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# TEXTBOOK FOR EMERGENCY MEDICAL TECHNICIANS

## A COMPLETE BOOK FOR DEMT

**As per the Latest Syllabus and Guidelines**

**Highlights**

- Comprehensive coverage of basic anatomy, physiology, biochemistry, pathology, microbiology and pharmacology
- Covers various trauma and medical emergencies
- Special emphasis on various skills and procedures required for emergency care by EMTs

**Devendra Richhariya**

*Forewords*
**Saleh Fares Al-Ali**
**Eric Revue**

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CHAPTER

# Hazardous Material (HAZMAT) and Waste

*Usha Yadav, Devendra Richhariya*

## INTRODUCTION

Biological, chemical, and radiologic materials that result in adverse effects to the health and safety of exposed individuals are termed hazardous materials (HAZMAT). Are there materials in your workplace that are hazardous? If so, then you must be aware:

- Which ones are hazardous
- What their hazards are
- How you can work with them safely.

Hazardous material can be:

- Corrosive
- Explosive
- Flammable
- Radioactive
- Reactive
- Toxic.

There are various routes from which hazardous materials can enter the body by three routes:

1. Skin and eye contact (absorption)
2. Inhalation (breathing)
3. Ingestion (eating).

This module consists of information about the nature of hazardous materials, and how they should be labelled, their usefulness in preplanning for hazardous material emergencies, extinguishing tactics, and environmental protection aspects.

All accidents/spills must be reported to safety and environmental department, and any other departments or persons as the situation requires (i.e., radiation safety officer in case radiation is involved, lab safety officer, research center chemical safety officer, clinical engineering or others). All hazardous materials received in a department shall be handled by appropriate personnel and shall be stored in an appropriate cabinet with proper ventilation, designated for chemical use only.

## CLASSIFICATION OF HAZARDOUS MATERIAL

Hazardous materials can be divided into three groups according to their effects:

1. *Substances that affect health:* Include poisons and other toxic substances that may enter the body through breathing (inspiration), swallowing (ingestion), or injecting through the skin (absorption).
2. *Substances that affect fire:* Fire hazardous materials may be in liquid, solid or gaseous form. All flammable liquids, by definition, are considered hazardous. A flammable liquid is a substance that has a flash point <100°F.

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3. *Substances that may react violently:* Explosives and oxidizing agents (which can be strong corrosives) give off oxygen and support combustion. Other substances may react in the same way when they come in contact with air.

## CLASSES OF HAZARDOUS MATERIALS

There are nine classes of hazardous materials. Each class has a distinctive symbol for labelling containers:

a. Explosives
b. Gases
c. Flammable liquids
d. Flammable solids and materials that are dangerous when wet
e. Oxidizers and organic peroxides
f. Poisonous and etiologic materials
g. Radioactive materials
h. Corrosive
i. Miscellaneous hazardous materials.

## STORAGE AND TRANSPORTATION OF HAZARDOUS MATERIALS

### Storage

- Chemical storage parameters include temperature control, ventilation, segregation, isolation, ignition control, and regulatory considerations.
- All chemicals shall be properly labelled with the description of hazard.
- Toxic materials which can decompose into toxic components from contact with heat, moisture, acid fumes shall be stored in a cool, well-ventilated place out of the direct rays of the sun.
- All flammable and combustible liquids should be kept in closed containers when they are not in use.
- Materials which ignite easily under normal conditions (flammable) shall be stored in a cool, dry, well-ventilated storage space.

### Transportation

- Chemicals must be transported safely to minimize the potential for spills, releases or accidental exposures.
- Chemicals should be transported in sealed and labelled, primary containers.
- Primary containers should be transported in secondary containers.
- Only manageable quantities of chemicals should be hand carried.
- Heavier quantities should be placed on a cart.
- Only persons knowledgeable about the chemicals' hazards should transport the chemical.

## SAFE USE OF HAZARDOUS MATERIAL

To avoid problems, be prepared and read the label which usually tells you at a glance:

- What is in the container?
- What the hazard could be (health, fire reactivity, etc.)?
- Special instructions: How to protect yourself and basic first aid?

Before using hazardous materials:

- Remove things that could burn, explode or react dangerously with nearby materials.
- Know where emergency showers and eyewashes are located.

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- Make sure the correct type of fire safety equipment is nearby and ready for use.
- Check for adequate ventilation.
- Know what to do in an emergency.

Assemble the personal protective equipment (PPE) might be required, such as:

- Safety glasses, goggles, or face shields
- Gloves
- Rubber boots or special shoes
- Respirators

## CHEMICAL SPILL AND DECONTAMINATION

### Chemical Spills

*If chemical spill happens:*

- Immediately inform housekeeping.
- Proper protective clothing must be worn. This includes solvent resistant gloves and respiratory protection.
- In case of large spill, follow steps set out in the "Chemical Hygiene Plan".
- Small spills can be cleaned up easily by using a chemical spill kit which is available in the laboratory.
- A "minor" (few drops) chemical spill is one that staff is capable of handling safely if the following criteria are satisfied: Staff should have access to and wear, appropriate personal protective equipment. Only knowledgeable and experienced personnel should clean up a minor chemical spill. Spill response kits or materials with instructions, absorbents, reactants, and protective equipment should be available. Staff have access to and use, appropriate spill clean-up equipment staff have a way to dispose of waste generated from spill clean-up activities.
- All other spills are considered "major" (>10 mL) and must be cleaned up by trained Hazmat Chemical Spill Response Team Members. The safety department is responsible for investigating significant hazardous chemical spills and unplanned releases.

### Decontamination

- Decontamination neutralizes harmful contaminants and removes them from personnel and equipment.
- Decontamination also reduces the chance that contaminants will be carried out of the release area. There are two major methods of decontamination—physical and chemical.
- Physical is done by diluting with water or blowing with air jets.
- Chemical is done by neutralizing hazardous materials with chemicals.

**Chemical exposure:** Staff, visitors, and patients can become contaminated with a hazardous substance in a variety of ways, including: contact with airborne contaminants, splash, walking through a spill on the floor, contact with contaminated equipment.

General guidance regarding decontamination methods and techniques are presented below:

- Eliminate further contact with the material.
- Identify the material.
- Decontaminate with copious amount of water or other appropriate material.
- Remove contaminated clothes and other material in contact with victim.
- Assess the amount and concentration.
- Obtain medical assistance.
- Notify supervisor.

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## HAZARDOUS WASTE AND SEGREGATION

### Segregation of Waste System

Waste classification system, effective to sort and handle the various types of waste generated by the hospital and protect our staff and the community from contamination. General objectives regarding the waste classification, in respect to hazardous medical waste including infectious waste and radioactive waste is to provide technical guidance in hazardous waste segregation, collection, packaging, storage, transporting, treating and finally proper safe disposal the waste separation and packaging of different colors that are part of the hospital policies, and requirements that everyone must comply with which are actually part of the existing contract. Waste is sorted as follows:

- *Red bags* used for isolation biological/contaminated waste
- *Yellow bags* used for radioactive waste
- *Orange bags* used for toxic waste
- *Blue bags* used for general waste
- *Black bags* used for regular trash general waste: Not considered infectious
- Infectious waste: Potentially infectious or hazardous, generated in the diagnosis, treatment, or immunization of human beings or animals.

## DEGREE OF HAZARD IDENTIFICATION FOR HAZARDOUS MATERIALS

Below is a system for marking the degree of hazardous materials which provides a simple and easily understood system. It also provides a general idea of the hazard of the materials and the severity of their hazards **(Table 1)**.

## HAZARDOUS MATERIAL SAFETY BOOKLET

Also known as material safety data sheet (MSDS) cornerstone of the hazard communication guidelines. They provide information about the chemical substances within a product, safe handling procedures, first aid measures and procedures to be taken when a product is accidentally spilled, they must be provided from chemical distributors, all new information regarding certain chemical substances must be provided by the distributor. It is required that all departments using chemicals must maintain copies of the booklet and ensure that they are readily accessible to employees during all work shifts.

## PERFORMANCE STANDARDS AND PERFORMANCE IMPROVEMENT

Safety committee is responsible for monitoring the performance, tracks the events, monitors hazardous materials and waste. Data and significant events, findings and trends are reported to the committee at least annually to identify potential risk and possible opportunities for improvement. Upon approval, the reports become part of the committee's minutes and are submitted to administration for review.

## PERSONAL PROTECTIVE EQUIPMENT IN HAZARDOUS MATERIALS INCIDENTS

Biological, chemical, and radiologic materials that result in adverse effects to the health and safety of exposed individuals are termed hazardous materials (HAZMAT). These substances represent significant risks to healthcare. Therefore, hospitals and their workforce must be prepared to use personal protective equipment (PPE) to protect themselves when these situations arise.

There are four key issues which must be fully understood whenever PPE is required:

1. The various types of PPE
2. The basics of a "hazard assessment"

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**Table 1:** Degree of hazard identification.

| | ***Identification of health hazard (type of possible injury)*** | ***Identification of flammability (susceptibility of materials to burning)*** | ***Identification of reactivity (susceptibility to release of energy signal)*** |
|---|---|---|---|
| ***Signal*** | ***Color code blue*** | ***Color code red*** | ***Color code yellow*** |
| 4 | Materials that on very short exposure could cause death or major residual injury | Materials which will rapidly or completely vaporize. At atmospheric pressure and normal ambient temperature, or that are readily dispersed in air and that will burn readily | Materials that in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures |
| 3 | Materials that on short exposure could cause serious temporary or residual injury | Liquids and solids that can be ignited under almost all ambient temperature conditions | Materials that in themselves are capable of detonation or explosive decomposition or reaction but require a strong initiating source or which react explosively with water |
| 2 | Materials that on intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury | Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur | Material that readily undergo violent chemical change at elevated temperatures and pressures or which react violently with water or which may form explosive mixtures with water |
| 1 | Materials that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material | Materials that must be preheated before ignition can occur | Materials that in themselves are normally stable, but which can become unstable at elevated temperatures and pressures |
| 0 | Materials that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material | Materials that will not burn | Materials that in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water |

3. How to select appropriate PPE; and
4. Training in the proper use of PPE.

The main function of PPE is to provide a barrier between the user and respiratory or skin exposure to the contaminant in the environment or on the skin/clothing of contaminated patients. PPE provides:

- Respiratory protection
- Eye and face protection
- Hand protection
- Foot protection
- Body protection.

A specific combination of PPE from each of these categories is normally needed to properly protect the wearer from each specific contaminant. Various level of PPE used in HAZMAT are summarized in **Table 2**.

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**Table 2:** Level of personal protective equipment for HAZMAT.

| ***Level A protection*** | ***Level B protection*** | ***Level C protection*** | ***Level D protection*** |
|---|---|---|---|
| Highest level of protection for eye skin respiratory system from liquid vapors and gases **(Fig. 1A)** | Level B protection provides adequate skin protection, but is not vapor impervious like level A **(Fig. 1B)** | Level C protection should be used when the atmospheric contaminants, liquid splashes, or other direct contact absorbed through any exposed skin **(Fig. 1C)** | Level D protection is used when the atmosphere contains no known hazard, and hardly any possibilities of splashes, unexpected inhalation of or contact with hazardous levels of any chemicals **(Fig. 1D)** |
| ***Components of level A protection*** | ***Components of level B protection*** | ***Components of level C protection*** | ***Components of level D protection*** |
| • Positive-pressure, full-face piece, self-contained breathing apparatus (SCBA), or<br>• Positive-pressure supplied air respirator with escape SCBA<br>• Totally encapsulating chemical-protective suit<br>• Gloves, outer, chemical resistant<br>• Gloves, inner, chemical resistant<br>• Boots, chemical resistant, steel toe and shank<br>• Disposable protective suit, gloves, and boots | • Positive-pressure, full-face piece SCBA, or positive-pressure supplied air respirator with escape SCBA<br>• Hooded chemical-resistant clothing (1- or 2-piece chemical splash suit; disposable chemical-resistant overalls)<br>• Gloves, outer, chemical resistant<br>• Gloves, inner, chemical resistant<br>• Boots, outer, chemical-resistant steel toe and shank<br>• Boot-covers, outer, chemical resistant (disposable)<br>• Face shield | • Full-face or half mask, air-purifying respirators<br>• Hooded chemical-resistant clothing (chemical splash suit)<br>• Gloves, outer, chemical resistant<br>• Gloves, inner, chemical resistant<br>• Boots, outer, chemical-resistant steel toe and shank<br>• Boot covers, outer, chemical resistant (disposable) | • A work uniform affording minimal protection<br>• Gloves<br>• Boots/shoes, chemical-resistant steel toe and shank<br>• Safety glasses or chemical splash goggles<br>• Face shield |




**Figs. 1A to D:** (A) Level A PPE; (B) Level B PPE; (C) Level C PPE; (D) Level D PPE.

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## SUMMARY

- Various hazardous material (HAZMAT), biological, chemical, and radiologic materials are present in and around the workplace that result in adverse effects to the health and safety of exposed individuals.
- Policies and procedures are laid down regarding the selection, handling, storage, use and disposal of hazardous materials and waste.
- Hazardous materials and hazardous waste include: Chemical biological radioactive pharmaceutical and chemotherapeutic, electronic hazardous gases, universal waste, mixed wastes.
- In response to hazardous materials spills, releases and exposures appropriate protocol should be implemented for reporting and investigating hazardous materials spills.
- Administration needs to ensure that mandated licenses and permits are maintained in compliance with applicable law and regulations and the granting regulatory agency requirements.
- Mechanism needs to established for the review, development and dissemination of hazardous materials policies and procedures.

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**Devendra Richhariya** MBBS MD MBA is a practicing senior emergency physician since the last 20 years. He is a senior emergency physician, educator, and mentor for national and international postgraduate emergency medicine students for the fellowship program. He is also the author and co-author of various textbooks, handbooks, and articles in national and international journals. He is the Chief Editor of the *Textbook of Emergency Medicine* including Intensive Care and Trauma published by Jaypee Brothers Medical Publishers, New Delhi, India.

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