**UNIT TERMINAL OBJECTIVE**

8-4 At the completion of this unit, the EMT-Critical Care Technician student will be able to evaluate hazardous materials emergencies, call for appropriate resources, and work in the cold zone.

**COGNITIVE OBJECTIVES**

At the completion of this unit, the EMT-Critical Care Technician student will be able to:

8-4.1 Explain the role of the EMT-Critical Care Technician/ EMS responder in terms of the following: (C-1)
- a. Incident size-up
- b. Assessment of toxicologic risk

8-4.2 Size-up a hazardous materials (haz-mat) incident and determine the following: (C-1)
- a. Potential hazards to the rescuers, public and environment
- b. Potential risk of primary contamination to patients
- c. Potential risk of secondary contamination to rescuers

8-4.3 Identify resources for substance identification, decontamination and treatment information including the following: (C-1)
- a. Poison control center
- b. Medical control
- c. Material safety data sheets (MSDS)
- d. Reference textbooks
- e. Computer databases (CAMEO)
- f. CHEMTREC
- g. Technical specialists
- h. Agency for toxic substances and disease registry

8-4.4 Explain the following terms/ concepts: (C-1)
- a. Primary contamination risk
- b. Secondary contamination risk

8-4.5 List and describe the following routes of exposure: (C-1)
- a. Topical
- b. Respiratory
- c. Gastrointestinal
- d. Parenteral

8-4.6 Explain the following toxicologic principles: (C-1)
- a. Acute and delayed toxicity
- b. Route of exposure
- c. Local versus systemic effects
- d. Dose response
- e. Synergistic effects

8-4.7 Explain how the substance and route of contamination alters triage and decontamination methods. (C-1)

8-4.8 Explain the limitations of field decontamination procedures. (C-1)

8-4.9 Explain the use and limitations of personal protective equipment (PPE) in hazardous material situations. (C-1)

8-4.13 Identify local facilities and resources capable of treating patients exposed to hazardous materials. (C-1)

8-4.14 Determine the hazards present to the patient and EMT-Critical Care Technician given an incident involving hazardous materials. (C-2)

8-4.15 Define the following and explain their importance to the risk assessment process: (C-1)
- a. Boiling point
- b. Flammable/ explosive limits
- c. Flash point
- d. Ignition temperature

e. Specific gravity
f. Vapor density
g. Vapor pressure
h. Water solubility
i. Alpha radiation
j. Beta radiation
k. Gamma radiation

8-4.16 Define the toxicologic terms and their use in the risk assessment process: (C-1)
a. Threshold limit value (TLV)
b. Lethal concentration and doses (LD)
c. Parts per million/ billion (ppm/ ppb)
d. Immediately dangerous to life and health (IDLH)
e. Permissible exposure limit (PEL)
f. Short term exposure limit (TLV-STEL)
g. Ceiling level (TLV-C)

8-4.17 Given a specific hazardous material be able to do the following: (C-1)
a. Research the appropriate information about it's physical and chemical characteristics and hazards
b. Suggest the appropriate medical response
c. Determine risk of secondary contamination

8-4.18 Determine the factors which determine where and when to treat a patient to include: (C-1)
a. Substance toxicity
b. Patient condition
c. Availability of decontamination

8-4.24 Explain the medical monitoring procedures of hazardous material team members to be used both pre and post entry, to include: (C-1)
a. Vital signs
b. Body weight
c. General health
d. Neurologic status
e. ECG

8-4.25 Explain the factors which influence the heat stress of hazardous material team personnel to include: (C-1)
a. Hydration
b. Physical fitness
c. Ambient temperature
d. Activity
e. Level of PPE
f. Duration of activity

8-4.26 Explain the documentation necessary for Haz-Mat medical monitoring and rehabilitation operations. (C-1)
a. The substance
b. The toxicity and danger of secondary contamination
c. Appropriate PPE and suit breakthrough time
d. Appropriate level of decontamination
e. Appropriate antidote and medical treatment
f. Transportation method

8-4.27 Given a simulated hazardous substance, use reference material to determine the appropriate actions. (C-3)

8-4.28 Integrate the principles and practices of hazardous materials response in an effective manner to prevent and limit contamination, morbidity, and mortality

**AFFECTIVE OBJECTIVES**

None identified for this unit.

**PSYCHOMOTOR OBJECTIVES**
None identified for this unit.

**DECLARATIVE**

I. Role of EMT-Critical Care Technician in hazardous materials response
  A. Incident size-up
    1. Recognition that incident involves hazardous materials
      a. Transportation incidents
      b. Highway crashes
      c. Storage of materials
      d. Manufacturing operations
      e. Acts of terrorism
    2. Use of the following to identify the substance
      a. Department of Transportation (DOT) emergency response guide
      b. United Nations (UN) numbers
      c. National Fire Protection Agency (NFPA) 704 placard system
      d. DOT placards
      e. Shipping papers
      f. Material safety data sheets (MSDS)
    3. Immediate need for evacuation or other action
    4. Immediate action with ambulatory patients
    5. Determine zones
      a. Hot zone - dangerous area
      b. Warm zone - entry/ decontamination point
      c. Cold zone - safe area
  B. Assessment of toxicologic risk
    1. Determine type of chemical
    2. Actions of chemical
    3. Potential for secondary contamination
    4. Out-of-hospital medical treatment
  C. NFPA levels of response
    1. All personnel who may arrive first must be trained to an awareness level
    2. EMT-Critical Care Technicians who may transport "semi-decontaminated patients" be trained to the NFPA 473 "Level-1"
    3. EMT-Critical Care Technicians who may have to rapidly "decon" and assist in the decontamination corridor be trained to the 473 "Level-2"
  D. Monitoring of hazardous materials personnel

II. Hazardous materials size-up
  A. High degree of awareness
    1. Vehicle crashes
      a. Commercial vehicles
      b. Pest control vehicles
      c. Tankers
      d. Cars with alternative fuels
      e. Tractor-trailers
    2. Transportation
      a. Railroads
      b. Pipelines

3. Storage
    a. Tanks/ storage vessels
    b. Warehouses
    c. Hardware/ agricultural stores
    d. Agriculture
4. Manufacturing operations
    a. Chemical plants
    b. All manufacturing operations
5. Terrorism
    a. Workplace
    b. Shopping
    c. Other public environments

B. Recognition of hazard
1. Placarding of vehicles
    a. Required by law
    b. Some vehicles not placarded
    c. Placarding in emergency response guide
2. UN/ DOT placard classifications
    a. Explosives
    b. Gasses
    c. Flammable liquids
    d. Flammable solids
    e. Oxidizers and organic peroxides
    f. Poisonous and etiologic agents
    g. Radioactive materials
    h. Corrosives
    i. Miscellaneous hazardous materials
3. Recognition of UN numbers
4. NFPA 704 System for fixed facilities
    a. Blue = health hazard
    b. Red = fire hazard
    c. Yellow = reactivity hazard

C. Identification of substances
1. The "crux" of dealing with a hazardous material
2. Often difficult-especially with unknown substances
3. Material safety data sheets (MSDS)
    a. Detailed substance information
4. Shipping papers
    a. Substance ID
5. DOT Emergency Response Guide
    a. UN numbers
    b. Names of substances
    c. Emergency action guide
    d. Placard facsimiles
    e. Evacuation/ isolation information
6. Poison control centers
    a. Detailed toxicology information
    b. Decontamination methods
    c. Treatment
7. CAMEO computer database

a. Information
b. Computer modeling

8. CHEMTREC
   a. 24 hour toll free hotline
   b. Product and emergency action information
9. Other reference sources
   a. Textbooks
   b. Handbooks
   c. Technical specialists
10. Monitors and testing for unknown materials
    a. Air monitoring equipment
    b. Gas monitoring equipment
    c. Ph testing
    d. Chemical testing
    e. Colormetric tube testing

D. Hazardous material zones
   1. Hot zone
      a. Contamination actually present
      b. Site of incident
      c. Entry with high level PPE
      d. Entry limited
   2. Warm zone
      a. Buffer zone outside of hot zone
      b. Where decontamination corridor is located
      c. Corridor has "hot" and "cold" end
   3. Cold zone
      a. Safe area
      b. Staging for personnel and equipment
      c. Where medical monitoring occurs
      d. One end of corridor

E. Specific terminology for medical hazardous materials operations
   1. Boiling point
   2. Flammable/ explosive limits
   3. Flash point
   4. Ignition temperature
   5. Specific gravity
   6. Vapor density
   7. Vapor pressure
   8. Water solubility
   9. Alpha radiation
   10. Beta radiation
   11. Gamma radiation

F. Specific toxicologic terms and their use in the risk assessment process
   1. Threshold limit value (TLV)
   2. Lethal concentration and doses (LD)
   3. Parts per million/ billion (ppm/ ppb)
   4. Immediately dangerous to life and health (IDLH)
   5. Permissible exposure limit (PEL)
   6. Short term exposure limit (TLV-STEL)
   7. Ceiling level (TLV-C)

III. Contamination and toxicology review
- A. Types of contamination
  - 1. Primary contamination
    - a. Exposure to substance
    - b. Only harmful to individual
    - c. Little chance of exposure to others
  - 2. Secondary contamination
    - a. Exposure to substance
    - b. Substance easily transferred
    - c. Touching patient results in contamination
    - d. Key concept in hazardous materials medical operations
    - e. Gas exposure rarely results in secondary contamination
    - f. Liquid and particulate matter more likely to result in secondary contamination
- B. How poisons are absorbed
  - 1. Topical absorption
    - a. Skin and mucous membranes
    - b. Not all skin absorbs at same rate
    - c. Not all poisons easily absorbed
  - 2. Respiratory inhalation
    - a. Absorption through bronchial tree
    - b. Oxygen deficient atmospheres
  - 3. Gastrointestinal ingestion
    - a. Ingestion of substances
    - b. Factors affecting absorption
  - 4. Parenteral injection
    - a. Injection
    - b. Wound entry
    - c. Invasive medical procedures
- C. Cycle of poison actions
  - 1. Absorption
    - a. Time to delivery into blood stream
  - 2. Distribution
    - a. Distribution to target organs
    - b. Poison or drug binds to tissues/ molecules
    - c. Actions
    - d. Deposits
  - 3. Biotransformation
    - a. Liver
  - 4. Elimination
    - a. GI
    - b. Kidney
    - c. Respiratory
- D. Poison actions
  - 1. Acute toxicity
    - a. Immediate effect from substance
  - 2. Delayed toxicity
    - a. No immediate effect
    - b. Symptoms later appear
    - c. Delayed pathology or disease
  - 3. Local effects

a. Effect immediate site
b. Burn model
c. Progression of effects like burn
d. Topical or respiratory
e. Skin irritation - acute bronchospasm

4. Systemic effects
   a. Cardiovascular
   b. Neurologic
   c. Hepatic
   d. Renal
5. Dose response
   a. Physiologic response to dosage
   b. How much to get an effect
   c. Essential concept for decontamination
6. Synergistic effects
   a. Combinations may react synergistically
   b. Standard pharmacologic approach
   c. Standard treatment can result in synergy
   d. Medical control/ poison control reference

E. Treatment for commonly encountered hazardous materials
1. Corrosives (acids/ alkalis)
   a. Typical exposures
   b. Actions
   c. Decontamination methods
   d. Treatment
   e. Transportation precautions
2. Pulmonary irritants (ammonia/ chlorine)
   a. Typical exposures
   b. Actions
   c. Decontamination methods
   d. Treatment
   e. Transportation precautions
3. Pesticides (carbamates/ organophosphates)
   a. Typical exposures
   b. Actions
   c. Decontamination methods
   d. Treatment
   e. Transportation precautions
4. Chemical asphyxiants (cyanide/ CO)
   a. Typical exposures
   b. Actions
   c. Decontamination methods
   d. Treatment
   e. Transportation precautions
5. Hydrocarbon solvents (xylene/ methylene chloride)
   a. Typical exposures
   b. Actions
   c. Decontamination methods
   d. Treatment
   e. Transportation precautions

6. Considerations for performing invasive procedures
    a. Risk versus benefit
    b. Patient need

IV. Decontamination approaches
- A. Purpose of decontamination
    1. Reduce the patient's dosage of material
    2. Decrease threat of secondary contamination
    3. Reduce risk of rescuer injury
- B. Environmental considerations
    1. Major consideration If there are no life-threats
        a. Prevent run off of material
    2. If there are life-threats, patient comes first
        a. Environmental considerations last
- C. Methods of decontamination
    1. Dilution
        a. Lavage with water
        b. Water is universal decontamination solution
        c. Dilution decreases dose and action
        d. Reduction of topical absorption
    2. Absorption
        a. Use of pads to "blot" up the material
        b. Towels to dry the patient after lavage
        c. Usually a secondary method to lavage
        d. Common for environmental clean up
    3. Neutralization
        a. Almost never used in patient decontamination
        b. Hazard of exothermic reactions
        c. Time to determine neutralizing substance
        d. Lavage usually dilutes and removes faster
        e. More practical with equipment, etc.
    4. Disposal/ isolation
        a. Removal of clothing
        b. Removal of substances which contain substances
- D. Decontamination decision making
    1. Field considerations
        a. Flight of walking contaminated to rescuers -"fast break" event - action required now
        b. Conscious, contaminated people will "self rescue" by walking out of hot zone
        c. Immediate decontamination often not avoidable
        d. Speed of hazardous material team response
            (1) Patients often can't wait that long
            (2) Patients become impatient and leave
        e. EMS gross decontamination and treatment
            (1) All EMS needs gross decontamination capability
            (2) EMS preparedness for quick decontamination
            (3) Need for rapid EMS PPE
            (4) Need quick transport isolation methods
    2. "Fast break" incident decision making
        a. Critical patient - unknown/ life-threatening material
            (1) Decontamination and treatment simultaneous

(2) Remove clothing
(3) Treat life-threatening problems
(4) Lavage - water universal decontamination solution
(5) Contain/ isolate patient
(6) Transport

b. Non-critical - unknown/ life-threatening material
(1) More contemplative approach
(2) Decontamination and treatment simultaneous
(3) Remove clothing
(4) Treat life-threatening problems
(5) Lavage - water universal decontamination solution
(6) Contain/ isolate patient
(7) Transport

c. Non-critical - substance known
(1) Slower approach
(2) Environmental/ privacy considerations
(3) More thorough decontamination
(4) Clothing removal
(5) Thorough lavage/ wash
(6) Drying/ reclothing PRN
(7) Medical monitoring
(8) Patient isolation PRN
(9) Transport

3. Longer duration event decision making
a. Patients in hot zone - non-ambulatory
(1) No rescue attempted
(2) Wait for hazardous material team
(3) Team will set up decontamination corridor

b. Team will not make entry until
(1) Medical monitoring of entry team
(2) Decontamination corridor established

c. Longer duration event
(1) Often 60 minutes for team deployment
(2) Set up time

d. Better opportunity for thorough decontamination
e. Better PPE
f. Less chance of secondary contamination
g. Better environmental protection

4. When in doubt - better grossly decontaminated and alive than perfectly decontaminated and dead
a. Deal with patient emergencies first
b. Have some type of chemical PPE

V. Medical monitoring and rehabilitation

A. Entry team/ decontamination team readiness prior to entry
1. Assessment of vital signs and documentation
2. Team members should have normal values on file
3. Documentation flow sheet must be started
a. Blood pressure
b. Pulse
c. Respiratory rate

- d. Temperature
- e. Body weight
- f. ECG
- g. Mental/ neurologic status

4. Rescuer PPE can cause considerable heat stress
5. Prehydration prior to entry
   - a. 8-16 ounces of water or sport drink

B. After exit personnel should return to the medical sector for "rehab"

1. Re-assessment of vital signs and documentation
2. Documentation flow sheet must be started
   - a. Blood pressure
   - b. Pulse
   - c. Respiratory rate
   - d. Temperature
   - e. Body weight
   - f. ECG
   - g. Mental/ neurologic status
3. Re-hydration at exit
   - a. 8-16 ounces of water or sport drink
4. Use weight to estimate fluid losses
   - a. Medical control/ protocol determination
     - (1) PO fluids
     - (2) IV Fluids
5. No re-entry until
   - a. Vitals back to normal
     - (1) Non-tachycardic
     - (2) Alert
     - (3) Normotensive
     - (4) Body weight within percentage of normal

C. Heat stress factors

1. Prehydration of member
2. Degree of physical fitness
3. Ambient air temperature
4. Degree of activity and duration
5. Rescue PPE
   - a. Suits protect but prevent cooling
   - b. There is no way to lose heat by
     - (1) Evaporation
     - (2) Conduction
     - (3) Convection
     - (4) Radiation
   - c. Like being in a sauna