Chapter 57
Hazardous Materials Awareness

Learning Objectives

• Define hazardous materials terminology.
• Identify legislation about hazardous materials that influences emergency health care workers.
• Describe resources to assist in identification and management of hazardous materials incidents.
Learning Objectives

• Identify the protective clothing and equipment needed to respond to selected hazardous materials incidents.
• Describe the pathophysiology and signs and symptoms of internal damage caused by exposure to selected hazardous materials.
• Identify the pathophysiology, signs and symptoms, and prehospital management of selected hazardous materials that produce external damage.

Learning Objectives

• Outline the prehospital response to a hazardous materials emergency.
• Describe medical monitoring and rehabilitation of rescue workers who respond to a hazardous materials emergency.

Learning Objectives

• Describe emergency decontamination and management of patients who have been contaminated by hazardous materials.
• Outline the eight steps to decontaminate rescue personnel and equipment at a hazardous materials incident.
Scope of Hazardous Materials

- Hazardous material defined as “any substance or material capable of posing an unreasonable risk to health, safety, and property”
  - More than 50 billion tons of hazardous materials are made in U.S. each year
  - About 2 billion tons are shipped within U.S.
  - From 1998 to 2007, U.S. Department of Transportation (DOT) reports there were 141 hazmat transportation-related fatalities, roughly 14 per year
    - Of these, 124 deaths were on highways and 17 were rail-related

Scope of Hazardous Materials

- Emergency responses to vehicular crashes are common
  - Potential for exposure to hazardous materials is great
  - Other possible causes of hazardous materials incidents
    - Mishaps in storage of materials and manufacturing operations
    - Illicit drug manufacturing (e.g., “meth labs”)
    - Acts of terrorism

Consider the industries in your area. Do any of these have the potential for a hazardous materials exposure?
Scope of Hazardous Materials

• Injury or illness can also result from exposure to
  – Household chemicals
  – Pesticides
  – Industrial toxins

Scope of Hazardous Materials

• The following statistics emphasize importance of EMS personnel knowing how to manage hazardous materials exposure
  – About 9000 deaths occur each year from exposure to poisonous solids, liquids, gases
  – Estimated 100,000 industrial workers are exposed to respiratory irritants each year
  – Pesticide poisoning accounts for more than 3000 hospitalizations each year
  – Most fire-related deaths result from inhalation of toxic products of combustion

Laws and Regulations

• In recent years, much focus has been placed on handling of hazardous materials
  – Major incidents have attracted attention of employee and citizen groups
  – Have drawn attention of local, state, and federal officials
Laws and Regulations

• In recent years, much focus has been placed on handling of hazardous materials
  – Examples of incidents
    • Union Carbide disaster in Bhopal, India (1984)
    • Chernobyl nuclear accident in Soviet Union (1986)
    • Three Mile Island incident in United States (1979)
    • Criticality accident in Tokaimura, Japan (1999)
    • Threats and acts of bioterrorism (e.g., sarin gas attack on Tokyo subways in 1995)
    • Anthrax attacks in United States (2001)
    • Need for proper disposal of hazardous wastes

Laws and Regulations

• Superfund Amendments and Reauthorization Act (Superfund Act) of 1986
  – Established requirements for federal, state, and local governments and industry regarding emergency planning and reporting of hazardous materials-related incidents
  – Intended to help communities better manage chemical emergency
  – Helped increase public knowledge about hazardous materials in communities
  – Helped to improve public access to this information

Laws and Regulations

• Superfund Amendments and Reauthorization Act (Superfund Act) of 1986
  – Required owners and operators of facilities using or storing any of extremely hazardous substances identified by EPA to notify
    • Local fire department
    • Local emergency planning committee
    • State emergency response commission
Laws and Regulations

• In 1989, OSHA and EPA published rules for workers at uncontrolled hazardous waste sites and those responding to hazardous chemical releases or spills
  – Govern training requirements
  – Emergency plans
  – Medical checkups
  – Other safety precautions

Laws and Regulations

• Superfund Act mandates that states adopt these rules
  – Training requirements apply to five groups of persons who may respond to emergency that involves hazardous materials

Laws and Regulations

• National Fire Protection Association (NFPA) has published standards that address competencies for EMS personnel at hazardous materials (hazmat) scenes
  – According to these standards, paramedics who transport patients who pose no risk of secondary contamination must be trained to NFPA standard 473 Level I
  – Paramedics who may have to decontaminate rapidly or assist in decontamination area must be trained to NFPA standard 473 Level II
Identification of Hazardous Materials

- At center of dealing with hazardous materials is identifying substance
  - Two methods used to identify such materials are informal product identification and formal product identification

Informal Product Identification

- Arriving emergency personnel may be able to determine presence and type of hazardous materials at scene
- Informal methods of identification
  - Visual inspection of scene with binoculars before entering site
  - Verbal reports by bystanders or other responsible individuals
  - Occupancy type
    - Intended use of a particular structure such as fuel storage or pesticide plant

Informal Product Identification

- Informal methods of identification
  - Incident location
    - Probable location for presence of hazardous materials
  - Location within building
    - What is stored in that area
  - Visual indicators
    - Vapor clouds, smoke, leakage
  - Vehicle types
    - Named carriers or company
Informal Product Identification

• Informal methods of identification
  – Container characteristics
    • Size
    • Shape
    • Color
    • Deformed containers
  – Senses
    • Peculiar smell reported by bystanders

Informal Product Identification

• Informal methods of identification
  – Signs and symptoms of victims of exposure
  – Informal ways to identify product should be used as quick means to determine presence of any hazardous materials
    • Always identify product formally before taking any action that may pose threat to safety of all responders

Formal Product Identification

• Traditionally, hazardous materials have been labeled by one or more of following six systems
  – American National Standards Institute uses label to identify specific hazard rather than specific chemical
    • Explosives
    • Flammable liquids
    • Radioactive materials
Formal Product Identification

• Traditionally, hazardous materials have been labeled by one or more of following six systems
  – U.S. Department of Transportation (DOT) uses labels and placards with pictographs and printed hazard categories
    • Requires specific information on shipping manifests
  – United Nations Labeling System uses pictographs, symbols, or both, similar to those used by DOT, to identify specific hazard rather than specific chemical
  – International Air Transport Association uses United Nations pictographs and indicates written emergency precaution measures in case of incident

Formal Product Identification

• Traditionally, hazardous materials have been labeled by one or more of following six systems
  – National Fire Protection Association uses color and numerical rating scale (NFPA 704 System) to identify degree of hazard for health, fire, and reactivity
    • Many state and local fire codes require diamond-shaped identification symbols on fixed facilities
    • Numbering system rates each category from 1 (least harmful) to 4 (most harmful)
  – U.S. Department of Labor requires material safety data sheets (also known as MSDSs) for hazardous chemicals that are stored, handled, or used in workplace
K1  Production: please take the W with the slash through it in the image on the slide and place it in the parentheses in the instructors notes below, just after the word “water”. Thank you.
Karen, 4/26/2012

K2  Karen, 4/26/2012
The next time you are on the highway, see if you can easily spot the placards on large trucks.

Placards and Shipping Papers

- Number of identification systems may be used
  - Hazardous materials usually are identified by placards and shipping papers
  - United Nations class (or division) identification number and North American number (UN/NA number) may be displayed on bottom of placard
  - Or number may be displayed on shipping paper after listed shipping name or names
  - In certain cases, class or division number may replace written name of hazard class in shipping paper description
### Placards and Shipping Papers

- Location and type of paperwork that identifies hazardous materials varies according to mode of transport
  - Most shipping papers are kept near operator (e.g., driver, pilot, or captain) of vehicle, aircraft, train, or ship
  - Several chemical agents may have same UN/NA number
    - Important to refer to specific guidelines for hazardous material by chemical name in addition to number

### Material Safety Data Sheets

- Material safety data sheets (MSDSs) are required by OSHA for each chemical produced, stored, or used in United States
  - Supplied by manufacturer
  - Contain information for safe and proper handling and storage of material
  - Have information on emergency actions to take
  - Classify potential of significant health hazards from exposure to material

### Material Safety Data Sheets

- Potential health hazard of material may be defined in number of different ways
  - May depend on degree of inherent toxicity and type of exposure
  - Provide useful information, should not be used as sole source of
    - Chemical information
    - Information on health risks
    - Treatment recommendations
  - Consult with medical direction, poison control center, or another appropriate authority
Other Information Sources

- Resources available for hazardous materials reference
  - Books
  - Telephone support through emergency hazmat agencies
  - Computer databases
  - Internet sources

Other Information Sources

- Product information should be referenced through one or more source
  - Preferably three sources should be used, if time and availability permit
  - North American Emergency Response Guidebook published by DOT
  - Transport Canada
  - Secretariat of Communications and Transportation of Mexico

Other Information Sources

- Emergency Response Guidebook lists more than 1000 hazardous materials
  - Lists basic first aid procedures for managing exposure
  - Includes names and identification numbers of substances
  - Cross-referenced in alphabetical and numerical order
  - Free reference is carried in emergency vehicles by many EMS, fire, and other public service agencies
Other Information Sources

• Emergency Response Guidebook lists more than 1000 hazardous materials
  – Designed to assist first responders with initial actions for evacuation only
  – Includes distance and area from incident that should be evacuated
  – Not stand-alone guide for dealing with hazmat emergencies

Other Information Sources

• Regional poison control centers
  – Valuable asset in any EMS system
  – Many are available 24 hours/day
  – Staffed with specialists who provide
    • Information
    • Consultation
    • Treatment recommendations
    • Patient follow-up
    • Data collection

Other Information Sources

• Regional poison control centers
  – Linked to many agencies that deal with toxic substances
  – Tied closely to all area hospitals
  – Maintain listing of more than 350,000 drugs, toxic substances, and other products
  – Universal Poison Control number is 1-800-222-1222
Other Information Sources

- Chemical Transportation Emergency Center (CHEMTREC)
  - Public service of Chemical Manufacturers Association
  - Provides immediate advice to on-scene personnel about management of known or unknown hazardous materials
  - Contacts shipper of material for more information or assistance when needed
  - Operates 24/7
  - Can be reached in U.S. & Canada toll-free number: 1-800-424-9300 (in Alaska 0-202-483-7616)

Other Information Sources

- CHEMTREC
  - Contact CHEMTREC as soon as possible during hazmat incident
  - Center should be supplied with
    - Name of substance
    - Identification number
    - Nature of problem
  - Involving CHEMTREC in management of hazmat incident is usually part of standard operating procedure of any emergency response team

Other Information Sources

- CHEMTEL, Inc., is emergency response communications center
  - Serves U.S. and Canada
  - Can provide specific product information
  - Can provide referral to proper state and federal authorities for incidents that involve radioactive material
  - Can be reached 24/7 through toll-free number: 1-800-255-3924
Other Information Sources

• Computer-aided management of emergency operations (CAMEO)
  – Assist emergency responders quickly in management of hazmat incidents
  – Available to municipalities
  – Uses computer modeling to predict effects of chemical spills and toxins released in plumes of smoke
  – Helps communities prepare emergency response plans
  – Provides information on more than 6,000 chemicals
  – Contains more than 80,000 chemical synonyms and identification numbers that can be quickly searched to identify unknown substances during an incident

Other Information Sources

• Internet sources for hazmat identification and management
  – Federal, state, and local governmental agencies
  – Colleges and universities
  – Businesses and industry
  – Trade associations
  – Non-profit groups that have established easily accessible websites

Personal Protective Clothing and Equipment

• Potential for injury from exposure to hazardous materials is related to toxicity, flammability, reactivity of particular substance
  – Use of right protection is crucial for anyone dealing with hazardous materials
  – Includes use of proper respiratory protection and personal protective equipment (PPE)
Protective Respiratory Devices

• Potential for exposure of respiratory system to hazardous materials is of paramount importance to emergency responder
  – Respiratory system can be protected by air purification devices and by equipment that supplies clean air (atmosphere supplying device)

Protective Respiratory Devices

• Air purification relies on respirators or filtration devices
  – Remove particulate matter, gases, or vapors from atmosphere
  – Do not use separate source of air
  – Require constant monitoring for contaminants and oxygen levels
  – Not recommended for use in hazardous materials release and must be fitted to wearer
  – Filtration devices are material specific (“must match gas”)
  – Not used in presence of multiple types of chemicals
  – Cannot be used in environment with low oxygen concentration

Protective Respiratory Devices

• Atmosphere-supplying devices rely on separate source of positive pressure to supply air
  – Provide highest level of respiratory protection.
  – Two basic types available
    • Self-contained breathing apparatus (SCBA)
    • Supplied-air breathing apparatus (SABA), or air lines
  – Use of either requires training, recertification, proper fit-testing as governed by regulations from OSHA
Protective Respiratory Devices

• SCBAs
  – Provide respiratory protection in oxygen-deficient and toxic atmospheres
  – Only SCBAs that maintain positive pressure in face piece during inhalation and exhalation should be used when working with hazardous materials
  – Considered excellent protection in hazardous environments
  – Rescuer should be aware of potential face piece penetration and contamination by certain toxic substances
    • Methyl bromide
    • Telone (1,3-dichloropropene and chloropicrin)
    • Ethyleneimine

• SABA
  – Supplies air to rescuer via air line hose away from scene
  – Used at hazardous material sites when extended working times are required
  – Must have escape capability for operations in atmospheres classified as immediately dangerous to life and health

• Respiratory protection devices that combine SCBAs and air line hose units are available
  – Because of their dependence on air supply via line, limit distance entry personnel can enter into contaminated area (hot zone)
Classifications of Protective Clothing

- Protective clothing is categorized in two ways:
  - Disposable or reusable
    - Made from a variety of materials designed specifically for certain chemical exposures
    - Training in use of this clothing should take place in a safe environment before used at emergency scenes
    - Examples of this material:
      - Tyvek/Saranex
      - Nitrile rubber
      - Teflon
      - Viton

- No single material is compatible with all chemicals:
  - Manufacturer’s guidelines and recommendations must be followed
  - OSHA and EPA classifications follow

- Level A
  - Provides highest level of skin, respiratory, and eye protection
  - Equipment typically is used by hazmat teams for entry into incident site
    - Positive-pressure (pressure demand), full face piece SCBA or positive-pressure supplied air respirator with escape SCBA, approved by NIOSH
    - Totally encapsulating (gastight) chemical protective suit
    - Coveralls and long underwear (optional)
    - Outer and inner gloves that are chemical resistant
Classifications of Protective Clothing

• Level A
  – Equipment typically is used by hazmat teams for entry into incident site
    • Undersuit hard hat (optional)
    • Disposable protective suit (including gloves and steel-toed boots) that may be worn over totally encapsulating suit
    • Unless specified by manufacturer, these disposable suits are not to be worn in flammable atmospheres

Classifications of Protective Clothing

• Level B
  – Provides highest level of respiratory protection
  – Provides lower level of skin protection
  – Protection typically worn by decontamination team
Classifications of Protective Clothing

- Level B
  - Equipment
    - Positive-pressure, full-face piece SCBA or positive-pressure supplied air respirator with escape SCBA (NIOSH approved)
    - Hooded, chemical-resistant clothing (overalls, long-sleeved jacket, coveralls, one- or two-piece chemical splash suit, disposable chemical overalls)
    - Coveralls (optional)
    - Inner and outer chemical-resistant gloves
    - Chemical-resistant boots with steel toe and shank
    - Outer chemical-resistant boot covers (optional)
    - Optional hard hat and face shield

Classifications of Protective Clothing

- Level C
  - Used during transport of contaminated patients
  - Used when concentration and type of airborne substance (or substances) is known and criteria for using air-purifying respirators are met
Classifications of Protective Clothing

<table>
<thead>
<tr>
<th>Level C</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Full face or half mask air-purifying respirators (NIOSH approved)</td>
<td></td>
</tr>
<tr>
<td>• Hooded, chemical-resistant clothing (overalls, two-piece chemical splash suit, disposable chemical-resistant overalls)</td>
<td></td>
</tr>
<tr>
<td>• Coveralls (optional)</td>
<td></td>
</tr>
<tr>
<td>• Outer and inner chemical-resistant gloves</td>
<td></td>
</tr>
<tr>
<td>• Outer chemical-resistant boots with steel toe and shank (optional)</td>
<td></td>
</tr>
<tr>
<td>• Disposable outer chemical-resistant boot covers (optional)</td>
<td></td>
</tr>
<tr>
<td>• Optional escape mask and face shield</td>
<td></td>
</tr>
</tbody>
</table>

Classifications of Protective Clothing

<table>
<thead>
<tr>
<th>Level D</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Work uniform that affords minimal protection</td>
<td></td>
</tr>
<tr>
<td>• Used for nuisance contamination only</td>
<td></td>
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<tr>
<td>• Protection commonly is known as firefighter “turnout” gear</td>
<td></td>
</tr>
<tr>
<td>• Turnout gear with SCBA may be considered level B protection for some chemicals that do not pose danger for skin contact or absorption</td>
<td></td>
</tr>
</tbody>
</table>

Classifications of Protective Clothing

<table>
<thead>
<tr>
<th>Level D</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Coverall</td>
<td></td>
</tr>
<tr>
<td>• Optional gloves</td>
<td></td>
</tr>
<tr>
<td>• Chemical-resistant boots or shoes with steel toe and shank</td>
<td></td>
</tr>
<tr>
<td>• Disposable outer chemical-resistant boots (optional)</td>
<td></td>
</tr>
<tr>
<td>• Safety glasses or chemical splash goggles</td>
<td></td>
</tr>
<tr>
<td>• Optional hard hat, escape mask, and face shield</td>
<td></td>
</tr>
</tbody>
</table>
What types of patient care do you think you will be able to provide when wearing each of the levels of hazardous materials protective gear?

Classifications of Protective Clothing

- The following points should be of concern to any rescuer involved in hazmat response
  - Protective clothing should not be affected adversely by hazardous materials involved
  - Protective clothing should seal all exposed skin
  - Contact with hazardous materials should be of absolute minimal duration required
  - Protective clothing and equipment should be decontaminated/discarded properly
Classifications of Protective Clothing

• The following points should be of concern to any rescuer involved in hazmat response
  – Safety standards and methods for cleaning and disposing of clothing and equipment should be followed strictly
  – Contaminated patient clothing should be left at scene for proper and safe disposal
    • Should not be transported with patient
    • Will limit contamination of ambulance

Health Hazards

• Hazardous materials may enter human body by
  – Inhalation
  – Ingestion
  – Injection
  – Absorption

• Entry by means of any of these routes may result in internal and external damage to rescuer
  – Exposure to dangerous substances may affect body in several different ways
    • May produce numerous injuries or illnesses

Health Hazards

• Exposure to poisons can produce
  – Acute toxicity
  – Delayed toxicity
  – Local and systemic effects
Health Hazards

- How body responds depends on concentration of chemical to which body is exposed
  - Also called dose response
- Be aware that drug treatment can result in synergistic effects
  - Effects of one chemical enhancing effects second chemical
  - All treatment methods must be guided by medical direction, poison control center, or other appropriate authority

Internal Damage

- Internal damage to human body from exposure to hazardous materials may involve
  - Respiratory tract
  - CNS
  - Other internal organs
- Some substances injure all cells on contact
  - Others have more direct effect on specific organs (target organs)

Internal Damage

- Depending on hazardous materials, physical injury may vary
  - May range from minor irritation to more serious complications
    - Cardiorespiratory compromise
    - Death
    - Chronic illness
    - Cancer
Internal Damage

- Some substances can cause abnormal fetal development and changes in gene structure
  - Penetrating radiation can lead to cell and chromosomal changes
    - Can cause genetic changes, cell death, sterility

Irritants

- Common complaint of rescuers and patients exposed to hazardous materials
  - Chemical irritants emit vapors that affect mucous membranes of body
    - Surfaces of eyes, nose, mouth, throat
  - As irritants combine with moisture, acidic or alkaline reactions may occur
  - Exposure may result in damage to upper, lower, deep respiratory tract
  - Chemical irritants include hydrochloric acid, halogens, ozone

Irritants

- Self-defense chemical sprays used by some civilians and law enforcement officers are common and can present hazard to responders
  - Sprays are irritants and produce excessive tearing of eyes
    - Chloroacetophenone
    - Orthochlorobenzalmalononitrile
    - Capsicum oleoresin (pepper spray)
Asphyxiants

- Gases that displace oxygen in air and dilute oxygen concentration of air
  - Simple asphyxiants
    - Carbon dioxide
    - Methane
    - Propane

- Blood poisons or chemical asphyxiants
  - Gases not only displace oxygen in air but also interfere with tissue oxygenation
  - Tend to interrupt transport or use of oxygen by tissue cells
  - Through various mechanisms, toxic gases deprive body tissue of needed oxygen
    - Hydrogen cyanide
    - Carbon monoxide
    - Hydrogen sulfide

Nerve Poisons, Anesthetics, and Narcotics

- Nerve poisons, anesthetics, and narcotics act on nervous system
  - Agents affect either cardiorespiratory mechanisms of brain or ability to transmit impulses required for adequate heart and lung function
Nerve Poisons, Anesthetics, and Narcotics

• Nerve poisons were developed by military
  – Often referred to as war gases, nerve gases, nerve agents
  – Similar substances are used in solid pesticides
  – Exposure to these chemicals may result in fatal complications
  – Examples of these poisons
    • Carbamates
    • Organophosphates
    • Prathion
    • Malathion

Nerve Poisons, Anesthetics, and Narcotics

• Nerve poisons were developed by military
  – Anesthetics and narcotics are less hazardous than nerve poisons
  – Continuous exposure or exposure to large concentrations may result in unconsciousness or death
  – Examples
    • Ethylene
    • Nitrous oxide
    • Ethyl alcohol

Hepatotoxins

• Substances that damage liver
  – Poisons accumulate in body and destroy ability of liver to function
  – Examples
    • Chlorinated and halogenated hydrocarbons
Cardiotoxins

- Hazardous materials that can cause myocardial ischemia and dysrhythmias
  - Examples
    - Some nitrates
    - Ethylene glycol

Cardiotoxins

- Acute MI and sudden death have been reported in healthy young persons who were exposed to these substances
  - Short-term exposure to fluorocarbons and other halogenated hydrocarbons also known to cause cardiac abnormalities

Nephrotoxins

- Hazardous materials that are especially destructive to kidneys
  - Examples
    - Carbon disulfide
    - Lead
    - High concentrations of organic solvents
    - Inorganic mercury
  - Exposure to carbon tetrachloride used as solvent for dry cleaning or fire-extinguishing agent can damage kidneys
Neurotoxins

- Poisons affect nervous system
  - Neurological and behavioral toxicity may result from exposure to hazardous substances such as
    - Arsenic
    - Lead
    - Mercury
    - Organic solvents
  - In some cases, cerebral hypoxia may occur as result of decreased oxygen in blood

Hemotoxins

- Hazardous substances that may cause destruction of red blood cells
  - Destruction can result in hemolytic anemia
  - Substances that can produce hemolytic anemia
    - Aniline
    - Naphthol
    - Quinones
    - Lead
    - Mercury
    - Arsenic
    - Copper
  - Pulmonary edema and cardiac and liver injury also may be caused by hemotoxin exposure

Carcinogens

- Carcinogens are cancer-causing agents
  - Many hazardous materials are carcinogenic or are suspected carcinogens
  - Exact amount of hazardous materials exposure required for cancer to develop is unknown
    - Short-term exposure to specific agents is known to produce long-term effects
    - Disease and complications have been reported 20 years after exposure to hazardous materials
Carcinogens

- Of particular interest to rescuers involved in firefighting is that all fossil and organic fuels when burned produce dioxins
  - Dioxin is a general term that describes a group of hundreds of chemicals highly persistent in the environment
  - Chemicals are unintentional byproduct of many industrial processes
  - Many dioxins are carcinogens

Carcinogens

- Positive-pressure SCBA is most important piece of protective equipment to protect against these carcinogenic vapors and respiratory poisons
  - All rescuers should avoid exposure to smoke or clouds of fumes as standard practice in scene safety

General Symptoms of Exposure

- Health effects from exposure to hazardous materials vary by individual
  - Depend on
    - Chemical involved
    - Concentration of chemical
    - Duration of exposure
    - Number of exposures
    - Route of entry
    - Age
    - Gender
    - General health
    - Allergies
    - Smoking habits
    - Alcohol consumption
    - Medication use
General Symptoms of Exposure

- Various symptoms may result from exposure to hazardous materials
  - Some may be delayed or masked by common illnesses such as influenza or by smoke inhalation

General Symptoms of Exposure

- If any of following symptoms present after exposure to hazardous materials, seek immediate medical attention
  - Changes in skin color or blushing
  - Chest tightness
  - Confusion, light-headedness, anxiety, dizziness
  - Coughing or painful respiration
  - Diarrhea and involuntary urination or defecation (or both)
  - Dim, blurred, or double vision; photophobia

General Symptoms of Exposure

- If any of following symptoms present after exposure to hazardous materials, seek immediate medical attention
  - Loss of coordination
  - Nausea, vomiting, abdominal cramping
  - Salivation, drooling, rhinorrhea
  - Seizure
  - Shortness of breath, burning of upper airway
  - Tingling or numbness of extremities
  - Unconsciousness
Two rescuers complain of similar symptoms on the scene of a rescue that may involve hazardous materials. What actions should be taken immediately?

External Damage

- Body surface tissue may be injured by hazardous materials
  - Many substances have corrosive properties or become corrosive when mixed with water
  - Exposure to substances may produce chemical burns and severe tissue damage
  - Examples
    - Hydrochloric acid
    - Hydrofluoric acid
    - Caustic soda

Soft Tissue Damage

- Corrosives are acids or bases (alkaline)
  - Exposure to either may cause pain on contact
  - Alkalis generally burn more extensively than acids
  - Exposing human tissue to base corrosive such as lye may result in liquefaction (a breakdown of fatty tissue) that produces a greasy or slick feeling to skin
  - Signs should alert rescuer to decontaminate immediately and seek medical attention
  - Unless substance is identified, decontamination should begin by brushing off dry powder and flushing skin with copious amounts of water
Soft Tissue Damage

- Paramedics should never try to neutralize an acid or base
  - Could produce great heat and cause further burns
  - Area should be flushed copiously with water
  - Patient should be transported for care
  - Rescuers should be aware of possible "off-gassing" or fumes resulting from decontamination of wound site and take appropriate protective measures

Soft Tissue Damage

- Cryogenics
  - Refrigerant liquid gases that can freeze human tissue on contact
  - Liquids vaporize as soon as released from their containers
  - May cause tissue damage
  - Extreme caution should be used when near any refrigerated liquids

Soft Tissue Damage

- Cryogenics
  - Can produce
    - Freeze burns
    - Frostbite
    - Other cold-related injuries
  - Examples
    - Freon
    - Liquid oxygen
    - Liquid nitrogen
Chemical Exposure to the Eyes

- Chemical exposure to eyes may cause damage, ranging from superficial inflammation to severe burns
  - Patients with these conditions have
    - Local pain
    - Visual disturbance
    - Tearing
    - Edema
    - Redness of surrounding tissues

Response to Hazardous Materials Emergencies

- When EMS crew is dispatched to scene involving potential for hazardous materials, decisions must be made about
  - Rescuer safety
  - Type and degree of potential hazard
  - Involvement of other agencies
  - Protection for general public
Response to Hazardous Materials Emergencies

- Preplanning and early coordination of activities in these major incidents is important
  - Medical direction should be advised of incident as soon as possible to prepare personnel and facilities
  - Not all hazmat incidents are large-scale events
    - Single event involving only one patient may require full hazmat response

Response to Hazardous Materials Emergencies

- First rescue personnel to arrive at scene of hazmat incident may not be most qualified or best equipped
  - Most communities look to first responders to provide immediate safety and direction
  - EMS crew must be capable of initial management of hazmat incidents

Hazard and Risk Assessment

- While en route to scene, EMS personnel should begin to research hazmat references
  - Begin hazard and risk assessment
  - In hazmat incidents, hazards are chemical properties of material that may cause danger or peril
  - Risk refers to the possibility of suffering harm or loss
Hazard and Risk Assessment

• Risk levels vary and are influenced by several factors
  – Hazardous nature of material involved
  – Worst-case scenario situations
  – Quantity of the material involved
  – Weather conditions that might affect scene adversely
  – Containment system and type of stress applied to the container
  – Proximity of exposures (e.g., schools, nursing homes, and shopping centers)
  – Level of available resources
  – Lead time for mutual aid

Hazard and Risk Assessment

• Hazard and risk assessment also includes consideration of
  – Potential hazards to public and environment
  – Potential risk of primary contamination to patients
  – Potential risk for secondary contamination to rescuers
Hazard and Risk Assessment

• If product can be identified through hazmat references, EMS crew should familiarize themselves with
  – Potential health hazards
  – Recommended PPE
  – Initial first aid
  – Safe distance factor (minimum safe distance for personal safety)

Hazard and Risk Assessment

• Most emergency response guides offer only general management actions
  – After formal product identification, appropriate hazmat agencies can give more exact information

Approaching the Scene

• Approach scene cautiously from uphill and upwind
  – EMS crew should be alert to environmental clues
    • Wind direction
    • Unusual odors
    • Leakage
    • Vapor clouds
    • Affected or afflicted wildlife and plant life
Approaching the Scene

• Can use binoculars initially to observe scene from safe distance
  – Emergency vehicles should never be driven through leakage or vapor clouds or smoke
  – Personnel should not enter incident area until it has been determined to be safe

Approaching the Scene

• Rescuers should do following as recommended in Emergency Response Guidebook
  – Approach cautiously
  – Resist urge to rush in; you cannot help others until you know what you are facing

Approaching the Scene

• Rescuers should do following as recommended in Emergency Response Guidebook
  – Identify hazards
    • Placards, container labels, shipping papers, knowledgeable persons on scene are valuable sources of information
  – Evaluate all of them and then consult recommended guide page before you place yourself or others at risk
Approaching the Scene

• Rescuers should do following as recommended in Emergency Response Guidebook
  – Do not be alarmed if new information from CHEMTREC expert changes some of emphasis or details of guide page warnings
    • Remember that guide page provides only most important information for your initial response with family or class of hazardous materials
    • As more accurate, material-specific information becomes available, your response becomes more appropriate for situation

Approaching the Scene

• Rescuers should do following as recommended in Emergency Response Guidebook
  – Secure scene
    • Without entering immediate hazard zone, do what you can to isolate area and ensure safety of persons and environment
    • Move and keep persons away from scene and perimeter
    • Allow enough room to move and remove your own equipment

Approaching the Scene

• Rescuers should do following as recommended in Emergency Response Guidebook
  – Obtain help
    • Advise your headquarters to notify responsible agencies and call for assistance from trained experts through CHEMTREC and National Response Center
Approaching the Scene

- Rescuers should do following as recommended in Emergency Response Guidebook
  - Decide on site entry
    - Any efforts you make to rescue persons or protect property or environment must be weighed against possibility that you could become part of problem
    - Enter area with appropriate protective gear (if trained to do so)
    - Above all, do not walk into or touch spilled material
    - Avoid inhaling fumes, smoke, vapors, even if no hazardous materials are known to be involved
    - Do not assume that gases or vapors are harmless because of lack of smell

Which of these guidelines would it be easy for the first arriving crew to miss?

Control of the Scene

- First agency to arrive at scene has several responsibilities
  - Detect and identify materials involved
  - Assess risk of exposure to rescue personnel and others
  - Consider potential risk of fire or explosion
  - Gather information from on-site personnel or other sources
  - Confine and control incident
  - Establish command post per preplanned incident command structure
  - Must define safety distances and zones
Safety Zones

• After presence of hazardous materials has been confirmed, scene should be separated into hot, warm, and cold zones
  – Zones should have access and egress corridors between them
    • Corridors provide control points
    • Allow responders working in zones to know where they should exit and enter for decontamination, accountability, debriefing
  – Safety zones should be established and enforced early in incident
    • Dispatch center and responding units should be advised of location of hot zone and safe approach directions

Safety Zones

• Hot zone is area of incident that includes hazardous material
  – Includes any surrounding area that may be exposed to gases, vapors, mist, dust, runoff
  – All rescue personnel and vehicles should be stationed outside zone
  – Anyone entering must wear high-level PPE
  – Only specially trained EMS personnel should attempt patient care activities in this area
  – Some EMS agencies and incident command system structures refer to hot zone as exclusion zone, restricted area, or red zone
Safety Zones

• Warm zone is larger, buffer area that surrounds hot zone with “cold” and “hot” end corridors
  – Although protective clothing is required, usually is considered safer environment for workers
  – If hot zone becomes unstable, warm zone may be exposed to hazardous materials
  – Where most EMS activities, such as decontamination and patient care activities, are performed
  – Some agencies refer to this zone as limited-access zone, containment reduction corridor, or yellow zone

Safety Zones

• Cold zone is area that encompasses warm zone
  – Restricted to emergency personnel
  – Usually is considered safe, requiring only minimal protective clothing
  – Contains command post and other support agencies necessary to control incident
  – Referred to by some agencies as support zone or green zone

Rehabilitation and Medical Monitoring

• Safety of rescue personnel is of prime importance in any emergency
  – Rehab and medical monitoring program should be part of any incident where rescue personnel may be at risk for physical and emotional stress
  – United States Fire Administration (USFA) and National Fire Protection Association (NFPA) recommend and require rehab and medical monitoring at all emergency scenes where personnel exceed safe level of physical or mental endurance
Rehabilitation

• Purpose
  – Sustain energy of rescuers
  – Improve performance
  – Decrease likelihood of on-scene injury or death

Rehabilitation

• Part of incident command structure and is responsibility of command
  – Area (or areas) usually established near incident but away from operations
  – Location must ensure safety and must provide for rest and recuperation
  – Depending on weather and nature of incident, these areas may be outdoors, in a building, or in a specially designed rehab vehicle

Rehabilitation

• Activities that may take place in rehab sector
  – Relief from environmental extremes (active or passive cooling or warming)
  – Rest and recovery
  – Rehydration
  – Food and drink replacement
Medical Monitoring

• Ongoing evaluation of rescuers who are at risk for illness or injury from operations at incident
  – Should not be confused with treatment
  – Purpose of medical monitoring in rehab area is to identify personnel who may need treatment (provided in treatment sector) or transport
  – In hazmat operations, may also include accountability, record keeping, periodic evaluation of surveillance program

Medical Monitoring

• Should include assessment protocols that involve “presuit” examination before entering hazardous area
  – Purpose of examination is to establish health history and baseline vital signs for any rescuer who will be exposed to hazardous substance
  – During presuit exam, rescuers should be advised of expected symptoms of illness or exposure before entering hazardous area
  – Responders working in protective clothing and equipment can become dehydrated and develop heat illnesses

Medical Monitoring

• Rescue protective suits protect, also prevent cooling through
  – Evaporation
  – Conduction
  – Convection
  – Radiation
Medical Monitoring

• Heat-stress factors are affected by
  – Prehydration of rescuer
  – Degree of physical fitness
  – Ambient air temperature
  – Degree and duration of physical activity

Medical Monitoring

• Parameters of pre-suit evaluation should include
  – Temperature, pulse, respiration, and BP measurements
  – Cardiac rhythm
  – Body weight
  – Cognitive and motor skills
  – Hydration
  – Significant recent medical history (e.g., medications or illnesses)

Medical Monitoring

• After entry into hazardous area, medical monitoring should note amount of time rescuer has been in protective clothing
  – Rescuers should be observed for any signs of heat-related illness or exposure
  – If illness or injury occurs to any team member, all entry team members should be removed from hot zone for treatment
  – Backup team should be ready to assist entry team members in hot zone at all times
Medical Monitoring

• After incident, rescue personnel should be reevaluated in “rehab sector,” using same parameters as in presuit examination
  – This exam determines rescuer’s ability to be released to reenter operation, if needed
  – As a rule, rescuers are not allowed to reenter site until vital signs and hydration are normal
  – Body weight generally is used to estimate fluid loss and need for oral or IV fluid replacement (per protocol)

What might prevent personnel from seeking out emergency medical services for medical monitoring unless there is a strict procedure to guarantee they are monitored?
Documentation

- Detailed records are necessary part of hazmat medical monitoring and rehabilitation
  - At minimum, records should include
    - Hazardous substance
    - Toxicity and danger of secondary contamination
    - PPE use and any permeation ("breakthrough") that occurred
    - Level of decontamination performed or required
    - Use of antidotes and other medical treatment
    - Method of transportation and destination
  - Baseline statistics from preentry and postentry screenings also should be included in records

Emergency Management of Contaminated Patients

- Patient care activities, triage, evacuation should be part of a preplanned incident command system structure
  - Identifying specific hazardous substance may take time
  - Rescue efforts, decontamination, possible evacuation, timely treatment of toxic exposures are important

Emergency Management of Contaminated Patients

- Primary goals of decontamination
  - Reduce patient’s dosage of material
  - Decrease threat of secondary contamination
  - Reduce risk of rescuer injury
Emergency Management of Contaminated Patients

- Specific substance and route of contamination affect triage and decontamination methods
  - Following guidelines for rapid decontamination are general
  - Should not supersede any organizational approach in scene management of hazmat incidents or treatment recommendations for chemical exposures

Emergency Management of Contaminated Patients

- Guidelines for rapid decontamination
  - Do not enter contaminated area or initiate care without adequate PPE
    - Must possess training specific to incident
    - Victims who can walk should be encouraged to extricate themselves from scene
    - Should be advised to stay together for treatment or until they are escorted individually to decontamination

Emergency Management of Contaminated Patients

- Guidelines for rapid decontamination
  - Patients who cannot walk should be removed from hot zone by trained personnel
    - Removal usually is performed by fire service personnel, specialized hazmat teams, or both
  - Patient care activities in hot zone should be limited to
    - Gross airway management
    - Spinal immobilization
    - Hemorrhage control
Emergency Management of Contaminated Patients

- Guidelines for rapid decontamination
  - Decontamination and further patient care should be done in warm zone by properly equipped decontamination team
  - All patients exposed to hot zone should be considered contaminated
    - Should be treated as such until properly assessed, triaged, decontaminated

- EMS personnel assisting in decontamination should be well protected with two to three layers of gloves, head coverings, positive-pressure SCBA, and proper protective clothing
  - Decontamination teams or anyone working in warm zone should be wearing same PPE as those working in hot zone

- Guidelines for rapid decontamination
  - Patient care provisions of airway, breathing, circulatory support should begin as soon as patient is contacted and conditions allow
    - Rescuer safety information received from hazmat agencies should be used when performing basic life support procedures
  - IV therapy should be administered only under physician's direction
    - Invasive procedures may allow hazardous materials to enter patient
Guidelines for rapid decontamination

- When hazardous material is a dry agent, lightly brush material from patient
  - Ensure dry agent is not introduced into patient’s airway
  - Cutting or removing clothing often removes most of contaminating material

- After dry agent has been removed, decontamination should continue
  - Wash patient with copious amounts of water and mild detergent soap
  - Make sure all water and runoff is contained in warm zone
  - Depending on exposure, other patient decontamination procedures may be warranted
  - Pay special attention to irrigation of eyes, hair, ears, underarms, pubic areas and thorough cleaning of body creases of neck, groin, elbows, and knees

- Be careful not to abrade skin, which may promote absorption of material involved
  - Leave all patient clothing, rescuer clothing, decontamination equipment in decontamination area
  - Safely move patient to support zone for further triage, treatment, transport
Emergency Management of Contaminated Patients

• Field decontamination procedures described represent only gross decontamination
  – Resources needed for full decontamination usually are not available at scene
  – Patient should be isolated from environment
    • Will help to contain any contamination that has been missed during these procedures

Emergency Management of Contaminated Patients

• Patient isolation
  – Accomplished by placing patient in body bag (or similar containment) to neck and covering patient’s hair
  – In absence of body bags, victim may be packaged for transport by folding one side of sheet or blanket over patient and using other side to overlap and package patient
  – If necessary, patient’s arm may be exposed through opening in sheet for vital sign assessment and fluid and drug administration

Decontamination Decision Making

• Hazardous materials incidents often are “fast breaking” and may require rapid decision making
  – Group of walking, contaminated persons at scene may be trying to reach rescuers
  – Others self-rescue by walking out of hot zone
  – Some may become impatient and leave hot zone while waiting for rescue teams to arrive
  – In these situations, paramedic crew must be prepared for
    • Quick gross decontamination and treatment
    • Rapid application of PPE
    • Quick transport and isolation procedures
Decontamination Decision Making

- If patient’s condition is critical (and is unknown if exposure involved a life-threatening material), perform decontamination and treatment simultaneously
  - Remove patient’s clothing
  - Treat life-threatening problems
  - Lavage patient with copious amounts of water
  - Provide for isolation and transportation
    - Patients who are not in critical condition can be managed in same manner with a more contemplative approach, particularly if hazardous substance is known

Decontamination Decision Making

- Hazmat incident that is well controlled (not fast-breaking event) can be managed over longer duration
  - In these cases, rescue should not be attempted for patients in hot zone
  - Paramedic crew should wait for hazmat team and for decontamination corridor to be established
  - Longer-duration events allow for
    - More thorough decontamination
    - Better PPE
    - Less chance of secondary contamination
    - Better environmental protection
What type of hazardous materials response resources does your community have?

Preparing Ambulance for Patient Transfer

• Contamination of ambulances and equipment can be minimized by preparing vehicle before transporting partly decontaminated patient
  – Measures include using as much disposable equipment as necessary
  – Include removing all items from cabinets that will not be needed for patient use

Preparing Ambulance for Patient Transfer

• Ideally, patient should be isolated completely in stretcher decontamination pool
  – Should be covered in plastic and secured to stretcher
  – Immediate notification of hospital staff that they will be receiving contaminated patients is crucial
  – Emergency department will need time to prepare and manage patients adequately and efficiently
Preparing Ambulance for Patient Transfer

- On arrival at hospital, EMS crew should follow decontamination protocols of hospital
  - Crew should not return to regular service until rescue personnel, vehicle, equipment have been monitored for contamination
  - Equipment decontamination should follow the recommendations of local, state, and federal authorities or standard operating procedures of medical direction
  - Specific solutions may be required for particular hazmat exposure
  - Most equipment can be cleaned adequately and made ready for use with soap and water

Decontamination of Rescue Personnel and Equipment

- Decontamination procedures of rescue personnel vary by agency and protocol
  - Typically involves eight steps and begins in decontamination corridor
- Decontamination steps
  - Entry point is established at “hot” end of the corridor where “dirty” personnel and equipment are set up to start decontamination process
  - Tool drop is designated
    - Outer gloves and boots are removed and placed in receptacle
Decontamination of Rescue Personnel and Equipment

- Decontamination steps
  - Gross surface contamination is removed
    - Generally done by washing with copious amounts of water
  - Contaminated SCBA bottles are removed (doffed) for personnel who must reenter dirty area
    - At this step they receive clean SCBA bottles

Decontamination of Rescue Personnel and Equipment

- Decontamination steps
  - Protective clothing is removed and handled (stored, decontaminated) as required
  - Other clothing is removed
    - This step depends on seriousness of hazardous materials involved

Decontamination of Rescue Personnel and Equipment

- Decontamination steps
  - Personnel wash their bodies using overhead showers
    - Usually two washings are required
    - Personnel dry off and receive new or clean, uncontaminated clothing
  - Personnel going through decontamination system receive medical evaluation
    - Then transported to a medical facility for continued medical evaluation
  - Do not touch your face, mouth, nose, or genital area before full body decontamination

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Decontamination of Rescue Personnel and Equipment

- Safety precautions should be followed by any rescuer exposed to hazardous materials
  - Shower first with cold rinse (no scrubbing) to wash off potential contaminants without opening up pores of skin
  - Then thoroughly wash with warm water, surgical soap, sponge, and brush
  - Pay particular attention to hair, body orifices (especially ears), and any body parts that come in contact with each other (arms and chest, thighs, fingers, toes, and buttocks)
  - Repeat shower and rinse
  - Shampoo hair several times and rinse thoroughly

Why do you think that extensive preplanning and drills are needed to make this system work well?

Clothing and Equipment Care and Maintenance

- After hazmat incident, take following precautions
  - Properly dispose of any protective clothing that has been torn or worn through
  - Properly and thoroughly clean all clothing and equipment
    - Will help to avoid risk of chemical reactions at future incidents
    - Will lessen potential for chronic exposure to absorbed chemicals
    - Some hazardous materials can destroy or penetrate protective clothing and equipment
    - Product compatibility tables should be evaluated during decontamination procedure
    - Decontamination provides no assurance that protective clothing is clean or that process of chemical penetration has stopped
**Summarized Text**

**Clothing and Equipment Care and Maintenance**

- After hazmat incident, rescuer should take following precautions
  - Do not wash or dispose of clothing or equipment at home
  - Helps to avoid exposing family members and contaminating home articles
  - Follow all local codes and laws regarding disposal or decontamination of equipment and clothing.
  - Carefully maintain personal SCBA

- When incident is over, all personnel operating at scene (in any capacity) should be debriefed
  - Debriefing session should include what substances were
  - Should include what possible acute and chronic health issues may arise and any associated signs and symptoms
  - Information on how to follow up regarding long-term effects also should be provided
  - Documentation for possible work-related exposures should follow standard department/company policies

**Summary**

- Hazardous material is any substance or material capable of posing unreasonable risk to health, safety, and property
Summary

• The Superfund Amendments and Reauthorization Act of 1986 established requirements for federal, state, and local governments and industry regarding emergency planning and the reporting of hazardous materials-related incidents
  – In 1989, OSHA and the EPA published rules to govern training requirements, emergency plans, medical checkups, and other safety precautions for workers at uncontrolled hazardous waste sites and those responding to hazardous chemical spills
  – NFPA has published standards that address competencies for EMS workers at hazmat scenes

Summary

• There are two methods used to identify hazardous materials
  – One is informal product identification
    • Includes visual, olfactory, and verbal clues
  – Other is formal product identification
    • Includes placards and shipping papers
  – Resources for hazardous materials reference include the North American Emergency Response Guidebook, regional poison control centers, CHEMTREC, CHEMTEL, and CAMEO

Summary

• It is crucial that anyone dealing with hazardous materials use proper protection
  – Includes using proper respiratory devices
    • Includes wearing protective clothing
  – Clothing is made of a variety of materials
    • Designed for certain chemical exposures
    • Manufacturer’s guidelines must be followed
Summary

- Hazardous materials may enter the body through inhalation, ingestion, injection, and absorption
  - Internal damage to the human body from hazardous materials exposure may involve the respiratory tract, CNS, or other internal organs
  - Chemicals producing internal damage include irritants, asphyxiants, nerve poisons, anesthetics, narcotics, hepatotoxins, cardiotoxins, nephrotoxins, neurotoxins, and carcinogens

Summary

- Exposure to hazardous materials may result in burns and severe tissue damage
- First agency to arrive at scene of a hazmat incident must detect and identify the materials involved, assess the risk of exposure to rescue personnel and others, consider the potential risk of fire or explosion, gather information from on-site personnel or other sources, and confine and control the incident

Summary

- Hazmat medical monitoring program may include medical examination for members of hazmat response teams, providing medical care, record-keeping, and periodic evaluation of the surveillance program
- Primary goals of decontamination are to reduce patient's dosage of material, decrease the threat of secondary contamination, and reduce the risk of rescuer injury
Summary

- Rescuers should follow strict protocols for proper decontamination of themselves, their clothing, and any contaminated equipment.