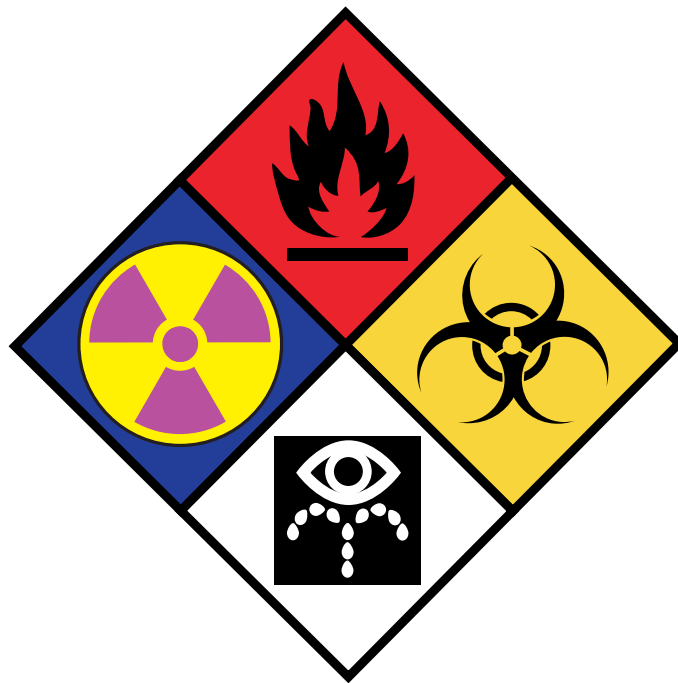


Laboratory Safety



To my wonderful husband and children

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Notice

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Laboratory Safety



A Self-Assessment Workbook

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AN OVERVIEW OF CLINICAL LABORATORY SAFETY

PURPOSE OF THIS TEXT

1. In a teaching laboratory, a 22 year old clinical laboratory science student acquired *Salmonella typhi* which caused an intestinal abscess. In addition to antibiotic therapy, the abscess required two separate surgeries for drainage and creation of a temporary diverting ileostomy. The student also required hyperalimentation but was able to completely recover in six months, at which time the ileostomy was reversed. (*Laboratory Medicine*, "Typhoid Fever Acquired in a Medical Technology Teaching Laboratory", volume 19, number 3, March 1988.)
2. Prior to 1976, sodium azide was used extensively as a preservative in laboratory reagents and was disposed of in ordinary plumbing. Copper and lead pipes cause the formation of metal azides which are more explosive than nitroglycerin. Therefore, serious explosions resulted from the manipulation of pipes and drains in laboratories when this disposal hazard was unrecognized. (*Clinical Laboratory Safety*, by Susan L. Rose, J. B. Lippincott, 1984.)
3. "Eighty ml of diazomethane dissolved in ether detonated in a domestic-type refrigerator. The door blew open, the frame bowed out, and the plastic lining ignited, causing a heavy blanket of soot to be deposited far down the adjoining corridor." (*From Health Care Facilities*, NFPA 99, National Fire Protection Association, Quincy, MA 02269, 1990.)
4. A research facility hired students for the summer, and one of the jobs given to six students was to clean out a closed satellite lab. The students were given minimal instruction and were left to move equipment and dispose of chemical and biological wastes. When they were cleaning out the cold room, someone left some chemicals on the bench top at room temperature, and the students all went to lunch. A short time later, the chemicals exploded and a terrible odor necessitated evacuation of the entire building. The students had been working in the room without protective gear and would have been seriously injured if they had not been out of the room. (*Laboratory Medicine*. "In My Opinion," volume 27, number 5, May 1996.)
5. On September 20, 2000 an MRI technician died from a nitrogen gas leak at New York Presbyterian Hospital. Nitrogen is colorless and odorless, and levels incompatible with life can accumulate without anyone being able to detect it. (www.healthsafetyinfo.com, accessed September 28, 2000.)
6. A worker thought a can of sodium had completely converted to sodium hydroxide, so he decided to flush it with water. The remaining unconverted sodium reacted with the water and caused the can to explode. The

resulting fire blocked the only door to the lab, so workers evacuated out the windows. Fortunately, the windows were on the first floor and a few weeks previously the security bars over the windows had been removed due to the safety department's insistence. (Furr, A. K., editor. *CRC Handbook of Laboratory Safety*, 5th Edition, CRC Press, 2000.)

The incidents above are real, and because all hazards can never be completely eliminated, lab accidents still occur regularly. Laboratory workers are often under pressure to produce results in a hurry, and they can become careless or be tempted to take short cuts. Even when laboratory workers are not under pressure, the familiarity with routine hazards may desensitize even conscientious workers to the need for appropriate caution.

The purpose of this text is to heighten the reader's awareness of safety issues and to promote the ability to:

1. Understand and apply the appropriate regulatory and professional requirements for safety, maintaining adequate records and documentation.
2. Establish standard operating procedures that routinely incorporate the appropriate safety techniques, monitor the management of hazards in a laboratory and properly dispose of waste.
3. Recognize potential safety hazards and/or hazards revealed through incidents and take action to prevent future accidents.
4. React promptly and correctly once an accident occurs.

This text is not intended to be all-inclusive. There are many special situations which require procedures not discussed herein, and this text will only address the most common hazards in a laboratory. Information cited in the text on the many safety regulations is accurate at the time of publication, but the reader should always check the most current version of any regulation before making changes in the laboratory. Resources from which current and additional information can be obtained are included in Appendix 1 at the end of this text. The reader is encouraged to consult these or other sources before embarking on any procedure which is unknown and therefore potentially dangerous.

LEARNING OBJECTIVES

Following study of the material contained in this text, the reader should be able to:

LEARNING OBJECTIVES (CONTINUED)

1. Explain the importance of each individual assuming some responsibility for complying with safety rules regulations
2. Discuss aspects of laboratory safety management such as the appointment of a laboratory safety officer, a safety committee and incident review committee and how these entities continuously formulate procedures, train staff, analyze incidents and reformulate procedures as necessary
3. Explain the role of the following governmental bodies/ regulations in laboratory safety:
 - a. US Occupational Safety and Health Administration (OSHA), describing the requirements for employers under the general duty clause and with regard to the following OSHA standards and advisories:
 - i. Hazard Communication Standard (“Right to Know”)
 - ii. Hazardous Chemicals in Laboratories Standard
 - iii. Bloodborne Pathogens Standard (including changes mandated by Needlestick Safety and Prevention Act)
 - iv. Formaldehyde Standard
 - v. Personal Protective Equipment Standard
 - vi. Control of Hazardous Energy Standard (“Lock out/tag out”)
 - vii. Ergonomics advisories
 - viii. Tuberculosis advisories
 - b. US Environmental Protection Agency (EPA)/ Resource Recovery and Conservation Act (RRCA)
 - c. US Nuclear Regulatory Commission (NRC)
 - d. US Department of Transportation (DOT)/ US Postal Service
 - e. US Centers for Disease Control and Prevention (CDC)/National Institute for Occupational Safety and Health (NIOSH)/National Institutes of Health (NIH)
 - f. US Department of Homeland Security (DHS)
4. Discuss fire hazards with respect to:
 - a. the fire “quadrahedron”
 - b. classes of fires, including examples of each class
 - c. National Fire Protection Association (NFPA) graphic symbols for each class
 - d. precautions for each class and fire prevention in general
 - e. appropriate means to extinguish each class
 - f. education and training
 - g. lab design and design of optimal evacuation routes
 - h. fire safety equipment, specifically the correct use of:
 - i. fire alarms
 - ii. sand buckets
 - iii. fire extinguishers, including the “PASS” acronym
 - iv. fire hoses
 - v. fire blankets
 - vi. respirators
 - i. evacuation and emergency plans in cases of fire, including the “RACE” acronym
5. Discuss chemical safety with respect to:
 - a. labeling of reagents, including interpretation of the following labeling systems:
 - i. National Fire Protection Association (NFPA) labeling system
 - ii. Hazardous Materials Information System (HMIS)
 - iii. Globally Harmonized System adopted by US Department of Transportation
 - b. classes of chemical hazards, giving examples or definitions of each of the following:

LEARNING OBJECTIVES (CONTINUED)

- i. corrosives
 - ii. ignitibles- flammables and combustibles
 - iii. health hazards- carcinogens, teratogens, mutagens, sensitizers, irritants, hepatotoxins, nephrotoxins, neurotoxins
 - iv. unstable or reactive compounds including explosives and oxidizers
 - v. incompatible mixtures
 - vi. chemicals of particular concern in histology/autopsy suites
 - c. procedures for using, handling and storing chemicals
 - d. security of materials from theft and terrorism
 - e. proper use and maintenance of a chemical fume hood
 - f. information on Material Safety Data Sheets (MSDS) and procedures to use the information
 - g. regulations for using chemicals, particularly hazardous mixtures
 - h. proper methods for disposing chemicals
 - i. protective wearing apparel
 - j. chemical spill protocols, including the "CLEAN" acronym
6. Discuss electrical safety with respect to:
- a. nature of electricity, conductors, insulators and circuits
 - b. effects of electricity on the human body
 - c. circuit requirement for shocks and the physical consequences of shock
 - d. the five essential principles of safe practice with electricity, explaining and give examples of each:
 - i. insulation
 - ii. grounding
 - iii. guarding
 - iv. circuit protection devices to include fuses, circuit breakers and ground-fault interrupters
 - v. safe work practices to include "lock out/tag out," emergency generators and proper use of electrical equipment
 - e. identification and prevention of electrical hazards
7. Discuss equipment safety with respect to:
- a. glassware safety
 - b. safety with sharps to include needles, scalpels, bone saws, etc
 - c. centrifuge safety
 - d. steam sterilizer (autoclave) safety
8. Discuss biological hazards with respect to:
- a. the universal biohazard symbol - color, where/how to display
 - b. types of biological hazards, including:
 - i. classes of microbes - viruses, bacteria, prions, protozoa and fungi
 - ii. microbe sources
 - iii. fomites
 - iv. aerosols - how they occur, how they are prevented
 - v. spills
 - c. essential components of a biosafety program
 - d. definition of CDC/NIH biosafety levels and basic requirements at each level
 - e. definitions of NIH and World Health Organization (WHO) biosafety levels
 - f. important examples in each CDC/NIH biosafety level

LEARNING OBJECTIVES (CONTINUED)

- g. identification of critical agents associated with bioterrorism and providing security
 - h. CDC Universal Precautions, Standard Precautions and Transmission-Based Precautions
 - i. examples of common hazards and situations
 - j. precautions used to reduce risk for each type of biohazard
 - k. precautions unique to autopsy suites and histology labs
 - l. precautions for working with animals in the lab
 - m. special issues regarding individual pathogens such as hepatitis B virus, human immunodeficiency virus, hepatitis C virus, infectious prions (such as Creutzfeldt-Jakob disease) and *Mycobacterium tuberculosis* to include:
 - i. signs of infections
 - ii. typical means of acquiring infection
 - iii. vaccine availability
 - iv. testing for presence of infection
 - v. treatment of workers exposed to organism
 - vi. applicable biosafety level
 - n. physical containment requirements including:
 - i. appropriate manipulation techniques
 - ii. biosafety cabinets - proper usage, maintenance, selection of correct type
 - iii. protective wearing apparel
 - iv. design of histology/autopsy suites
 - o. biohazard decontamination to include:
 - i. chemical agents
 - (1) low-, middle- and high-level disinfectants
 - (2) sterilants
 - (3) antiseptics
 - (4) proper use of bleach as mid-level disinfectant (concentration, expiration)
 - (5) debulking material and sufficient contact time
 - ii. heat, pressure, autoclaving
 - iii. radiation - ionizing and ultraviolet
 - iv. special procedures for infectious prions
 - p. treatment of spills
 - q. treatment of accidental exposures
 - r. methods for disposing biohazards
9. Discuss compressed gases with respect to:
- a. definition and characteristics of compressed gases
 - b. correct labeling and color coding of cylinders
 - c. hazards associated with compressed gases
 - d. methods of transport, storage, usage and inventory
 - e. installing and reading a regulator on a compressed gas tank
 - f. methods of handling empty and full tanks
 - g. special precautions with cryogenic gases and gases for medical use
10. Discuss radioactive materials with respect to:
- a. definitions of terms including:
 - i. alpha, beta and gamma radiation
 - ii. rems
 - iii. Curies and Becquerels

LEARNING OBJECTIVES (CONTINUED)

- iv. half-life
 - b. effects of radiation on the human body
 - c. precautions including correct shielding (lucite for beta and alpha, lead for gamma)
 - d. storage and usage
 - e. methods of disposal and spill cleanup
 - f. regulatory requirements and documentation
 - g. environmental and personnel monitoring
 - h. the universal radiation hazard symbol
 - i. the “ALARA” principle to keep radiation exposure “as low as reasonably achievable”
 - j. managing radiation exposure by time, shielding and distance
 - k. security of materials from theft and terrorism
11. Discuss laboratory waste and waste management to include:
- a. listed wastes and characteristic wastes
 - b. EPA categories of waste generation
 - c. infectious and medical waste
 - d. radioactive waste, including “decay in storage”
 - e. general EPA and RCRA requirements
 - f. importance of tracking and keeping waste manifests
 - g. definition of “cradle to grave” responsibility
 - h. waste disposal in the sanitary sewer
 - i. waste minimization including segregation, planning, reducing, reusing and recycling
 - j. protocols for accidental waste release
12. Define and give examples of the following OSHA terms: administrative controls, engineering controls, work practice controls
13. List important basic work practices that are common to all labs, giving examples, to include:
- a. no eating, drinking, smoking and other hand-to-face contact
 - b. complying with policies on protective equipment, personal dress, working alone, etc
 - c. refraining from jokes, horseplay, drugs and alcohol
 - d. maintaining a neat and clean work area, decontaminating and removing trash as required
 - e. decontaminating hands to include glove removal, handwashing techniques, alcohol gels and segregating sinks
14. Explain the purpose for and correct techniques to select, install, maintain and use safety equipment to include:
- a. safety shower
 - b. eye wash
 - c. personal protective apparel/equipment
 - i. goggles and safety glasses with side shields
 - ii. face shields
 - iii. lab coats and aprons
 - iv. footwear
 - v. gloves - latex, nitrile, vinyl, chemical-resistant
 - vi. masks and respirators
 - vii. ear plugs and muffs
 - d. chemical fume hood
 - e. biological safety cabinet
 - f. containers for sharps and broken glass
 - g. telephones

LEARNING OBJECTIVES (CONTINUED)

- h. signage, including recognition of relevant symbols (eyewash, shower, etc)
- 15. Discuss the causes, signs, symptoms and prevention strategies regarding latex allergies
- 16. Discuss the importance of filing an accident report, the information which should be included in such a report and the analysis and action that should take place after an accident
- 17. Outline how and when OSHA should receive accident reports and what forms should be used
- 18. List and describe the “Check, Call, Care” first steps to take when encountering an accident situation
- 19. Discuss basic first aid in the following categories:
 - a. clearing the airway
 - b. restoring breathing
 - c. restoring circulation - cardiopulmonary resuscitation (CPR) or automated external defibrillator (AED)
 - d. stopping bleeding
 - e. treatment for shock
 - f. treatment for wounds to include:
 - i. chemical and thermal burns
 - ii. bone, muscle and joint injuries
 - iii. eye injuries
 - iv. cuts and punctures
 - g. recognizing and/or treating heart attacks and strokes
- 20. Identify graphic symbols or universal symbols corresponding to the following:
 - a. chemical hazards - flammables, oxidizers, corrosives, poisons, explosives, etc
 - b. biohazard
 - c. radiation hazard
 - d. compressed gas hazard
 - e. laser hazard
 - f. personal protective equipment - gloves, goggles, glasses, lab coats, etc
 - g. safety equipment - deluge shower, eyewash, fire extinguisher, fire blanket, etc
- 21.* Given the location and type of work that a lab does, list and justify the appropriate safety equipment and contents of first aid kits for that lab
- 22.* Given the location and type of work that a lab does, formulate laboratory protocols that meet all applicable safety standards
- 23.* Given an accident case history, list the precautionary measures that should have been taken to prevent the accident
- 24.* Given an accident situation, list the appropriate remedial actions that should be taken

*Denotes terminal objective. The terminal objective indicates what the learner should be able to do upon completion of the text.