confirmed Exposures
- Treat Psychological Harm
- Surveillance

The most important treatment step is to simply STOP any further exposure
If something BAD is on patient – GET IT OFF!
If something BAD is around patient – GET HIM AWAY FROM IT!

Reasons for Decontamination

- Prevent further exposure of the patient to the toxin
- Prevent the spread of toxins into the hospital

Rapid decontamination

- Clothing removal (acts like an occlusive dressing)
- Copious water irrigation

Examples of Antidotes for Acute Workplace Exposures

| <u>ANTIDOTE</u> | <u>TOXIN</u> |
|-----------------------------|---------------------------------------|
| Cyanide Antidote Kit | Cyanide |
| Methylene Blue | Methemoglobin Inducers |
| Atropine/Pralidoxime | Organophosphates/Carbamates |
| Chelators (BAL, DMSA, EDTA) | Heavy Metals (Lead, Mercury, Arsenic) |
| Calcium | Hydrofluoric Acid |

Examples of Treatments for Cutaneous Exposures

| <u>TREATMENT</u> | <u>TOXIN</u> |
|----------------------------------|--|
| Ascorbic Acid | Chromium |
| Polyethylene glycol/ Isopropanol | Phenol |
| Moistened Gauze | White Phosphorus |
| Mineral Oil | Elemental Metals (e.g., Lithium, Sodium) |
| Calcium | Hydrofluoric Acid |

- **Treatment of Occupational Exposures: Psychological Harm
Patient's Perception is Reality**

- Patient may have misperception about events
- A patient's BELIEF has greater influence than any FACT
- Perceptual Bias
 - Odor
 - Preconceived notions - Media influence
- What you say and how you act IS important!
 - "You are going to die"
 - "I don't know"

Doctor-Patient Relationship

- WIN-LOSE
 - Doctor "Your Faking"
 - Patient "You think it is all in my head"
- WIN-WIN
 - Do not spend time with PROOF of Cause and Effect
 - Get patient back to functioning in life
 - Rule out treatable causes
 - Document in detail (Likely to be medicolegal case)

Selected Readings

- Managing Hazardous Materials Incidents. Volume 3, Medical Management Guidelines for Acute Chemical Exposures. Washington, DC: Agency for Toxic Substance and Disease Registry, US Department of Health and Human Services, 1994.
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