Guidelines for Protecting the Safety and Health of Health Care Workers

U. S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer
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Preface

The purpose of the Occupational Safety and Health Act of 1970 (Public Law 91-596) is to ensure safe and healthful working conditions for every working man and woman in the Nation and to preserve our human resources by providing medical and other criteria that will ensure, insofar as practicable, that no workers will suffer diminished health, functional capacity, or life expectancy as a result of their work experience. The Act authorizes the National Institute for Occupational Safety and Health (NIOSH) to develop and establish recommended occupational safety and health standards, and to conduct the necessary research and experimental programs to develop criteria for new and improved occupational safety and health standards. Although this document does not recommend a new standard, it does present guidelines for reducing the incidence of injury and disease among health care workers. Every effort was made to address all major health and safety hazards that might be encountered in hospitals or other health care centers. The document is not intended to affect patients directly, but implementing the guidelines will generally benefit patient care.

The present document is a major revision of an earlier draft and incorporates the most recent NIOSH recommended standards, the Occupational Safety and Health Administration regulations, and Centers for Disease Control guidelines. Also included is specific information from the Joint Commission on...
Accreditation of Healthcare Organizations (formerly the Joint Commission on Accreditation of Hospitals), the National Fire Protection Association, the US Environmental Protection Agency, and other agencies. State and local regulations are not addressed, however, and should be consulted where applicable.

Abstract

These guidelines provide information needed to protect the health and safety of health care workers in hospitals and other health care facilities. The document includes an overview of hospital hazards; methods for developing hospital safety and health programs; discussions of safety hazards, infection diseases, and noninfectious health hazards; methods for disposing of hazardous wastes; and a list of occupational safety and health agencies and resource organizations. Because no single set of health and safety regulations applies to all aspects of hospital work or health care delivery, the guidelines presented here were compiled from many sources, including the National Institute for Occupational Safety and Health, the Centers for Disease Control, the Occupational Safety and Health Administration, the US Environmental Protection Agency, the Joint Commission of Accreditation of Healthcare Organizations, and others. Adherence to these guidelines should reduce the risk of injury and disease among health care workers.

Abbreviations

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<tr>
<th>Abbreviation</th>
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<tr>
<td>AAMI</td>
<td>Association for the Advancement of Medical Instrumentation</td>
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<td>ACGIH</td>
<td>American Conference of Governmental Industrial Hygienists</td>
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<td>ACIP</td>
<td>Immunization Practices Advisory Committee of the US Public Health Service</td>
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<td>ADA</td>
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<td>AHA</td>
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<td>AIDS</td>
<td>acquired immunodeficiency syndrome</td>
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<td>American Industrial Hygiene Association</td>
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<td>ANSI</td>
<td>American National Standards Institute</td>
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<td>BCG</td>
<td>bacille CalmetteGuerin</td>
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<td>BLS</td>
<td>Bureau of Labor Statistics</td>
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<td>CAP</td>
<td>College of American Pathologists</td>
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<td>CAT</td>
<td>computerized axial tomography</td>
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<td>cc</td>
<td>cubic centimeter</td>
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<td>CDC</td>
<td>Centers for Disease Control</td>
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<td>CFR</td>
<td>Code of Federal Regulations</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<td>CMV</td>
<td>cytomegalovirus</td>
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<td>CPC</td>
<td>chemical protective clothing</td>
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<td>cardiopulmonary resuscitation</td>
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<td>decibel</td>
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<td>deoxyribonucleic acid</td>
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<td>ethylene diaminetetraacetic acid</td>
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<td>EPA</td>
<td>U. S. Environmental Protection Agency</td>
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<td>f</td>
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<td>FA</td>
<td>fluorescent antibody</td>
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<td>Food and Drug Administration</td>
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<td>GFCI</td>
<td>ground fault circuit interrupter</td>
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<td>HAV</td>
<td>Hepatitis A virus</td>
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<td>HBIG</td>
<td>Hepatitis B immune globulin</td>
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<td>HBV</td>
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<td>HBeAg</td>
<td>Hepatitis B &quot;e&quot; antigen</td>
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<td>Hepatitis B surface antigen</td>
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<td>HHE</td>
<td>health hazard evaluation</td>
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<td>hemagglutination inhibition</td>
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<td>Health Resources Administration</td>
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<td>Health Resources and Services Administration</td>
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<td>HSV</td>
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<td>human T-lymphotropic virus type III lymphadenopathy-associated virus</td>
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<td>IAHS</td>
<td>International Association of Healthcare Security</td>
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<td>IARC</td>
<td>International Agency for Research on Cancer</td>
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<td>ICU</td>
<td>intensive care unit</td>
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<td>IDLH</td>
<td>immediately dangerous to life or health</td>
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<td>IG</td>
<td>immune globulin</td>
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<td>IHSSF</td>
<td>International Healthcare Safety and Security Foundation</td>
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<td>immune serum globulin</td>
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<td>JCAH</td>
<td>Joint Commission on Accreditation of Hospitals</td>
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<td>kHz</td>
<td>kilohertz</td>
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<td>LCM</td>
<td>lymphocytic choriomeningitis</td>
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<td>Abbreviation</td>
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<td>LPG</td>
<td>liquid propane gas</td>
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<td>licensed vocational nurse</td>
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<td>m</td>
<td>meter</td>
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<td>MeV</td>
<td>million electron volts</td>
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<td>mg/m³</td>
<td>milligram per cubic meter</td>
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<td>MMWR</td>
<td>Morbidity and Mortality Weekly Report</td>
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<td>measles, mumps, and rubella vaccine</td>
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<td>mrem</td>
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<td>MSDS</td>
<td>Material Safety Data Sheet</td>
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<td>mW</td>
<td>milliwatt</td>
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<td>NANB</td>
<td>nonA, nonB viral hepatitis</td>
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<td>NCRP</td>
<td>National Council on Radiation Protection and Measurements</td>
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<td>NEC</td>
<td>National Electrical Code</td>
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<td>National Fire Protection Association</td>
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<td>NICU</td>
<td>neonatal intensive care unit</td>
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<td>NIH</td>
<td>National Institutes of Health</td>
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<td>NIOSH</td>
<td>National Institute for Occupational Safety and Health</td>
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<td>nm</td>
<td>nanometer</td>
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<td>nuclear magnetic resonance</td>
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<td>National Occupational Health Survey</td>
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<td>NRC</td>
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<td>National Safety Council</td>
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<td>National Toxicology Program</td>
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<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
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<tr>
<td>pa</td>
<td>posterior and anterior view</td>
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<tr>
<td>(Pa)</td>
<td>micropascal</td>
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<td>PAA</td>
<td>peracetic acid</td>
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<td>PEL</td>
<td>permissible exposure limit</td>
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<td>PMR</td>
<td>proportionate mortality ratio</td>
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<td>PPD</td>
<td>purified protein derivative</td>
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<tr>
<td>PPDS</td>
<td>purified protein derivativestandard</td>
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<tr>
<td>ppm</td>
<td>part per million</td>
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<tr>
<td>psi(a)</td>
<td>pound per square inch (absolute)</td>
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<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>ptAP</td>
<td>paratertiary amylphenol</td>
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<td>ptBP</td>
<td>paratertiary butylphenol</td>
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<tr>
<td>QNFT</td>
<td>quantitative fit testing</td>
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<tr>
<td>RAD</td>
<td>radiation absorbed dose</td>
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<td>RDL</td>
<td>respirator decision logic</td>
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<td>REL</td>
<td>recommended exposure limit</td>
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<td>rem</td>
<td>roentgen equivalent man</td>
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<tr>
<td>RF</td>
<td>radiofrequency</td>
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<tr>
<td>RN</td>
<td>registered nurse</td>
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<tr>
<td>RSV</td>
<td>respiratory syncytial virus</td>
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<td>RTECS</td>
<td>Registry of Toxic Effects of Chemical Substances</td>
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<tr>
<td>SCE</td>
<td>sister chromatid exchange</td>
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<tr>
<td>SI</td>
<td>Systeme International d’Unites</td>
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<tr>
<td>STEL</td>
<td>shortterm exposure limit</td>
</tr>
<tr>
<td>TB</td>
<td>tuberculosis</td>
</tr>
<tr>
<td>TLD</td>
<td>thermoluminescent dosimeter</td>
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<tr>
<td>TLV (r)</td>
<td>threshold limit value</td>
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<td>TLVC</td>
<td>threshold limit value – ceiling</td>
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<tr>
<td>TLV – skin</td>
<td>threshold limit value – skin adsorption</td>
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<tr>
<td>TLVSTEL</td>
<td>threshold limit value – shortterm exposure limit</td>
</tr>
<tr>
<td>TU</td>
<td>tuberculin unit</td>
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<tr>
<td>TWA</td>
<td>timeweighted average</td>
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<td>UV</td>
<td>ultraviolet</td>
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<td>V</td>
<td>volt</td>
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<tr>
<td>VDT</td>
<td>video display terminal</td>
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<tr>
<td>VZV</td>
<td>varicella zoster virus</td>
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<tr>
<td>W</td>
<td>microwatt</td>
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<tr>
<td>WBGT</td>
<td>wet bulb globe temperature</td>
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Introduction

Health care facilities present workers with a myriad of potential health and safety hazards. Compared with the total civilian workforce, hospital workers have a greater percentage of workers’ compensation claims for sprains and strains, infectious and parasitic diseases, dermatitis, hepatitis, mental disorders, eye diseases, influenza, and toxic hepatitis.

This document contains guidelines for reducing the incidence of injury and disease among health care workers. Although much of the information here was obtained from studies conducted in hospitals, it can also be applied to health care workers in other settings, including outpatient clinics, nursing homes, acute care centers, physicians’ and dentists’ offices, blood banks, and private residences. Workers who provide emergency medical services outside health care facilities have not been addressed because of the unique nature of their work, but medical technicians and others who occasionally provide emergency medical treatment (first aid) may benefit from these guidelines.

Hospitals are regulated and guided in their operations by a wide variety of local, State, and Federal agencies and organizations. As a consequence, no single set of health and safety regulations applies to all aspects of hospital work or health care delivery. The health and safety guidelines in this document were compiled from many sources, including the National Institute for Occupational Safety and Health, the Centers for Disease Control (CDC), the Occupational Safety and Health Administration, the Joint Commission on Accreditation of Healthcare Organizations, the National Fire Protection Association, and the US Environmental Protection Agency.

The document has seven sections. Section 1 is an overview of hospital hazards, and Section 2 contains methods for developing hospital safety and health programs. These sections are organized so that the user can follow a logical progression of recognition, evaluation, and control of hazards. Section 3 focuses on safety hazards such as fires, flammable and explosive materials, electricity, and assaults. Section 4 refers readers to CDC guidelines for protection workers from selected infectious diseases, including acquired immunodeficiency syndrome (AIDS). The applicable CDC guidelines are reprinted in the Appendices. Section 5 contains discussions of noninfectious health hazards, including chemical agents and dusts, physical agents, mutagenic and teratogenic agents, skin irritants, and stress. Section 6 outlines procedures for hazardous waste disposal, and Section 7 contains a directory of occupational safety and healthy agencies and resource organizations.

1. Overview of Hospital Hazards

1.1 Occupational Injury and Illness Among Hospital Workers
Hospitals employ approximately 4.5 million of the 8 million health care workers in the United States, or about 4% of the total US workforce (BLS 1988). The percentage distribution of hospital workers by occupation is shown in Appendix 1.

Few workplaces are as complex as the hospital. not only does it provide the basic health care needs for a large number of people, but it is often a teaching and research center as well. As a result, the list of potential hazards includes radiation, toxic chemicals, biological hazards, heat, noise, dusts, and stress.

Maintenance workers are potentially exposed to solvents, asbestos, and electrical hazards. Persons working in or around boiler rooms are regularly exposed to high levels of noise and heat.

Housekeepers are exposed to detergents and disinfectants that can cause skin rashes and eye and throat irritation. They risk exposure to hepatitis and other diseases from hypodermic needles that have not been discarded properly. Sprains and strains are also common problems for housekeepers.

Food service workers face problems such as cuts from sharp-edged equipment, burns from hot surfaces and steam lines, falls on slippery floors, and fatigue and stress from long periods of standing on hard surfaces. Nonionizing radiation from improperly maintained microwave ovens is a potential hazard. Skin rashes from fresh foods, detergents, and humidity are also common, and excessive exposure to noise has been documented.

Registered nurses, (RN’s), nurse practitioners, and licensed vocational/licensed practical nurses (LVN’s/ LPN’s) confront such potential problems as exposure to infectious diseases and toxic substances, back injuries, and radiation exposure. Nurses also deal with less obvious hazards resulting from stress and shift work.

Radiology technicians are potentially exposed to radiation from X-rays and radioactive isotopes. Even with the adequate maintenance of equipment, risks can result from incorrect work practices (such as holding infants under a radiation beam without adequate self-protection) or from infectious diseases transmitted by patients. Radiology technicians may also be exposed to chemical hazards.

Operating-room workers (both female and male, and the wives of male workers) may face the increased risk of reproductive problems as a result of exposure to waste anesthetic gases. They are also subject to cuts and puncture wounds, infection, radiation, and electrical hazards.

1.1.1 Published Data

A 1972 national survey of occupational health services in more than 2,600 hospitals reported an annual average of 68 injuries and 6 illnesses among workers in each institution (NIOSH 1974-1976). The most frequent injuries were strains and sprains, followed by puncture wounds, abrasions and contusions, lacerations, back injuries, burns, and fractures. The most frequent illnesses were respiratory problems, infections, dermatitis, hepatitis, and drug or medication reactions. Although studies have shown the adverse effects of some hospital hazards such as anesthetic gases, ethylene oxide, and certain cytotoxic rugs, the effects of many others are not well understood. Hazard surveillance data in the hospital industry (NIOSH 1985) have identified 159 known primary skin or eye irritants used in hospitals and 135 chemicals that are potentially carcinogenic, teratogenic, mutagenic, or a combination of these (see Appendix 4).

In 1978, the California State Department of Industrial Relations published injury and illness data for 1976-1977 from an intensive study of hospital personnel (California Department of Industrial Relations, 1978).
The work injury rate in convalescent hospitals (8.4 lost workday cases per 100 full-time workers) was almost double that in acute-care hospitals and in all California industries. Major causes of disabling injury and illness were strain or overexertion, falls or slips, being struck by or striking against objects, burns, and exposure to toxic or noxious substances. Workers with the highest reported number of injuries and illnesses were aides, nursing attendants, orderlies, kitchen workers, housekeeping and maintenance workers, laundry room workers, RN's, LVN's/LPN's, clerks and office workers, and technicians. In Florida, the annual rate of illness and injury reported for hospital workers was 10.0 per 100 workers -- about the same as that recorded for sheet metal workers, auto mechanics, and paper mill workers (American Journal of Nursing 1982).

Two national data systems have been analyzed by Gun (1983): (1) the National Health Interview Survey (1970-1977), which describes the hospital workforce and compares the rates of acute and chronic conditions for hospital workers with those for the total workforce, and (2) compensation data from the Bureau of Labor Statistics. The study compared disease rates for hospital workers with data for all workers combined from the National Health Interview Survey.

1.1.2 Chronic Conditions

Gun (1983) noted that an excessive incidence of some chronic conditions among hospital workers was clearly due to primarily female medical conditions in a predominantly female workforce. After allowance was made for this factor, six conditions of interest were found:

1. **Hypertension**, among service and blue collar workers
2. **Varicose veins**, among nearly all categories of hospital workers
3. **Anemia**, mostly among females, but sex bias was not the sole cause of excess incidence
4. **Diseases of the kidneys and urinary system**, mostly among females (69%), but an excess incidence appeared in all categories of hospital worker
5. **Eczema, dermatitis, and urticaria**, mostly among females (57%), but an excess incidence appeared in most categories of hospital workers
6. **Displacement of intervertebral disc (low-back injury)**, mostly among females (166% relative risk)

No data were provided on the risks of diseases such as cancer or reproductive impairment.

1.1.3 Acute Conditions

Hospital workers had a significantly greater incidence of acute conditions compared with all workers in all categories of sex, race, age, and occupational status (Gun 1983). Respiratory problems accounted for more than half of all acute conditions in both hospital workers and all workers. The incidence of every major category of acute condition was higher in hospital workers than in all workers. The risk for hospital workers was about 1.5 times greater than that for all workers, and it was statistically significant for all conditions, including infectious and parasitic diseases, respiratory conditions, digestive system conditions, and "other" conditions (diseases of the ear, headaches, genitourinary disorders, problems associated with childbirth, disorders of pregnancy and the puerperium, and diseases of the skin and musculoskeletal system). The risk of injury for hospital workers was only slightly greater than for all workers.
1.1.4 Compensable Injury and Disease

A review of data from the Bureau of Labor Statistics (BLS 1983) for compensable injury and disease showed that sprains and strains (often representing low-back injury) were by far the most common type of condition, constituting 51.6% of the total. The data in Table 1-1 also show that cuts, lacerations, and punctures account for a significant number of hospital workers’ compensation claims. Because these injuries also have a potential for contamination with blood and other body fluids, they should be carefully monitored and recorded. Employers should provide medical consultation for workers who sustain puncture wounds involving potentially infectious materials.

The injuries and illnesses listed in Table 1-2 are reported more commonly on hospital workers’ compensation claims compared with those of all civilian workers. An excess percentage of hospital workers’ compensation claims resulted from the following conditions: strains and sprains, dermatitis, serum and infectious hepatitis, mental disorders, ill-defined conditions, eye diseases, influenza, complications peculiar to medical care, and toxic hepatitis.

### Table 1-1

Workers' compensation claims for injury or illness among hospital workers (SIC 806)*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number†</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprains, strains</td>
<td>35,405</td>
<td>51.6</td>
</tr>
<tr>
<td>Contusion, crushing, and bruising</td>
<td>7,635</td>
<td>11.1</td>
</tr>
<tr>
<td>Cuts, lacerations, and punctures</td>
<td>7,374</td>
<td>10.8</td>
</tr>
<tr>
<td>Fractures</td>
<td>3,865</td>
<td>5.6</td>
</tr>
<tr>
<td>Multiple injuries</td>
<td>1,473</td>
<td>2.1</td>
</tr>
<tr>
<td>Thermal burns</td>
<td>1,343</td>
<td>2.0</td>
</tr>
<tr>
<td>Scratches, abrasions</td>
<td>1,275</td>
<td>1.9</td>
</tr>
<tr>
<td>Infections and parasitic diseases</td>
<td>865</td>
<td>1.3</td>
</tr>
<tr>
<td>Dermatitis and other skin conditions</td>
<td>850</td>
<td>1.2</td>
</tr>
<tr>
<td>All other</td>
<td>8,484</td>
<td>12.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>68,569</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

†Figures are adjusted to allow for States that do not provide a sample of their cases.

### Table 1-2.

Conditions reported more commonly on hospital workers' (SIC 806)* compensation claims

<table>
<thead>
<tr>
<th></th>
<th>Hospital workers</th>
<th>All civilian workers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Condition</th>
<th>Number†</th>
<th>%</th>
<th>Number†</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprains, strains</td>
<td>35,405</td>
<td>51.63</td>
<td>649,685</td>
<td>37.76</td>
</tr>
<tr>
<td>Infectious and parasitic diseases:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>35</td>
<td>.05</td>
<td>142</td>
<td>.01</td>
</tr>
<tr>
<td>Conjunctivitis</td>
<td>102</td>
<td>.15</td>
<td>366</td>
<td>.02</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>87</td>
<td>.13</td>
<td>183</td>
<td>.01</td>
</tr>
<tr>
<td>Other</td>
<td>641</td>
<td>.93</td>
<td>2,063</td>
<td>.12</td>
</tr>
<tr>
<td>Total</td>
<td>865</td>
<td>1.26</td>
<td>2,754</td>
<td>.16</td>
</tr>
<tr>
<td>Dermatitis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>68</td>
<td>.10</td>
<td>1,291</td>
<td>.08</td>
</tr>
<tr>
<td>Contact dermatitis</td>
<td>407</td>
<td>.59</td>
<td>9,180</td>
<td>.53</td>
</tr>
<tr>
<td>Allergic dermatitis</td>
<td>106</td>
<td>.15</td>
<td>2,042</td>
<td>.12</td>
</tr>
<tr>
<td>Skin infections</td>
<td>223</td>
<td>.33</td>
<td>812</td>
<td>.05</td>
</tr>
<tr>
<td>Other</td>
<td>22</td>
<td>.03</td>
<td>402</td>
<td>.02</td>
</tr>
<tr>
<td>Skin conditions not elsewhere classified</td>
<td>24</td>
<td>.04</td>
<td>191</td>
<td>.01</td>
</tr>
<tr>
<td>Total</td>
<td>850</td>
<td>1.24</td>
<td>13,918</td>
<td>.81</td>
</tr>
<tr>
<td>Serum and infectious hepatitis</td>
<td>362</td>
<td>.53</td>
<td>903</td>
<td>.05</td>
</tr>
<tr>
<td>Mental disorders</td>
<td>360</td>
<td>.53</td>
<td>5,775</td>
<td>.34</td>
</tr>
<tr>
<td>Ill-defined conditions</td>
<td>263</td>
<td>.38</td>
<td>4,880</td>
<td>.28</td>
</tr>
<tr>
<td>Eye diseases</td>
<td>250</td>
<td>.36</td>
<td>4,805</td>
<td>.28</td>
</tr>
<tr>
<td>Influenza</td>
<td>136</td>
<td>.20</td>
<td>2,389</td>
<td>.14</td>
</tr>
<tr>
<td>Complications peculiar to medical care</td>
<td>114</td>
<td>.17</td>
<td>295</td>
<td>.02</td>
</tr>
<tr>
<td>Toxic hepatitis</td>
<td>37</td>
<td>.05</td>
<td>95</td>
<td>.01</td>
</tr>
<tr>
<td>Total</td>
<td>38,642</td>
<td>56.35</td>
<td>685,499</td>
<td>39.85</td>
</tr>
</tbody>
</table>

*Adapted from information published in the Supplementary Data System by the U.S. Department of
Until recently, safety and health policies in hospitals were developed mainly for patients, not workers. Traditionally, hospital administrators and workers considered hospitals and health institutions safer than other work environments and recognized mainly infectious diseases and physical injuries as risks in the hospital environment. Administrators have therefore emphasized patient care and have allocated few resources for occupational health. The following factors have contributed to the lack of emphasis on worker health:

- Hospital workers have been viewed as health professionals capable of maintaining their health without assistance.
- The availability of informal consultations with hospital physicians reduces the use of worker health services.
- Hospitals are oriented toward treating disease rather than maintain health.

1.2.1 Early Attempts to Protect Workers

Although infectious diseases, like most hospital hazards, were first recognized as risks for patients rather than staff, early attempts to protect patients against hospital infections also benefited workers. For example, Florence Nightingale introduced basic sanitation measures such as open-window ventilation and fewer patients per bed; and the Austrian surgeon, Semmelweis, initiated routine hand-washing more than a century ago. New hazards began to appear in the 1900’s when physicians experimenting with X-rays were exposed to radiation, and operating-room personnel faced possible explosions during surgery involving anesthetic gases. These hazards finally called attention to the many dangers facing hospital workers, and hospitals began to monitor their workers for tuberculosis and other infectious diseases.

1.2.2 Development of Worker Health Programs

In 1958, the American Medical Association (AMA) and the American Hospital Association (AHA) issued a joint statement in support of worker health programs in hospitals. In addition to describing the basic elements of an occupational health program for hospital workers, they stated that “hospitals should serve as examples to the public at large with respect to health education, preventive medicine, and job safety” (AMA 1958). NIOSH subsequently developed criteria for effective hospital occupational health programs (NIOSH 1974-1976) (see Appendix 2).

1.2.3 The NIOSH Hospital Survey

NIOSH undertook the first comprehensive survey of health programs and services for hospital workers in 1972 (NIOSH 1974-1976). Questionnaires sent to hospitals of all sizes throughout the country were completed at more than 2,600 hospitals. The results demonstrated important deficiencies in the worker health programs of most hospitals, especially hospitals with fewer than 100 beds.

Although 83% of the hospitals surveyed gave new workers at least a general orientation on safety and health, only about half of the hospitals had a regular safety and health education program. Only 35% of the small
hospitals had regular safety and health education programs, whereas 70% of the large hospitals had them.

Other inadequacies uncovered by the survey included a lack of immunization programs for infectious disease control (only 39% of surveyed hospitals had such programs) and an absence of in-service training in critical areas (only 18% of surveyed hospitals provided training in six critical areas identified).

Since the NIOSH survey, the number and size of worker health programs in hospitals and health facilities have increased rapidly across the Nation. The number of trained professionals is still limited, however, and although some hospitals have expanded the roles of infection-control committees, others have assigned control duties to security or other administrative personnel who have little training or experience in occupational safety and health.

1.3 Worker Health programs and Safety and Health Committees

Only 8% of the hospitals reporting in the 1972 NIOSH survey (NIOSH 1974-1976) met all nine NIOSH criteria for comprehensive hospital safety and health programs (Appendix 2). Many hospitals have since taken steps to initiate or improve worker health service: (1) Professional organizations have been formed for hospital safety officers and worker health service personnel; (2) the number of articles, books, and other published resources on hospital safety and health have increased dramatically; and (3) several organizations now offer annual conferences on occupational health for hospital workers.

In 1977, NIOSH published a full set of guidelines for evaluating occupational safety and health programs in hospitals. Appendix 2 contains these guidelines. See also Kenyon for the practical design of a full safety and health program.

Some hospitals have established joint labor-management safety and health committees. Labor unions representing workers in other hospitals have formed safety and health committees that have made important contributions by identifying safety and health problems and by educating the workforce about safety and health issues.

Major functions of safety and health committees include the following:

- Inspecting workplaces regularly to identify safety and health hazards
- Regularly reviewing accident rates, results from prevention activities, and other relevant workplace data
- Preparing information for workers on identified hazards
- Organizing educational classes
- Reviewing safety and health aspects when planning new construction or renovating facilities
- Investigating accidents
- Establishing motivational programs (e.g. recognition, awards, and dinners) to stimulate worker participation in safety and health activities.

Strong and effective safety and health committees require the full support and commitment of the hospital
administration. Committee functions should not be informal tasks for the members but a regular part of their job responsibilities.

The safety and health committees of labor unions have played important roles in articulating worker concerns, identifying potential hazards, educating their members, and improving work practices. For example, a union safety and health committee in New York City that was investigating risks associated with handling infectious disease specimens identified clusters of hepatitis cases among personnel in the chemistry laboratory, the intensive care unit, and the blood-gases laboratory. After meeting with hospital representatives and studying the problem, the committee identified several potential problem areas. Specific actions were initiated to correct unsafe work practices and conditions. Such safety and health committees can help ensure safe work environments in hospitals.

1.4 REFERENCES


1.5 ADDITIONAL RESOURCES


2. Developing Hospital Safety and Health Programs

2.1 Addressing Diverse Needs

The diverse safety and health concerns in hospitals are traditionally divided into hazards that pose an immediate threat and hazards that cause long-term health problems. Safety hazards include sharp-edged equipment, electrical current, and floor surfaces that can contribute to slipping or tripping. Health hazards are often more difficult to identify than safety hazards. They may result in an immediate illness or in the long-term development of disease. Although a needle puncture may result in hepatitis in 90 to 180 days, exposure to excess radiation or to some chemicals may not result in any noticeable health effects for 20 to 30 years. Thus workers may appear and feel healthy when, in fact, their health is being seriously threatened. Because workers are often exposed to hazards for which the effects are not well known, they may have difficulty associating a new illness with past workplace exposures.

This section contains steps for developing safety and health programs to identify and control occupational hazards within the hospital setting. These steps are summarized in Table 2-1. Personnel trained in occupational safety and health are needed to design, implement, and manage such a program. Many organizations listed in this manual offer courses designed specifically to train nurses, safety officers, physicians, and nonprofessional workers (see Section 7).

<table>
<thead>
<tr>
<th>Item</th>
<th>Component tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Administrative support</td>
<td>Form a safety and health committee.</td>
</tr>
<tr>
<td></td>
<td>Appoint a safety officer, employee health director, and other responsible personnel.</td>
</tr>
<tr>
<td></td>
<td>Allocate time for surveys and committee meetings.</td>
</tr>
<tr>
<td></td>
<td>Allocate funds to evaluate and monitor hazards, implement controls, and conduct health examinations.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2. Hazard identification</td>
<td>Conduct periodic walk-through inspections.</td>
</tr>
<tr>
<td></td>
<td>Obtain material safety data sheets (USDS's) and other information on potential hazards</td>
</tr>
<tr>
<td></td>
<td>Maintain a log of hazardous chemicals and materials that are used or stored in each department.</td>
</tr>
<tr>
<td>3. Hazard evaluation</td>
<td>Conduct safety inspections and industrial hygiene monitoring of potential hazards and determine needs for hazard controls.</td>
</tr>
<tr>
<td></td>
<td>Conduct medical evaluations.</td>
</tr>
<tr>
<td></td>
<td>Select appropriate medical surveillance programs.</td>
</tr>
<tr>
<td>4. Training</td>
<td>Develop and begin a training program for workers, based on job responsibilities.</td>
</tr>
<tr>
<td>5. Controls</td>
<td>Select appropriate control measures and implement controls and medical surveillance programs as determined in Item 3.</td>
</tr>
<tr>
<td>6. Program review</td>
<td>Preview results of periodic safety inspections, industrial hygiene monitoring, and medical surveillance programs to find patterns of hazards, to measure the success of the safety and health program, and to determine the effectiveness of controls.</td>
</tr>
<tr>
<td></td>
<td>Change the safety and health program as new materials or procedures are introduced or as new hazards are identified in the review process.</td>
</tr>
<tr>
<td>7. Recordkeeping</td>
<td>Maintain records of results for all surveys, evaluations, monitoring, corrective actions, and worker medical examinations. Records must be maintained in accordance with applicable local, State, and Federal regulations.</td>
</tr>
</tbody>
</table>

### 2.1.1 Enlisting Administrative Support

Developing an appropriate and useful safety and health program for a hospital or health facility requires the involvement of a safety and health committee that represents workers and supervisors from all departments in the hospital. Such involvement is essential because workers frequently observe real and potential hazards that supervisory staff, the employee health service, or other safety and health personnel do not recognize. To be effective, committee members should be knowledgeable in occupational safety and health and have explicit responsibilities and appropriate authorities.

### 2.1.2 Identifying Hazards

Hazard identification involves not only recognizing the hazards themselves but also learning their specific characteristics and identifying the population at risk so that control programs can be designed. See also
sections 5 and 7 of this document for further details on obtaining necessary hazard information.

### 2.1.2.1 Walk-Through Inspections

Hospital safety and health personnel should conduct an initial survey of safety hazards such as those outlined in Section 3. The hospital safety and health committee should assist with this in consultation with workers from each department. The first step in identifying hazards is usually a physical inspection called a walk-through survey. Persons conducting the survey actually walk through the unit and note as many hazards as possible.

During a walk-through survey, survey personnel should communicate with supervisors and workers in each department, follow a checklist, and ask any additional questions that may arise. For example, have common health problems been noticed among the workers in the department? Do any hazards exist that are not on the checklist? How is the department different from a typical department of its type? A diagram of each department should be developed to include the number and location of workers and the sources of potential exposure. Several organizations listed in Section 7 have developed sample checklists for walk-through inspections.

### 2.1.2.2 Published Sources of Information

The following references should be consulted when considering the potential toxicity of substances used in the hospital:

2. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards (NIOSH 1978a)
3. NIOSH Pocket Guide to Chemical Hazards (NIOSH 1985)
4. Chemical Hazards of the Workplace (Proctor and Hughes 1978)

### 2.1.2.3 Material Safety Data Sheets

In 1975, NIOSH developed a basic format for material safety data sheets (MSDS’s) to provide information on the content, potential toxicity, recommended handling methods, and special precautions for substances found in the workplace (NIOSH 1974). In 1986, OSHA promulgated a hazard communication standard requiring that the following information be included on MSDS’s (29 CFR* 1910.1200):

- Product identity from the label, including chemical and common names of hazardous ingredients
- Physical and chemical characteristics of ingredients (e.g. vapor pressure and flash point)
- Physical hazards of ingredients (potential for fire, explosion, and reactivity)
- Health hazards associated with ingredients (including signs and symptoms of exposure and any medical conditions generally recognized as being aggravated by exposure to the product)
- Primary routes of entry to the body
• The OSHA permissible exposure limit (PEL), the ACGIH threshold limit value (TLV®), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the MSDS

• An indication as to whether the product and/or ingredients are listed in the National Toxicology Program (NTP) Annual Report on Carcinogens (latest edition) or are designated as a potential carcinogen by OSHA or in the International Agency for Research on Cancer (IARC) Monographs (latest editions)

• Any generally applicable precautions for safe handling and use known to persons preparing the MSDS (e.g. appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for cleanup of spills and leaks)

• Any known, generally applicable control measures (e.g. appropriate engineering controls, work practices, or personal protective equipment)

• Emergency and first aid procedures

• Date of MSDS preparation or last amendment

• Name, address, and telephone number of a responsible party who can provide additional information on the hazardous chemical and on appropriate emergency procedures


NIOSH also recommends that MSDS’s contain the NIOSH recommended exposure limit (REL). MSDS’s must also be updated with any new data on the hazards of a chemical or new methods for protecting workers from the hazards. For further information regarding the identification of hazardous materials, see the OSHA hazard communication standard (29 CFR 1910.1200) and the NIOSH (1974) publication entitled Criteria for a Recommended Standard: An Identification System for Occupationally Hazardous Materials.

Manufacturers are now required by Federal law to provide MSDS’s with their products (29 CFR 1910.1200). The regulation requires that a specific chemical identity be made available to health professionals, workers, and their designated representatives in accordance with the provisions given in the occupational safety and health standard. This regulation also requires employers to develop a written hazard communication program and provide workers with training and information. NIOSH also recommends that hospitals provide completed MSDS’s or their equivalent to personnel in materials management and purchasing or central supply before products are purchased or reordered. The hospital safety and health committee should also maintain a file of MSDS’s. Most MSDS’s now available do not include information on the chronic health effects of low-level exposure, but they do provide information on the acute effects of relatively high levels. 2.1.2.4 NIOSH Policy Documents NIOSH has prepared criteria documents and other recommendations on many hazardous substances. These extensive evaluations of the scientific literature include recommendations to the US Department of Labor for controlling exposures. NIOSH documents are available for the following substances and agents that may be found in hospitals:
<table>
<thead>
<tr>
<th>Substance</th>
<th>Substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos</td>
<td>Ethylene oxide</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Formaldehyde</td>
</tr>
<tr>
<td>Benzene</td>
<td>Hot environments</td>
</tr>
<tr>
<td>Benzidine</td>
<td>Isopropyl alcohol</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>Noise</td>
</tr>
<tr>
<td>Chloroform</td>
<td>Phenol</td>
</tr>
<tr>
<td>Chromium (VI)</td>
<td>Toluene Ultraviolet radiation</td>
</tr>
<tr>
<td>Dioxane</td>
<td>Waste anesthetic gases and vapors</td>
</tr>
<tr>
<td>Ethylene dichloride</td>
<td>Xylene</td>
</tr>
</tbody>
</table>

2.1.2.5 Occupational Health Organizations

A list of occupational health organization appears in Section 7 of this document (Directory of Occupational Safety and Health Information for Hospitals).

2.2 Evaluating Hazards

Once hazards have been identified, they should be evaluated to determine how serious the problems are and what changes can be introduced to control them (See Section 2.3). Methods for measuring exposures to hazards in the workplace are recommended in the NIOSH Manual of Analytical Methods (NIOSH 1984). Health hazards posed by chemicals (in the form of dusts, liquids, or gases), radiation, noise, and heat should be evaluated initially by an industrial hygienist. If no industrial hygienist is available, consultation can be obtained from NIOSH, OSHA, private consultants, or in some cases insurance companies.

After controls are installed, they should be checked periodically to see that they are being maintained and are protecting the workers adequately. A chart or grid should be prepared to list hazardous materials and the departments where they are usually found, exposure limits, precautions to follow, and other relevant factors. Such a chart can be a quick reference and a means of tracking program development.

A hazard evaluation program should consist of the following elements: periodic inspection and monitoring of potential safety and health problems, informal interviewing of workers, medical evaluations, and evaluation of worker exposures and the workplace. The following subsections contain descriptions of each element and definitions of terms commonly used in industrial hygiene standards.

2.2.1 Periodic Inspection and Monitoring of Safety and Industrial Hygiene

When an evaluation reveals a potential hazard and control measures are applied, the hazard should be re-evaluated to determine the effectiveness of the controls. Complex work procedures (e.g. operating-room practices) should be analyzed carefully, noting products and byproducts formed during the procedures.

The frequency with which hazards should be monitored depends, among other things, on the extent of exposure to the agent, the severity of the adverse effects, the complexity of the work process, seasonal variations of temperature and humidity, and protective measures. OSHA regulations mandate inspection schedules for a few substances such as asbestos (29 CFR 1910.1001). Experience and a high degree of awareness will allow each hospital safety and health committee to decide on an appropriate inspection schedule for each department.

2.2.2 Informal Interviews of Workers
In the first assessment of hazards in each work unit, a short questionnaire or informal interview with the workers may identify problems that are not easily noted by visual inspection. For example, questionnaires, informal discussions, or physical inspections may reveal a potential for back strain resulting from poor work practices, stress caused by staffing or shift rotation systems, or inadequate training for handling infectious materials. The following general questions should be posed:

- Since starting the job, has the worker developed any new health problems or have existing problems worsened? What symptoms have been observed? When did the symptoms begin or become more severe? When did the problems improve or become less noticeable?

- Has the worker noticed any health problems in the other workers in the same department that may be related to or caused by their work?

- Is there anything in the job that might affect the worker’s health or the safety and health of other workers now or in the future?

The last question will also help identify worker concerns about the future safety and health effects of their current exposures. Remember, however, that workers may not notice a connection between symptoms and causative agents. Thus a negative response to the above questions does not necessarily mean that no safety or health problems exist. A positive response may also indicate a safety or health problem resulting from nonwork activities.

2.2.3 Medical Evaluations

The signs and symptoms that workers experience should be evaluated medically, taking care to avoid preconceptions about which ones are work related. The potential health effects of each exposure should be determined using the references mentioned earlier in this section (Subsection 2.1.2.2). An occupational history should also be maintained for each worker to help evaluate the long-term effects of exposures. This history should contain at least the worker’s prior occupations and job titles, the duration of employment at each job, and the name of any substance or agent to which the worker may have been exposed.

2.2.4 Environmental Evaluations

An industrial hygienist may take area samples, personal samples, or wipe samples to help determine the extent of a workplace hazard. Most methods for chemical sampling require laboratory analysis, which should be performed by a laboratory accredited by the American Industrial Hygiene Association. The safety officer should consider using direct-reading instruments that are available. These are discussed in Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ACGIH 1983).

2.2.4.1 Area Samples

Area samples from the general work space can measure the extent of potential worker exposure to chemicals, extreme temperatures, excessive noise, ionizing and nonionizing radiation, and other environmental stressors. Industrial hygienists may monitor work environments with equipment that provides information immediately, or they may use methods that require laboratory analysis of collected samples. Direct-reading sampling devices include colorimetric detector tubes, mercury "sniffers", infrared spectrophotometers, microwave survey meters, and sound-level meters. Air samples for such substances as nitrous oxide, formaldehyde, ethylene oxide, and asbestos may require laboratory analysis. Sometimes both types of sampling devices exist for the same chemical, and the choice depends on the precision and accuracy required.
2.2.4.2 Personal Samples

Personal samples are used to measure contaminants in the worker’s breathing zone. Evaluations of personal exposure to chemical dusts, fumes, gases, and vapors are frequently expressed as an 8-hr time-weighted average (TWA) concentration (which is the average exposure concentration during an 8-hr workday) or as a short-term exposure concentration. The two main types of personal sampling devices are:

1. A pump mounted on the worker’s belt that provides suction and draws air from the worker’s lapel (breathing zone) through a tube and into the collection medium attached to the pump, and

2. A passive dosimeter (often like a large button), which can be clipped to the worker’s lapel and absorbs substances from the surrounding air.

2.2.4.3 Wipe Samples

Wipe samples are analyzed to measure the contamination of work surfaces.

2.2.5 Occupational Safety and Health Standards

Worker safety and health is the responsibility of the Occupational Safety and Health Administration (OSHA), which was established in the US Department of Labor by the Occupational Safety and Health act of 1970 (Public Law 91-596). The principal function of OSHA is to promulgate and enforce workplace safety and health standards, which are contained in Volume 29 of the Code of Federal Regulations. The Occupational Safety and Health Act also created the National Institute for Occupational Safety and Health (NIOSH). The principal functions of NIOSH are to conduct research and to recommend new and improved safety and health standards to OSHA. Throughout this document, reference is made to OSHA standards and NIOSH recommendations. OSHA standards for exposure to airborne chemicals are generally referred to as permissible exposure limits (PEL’s). NIOSH recommendations for controlling airborne contaminants are referred to as recommended exposure limits (REL’s). The OSHA PEL’s are legally enforceable standards that must also be economically feasible, whereas the NIOSH REL’s are recommended standards based solely on public health considerations.

The American Conference of Governmental Industrial Hygienists (ACGIH) is a professional association that recommends limits for airborne contaminants, called threshold limit values (TLVs). TLVs are intended to serve only as guidelines for the professional industrial hygienist; they are not intended to be enforceable exposure limits.

2.2.5.1 Terms Used in Industrial Hygiene Standards The following terms are used in Federal standards or recommendations for the workplace.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEL</td>
<td>Permissible exposure limit. A PEL is the maximum airborne concentration of a substance regulated by OSHA to which a worker may be exposed. These values are enforced by law.</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts per million.</td>
</tr>
<tr>
<td>REL</td>
<td>Recommended exposure limit. A NIOSH REL is the maximum recommended exposure to a chemical or physical agent in the workplace. The REL is intended to prevent adverse health effects for all occupationally exposed workers.</td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>TLV</td>
<td>Threshold limit value. A TLV is the airborne concentration of a substance to which nearly all workers can be exposed repeatedly day after day without adverse effect (ACGIH 1987). ACGIH recommends and publishes these values annually on the basis of the most current scientific interpretations. TLVs are not OSHA standards and are not enforced by law.</td>
</tr>
<tr>
<td>TLV-C</td>
<td>Threshold limit value ceiling. The TLV-C is the airborne concentration of a substance that should not be exceeded even for an instant during any part of the working exposure (ACGIH 1987).</td>
</tr>
<tr>
<td>TLV-SKIN</td>
<td>Threshold limit value-skin adsorption. TLV-SKIN refers to the potential contribution of absorption through the skin including mucous membranes and eyes to a worker’s overall exposure by either airborne or direct contact with a substance (ACGIH 1987).</td>
</tr>
<tr>
<td>TLV STEL</td>
<td>Threshold limit value short-term exposure limit. The TLV-STEL is the maximum exposure concentration allowed for up to 15 min during a maximum of four periods each workday. Each exposure period should be at least 60 min after the last period (ACGIH 1987).</td>
</tr>
<tr>
<td>TWA</td>
<td>Time-weighted average. The TWA is the average exposure concentration during an 8-hr workday. Exposure for more than 8 hr per day or more than 40 hr per week, even at or below the TLV or PEL, may represent a health hazard. NIOSH recommendations typically include 10-hr TWA’s for up to a 40-hr workweek. The TWA for an 8-hr workday is calculated as follows:</td>
</tr>
</tbody>
</table>

$$\text{sum of } \{ (\text{exposure period}) \times (\text{exposure concentration}) \} \text{ for each exposure period}$$

---

$$\text{8-hr workday}$$

For example, formaldehyde exposure in a laboratory might be:

$$\frac{(5 \text{ ppm} \times 2 \text{ hr}) + (1 \text{ ppm} \times 6 \text{ hr})}{8 \text{ h-hr workday}} = 2.0 \text{ ppm TWA}$$
2.3 Controlling Hazards

Once potential exposures and safety problems in the hospital have been identified and evaluated, priorities should be established for controlling the hazards. Identified safety hazards should be promptly corrected, and educational programs should be developed on subjects such as correct lifting procedures and the handling of electrical equipment. Workers who are potentially exposed should be fully informed and trained to avoid hazards, and controls should be instituted to prevent exposures. Control methods that can be used for environmental hazards include substitution, engineering controls, work practices, personal protective equipment, administrative controls, and medical surveillance programs. Each of these methods is discussed in the following subsections.

2.3.1 Warning Systems

Any system designed to warn worker of a hazard should

- Provide immediate warnings of potential danger to prevent injury, illness or death
- Describe the known acute (short-term) or chronic (long-term) health effects of physical, chemical, and biologic agents
- Describe any safety hazards that might be encountered, including chemical exposures that might result in traumatic injuries
- Indicate actions for preventing or reducing exposure to hazards
- Provide instructions for minimizing injury or illness in the event exposure has already occurred
- Include a plan for dealing with emergency situations
- Identify the population at risk so that information is provided to the correct group of workers
- Identify actions to be taken in the case of illness or injury

2.3.2 Substitution
The best way to prevent occupational safety and health problems is to replace the offending agent or hazard with something that is less hazardous. For example, highly explosive anesthetic gases have been replaced by nonflammable gases. Replacements for asbestos are being used in new construction, and cleaning agents are often changed when workers complain of dermatitis.

2.3.3 Engineering Controls

Engineering controls may involve modifying the workplace or equipment to reduce or eliminate worker exposures. Such modifications include both general and local exhaust ventilation. Isolating patients or work processes from the hazard, enclosing equipment or work processes (as in glove-box cabinets), and altering equipment (such as adding acoustic padding to reduce noise levels).

2.3.4 Work Practices

How workers carry out their tasks may create hazards for themselves and others. For example, staff, nurses, or doctors who do not dispose of used needles safely create a severe hazard for housekeepers, laundry workers, and themselves. Workers sometimes perform tasks in ways that create unnecessary exposures. This includes staff members who try to lift patients without assistance and laboratory workers who pipette by mouth rather than by rubber bulb, thereby increasing their risk of injury or contamination.

2.3.5 Personal Protective Equipment

Personal protective equipment includes gloves, goggles, aprons, respirators (not surgical masks), ear plugs, muffs, and boots. Although the use of such equipment is generally the least desirable way to control workplace hazards because it places the burden of protection on the worker, the equipment should be available for situations when an unexpected exposure to chemical substances physical agents, or biologic materials could have serious consequences.

Personal protective equipment is frequently uncomfortable and difficult to work in, and it must be adequately maintained. Maintenance requires constant supervision and training. The use of respirators also requires frequent testing to ensure adequate fit for each wearer. For this reason, the policy of OSHA and NIOSH has been to use personal protective equipment for preventing inadvertent exposures that are threatening to health or life only when (1) engineering and administrative controls are not feasible, (2) such controls are being developed or installed, (3) emergencies occur, or (4) equipment breaks down.

The proper selection of chemical protective clothing (CPC) requires an evaluation by a trained professional such as an industrial hygienist. The selection process must include

- Assessing the job or task
- Determining the body parts that need to be protected
- Determining the necessary flexibility and durability that will allow the worker to perform the job or task
- Assessing the exposure situation in view of the chemicals present, the toxicity of those chemicals, and the concentrations to which workers will be exposed
- Assessing existing laboratory data on the capacity of CPC to withstand contact with the chemicals
during use and to prevent penetration by those chemicals (permeation data are available for many chemical and CPC materials (ACGIH 1985) and should be consulted)

- Evaluating candidate materials in the laboratory and, if possible, at the worksite

Standard operating procedures for the proper use of CPC should be established and should include

- Training in proper ways to put on and take off CPC
- Training in proper disposal methods
- Periodic evaluation of the effectiveness of the CPC

NIOSH does not recommend reuse of CPC unless data are available that demonstrate the efficacy of decontamination procedures in maintaining the effectiveness of the CPC against the chemicals used.

Recommendations for personal protective equipment for chemical hazards are also discussed in the NIOSH Pocket Guide to Chemical Hazards (NIOSH 1985) and the NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards (NIOSH 1981a).

2.3.5.1 Eye and Face Protection

Eye protection or face shields are required when the worker may be injured by flying particles, chips, or sparks or splashed by such liquids as caustics, solvents, and blood or body fluids. Workers should wear protective equipment and clothing when they use machinery that produces dusts and chips or when they handle toxic and corrosive substances. Eye and face shields should provide adequate protection against the particular hazards to which the worker is exposed. The equipment should be easy to clean and disinfect. If workers who wear glasses must also wear goggles, the goggles should fit over the glasses, or the corrective lenses should be mounted behind the protective lenses.

2.3.5.2 Head Protection

Protective head coverings (hard hats) should be required in situations where workers may be struck on the head by falling or flying objects.

2.3.5.3 Foot Protection

Safety shoes are recommended to prevent injury to the feet from falling objects and other hazards. They are particularly important where heavy materials or parts are handled and during shipping and receiving operations. Appropriate footwear with good traction should be worn for wet or slippery areas. Periodic conductivity checks should be made on footwear worn in surgical areas, and disposable shoe covers should be readily available to minimize the potential for static electricity in surgical areas.

2.3.5.4 Gloves, Aprons, and Leggings

Aprons and leggings may be necessary for workers in some operations, depending on the type of hazard. Gloves and arm protectors should be used to prevent lacerations from sharp edges, to prevent contact with chemical and biologic materials, to prevent burns, and to provide shielding from radiation.
2.3.5.5 Hearing Protection

If noise levels exceed current standards, workers must be provided with hearing-protection devices and directed to wear them (29 CFR 1910.95).

2.3.5.6 Respiratory Protection

The employer must provide approved respiratory protection (not surgical masks, which do not provide respiratory protection) when the air is contaminated with excessive concentrations of harmful dusts, fumes, mists, gases, vapors, or microorganisms. Respiratory protection may be used as a control only when engineering or administrative controls are not feasible or while these controls are being developed or installed.

Respirators must be selected by individuals knowledgeable about the workplace environment and the limitations associated with each class of respirator. These individuals must also understand the job tasks to be performed. The correct use of a respirator is as important as the selection process. Without a complete respiratory protection program, workers will not receive the protection anticipated even if the respirator has been correctly chosen. Training, motivation, medical evaluation, fit testing, and a respirator maintenance program are critical elements of an adequate respiratory protection program.

NIOSH has recently updated its "Guide to Industrial Respiratory Protection", which covers the selection, use, and maintenance of respiratory protective devices (NIOSH 1987a). NIOSH has also developed a respirator decision logic (RDL) (NIOSH 1987b) to provide knowledgeable professionals with a procedure for selecting suitable classes of respirators. The RDL identified criteria necessary for determining the classes of respirators that provide a known degree of respiratory protection for a given work environment, assuming the respirators are used correctly.

The criteria and restrictions on respirator usage in the following two subsections were adapted from the NIOSH RDL (NIOSH 1987).

2.3.5.6.1 Criteria for selecting respirators

The first step is to determine which contaminants the worker are exposed to and then to assemble the necessary toxicologic, safety, and other relevant information for each. This information should include

- General use conditions
- Physical, chemical, and toxicologic properties
- Odor threshold data
- NIOSH recommended exposure limit (REL) or OSHA permissible exposure limit (PEL), whichever is more protective; if no REL or PEL exists use another recommended exposure limit
- The concentration of the contaminant believed to be immediately dangerous to life or health (IDLH)
- Potential for eye irritation
- Any service life information available for cartridges and canisters
2.3.5.6.2 Restrictions and requirements for all respirator use

The following requirements and restrictions must be considered to ensure adequate protection by the selected respirator under the intended conditions for use:

1. A complete respiratory protection program should be instituted and should include information on regular worker training, use of the respirator in accordance with the manufacturer’s instructions, fit testing, environmental monitoring, and maintenance, inspection, cleaning, and evaluation of the respirator. Whenever possible, quantitative evaluation of the protection factor should be performed in the workplace to confirm the actual degree of protection provided by the respirator to each worker. Minimum respiratory protection requirements for air contaminants can be found in the OSHA Safety and Health Standards (29 CFR 1910.134) and in separate sections for specific contaminants (e.g., 1910.1001 for asbestos, and 1910.1025 for lead (see Section 5 of this document)).

2. Qualitative or quantitative fit tests should be conducted as appropriate to ensure that the respirator fits the individual. Periodic evaluations should be made of the effectiveness of each respirator during workplace use. When quantitative fit testing is used, the fit-factor screening level should be chosen with caution, recognizing the uncertainty of its effectiveness (no studies have demonstrated which fit factor values provide adequate acceptance of rejection criteria for quantitative fit screening).

3. Negative-pressure respirators should not be used when facial scars or deformities interfere with the face seal.

4. No respirator (including positive-pressure respirators) should be used when facial hair interferes with the face seal.

5. The respirators should be maintained properly, used correctly, and worn conscientiously.

6. The usage limitations of air-purifying elements (particularly gas and vapor cartridges) should not be exceeded.

7. All respirators must be approved by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA).

8. Workers should be instructed to leave a contaminated area immediately if they suspect that the respirator has failed.

9. Workers are usually not exposed to a single, unvarying concentration of a hazardous substance, but exposures may vary throughout a workshift and from day to day. Thus the highest anticipated concentration should be used to compute the required protection factor for each respirator wearer.

10. Respirator wearers should be aware of the variability in human response to the warning properties of hazardous substances. Thus when warning properties must be relied on as part of a respiratory protection program, the employer should screen each prospective wearer for the ability to detect warning properties of the hazardous substance(s) at exposure concentrations below the REL or PEL, whichever is more protective.

2.3.6 Administrative Controls
Administrative controls involved reducing total daily exposure by removing the worker from the hazardous area for periods of time. These controls are used when it is impractical to reduce exposure levels in the workplace through engineering controls. Administrative controls include (1) rescheduling work to reduce the necessity of rotating shifts, and (2) increasing the frequency of rest period for persons who work in hot environments.

2.3.7 Medical Monitoring Programs

2.3.7.1 Designing the Program

Appropriate medical procedures exist to evaluate the extent of some workplace exposures (e.g. measuring lead levels in blood) or the effects of exposure on the worker’s health (e.g. measuring hearing loss).

Section 5 contains the specific tests appropriate for some common hospital hazards. A medical monitoring program should be designed for each department based on information from safety and health walk-through surveys and industrial hygiene evaluations.

The following questions should be considered for designing medical monitoring programs:

- Are the selected tests specific to the potential exposures? Multiphasic or other general examinations do not target specific hazards.

- Are the selected tests likely to detect adverse health effects? A chest X-ray may detect asbestosis, but asbestosis does not usually develop until 10 or more years after first exposure. Thus a yearly chest X-ray for asbestosis would not help new workers.

- Are there any side effects from the selected test? A chest X-ray may detect some diseases, but it also exposes a worker to radiation. The potential test benefits must be weighed against potential harm.

Specific tests for each job category should be incorporated into the monitoring program of the worker health service. Appendix 2 contains NIOSH recommendations for general safety and health programs, including pre-employment, preplacement and periodic worker health examinations. In addition, the worker health service may test for conditions that are not necessarily job related but are important for promoting general worker health (e.g. high blood pressure) or are specific to the region (e.g. some hospitals in the southwestern United States routinely administer skin tests for coccidioidomycosis in preplacement physicals).

2.3.7.2 Consent and Confidentiality

Before certain immunizations (e.g. M-M-R {measles, mumps, rubella} and Heptavax-B vaccinations) are given, workers should read, sign, and date informed consent forms designed to alert them to potential side effects. The results of medical testing should be provided directly and confidentially to individual workers. The workers and the safety and health committee should receive group results of testing by work unit (e.g. a table of audiometry result for maintenance worker) to assess the adequacy of worker protection in each unit; individual workers should not be identified.

If a worker must be temporarily or permanently removed from a job for occupational safety or health reasons, the employer should be informed without receiving actual medical information. For example, the notification should read, "Jane Doe may not continue to be exposed to solvents and must be transferred out of the histology section", rather than, "Jane Doe has liver disease and must be transferred out of histology".
2.3.7.3 Recordkeeping

adequate recordkeeping is very important: (1) to track the safety and health of individual workers and work groups over time, (2) to provide documentation for future evaluations, (3) to help the hospital administration and the safety and health committee identify problem areas, and (4) to measure the effectiveness of safety and health programs.

Many specific OSHA standards (e.g. for ethylene oxide and asbestos) contain detailed provisions for recordkeeping, monitoring, and medical surveillance. These standards should be consulted. In 29 CFR 1904, the Department of Labor also requires all employers covered by the Occupational Safety and Health act of maintain logs of all occupational injuries and illnesses that have occurred in their workplaces over the last calendar year. These logs (usually OSHA form 200) must be posted in conspicuous places where notices to worker are usually posted. The employer must maintain these records for at least 5 years and provide access to these records for the Secretary of the Department of Health and Human Services. Workers and their representatives also have the right to access these records. When there is a specific standard for a substance, OSHA generally requires that records be maintained for at least the duration of employment plus 30 years.

2.3.7.4 Preplacement Evaluations

Preplacement physical examinations are very important for establishing baselines (pre-exposure measurements of health) and for ensuring that the worker is physically able to perform the job. The Centers for Disease control (CDC), the American Hospital Association (AHA), and State hospital codes have developed guidelines for screening new hospital workers. The results of the hazard identification procedures outlined in this section should be used to design appropriate preplacement programs. For example, when a person is hired for a position that may require the use of respiratory protection, the preplacement examination should include an evaluation of the worker’s physical ability to wear a respirator.

Because many workers do not have general medical examinations regularly, some worker health services in hospitals include a simplified general medical questionnaire and examination when tests are given for more specific reasons. A report of 3,599 preplacement examinations in a large teaching hospital indicated that the most frequent problems involved (1) susceptibility to communicable diseases such as diphtheria or rubella, or (2) the potential for disease transmission, as indicated by tuberculin-positive skin tests, intestinal parasites in stool examinations, positive serological tests for syphilis, or the presence of the hepatitis B surface antigen. The most frequent noninfectious illnesses were hypertension and anemia (Schneider and Dykan 1978).

2.4 Occupational Safety and Health Agencies and Organizations

Several agencies and organizations are involved in promoting safety and health in hospitals, and significant differences exist among state agencies that hold enforcement powers. Federal agencies such as NIOSH help assess potential hazards and make recommendations for correction without the threat of citation or penalty. Private organizations such as the AHA and the National Safety Council (NSC) also develop recommendations and provide materials and assistance. The major agencies and organizations that develop regulations, standards, recommendations, and codes for occupational safety and health in hospitals are described briefly below. Other organizations addressing more specific groups of health professionals (e.g. the College of American Pathologists) are listed in Section 7.

2.4.1 Occupational Safety and Health Administration

The Occupational Safety and Health Administration (OSHA) is responsible for promulgating and enforcing
standards in most workplaces, including Federal and private sector hospitals. About half of all States have approved State OSHA plans, which must be at least as effective as Federal plans in providing for safe and healthful employment. State plans may also cover hospitals operated by State and local governments. OSHA offices are listed in Section 7.

OSHA has developed specific standards for hazards such as noise, mercury, ethylene oxide, and asbestos. Also, a general duty clause states that employers must provide their worker with "employment and a place of employment which are free from recognized hazards that are likely to cause death or serious physical harm...."(Public Law 91-596).

OSHA has the authority to inspect workplaces in response to requests from workers or as part of targeted or routine inspection schedules. Citations and fines may be imposed for violations discovered during these inspections. OSHA also has a free consultation service that provides employers with evaluations of workplace hazards and advice on control methods without the risk of citations or fine -- provided the employer agrees to abate any serious hazards identified during a consultation. OSHA has a referral system for serious violations that are not abated after a consultation visit.

2.4.2 National Institute for Occupational Safety and Health

The National Institute for Occupational Safety and Health (NIOSH) conducts research on workplace hazards and recommends new or improved standards to OSHA. NIOSH also investigates specific workplace hazards in response to requests by worker or employers. Although NIOSH has the same right of entry as OSHA to conduct health hazard evaluations (HHE’s), NIOSH can only recommend hazard controls and has no enforcement authority. HHE’s can be particularly useful where the causes of workplace hazards are unknown, where a combination of substances may be causing a problem, or where a newly recognized health effect is suspected for a substance that is already regulated. NIOSH also investigates potential health hazards on an industry wide basis, performs research on methods for controlling safety and health hazards, recommends standards to OSHA for promulgation, publishes and distributes NIOSH studies and investigations, and provides training programs for professionals. For more detailed information on the NIOSH HHE program, refer to a Worker’s Guide to NIOSH (NIOSH 1978). NIOSH also assesses and documents new hazards control technology for processes and specific hazards. An article by Kercher and Mortimer (1987) is an example of such an assessment.

In addition to conducting HHE’s and control technology assessments, NIOSH investigates the circumstances of fatal accidents and recommends safe work practices and controls to reduce or eliminate hazards.

2.4.3 Centers for Disease Control

The Centers for Disease Control (CDC) is a Federal public health agency based in Atlanta, Georgia. Among other responsibilities, CDC is charged with the surveillance and investigation of infectious diseases in hospitals. CDC collects weekly, monthly, and yearly statistics on many infectious diseases, on control programs and activities for hospital infections, and on new problems as they appear. The Agency is also charged with making recommendations necessary for disease control.

2.4.4 Health Resources and Services Administration

Under the Hill-Burton legislation (Public Law 79-725, as amended), the health Resources Administration (HRA) (now the Health Resources and Services Administration [HRSA] published Minimum Requirements of Construction and Equipment for Hospital and Medical Facilities (HRS 1979). Hospitals receiving Federal assistance must comply with these regulations.
2.4.5 Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) adopts and enforces standards for departments of nuclear medicine in hospitals, although some states have agreements with the federal government to assume these responsibilities. In these cases, the responsible state agency is usually the state health department. NRC regulates roentgenogram sources (title 21) and all radioactive isotope sources except radium (Title 10) (21 CFR 100-1050 {1958}; 10 CFR 20 and 34 {1985}) but does not have authority to regulate naturally occurring radioactive materials such as radium or radon. The Food and Drug Administration (FDA) is responsible for those regulations. NRC publishes and continuously revises guides to describe methods acceptable for implementing specific parts of the Commission’s regulations. These guides are published and revised continuously.

2.4.6 State, County, and Municipal Health Agencies

With some variation, state health departments adopt and enforce regulations in the following areas: radiation, nuclear medicine, infectious disease control, infectious disease and hazardous waste disposal, and food handling. In some states, the health department and the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) (formerly the Joint Commission on Accreditation of Hospitals (JCAH) accredit hospitals jointly. Both the JCAHO and the State health departments have the patient’s rather than the worker’s safety and health as their primary concern. Thus the accreditation requirements are not fully developed in the area of worker health protection. County and city health departments also have jurisdiction over food handling and some other hospital functions, and they help evaluate many potential hazards regulated at the state level.

2.4.7 Joint Commission on Accreditation of Healthcare Organizations

The Joint Commission on Accreditation of Healthcare Organization (JCAHO) re-evaluates the accreditation every 3 years for hospitals that choose to apply. The accreditation inspections reflect a primary concern for patients’ safety and health, but JCAHO does require hospitals to establish policies and procedures for monitoring and responding to safety and health hazards.

2.4.8 National Fire Protection Association

The National Fire Protection Association Code for Safety to Life from Fire in Buildings and Structures (NFPA 1985) is the most basic and complete code for fire safety in hospitals. OSHA, JCAHO, and HRSA have adopted portions of this and other NFPA codes, although the specific references are often to earlier versions.

2.4.9 National Safety Council

The National Safety Council (NSC) recommends general safety and (in the case of ethylene oxide) health recommendations. The hospital section of NSC is responsible for preparing recommendations for hospitals, whereas the research and development and chemical sections are responsible for laboratory safety guidelines.
2. Developing Hospital Safety and Health Programs (continued)

2.5 REFERENCES


nst~tute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-181.


2.6 ADDITIONAL RESOURCES


Association and National Safety Council.


This page was last updated: April 27, 1998
3. Recommended Guidelines for Controlling Safety Hazards in Hospitals

The hospital work environment contains many safety hazards such as wet floors, flammable or explosive liquids, and tasks requiring heavy lifting. The most common hazards are well-recognized, but others can only be recognized and corrected by trained workers. This section covers some of the most common safety hazards in hospitals and the special hazards that can be present in particular hospital departments (See Appendices 5, 6, and 8 for information about needle-puncture wounds).

3.1 Types of Safety Hazards

3.1.1 Physical Exertion

3.1.1.1 Hernias

Hernias develop when an act of lifting or straining caused increased pressure in the abdomen and bowel or when the tissue that covers the bowel is pushed through a weak area in the abdominal wall. Although pain may be the first symptom, a noticeable bulge in the scrotum, lower abdomen, or thigh may also be observed.

3.1.1.2 Back Injuries

Nearly 50% of all compensation claims for hospital workers involved back injuries (Health Alert 1978). In 1978, back injuries accounted for approximately 25 million lost workdays and about $14 billion in treatment costs among all workers in the United States (Goldberg et al. 1980). Data from the Bureau of Labor Statistics for 1980 indicate that nurses aides, orderlies, and attendants in New York filed workers’ compensation claims for back sprains and strains more frequently than did workers in any other occupation (8.26 claims/1000 eligible workers). Claims from licensed practical nurses ranked third (5.62 claims/1000 eligible workers), while those from registered nurses ranked sixth (2.20 claims/1000 eligible workers) Other health care categories ranked in the top ten included health aides (not nursing aides), radiologic technicians, and health-record technicians (Jensen 1986). Frequently, these workers must lift and move patients without adequate help.

3.1.1.2.1 Frequent causes of back pain

Lloyd et al. (1987) list the most common causes of all work-related back pain as (1) job performance by a worker who is unfit or unaccustomed to the task, (2) postural stress, and (3) work that approaches the limit of a worker’s strength. Factors that contribute to these causes of back pain are understaffing, the lack of regular training programs in proper procedures for lifting and other work motions, and inadequate general safety precautions.

Specific causes of back problems for hospital workers are listed below by type of worker:
Food service workers: Pushing or pulling carts, lifting heavy food trays, and moving dishes, racks, and containers

Housekeepers: Lifting and setting down objects, and using scrubbing machines, brooms, and mops

Clerical workers: Using chairs that are not designed for desk work and do not provide the proper support

Laundry workers: Pushing or pulling carts

Maintenance workers: Lifting, moving, and handling large packs, boxes, or equipment

Patient-care providers: Assisting patients and raising or lowering beds

3.1.1.2.2 Preventing back injuries

Written guides and programs for preventing back injury are available for all workers and specifically for hospital workers. NIOSH has published a general guide, Work Practices Guide for Manual Lifting (NIOSH 1981b), which contains weight-limit recommendations. The Back Pain Association and the Royal College of Nursing in the United Kingdom have together published a comprehensive guide for nurses entitled The Handling of Patients: A guide for Nurses (Lloyd et al. 1987). This document contains discussions on the anatomy and physiology of the back, the causes of back pain, preventive approaches, principles for handling patients, and aids for lifting patients.

The primary approach to preventing back injury involves reducing manual lifting and other load-handling tasks that are biomechanically stressful. The secondary approach relies on teaching workers how to (1) perform stressful tasks while minimizing the biomechanical forces on their backs, and (2) maintain flexibility and strengthen the back and abdominal muscles.

The most important elements in a program to prevent back injuries among hospital staff are

- Mechanical devices for lifting patients and transferring cart tops, X-ray tables, and other heavy objects
- Wheels and other devices for transporting heavy, nonportable equipment
- Adequate staffing to prevent workers from lifting heavy patients or equipment alone
- Close supervision for newly trained workers to assure that proper lifting practices have been learned
- In-service education for both new and experienced staff on the proper measures for avoiding back injuries
- Preplacement evaluation of workers. Workers with significant pre-existing back disorders should not be assigned jobs that require lifting. A history of current lower-back pain is the primary basis for excluding workers from jobs that required lifting. Routine lower-back (lumbar) X-rays are not recommended for preplacement evaluations because studies indicate they do not predict which workers will suffer future back injuries. Preplacement strength testing may occasionally help in assigning workers to tasks that routinely involved moving very heavy objects. Several articles listed in
the Additional Resources for this section present methods for analyzing the physical demands of a job and the strength of a job applicant.

Training programs for workers should emphasize

- Proper lifting techniques (Lloyd et al. 1987; NIOSH 1981b)

- Preventing initial back injuries. Because a back that has already sustained an injury is much more likely to be reinjured, preventing the first back injury is the most important step.

- Requesting help. When in doubt about whether a task may strain the back, a worker should request help rather than taking a chance.

- Performing back exercises. Some exercises can be used to strengthen the back muscles and help prevent back injuries. A physician or physical therapist should be consulted.

- Transferring patients. Patient transfers are particularly hazardous for hospital workers and are not often covered in general publications on preventing back injury. The following special points should be emphasized to prevent back injuries during transfers
  - Communicate the plan of action to the patient and other workers to ensure that the transfer will be smooth and without sudden, unexpected moves
  - Position equipment and furniture effectively (for example, move a wheelchair next to the bed) and remove obstacles
  - Ensure good footing for the staff and patient (patients should wear slippers that provide good traction)
  - Maintain eye contact and communication with patient: be alert for trouble signs
  - If help is needed, request that a co-worker stand by before attempting the transfer
  - Record any problems on the patient’s chart so that other shifts will know how to cope with difficult transfers; note the need for any special equipment, such as a lift.

- Reducing accident hazards such as wet floors, stairway obstructions, and faulty ladders. Wet-floor hazards can be reduced by proper housekeeping procedures such as marking wet areas, cleaning up spills immediately, cleaning only one side of a passageway at a time, keeping halls and stairways clear, and providing good lighting for all halls and stairwells. Workers should be instructed to use the handrail on stairs, to avoid undue speed, and to maintain an unobstructed view of the stairs ahead of them—even if that means requesting help to manage a bulky load.

  Ladders are especially hazardous. Falls from even low stools and step ladders can cause painful and disabling injuries. Ladder hazards can be reduced before use by performing safety checks to ensure that
  - The ladder is in good condition
The ladder has level and secure footing with nonslip feet and is supported by another worker if necessary

The ladder is fully opened and is not too far from the wall

Neither the rungs of the ladder nor the worker’s feet are wet

The person using the ladder is not working more than a comfortable arm's reach from an upright position

Not more than one person occupies a ladder at one time

### 3.1.2 Fires and Natural Disasters

Hospital fires and natural disasters are especially dangerous because workers must evacuate large numbers of patients and also protect themselves. Thus it is important to know both the most common causes of hospital fires and the most common causes of death in these disaster situations.

#### 3.1.2.1 Fires

A survey conducted by the National First Protection Association (NAPA) (Fire Journal 1970) revealed that almost one-third of hospital fires originated in patient rooms or worker quarters, with matches and smoking as the most frequent causes. Fires also originate from malfunctioning or misused electrical equipment such as hot plates, coffeepots, and toaster ovens. (See 3.1.5)

Deaths during hospital fires were overwhelmingly due to inhaling the toxic products of combustion rather than to direct exposure to the fire.

The most common fire hazards by hospital setting are:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Hazard</th>
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</thead>
<tbody>
<tr>
<td>Patient rooms</td>
<td>Smoking materials, faulty equipment (including the patient's personal grooming devices)</td>
</tr>
<tr>
<td>Storage Areas</td>
<td>Linens, maintenance equipment, compressed gas cylinders, flammable liquids, smoking materials, welding, heaters, trash removal</td>
</tr>
<tr>
<td>Machinery and equipment areas</td>
<td>Solvents, oily rags, faulty equipment</td>
</tr>
</tbody>
</table>

An effective and ongoing program to educate the staff about the hazards of smoking and electrical fires can help reduce these risks. Patients should be informed about the dangers of smoking when admitted and should be reminded frequently. Some states prohibit ambulatory patients from smoking in bed and require that bedridden patients be supervised by either staff or family members while smoking.

The use of oxygen in patient areas is another obvious fire hazard. Fires can occur in an oxygen-enriched atmosphere because of patient smoking, electrical malfunctions, and the use of flammable liquids. Procedures should be developed and strictly enforced to prevent fire hazards in patient areas where oxygen is used.

The basic code for fire safety is the NFPA Life Safety Code (NFPA 1983, Volume 9). Many municipal, State
and Federal agencies and nongovernment organizations have also produced regulations, codes and recommendations for fire safety. Engineering a Safe Hospital Environment and Safety Guide (Stoner et al. 1982) and Safety Guide for Health Care Institutions (AHA/NSC 1983) contain summaries and discussions of the latter. Fire drills should be held regularly and should include training to operate fire extinguishers, locate alarms and identify their codes, assign responsibilities for patient safety, and locate exits.

3.1.2.2 Natural Disasters

Although emergency plans for fires are the most important, disaster plans should also be prepared for natural events (e.g. tornadoes, earthquakes and hurricanes), gas leaks, and bomb threats. Such plans should be written and readily available, and workers should at least know the exit routes. If all workers are informed and trained, they can help avert panic and enhance a rapid and safe evacuation for themselves and others.

3.1.3 Compressed Gases

Because some compressed gases are flammable and all are under pressure, they must be handled with extreme care. An exploding cylinder can have the same destructive effect as a bomb. Compressed gases used in hospitals include acetylene, ammonia, anesthetic gases, argon, chlorine, ethylene oxide, helium, hydrogen, methyl chloride, nitrogen, and sulfur dioxide. Acetylene, ethylene oxide, methyl chloride, and hydrogen are flammable, as are the anesthetic agents cyclopropane, diethyl ether, ethyl chloride, and ethylene. Although oxygen and nitrous oxide are labeled as nonflammable, they are oxidizing gases that will aid combustion. The proper handling of compressed gas cylinders requires training and a well-enforced safety program. Engineering a Safe Hospital Environment (Stoner et al. 1982) contains a discussion for developing a hospital-based program with special emphasis on the necessary precautions for handling oxygen cylinders and manifolds.

Storage areas for compressed gas cylinders should be well ventilated, fireproof, and dry. Compressed gas cylinders should never be subjected to temperatures higher than 125°F (Stoner 1982). Cylinders should not be stored near steam pipes, not water pipes, boilers, highly flammable solvents, combustible wastes, unprotected electrical connections, open flames, or other potential sources of heat or ignition. Cylinders should be properly labeled. The valve protection cap should not be removed until the cylinder is secured and ready for use.

Stoner (1982) presents the following general precautions for storing and handling compressed gas cylinders:

1. Secure all cylinders and do not place a cylinder of one type against a cylinder of another type.

2. Smoking should not be permitted in any area where gases are being used or stored.

3. Never drop cylinders or allow them to strike each other.

4. If cylinders are temporarily stored outside in the summer, make sure they are shaded from the rays of the sun.

5. Do not drag, roll, or slide cylinders. Use a hand truck and secure cylinders before moving.


7. Do not store empty cylinders with full ones.
8. Do not allow a flame to come into contact with any part of a compressed gas cylinder.

9. Do not place cylinders where they may come in contact with electricity.


Workers responsible for transferring, handling, storing, or using compressed gases should review the requirements of 29 CFR 1910.101 through 1910.105; 49 CFR, Parts 171-179; the National Fire Codes (NFPA 1983, Volume 4); and any applicable State or local regulations. Specific OSHA standards should be consulted for the following compressed gases:

<table>
<thead>
<tr>
<th>Substance</th>
<th>OSHA Standard in 29 CFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene</td>
<td>1910.102</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>1910.103</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1910.104</td>
</tr>
<tr>
<td>Nitrous Oxide</td>
<td>1910.105</td>
</tr>
</tbody>
</table>

### 3.1.4 Flammable and Combustible Liquids, Vapors, and Gases

The widespread use and storage of flammable and combustible liquids presents a major fire hazard in all hospitals. Although workers usually recognize this potential hazard, they should also be aware of important facts about flammable liquids that can help to prevent fires.

Many liquids have vapors that are flammable or combustible and can be ignited by a spark from a motor, friction, or static electricity. A liquid may be classified as either combustible or flammable, depending on its flash point, which is the temperature at which it gives off enough vapor to form an ignitable mixture with air. When a liquid reaches its flash point, contact with any source of ignition (e.g. a cigarette or static electricity) will cause the vapor to burst into flame.

OSHA and NFPA have defined the limits for combustibility and flammability as follows: a combustible liquid has a flash point at or above 100°F (37.8°C) and a vapor pressure at or below 40 pounds per square inch (psia) (276 kPa) at 100°F (37.8°C) (NFPA 1983, Volume 3). Because a flammable liquid can reach its flash point even at room temperature, any unrecognized leak can pose a particular hazard. If escaping vapors are heavier than air, they can move for some distance along the ground in an invisible cloud and settle in low areas.

Examples of flammable and combustible liquids are as follows:

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Flash point (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xylene</td>
<td>81</td>
</tr>
</tbody>
</table>
Most alcohols & 50-60
Toluene & 40
Benzene & 12
Tetrahydrofuran & 6
Acetone & 1.4
Ethyl ether & -49

Combustible liquids:
Lubricating oils & 250-475
Ethylene glycol & 232
Carbolic acid & 175
Some cleaning solvents & 140
Most oil-based paints & 105-140

Piping systems (including the pipe, tubing, flanges, bolting, gaskets, valves, fittings, and the pressure-containing parts of other components) that contain flammable and combustible liquids must meet the requirements of NFPA 30 (NFPA 1983, Volume 3).

The following precautions must be taken for flammable and combustible liquids:

- The transfer of flammable or combustible liquids from bulk stock containers to smaller containers must be made in storage rooms as described by NFPA 30 or with a fume hood that has a face velocity of at least 100 ft/min (30.5 m/min) (NFPA 1983, Volume 4).

- Spills of flammable and combustible liquids must be cleaned up promptly (NFPA 1983, Volume 3). Cleanup personnel should use appropriate personal protective equipment. If a major spill occurs, remove all ignition sources and ventilate the area. Such liquids should never be allowed to enter a confined space such as a sewer because explosion is possible.

- Flammable or combustible liquids must be used from and stored in approved containers according to NFPA 30 (NFPA 1983, Volume 3).

- Flammable liquids must be kept in closed containers (29 CFR 1910.106).
Combustible waste material such as oily shop rags and paint rags must be stored in covered metal containers and disposed of daily (29 CFR 1910.106).

Storage areas must be posted as NO SMOKING areas (29 CFR 1910.106).

3.1.4.1 Storage cabinets

Storage cabinets should be labeled FLAMMABLE- KEEP FIRE AWAY. The NFPA National Fire Codes (NFPA 1983, Volume 3) details requirements for metal storage cabinets that contain flammable and combustible liquids, including the following:

- Metal cabinets must be constructed of sheet steel that is at least No 18 gauge. They must be double-walled with a 1.5 inch air space, and they must have joints that have been riveted, welded, or otherwise made tight.
- Doors must have a three-point latch arrangement, and the sill must be at least 2 in above the bottom of the cabinet.

3.1.4.2 Inside Storage Areas

Each inside storage area should be prominently posted as a NO SMOKING area. The NFPA National Fire Codes (NFPA 1983, Volume 3) details requirements for inside storage areas for flammable and combustible liquids, including the following:

- Openings to other rooms or buildings must be provided with noncombustible, liquid-tight, raised sills or ramps that are at least 4 in high or are otherwise designed to prevent the flow of liquids to adjoining areas. A permissible alternative to a sill or ramp is an open-grated trench that spans the width of the opening inside the room and drains to a safe location.
- General exhaust ventilation, mechanical or gravity, is required.
- Electrical wiring and equipment in inside rooms used to store flammable and combustible liquids must conform to the requirement of NFPA 70, the National Electrical Code (NFPA 1983, Volume 6). A fire extinguisher must be available.

3.1.4.3 Outside Storage Areas

If flammable and combustible liquids are stored outside, the storage area must either be graded to divert spills from buildings and other potential exposure areas, or it must be surrounded by a curb at least 6 in (152.4 mm) high (NFPA 1983, Volume 3). The storage area should be posted as a "NO SMOKING" area and kept free of weeds, debris, and other combustible material. A fire extinguisher should be available at the storage area.

3.1.4.4 Liquid Propane gas Storage Areas

Storage areas for liquid propane gas (LPG) tanks should be posted as "NO SMOKING" areas. A fire extinguisher must be available in the area (NFPA 1983, Volume 5).

3.1.5 Electrical Equipment
Electrical malfunction is the second leading cause (after matches and smoking) of fires in hospitals. Violations of standards governing the use of electrical equipment are the most frequently cited causes of fires (Fire Journal 1970). Hospital personnel use a wide variety of electric equipment in all areas -- general patient care, intensive care units, emergency rooms, maintenance, housekeeping service, food preparation, and research.

Thorough electrical maintenance records should be kept, and considerable effort should be devoted to electrical safety, particularly in areas where patient care is involved.

3.1.5.1 Food Preparation Areas

NIOSH has published an Alert on the prevention of electrocutions in fast food restaurants (NIOSH 1984). The following recommendations from that document also apply to food preparation areas in hospitals:

- Ground-fault circuit interrupters (GFCI’s) of the breaker or receptacle type should be installed wherever there is electricity in wet areas. These devices will interrupt the electrical circuit before current passes through a body in sufficient quantities to cause death or serious injury. GFCI’s are inexpensive ($50.00 to $85.00 for the breaker type or $25.00 to $45.00 for the receptacle type), and a qualified electrician can install them in existing electrical circuits with relative ease.

- Exposed receptacle boxes should be made of nonconductive material so that contact with the box will not constitute a ground.

- Plugs and receptacles should be designed so that the plug is not energized until insertion is complete.

- Electrical panels should bear labels that clearly identify the corresponding outlets and fixtures for each circuit breaker or fuse. Breaker switches should not be used as on-off switches.

- Workers should be instructed when hired about safe electrical practices to avoid work hazards. Workers should not contact (1) A victim experiencing electrical shock or (2) the electrical apparatus causing it, until the current has been cut off.

- Workers, whether involved in direct patient care or not, should be encouraged to obtain training in cardiopulmonary resuscitation (CPR) and to know how to call for emergency assistance in their hospital.

3.1.5.2 Unsafe Equipment and Appliances

Equipment and appliances that are frequently ungrounded or incorrectly grounded include

- Three-wire plugs attached to two-wire cords
- Grounding prongs that are bent or cut off
- Ungrounded appliances resting on metal surfaces
- Extension cords with improper grounding
- Cords molded to plugs that are not properly wired
- Ungrounded, multiple-plug spiders that are often found in office areas and at nurses' stations

- Personal electrical appliances, such as radios, coffeepots, fans, power tools, and electric heaters -- brought by the workers from home -- that are not grounded, have frayed cords or poor insulation, or are otherwise in poor repair.

3.1.5.3 National Electrical Code of Federal Regulations

OSHA has adopted the National Electrical Code (NEC) in NFPA 70 as a national consensus standard. The NEC is designed to safeguard persons and property from the hazards of using electricity. Article 517 of NFPA 70 (NFPA 1983, Volume 6), and NFPA 76a and 76b (NFPA 1983 volume 7) contain special electrical requirements for health care facilities. In addition, there may be applicable State and local laws and regulations.

3.1.5.3.1 Electrical requirements for service and maintenance areas

Electricians and maintenance personnel should consult OSHA’s electrical safety standards found in 29 CFR 1910.301 through 1910.399 and the NEC in NFPA 70 (NFPA 1983 Volume 6). Some general minimum requirements are listed as follows:

- Each device for disconnection e.g. circuit breaker or fuse box, should be legibly marked to indicate its purpose unless the purpose is evident

- Frames of electrical motors should be grounded regardless of voltage

- Exposed, noncurrent-carrying metal parts of fixed equipment, which may become energized under abnormal conditions should be grounded under any of the following circumstances:
  - If the equipment is in a wet or damp location
  - If the equipment is operated in excess of 150 volts
  - If the equipment is in a hazardous location
  - If the equipment is near the ground or grounded metal objects and subject to contact by workers
  - If the equipment is in electrical contact with metal
  - If the equipment is supplied by metal-clad, metal-sheathed, or grounded metal raceway wiring

- Exposed noncurrent-carrying metal parts of plug-connected equipment that may become energized should be grounded under any of the following circumstances:
  - If the equipment is a portable, hand-held lamp or motor-operated tool
  - If the equipment is a refrigerator, freezer, air conditioner, clothes-washing or drying machine, sump pump electrical aquarium equipment, hedge clippers, lawn mower snow blower, wet scrubber, or portable and mobile X-ray equipment
  - If the equipment is operated in excess of 150 volts
  - If the equipment is in a hazardous location
  - If the equipment is used in a wet or damp location
  - If the equipment is used by workers standing on the ground or on metal floors

- Outlets, switches, junction boxes, etc., should be covered.
- Flexible cords should not be:
  - Used as a substitute for fixed wiring
  - Run through holes in walls, ceilings, or floors
  - Run through doors, windows, etc.
  - Attached to building surfaces

- Flexible cords should be connected without any tension on joints or terminal screws.

- Frayed cords or those with deteriorated insulation should be replaced.

- Splices in flexible cords should be brazed, welded, soldered, or joined with suitable splicing devices. Splices, joints, or free ends of conductors must be properly insulated.

### 3.1.5.3.2 Damp or wet areas

Because hospitals contain many damp or wet areas, electrical safety requirements are particularly important. A switch or circuit breaker in a wet area or outside a building should be protected by a weatherproof enclosure. Cabinets and surface-type cutout boxes in damp or wet areas should be weatherproofed and located to prevent moisture from entering and accumulating in the cabinet or box. The boxes should be mounted with at least 0.25 inches of air space between the enclosure and the wall or supporting surface. Nonmetallic-sheathed cable and boxes made of nonconductive material are recommended.

In all areas where walls are washed frequently or where surfaces consist of absorbent materials, the entire wiring system (including all boxes, fittings, conduit, and cable) should be mounted with at least 0.25 inches of air space between the electrical device and the wall or support surface.

### 3.1.5.3.3 Special requirements

Specific NEC recommendations apply in areas where flammable materials are stored or handled, in operating rooms, and in patient-care areas. Consult Article 517 of the NEC (NFPA 1983 Volume 6) for further details on these requirements.

Orientation and continuing in-service training programs are necessary to maintain worker awareness of electrical hazards. The following work practices can also help prevent shocks to hospital workers:

- Develop a policy for using extension cords; use a sign-out system to list the number and location of all extension cords currently in use.

- Do not work near electrical equipment or outlets when hands, counters, floors, or equipment are wet.

- Consider defective any device that blows a fuse or trips a circuit breaker, and prohibit its use until it has been inspected.

- Do not use any electrical equipment, appliance, or wall receptacle that appears to be damaged or in poor repair.

- Report all shocks immediately, even small tinges may indicate trouble and precede major shocks. Do not use the equipment again until it is inspected and repaired if necessary.
Protecting workers from assault in and around hospitals has been a growing problem in recent years. The need for increased hospital security was highlighted by a survey that directors of the International Association of Healthcare Security (IAHS) conducted in 1987 (Stultz 1987). Respondents from 418 hospitals reported a total of 2,118 assaults, 426 suicides, 89 robberies, 63 rapes, 18 kidnappings, 551 bomb threats, and 72 arson incidents for 1986. These incidents occurred in inner city, urban, and rural hospitals. Assaults by patients are particularly common in emergency rooms, state institutions, and the psychiatric wards of hospitals. Patient-care staff should be trained to recognize potentially aggressive behavior in patients and to handle such situations when they arise. Staff should be clearly instructed to avoid dealing on their own with acute with acute violence or physical danger. Security officers and staff should receive special training for such situations. Police and other municipal departments can offer on-site training programs in self-defense.

Personal and property crimes are frequent problems because many hospital personnel must work evening and night shifts at hospitals located in high-crime area. The IAHS directors and the International Healthcare Safety and Security Foundation (IHSSF) have suggested the following steps (Stultz 1987) to help protect workers:

- Improve staffing and training for hospital security to ensure that
  - security officers and supervisors are trained to meet certain minimum standards within 1 year of employment
  - security directors and managers are trained in hospital management, hospital security, safety, and risk management
  - security procedures are written out for patient restraint, use and detection of weapons, prisoner restraint, and emergency responses

- Increase worker safety during arrival and departure by encouraging car and van pools and by providing security escorts and shuttle service to and from parking lots and public transportation.

- Improve lighting and eliminate unnecessary bushes or shrubbery near sidewalks, parking areas, and bus stops.

- Install direct-dial emergency telephones in parking lots, underground tunnels, elevators, and locker-rooms. Mark phone locations by a distinctive red light.

- Install locks on all outside doors to bar entrance to, not exit from, the building.

- Improve visibility with increased lighting, stairwell and elevator mirrors, and other physical changes.

- Increase staffing in areas where assaults by patients are likely.

- Install a panic-button alarm system in areas where assaults by patients are likely.

- Install closed-circuit televisions in common areas and rooms where psychiatric patients are treated.

- Increase control over hospital access areas.

- Provide separate emergency room facilities for mentally disturbed patients.
• Provide a secure reception area that has good visibility.

• Provide a physical barrier between receptionists and patients.

• Install a buzzer at the entrance to emergency facilities.

• Post escape and evacuation routes.

• Increase security in pharmacies, cash or storage areas, emergency rooms, nurseries, exits, and parking lots by
  ❍ Installing closed-circuit televisions, bullet-proof separation windows, pass-through windows with intercoms, panic alarms, and intrusion alarms
  ❍ Locating these areas away from main entrances and major traffic-flow corridors

The Joint Commission on Accreditation of Healthcare Organizations also recognizes the importance of improved hospital security and has developed a Security Systems Standard, PL.19.11 (JCAHO 1987).

3.2 SPECIFIC SAFETY HAZARDS BY HOSPITAL DEPARTMENT

The safety hazards discussed in the preceding subsection are found in most or all areas of the hospital, but some hazards are typically found in one or only a few departments. This subsection outlines the most important safety problems in each major hospital department. See Section 5 and Appendices 5, 6 and 8 for the health effects of some of these hazards.

3.2.1 Central Supply

Central supply areas in some hospitals are very similar to small manufacturing plants. Their operations include receiving, packaging, processing, and distributing. The major activities involve some type of material handling.

3.2.1.1 Sterilization Equipment

Improper use of sterilization equipment can result in burns from steam and exposure to ethylene oxide. Detailed operating instructions should be posted on or near the sterilization units. Autoclaves and other steam-pressured vessels should be inspected periodically, and records of the inspections should be maintained. These steps will protect workers and ensure that sterilization is adequate.

Piping ethylene oxide through the hospital from a storage area may increased the potential for exposure to this hazard. During such piping, supply lines from gas cylinders transfer a liquid mixture of 12% ethylene oxide and 88% Freon under pressure to the sterilizers. Ethylene oxide is usually supplied with Freon® so that the mixture is nonflammable. If supply lines are not drained before the tanks are changed, the gaseous mixture can spray the maintenance worker before the pressure is released. Long supply lines from the cylinders to the sterilizers are also a potential source of exposure for many people and may make it difficult to locate and repair ruptures or leaks. By placing the cylinders close to the sterilizer in a mechanical access room (as many hospitals do) the exposure and accident hazard can be contained and controlled. Although the mechanical access room is usually very warm and humid, these conditions can be controlled through adequate exhaust ventilation.

Hospitals with sterilizers that use 100% ethylene oxide cartridges should store only a few cartridges in the
department. The rest should be kept in a cool, dry place. Exhaust systems for ethylene oxide should be
designed to prevent re-entry of the vapors into other areas of the building. The health effects of ethylene
oxide are discussed in Section 5.1.5.

3.2.1.2 Sharp Objects

Cuts, bruises, and puncture wounds from blades, needles knives, and broken glass are among the most
common accidents in central supply areas. Rules for gathering and disposing of sharp or other hazardous
instruments should be reviewed regularly. Workers should handle items returned to central supply as if they
contained sharp or hazardous instruments.

3.2.1.3 Material Handling

Strains, sprains, and back injuries are common in central supply areas. Workers should be provided with
appropriate carts, dollies, and other material-handling aids, and they should be instructed in proper
techniques for handling materials. Step stools and ladders should be available and checked frequently for
serviceability. Chairs, boxes, and other makeshift devices should not be used for climbing because they are a
frequent cause of falls.

3.2.1.4 Soaps, Detergents, and Cleaning Solutions

Workers may also develop dermatitis from soaps, detergents, and solutions used in central supply. When
possible, agents that do not cause dermatitis should be substituted for those that do, or protective clothing
should be provided.
3. Recommended Guidelines for Controlling Safety Hazards in Hospitals
(Continued)

3.2.2 Food Service

Injuries occur in food service areas while workers are (1) handling materials as they are received, processed, and distributed, (2) walking on wet and greasy floor areas, and (3) using faulty equipment. These hazards can be reduced by

- servicing electrical components and equipment adequately,
- training workers in correct material-handling techniques,
- properly guarding machinery and hot surfaces,
- maintaining dry and uncluttered walking and working surfaces, and
- maintaining good work and housekeeping practices.

3.2.2.1 Walking and working Surfaces

The floors in wet and greasy areas (around sinks, dishwashers, and stoves) should be made of nonskid material or covered with nonskid mats. Spilled foods, liquids, and broken dishes should be swept or cleaned up immediately, or the area should be clearly marked and roped off until cleanup. Where work surfaces are slippery, workers should wear shoes with slip-resistant soles. Damaged floor mats should be repaired or replaced promptly.

Workers should not stand on chairs, stools, and boxes. Step stools or ladders should be provided to help workers reach high storage areas. Carts, boxes, or trash should not obstruct aisles or block exits.

3.2.2.2 Electrical Equipment

Workers should follow the recommendations discussed in Subsection 3.1.5 (Electrical Equipment). Toasters, blenders, hand mixers, fans, refrigerators, and radios should be grounded or double insulated. If these items were designed for household use, they should be checked to ensure proper grounding for industrial application.
Workers should turn off switches and pull plugs before adjusting or cleaning power equipment such as slicers, grinders, and mixers. Equipment that is being serviced or cleaned should be tagged as "OUT OF SERVICE". Workers should never plug in electric equipment while their hands are wet or while they are standing in water.

When fixed-equipment (i.e. permanently wired equipment) must be serviced, the electrical power to the equipment should be disconnected. To prevent someone from inadvertently turning the power on while the unit is being serviced, a lock and a tag should be placed on each disconnecting means used to deenergize the equipment. Each worker should apply his own lock, and only the person who applies the lock should remove it.

3.2.2.3 Stove Hoods

Stove hoods should be cleaned and filters should be replaced on a regular schedule. The flange on a stove hood, which is a repository for condensed oil from cooking, should be cleaned regularly. The stove should not be used if hood filters are not in place. Because improperly installed and makeshift filters can be fire hazards, only the proper size and type of filters should be used as replacements.

3.2.2.4 Fire Extinguisher Systems

Kitchen workers should be taught how to use the fire extinguishers and hood extinguishing systems. They should also know when to stay in the area and use the fire extinguisher and when to leave and call the fire department. Fire extinguishers should be properly mounted, and the immediate area around their location should be kept clear.

Where automatic fire control systems are in place, the head or nozzle should be directed toward a potential fire area.

Inspections must be made in accordance with OSHA standards (29 CFR* 1910).


3.2.2.5 General Kitchen Equipment

Meat saws, slicers, and grinders should be properly guarded. Tamps or push sticks should be used to feed food grinders and choppers.

The wheels of food carts should be kept in good repair. Workers should be instructed to obtain help when moving a heavily loaded cart over a carpet or mat or from an elevator that has not leveled properly. Workers should also be instructed to push, not pull, food carts.

Carbon dioxide tanks should be secured or stored where they cannot be knocked over. All tank gauges should be kept in good working order.

All exposed drive belts, gears chains, and sprockets on dishwashers, conveyors, and other equipment should
be guarded.

Dumbwaiters should be securely closed when not in use.

Steam, gas, and water pipes should be clearly marked, e.g. color-coded, for identification, and personnel should learn the coding system and the location and operation of shut-off valves.

3.2.2.6 Knives

Workers should be instructed about the safe handling and use of knives. Cutlery should be kept sharpened and in good condition: dull knives tend to slip. A cutting board or other firm surface should always be used. The direction of the cut should always be away from the body.

Knives, saws, and cleavers should be kept in a designated storage area when not in use. The blades should not be stored with the cutting edge exposed. Knife holders should be installed on work tables to prevent worker injury. Knives and other sharp objects should not be put into sinks between periods of use.

Newly purchased knives should be equipped with blade guards, knuckle guards, that protect the hand from slipping onto the blade.

3.2.2.7 Hot Utensils and Equipment

All stoves, pots, and pans should be treated as hot equipment. The handles of cooking utensils should be turned away from the front of the stove. Hand protection for grasping hot utensils should be readily available near stoves.

When uncovering a container of steaming materials, the worker should hold the cover to deflect steam from the face.

Workers should take special care to stand to the side of the unit when lighting gas stoves and ovens.

3.2.2.8 chemical and Physical Agents

Workers in food service areas can be exposed to agents that pose potential occupational safety and health problems. The most common are listed below:

3.2.2.8.1 Ammonia

Ammonia solution is frequently used as a cleaning agent, and ammonia gas is used as a refrigerant. Because concentrated solutions of ammonia can cause severe burns, workers should avoid skin contact with this substance by wearing protective clothing such as appropriate gloves, see sec 2.3.5. Respirators should be used as needed (see Section 2.3.5.6). If skin or eye contact occurs, the affected area should be washed promptly with water.

Workers who handle concentrated solutions of ammonia should wear rubber gloves and goggles or a face shield. Because ammonia gas is released from solution, good ventilation should be provided. For example, stove hoods should be operating when workers use ammonia to clean grease from stoves. Because ammonia can react with some deodorizing chemicals to produce harmful byproducts, these substances should not be stored or used together.
3.2.2.8.2 Chlorine

Chlorine solutions can be used as disinfectants in dishwashing. When chloride solutions are added to other compounds, a chemical reaction may occur, and chlorine gas may be released. Exposure to chlorine, even at low concentrations, can cause eye, nose, and throat irritation; high concentrations can produce pulmonary edema. Protective clothing and equipment should be used when personnel are working with chlorine. Selection of the appropriate protective equipment and clothing should be based on the type and extent of exposure anticipated (see Section 2.3.5).

3.2.2.8.3 Drain cleaners

Drain cleaners can cause skin burns and damage to the eyes. Workers should wear rubber gloves and goggles or face shields when they use drain cleaners and when splashing is possible (see Section 2.3.5).

3.2.2.8.4 Ambient Heat

Ambient heat may be a problem in kitchen areas. High heat levels can cause heat-related illnesses, and workers should be aware of the symptoms of heat disorders and the need for frequent water consumption and rest periods.

3.2.2.8.5 Microwave Radiation

Microwave ovens are becoming standard appliances in hospitals. As these ovens wear out, hinges and catches may loosen, and microwave radiation may be released from the units. The units should be cleaned regularly because spilled food can prevent oven doors from closing properly. If the interlock system fails, the unit may not shut off when the door is opened. Trained personnel should check units periodically for leaks.

3.2.2.8.6 Oven cleaners

Oven cleaners may be sprayed or brushed onto oven walls. Workers using oven cleaners should wear protective gloves and goggles and avoid breathing the vapors. Most oven cleaners can cause skin irritation, such as rashes and dermatitis; inhaled vapors are also irritating to the respiratory tract (see Section 2.3.5).

3.2.2.8.7 Soaps and detergents

Soaps and detergents may cause dermatitis if precautions are not taken, for example, gloves should be worn and substitutes should be found for known sensitizers.

3.2.2.8.8 Strong caustic solutions

Strong caustic solutions are often used to clean reusable filters on stoves, grills, and broiler exhaust hoods. Strong caustics can burn the skin, harm the eyes, and cause skin rashes and dermatitis. Protective clothing and equipment should be used to prevent skin and eye contact. 3.2.3 Housekeeping

Housekeeping workers serve in all patient and nonpatient areas and are thus potentially exposed to all of the health and safety hazards found in the hospital environment. They should receive periodic instruction to keep them aware of the specific hazards in each department, especially in those areas where X-rays, radioisotopes, oxygen and other gases, and specific chemicals are used.
3.2.3.1 Health and Safety Guidelines for Housekeeping Workers

The following specific guidelines should be included in a health and safety program for housekeeping workers:

- Workers should be trained in proper material-handling techniques.

- Workers should be instructed to wash their hands thoroughly before eating, drinking, and smoking, before and after using toilet facilities, after removing contaminated work gloves, and before going home.

- Workers should be aware that other persons may not have followed proper procedures for disposing of needles, knives, and glassware. All refuse should be handled as if hazardous items were present.

- Workers should seek help either from other persons or with mechanical devices when lifting or moving equipment or furniture that is heavy or awkward to handle.

- Workers may be injured as a result of improper use and poor maintenance of ladders, step stools, and elevated platforms. To reduce the frequency of falls
  - Workers should not stand on the top two steps of a ladder, and
  - Workers should not substitute chairs, beds, boxes, or other items for a ladder.

- All electrical appliances, such as vacuums and polishers, should have grounded connections.

- Service carts should be equipped with large, wide wheels to make them easier to push.

- The slippery areas on floors that are being scrubbed or polished, should be identified with signs or roped-off areas.

3.2.3.2 Chemical and Physical Agents

Some hazardous chemical and physical agents frequently encountered by housekeeping workers are listed below.

3.2.3.2.1 Soaps and detergents

Soaps and detergents may cause dermatitis or sensitization reactions. Workers should be trained to use these materials properly and should be provided with appropriate protective gloves. Effective cleaning solutions that do not cause dermatitis or sensitization should be substituted when possible. Sensitized workers should be transferred to other duties if necessary.

3.2.3.2.2 Solvents

Solvents, such as methyl ethyl ketone, acetone, and Stoddard solvent, are often used to clean grease from equipment and may have several cleaning applications throughout the hospital. Workers should be instructed in their proper use to prevent both fire hazards and exposures that could lead to illness. Many solvents
remove the natural fats and oils from the skin and when absorbed through the skin, can cause respiratory effects. Appropriate personal protective equipment should be worn by workers who come into contact with solvents.

3.2.3.2.3 Cleaners

Cleaners used throughout the hospital may contain acids or caustics that can cause burns. Workers who use these solutions should wear proper protective clothing such as rubber gloves, rubber or plastic aprons, and eye protection.

3.2.3.2.4 Disinfectants

Disinfectants, including quaternary ammonia compounds, phenols, and iodophors, are used in such hospital areas as nurseries and operating rooms. Because many disinfectants can produce skin rashes and dermatitis, personal protective equipment for the skin and eyes is required.

3.2.3.3 Bacteria and Viruses

Housekeeping personnel are frequently exposed to viruses and bacteria. They should therefore (1) follow instructions issued by the infection control personnel for reporting infections, and (2) take appropriate measures to limit further contagion from patients by practicing universal precautions for handling blood and body fluids.

3.2.4 Laundry

The following points should be included in a health and safety program for hospital laundry workers:

- Floors should be kept as dry as possible, and wet floors should be labeled. Nonskid mats or flooring should be provided in wet areas, and workers should wear nonskid boots or shoes.

- Laundry should be handled as if hazards were present because puncture wounds and cuts can result form needles, knives, and blades that are folded in soiled linens.

- Soiled linens should be handled as little as possible and with minimum agitation to prevent contamination of the air. This is especially true for linens used by patients who have infectious microorganisms or radioactive implants or are taking cytotoxic drugs. All soiled linens should be bagged with impervious, color-coded bags at the site where they are used, and materials contaminated with potentially infective agents, cytotoxic drugs, or radionuclides should be clearly labeled and handled with special care. To protect workers from unnecessary contact, a barrier should separate soiled linen areas from the rest of the laundry area.

- Proper precautions should be taken when handling soaps and detergents, for example gloves should be worn and substitutes should be used for known sensitizers.

- The high temperatures and excessive humidity in some laundry areas may be impossible to control with engineering devices alone, especially during the summer months. Administrative controls may be necessary (NIOSH 1986) and persons working in excessively hot environments can be rotated to other jobs or shifts.
- Workers should be aware of the symptoms of heat stress and the need for water consumption and more frequent breaks.

- Workers who sort and wash contaminated linens should wear proper protective clothing and respirators.

- Workers should be trained in the proper techniques for lifting and material handling.

- Laundry personnel should be instructed to wash their hands thoroughly before eating, drinking, and smoking, before and after using toilet facilities, and before going homes.

- Workers who handle and sort soiled linen in the laundry department should be included in the hospital immunization program.

- The wrapping on steam lines should be adequately maintained to protect workers from burns.

### 3.2.5 Maintenance Engineering

Maintenance shops in hospitals tend to be overlooked when safety and health are considered. Housekeeping is often very poor, with materials scattered in aisles and over floors, equipment and stock stored improperly, and machinery improperly guarded. Standards pertinent to maintenance areas may be found in 29 CFR 1910, NFPA (1983) codes, and state and local laws and regulations. Section 5 addresses in detail many of the hazards encountered in maintenance areas. The major hazards will be described briefly below.

#### 3.2.5.1 General Rules for Maintenance Areas

The following general rules should be applied to maintenance areas:

- Drive belts must be guarded. Gears, shafting, and chains and sprockets must be properly enclosed (29 CFR 1910, Subpart 0).

- Tool rests, adjustable tongue guards, and spindle guards on grinders must be installed and kept properly adjusted (29 CFR 1910, Subpart 0).

- Blade guards must be installed on table saws, band saws, and radial arm saws. If saws are used for ripping, anti-kickback devices must be installed (29 CFR 1910, Subpart 0).

- Electrical equipment must be properly grounded or double insulated (29 CFR 1910, Subpart 0).

- Extension cords must be the three-wire type and have sufficient capacity to safely carry the current drawn by any devices operated from them. Extension cords may be used only in temporary situation and may not be substituted for fixed wiring (29 CFR 1910, Subpart 0).

- Electrical switches on circuit boards should be marked with danger tags and physically locked to prevent circuit activation when machinery is being repaired. Circuits should be deenergized before repair work begins.

- Metal ladders should never be used by workers to change light bulbs or work on electrical equipment or wiring.
• Broken ladders should be destroyed or tagged, removed from service, and repaired. Battery-charging areas should be adequately ventilated to prevent a buildup of hydrogen gas. These areas should be designated as "NO SMOKING" areas.

• Gasoline and diesel powered equipment should be properly maintained and operated only in areas that are well-ventilated or vented to the outside to prevent a buildup of carbon monoxide. Data obtained recently from animal studies indicate that diesel exhaust is a potential carcinogen.

• Workers should wear protective clothing and equipment when exposed to hazards requiring such protection (see Section 2.3.5). Protective clothing and equipment include:
  ❍ Gloves for handling hot, wet, or sharp objects and chemicals
  ❍ Eye and face protection to prevent injuries from chips, sparks, glare, and splashes
  ❍ Hearing protection to prevent hearing loss from noise sources
  ❍ Respirators to prevent exposure to dusts, fumes, and vapors, as appropriate

• Paints solvents and other flammable materials must be stored in cabinets or rooms that meet the requirements outlined in NFPA 30 (NFPA 1983 Volume 3).

• Hand tools should be maintained and stored properly.

• Fuel and cylinders of flammable gas must be stored separately from cylinders of oxidizing gas. Cylinders must be kept away from heat sources such as radiators, steam pipes, and direct sunlight (NFPA 1983 Volume 4).

• Cylinders must be stored and used in the upright position (NFPA 1983 Volume 4). Cylinders of compressed gas must be chained or secured to prevent them from falling.

• Trash compactors should not be operated in the open position. They should have guarding devices, such as two-hand controls, electric eyes, and emergency shut-off bars.

• In laboratories that use sodium azide for the automatic counting of blood cells, the pipes should be flushed before plumbing repairs can be made because a buildup of sodium azide in the pipes can result in a violent explosion. A sodium-azide decontamination procedures is available from NIOSH (NIOSH 1976).

• The use of compressed air for cleaning surfaces should be avoided.

For additional requirements regarding electrical equipment and storing and handling compressed-gas cylinders, refer to Sections 3.1.5 and 3.1.3, respectively.

3.2.5.2 Chemical and Physical Agents

Some chemical and physical agents that pose common occupational health hazards in maintenance shops area discussed below.
3.2.5.2.1 Asbestos

Asbestos was commonly used in older buildings as an insulating material for steam pipes. When that insulation is torn off and replaced, asbestos fibers may be released into the air. Persons exposed to asbestos fibers may develop a fibrosis of the lungs, asbestosis, and possibly lung cancer or peritoneal mesothelioma. Smokers are more susceptible to asbestos induced lung cancer than are nonsmokers.

To reduce asbestos exposure, workers should wear a NIOSH approved positive pressure, air supplied respirator (NIOSH-EPA 1986) and the insulation material should be dampened before it is cut or torn apart. Areas containing asbestos should be vacuumed rather than swept, and waste material should be discarded in sealed plastic bags. State health departments or other responsible jurisdictions should be contacted before asbestos removal operation begin; many states certify companies engaged in asbestos removal. Guidance for Controlling Asbestos-Containing Materials in Buildings (EPA 1985) contains procedures for removing asbestos. Specific federal requirements govern asbestos exposure; for more information on asbestos, see 29 CFR 1910.1001 and Section 5.1.2 of this document.

3.2.5.2.2 Ammonia

Ammonia is used as a liquid cleaning agent and as a refrigerant gas. Concentrated solutions of ammonia can cause severe burns. Workers should avoid skin contact with ammonia by wearing protective clothing (see Section 2.3.5). If skin or eye contact occurs, the affected area should be washed promptly. Workers who handle concentrated solutions of ammonia, should wear rubber gloves and goggles or face shields. Ammonia gas is released from a concentrated solution, and thus good ventilation should be provided. Ammonia and some deodorizing chemicals should not be stored or used together because they can react to produce harmful byproducts. The NIOSH REL for ammonia is 50 ppm, 35 mg/m³, as a 5-min ceiling; the OSHA PEL for ammonia is 50 ppm as an 8-hr TWA; the ACGIH recommended TLV is 25 ppm (18 mg/m³) as an 8-hr TWA with a STEL of 35 ppm (27 mg/m³).

3.2.5.2.3 Carbon monoxide

Carbon monoxide exposures can occur when the gasoline-powered engines of forklifts, auxiliary power generators, etc are run in poorly ventilated area. Symptoms of carbon monoxide exposure begin with a slight headache followed by nausea, dizziness, and unconsciousness. Emergency care should be initiated for any worked exposed to excessive carbon monoxide. The NIOSH REL for carbon monoxide is 35 ppm as an 8-hr TWA with a ceiling of 20 ppm; the OSHA PEL is 50 ppm as an 8-hr TWA.

3.2.5.2.4 Drain-Cleaning Chemicals

Drain-cleaning chemicals can burn the skin and damage the eyes. Workers should wear rubber gloves and goggles or face shields when they use drain cleaners and splashing is possible. Product information sheets or material safety data sheets contain additional information.

3.2.5.2.5 Noise

Noise exposure at levels that exceed 90 decibels -- measured on the A scale (dBA) -- often occurs in boiler houses and power-supply locations. Adequate hearing protection should be provided and worn in noise areas when engineering or administrative controls cannot eliminate the exposure. When noise levels exceed 85 dBA, OSHA required a hearing conservation plant. The OSHA standard for occupational noise exposure
3.2.5.2.6 Paints and adhesives

Paints and adhesives contain a wide variety of solvents and should be used only in areas with adequate ventilation. If ventilation is inadequate, workers should wear respirators approved for use with organic vapors. Skin contact with epoxy paints and adhesives can be prevented by using gloves and other personal-protective clothing. If skin contact does occur, the skin should be washed immediately. Section 5 contains more information about the hazards associated with solvent exposure.

3.2.5.2.7 Pesticides

Pesticides are used throughout the hospital for fumigation and pest extermination. Workers who apply these substances should wear protective gloves and respirators (see Section 2.3.5) approved for use with pesticides (organic dusts and vapors). Workers should be familiar with emergency procedures for spills and splashes and federal regulations governing the application of pesticides.

3.2.5.2.8 Solvents

Solvents such as methyl ethyl ketone, acetone, and Stoddard solvent may be used to clean parts in maintenance shops. Recommended personal protective equipment should be worn by workers who come into contact with solvents (see Section 2.3.5). Many solvents remove the natural fats and oils form the skin and may be absorbed through the skin. Neurotoxicity is a principal effect of solvent exposure (NIOSH 1987). All organic solvents should be used with adequate ventilation. Because some solvents are also flammable, they should be stored in approved safety containers. Cleaning tanks should be kept closed when not in use (see Section 5).

3.2.5.2.9 Waste anesthetic gases and ethylene oxide

Maintenance workers may be exposed to waste anesthetic gases and ethylene oxide when repairing ventilation or exhaust systems that are used to remove these gases. Workers should be aware of the health effects of anesthetic gases and ethylene oxide as well as their physical properties. For example, ethylene oxide is a carcinogen and is extremely flammable. Appropriate personal protective equipment and clothing should therefore be provided and worn by workers when exposure to either anesthetic gases or ethylene oxide is possible (see Section 2.3.5). Control measures should be followed to minimize the levels of exposure. See Section 5.1.5 for more information about ethylene oxide. See Section 5.1.12 and the NIOSH criteria document (NIOSH 1977a) for more information about waste anesthetic gases.

3.2.5.2.10 Welding fumes

Welding fumes contain particulate matter and gases from the metals being joined, the filler material used, and coatings on the welding rods. Exposure to welding fumes frequently occurs when maintenance personnel weld in confined spaces. Local exhaust ventilation should be provided when extensive welding operations are performed. Workers who weld should be familiar with the potential adverse health effects of exposure to welding fumes. NIOSH has published a criteria document (NIOSH 1988) that contains recommendations for protecting the safety and health of welders.

3.2.6 Office Areas

Office areas are frequently overlooked during health and safety inspections in hospitals. The following guidelines should be included in health and safety programs for office workers:
- Desks and countertops should be free of sharp, square corners.

- Material should be evenly distributed in file cabinets so that the upper drawers do not unbalance the file and cause it to fall over. Only one drawer should be opened at a time, and each drawer should be closed immediately after use.

- Papers and other office materials should be properly stored and not stacked on top of filing cabinets.

- Aisles and passageways should be sufficiently wide for easy movement and should be kept clear at all times. Temporary electrical cords and telephone cables that cross aisles should be taped to the floor or covered with material designed to anchor them.

- Electrical equipment should be properly grounded, and the use of extension cords should be discouraged.

- Carpets that bulge or become bunched should be relaid or stretched to prevent tripping hazards.

- Heavy materials should not be stored on high shelves.

Video display terminals (VDT's) have been introduced on a large scale in hospital office areas during the past decade. Terminals should be selected that incorporate modern ergonomic advances in design. They should then be properly installed, and training in their use should be provided. Otherwise, they may be a source of musculoskeletal disorders, shoulder, neck and arm, and eyestrain. The NIOSH report, Potential Health Effects of Video Display Terminals, contains recommendations for preventing these problems (NIOSH 1981a). (See also Section 5)

3.2.7 Print Shops

The following guidelines should be followed in print shops:

Material safety date sheets, MSDS's, should be requested from the manufacturers of all chemicals used in the print shop. The MSDS's must conform to requirements of the OSHA hazard communication Standard (29 CFR 1910.1200). Once the composition of chemicals is known, proper safety and health precautions should be implemented.

- Smoking should be prohibited because highly flammable inks and solvents are used in the print shop.

- Waterbased inks should be used whenever possible.

- Safety cans should be used to store all flammable liquids. Ink cleaning chemicals should be dispensed from plunger type safety cans.

- All rags soaked with solvent and solvent based ink should be disposed of in covered metal containers that are emptied at least daily.

- Ventilation should be provided as needed to control airborne concentrations of solvents and other toxic substances used in the print shop.
The cutting edge of guillotine papercutters should be guarded. Two-hand controls are an effective method or reducing this hazard. All gears, belts, pulleys, and pinch points should be guarded.

Because printing equipment produces a noisy environment, control measures should be implemented to reduce noise to the lowest possible level. Adequate hearing protection should be provided, and surveys of noise level should be conducted routinely.

3.2.8 Patient Care Areas (Nursing Service)

3.2.8.1 Physical Exertion

Strains and sprains account for approximately half of the compensable disorders among hospital workers (see Table 1-1 and Health Alert [1978]). Falling, lifting patients and heavy materials, moving beds and furniture, pushing heavy carts, and wearing improper footwear all contribute to the frequency of these injuries.

The following control measures can help prevent strains and sprains:

- Make aisles and passageways adequate for the movement of personnel and materials. Passageways, aisles, and halls should not be used as storage areas.
- Treat floors with nonslip material.
- Clean up spills immediately.
- Teach workers to use proper lifting techniques to help prevent injuries.
- Place temporary electric cords for lights, radios, televisions, and patient-monitoring equipment in a way that prevents tripping hazards; either tape them to the floor or cover and anchor them with other material.
- Use only properly maintained, safe ladders to reach high objects. Do not use stools, chairs, or boxes as substitutes for ladders.

3.2.8.2 Needles and Sharp Instruments

Cuts, lacerations, and punctures are also common among hospital workers (see Table 1-1 and Health Alert [1978]). Needles and other sharp instruments should be discarded in designated puncture-resistant containers and not in trash cans or plastic bags. Hospitals should establish and enforce policies to prevent the recapping of needles.

Rules for safe disposal and collection of sharp instruments or other hazardous materials should be reviewed regularly. Workers should examine and handle soiled linens and similar items as if they contained hazardous items.

3.2.8.3 Obstacles and Broken Objects

Abrasions, contusions, and lacerations are also among the more frequently reported occupational injuries in patient care areas. Control measures to prevent such injuries include:
● Arranging furniture to allow free movement about the room

● Keeping doors and drawers closed when not in use

● Turning bed-adjustment handles in or under the bed.

● Allowing only smooth and rounded corners on desks and countertops at the nurses’ stations.

● Sweeping up and disposing of broken glass immediately and properly. Workers should not pick up broken glass with their fingers.

● Grasping ampoules with protective gauze before scoring the tip with a metal file and snapping the top open.

3.2.8.4 Electrical Hazards

Workers should be instructed in the proper use of electrical equipment and should take the following precautions:

● Report defective equipment immediately, tag it, remove it from service, and repair or discard it.

● Prohibit patients, visitors, and workers from using ungrounded coffeepots, radios, cooling fans, portable heaters, or other appliances.

● Implement a program to check all electrical equipment and connections in nurses' stations and kitchenette areas regularly to find damaged cords and ungrounded electrical equipment.

● Implement a program to check regularly all electrical equipment (e.g. razors and hair dryers) brought into the hospital by patients.

● Ground beds that have electrical controls and place cords under the bed.

● Clean microwave ovens regularly and check periodically for proper door closure and seal. These ovens should be used only in designated areas.

3.2.8.5 Other Hazards

The following guidelines apply to miscellaneous hazards found in patient care areas:

● Label acids and other chemicals properly and store and handle safely.

● Label linens and wastes properly.

● Use personal protective equipment and protective measures as recommended (see Section 2.3.5).

● Enforce the isolation techniques developed according to CDC recommendations when staff members (including physicians) provide care for patients with infectious diseases.
- Enforce exposure limits for ionizing radiation according to federal or state regulations and standards.
3. Recommended Guidelines for Controlling Safety Hazards in Hospitals (Continued)

3.2.9 Pharmacy

Pharmacy workers are also subject to slips and falls, back injuries, cuts from broken bottles and equipment, and exposure to chemicals, such as alcohols and solvents, dusts, such as talc and zinc oxide, and antineoplastic drugs. The following control measures should be considered:

- Provide stepladders to help personnel reach items stored on high shelves.
- Clean up spills promptly.
- Disposes of broken bottles and unusable pharmaceuticals according to established procedures.
- Guard mixers, packaging and bottling equipment, and labeling machinery properly. Adequate exhaust hoods should be provided where needed. If a laminar air-flow hood is used, it should be checked frequently to determine whether it is operating properly.
- Make pharmacy personnel aware of hazards associated with handling antineoplastic agents and make them familiar with safety guidelines. See Section 5 for a more in-depth discussion of antineoplastic agents.
- Instruct workers in safe practices for lifting and carrying to prevent injuries.
- Do not repair thermometers, manometers, and other instruments that contain mercury in the pharmacy. This equipment should either be repaired in an appropriate hospital shop or sent out for repair.
- Install opening devices on the inside of walk-in vaults and refrigerators to prevent workers from being accidentally locked inside.
- Identify through medical surveillance the adverse effects of exposure to any medications that are packaged or dispensed in the pharmacy.
- Do not permit workers to smoke or eat in pharmacy preparation areas because drug aerosols may be inhaled or pharmaceuticals may be ingested.
3.2.10 Laboratories

3.2.10.1 Types of Laboratory Hazards

3.2.10.1.1 Equipment

Increased attention in the past decade has been focused on health hazards in the laboratory, such as infectious diseases and toxic chemicals, but laboratory safety is still a problem. Electric appliances that replaced the open flames of Bunsen burners have resulted in increased risk of electric shock.

Chemical Laboratory Safety Audit (Reich and Harris 1979) provides a general protocol to help identify potential safety problems.

3.2.10.1.2 Infection

Microorganisms in the laboratory can be inhaled, ingested, or inoculated through the skin. Pike (1976) reviewed published case reports of infections associated with medical laboratories and found 42% caused by bacteria and 27% associated with viruses. Many laboratory-acquired infections, especially common diseases, were not reported, and Pike concludes that laboratory acquired tuberculosis and hepatitis are significantly under reported. Nearly all sizable blood banks and serology laboratories had at least one case of hepatitis. Of the 3,921 cases reported, 65% involved trained workers, 59% were in research laboratories, and 17% were in diagnostic laboratories.

For 82% of the reported infections, no source was recognized. Of the 18% for which a source was recognized, one fourth involved needle punctures, leaking syringes, or contamination while separating needles from syringes. Other commonly recognized exposure incidents included spills and breakage resulting in sprays (aerosols) of infectious material, injuries with broken glass or other sharp instruments, and aspiration during mouth pipetting. Research laboratories were the most hazardous because they lack the standard and routine handling procedures found in large commercial laboratories.

For the 75% to 80% of all laboratory infections for which there is no recognized causal accident or event, the suspected source is usually an aerosol (Collins 1980). Aerosols are airborne droplets of infectious material that may be generated by

- Opening containers
- Blowing out pipettes
- Mixing test tube contents
- Opening lyophilized cultures
- Centrifuging suspensions
- Pouring liquids
- Using automatic pipetters
- Mixing fluid cultures by pipette
- Harvesting or dropping infected eggs
- Mixing with high speed blenders
- Using poorly made, open, or large wire loops
- Spilling liquids

Small aerosol particles dry almost instantly and remain suspended in the air for long periods. When inhaled, they penetrate deep into the lung and may cause infections. Larger and heavier particles settle slowly on laboratory surfaces and workers’ skin. They may enter the body through contaminated foods, contaminated skin, or objects that touch the eyes or mouth (Collins 1980).

Ways to reduce aerosols include:

- Using smooth agar and a glass rod, or cool wire loop if necessary for spreading
- Draining pipettes instead of blowing them out
- Mixing cultures in a tube mixer
- Using disinfectant gauze of Benchkote on work surfaces during transfers of biogenic material
- Wrapping needles and bottle tops in alcohol soaked pledgets when withdrawing needles from stoppered vaccine bottles
- Properly maintaining equipment such as high speed blenders
- Using sealed centrifuge buckets
- Carefully packaging specimens during transport and storage

3.2.10.1.3 Allergic sensitization

Allergic sensitization to laboratory materials is a related but less common hazard for some workers. Severe allergic reactions may required a job change to an allergen-free environment. Ascaris, brucella, formaldehyde, penicillin, tuberculin, and the dander of laboratory animals are common allergens and sensitizers.

3.2.10.1.4 General chemical hazards

Each laboratory should identify the chemicals used there and should establish appropriate training, precautions, personal protective equipment (see Section 2.3.5) and controls. Although laboratory workers usually recognize warning for explosive gases and liquids, they should also be aware of several hazardous mixtures, such as mixtures of bleach, chromic acid, and certain organics; oxidants and flammable liquids; and chemicals like ethers and alkenes. The American Association of Anatomists has listed and reviewed the following chemicals ordinarily used in medical laboratories (Lavelle 1979):
### 3.2.10.1.5 Carcinogens

Although only about two dozen chemicals have been established as human carcinogens (Olishifski 1979) several hundred have been found to cause cancer in test animals, and many more have not yet been tested. Laboratory workers may frequently be exposed to many potential carcinogens, including chromium trioxide, benzidine, carbon tetrachloride, 1,2-dichloroethane, ethylene oxide, benzene, 1,4-dioxane, and 2,2',2"-nitrilotriethanol. Because laboratory workers are potentially exposed to many suspected carcinogens, engineering controls and safe work practices should be used to reduce worker exposure as much as possible.

### 3.2.10.1.6 Mutagens and teratogens

Laboratory workers are potentially exposed to both mutagens (chemicals that may cause mutations or genetic changes) and teratogens (chemicals that may cause congenital malformations in the developing fetus of a pregnant worker). Although most reproductive hazards may affect both men and women, the fetus is particularly at risk from exposure to ionizing radiation, drugs and biologic agents. An estimated 125,000 women work in laboratories in the US (Hricko and Brunt 1976). Studies suggest a higher rate of adverse reproductive outcomes, major malformations, spontaneous abortions, and neonatal deaths, among female laboratory workers (Ericson and Kallen 1984, Axelsson and Jeansson 1980, and Meirik et al. 1979).

Known and suspected reproductive hazards include:

<table>
<thead>
<tr>
<th>Ionizing radiation</th>
<th>alpha-, beta-, and gamma-emitting radionuclides and X-rays</th>
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<tr>
<td>Drugs</td>
<td>actinomycin D, antineoplastics, mitomycin, quinine, and streptomycin</td>
</tr>
<tr>
<td>Chemicals</td>
<td>anesthetic gases, benzene, dibutyl phthalate, diethyl phthalate, diethylhexyl phthalate, ethylene oxide, ethylene diaminetetraacetic acid EDTA, diazo dyes (Evans blue, Niagara blue, Congo red, Janus green B), lead, lead acetate, mercury, sodium arsenate, toluene, xylene</td>
</tr>
</tbody>
</table>
Biologic agents | cytomegalovirus, mumps, rubella (German measles), *Toxoplasma gondii* (Toxoplasmosis), varicella (herpes zoster), hepatitis viruses (hepatitis), human immunodeficiency virus (acquired immunodeficiency syndrome)

### 3.2.10.1.7 Physical stress

Forester and Lewy (1983) described a case of pipetter's shoulder, tendinitis resulting from the frequent repetitive movement of the shoulder joint during prolonged periods of pipetting, that developed after a worker had performed an unusually large number of assay procedures. Minuk et al. (1982) reported a case of osteoarthrhritis that developed in the right thumb of a pipetter. The frequency of these problems among laboratory workers has not been determined.

### 3.2.10.1.8 Laboratory animals

Animals can carry and transmit serious diseases. An university hospital reported 15 cases of lymphocytic choriomeningitis (LCM) among laboratory workers, and another hospital reported 46 cases of LCM where staff worked in close contact with a hamster colony (Hotchin et al. 1974). Q fever has been a recurrent source of infection, serious disease, and occasional fatality for laboratory and research workers, and CDC ahs developed a set of guidelines for managing this risk at medical research centers that use sheep (CDC 1979).

### 3.2.10.1.9 Emotional stress

Laboratory workers commonly report stress as a job hazard. A NIOSH study ranked clinical laboratory work seventh among stressful occupations based on frequency of admission to community mental health centers (Colligan et al. 1977). Griffin and Klun (1980) listed the primary source of stress for hospital-employed medical technologists as physician attitudes, followed by emergency-response procedures, the need for accuracy, lack of communication (between shifts, between laboratory workers and doctors, and among laboratory staff), fear of making an error, especially if it might result in a patient's death, overwork, deadlines, lack of support from pathologists or supervisors, and lack of appreciation by other hospital staff members.

### 3.2.10.2 Standards and Recommendations

No uniform national safety standards exist for all laboratories. In August 1986, OSHA proposed a standard to protect laboratory workers; but until that standard is promulgated only laboratories involved in interstate commerce are regulated by the Clinical Laboratory Improvement Act of 1967.

Accreditation by the College of American Pathologists (CAP) requires that laboratories comply with Standards for Accreditation of Medical Laboratories (CAP 1982). Some federal funding and insurance legislation also includes general requirements for safe practices and conditions in laboratories.

The CRC Handbook of Laboratory Safety (Steere 1971) contains extensive additional information on laboratory safety. Biosafety Guidelines for Microbiological and Biomedical Laboratories (CDC-NIH 1984), developed jointly by CDC and the National Institutes of Health (NIH) offer a recommended code of practice for laboratories involved with infectious microbial agents.

### 3.2.10.3 Methods for Controlling Exposure

Both *Engineering a Safe Hospital Environment* (Stoner et al. 1982) and *Industrial Ventilation* (ACGIH 1986)
contain information on exhaust ventilation hoods, biological safety cabinets, and other forms of hazard control for laboratory safety.

3.2.10.3.1 Storage and disposal of laboratory waste

The correct storage and disposal of laboratory waste, including infectious materials and chemicals, are complex and important issues. The hazards of improper disposal include:

- Mercury trapped in porous sinks that continues to vaporize
- Improper use of perchloric acid than can result in an explosion
- Azides that combine with the metals, copper, ammonium, or lead, in plumbing systems and may form explosive combinations when dry
- Organic solvents that continue to vaporize and contaminate laboratory air even after vigorous flushing
- Aerosols of infectious material that are accidentally sprayed throughout the laboratory environment

Storage of hazardous waste is discussed throughout this section; disposal is covered in Section 6. Stations should be installed to receive, handle, and dispense volatile or corrosive chemicals. Appropriate protective equipment, eye washes, and emergency showers should be provided. Laboratory workers should be trained in emergency procedures and routine safe work practices.

3.2.10.3.2 Protective equipment

Because no universally protective material exists, protective equipment such as gloves and respirators should be selected specifically for agents to which the worker may be exposed. The manufacturers of chemical protective clothing and equipment can provide specific information.

3.2.10.3.3 Work practices

Safe work practices are very important in protecting laboratory workers. The following precautions should be taken to avoid accidental poisonings with laboratory chemicals:

- Do not eat, drink, or smoke in a laboratory. Food and beverages should not be stored in refrigerators or elsewhere in laboratories.
- Do not wear contact lenses when working with chemicals.
- Never pipette by mouth.
- Wear a laboratory coat or apron while in the laboratory and remove it when leaving.
- Wear chemical worker's goggles or a face shield when accidental splashes to the face or eyes are possible.

Ventilation hoods can be effective for capturing and containing contaminants. Design specifications for
laboratory fume hoods may be found in *Industrial Ventilation: A Manual of Recommended Practice* (ACGIH 1986).

Ventilation rates should be measured and recorded for all hoods, and the measurements should be kept near the hoods of future reference. The entire ventilation system should be monitored monthly check its efficiency. In addition, chemical fume hoods must at least meet the requirements of NFPA 45, Laboratory Ventilating Systems and Hood Requirements (NFPA 1983, Volume 3).

### 3.2.10.3.4 Labeling

All chemicals used in a laboratory should be clearly labeled with the generic chemical name, date of arrival, probable shelf life, hazardous character and special storage requirements. The laboratory safety officer should maintain a complete list of all chemical sin the laboratory and review it with the hospital health and safety committee and the personnel health service. The hospital health and safety committee or officer should consult the OSHA hazard communication standard (29 CFR 1910.1200).

### 3.2.10.3.5 Laboratory equipment

All electrical equipment should be grounded. The disconnects for all equipment should be properly marked, and the areas around the breaker boxes should be kept clear. Wiring and connections on all electrical equipment should be checked regularly; equipment that rotates, moves, and vibrates may wear through the insulation or put tension on the terminal screws.

Cylinders of compressed gas should be secured and kept upright, and the valve-protection caps should be fastened when not in use. Hoses fittings, and gauges for compressed gas should be kept in good condition and checked periodically for leads.

Laboratory equipment and work surfaces that have been contaminated with infectious material should be cleaned with an effective disinfectant.

### 3.2.10.3.6 Chemical, physical, and biologic agents

Laboratory work requires the use of many chemical, physical, and biologic agents that are not discussed in the manual. The following recommendations will help control common laboratory hazards:

- Compile a list of the common agents used in each laboratory including:
  - organic compounds such as acetone, formaldehyde, xylene, and other solvents
  - inorganic compounds
  - physical hazards such as ultraviolet radiation and ultrasonic devices
  - Biologic hazards such as viruses (hepatitis) and bacteria (tuberculosis), and
  - Radioactive isotopes such as those of iodine and cesium

- Inform workers potentially exposed to hazardous substances about the hazards, symptoms of exposure, and effects of over exposure.

- Monitor worker exposures to ensure that airborne concentrations of specific contaminants are at least below the allowable limits. The local OSHA office, NIOSH (see the listing in Section 7), or a state or local industrial hygiene office can supply information on air sampling techniques.
● Collect biologic samples to monitor worker exposures to toxic substances (e.g. mercury in the blood, hippuric acid in the urine [toluene exposure] and enzyme activity levels [liver damage]).

● Establish a procedure for the proper storage, handling, and disposal of all chemicals

● Establish a procedure to ensure that biologic safety cabinets are decontaminated routinely and certified annually.

● Establish a detailed procedure for dealing with chemical spills.

● Check floors and benches for accumulations of spilled mercury.

● Post names and telephone numbers of persons to be notified in emergency situations. This is particularly important for large research laboratories involved in experimental work.

3.2.11 Surgical Services

Hazardous materials found in operating rooms include anesthetic gases, their vapors, and the vapors of various solvents.

3.2.11.1 Anesthetic Gases

Because anesthetic gases can pose both safety and health hazards, testing for leaks should be performed on a continuing basis. The volume of anesthetic gases used should be recorded, and the records should be analyzed routinely as a check for leakage.

Nitrous oxide is the most commonly used anesthetic gas. The vapors of diethyl ether cyclopropane, enflurane, halothane, and isoflurane are also used frequently and will be considered as gases in this documents. The principal source of waste anesthetic gases in operating rooms is leakage from equipment, particularly when anesthetic is administered by face mask.

The NIOSH criteria document on waste anesthetic gases (NIOSH 1977a) provides a description of work practices for areas where anesthetic gases are used. More recent sources are Eger (1985), Saidman and Smith (1984), and Whitcher (1987).

3.2.11.2 Flammable Anesthetics

Although many hospitals have discontinued the use of flammable anesthetics, they may still be used in some cases. The following measures should be implemented in operating rooms where flammable anesthetics are used:

● Only electrical equipment approved by the hospital engineering department should be used in operating rooms. The equipment should be check regularly to ensure that it is operating properly.

● Flammable anesthetics should have a separate, fire-resistant storage space that is vented to the outside.

● The floors of operating rooms should be covered with an approved conductive material; it should be tested regularly for conductivity, and records of the testing should be kept.
Conductive clothing should be worn where required. Conductive footwear should be required and tested daily for conductivity.

The NFPA standard for inhalation anesthetics (NFPA 1984, Volume 4) and the National Electrical Code (NFPA 1983, Volume 6) contain further information.

3.2.11.3 compressed Gases

Compressed gases used for anesthesia or other purposes in surgical suites include oxygen, nitrous oxide, ethylene oxide, and air. These gases may be piped from a central storage area or used directly from cylinders in the surgical suites. Hospital administrative personnel must ensure that cylinders of compressed gas are stored and used safely. The NFPA has made recommendations for the storage and labeling of compressed gas cylinders and the use of regulators, valves, and connections (NFPA 1983, Volume 4, 56A). The principal recommendations are to conduct proper inspections to ensure that the gas delivered is the same as that shown on the outlet label and to provide appropriate storage rooms for oxidizing gases such as oxygen and nitrous oxide. The National Fire Codes (NFPA 1983, Volume 4, 56A) give a more detailed explanation of the NFPA recommendations.

3.2.11.4 Scavenging

Scavenging is the process of collecting and disposing of waste anesthetic gases and vapors from breathing systems at the site of overflow. It is carried out to protect operating room personnel by preventing the dispersal of anesthetic gases into the room air. A scavenging system has two major parts: a collecting device or scavenging adapter to collect waste gases, and a disposal route to carry gases from the room.

The NIOSH publication, Development and Evaluation of Methods for the Elimination of Waste Anesthetic Gases and Vapors in Hospitals (NIOSH 1977), contains information about control methods to establish and maintain low concentrations of waste anesthetic gas in operating rooms. The document includes techniques for scavenging, maintaining equipment, monitoring air, and minimizing leakage while administering anesthesia. It also illustrates various scavenging systems, details procedures for initiating a scavenging program, and presents the results of gas distribution and air monitoring studies.

3.2.11.5 General Guidelines

Persons responsible for health and safety in the hospital surgical department should be aware of the availability of new products and new information on familiar products. For example, methyl methacrylate, which is used in bone surgery, has been recently investigated as a potentially hazardous substance.

The following guidelines will help protect workers in the surgical service:

- Use separate collection containers for glass, empty ether cans, aerosol cans, disposables, etc, that are not to be incinerated.

- Dispose of sharp instruments, blades, and needles in designated, puncture resistant containers. All supplies and instruments used should be accounted for to prevent their disposal in linens and other materials that will be handled by hospital workers.

- Keep towel clips and scissors closed when not in use.
- Install suction lines and electrical cords to minimize tripping hazards. Lines and cords should be suspended from the ceiling or placed under the floor whenever possible.

- Instruct personnel to report defective equipment.

- Post warning signs where necessary and enforce proper work practices.

- Instruct workers in proper lifting practices.

- Discuss safe work practices and health hazards with each new worker as part of orientation. Review this training periodically.

3.2.12 Temporary Personnel (Floaters)

Nursing students, medical students, and medical house staff who rotate through many different training situations have potential exposure to a wider variety of hazards than do most workers who are stationary. Temporary workers are usually unfamiliar with the hazards of each new department and the proper work practices and other means of preventing injury or illness to themselves and others.

Sleep deprivation is a problem for medical students and house staff (who often work 80 hours a week or more) and for some nursing students (who may support themselves with a second job while completing training). A study of sleep deprivation in a group of medical interns (Friedman et al. 1973) showed difficulty in thinking, depression, irritability, depersonalized treatment of patients, inappropriate attitudes or behavior, and short-term memory loss. Medical students have also exhibited high rates of psychotic depression, withdrawal from medical school, and suicidal thoughts and actions. When students and house staff are deprived of sleep, both patient care and inter-staff relations suffer.

Chemical hazards for laboratory and other technicians may be greater during training periods when they have not received health and safety instruction or learned to carry out procedures smoothly and quickly.

For example, nursing students who do not know how to protect themselves may change dressings, apply topical medications, and perform other duties in close contact with patients who have infectious diseases. Medical students spend many hours their first year dissecting cadavers preserved in formaldehyde (a suspected carcinogen) without knowing the danger or how to avoid the risks. The student or trainee usually feels pressured to carry out the assigned task and hesitates to question the wisdom or manner of carrying it out. Volunteers (e.g. premedical or other pre-health-care career students), who are even less well trained to recognize or prevent health hazards in the transmission of infectious diseases, often go from patient to patient distributing reading materials and doing other errands.

To solve these problems, transient workers should have (1) prompt and adequate training in hospital health and safety, (2) training specific to the departments in which they will spend time, (3) adequate time to perform tasks in a careful and safe manner, (4) adequate supervision to monitor their performance and answer their questions, and (5) sufficient rest to perform their duties safely.
3. Recommended Guidelines for Controlling Safety Hazards in Hospitals
(Continued)

3.3 REFERENCES


3.4 ADDITIONAL RESOURCES

3.4.1 General Safety


3.4.2 Back Injuries


3.4.3 Fires and Emergency Plans


3.4.4 Compressed Gases


3.4.5 Electrical Safety


3.4.6 Security


**3.4.7 Hospital Departments**


4. Recommended Guidelines for Controlling Infectious Disease Hazards in Hospitals

CDC, through its Center for Infectious Diseases and NIOSH, is developing new recommended guidelines for protecting health care workers from infectious diseases. For the present, the reader is referred to guidelines that CDC has already published on this topic. Reprinted in appendices 5, 6, and 8.

Appendix 5 contains the Joint Advisory Notice from the Department of Labor and the Department of Health and Human Services entitled Protection Against Occupational Exposure to Hepatitis B Virus HBV and Human Immunodeficiency Virus HIV, published 10/19/87.


Appendix 8 contains three guidelines in a series of CDC recommendations for preventing and controlling nosocomial infections: infection control in hospital personnel 84, isolation precautions in hospitals, 83, and guidelines for handwashing and hospital environment control, 85.
5. Recommended Guidelines for Controlling Noninfectious Health Hazards in Hospitals

Workers encounter many noninfectious health hazards in hospitals, including chemical hazards, physical hazards, mutagens and teratogens, dermatologic hazards, and stress. The following subsections describe these hazards in terms of their location in the hospital, potential health effects, existing standards and recommendations for safe use, recommended environmental monitoring, existing exposure control methods, and recommended medical surveillance.

5.1 Chemical Hazards

5.1.1 Introduction

Chemicals may exert either acute or chronic effects on workers. The effects depend on (1) extent (concentration and duration) of exposure, (2) the route of exposure, and (3) the physical and chemical properties of the substance. The effects exerted by a substance may also be influenced by the presence of other chemicals and physical agents or by an individual’s use of tobacco, alcohol, or drugs. Basic principles of toxicology are reviewed in Doull et al. (1980).

5.1.1.1 Extent of Exposure

The exposure concentration of a substance is the mass per unit volume of air to which a worker is exposed. In the workplace, airborne concentrations are usually expressed in terms of milligrams of substance per cubic meter of air (mg/m³) or parts of substance per million parts of air (ppm). In the case of asbestos, concentration is expressed as fibers per cubic centimeter (f/cc) or fibers per cubic meter (f/m³) of air. The exposure dose is the amount of a substance that actually enters the body during the period of exposure. The substance continues to be present in the body until it is metabolized or eliminated. Although some chemicals are rapidly metabolized, others are not and may be excreted unchanged or stored in the fatty tissues (solvents), lungs (dusts and fibers), bone (lead and radium), or blood (soluble gases).

5.1.1.2 Route of Entry into the Body

Toxic substances can enter the body through several routes, including the intact skin, the respiratory system (inhalation), the mouth (inhalation and ingestion), the eyes, and by accidental needle punctures. Some substances can also damage the skin or eyes directly without being absorbed. Not all substances can enter the body through all routes. Inorganic lead, for example, can be inhaled or swallowed, but it does not penetrate the skin. (It should be noted that tetraethyl lead, a component of automotive gasolines, can be absorbed through the skin and therefore can contribute to the total absorbed dose.) Sometimes a chemical substance can enter through more than one route. Asbestos, for example, can be swallowed or inhaled, but the latter
route appears to be more hazardous.

5.1.1.3 Physical and Chemical Properties

The physical properties of a chemical or physical agent include such characteristics as vapor pressure, solubility in water and organic solvents, boiling point, melting point, molecular weight, specific gravity, and morphology. Chemical properties describe the reactivity of a substance with other chemicals.

5.1.1.4 Warning Properties

Some chemicals have characteristics that can be perceived by workers and can serve as a warning of the chemical’s presence. The most commonly discussed warning property is odor. Depending on a person’s ability to detect the odor of a substance, a chemical is considered to provide either good or poor warning of its presence. The lowest concentration at which the odor of a chemical can be detected is called the odor threshold. Some substances, such as asbestos, have no odor and therefore provide no warning of their presence. In many cases, the concentration of a chemical that can be detected by odor and the concentration that is capable of causing adverse effects are similar. For example, the odor threshold of ethylene oxide is about 700 ppm (Jay et al. 1982), a concentration that has been demonstrated to cause a variety of severe effects among exposed workers. In other cases, exposure to a chemical can cause olfactory fatigue that prevents a worker from continuing to smell the chemical. People cannot detect odors equally well. Thus some may be able to detect the odor of chlorine at a concentration of 0.02 ppm, and others cannot detect its presence until the concentration reaches 0.2 ppm (NIOSH 1976b). For these reasons, workers should not rely on their sense of smell to warn them of the presence of hazardous substances. Nevertheless, available information on odor thresholds has been included for the substances discussed here. A more complete discussion of odor as a warning property can be found in Odor as an Aid to Chemical Safety: Odor Thresholds Compared with Threshold Limit Values and Volatilities for 214 Industrial Chemicals in Air and Water Dilution (Amoore and Hautala 1983) and Odor Threshold Determinations of 53 Odorant Chemicals (Leonardos et al. 1969).

5.1.1.5 Synergistic Effects of Various Hazards

Possible interactions may occur as a result of the multiple exposures that exist in a hospital environment. These interactions may involve (1) exposures to chemical and/or physical agents, (2) an individual’s use of tobacco, alcohol, or drugs, or (3) the physiological or psychological state of the worker. Limited data are available on interactions of physical and chemical agents; however two studies of other occupations have shown increased toxicity resulting from the synergistic effects of solvent mixtures (Murphy 1984; Struwe and Wennberg 1983). Information is also available on the interactions of chemical and physical agents and the consumption of tobacco, alcohol, or drugs (Bos et al. 1982; Robbin 1979; Hills and Venable 1982). NIOSH Current Intelligence Bulletin 31 includes a discussion of the adverse health effects of smoking in the work environment. To determine an exposure, it is imperative to consider other possible exposures or factors that might influence the results.

5.1.2 Asbestos

Asbestos refers to a group of impure magnesium silicate minerals that occur in fibrous form. Asbestos is defined to be chrysotile, crocidolite, and fibrous cummingtonite-grunerite including amosite, fibrous tremolite, fibrous actinolite, and fibrous anthophyllite (NIOSH 1980b). Because of the limitations of the analytical method, only fibers that are 5 micrometers or more in length and have a length-to-diameter ratio of 3:1 or greater are considered when determining a worker’s asbestos exposure (29 CFR* 1910.1001).
Because asbestos is an extremely hazardous material and compliance with all relevant aspects of the OSHA asbestos regulations must be assured, hospitals should develop a policy for working with asbestos. All workers who may have reason to work with this substance should receive training.

A hospital asbestos policy must outline specific OSHA requirements (29 CFR 1910.1001) for the following:

- Reports of each asbestos use or exposure (a log of all jobs in which personnel are exposed)
- Work practices for handling asbestos, such as wet handling, development of cleanup protocols, use of plastic sheeting to seal off work areas, and bagging of removed insulation during routine operations, maintenance, and repair
- Asbestos waste collection, labeling, and disposal
- Respiratory protective equipment (types of respirators, maintenance, training programs, use, and recordkeeping)
- Dressing rooms and special clothing
- Air monitoring
- Recordkeeping and maintenance of records (30 years)
- Medical surveillance (requirements are set by OSHA according to the level of asbestos exposure)
- Training

Asbestos removal must only be conducted by fully trained personnel as specified by OSHA (29 CFR 1910.1001).


5.1.2.1 Hazard Location

Hospitals use asbestos for many purposes, including the noncombustible, nonconducting, or chemically resistant materials required for fireproof clothing, curtains, and roofing. Before the early 1970’s, asbestos was used as insulation throughout most buildings (including hospitals). Significant asbestos exposures can occur when insulation in old buildings is removed during renovation. Maintenance personnel in most hospitals do not know and often are not trained in the proper methods of performing repairs on systems that contain asbestos. They frequently perform spot repairs without protecting themselves, patients, or staff from exposure. Asbestos is also used to make heat-resistant protective gloves for central supply and laboratories. With time, these gloves may become worn and disintegrate, releasing fibers into the air.

5.1.2.2 Potential Health Effects
Asbestos causes asbestosis (a fibrosis or scarring of the lung tissue) and cancer. These diseases may develop 15 to 30 years after the first exposure.

Asbestosis belongs to the group of pulmonary diseases called pneumoconioses; these include coal workers’ pneumoconiosis (often called black lung disease) among coal workers and silicosis among workers with prolonged exposure to sand blasting or other operations in which silica-containing rock is crushed, drilled, or used. Pneumoconiosis is characterized by restriction of lung function, which eventually increases the load on the circulatory system so that the fully developed disease usually involves heart failure as well. The only hospital workers most likely to encounter enough asbestos to produce asbestosis are engineers who work in furnace rooms where boilers are lined with asbestos, and maintenance workers who frequently repair old piping or do minor renovation. These workers must take special care to protect themselves and to ensure that asbestos is not spread throughout the facility when they perform tasks involving this substance.

Inhaling asbestos, even in small amounts, may result in lung cancer, gastrointestinal cancer, or mesothelioma (a cancer of the lung and abdomen lining). An association has also been suggested between the ingestion of asbestos and the development of gastrointestinal cancer, but no studies have yet confirmed this. Persons with less than a month of exposure have been known to develop mesotheliomas 20 or 30 years later. Because there is no known safe level of asbestos exposure, any hospital worker who is exposed to moderate or high concentrations of asbestos for even a relatively short time may be at increased risk of developing asbestos-related diseases.

All asbestos-exposed workers have a higher risk of lung cancer than nonexposed workers, but exposed workers who smoke cigarettes have a markedly greater risk of lung cancer than nonsmoking exposed workers (29 CFR 1910.1001).

5.1.2.3 Standards and Recommendations

The current OSHA PEL for asbestos is an 8-hour TWA concentration of 0.2 f/cc (200,000 f/m³) for fibers that are 5 micrometers or longer and that have a length-to-diameter ratio of 3:1 (29 CFR 1910.1001). The asbestos standard is very detailed and has specific requirements for training, labeling, protective equipment, medical surveillance, and environmental monitoring. Questions regarding the implementation of the standard should be referred to the State or Federal OSHA program, which has a consultation service. The NIOSH REL for asbestos (fibers longer than 5 micrometers with a length-to-diameter ratio of 3:1 or greater) is an 8-hr TWA concentration of 100000 f/m³ (0.1 f/cc) (NIOSH 1984b).

5.1.2.4 Environmental Monitoring

Sampling should be conducted in a manner and on a schedule that will provide an accurate depiction of job-specific asbestos exposures. All analyses should be done by laboratories accredited by the American Industrial Hygiene Association (AIHA). The minimum schedule for monitoring is established by OSHA regulation (29 CFR 1910.1001).

5.1.2.5 Exposure Control Methods

5.1.2.5.1 Removal and encapsulation

Whenever asbestos fibers are exposed, they present a hazard that can be eliminated by removing or encapsulating (covering) them so that they will not be released. Asbestos must only be removed by fully trained personnel using methods and protective equipment mandated by OSHA (29 CFR 1910.1001).
5.1.2.5.2 Protective equipment

Complete physical covering and a NIOSH/MSHA-certified, positive-pressure, air-supplied respirator are required for any worker exposed to asbestos. The OSHA asbestos standard should be consulted along with the NIOSH/EPA document entitled A Guide to Respiratory Protection for the Asbestos Abatement Industry (NIOSH/EPA 1986).

5.1.2.5.3 Work practices

Only workers fully trained in asbestos handling should be allowed in areas where asbestos is exposed. The work practices appropriate for handling asbestos are set out in detail in the OSHA regulation (29 CFR 1910.1001).

5.1.3 Chemical Disinfectants

Because of the variety of needs for disinfectants within the hospital, a number of different substances are used. The most important are:

- Isopropyl alcohol
- Sodium hypochlorite (chlorine)
- Iodine
- Phenolics
- Quaternary ammonium compounds
- Glutaraldehydes
- Formaldehyde

Many of the following descriptions of disinfectants refer to the lowest concentration at which the odor of these substances can be detected; however, workers should not rely on odor as a warning of exposure because many persons are unable to detect odors.

5.1.3.1 Isopropyl Alcohol

5.1.3.1.1 Hazard location

Isopropyl alcohol is a widely used antiseptic and disinfectant; it is used mostly to disinfect thermometers, needles, anesthesia equipment, and various other instruments.

5.1.3.1.2 Potential health effects

The odor of isopropyl alcohol may be detected at concentrations of 40 to 200 ppm (NIOSH 1976a). Exposure to isopropyl alcohol can cause irritation of the eyes and mucous membranes. Contact with the liquid may also cause skin rashes.
5.1.3.1.3 Standards and recommendations

The OSHA PEL for isopropyl alcohol is 400 ppm (980 mg/m³) as an 8-hr TWA (29 CFR 1910.1000, Table Z-1). The NIOSH REL for isopropyl alcohol is 400 ppm (984 mg/m³) for up to a 10-hr TWA with a ceiling of 800 ppm (1,968 mg/m³) for 15 min (NIOSH 1976a).

5.1.3.1.4 Exposure control methods

Workers should be provided with and required to use appropriate protective clothing (see Section 2.3.5) such as gloves and face shields to prevent repeated or prolonged skin contact with isopropyl alcohol. Splash-proof safety goggles should also be provided and required for use where isopropyl alcohol may contact the eyes.

Any clothing that becomes wet with isopropyl alcohol should be removed immediately and reworn only after the compound has been removed. Clothing wet with isopropyl alcohol should be stored in closed containers until it can be discarded or cleaned. The worker who is laundering or cleaning such clothes should be informed of isopropyl alcohol’s hazardous properties.

Skin that becomes wet with liquid isopropyl alcohol should be promptly washed or showered.

Adequate exhaust ventilation must be supplied in the hospital to remove isopropyl alcohol vapor in the work area.

5.1.3.2 Sodium Hypochlorite (Chlorine)

Chlorine can be generated from solutions of sodium hypochlorite. Chlorine is effective against bacteria and viruses, and it can destroy some spores, depending on the concentration.

5.1.3.2.1 Hazard location

Chlorine is used for disinfecting water tanks, bathtubs, toilets, and bathrooms; it is also used as a bleach for laundries, a sanitizer for dishwashing, and a disinfectant for floors. Chlorine-containing cleaning materials should never be mixed with ammonia or ammonia-containing materials because the reaction may produce a toxic gas.

5.1.3.2.2 Potential health effects

Chlorine is released slowly from cleaning and bleaching solutions as they are used. Repeated exposure to chlorine may cause a runny nose, coughing, wheezing, and other respiratory problems (NIOSH 1976b). Mild irritation of the mucous membranes can occur at exposure concentrations of 0.5 ppm (ACGIH 1986).

5.1.3.2.3 Standards and recommendations

The OSHA PEL for chlorine is a ceiling of 1 ppm (3 mg/m³) (29 CFR 1910.1000, Table Z-1). The NIOSH REL is a ceiling of 0.5 ppm for 15 min (NIOSH 1976b). Chlorine has an odor threshold between 0.02 and 0.2 ppm, but since the sense of smell is dulled by continued chlorine exposure, odor does not provide adequate warning (NIOSH 1976b).

The ACGIH recommends a TLV of 1 ppm (3.0 mg/m³) as an 8-hr TWA and a short-term exposure limit
(STEL) of 3 ppm (9 mg/m³) but has published a notice of intended change to a TLV of 0.5 ppm (1.5 mg/m³) as an 8-hr TWA and a STEL of 1 ppm (3 mg/m³) (ACGIH 1987).

5.1.3.2.4 Exposure control methods

Workers should be provided with and required to use splash-proof safety goggles where there is any possibility that chlorine-containing solutions may contact the eyes. To prevent any possibility of skin contact with chlorine-containing liquids, workers should be provided with and required to use appropriate personal protective equipment (see Section 2.3.5) such as gloves, face shields, and respirators (see Section 2.3.5.6) as necessary. Nonimpervious clothing that becomes contaminated with chlorine-containing solutions should be removed immediately and reworn only after the chlorine-containing solution is removed from the clothing. Skin that becomes contaminated with chlorine should be immediately washed to remove any chlorine. Additional control measures for chlorine include process enclosure and good exhaust ventilation.

5.1.3.3 Iodine

Iodine is a general disinfectant; it can be mixed with alcohol for use as a skin antiseptic or with other substances for general disinfecting purposes.

5.1.3.3.1 Hazard location

Iodine can be found throughout the hospital.

5.1.3.3.2 Potential health effects

Symptoms of iodine exposure include irritation of the eyes and mucous membranes, headaches, and breathing difficulties (ACGIH 1986). Crystalline iodine or strong solutions of iodine may cause severe skin irritation: it is not easily removed from the skin and may cause burns.

5.1.3.3.3 Standards and recommendations

The OSHA PEL for iodine is a ceiling of 0.1 ppm (1.0 mg/m³) (29 CFR 1910.1001, Table Z-1). The ACGIH recommends a TLV of 0.1 ppm (1.0 mg/m³) as a ceiling (ACGIH 1987). NIOSH has no REL for iodine.

5.1.3.3.4 Exposure control methods

To prevent skin contact with solids or liquids containing iodine, workers should be provided with and required to use personal protective equipment such as gloves, face shields, and any other appropriate protective clothing deemed necessary (see Section 2.3.5).

If there is any possibility that clothing has been contaminated with solid iodine or liquids containing iodine, a worker should change into uncontaminated clothing before leaving the work area. Clothing contaminated with iodine should be stored in closed containers until provision is made to remove the iodine. The person laundering or cleaning such clothes should be informed of iodine’s hazardous properties.

Skin that becomes contaminated with solids or liquids containing iodine should be immediately washed with soap or mild detergent and rinsed with water. Workers who handle solid iodine or liquids containing iodine should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using
5.1.3.4 Phenolics

Phenolics were among the first disinfectants used in hospitals. Certain detergent disinfectants belong to the phenol group, including phenol, para-tertiary butylphenol (ptBP), and para-tertiary amylphenol (ptAP). They are generally used for a wide range of bacteria, but they are not effective against spores.

5.1.3.4.1 Hazard location

Phenolics are widely used on floors, walls, furnishings, glassware, and instruments.

5.1.3.4.2 Potential health effects

Phenol may be detected by odor at a concentration of about 0.05 ppm. Serious health effects may follow exposure to phenol through skin adsorption, inhalation, or ingestion. These effects may include local tissue irritation and necrosis, severe burns of the eyes and skin, irregular pulse, stertorous breathing (harsh snoring or gasping sound), darkened urine, convulsions, coma, collapse, and death (NIOSH 1976d). Both ptBP and ptAP have caused hospital worker to experience loss of skin pigment that was not reversed one year after use of the compounds was discontinued (Kahn 1970).

5.1.3.4.3 Standards and recommendations

The OSHA PEL for phenol is 5 ppm (19 mg/m³) as an 8-hr TWA (Skin) (29 CFR 1910.1000, Table Z-1). The NIOSH REL for phenol is 20 mg/m³ (5.2 ppm) for up to a 10-hr TWA with a 15-min ceiling of 60 mg/m³ (15.6 ppm) (NIOSH 1976d). Neither OSHA nor NIOSH has established exposure limits for ptBP or ptAP.

5.1.3.4.4 Exposure control methods

When working with phenol, workers should be provided with and required to use protective clothing (see Section 2.3.5), gloves, face shields, splash-proof safety goggles, and other appropriate protective clothing necessary to prevent any possibility of skin or eye contact with solid or liquid phenol or liquids containing phenol.

If there is any possibility that the clothing has been contaminated with phenol, a worker should change into uncontaminated clothing before leaving the work area and the suspect clothing should be stored in closed containers until it can be discarded or until provision is made for removal of the phenol. The worker laundering or cleaning such clothes should be informed of phenol’s hazardous properties.

Skin that becomes contaminated with phenol should be immediately washed with soap or mild detergent and rinsed with water. Eating and smoking should not be permitted in areas where solid or liquid phenol or liquids containing phenol are handled, processed, or stored. Workers who handle solid or liquid phenol or liquids containing phenol should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

Additional measures to control phenol exposure include process enclosure, local exhaust ventilation, and personal protective equipment.

5.1.3.5 Quaternary Ammonium Compounds
5.1.3.5.1 Hazard location

Quaternary ammonium compounds are widely used as disinfectants in hospitals, and they have the major disadvantage of being ineffective against tuberculosis and gram-negative bacteria. Quaternary ammonium compounds are most likely to be encountered by workers in central supply, housekeeping, patient, and surgical services areas. The detergent benzalkonium chloride is the most widely used quaternary ammonium compound and is found in the following commercial products (Cohen 1987):

- Zephiran chloride
- Zephirol
- BTC
- Roccal
- Benirol
- Enuclen
- Germitol
- Drapolene
- Drapolex
- Cequartyl
- Paralkan
- Germinol
- Rodalon
- Osvan

5.1.3.5.2 Potential health effects

Quaternary ammonium compounds can cause contact dermatitis, but they tend to be less irritating to hands than other substances. They can also cause nasal irritation.

5.1.3.5.3 Standards and recommendations

No OSHA PEL, NIOSH REL, or ACGIH TLV exists for quaternary ammonium compounds.

5.1.3.6 Glutaraldehyde

Although glutaraldehyde is available in 50%, 25%, 10% and 2% solutions, most hospitals use 2% glutaraldehyde solutions buffered to pH 7.5 to 8.5 before use. Glutaraldehyde solutions also contain surfactants to promote wetting and rinsing of surfaces, sodium nitrite to inhibit corrosion, peppermint oil as an odorant, and FD&C yellow and blue dyes to indicate activation of the solution (NIOSH 1983b). One disadvantage of buffered glutaraldehyde solutions is that they are stable for less than 2 weeks, so solutions must be dated and made as needed (Gorman et al. 1980). Another disadvantage is that at 20 degrees C (68°F), a 50% solution of glutaraldehyde has a vapor pressure of 0.015 mmHg (ACGIH 1986) and thus can generate an atmosphere that contains as much as 20 ppm of glutaraldehyde. This concentration is well above that shown to cause adverse health effects in animals and humans.

5.1.3.6.1 Hazard location

Glutaraldehyde is a newer disinfectant that is especially effective for cold sterilization of instruments; it has recently been used as a substitute for formaldehyde during embalming. Glutaraldehyde has been used in
pulmonary physiology units, at nurses’ stations, and in research laboratories. As a disinfectant, glutaraldehyde has been used to clean sputum mouthpieces, suction bottles and tubing, and equipment used for ear, nose, and throat treatment (NIOSH 1983b).

5.1.3.6.2 Potential health effects

Glutaraldehyde may be absorbed into the body by inhalation, ingestion, and skin contact. Extensive skin contact may cause allergic eczema and may also affect the nervous system. Glutaraldehyde has an odor threshold of about 0.04 ppm, is highly toxic, and is irritating to the skin and mucous membranes at concentrations of about 0.3 ppm (1.05 mg/m³) (ACGIH 1986). In a study of 541 members of a hospital cleaning department, 39.1% of the workers had skin disease during their employment. In 21% of the workers, contact dermatitis was attributed to the use of glutaraldehyde, formaldehyde, and chloramine (Hansen, 1983).

A NIOSH investigation (NIOSH 1983b) determined that airborne glutaraldehyde concentrations of 0.4 ppm (1.5 mg/m³) were responsible for symptoms of irritation in 9 of 11 (82%) exposed workers. Eye, throat, and lung irritation were reported among 45% of the workers. Other symptoms, including cough, chest tightness, headache, skin irritation, and asthma-like symptoms, were also reported.

Glutaraldehyde exposure has been associated with fetotoxicity in mice, DNA damage in chickens and hamsters, and mutagenicity in microorganisms (NIOSH 1985).

5.1.3.6.3 Standards and recommendations

The ACGIH recommended ceiling limit for glutaraldehyde is 0.2 ppm (0.8 mg/m³) (ACGIH 1986). OSHA does not have a PEL for glutaraldehyde, and NIOSH and no REL.

5.1.3.6.4 Exposure control methods

Workers should avoid breathing glutaraldehyde vapors. They should also be provided with and required to use splash-proof safety goggles where there is any possibility of contaminating the eyes with glutaraldehyde. To prevent any possibility of skin contact, workers should be provided with and required to use protective clothing (See Section 2.3.5). If clothing becomes contaminated with glutaraldehyde, it should be promptly removed and not reworn until the glutaraldehyde has been removed. The worker who is laundering or cleaning such clothes should be informed of glutaraldehyde hazardous properties. Skin that becomes contaminated with glutaraldehyde should be washed immediately or showered.

5.1.3.7 Formaldehyde

formaldehyde is used for cold sterilization of various instruments and as an embalming agent. This compound is fully discussed later in this Section (5.1.6).
5.1.4 Antineoplastic Drugs

Nurses and pharmacists face a variety of potential hazards from contact with pharmaceuticals. The drugs of greatest concern are those associated with cytotoxicity and fetotoxicity (e.g. folate antagonists, 6-mercaptopurine, and some alkylating agents), and teratogenicity (e.g. actinomycin-D, mitomycin-C, nitrogen mustard, prednisone, procarbazine, streptomycin, and vincristine). Many chemotherapeutic agents have been reported to cause cancer in animals and thus can be considered to be potential human carcinogens (e.g. cyclophosphamide and chlorambucil) (Sorsa et al 1985).

Antineoplastic drugs derive their name from the fact that they interfere with or prevent the growth and development of malignant cells and neoplasms. They may also be called cytotoxic or cytostatic because they have the ability to prevent the growth and proliferation of cells. Approximately 30 antineoplastic drugs are currently available commercially. Each year some 200,000 to 400,000 cancer patients are treated with antineoplastic drugs (Sorsa et al. 1985; Devita 1982).

5.1.4.1 Effects of antineoplastic drugs

Many antineoplastic drugs are reported to cause mutations in test systems and are carcinogenic and teratogenic in experimental animals (See table 5-1). Evidence indicated that cyclophosphadime, chlorambucil, 1,4-butanediol dimethylsulfonate, and melphalan are human carcinogens (Sorsa et al 1985). When given to patients in therapeutic doses, many antineoplastic drugs (e.g. cyclophosphamide) have been associated with an increased incidence of malignant tumors that develop at a later date (IARC 1981). Available human evidence suggest that cyclophosphamide is also a teratogen.

<table>
<thead>
<tr>
<th>Compound used in chemotherapy</th>
<th>Degree of evidence for carcinogenicity in Humans</th>
<th>Teratogenicity and embryotoxicity†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinomycin-D</td>
<td>Inadequate</td>
<td>Limited</td>
</tr>
<tr>
<td>Adriamycin</td>
<td>Inadequate</td>
<td>Sufficient</td>
</tr>
<tr>
<td>BCNU</td>
<td>Inadequate</td>
<td>Sufficient</td>
</tr>
<tr>
<td>Bleomycin</td>
<td>Inadequate</td>
<td>Inadequate</td>
</tr>
</tbody>
</table>
1,4-Butanediol dimethylsulfonate (Myleran, Busulfan) & Sufficient & Limited & T  
Chlorambucil & Sufficient & Sufficient & T,E  
CCNU & Inadequate & Sufficient & T,E  
Cisplatin & Inadequate & Limited & E  
Cyclophosphamide & Sufficient & Sufficient & T,E  
Dacarbazine & Inadequate & Sufficient & T,E  
5-Fluorouracil & Inadequate & Inadequate & T,E  
Melphalan & Sufficient & Sufficient & T  
6-Mercaptopurine & Inadequate & Inadequate & T,E  
Methotrexate & Inadequate & Inadequate & T,E  
Nitrogen mustard & Inadequate & Sufficient & T,E  
Procarbazine & Inadequate & Sufficient & T,E  
Thiotepa & Inadequate & Sufficient & T  
Uracil mustard & Inadequate & Sufficient & T  
Vinblastine & Inadequate & Inadequate & T,E  
Vincristine & Inadequate & Inadequate & T,E  

*Adapted from Sorsa et al. (1985).  
†Teratogenicity (T) and embryotoxicity (E) in experimental animals as summarized by IARC (1975, 1976, 1981).

Toxic effects have been observed in patients treated with antineoplastic drugs. These effects include lack of sperm production, reduced sperm counts, amenorrhea, and adverse effects on the bone marrow, heart, central nervous system, liver, skin, ears and pancreas, lungs, kidneys, and endocrine glands (Stellman and Zoloth 1986). Treatment with antineoplastic drugs has also resulted in depression of the hematopoietic system (LaFond 1978; Caro 1980).

The acute effects of accidental exposure to these drugs can be severe. For example, an accidental needle prick of a patient’s finger with mitomycin-C has been reported to cause the eventual loss of function of that hand (Duvall and Baumann 1980). Some antineoplastic drugs e.g. mustine hydrochloride and doxorubicin are strong vesicants that can cause varying degrees of local tissue necrosis upon direct contact Knowles and Virden 1980.

Little is known about the potential health hazards of chronic exposure to antineoplastic drugs, but Selevan et al. (1985) observed a statistically significant association between fetal loss and the occupational exposure of nurses to these drugs. Sotaniemi et al (1983) documents liver damage in three oncology nurses who handled antineoplastic drugs for a number of years. Light-headedness, dizziness, nausea, headaches, skin and mucous membrane reactions, hair loss, cough, and possible allergic reactions have been reported by nurses handling antineoplastic drugs Crudi (1980) These side effects observed in nurses are the same as those noted by patients receiving antineoplastic drugs Crooke and Prestayko (1981).

Several other antineoplastic drugs (e.g. methotrexate and vincristine) are skin and mucous membrane irritants.
Knowles and Virden 1980. Bleomycin and cisplatin may cause allergic reactions following skin contact with a variety of antineoplastic drugs (Knowles and Virden 1980).

5.1.4.2 Methods for estimating exposure to antineoplastic drugs

At present, few economically feasible tests are available for monitoring the exposures of nurses and pharmacy technicians who work with a variety of antineoplastic drugs. Primary routes of worker exposure to antineoplastic drugs are inhalation and dermal absorption.

Exposures by inhalation can occur during drug preparation or administration. Aerosols can be generated when inserting needles into or withdrawing them from vials, and when expelling air from syringes before injection (Hirst et al. 1984; Stellman et al. 1984). In one study, for example, low levels of the antineoplastic drugs cyclophosphamide and fluorouracil were measured in workroom air (deWerk et al. 1983).

Skin absorption may occur when antineoplastic drugs are spilled during their preparation or administration (Jardine et al. 1978). Skin exposure may also occur as a result of contact with the urine of patients being treated with antineoplastic drugs (Hirst et al. 1984). Because of the relatively large number of antineoplastic drugs in use and the variety of metabolites formed, it is not economically feasible for the hospital laboratory to conduct biological monitoring for each drug in use. However, methods have been developed for detecting platinum (from cisplatin exposure) and cyclophosphamide in the urine of exposed workers (Venitt et al. 1984).

Mutagenicity assays using urine can detect excreted mutagenic parent compounds or their mutagenic metabolites. Several studies have analyzed mutagenic constituents in the urine as a measure of exposure to antineoplastic drugs. Five studies reported that nurses or pharmacy technicians handling antineoplastic drugs have increased urine mutagenicity compared with a control population (Nguyen et al. 1982; Falck et al. 1979; Kolmodin-Hedman 1983; Bos et al. 1982; Anderson et al. 1982). However, negative results were reported in five other studies of similar groups of nurses or pharmacy technicians (Venitt et al. 1984; Staiano et al. 1981; Rorth et al. 1983; Ratcliffe 1983; Gibson et al. 1984). Evidence is still insufficient to recommend routine urine mutagenicity testing for estimating exposure to antineoplastic drugs.

Sister chromatid exchange (SCE) analysis using human peripheral blood lymphocytes is thought to provide an estimate of DNA damage produced by mutagens and carcinogens. Increased frequencies of SCE and chromosome aberrations were found in hospital personnel handling antineoplastic drugs (Norrpaa et al. 1980; Waksvik et al. 1981; Nikula et al. 1983). However, these observations were not confirmed by other investigators (Barale et al. 1985; Kolmodin-Hedman et al. 1983). Thus evidence is still insufficient to recommend routine SCE analysis for estimating exposure to antineoplastic drugs.

5.1.4.3 Methods for preventing exposure to antineoplastic drugs

Methods for preventing exposure to antineoplastic drugs are detailed in the OSHA work practice guidelines attached to this document as Appendix 7 OSHA 1986. These guidelines address drug preparation, drug administration, waste disposal, spills, medical surveillance, storage and transport, training, and information dissemination. Recommendations have also been issued by the National Institutes of Health NIH, the Society of Hospital Pharmacists, the American Society of Hospital Pharmacists, the National Study Commission on Cytotoxic Exposure, and Individual directors of hospital pharmacies (Knowles and Virden 1980; Waksvik et al. 1981; Crudi 1980; Crooke and Prestayko 1981; Caro 1980; Vaughn and Christensen 1985).

5.1.4.4 Medical monitoring
Workers exposed to antineoplastic drugs should receive preplacement and periodic medical evaluations that include at least the following:

- A complete work history and medical history
- An examination that emphasizes the skin, the liver, and the hematopoietic, reproductive, and nervous systems

Other tests may be performed at the discretion of the examining physician, who should be particularly alert for symptoms of liver disease, skin and mucous membrane irritation, central nervous system depression, teratogenic effects, and cancer.

5.1.5 Ethylene Oxide

Ethylene oxide, which is a colorless gas with a distinctive sweet, ether-like odor (NIOSH 1981j), is used to sterilize medical instruments, particularly those made of heat-labile materials (Gross et al. 1979). This compound is regulated by OSHA as a carcinogen 29 CFR 1910.1047. Ethylene oxide is typically supplied to US hospitals in compressed gas cylinders that contain 88% Freon (see Section 5.1.7) and 12% ethylene oxide, or in single-dose cartridges of 100% ethylene oxide (NIOSH 1977d).

5.1.5.1 Hazard Location

Workers in central supply, dental operatories, and surgical suites who use ethylene oxide are at risk of potential exposure. In 1983, OSHA estimated that approximately 62,370 workers were directly exposed to ethylene oxide and that 25,000 others may have been incidentally exposed in US hospitals (Federal Register 1983). An estimated 7,700 ethylene oxide sterilizers are in operation in 6,300 hospitals in the United States (Federal Register 1983).

The typical source of ethylene oxide exposure in the hospital environment is through the operation of sterilizing equipment. Unless good engineering controls and good work practices area used, workers may encounter relatively high concentrations of ethylene oxide over relatively brief periods. A study by Yager et al. (1983) highlights the need to control short-term peak exposures to ethylene oxide.

5.1.5.2 Potential Health Effects

Exposure to ethylene oxide occurs primarily through inhalation, but exposure of moist skin to the vapors can also cause irritation.

5.1.5.2.1 Acute effects

Although ethylene oxide has an odor threshold of about 700 ppm Jay et al. (1982), exposure at 200 ppm may cause irritation of the eyes and upper respiratory system. High concentrations can cause severe skin burns, rashes, sores, headache, nausea, and hemolysis (the destruction of red blood cell). Very high exposures may cause vomiting, shortness of breath, weakness, drowsiness, lack of coordination, cyanosis, bluish skin color resulting from oxygen insufficiency, and pulmonary edema (NIOSH 1977d).

Contact with ethylene-oxide-sterilized equipment or wrappings that have not been adequately aerated to remove residual ethylene oxide may cause severe skin burns with large blisters and peeling skin. Healing may leave hyperpigmentation (brown discoloration of skin).
Ethylene oxide may also pose a fire hazard, depending on how it is stored and used (see Section 3).

5.1.5.2 Chronically Effects

Ethylene oxide is a mutagen in many assay systems and causes reproductive damage in both male and female experimental animals. Some data also suggest that ethylene oxide may adversely affect human reproduction (Hemminki et al. 1982). Thiess et al. (1981) found chromosomal abnormalities in workers exposed to alkylene oxides including ethylene oxide, and Garry et al. (1979) found a dose-response relationship between ethylene oxide concentrations and chromosomal abnormalities. The significance of these chromosomal abnormalities is not known, but concern exists over a possible link between them and the ability to cause cancer and adverse reproductive effects (Hogstedt et al. 1979b). An increased incidence of spontaneous abortion has also been associated with ethylene oxide exposure (Hemminki et al. 1982).

In 1981 NIOSH published a Current Intelligence Bulletin stating that ethylene oxide should be considered a potential occupational carcinogen (NIOSH 1981j). An increased rate of leukemia has been found in workers exposed to levels below the former OSHA PEL of 50 ppm as an 8-hr TWA, but this result has not been confirmed by other studies (Hogstedt et al. 1979a).

The neurotoxicity of ethylene oxide has been documented in four exposed workers (Gross et al. 1979). Findings included acute encephalopathy and peripheral neuropathy. Nerve conduction velocity was abnormal in most patients. Decreasing the amount of exposure relieved symptoms, but only total removal from exposure caused nerve conduction velocities to return to normal.

Chronic exposure to ethylene oxide increases the risk of sensitization and cataract development (Jay et al. 1982).

5.1.5.3 Standards and Recommendations

The OSHA PEL for ethylene oxide is an 8-hr TWA of 1 ppm with an excursion limit of 5 ppm for any 15-min period (29 CFR 1910.1047). The NIOSH REL for ethylene oxide is a ceiling of 5 ppm for no more than 10 min in any working day, and an 8-hr TWA less than 0.1 ppm (NIOSH 1983e).

5.1.5.4 Environmental Monitoring

A comprehensive monitoring program is an important part of the overall ethylene oxide control strategy. A detailed discussion of hospital sampling procedures and methods appears in the Technical Industrial Processes Sourcebook (Wood 1984).

Three types of monitoring are generally used for ethylene oxide; direct-reading instruments (e.g. infrared analyzers) samples collected on activated charcoal for subsequent analysis, and passive dosimeters. Portable infrared analyzers are direct-reading instruments that may be used for area monitoring of ethylene oxide concentrations. Note, however, that these instruments may not be accurate at ethylene oxide concentrations below 1 ppm (1.8 mg/m³) because they are sensitive to high humidity and may produce false readings. Activated charcoal tubes are used to determine exposure for the entire sampling period (an 8-hr day, for example). Passive dosimeters are generally worn on a worker’s lapel; after chemical analyses, they can provide a semi-quantitative indication of exposure.

5.1.5.5 Exposure Control Methods
A NIOSH study of hospitals with good engineering controls has shown that ethylene oxide exposures can be kept below 0.1 ppm (0.18 mg/m^3) for an 8-hr TWA and below 5 ppm (9mg/m^3) for short-term exposures of less than 2 min (Kercher and Mortimer 1987).

5.1.5.5.1 Substitution

In most cases, no acceptable substitute exists for ethylene oxide in the sterilization of heat-sensitive equipment.

5.1.5.5.2 Engineering controls

The following engineering controls are recommended:

- The sterilizer should be enclosed either in a mechanical access room or a cabinet, and the enclosure should be exhausted to a dedicated ventilation system.*

  *A dedicated exhaust system is one that serves the sterilizer area only and routes ethylene oxide directly to the outside of the building at a location where prevailing winds will not carry the exhaust into populated areas or into the air intakes of other buildings.

- Sterilizing operations should be centralized and access to sterilizer rooms should be restricted.

- The sterilizer should be checked with the infrared analyzer at least once every 3 months.

- Floor drains should have a cover with an anti-siphon air gap. The air gap, at the junction of the vacuum pump discharge line with the floor drain, should be enclosed. Dedicated exhaust ventilation should be provided for the enclosures.

- Local exhaust ventilation sufficient to effectively remove ethylene oxide should be as close as possible to the top of the sterilizer door.

- The number of exhaust cycles recommended by the sterilizer manufacturer should be completed before the door is opened; the door should remain only slightly open for at least 15 min.

- Supply cylinders should be located in a ventilated enclosure (either a ventilated cabinet or a hood that covers the point where the cylinder is connected to the sterilizer supply line).

- Aerators and the overpressure relief valves (if present) should be vented to a dedicated exhaust system.

- Sensors should be provided to identify a ventilation failure and to detect ethylene oxide. Both audible and visual alarms should be activated by the sensors.

- Ventilation air from the sterilizing room should not be recirculated.

- Exhaust gases should preferably be vented directly to the outside of the building (away from intake vents); this procedure is strongly recommended for all sterilizers.
Sterilized material and its packaging should be aerated in aeration cabinets, since approximately 5% of the ethylene oxide in the sterilizer remains in these items. Aeration times depend on the composition, form, and weight of the material. Refer to the recommendations from the Association for the Advancement of Medical Instrumentation (AAMI 1982), and follow the manufacturer’s recommendations for each type of equipment sterilized. Materials that do not absorb ethylene oxide (metal and glass) need no aeration unless they are wrapped.

Sterilizers that use glass ampules in a plastic bag (flash bag) have a high potential for worker exposure to ethylene oxide. If they are used, all sterilization procedures should be conducted in a ventilated enclosure.

5.1.5.5.3 Protective equipment

A worker should use protective gloves (see Section 2.3.5) and splash-proof goggles and/or a face shield when changing ethylene oxide supply cylinders. If good engineering controls are used, i.e. if the cylinder is located in a ventilated hood, a respirator should not be necessary. If a respirator is necessary or desired, the worker should use a chemical cartridge respirator with an end-of-service-life indicator that has been approved by NIOSH/MSHA. The end-of-service-life indicator is needed because the odor threshold for ethylene oxide is about 700 ppm (Jay et al. 1982), and failure of the adsorbent material will not be detected by the user.

Protective gloves and long-sleeved garments should be worn when removing items from the sterilizer or transferring them to the aerator.

When cleaning up liquid spills that contain ethylene oxide, workers should wear protective outer clothing and dispose of or launder it immediately afterward. If leather shoes become contaminated with ethylene oxide, they should be discarded.

A positive-pressure, self-contained breathing apparatus should be available for emergency situations and should be stored in an area away from the sterilizer and the ethylene oxide supply location.

5.1.5.5.4 Work practices

Sterilizers should be operated only by personnel trained in sterilization procedures and in the health and safety hazards of ethylene oxide. If local exhaust ventilation has been provided above the sterilizer door, a worker should open the door slightly and step away for an established time period. The time period should be determined by monitoring and should be at least 15 min. The door opening should be smaller than the capture distance of the hood.

To clean the sterilizer, especially the back surfaces, a worker must often reach inside the chamber with the whole upper body. Ethylene oxide exposure during this cleaning can be controlled by (1) scheduling the cleaning activity as long as possible after processing a load, (2) leaving the sterilizer door fully open for at least 30 min before cleaning, and (3) wearing a respirator.

5.1.5.6 Medical Monitoring

Employers should obtain pre-employment baseline data on workers who will be handling ethylene oxide. This information should include data on the eyes, skin, blood, and respiratory tract. Periodic examinations thereafter should include the following organs and systems:
<table>
<thead>
<tr>
<th>Organ or System</th>
<th>Suspicious symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>Rashes, cracking, burns, blisters</td>
</tr>
<tr>
<td>Eyes</td>
<td>Swelling or irritation</td>
</tr>
<tr>
<td>Respiratory system</td>
<td>Breathing difficulty, nose or throat irritation, prolonged or dry cough, chest pains, wheezing</td>
</tr>
<tr>
<td>Neurological system</td>
<td>Drowsiness, numbness or tingling of hands or feet, weakness or lack of coordination, headaches</td>
</tr>
<tr>
<td>Reproductive system</td>
<td>Spontaneous abortions, birth defects</td>
</tr>
</tbody>
</table>

5.1.6 Formaldehyde

NIOSH regards formaldehyde as a potential occupational carcinogen (NIOSH 1981; NIOSH 1986c). Formaldehyde is used for cold sterilization of some instruments, but it is not used as a general disinfectant because it is very caustic.

5.1.6.1 Hazard location

Formaldehyde may be encountered in the laboratory as a tissue preservative, in central supply as a sterilant, and in the dialysis unit as a sterilant. Formaldehyde is often combined with methanol and water to make formalin.

5.1.6.2 Potential Health Effects

5.1.6.2.1 Acute effects

The odor of formaldehyde can be detected in air at about 0.8 ppm (Amoore and Hautala 1983). Formalin solutions splashed in the eyes may cause severe injury and corneal damage. Low ambient concentrations of formaldehyde 0.1 to 5 ppm, may cause burning and tearing of the eyes and irritation of the upper respiratory tract. Higher concentrations, 10 to 20 ppm, may cause coughing, chest tightness, increased heart rate, and a sensation of pressure in the head. Exposures of 50 to 100 ppm may cause pulmonary edema, pneumonitis, and death (NIOSH 1981i).

5.1.6.2.2 Chronic effects

Repeated exposure to formaldehyde may cause some persons to become sensitized. Sensitization may occur days, weeks or months after the first exposure. Sensitized individuals will experience eye or upper respiratory irritation or an asthmatic reaction at levels of exposure that are too low to cause symptoms in most people. Reactions may be quite severe with swelling itching, wheezing, and chest tightness (NIOSH 1976f).

One study (Hendrick et al. 1982) reported that two nurses working in a renal dialysis unit developed asthmatic symptoms associated with their work with formaldehyde. The symptoms completely resolved for the nurse who spent 5 to 7 years without further exposure to formaldehyde, but the other nurse, who continued the exposure, continued to have symptoms. Dermatitis, including red, sore, cracking, and blistered skin, is also a common problem with formaldehyde exposure. Repeated exposure may make the fingernails soft and brown (NIOSH 1976f). A NIOSH health hazard evaluation of a hospital hemodialysis unit (NIOSH 1983a) indicated that respiratory irritation, eye irritation, and dermatological problems were the primary
health problems associated with formaldehyde exposure.

Formaldehyde is a mutagen in many assay systems and has caused nasal and other cancers in experimental animals. In 1981, NIOSH published the Current Intelligence Bulletin 34 (NIOSH 1981I) which recommended that formaldehyde be handled as a suspect carcinogen in the workplace.

5.1.6.3 Standards and Recommendations

The OSHA standard for formaldehyde is 1 ppm as an 8-hr TWA with a ceiling concentration of 2 ppm as a 15-min short-term exposure limit (29 CFR 1910.1048).

The NIOSH REL for formaldehyde is 0.1 ppm as determined in any 15-min air sample and 0.016 ppm as an 8-hr TWA (NIOSH 1986d). In the Current Intelligence Bulletin 34, NIOSH recommended that engineering controls and stringent work practices be used to reduce occupational exposure to the lowest feasible limit (NIOSH 1981i).

The ACGIH has designated formaldehyde a suspected human carcinogen and has recommended a TLV of 1 ppm (1.5 mg/m³) as an 8-hour TWA with a short term exposure limit, STEL, of 2 ppm (3 mg/m³) (ACGIH 1987).

The odor of formaldehyde can be detected at about 0.8 ppm (Amoore and Hautala, 1983), but even a short period of exposure will decrease the worker’s ability to smell it. Thus odor is not a reliable warning for the presence of formaldehyde (NIOSH 1976f).

5.1.6.4 Environmental Monitoring

NIOSH industrial hygiene surveys have found formaldehyde concentrations ranging from 2.2 to 7.9 ppm in hospital autopsy rooms (NIOSH 1981i). Passive dosimeters, direct-reading colorimetric detector tubes, and the personal sampling pump may be used to monitor exposures. Although some colorimetric detector tubes can detect as little as 0.05 ppm formaldehyde, personal sampling pumps and charcoal tubes are preferred for measuring low-level exposures. For a more detailed description of sampling procedures for formaldehyde, refer to the Technical Industrial Processes Sourcebook (Wood 1984), or Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ACGIH 1983).

5.1.6.5 Exposure Control Methods

Phenols may be substituted for formaldehyde in some cases, and dilute bleach solutions can be used to disinfect the exteriors of dialyzers. Other cold sterilants such as glutaraldehyde are also available. These substitutes should be used with caution.

5.1.6.5.1 Engineering controls

The following engineering controls are recommended to minimize formaldehyde exposure:

- Local exhaust ventilation should be installed over work stations using formalin or specimens preserved in formalin.

- Small quantities of formaldehyde should be purchased in plastic containers for ease of handling and safety.
● Traps should be placed in floor drains.

● Spill-absorbent bags should be available for emergencies.

● Engineering controls in hemodialysis units should include (1) isolating the main system from personnel and patients in case of inadvertent spills of (2) disconnecting the dialyzers before the sterilization process is completed. Also, formaldehyde vapors should be prevented from entering the room from the drains serving the main system and the dialysis consoles. The air should be regularly monitored for formaldehyde, and in-service education should be conducted periodically on the effects of formaldehyde.

5.1.6.5.2 Protective equipment

Skin and eye contact with formaldehyde should be avoided. Goggles, face shields, aprons, NIOSH certified positive-pressure air-supplied respirators, and boots should be used in situation where formaldehyde spills and splashes are likely. Appropriate protective gloves should be used whenever hand contact is possible; latex examination gloves are too fragile.

5.1.6.6 Medical monitoring

Pre-employment baseline data should be recorded for the respiratory tract, liver, and skin condition of any worker who will be exposed to formaldehyde. Thereafter, periodic monitoring should be conducted to detect symptoms of pulmonary or skin sensitization or effects on the liver.
5. Recommended Guidelines for Controlling Noninfectious Health Hazards in Hospitals

(Continued)

5.1.7 Freon®

Freon includes a number of gaseous, colorless chlorofluorocarbons. Those most commonly used in hospitals are Freon 12 (dichlorodifluoromethane) Freon 11 (fluorotrichloromethane) and Freon 22 (chlorodifluoromethane).

5.1.7.1 Hazard location

Workers may encounter Freon hazards in the pathology laboratory, with it is used to prepare frozen tissue sections, in aerosol cans, where it is used as a propellant, in central supply departments, where it is used in combination with ethylene oxide for sterilization, and in refrigerant gas. Freon can freeze the skin and also cause defatting.

5.1.7.2 Potential Health Effects

Exposure to Freon may cause eye and skin irritation or sensitization. High concentrations of Freon cause severe depression of the central nervous system, weakness, dizziness, convulsions, and cardiac arrhythmia, irregular heart beat, ACGIH 1986. In one study of pathology residents in a Boston hospital, all residents in their second and third years experienced palpitations that appeared to be associated with the addition of the surgical pathology rotation to their schedules. On this rotation, the only procedure that could have possibly caused palpitations was the preparation of frozen sections in which a Freon-22-based aerosol was used to decrease work time. Freon exposures of 300 ppm were measured over a 2-min period for workers engaged in tissue preparation. Four residents experienced palpitations severe enough to prompt electrocardiograms (Speizer et al. 1975). A number of deaths (7 in 1967, 31 in 1968, and 27 in 1969) have been reported among persons "sniffing" Freons intentionally (Reinhardt et al. 1971).

5.1.7.3 Standards and Recommendations

The OSHA PEL for Freon 11 is 1000 ppm (5600 mg/m³) as an 8-hr TWA; the OSHA PEL for Freon 12 is 1,000 ppm as an 8-hr TWA. The ACGIH TLVs for Freon 11 and Freon 12 are identical to the respective OSHA PEL’s. There is no OSHA PEL for Freon 22, but the ACGIH TLV for Freon 22 is 1,000 ppm as an 8-hr TWA. There are no NIOSH REL’s for the Freon compounds.

5.1.7.4 Environmental Monitoring
Freon concentrations can be estimated using direct-reading colorimetric detector tubes or determined by charcoal-tube adsorption and gas chromatography analysis.

5.1.7.5 Exposure Control Methods

5.1.7.5.1 Engineering controls

Local exhaust ventilation hoods should be installed to carry Freon vapors away from laboratory workers. Ventilation controls that protect workers adequately from ethylene oxide during sterilizing procedures will also protect them from Freon.

5.1.7.5.2 protective equipment

Goggles, aprons, and protective gloves should be provided to workers exposed to large amounts of Freon such as those encountered in the repair of refrigerant systems. Because Freon does not have adequate warning properties, only approved atmosphere-supplying respirators should be used.

5.1.7.5.2 Work practices

Hand contact should be minimized because of the possibility of sensitization. Workers should be warned against touching their eyes with contaminated hands or gloves for the same reason.

5.1.7.6 Medical Monitoring

A cardiovascular history should be obtained from each worker exposed to Freon because exposure may pose a greater risk to those with cardiovascular problems. Eyes, skin, cardiac symptoms, and electrocardiograms should be monitored periodically for exposed workers.

5.1.8 Mercury

Elemental mercury is a metallic element that is liquid at room temperature.

5.1.8.1 Hazard Location

Mercury is used in many types of hospital equipment and can be found in thermometers, Coulter counters, Van Slyke apparatus, Miller-Abbot and Cantor tubes, and sphygmomanometers (Notani-Sharma 1980). Mercury is also used in dental amalgams. Exposure to mercury in the hospital is usually the result of an accidental spill. The two procedures during which such exposures usually occur are (1) repair of broken sphygmomanometers in central supply or maintenance, and (2) sterilization and centrifugation of thermometers in central supply (Notani-Sharma 1980).

5.1.8.2 Potential Health Effects

Although inhalation is the major route of entry for mercury, the element can also be absorbed through the skin.

Exposure to short-term high levels of mercury can produce severe respiratory irritation, digestive disturbances, and marked renal damage (NIOSH 1973a).
Long-term exposure to low levels of mercury results in the classic mad hatter syndrome, named for the makers of felt hats who used mercury in processing. This syndrome is characterized by emotional instability and irritability, tremors, inflammation of the gums, gingivitis, excessive salivation, anorexia, and weight loss. Mercury has also been reported as a cause of sensitization dermatitis (NIOSH 1973a).

5.1.8.3 Standards and Recommendations

The current OSHA PEL for mercury is 0.1 mg/m³ as a ceiling value (29 CFR 1910.1000, Table Z2). The NIOSH REL is 0.05 mg/m³ as an 8-hr TWA (NIOSH 1973a).

5.1.8.4 Environmental Monitoring

Mercury vapors can be measured with a direct-reading colorimetric dosimeter, diffusion tubes, or mercury vapor analyzer, mercury sniffer, or with charcoal tubes impregnated with iodine. Particulate contamination can be collected on a filter for subsequent analysis.

If mercury spills are not promptly cleaned up, mercury may accumulate in the carpeting, on floors, and on other surfaces such as porous laboratory sinks and counters. In most cases, workers in these situations were unaware that mercury vaporizes easily at room temperatures.

In one investigation (Harrington 1974), several workers in a quality-control laboratory noticed their jewelry becoming silvered with no apparent cause. A source of mercury vapor was found when droplets of mercury were observed in the sink, on a bench, on the floor, and in the clothing of the lab assistants. The floor was removed, and pools of mercury were discovered. In another laboratory, nearly 7 lb. of mercury was discovered beneath the floor (Harrington 1974). A study of 298 dentists reported that 30% of those with urine mercury levels above 20 micrograms/g had polyneuropathies, nervous system symptoms (Shapiro et al. 1982). Other surveys have found high background levels of mercury in the air of about 10% of the dental offices and elevated mercury levels in the urine and hair of workers in these offices (Shapiro et al. 1982).

5.1.8.5 Exposure Control Methods

5.1.8.5.1 Engineering controls

Emergency engineering procedures for handling mercury contamination should include procedures for cleanup as well as for respirator selection. Exhaust systems should be designed and maintained to prevent the accumulation or recirculation of mercury vapor into the workroom.

5.1.8.5.2 Protective equipment

Disposable protective equipment such as shoe covers, protective gloves, special mercury vapor respirators, and gowns and hoods should be used while cleaning up mercury spills.

5.1.8.5.3 Work practices

Spills should be cleaned up promptly with special mercury vacuum cleaners, disposable protective equipment, and a water-soluble mercury decontaminant. Mercury wastes must be disposed of according to US Environmental Protection Agency regulations (40 CFR 261.24).

All spill areas should be clearly posted until adequate cleanup has been accomplished. If the spill is extensive, patients and personnel other than the cleanup crew should be removed from the area.
5.1.8.6 Medical Monitoring

Pre-exposure data should be recorded for the respiratory tract, nervous system, kidneys, and skin of any worker who may be exposed to mercury. Urine mercury levels should be monitored periodically in workers who are routinely or accidentally exposed to this element. Although there is no critical level of mercury in urine that indicates mercury poisoning, observers have suggested that 0.1 to 0.5 mg of mercury/liter of urine has clinical significance (NIOSH 1973a).

5.1.9 Methyl Methacrylate

5.1.9.1 Hazard Location

Methyl methacrylate is an acrylic cement-like substance commonly used in operation rooms to secure surgical prostheses to bone, e.g. in total hip replacements. This compound is also used in dental prostheses (NIOSH 1977e). The two components, a liquid and a powder, are mixed immediately before use.

In a study of operating room exposures, concentrations of methyl methacrylate reached 280 ppm immediately after the components were mixed, but fell below 50 ppm within 2 min and to 2 ppm after 6 min (ACGIH 1986). The mixing process usually takes no more than 2 min.

5.1.9.2 Potential Health Effects

5.1.9.2.1 Acute effects

Methyl methacrylate has been reported to have an odor threshold about 0.08 ppm (Amoore and Hautala 1983). At concentrations in excess of 400 ppm, methyl methacrylate affects the central nervous system (ACGIH 1986). Methyl methacrylate is an eye, skin, and mucous membrane irritant in concentrations at or above 170 to 250 ppm. Patients exposed to this compound have suffered acute episodes of hypotension, low blood pressure, and cardiac arrest (Hyderally and Miller 1976).

5.1.9.2.2 Chronic effects

Methyl methacrylate has been reported to produce degenerative liver changes in experimental animals (NIOSH 1977e). This chemical has also been reported to be mutagenic, but has not been found to be carcinogenic in rats or mice. Methyl methacrylate has also been reported to be teratogenic (Singh et al. 1972).

5.1.9.3 Standards and Recommendations

The OSHA PEL, as well as the ACGIH TLV, for methyl methacrylate is 100 ppm (410 mg/m$^3$) as an 8-hr TWA (29 CFR 19190.1000, Table Z1; ACGIH 1987). NIOSH has not recommended a standard for methyl methacrylate.

5.1.9.4 Environmental Monitoring

Methyl methacrylate is monitored in the environment by sampling with an adsorption tube and analyzing with gas chromatography (NIOSH 1980a).

5.1.9.5 Exposure Control Methods
5.1.9.5.1 engineering controls

A local exhaust hood should be used to conduct exhaust fumes from the area in which methyl methacrylate is mixed. A tent hood may be used unless mixing can be done in a separately ventilated area. Portable hoods are available for operating room use.

5.1.9.5.2 Protective equipment

Workers who handle methyl methacrylate should wear personal protective equipment and clothing. This may include gloves, goggles, face shields, and respirators, as appropriate. Portable hoods are available for operating room use.

5.1.9.5.3 Work practices

Workers should be instructed to avoid touching contaminated hands or gloves to their eyes or mouths.

5.1.9.6 Medical Monitoring

Pre-exposure data should be recorded for the skin and respiratory systems of workers who may be exposed to methyl methacrylate. Periodic monitoring thereafter should emphasize the skin and respiratory systems.

5.1.10 Peracetic Acid PAA

5.1.10.1 Hazard Location

Peracetic acid, peroxyacetic acid, is used in hospitals to sterilize the surfaces of medical instruments and may be found in laboratories, central supply, and patient care units.

5.1.10.2 Potential Health Effects

Peracetic acid, peroxyacetic acid, is a strong skin, eye, and mucous membrane irritant in both humans and animals. Continued skin exposure may cause liver, kidney, and heart problems. Peracetic acid has been observed to promote wart-like tumors, skin papillomas, in rats (NIOSH 1985). As a result, direct skin contact and exposure to vapors should be restricted.

5.1.10.3 Standards and Recommendations

Currently no standards exist for regulating exposures to peracetic acid, and no recommendations have been made by others such as NIOSH, ACGIH, or ANSI.

5.1.10.4. Exposure Control Methods

Use of an isolation chamber should eliminate major exposure to peracetic acid vapors in hospitals. This chamber should be checked frequently for defects. Peracetic acid should never be used outside this chamber.

5.1.11 Solvents

5.1.11.1 Hazard Location
The generic term solvent refers to a large number of chemicals used in medical laboratories. Some are used widely as cleaning agents in housekeeping and maintenance, and some are present in inks and in cleaning agents in print shops.

5.1.11.2 Potential Health Effects

Most solvents can be absorbed through the skin or by inhalation and ingestion.

5.1.11.2.1 Acute effects

Many solvents act as central nervous system depressants, causing headaches, dizziness, weakness, nausea, and other symptoms, NIOSH 1986c. Solvents may also irritate eyes, skin, and the upper respiratory tract. Prolonged contact may result in defatting and dehydration of the skin.

5.1.11.2.2 Chronic effects

Long-term exposure to some solvents has been associated with cancer, adverse reproductive effects, cardiovascular problems, and damage to the liver, kidneys, central nervous system, and hematopoietic system (see Table 5-2)(NIOSH 1974, 1975a, 1977a).

Table 5-2. Health effects and exposure limits for certain solvents

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Specific effect</th>
<th>OSHA PEL*</th>
<th>NIOSH REL†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dioxane</td>
<td>Suspected carcinogenic effects, liver and kidney effects</td>
<td>100 ppm (360 mg/m3) as 8-hr TWA (Skin)</td>
<td>1-ppm (3.6 mg/m3) ceiling for 30 min</td>
</tr>
<tr>
<td>Xylene</td>
<td>Cardiovascular and reproductive effects, central nervous system depressant</td>
<td>100 ppm (435 mg/m3) as 8-hr TWA</td>
<td>100 ppm (434 mg/m3) for up to a 10-hr TWA; 200-ppm (868 mg/m3) ceiling for 10 min</td>
</tr>
<tr>
<td>Benzene</td>
<td>Cancer (leukemia) and blood changes, including aplastic anemia</td>
<td>1 ppm as 8-hr TWA; 5-ppm short-term exposure limit (15 min)</td>
<td>0.1 ppm (0.32 mg/m3) as 8-hr TWA; 1-ppm (3.2 mg/m3) ceiling for 15 min</td>
</tr>
</tbody>
</table>

†CDC (1986).

5.1.11.3 Standards and Recommendations

The hospital safety officer should develop an inventory of solvents in use and consult 29 CFR 1910.1000 for the pertinent OSHA PEL. The safety officer should also consult the NIOSH criteria documents. Current Intelligence Bulletins, and other documents on solvents, which are listed by compound in NIOSH Recommendations for Occupational Safety and Health Standards (CDC 1986).

5.1.11.4 Environmental Monitoring

NIOSH investigations have found high concentrations of solvents, either as TWA’s or as peaks during certain processes in medical laboratories (NIOSH 1981f). The effects reported by workers are frequently those of a
combination of solvents, each one of which is present at a concentration below the established standard. No regulation exists to cover the additive or synergistic effects of similar chemicals.

Solvents can be collected on adsorbent charcoal for later analysis, or they can be directly measured with colorimetric detector tubes or passive dosimeters. For a more detailed description of sampling procedures for solvents, refer to the Technical Industrial Processes Sourcebook (Wood 1984) and Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ACGIH 1983).

5.1.11.5 Exposure Control Methods

5.1.11.5.1 Substitution

A less hazardous solvent can frequently be substituted for one of those discussed.

5.1.11.5.2 Engineering Controls

Local exhaust ventilation and enclosure of solvent vapor sources are the preferred methods for controlling exposures to solvents in laboratories. When selecting engineering and other controls, consideration must be given to not only the toxicity of the solvent, but to its flammability and explosion potential as well.

5.1.11.5.3 Protective equipment

Protective gloves help prevent absorption of solvents through the skin. Respirators, rubber aprons, goggles, and boots may be required during certain procedures or during cleanup of spills.

5.1.11.5.4 Work practices

Workers should be thoroughly trained to recognize the symptoms of solvent exposure, to avoid eating in potentially contaminated areas, to work only under exhaust hoods when handling solvents and to follow those work practices recommended for specific solvents.

5.1.11.6 Medical Monitoring

Pre-exposure information should be recorded for worker who will be exposed to solvents and should include baseline and current date on the skin, kidney, liver, and nervous and hematopoietic systems NIOSH 1986b. Kidney and liver function tests and a complete blood count should be performed.

5.1.12 Waste Anesthetic Gases

The principal source of waste anesthetic gas in the hospital is leakage from anesthetic equipment. Nitrous oxide, enflurane, halothane, and isoflurane are currently the most widely used inhalation anesthetic agents in the US (NIOSH 1977c; Whitcher 1987b). Methoxyflurane, once in general use, is now used primarily in veterinary procedures (Whitcher 1987b).

5.1.12.1 Hazard Location

In 1977, NIOSH estimated that some 50,000 operating-room personnel excluding surgeons, were exposed each year to waste anesthetic gases (NIOSH 1977c). Exposures occur in operating rooms; labor delivery, and recovery rooms; dental operatories; emergency rooms; outpatient clinics; and miscellaneous locations.
Leakage from anesthetic equipment is in most cases associated with the work practices and habits of the anesthesiologists and nurse anesthetists. Incorrect installation and maintenance of scavenging systems is also a major factor.

Exposures may occur in the following ways:

- Gas may escape during hook-up and check-out of the system.
- Excess gas may seep over the lip of the patient’s mask.
- The patient may exhale gas into the room.
- Leaks may occur in the anesthetic breathing system.
- Scavenging systems may be misused or not used at all.

The degree of exposure in the operating room depends on the amount of leakage, the adequacy of the ventilation system, and the type of operation being done. Gas leakage occurs primarily when face masks are used for short procedures and a problem exists with the anesthetist’s technique or with the patient’s facial anatomy (e.g. when the patient has no teeth).

A related problem is the exposure of recovery room personnel to waste gases in the exhaled breath of post operative patients. Nitrous oxide, halothane, and methoxyflurane have all been found in the exhaled breath of both patients and operating room staff for periods ranging from hours to several days after the administration of the anesthetic (NIOSH 1977c). This phenomenon may pose a significant health hazard to staff in crowded recovery rooms with a high patient turnover rate.

5.1.12.2 Potential Health Effects

5.1.12.2.1 Acute effects

Workers exposed to excessive amounts of anesthetic gases begin to feel like anesthetized patients, experiencing drowsiness, irritability, depression, headache, nausea, fatigue, and problems of judgment and coordination (NIOSH 1977c). These behavioral effects are of particular concern because both the success of the surgery and health of the operating room staff may be compromised.

5.1.12.2.2 Chronic effects

Epidemiologic studies have found increased incidences of embryo toxicity, liver and kidney disease, and cancer among groups of female personnel working in the operating room, Cohen et al 1975. Some observers have suggested a relationship between exposure to waste anesthetic gases and reports of increased cancer rates and adverse effects on reproduction among exposed workers (NIOSH 1977c).

5.1.12.2.3 Reproductive effects

A 1975 survey (Cohen et al.1975) indicated an increased risk of spontaneous abortion among female anesthesiologists, nurse-anesthetists, and other staff personnel who worked in operating rooms during their first trimester of pregnancy and the year preceding. An increased risk of congenital abnormalities also existed.
among the live-born babies of exposed female participants in the survey. Studies have also shown a higher incidence of miscarriage in the wives of male operating-room personnel (Cohen et al. 1975).

5.1.12.3 Standards and Recommendations

NIOSH has recommended exposure limits for the following anesthetic gases (NIOSH 1977c).

- **Chloroform**: 2 ppm (9.76 mg/m³) ceiling (1 hr)
- **Trichloroethylene***: 2 ppm (10.75 mg/m³) ceiling (1 hr)
- **Halothane**: 2 ppm (16.15 mg/m³) ceiling (1 hr)
- **Methoxyflurane**: 2 ppm (13.5 mg/m³) ceiling (1 hr)
- **Enflurane**: 2 ppm (15.1 mg/m³) ceiling (1 hr)
- **Fluroxene**: 2 ppm (10.31 mg/m³) ceiling (1 hr)
- **Nitrous oxide**: 25 ppm (30 mg/m³) as a TWA over period of use

*NIO SH recommends that trichloroethylene be regarded as a potential occupational carcinogen, (NIOSH 1978b).

When nitrous oxide is used in combination with the halogenated agents described above, control of nitrous oxide to 25 ppm during the administration period will result in concentrations of the halogenated agents of about 0.5 ppm.

5.1.12.4 Environmental monitoring

The vapors of anesthetic agents such as enflurane, halothane and isoflurane can be monitored with charcoal tubes. Nitrous oxide can be monitored with a direct-reading infrared analyzer or by passive dosimeters.

Records of all collected air samples should be kept, and results should be noted in the medical records of the corresponding workers. Detailed descriptions of sampling procedures for nitrous oxide are available from several sources (Eger 1985; Saidman and Smith 1984; Wood 1984; Whitcher 1987a).

5.1.12.5 Exposure Control Methods


5.1.12.5.1 Engineering controls

A scavenging system is the basic engineering control for waste anesthetic gases. Such systems collect waste gas and ventilate it from the operating room. Although some scavenging systems are elaborate and costly, adequate systems can be inexpensive and can dramatically reduce contamination of the operating room.
environment. A scavenging system should be selected, installed, used, and maintained according to the references listed above in 5.1.12.5.

The equipment must be regularly monitored for leakage, improper design, or tubing defects. In some cases, poor wall connections and compression fittings or other defective equipment may be the sources of leakage.

The 1977 NIOSH document entitled Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors (NIOSH 1977c) contains information on control procedures and work practices that have been demonstrated to reduce anesthetic gas concentrations to the NIOSH recommended exposure limits. A more thorough discussion of ventilation systems for anesthetic gases and their disposal can be found in the NFPA Health Care Facilities Handbook (NFPA 1984), which contains the complete text of NFPA 99 (Standard for Health Care Facilities). Stoner et al. (1982) provide a general description of the control of anesthetic gases, including discussions of physiological effects, anesthetic methods, and monitoring techniques.

The International Labour Office proposes three steps to control exposure to waste anesthetic gases (Parmeggiani 1983): (1) installing a proper nonrecirculating air conditioning system with a minimum of 20 room air exchanges per hour; (2) installing a scavenging system for collecting waste gases at the anesthetic breathing level, and (3) using low-flow rates of anesthetic gases.

5.1.12.5.2 Personal protective equipment

Personal protective equipment is not needed or recommended if an adequate control program is in place. However, monitoring should be done, and personal protective equipment should be available for use in case of an emergency.

5.1.12.5.3 Work practices

Operating-room workers can protect themselves from excess exposure by properly connecting the scavenging equipment, turning the gas off when the breathing system is disconnected from the patient, and ensuring that all patients have properly fitting masks.

5.1.12.5.4 Training programs

Workers involved with waste anesthetic gases should be trained to recognize, understand, monitor, and reduce the health and safety risks of exposure to these substances.

5.1.12.6 Medical Monitoring

Workers exposed to anesthetic gases should have complete medical histories on file. These should include family, genetic, and occupational histories and the outcomes of all pregnancies of female workers or of the wives of male workers. Baseline data should be obtained on the hepatic, renal, and hematopoietic systems. Exposed workers should be monitored periodically for liver and kidney function.
5.2 PHYSICAL HAZARDS

5.2.1 Heat

5.2.1.1 Hazard Location

The laundry, boiler room, and kitchen are known as hot environments. Other departments of the hospital may also be hot during the summer months, especially in older facilities that have inadequate ventilation and cooling systems.

5.2.1.2 Potential Health Effects

Heat-related health effects include heat stroke, heat exhaustion, heat cramps, fainting, and heat rash (NIOSH 1986b).

5.2.1.2.1 Heat stroke

Heat stroke is the most serious heat-related health effect; it results from a failure of the body’s temperature regulating mechanism. The victim’s condition may be characterized by hot, dry skin, dizziness, headache, thirst, nausea, muscular cramps, mental confusion, delirium, convulsions, or unconsciousness. Body temperature may exceed 105°F (41°C). Unless quick and proper treatment is rendered, death may occur.

Workers with any of these symptoms should be immediately removed to a cool area and attempts should be made to reduce body temperature by soaking the clothing thoroughly with water and fanning vigorously. A physician should be called immediately.

5.2.1.2.2 Heat exhaustion

Heat exhaustion is caused by the loss of large amounts of fluid and sometimes by the excessive loss of salt through sweating. The symptoms of heat exhaustion resemble those of heat stroke, but unlike the latter, the symptoms are milder and victims sweat and have a body temperature that is normal or only slightly elevated.

Victims of heat exhaustion should be removed to a cool place and given large amounts of liquids to drink. In mild cases, recovery is usually spontaneous with this treatment. Severe cases require the attention of a
physician and may take several days to resolve.

5.2.1.2.3 Heat cramps

Heat cramps are painful muscle spasms that occur from salt loss through sweating and from the dilution of body fluids through drinking large quantities of liquids. The cramps usually occur in those muscles that are being used for work. Cramps may occur during or after work and may be relieved by drinking salty liquids. Workers on low sodium diets should consult a physician before beginning work in a hot environment.

5.2.1.2.4 Fainting

One mechanism for dissipating body heat is dilatation of blood vessels, which may cause fainting when blood pools in the legs and reduces circulation to the brain. This problem may affect unacclimatized workers who spend much of their time standing with little movement. Recovery may be hastened by placing the victim on his back with the legs elevated. Workers who must stand for long periods can prevent fainting by moving around.

5.2.1.2.5 Heat rash

Heat rash, prickly heat, results when the skin remains wet with sweat for prolonged periods and evaporation is reduced or absent. These conditions cause the sweat glands to become plugged and irritated, leading to development of a rash. Although it is not a health-threatening condition, heat rash may be sufficiently irritating to impair the worker’s performance. Heat rash can be prevented by keeping the skin dry and clean.

5.2.1.3 Standards and Recommendations

NIOSH has recommended an occupational standard for workers exposed to hot environments, Figures 5-1 and 5-2 (NIOSH 1986a). The standard includes recommendations for exposure limits, medical surveillance, posting of recommendations for exposure limits, medical surveillance, posting of hazardous areas, protective clothing and equipment, worker information and training, methods for controlling heat stress, and recordkeeping. The recommendations consider both acclimatized and unacclimatized workers and combined effects of metabolic and environmental heat (NIOSH 1986a). Table 5-3 provides data for estimating metabolic heat.

The values in Table 5-3 can be used to calculate the approximate total metabolic heat (Hₜ) consumed by a worker performing various tasks.
Figure 5-1. Recommended exposure limits (REL) for unacclimatized workers. Data assume a standard worker having a body weight of 154 lb. (70 kg) and a surface area of 19.4 ft $^2$ (1.8 m$^2$). Adapted from NIOSH 1986a.

Figure 5-2. Recommended exposure limits (REL) for acclimatized workers. Data assume a standard worker having a body weight of 154 lb. (70 kg) and a surface area of 19.4 ft $^2$ (1.8 m$^2$). Adapted from NIOSH 1986a.
Table 5-3.
Approximate energy consumption of a standard* worker during various work tasks†

<table>
<thead>
<tr>
<th>Activity or work task</th>
<th>Average kcal/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body position and movement:</strong></td>
<td></td>
</tr>
<tr>
<td>Sitting</td>
<td>18</td>
</tr>
<tr>
<td>Standing</td>
<td>26</td>
</tr>
<tr>
<td>Walking on a level surface</td>
<td>150</td>
</tr>
<tr>
<td>Walking uphill</td>
<td>To 150 add 48 for every meter of rise</td>
</tr>
<tr>
<td><strong>Type of work:</strong></td>
<td></td>
</tr>
<tr>
<td>Hand work:</td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>24</td>
</tr>
<tr>
<td>Heavy</td>
<td>54</td>
</tr>
<tr>
<td>One-arm work:</td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>60</td>
</tr>
<tr>
<td>Heavy</td>
<td>108</td>
</tr>
<tr>
<td>Two-arm work:</td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>90</td>
</tr>
<tr>
<td>Heavy</td>
<td>150</td>
</tr>
<tr>
<td>Whole-body work:</td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>210</td>
</tr>
<tr>
<td>Moderate</td>
<td>300</td>
</tr>
<tr>
<td>Heavy</td>
<td>420</td>
</tr>
</tbody>
</table>
Total metabolic heat is calculated using the following formula:

\[ H_t = H_m + H_w + M_b \]

where

- \( H_t \) = total metabolic heat, kcal/hr
- \( H_m \) = heat of movement, kcal/hr
- \( H_w \) = heat of work, kcal/hr
- \( M_b \) = basal metabolism, 1 kcal/hr

For example, a worker who is standing and using both arms to perform a task would be producing metabolic heat as follows:

- \( H_m \)_{standing} = 36 kcal/hr
- \( H_w \) for two arms = 150 kcal/hr
- \( M_b \) = 60 kcal/hr

Thus

\[ H_t = 36 \text{ kcal/hr} + 150 \text{ kcal/hr} + 60 \text{ kcal/hr} = 246 \text{ kcal/hr} \]

the metabolic heat is used with the wet bulb globe temperature to determine exposure limits for work (Figures 5-1 and 5-2).

5.2.1.4 Environmental Monitoring

the most common and direct way of measuring heat exposure is with wet bulb and globe thermometers and the wet bulb globe temperature (WBGT) index. The WBGT index combines the effects of radiant heat and humidity with the dry bulb temperature. This method is inexpensive and simple (NIOSH 1986a).

5.2.1.5 Exposure Control Methods

A good source of general information on the health effects and control of occupational heat exposures is Criteria for a Recommended Standard: Occupational Exposure to Hot Environments (NIOSH 1986a). Listed below are some specific steps for reducing heat stress in hospital workers exposed to hot work areas (NIOSH 1986a, NIOSH 1986b):
• Schedule heavy work for the coolest part of the day and allow frequent rest breaks in cool areas.

• Isolate, enclose, and/or insulate hot equipment.

• Install exhaust ventilation to draw heat or steam away from the work area.

• Install reflective shielding where appropriate.

• Provide fans to increase sweat evaporation.

• Make cool water available.

• Provide cool areas for rest breaks and lunches.

• Train workers to recognize symptoms of heat stress.

• Permit workers who are new or returning from vacation or illness to become acclimatized to the hot environment. Heat acclimatization can usually be accomplished in 5 to 7 days while working in a hot job (NIOSH 1986a).

5.2.2 Noise

Noise is any unwanted sound; it is created by sound waves, which are rapid vibrations in the air. Sound has three characteristics: frequency, pitch, amplitude (intensity) and perceived loudness. Frequency is measured in cycles per second, or Hertz (Hz) and sound intensity is measured in decibels (dB). The decibel scale is a logarithmic measure of intensity. When a sound increased by 10 dB, it is 10 times as intense and is perceived as being twice as loud. Loudness, unlike intensity, is a subjective perception of sound and cannot be measured by instrument.

5.2.2.1 Hazard Location

Exposure to high levels of noise in the workplace is one of the most common job hazards, and despite the popular image of hospitals as quiet zones, they can be noisy places. In a 1979 survey of noise levels in 26 hospitals, five work areas were identified as noisy enough to reduce productivity (Seidletz 1981): the food department, laboratory, engineering department, business office or medical records department, and nursing units.

5.2.2.2 Potential Health Effects

The ear changes air pressure waves into nerve impulses that the brain interprets as sound. Hair cells in the inner ear stimulate nerves that carry the message to the brain. Loud noise damages these nerves and decreases hearing acuity. This decrease is called a temporary threshold shift. Such shifts can be reversed if there is enough rest from high noise levels, but exposure to loud noise for many years leads to irreversible hearing loss. Very loud noises of short duration, such as gunfire, can cause a permanent hearing decrement.

Noise may also trigger changes in cardiovascular, endocrine, neurologic, and other physiologic functions, all of which suggest a general stress reaction. These physiologic changes are typically produced by intense sounds of sudden onset, but they can also occur under sustained high-level or even moderately strong noise.
conditions. Whether repeated noise-induced reactions of this type can ultimately degrade one’s physical and mental health is still uncertain. There are some reports that show that prolonged exposure to high-level noise may lead to physiologic disorders in animals (NIOSH 1972).

In addition to adverse health effects, work in high-noise areas makes it difficult for workers to communicate among themselves, either to relate socially or to warn others of impending danger (e.g. falling equipment or a slippery floor) or to concentrate on critical job functions.

5.2.2.3 Standards and Recommendations

The OSHA occupational exposure limit for noise is 90 dB measured on the A-weighted scale* (90 dBA) as an 8-hr TWA (29 CFR 1910.95). Because the noise exposure limit is time-weighted, the amount of time workers are permitted to spend in a noise exposure area varies according to the noise level, as follows:

<table>
<thead>
<tr>
<th>Hours of exposure per workday</th>
<th>Permissible noise level (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>105</td>
</tr>
<tr>
<td>0.5</td>
<td>110</td>
</tr>
<tr>
<td>0.25</td>
<td>115</td>
</tr>
</tbody>
</table>

*The A-weighted scale approximates the frequency response of the human ear.

For more detailed information on determining and complying with the OSHA noise standard, refer to 29 CFR 1910.95. This standard was amended in 1983 to require that employers document any worker exposures to noise levels equal to or greater than an 8-hr TWA of 85 dBA. If workers are exposed to higher noise levels, employers must administer a continuing hearing conservation program as cited in the OSHA standard. An important part of this program is the requirement for an audiometric testing program.

5.2.2.4 environmental Monitoring

The OSHA publication Noise Control: A Guide for Workers and Employers (OSHA 1983) is a helpful guide for establishing a noise monitoring and control program. The standard sound level meter is the basic noise-measuring instrument; however, there are noise dosimeters that can measure the integrated (daily) noise exposure. 5.2.2.5 Exposure Control Methods

5.2.2.5.1 Noise abatement programs

A noise survey should be made by trained personnel. If a worker’s noise exposure exceeds the standard, a
noise abatement program is required. Such a program should include periodic noise measurement, engineering and administrative controls, hearing protection for use while controls are being implemented, and annual audiometric testing.

5.2.2.5.2 Engineering controls

The goal of the hearing conservation program should be to develop engineering controls to reduce noise exposure. Engineering controls could include enclosure of noisy equipment, acoustical treatment of walls to reduce noise reflection, vibration damping of noisy machines, and replacement of metal-to-metal contact with synthetic material-to-metal contact. Administrative controls can also be used to limit a worker’s exposure time to excessive noise.

5.2.2.5.3 Hearing protection devices

If engineering or administrative controls are not feasible, or if they are in the process of being implemented, hearing protection is required. Many forms of hearing protection are available, including ear muffs and ear plugs. Some are more effective than others depending on the noise level, frequency, and individual fit of the devices. Protection must be effective but reasonably comfortable.

5.2.2.5.4 Methods for reducing noise levels in various departments

5.2.2.5.4.1 Food department
The following methods can significantly reduce noise within the food department and still allow sanitary requirements to be met (Seidletz 1981):

- Mount table-top equipment on rubber feet or pads.
- Install sound-absorbent floor tiles.
- Isolate dishwashing areas when dishwasher noise cannot be reduced.
- Use acoustical ceiling tiles, wall hangings, and carpets to reduce cafeteria noise.
- Place rubber matting on landing tables (for scraping dishes) and in the steam table area.
- Install sealing around doors.

5.2.2.5.4.2 Office areas

Noise levels in office areas generally average 68 to 75 dBA. The use of padding under typewriters and sound-absorbing wall hangings reduced noise levels by 13 to 18 dB (Seidletz 1981). 5.2.2.5.4.3 Engineering department

In engineering departments, noise levels range from 78 to 85 dBA, with short bursts as high as 100 dBA. Noise levels around hospital generators may reach 110 dBA. Significant noise reduction can be achieved by isolating the generator area and installing mufflers and using sound-absorbing materials wherever possible (Seidletz 1981).

5.2.2.5.4.4 Nursing units and laboratories
Noise in nursing units and laboratories results from sources such as the ventilation system, intercom system, door closings, telephones, food service carts, radios, televisions, and conversations among staff, patients, and visitors. The results of a hospital noise survey showed that noise levels interfered with speech during the day and with sleep at night (Turner et al. 1975).

Most noise in nursing areas and laboratories can be simply and economically eliminated by the following methods Turner et al 1975:

- Decrease the volume of intercom speakers, televisions, and radios.
- Lubricate wheels, hinges, and latches.
- Adjust closers on doors to prevent slamming.
- Use sound-adsorbent materials wherever possible.
- Make the staff aware of noise problems and secure their cooperation.

5.2.2.6 Medical Monitoring

As mentioned earlier, the OSHA noise standard (29 CFR 1910.95) requires audiometric testing, at least once a year, for all workers exposed to noise levels equal to or greater than an 8-hr TWA of 85 dBA.

5.2.3 Ionizing Radiation

5.2.3.1 Types of Ionizing Radiation

Ionizing radiation is part of the natural environment, and since the discovery of X-rays and radioactivity, it has become part of the work environment as well (NIOSH 1977d). Radiation is measured and defined as follows (SI units are given in the definitions):

<table>
<thead>
<tr>
<th>Curie</th>
<th>A measure of a substance’s radioactivity. 1 curie (ci) = 3.7 x 1010 disintegrations per second.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorbed dose</td>
<td>The amount of radiation that the body absorbs.</td>
</tr>
<tr>
<td>Exposure</td>
<td>The amount of radiation to which the body is exposed.</td>
</tr>
<tr>
<td>Radioactive half-life</td>
<td>The time required for the radioactivity of an isotope to decrease by 50%.</td>
</tr>
<tr>
<td>Rem (rem)</td>
<td>Acronym for roentgen equivalent man – the dosage of any ionizing radiation that will cause biological injury to human tissue equal to the injury caused by 1 roentgen of X-ray or gamma-ray dosage. 1 rem = 0.01 sievert (SV).</td>
</tr>
<tr>
<td>Millirem (mrem)</td>
<td>10^-3 rem. 1 mrem = 0.01 mSV.</td>
</tr>
<tr>
<td>Rad</td>
<td>Acronym for radiation absorbed dose a unit that measures the absorbed dose of ionizing radiation. 1 Rad = 100 ergs/gm = 0.01 Gray (Gy).</td>
</tr>
<tr>
<td>Roentgen</td>
<td>Unit of measure for quantity of ionization produced by X-radiation or gamma radiation. 1 Roentgen(R) = 2.58 x 10^-4 coulomb/kg.</td>
</tr>
</tbody>
</table>

The different types of ionizing radiation vary in their penetrative powers as well as in the number of ions they
produce while traversing matter.

Ionizing radiation is produced naturally by the decay of radioactive elements or artificially by such devices as X-ray machines. A radioactive element is one that spontaneously changes to a lower-energy state, emitting particles and gamma rays from the nucleus in the process. The particles commonly emitted are alpha or beta particles. X-rays are produced when high-energy electrons strike the nuclei of a suitable target, such as tungsten. When these fast-moving electrons approach the electrical field around the nuclei of the target material, the electrons are deflected from their path and release energy in the form of high-energy electromagnetic radiation (X-rays).

Alpha particles usually have energies of 4 to 8 million electron volts (MeV). They travel a few centimeters in air and up to 60 microns into tissue. The high energy and short path result in a dense track of ionization along the tissues with which the particles interact. Alpha particles will not penetrate the stratum corneum of the skin, and thus they are not an external hazard. However, if alpha-emitting elements are taken into the body by inhalation or ingestion, serious problems such as cancer may develop. Radium implants (radium-226 and radium-222) are examples of alpha particle emitters that may be used in hospitals.

Beta particles interact much less readily with matter than do alpha particles and will travel up to a few centimeters into tissue or many meters through air. Exposure to external sources of beta particles is potentially hazardous, but internal exposure is more hazardous. Examples of beta-particle emitters are the isotopes carbon-14, gold-198, iodine-131, radium-226, cobalt-60, selenium-75, and chromium-51.

Protons with energies of a few MeV are produced by high-energy accelerators and are quite effective in producing tissue ionization. The path length of a proton is somewhat longer than that of an alpha particle or equivalent energy.

X-rays generally have longer wavelengths, lower frequencies, and thus lower energies than gamma rays. The biologic effects of X-rays and gamma rays are better known than those of any of the other ionizing radiation. X-rays may be encountered during the use of electronic tubes and microscopes. Examples of gamma emitters are cobalt-60, cesium-137, iridium-192, and radium-226.

5.2.3.2 Sources of Radiation Exposure

In the United States, natural radiation results in an estimated average dose of about 125 mrem each year (Hamilton and Hardy 1974). In 1973, NIOSH estimated that medical and dental irradiation of patients in diagnostic and therapeutic procedures produced an average dose of 50 to 70 mrem per person per year in addition to natural radiation (NIOSH 1973c).

5.2.3.3 Hazard Location

Radiation exposure usually results from (1) the scatter of X-ray beams caused by deflection or reflection from the main beam, or (2) the emission of gamma rays by patients who are being treated with radionuclides or have therapeutic implants that emit gamma and beta radiation. Ionizing radiation is used in the hospital for (1) diagnostic radiology, including diagnostic X-ray, fluoroscopy and angiography, dental radiography, and computerized axial tomography scanners (CAT scanners), (2) therapeutic radiology, (3) dermatology, (4) nuclear medicine in diagnostic and therapeutic procedures, and (5) radiopharmaceutical laboratories. A radiation hazard may also exist in areas where radioactive materials are stored or discarded. Radiation safety is usually well managed in diagnostic and therapeutic radiology units by the radiation protection officer. Staff in departments where portable X-rays are taken (operating rooms, emergency rooms, and intensive care units, are often inadvertently exposed and inadequately monitored for the effects of radiation exposure.
5.2.3.4 Types and Amounts of Radiation Exposures

The conditions presented by external radiation sources are entirely different from those presented by internal sources. Radiation can be deposited in the body as a result of accidental skin puncture or laceration and subsequent contact with radioactive material. Once inside the body, radionuclides can be absorbed, metabolized, and distributed throughout the tissues and organs. The extent of the effects of radiation on organs and tissues depends on the energy and type of radiation and its residence time in the body, biological half-life, and the radioactive half-life of the radioisotope. But the principal hazard presented by internal radiation sources is the continuous irradiation of cells.

The amount of external radiation received depends on the amount of radiation present, the duration of the exposure, the distance from the source to the worker, and the types of barriers between the source and the worker. The effects of radiation from external sources depend on the energy. Unless alpha and beta particles are inhaled or ingested, they are of little concern since they are low energy sources that do not penetrate the outer tissues. Gamma radiation is also rapidly attenuated.

Radiation workers in hospitals receive an annual average dose of radiation that ranges from 260 to 540 mrem. Twelve percent of dental personnel had an average annual exposure of 41 mrem, and 98% had exposures of less than 500 mrem (0.5 rem) (National Research Council 1980). Nuclear medicine technicians who assist in many procedures during a single day may have higher exposures than others who handle radioactive materials. For example, technicians involved in nuclear cardiovascular studies can receive exposures of 2.5 mrem/hr (Syed et al. 1982). Radio-pharmaceuticals have been found contaminating the hands, wrists, lab coats, and urine of technicians and laboratory workers studies (Nishiyama et al. 1980). Angiography is an activity of particular concern. Exposures during these procedures have ranged from 1 to 10 mrems inside the lead apron, and eye exposures have ranged up to 57 mrems inside the lead apron, and eye exposures have ranged up to 57 mrem (Santen et al. 1975; Kan et al. 1976; Rueter 1978).

5.2.3.5 Potential Health Effects

Radiation produces acute effects as well as delayed injuries. The degree of radiation damage depends on which organs and tissues are radiated. In general, the effects of radiation exposure are cumulative.

5.2.3.5.1 Acute effects

Occupational exposure to ionizing radiation is usually localized and can lead to erythema or radiodermatitis. An acute radiation syndrome episode occurs very rarely. Such an episode involves whole-body exposure exceeding 100 roentgens during a very short period. Persons with the syndrome usually suffer from nausea, vomiting, diarrhea, weakness, and shock. Following a latent period of 2 to 14 days, symptoms of fever and malaise occur and hemorrhagic lesions of the skin often appear. By the third week, epilation occurs. Internal and external ulceration may appear over the entire body, and bloody diarrhea may occur. Death may result from severe bone marrow depression if the radiation exposure level is high. If the person survives the toxic stage, recovery usually begins in the fifth or sixth week and is essentially complete after a long period (NIOSH 1977d).

A very high dose of radiation can produce symptoms of cerebral edema within minutes and death with 24 hr.

5.2.3.5.2 Chronic effects

Evidence continues to accumulate that low levels of radiation can cause biological damage. Researchers differ over the amount of radiation that is hazardous, but any amount of radiation is assumed to involve some
risk. Workers should therefore avoid any radiation exposure. Variables such as age, sex, cigarette smoking, genetic makeup, state of health, diet, and endocrine status may modify the effects of ionizing radiation.

Ionizing radiation can cause gene mutation and chromosomal alteration; it can also delay or impair cell division and interfere with metabolic processes. Cells that normally divide rapidly (e.g. the blood-forming tissues, skin, gonads, and eye lenses) are usually more severely affected than the slower-dividing cells (e.g. the bones, endocrine glands, and nervous system).

Other somatic effects that result from irradiation include several types of cancers (myelogenous leukemia, bone, skin, and thyroid in children) lung and kidney fibrosis, lens opacities, cataracts, aplastic anemia, sterility, radiodermatitis, and shortened life span resulting from accelerated aging.

Prenatal radiation exposure may result in prenatal death from leukemia and morphological abnormalities in the developing nervous system or other organ systems. Sex-ratio changes have been noted. Doses of 10 to 19 rem received by human fetuses have been shown to produce small head size; doses above 150 rem have been associated with mental retardation (Beebe 1981; Meyer and Tonascia 1981).
5. Recommended Guidelines for Controlling Noninfectious Health Hazards in Hospitals
(Continued)

5.2.3.6 Standards and Recommendations

OSHA has a standard for ionizing radiation (19 CFR 1910.96) that is intended to protect those workers not covered by the Nuclear Regulatory Commission (NRC) in 10 CFR 20. Several other agencies also have the authority to set and enforce standards and other measures to protect workers from radiation exposure (see Table 5-4). The National Council on Radiation Protection and Measurements (NCRP) was created by Congress in part to collect, analyze, develop, and disseminate information and recommendations about radiation measurements, quantities, and units. In 1971, the NCRP recommended maximum permissible dose equivalents of ionizing radiation during occupational exposure (NCRP 1975). The annual permissible dose for total body exposure is 5 rem per year, with 3 rem permitted within a 13-week period. The basic goals of the NCRP radiation dose limits are to prevent injuries such as cataracts and erythema and to reduce the probability of cancer. An exposure equivalent to 5 rem per year for the whole body or for certain organ systems is believed to permit a lifetime occupational exposure without reaching an injurious level. Specific limitations exist for dosages to various parts of the body such as the head, arms, hands, and trunk. In addition, the dose limit for the fetus of an occupationally exposed woman is 0.5 rem for the entire gestation period (NCRP 1977).

Under the Federal Food, Drug, and Cosmetic Act and other laws, the US Food and Drug Administration (FDA) has the authority to regulate the manufacture and distribution of radiopharmaceuticals and medical devices containing radioactive materials. FDA shares this authority with the Nuclear Regulatory Commission (NRC) which has similar powers when the drugs or devices contain materials governed by the Atomic Energy Act. The two agencies have worked together in the development of regulations. The FDA’s National Center for Devices and Radiological Health sets basic performance standards for X-ray machines and other radiation-emitting electronic products manufactured after 1973. The standards ensure that the produces emit the smallest amount of radiation consonant with effective operation.

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</tr>
<tr>
<td>Radiation Worker:</td>
<td>Whole body</td>
<td>Whole body</td>
<td>Whole body</td>
<td>Whole body</td>
</tr>
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<td>------------------</td>
<td>------------</td>
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</tr>
<tr>
<td>Whole body</td>
<td>5 rem/year, 3 rem/quarter, not to exceed the cumulative lifetime limit</td>
<td>5 rem/year, 3 rem/quarter, not to exceed the cumulative lifetime limit</td>
<td>5 rem/year, 3 rem/quarter, not to exceed the cumulative lifetime limit</td>
<td>3 rem/quarter</td>
</tr>
<tr>
<td>Cumulative life-time limit</td>
<td>5(N-18) rem</td>
<td>5(N-18) rem</td>
<td>5(N-18) rem</td>
<td>5(N-18) rem</td>
</tr>
<tr>
<td>General population, individual, whole body</td>
<td>0.5 rem/year</td>
<td>0.5 rem/year</td>
<td>0.5 rem/year</td>
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</tr>
</tbody>
</table>

Adapted from ACGIH (1986), Documentation of the threshold limit values. Cincinnati, OH: American Conference of Goverment Industrial Hygienists.

Workers in the radiation department of other job categories potentially exposed to ionizing radiation.

N-18 = age of worker minus 18 years.

FDA also issues recommendations for the use of X-ray machines and other radiation emitters, conducts education programs, and assists the States with their activities. Title 10 of the Code of Federal Regulations contains the NRC rules on isotope source (10 CFR Parts 20 and 34) and Title 21 for the FDA regulations on X-ray machines (21 CFR Parts 1,000 and 1,050). Many States have executed agreements with the Federal Government to assume responsibility for regulation of radiation sources in their States.

The JCAHO requires that a professional health physicist be available on the staff or as a consultant in any hospital with radiology equipment (JCAH 1979).

5.2.3.7 Exposure Control Methods

The amount of protection needed for a particular source of X-rays or gamma rays depends on the energy of the radiation and the length of time it will be in use (Parmeggiani 1983). The chief methods for reducing doses from external X-rays and gamma rays are to limit the time of exposure, increase the distance from the source of the exposure, shield the source with protective material, and avoid unnecessary exposures. Improved equipment, knowledge, and reduced exposures have greatly reduced the risk for radiation workers.

5.2.3.7.1 Radiation protection officer

Reducing radiation exposure to personnel requires an integrated program directed by a radiation protection officer. This officer is responsible for all aspects of a radiation safety in the hospital and should be available or on call at all times. The telephone number should be posted wherever radiation or radioactive materials are used. One of the functions of the radiation protection officer is to monitor workers and patients to ensure that applicable radiation exposure limits are not being exceeded. The office must therefore devise a radiation monitoring program for both workers and patients to ensure that appropriate controls are implemented (NCRP 1976). The officer must also maintain an inventory and monitor the flow of radioactive materials entering and leaving the hospital. Training in the handling of radioactive materials is also the function of the education program and should include information on equipment maintenance personnel monitoring, and documentation. A successful program can reduce most personnel exposures to well below 0.5 rem per year (Laughlin 1981).
5.2.3.7.2 Recordkeeping

The following records should be kept:

- Personal radiation exposures
- Radioisotope inventory
- Receipt and disposition log
- Radiation survey reports

Recordkeeping requirements of the Nuclear Regulatory Commission are published in 10 CFR 20.401.

5.2.3.7.3 Protective equipment

No part of the body should be directly exposed to radiation. If there is a danger of exposing a body part, appropriate protection must be used. Lead aprons, gloves, and goggles should be worn by workers located in the direct field or in areas where radiation levels from scattering are high. All protective equipment should be checked annually for cracks in the lead and other signs of deterioration. For consistently elevated exposure (such as that occurring during angioplasty), a thyroid shield and leaded glasses are recommended. 5.2.3.7.4 General control measures for radiation exposure

The following measures should be taken to reduce occupational radiation exposure in hospitals:

- Properly mark any rooms housing radiation sources; allow only authorized personnel in the area.
- Enclose all radioactive materials.
- Maintain effective contamination control boundaries around all sources.
- Locate X-ray controls to prevent the unintentional energizing of the unit.
- Check all X-ray machines before each use to ensure that the secondary radiation cones and filters are in place.
- Keep X-ray room door closed when equipment is in use.
- Equip treatment rooms with radiation monitors, door interlocks, and visual alarm systems.
- In therapeutic radiology settings, check system calibration periodically with lithium fluoride solid state dosimeters.
- Permit only the patient and trained personnel in the room where portable X-ray units and radioisotopes are used. Provide adequate warning to nearby workers when portable X-rays are about to be taken.
- Clearly identify patients who have received radioactive implants or other therapeutic radiology procedures.
- Follow correct decontamination procedures when control methods fail.
- Lead aprons, gloves, and goggles should be worn by workers located in the direct field or in areas where scatter radiation levels are high.

- Check all protective equipment annually for cracks in the lead.

- Use a thyroid shield and leaded glasses for consistently elevated exposure, such as that occurring during angioplasty.

- Prevent radiation exposure of pregnant workers.

5.2.3.7.5 Control measures for radioactive materials

Unlike X-rays, radioactive materials may be widely used throughout the hospital. They may be present in laboratories or in any place where patients are examined or cared for. Various precautions are needed when using radioactive materials – not only to avoid undue exposures to the radiation, but also to prevent these materials from contacting the skin or entering the body through cuts or injuries. To protect workers from radionuclides, attention must be paid to methods of handling them and to the laboratories where they are used. This section contains information to help minimize radiation exposure during diagnostic, therapeutic, and laboratory procedures.

5.2.3.7.5.1 Diagnostic procedures

The purpose of diagnostic procedures is to determine an organ’s shape and how it is functioning. Most diagnostic procedures use small amounts of radioactive materials with short half-lives. Thus patients who are receiving such materials pose little risk of exposing others. Workers who must handle patients receiving diagnostic radioactive materials should observe the following precautions:

- The radiation protection officer should monitor all diagnostic procedures to ensure that radioactive materials, including radioactive urine or fecal material, are handled properly (NCRP 1976).

- Waterproof gloves should be worn during the collection or transfer of radioactive urine or fecal material and during the cleaning of bedpans, urinals, or other contaminated items (NCRP 1976).

- Urine and feces of these patients may be discarded through the sanitary sewer (Stoner et al. 1982).

- Materials that contact radioactive liquids (e.g. syringes) should be regarded as radioactive and disposed of accordingly (see Section 6) (Stoner et al. 1982).

- When small quantities of radioactive gases are administered to patients, the expired gases should be exhausted through a shielded duct system that is vented at the top of the building at a safe distance from the building’s air intake (Stoner et al. 1982).

5.2.3.7.5.2 Therapeutic procedures

The proper control of radioactivity during therapeutic procedures depends on the class of radioactive procedure being used (NCRP 1976):

Class A – Procedures in which radioactive materials are administered by mouth.
Class B – Procedures in which radioactive materials are injected into body cavities.

Class C – Procedures in which radioactive materials are injected into tumors and left there permanently.

Class D --- Procedures used to deliver radiation at distances of up to a few centimeters, brachtherapy.

Workers involved in the care of patients who have undergone any of these therapeutic procedures should receive a sheet of specific instructions on proper patient care, see NCRP 1970 for details. Workers should adhere to the following guidelines when caring for patients who have been treated therapeutically with radioactive material (NCRP 1976):

- The radiation protection officer should establish limits for the time that any individual should spend with the patient.

- A “radioactivity precautions” tag should be attached to the patient, the chart, and the bed.

- Workers should enter the patient’s room to perform normal hospital duties but they should not spend time visiting or performing nonvital personal services without authorization.

- Patients should be asked to care for themselves insofar as possible.

- Visitors may call, but they should stand at least 6 ft from the patient. Visits should be limited to 1 hr and should not include pregnant women or children.

- Pregnant workers should not be assigned to the routine care of radioactive patients.

- The radiation protection officer and the physician charge should address all questions about the handling or disposal of contaminated clothing or instruments.

Patients who have undergone Class A procedures (radioactive material administered by mouth) may contaminate items such as linen, clothing, food utensils, and skin. In such an event, the radiation protection officer should be notified immediately. Patient care orders should provide special instructions for dealing with spilled urine, vomitus, excretion, or other body fluids. After a Class A procedure, the urine of patients may be collected during the first 24 to 48 hr for determination of radioactivity. If urine is not collected, the patient may use the regular toilet facilities (NCRP 1976). Patients who have undergone Class B procedures (radioactive material injected into body cavities) may emit high energy gamma radiation or may be the source of contaminated surgical dressings or bandages. The latter should be changed only as directed by the physician in charge, and surgical gloves should be used to handle such materials. If the dressings are stained or bloody, they should be handled with forceps or tongs, and the physician in charge and the radiation protection officer should be notified immediately (NCRP 2976). Patients who have undergone Class C procedures (radioactive material injected into tumors) may emit appreciable amounts of radiation for some time (NCRP 1976). The NCRP guidelines listed above in this subsection should be followed for such patients. Patients who have undergone Class D procedures, brachytherapy, contain removable radioactive tubes or needles and present the greatest potential hazards. The exposure rate is likely to be considerable a few feet from the patient, and lead-impregnated aprons and gloves offer virtually no protection against high-energy gamma radiation. The NCRP has developed guidelines that should be follow for such patients (NCRP 1976):
- Nurses frequently assisting the physicians who implant radioactive tubes or needles should be designated as radiation workers. They should wear radiation monitors if the possibility exists for receiving one fourth of the permissible dose for radiation workers.

- Radioactive sources must be delivered to the operating room in lead-shielded containers by a worker responsible for proper handling and disposition of the material.

- No person should stand closer than necessary to the radioactive material either before or after its introduction into the patient.

- Any worker attending the patient after the operative procedure should stay as far as possible from the patient. Workers who attend such patients frequently may need to be classified as radiation workers.

- Nonhospital personnel should not be permitted to ride in elevators with such patients.

- X-rays of such patients should be completed as quickly as possible to avoid exposures of others in the area and to prevent fogging of X-ray film.

- These patients should remain in their own rooms unless other orders are issued.

- Linens, clothing, and bed pans should be checked regularly for radioactive tubes or needles that may have fallen out of the patient.

- If the patient’s packing or dressing seems disturbed, the physician in charge should be notified, and the room should be checked for the presence of a tube, needle, or application device.

- If a radioactive capsule, needle, or other application device is loose or falls out, it should be picked up gently with forceps and placed in a container in the patient’s room. Both the radiation protection officer and the physician in charge should be contacted immediately.

- Workers should limit the time they spend with these patients to that necessary for proper nursing care. The radiation protection officer should determine a work schedule and nursing assignments to minimize exposure.

- Bed baths should be omitted as long as the radioactive material is in place, and perineal care should not be given to gynecological patients.

- Only the attending physicians or their delegates should change dressings or bandages covering an area of insertion. Dressings should be safely stored while awaiting disposal.

- No special precautions are needed for vomitus, sputum, urine, feces, or eating utensils.

- When a radioactive source is removed from the patient, it should be returned to the worker who has been assigned the responsibility for its dispositions.
5. Recommended Guidelines for Controlling Noninfectious Health Hazards in Hospitals (Continued)

5.2.3.7.6 Control measures for radiological procedures.

5.2.3.7.6.1 Diagnostic procedures

Before X-ray equipment is used, the radiation protection officer should take the following steps (CRP 1976):

- Conduct a complete radiation survey to ensure that walls and other barriers are sufficiently protective.
- Ensure that all equipment complies with applicable regulations and is in proper working order.
- Survey all adjacent floors and rooms.
- Designate certain areas as radiation areas with restricted occupancy.

Guidelines for general radiographic procedures, including mammography and dental radiology, are as follows (NCRP 1976):

- Only patients are allowed in unshielded areas when X-rays are generated.
- All X-ray technicians must be inside a shielded booth or behind a protective screen.
- Avoid using any person to hold or restrain a patient undergoing diagnostic radiology. If such restraint is necessary, efforts should be made to limit the number of times any worker performs this duty. A family member should be used if possible. Any such assistant should be provided with a protective apron and gloves and positioned to minimize direct exposure to the X-ray beam.
- When portable X-ray machines are used, the operator should be located at least 6 ft from the patient. Anyone assisting in the procedure should wear protective equipment.

Fluoroscopy and angiography require the presence of a number of personnel, all of whom should be aware of the basic principles of radiation protection and should take the following precautions, NCRP 1976:

- Protective devices supplied with the equipment, e.g. lead drapes, protective pull-up panels, etc., should be used whenever possible.
- Special shielding devices should be devised when a number of patients are to be examined with the same physical setup.

- Persons not required to attend the patient should stand back as far as possible or behind a protective shield.

All recommendations for control of radiological procedures should also be followed by radiation workers in animal laboratories.

5.2.3.7.6.2 Therapeutic procedures

No radiation is emitted from X-ray machines, linear accelerators, or betatrons until they are turned on. Workers may therefore enter treatment rooms without fear of exposure, but they must leave before the equipment is switched on. When radioactive cobalt or cesium is used for therapy, a low level of radiation is present at all times. When therapeutic procedures are performed, the following precautions should be implemented:

- The radiation protection officer must ensure that all workers are aware of the potential hazard and methods for minimizing exposures.

- Equipment used in radiation therapy should be checked for leaks at least once every 6 months and records should be maintained on the equipment’s use, maintenance, and any malfunctions.

- Treatment rooms should be equipped with radiation monitors and an alarm system to indicate high levels of radiation and to prevent the door from being opened during treatment.

5.2.3.7.7 Control measures for laboratories

The following measures should be taken to control radiation exposures in laboratories, NCRP 1976:

- Accurate records must be maintained for radioactive materials used in the laboratories.

- All laboratory personnel must be trained in proper handling, use, and disposal of radioactive materials.

- Laboratory workers should not eat, drink, smoke, or apply cosmetics in the laboratory.

- Workers should remove any protective clothing, including laboratory coats, before leaving the laboratory.

- The radiation protection officer should conduct periodic surveys of the laboratory and keep records of the results.

- In addition to the surveys by the radiation protection officer, the laboratory worker should check counters, floors, and other work areas for contamination.

- The radiation protection officer should be called in the event of a spill of radioactive material.

- When radioactive materials are used in research with animals, any fluids or wastes should be handled and disposed of as radioactive materials.

5.2.3.7.8 Procedures following the death of a patient containing therapeutic amounts of radioactive material.
The NCRP offers detailed procedures for handling the bodies of patients containing radioactive materials, NCRP 1970. General procedures are as follows, NCRP 1976:

- The radiation protection officer must be notified immediately when such a patient dies.
- The attending physician is responsible for the removal of brachytherapy sources and applicators.
- A report describing the nature and extent of the radioactive material used should accompany the body.
- The radiation protection officer should be contacted before an autopsy is performed on any body containing radioactive material.
- All personnel involved in such an autopsy should wear protective clothing.
- Tissues and fluids from such an autopsy should be disposed of as radioactive materials.

5.2.3.8 Environmental Monitoring

Dosimeters should be worn by all personnel exposed to sources of ionizing radiation. Two types of dosimeters are used to monitor ionizing radiation exposure—film and thermoluminescent dosimeters. Both are acceptable, but the thermoluminescent dosimeter is becoming more widely used because of the relative ease of processing. Wearing one film badge under the apron and one over the apron at the collar level will allow evaluation of both whole-body exposure and head and neck exposure. The pocket ionization chambers that can be worn and read daily are not acceptable for compliance purposes.

- A dosimetry program should include:
  - Regular analysis and recording of the results
  - A program for informing workers of their measured exposures
  - Laboratories that have a good quality control program

5.2.3.9 Medical Monitoring

All radiation workers should have preplacement and periodic examinations. These should include a complete blood count and differential white blood count, an eye examination, a history or previous radiation exposure, and a reproductive history.

The NRC regulatory guide entitled Instruction Concerning Prenatal Radiation Exposure may be helpful in assessing potential risks to women considering pregnancy (NRC 1975).

5.2.4 Nonionizing Radiation

Nonionizing radiation does not have enough energy to ionize atoms, but it vibrates and rotates molecules, causing heating. Nonionizing radiation is classified by frequency, which is stated in units of hertz, Hz. The following types of nonionizing radiation may be present in the hospital environment: ultraviolet, UV, visible, including lasers, infrared, IR, radiofrequency, RF/microwave, and ultrasound.
5.2.4.1 UV Radiation

5.2.4.1.1 Hazard location

UV radiation may be emitted from germicidal lamps, some dermatology treatments, nursery incubators, and some air filters in hospitals.

5.2.4.1.2 Potential health effects

Over-exposure may result in the burning of exposed skin and serious eye effects. Eye exposure is especially dangerous because the results of over exposure are not immediately evident. Damage is apparent only 6 to 8 hrs after exposure. Although resulting conjunctivitis can be extremely painful, it is usually temporary. Long-term unprotected exposure can lead to partial loss of vision, accelerated skin aging, and increased risk of skin cancer (NIOSH 1977b).

5.2.4.1.3 Standards and recommendations

No OSHA standard exists for UV radiation exposure, but NIOSH has made recommendations for UV light in the spectral region of 200 to 400 nanometers (nm). For the spectral region of 315-400 nm, NIOSH recommends that the total amount of UV radiation allowed to strike unprotected skin or eyes (based either on measurement data or on output data) be no greater than 1.0 milliwatt (mW) /cm\(^2\) for periods greater than 1000 sec; for exposure times of 1000 sec or less, the total radiant energy must not exceed 1,000 mW sec/cm\(^2\) (1.0 joule/cm\(^2\)) (NIOSH 1973b). For the UV spectral region of 200 to 315 nm, the total amount of UV radiation allowed to strike unprotected skin or eyes should not exceed the levels described in the NIOSH criteria documents for UV radiation (NIOSH 1973b).

The following recommendations were developed by ACGIH 1987:

<table>
<thead>
<tr>
<th>Duration of exposure per day</th>
<th>Effective irradiance (microW/cm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hr</td>
<td>0.1</td>
</tr>
<tr>
<td>4 hr</td>
<td>0.2</td>
</tr>
<tr>
<td>2 hr</td>
<td>0.4</td>
</tr>
<tr>
<td>1 hr</td>
<td>0.8</td>
</tr>
<tr>
<td>30 min</td>
<td>1.7</td>
</tr>
<tr>
<td>15 min</td>
<td>3.3</td>
</tr>
<tr>
<td>10 min</td>
<td>5</td>
</tr>
<tr>
<td>5 min</td>
<td>10</td>
</tr>
<tr>
<td>1 min</td>
<td>50</td>
</tr>
<tr>
<td>30 sec</td>
<td>100</td>
</tr>
<tr>
<td>10 sec</td>
<td>300</td>
</tr>
<tr>
<td>0.5 sec</td>
<td>6000</td>
</tr>
<tr>
<td>0.1 sec</td>
<td>30000</td>
</tr>
</tbody>
</table>

5.2.4.1.4 Exposure control methods
The best preventive approach to UV exposure in hospital settings including newborn and intensive care nurseries is to provide a strong educational program and to issue protective glasses for potentially exposed workers. The use of shaded glass is usually sufficient to prevent damage to the eyes. Enclosures and shielding may also be used.

5.2.4.2 Visible Radiation

Sources of visible radiation in the hospital include incandescent and fluorescent lighting and laser.

5.2.4.2.1 Incandescent and fluorescent lighting

5.2.4.2.1.1 Potential health effects

Constant exposure to glare from hospital lighting may result in visual fatigue and headaches. These effects are temporary and produce no known lasting physiological changes.

5.2.4.2.1.2 Standards and recommendations

No OSHA standard or NIOSH recommendation exists for exposure to visible radiation.

5.2.4.2.1.3 Exposure control methods

Glare from visible radiation sources can be reduced by properly positioning equipment, filters, or shields; routine rest periods are also helpful.

5.2.4.2.2 lasers

Lasers, light amplification by stimulated emission of radiation, emit electromagnetic radiation in either the UV, IR, or visible spectrum. The wavelength and frequency of the emitted light depend on which spectrum is used. In the biomedical field, the laser has been used for microsurgery and for measuring immunoglobulins and other elements in the blood. Lasers are becoming increasingly popular in surgery.

5.2.4.2.2.1 Hazard location

The most typical locations for lasers in the hospital are in radiology departments where they are used to help align patients for radiographic treatment and surgical areas where they have a wide variety of applications.

5.2.4.2.2.2 Potential health effects and safety hazards

Lasers cause damage because they focus large amounts of light energy on a small surface area. The eyes and skin are the organs most susceptible to damage by laser (NIOSH 1977b).

The cornea and lens of the eye can focus the light from a laser of visible wavelength so that the light energy may cause lesions because it is more concentrated when it strikes the retina. In some cases, the damage to the retina is not reversible. The light from UV lasers may also cause damage by heating the surfaces of tissues and denaturing proteins.

When lasers strike the skin, the effects may range from erythema to blistering and charring. The extent of the damage depends on the wavelength, power, and duration of exposure. Because lasers use voltages as high as
15,000 V, the present a potential electrocution hazard.

5.3.4.2.2.3 Standards and recommendations

No OSHA standards exist for exposure to lasers, but their performance is regulated by the US Food and Drug Administration (FDA) Bureau of Radiological Health under 21 CFR 1040. This regulation should be consulted when lasers are used. In the regulation, FDA has identified the following four classes of lasers that have been summarized by Stoner et al. (1982) as follows:

Class 1: Lasers that are incapable of producing a damaging radiation level. These are exempt from control measures.

Class 2. Lasers that may be viewed directly under carefully controlled exposure conditions. (These must bear a precautionary label.)

Class 3. Lasers that require control measures to prevent direct viewing and subsequent eye damage.

Class 4. Lasers that must be controlled to prevent eye and skin damage.

ANSI also provides guidelines for the safe use of lasers (ANSI 1973) and ACGIH has published recommendations for occupational exposure to laser radiation (ACGIH 1986).

5.2.4.2.2.4 Exposure control methods

The primary means of worker protection is the use of effective eye protection and shielding of high-energy beams. When selecting eye protection, care must be taken to ensure that the filtering characteristics of the glass are appropriate for the laser being used. Protective glasses should be mounted in goggle-type frames to ensure that the eyes are protected from the side as well as the front. Each pair of goggles should be clearly marked to show the type of laser they are to be used for. Protective glasses should be checked regularly for cracks in the glass or deterioration of the frame. Hand protection should also be worn when working in or near the target area. Extreme care should be taken to ensure that the laser beam is not focused on any reflective surfaces. Special care should be taken with carbon dioxide lasers because of their invisible beams. In all cases, dry cloth, paper, or other flammable materials should not be located near the beam.

NIOSH recommends that a laser safety officer be appointed in facilities where lasers are used extensively. The laser safety officer should be responsible for developing the laser safety program and ensuring the proper maintenance of equipment.

5.2.4.2.2.5 Medical surveillance

Workers who are exposed to lasers should receive a periodic examination of the eyes and skin.

5.2.4.3 IR Radiation

5.2.4.3.1 Hazard location

All objects with temperatures above absolute zero (-273°C, or -459.67°F) emit IR radiation, which increases as a function of the object’s temperature. In humans and animals, the major IR insult occurs as a result of a temperature rise in the absorbing tissues (NIOSH 1977b). Exposure to IR radiation in hospitals may occur during the use of heating or warming equipment in the kitchen and during procedures involving lasers or
thermography.

5.2.4.3.2 Potential health effects

The hazards associated with exposure to IR radiation are acute skin burns, increased vasodilation of the capillary beds, and an increased pigmentation that may continue for some time. Continued exposure may result in eye damage. Where highly intense and compact sources of radiation are used, an injury may occur fractions of a second before the pain is evident.

5.2.4.3.3 Standards and recommendations

No OSHA standard or NIOSH recommendation exists for occupational exposure to IR radiation.

5.2.4.3.4 Exposure control methods

Eye protection with proper filters should be provided to workers for use in areas with IR radiation. Shielding and enclosures may also be used to control exposures.

5.2.4.4 RE/Microwave Radiation

5.2.4.4.1 Hazard location

Numerous applications exist in the hospital environment for RF/microwave radiation. These applications include heating in diathermy, cancer therapy, thawing of frozen organs for transplantations, sterilization of ampuls, and enzyme inactivation in tissues of experimental animals. Microwave ovens are also used to heat food.

5.2.4.4.2 Potential health effects

RF/microwave radiation may produce some adverse biological effects from the heating of deep body tissues (NIOSH 1979c). As a result of this heating, potentially damaging alterations may be produced in cells. Some concern also exists for nonthermal effects. Effects associated with RF/microwave radiation include neurological, behavioral, and immunological changes.

RF/microwave radiation effects that are due to heating have been well documented in animals, but evidence is incomplete and in dispute for those effects occurring without an increase in tissue temperature. Thermal effects are in direct proportion to the field strength or power density. When the amount of heat generated from the absorbed energy is too great to be released into the surrounding environment, the temperature of the body gradually increases and can lead to heat stress.

A large body of literature addresses the various aspects of animal and human exposures to RF/microwaves. Most of the animal studies have investigated the thermal effects of RF/microwave radiation. The reports of human effects consist of a series of clinical and epidemiologic investigations into the association between RF radiation and damage to the eyes, central nervous system, and reproductive capability. Firm associations between RF radiation and these effects have not been demonstrated. A complete discussion of this literature is beyond the scope of this document.

5.2.4.4.3 Standards and recommendations

The OSHA standard for exposure to microwaves is 10 mW/cm². Both ANSI and ACGIH have published
guidelines for occupational exposure to RF/microwave radiation (ANSI 1981; ACGIH 1986). FDA’s Bureau of radiological Health has set a limit of 5 mW/cm² for leakage from microwave ovens during normal use (21 CFR 1030.10). 5.2.4.4.4 environmental monitoring

Leakage from diathermy equipment should be monitored in the proximity of the applicator before each treatment. Microwave ovens should be checked at least every 3 months; leakage can be checked easily with a small, hand-held instrument.

5.2.4.4.5 Exposure control methods

Any area where RF/microwave radiation exposure exceeds permissible levels should be considered potentially hazardous. The area should be clearly identified, and warning signs should be posted. Interlocks may be used to prevent unauthorized entry. Basic protective measures include the provision of shields or absorbing enclosures for equipment. Personal protective equipment may be used, e.g. gonad shields, protective suits, and wire-netting helmets. Although special protective goggles have been developed, they may not provide sufficient protection.
5. Recommended Guidelines for Controlling Noninfectious Health Hazards in Hospitals

(Continued)

5.2.4.5 Ultrasound

5.2.4.5.1 Hazard location

Ultrasound is the mechanical vibration of an elastic medium that is produced in the form of alternating compressions and expansions. The vibration may be produced by continuous or impulse sound in the form of a sequel of interrupted vibrations. The medical uses of ultrasound include therapeutic surgical, and diagnostic procedures.

5.2.4.5.2 Potential health effects

Although exposure to ultrasound does not appear to pose a human health risk, exposure to audible high-frequency radiation above 10 kHz can result in a syndrome involving nausea, headaches, tinnitus, pain, dizziness, and fatigue. Temporary hearing loss and threshold shifts are also possible from high-frequency ultrasound radiation.

Low-frequency ultrasound radiation may produce local effects when a person touches parts of materials being processed by ultrasound. The hands are often involved in the area where ultrasound acts most strongly. Exposure to powerful sources of ultrasound may result in damage to peripheral nervous and vascular structures at the points of contact. Airborne ultrasound vibration may produce effects on the central nervous system and on other systems and organs through the ear and through extra-auditory routes.

5.2.4.5.3 Standards and recommendations

No OSHA standard or NIOSH recommendation exists for ultrasound. ACGIH has proposed the following TLVs for permissible exposure to airborne upper sonic and ultrasonic acoustic radiation (ACGIH 1987):

<table>
<thead>
<tr>
<th>Mid-frequency of third-octave band kHz</th>
<th>One-third octave-band level in dB re 20 microPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>12.5</td>
<td>80</td>
</tr>
<tr>
<td>16</td>
<td>80</td>
</tr>
<tr>
<td>20</td>
<td>105</td>
</tr>
</tbody>
</table>
Exposure control methods

Exposure to ultrasonic vibration can be reduced by the use of enclosures and shields. Sound-isolating panels on ultrasonic equipment should be free of any openings and should be isolated from the floor by rubber seals. Workers operating or repairing ultrasonic equipment should be provided with appropriate protective equipment that is selected based on the task being performed and the likelihood of exposure to radiation above 10 kHz or to contact with low-frequency sources.

Video Display Terminals

Hazard location

Video display terminals, VDTs have rapidly replaced other word processing and data management systems in many hospital departments.

Potential health effects

VDT’s are a frequent source of worker complaints. Eyestrain, back, neck, and arm discomfort, and symptoms of stress have all been associated with VDT work. These problems may be controlled or improved with ergonomic measures such as adjusting the position of the screen and keyboard, the chair, the lighting and glare, the color contrast, and the frequency of rest periods. Whether long-term VDT use causes significant visual dysfunction or degeneration is unknown. Extensive radiation measurements and health data have indicated that VDTs do not appear to present a radiation hazard to the operators (Pomroy and Noel 1984) or to the developing fetuses of pregnant operations (NIOSH 1984a). However, clusters of miscarriages and birth defects have been reported among VDT operators and warrant further investigation (NIOSH 1984a).

Recommendations

NIOSH studies have resulted in a report entitled Potential Health Effects of Video Display Terminals (NIOSH 1981h) which contains specific recommendations for the installation, maintenance, and use of VDT’s. NIOSH recommends the following general guidelines for VDT work (NIOSH 1984a).

Workstation design: VDT units, supporting tables, and operator chairs should be designed with maximum flexibility. VDT’s should have detachable keyboards, and work tables should be adjustable for height. Chairs should be adjustable for height and should provide proper back support.

- Illumination: Sources of glare should be controlled through VDT placement, i.e. parallel to windows, and parallel to and between lights, proper lighting, and the use of glare-control devices on the VDT screen surface. For VDT tasks requiring screen-intensive work, illumination levels should be lower than those needed when working with hard copy, which may require local lighting in addition to normal office lighting.

- Work regimens: Continuous work with VDT’s should be interrupted periodically by rest breaks or
other work activities that do not produce visual fatigue or muscular tension. As a minimum, a break should be taken after 2 hr of continuous VDT work. Breaks should be more frequent as visual, mental, and muscular burdens increase.

- Vision testing: VDT workers should have visual testing before beginning VDT work and periodically thereafter to ensure that they have adequately corrected vision to handle such work.

5.3 MUTAGENS and TERATOGENS

5.3.1 Introduction

Measures for locating mutagens and teratogens, controlling worker exposures, and conducting medical surveillance of exposed workers are also discussed by specific agent in Section 4 and in the other subsections of Section 5.

Health care workers may be exposed to a number of agents that are considered to be mutagenic or teratogenic. These agents include the following (Yager 1973):

- **Biological agents**
  - Rubella virus
  - Cytomegalovirus
  - Hepatitis B virus

- **Chemicals**
  - Ethylene oxide
  - Organic solvents

- **Pharmaceuticals**
  - Anesthetic gases
  - Antibiotics
  - Cytotoxic drugs

- **Physical agents**
  - Ionizing radiation

5.3.2 Effects of Exposure

Estimates indicate that up to 4 million women employed in hospitals may be exposed to reproductive hazards (Kooker 1987). Lists of teratogenic agents present in the hospital environment have been compiled by Beckman and Brent (1986) and Schardein (1985). Despite the presence of known human teratogens in the hospital, there is no clear evidence that exposure conditions in hospitals have resulted in an excess rate of birth defects among the offspring of hospital workers. For example, cytomegalovirus is recognized as a human teratogen, but exposed nursery and pediatric care personnel do not appear to be at increased risk of cytomegalovirus-induced birth defects (U.S. Congress 1985).
A number of studies have supported more general associations between employment in hospitals or laboratories in general, and an increased risk of adverse reproductive effects, primarily spontaneous abortion. For example, spontaneous abortions and birth defects have been associated with exposure of female operating room personnel to waste anesthetic gases; a similar relationship was also suggested for the wives of exposed men (NIOSH 1977a). Exposure to sterilizing agents, primarily ethylene oxide, has also been associated with increased frequencies of spontaneous abortions (Hemminke et al. 1982) and with chromosomal abnormalities in circulating lymphocytes (Hogstedt et al. 1983; Laurent et al. 1984).

5.4 DERMATOLOGICAL HAZARDS

5.4.1 Introduction

Skin injuries and diseases account for a large proportion of all occupational injuries and diseases (ASPH/NIOSH 1988). Skin injuries in the hospital environment include cuts, lacerations, punctures, abrasions, and burns. Skin diseases and conditions of hospital workers include dermatitis, allergic sensitization, infections such as herpes, and skin cancer. In 1984, dermatologic diseases accounted for more than 34% of all chronic occupational illnesses in the United States. Of workers who develop a dermatologic disease, 20% to 25% lose an average of 11 working days each year. In the service industries, which include the health service industry, nearly 8,000 cases of dermatologic diseases were reported to the Bureau of Labor Statistics in 1984 -- an incidence of 5 cases per 10,000 full-time workers (ASPH/NIOSH 1988).

5.4.2 Hazard location

Skin problems among hospital workers have been associated with work in every part of the hospital, but they are especially common among housekeeping personnel, maintenance workers, orderlies, and aides. In one hospital, 60% of the workers with occupational dermatitis of the hands were aides and housekeepers, even though these two categories made up only 17% of the total workers in the hospital (Dahlquist and Fregart 1970). Half of the workers with dermatitis had suffered with the skin problem for 6 months or more.

The NIOSH publication Occupational Diseases: A Guide to Their Recognition (NIOSH 1977d) contains an extensive list of occupational irritants and causes of dermatologic allergy. Listed below are some of the common causes of skin problems for some categories of hospital workers:

<table>
<thead>
<tr>
<th>Category of worker</th>
<th>Common cause of skin irritation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food service workers</td>
<td>Heat, moisture, Candida yeast, bacteria, grease, synthetic detergents, water softeners, soaps, fruit, acids, spices, sugars, and vegetable juices</td>
</tr>
<tr>
<td>Housekeepers</td>
<td>Bacteria, synthetic detergents, disinfectants, houseplants, polishes, waxes, soaps, solvents, rubber gloves, and bactericides</td>
</tr>
<tr>
<td>Laundry workers</td>
<td>Alkalis, bactericides, bleaches, synthetic detergents, enzymes, fiber glass, fungicides, heat, moisture, optical brighteners, and soaps</td>
</tr>
<tr>
<td>Nurses</td>
<td>Local anesthetics, antibiotics, antiseptics, bacteria, synthetic detergents, disinfectants, ethylene oxide, rubber gloves, soaps, drugs, fungi, and moisture</td>
</tr>
</tbody>
</table>

5.4.3 Potential Health Effects

Chemicals can directly irritate the skin or cause an allergic sensitization. Physical agents can also damage the skin, and skin that has been chemically or physically damaged is vulnerable to infection.
5.4.3.1 Effects of Chemical Agents

Skin reactions, dermatitis, are the most common and often the most easily preventable of all job-related health problems. The skin is the natural defense system of the body: it has a rough, waxy coating, a layer of protein, keratin, and an outer layer of dead cells to help prevent chemicals from penetrating the tissues and being absorbed into the blood.

5.4.3.1.1 Direct irritation

Many chemicals cause irritation on contact with the skin, irritant contact dermatitis, by dissolving the protective fats or keratin protein layer, dehydrating the skin, or killing skin cells. Symptoms of this kind of irritation are red, itchy, peeling, dry, or cracking skin. Some chemicals are not irritants under normal conditions, but they will irritate skin that has already been damaged by sunburn, scratching, prolonged soaking, or other means. Tars, oils, and solvents can plug the skin pores and hair follicles, causing blackheads, pimples, and folliculitis.

Irritant contact dermatitis is diagnosed by a history of contact with a chemical and by the improvement or disappearance of symptoms when contact is discontinued.

Data from California (ASPH/NIOSH 1988) suggest that the following five types of agents are responsible for the greatest number of workers’ compensation claims:

- Soaps, detergents, cleaning agents
- Solvents
- Hard, particulate dusts
- Food products
- Plastics and resins

5.4.3.1.2 Allergic contact dermatitis

Some persons become sensitized to chemicals days, months, or even years after their first exposure. This allergic reaction does not occur in every worker who contacts the chemical. Symptoms are red, itchy, and blistering skin, like a poison oak or ivy reaction, and may be much more severe than the direct irritation described in the previous subsection.

Sensitization is usually diagnosed by a history of contact and by patch testing, in which a physician applies a small amount of the suspect chemical to the skin under a patch to observe the reaction over 48 hr. Workers who are sensitized to a chemical will usually continue to have severe reactions unless all contact is prevented by substituting another chemical or transferring to another job. Common contact allergens include (ASPH/NIOSH 1988) the following:

- Metallic salts (i.e. salts of nickel, chrome, cobalt, gold, mercury)
- Rubber accelerators and antioxidants (these may leach from rubber gloves) such as thiurans,
dithiocarbamates, mercapto compounds, and paraphenylenediamine derivatives

- Plastic resins such as epoxies, phenolics, and acrylics
- Organic dyes such as those in photographic color-developing solutions
- First aid cabinet preparations such as neomycin, themerosal, and benzocaine
- Common laboratory chemicals such as phenol and formaldehyde.

5.4.3.2 Effects of Physical Agents

The skin can be damaged in a variety of ways including:

- Mechanical trauma (i.e. cuts lacerations, abrasions, punctures)
- Burns from physical agents, electricity, heat, or UV radiation
- Chemical burns

Although there are no data describing skin injuries among hospital workers specifically, data from the Bureau of Labor Statistics for 1983 indicate that almost 10% of the workers’ compensation claims for skin injuries from 30 reporting states occurred among cooks and food service workers (ASPH/NIOSH 1988).

5.4.3.3 Skin cancer

The association between basal and squamous cell carcinomas and ultraviolet radiation has been well established. The association between skin cancer and exposure to other agents is less well documented, but ionizing radiation and antineoplastic drugs have been implicated. Other evidence indicates that malignant transformation of cells damaged by chronic allergic contact dermatitis may occur (ASPH/NIOSH 1988).

5.4.3.4 Effects of Biologic Agents

The skin can be damaged by a variety of microorganisms, including bacteria, fungi, viruses, and parasites. Herpes simplex is the most common dermatologic infection among dentists, physicians, and nurses. About 5% of all workers’ compensation claims for skin diseases in 1985 were the result of primary skin infections. Biologic agents can also cause secondary skin infections when skin has been damaged chemically or physically. Secondary infections are particularly likely if good personal hygiene is not practiced (NIOSH 1987a).

5.4.4 Standards and Recommendations

There are no OSHA standards or NIOSH recommendations that specifically address dermatitis.

5.4.5 Exposure Control Methods

Relatively simple precautions can considerably reduce skin hazards. Effective measures include work practices and engineering controls that limit solvent exposure, the use of personal protective equipment,
substitution of less irritating chemicals, and the institution of a good hygiene program. A more complete
discussion of methods for controlling dermatologic hazards is contained in A Proposed National Strategy for
5.5 STRESS

5.5.1 Introduction

At a 1986 symposium on 10 leading work-related diseases and injuries, NIOSH investigators presented a draft national strategy for the prevention of psychological disorders (ASPH/NIOSH 1988). The strategy identified the following clinical disorders as attributable to job stress:

- Affective disturbances such as anxiety, depression, and job dissatisfaction
- Maladaptive behavioral or lifestyle patterns
- Chemical dependencies and alcohol abuse

Estimates based on data obtained from the National Institute of Mental Health indicate that about 25% of the Americans aged 25 to 55 (the prime working age) suffered psychological disorders (ASPH/NIOSH 1988).

Hospital work often requires coping with some of the most stressful situations found in any workplace. Hospital workers must deal with life-threatening injuries and illnesses complicated by overwork, understaffing, tight schedules, paperwork, intricate or malfunctioning equipment, complex hierarchies of authority and skills, dependent and demanding patients, and patient deaths; all of these contribute to stress. In addition, the increasing size and bureaucracy of many hospitals may depersonalize the environment and leave many workers feeling isolated, fatigued, angry, powerless and frustrated. The brunt of these feelings may be borne by other workers, patients, or the worker's family. These feelings may also be expressed as apathy, loss of self-confidence, withdrawal, or absenteeism. Failure to recognize and treat the sources of stress results in workers who suffer "burnout" (i.e., those who remain on the job but cease to function effectively).

In 1977 NIOSH investigators published a study of hospital admissions for mental health disorders among 130 major occupational categories. Of the 22 occupations with the highest admission rates for mental disorders, six were health care occupations—health technologists, practical nurses, LPN, clinical laboratory technicians, nurses' aides, health aides registered nurses, and dental assistants (Colligan et al. 1977). Another study reported that the proportional mortality ratio (PMR) for suicide was elevated for male dentists, physicians, medical and dental technologists, and female nurses. The PMR for suicide was also elevated among chiropractors and veterinarians (NIOSH 1983c).
Hoiberg (1982) examined occupational stress and illness among white male enlisted Navy personnel and found that mess management specialists and hospital corpsmen were more frequently hospitalized for stress-related illnesses than Navy personnel in other occupational groups. She also reported that the rate of hospitalization increased with tenure; those in their second enlistment period had hospitalization rates for stress-related illnesses that were nearly five times the rates for personnel in their first enlistment period. Those in their third decade of service were hospitalized twice as frequently as personnel in their second decade of service. Hospitalization rates for neuroses, transient situational disturbances, hypertension, and ulcers exceeded the rates for six other stress-related causes of hospitalization. Hoiberg (1982) reported that the following factors contributed to the stress experienced by mess management specialists and corpsmen:

- Low job status
- Less favorable job characteristics such as work load, responsibility for the well being of others, and lack of participation in deciding work tasks
- Less satisfactory work environment composed of high physical demands, occasional high noise levels, occasional-to-frequent high temperatures, and occasionally dangerous work.

This study Hoiberg (1982) reinforces existing information on stress among nurses and other occupational groups involved in direct patient care; it also indicates that hospital food service work should be considered a high-stress occupation.

5.5.2 Hospital Locations Associated with Stress

Workers are most likely to encounter severe stress in intensive care units, burn units, emergency rooms, and operating rooms.

5.5.2.1 Intensive Care Unit

One of the most stressful areas of the hospital is the intensive care unit ICU. Several studies of ICU nurses indicate that the following factors also lead to stress (Huckabay and Jagla 1979; Bailey et al. 1980; Gribbins and Marshall 1982):

- Interpersonal conflicts (nurse-physician, nurse-nurse-nurse, and nurse-supervisor)
- Knowledge base (complex disease states, treatments, and equipment)
- Management of the unit (staffing problems)
- Nature of direct patient care (emergencies attempts to prolong life, sudden death, and the deaths of special patients)
- Physical work environment (malfunctioning or noisy equipment, lack of space, and physical injury)
- Lack of administrative rewards (pay, benefits, and advancement opportunity)

5.5.2.2 Neonatal Intensive Care Unit

Over several years of employment, nurses progressed through various stages of stress. Initially the nurses were concerned about their competence in the new job. Later they raised questions about the job itself (e.g. they questioned the quality of life for NICU survivors). Still later they felt they had mastered the job and were indifferent because they did not receive enough positive rewards for their work. Those still in the unit after 3 years had developed a number of coping mechanisms such as humor and tolerance.

5.5.2.3 Burn Units

Koran et al. (1983) explored the problems of 37 health care workers in the burn unit of a 425-bed county general hospital to determine how their job stresses affected morale and patient care. Koran et al described the following emotional stressors of these workers:

- The pain suffered by patients during dressing changes and debridement
- Uncooperative behavior, expressions of hostility and rejection by patients because of the necessity to inflict pain during debridement
- Unreasonable demands made by distraught family members
- Dealing with psychiatric disorders that frequently precede or accompany severe burns
- Problems common to staff members of other ICU’s including:
  - Lifting of heavy patients
  - Exposure to mutilated bodies
  - Conflicts with administrators over staffing and scheduling
  - Lack of emotional support from physicians
  - Concern about the inevitability of mistakes
  - Anguish caused by a patient’s death.

5.5.3 Potential Health Effects

Stress has been associated with loss of appetite, ulcers, mental disorder, migraines, difficulty in sleeping emotional instability, disruption of social and family life, and the increased use of cigarettes, alcohol, and drugs. Stress can also affect worker attitudes and behavior. Some frequently reported consequences of stress among hospital workers are difficulties in communicating with very ill patients, maintaining pleasant relations with coworkers, and judging the seriousness of a potential emergency.

5.5.4 Causes of Stress

Factors commonly mentioned as causes of stress by all categories of hospital workers are as follows (NIOSH 1978c; Huckabay and Jagla 1979; Bailey 1980; Gribbins et al. 1982; Koran et al. 1983):
- Understaffing
- Role conflict and ambiguity
- Inadequate resources
- Working in unfamiliar areas
- Excessive noise
- Lack of control (influence, power) and participation in planning and decision making
- Lack of administrative rewards
- Under-utilization of talents and abilities
- Rotating shift work
- Exposure to toxic substances
- Exposure to infectious patients

Other important stress factors include job specialization, discrimination, concerns about money, lack of autonomy, work schedules, ergonomic factors, and technological changes. These factors are discussed briefly in the following subsections.

5.5.4.1 Job Specialization

Increased job specialization has made it more difficult for workers to move to higher positions in the hospital. Specialized jobs are stressful and involve a higher rate of occupational injuries such as back strain and dermatitis.

5.5.4.2 Discrimination

Despite recent trends to the contrary, women and minorities still tend to be clustered in lower-level hospital positions.

5.5.4.3 Concerns about Money

Money matters are a significant source of stress for many hospital workers. Although hospital workers’ wages have increased over the past decade, the difference between the higher- and lower-paying hospital positions has also increased. Meeting financial obligations and facing the threat of possible unemployment can be real sources of stress, especially for workers who are the sole support of a family.

5.5.4.4 Lack of Autonomy

Frustration over the frequent lack of decision-making power is a significant stressor. Nurses sometimes feel demeaned when their observations and recommendations for patient care are ignored or overruled.
5.5.4.5 Work Schedule

The effects of stress can be made worse by shift work, especially rotating shift work. A NIOSH study of the effects of rotating shifts indicated that about 25% of the 1,219 nurses in the study regularly worked rotating shifts. These nurses reported visiting clinics for medical problems significantly more often than those working regular shifts (NIOSH 1978a). More nurses on rotating shifts stated that they stayed away from work because of acute respiratory infections, upper and lower gastrointestinal symptoms, headaches, colds, and influenza. The nurses on rotating shifts also visited clinics more because of these complaints and complaints of otitis, pharyngitis, gastritis, menstrual disorders, dermatitis, nervous symptoms, sprains and strains, contusions, and crushed body parts (NIOSH 1978a).

5.5.4.6 Ergonomic Factors

Stress can also result from ergonomic factors such as the poor design of furniture, lighting, and equipment and the need to lift heavy patients.

5.5.4.7 Technological Changes

Technological changes have contributed increasingly to the stress of hospital workers in the past 5 years. The introduction of VDT’s at ward desks, the rapid change in medication protocols, and the development of new procedures and equipment may all frustrate staff when they are not given adequate training and time to incorporate these changes into their work patterns.

5.5.5 Methods for Coping with Stress

Some of the methods that have successfully reduced hospital worker stress and dissatisfaction area as follows (Huckabay and Jagla 1979; Bailey et al. 1980; Koran et al. 1983):

- Regular staff meetings and discussions to communicate feelings, gain support, and share innovative ideas
- Institution of stress management programs
- Readily available counseling from a nonjudgmental source
- Flexibility and innovation by supervisors to create alternative job arrangements
- Adequate staffing
- Reasonable shift schedules for house staff to allow adequate time for sleep each day
- Group therapy for staff with particularly difficult professional problems such as dealing with cancer patients, chronic illness, and death
- Organized and efficient work functions and environment
- Recognition of and action on legitimate complaints regarding overbearing physicians and supervisors
Individual approaches such as relaxation exercises and biofeedback to relieve symptoms of stress until the sources are identified and evaluated

- Frequent in-service educational sessions and other opportunities to improve skills and confidence
- More flexibility and worker participation in scheduling (possibly a 10 hr, 4-day workweek)
- Scheduled rotation of unit assignments

Koran et al. (1983) attempted to improve the work environment in a burn unit by providing the nursing staff with feedback about their work setting and by helping the staff use that information to formulate and implement changes. Using survey results and a series of meetings between the staff and a psychiatrist, substantial improvements in staff morale were observed and the quality of patient care seemed to be improved. Koran et al. (1983) believed that these improvements were realized because:

- The staff was encouraged to think about the elements of their work setting in terms of those that were stressful and those that were nonstressful.
- The staff began to focus on work setting characteristics that are often overlooked, such as clarity of expectations.
- The staff attempted to effect change in only a few areas at a time rather than in many.
- The staff’s involvement in their work increased as they began to work together to effect change.
- The staff began to feel concern not only for their own patients but for all patients and staff.
5. Recommended Guidelines for Controlling Noninfectious Health Hazards in Hospitals

(Continued)

5.6 REFERENCES


Crudi CB (1980). A compounding dilemma: I've kept the drug sterile but have I contaminated myself. National IV Therapy Association 3: 77-78.


Kahn G (1970). Depigmentation caused by phenolic detergent germicides. Archives of Dermatology 102:177-


NIOSH (1976c). Criteria for a recommended standard: 1,1,1-trichloroethane (methyl chloroform). Cincinnati,


Seidlitz PR (1981). Excessive noise levels detrimental to patients, staff. Hospital Progress 62(2):54-56, 64.


5. Recommended Guidelines for Controlling Noninfectious Health Hazards in Hospitals
(Continued)

5.7 ADDITIONAL RESOURCES

5.7.1 Chemical Agents and Dusts

5.7.1.1 Asbestos


5.7.1.2 Chemical Disinfectants


5.7.1.3 Drugs (Pharmaceuticals)


5.7.1.4 Ethylene Oxide


5.7.1.5 Formaldehyde


5.7.1.6 Mercury


5.7.1.8 Solvents


5.7.1.9 Waste Anesthetic Gases


5.7.2 Physical Agents

5.7.2.1 Heat


5.7.2.2 Noise


5.7.2.3 ionizing Radiation


5.7.2.4 Nonionizing Radiation


5.7.2.5 Video Display Terminals


5.7.3 Mutagenic and Teratogenic Agents


**4.5.7.4 Dermatitis**


**5.7.5 Stress**

AMA (1980). Bibliography on the impaired physician. Chicago, IL: American Medical Association, Department of Mental Health.


6. HAZARDOUS WASTE DISPOSAL

Hospitals generate large amounts of diverse wastes that require disposal. Much of the waste is hazardous and must therefore be packaged, transferred, and disposed of properly to protect both the persons handling it and the environment.

Hospital wastes can be categorized as infectious or noninfectious. Infectious wastes include human, animal, or biological wastes and any items that may be contaminated with pathogens. Noninfectious wastes include toxic chemicals, cytotoxic drugs, and radioactive, flammable, and explosive wastes.

6.1 INFECTIOUS WASTES

The material in this section is extracted from the EPA guide for Infectious Waste Management (EPA 1986). The following publications are also recommended:

- Guideline for Handwashing and Hospital Environmental Control Section 4 (Garner and Favero 1985). This document reprinted in Appendix 8.

- Guideline for Isolation Precautions in Hospitals (Garner and Simmons 1983). This document is reprinted in Appendix 8.

- Waste Disposal in Microbiology Laboratories, Chapter 9 (Mackel and Mallison 1981).

6.1.1 Infectious Waste Management Plan

Compliance with State and local regulations should be carefully considered when developing an infectious waste treatment plan. Each hospital should develop an infectious waste treatment plan. Each hospital should develop an infectious waste management plan that provides for (1) Designation of the waste that should be managed as infectious, (2) Segregation of infectious waste from the noninfectious waste, (3) Packaging, (4) Storage, (5) Treatment, (6) Disposal, (7) Contingency measures for emergency situations, and (8) Staff training.

6.1.2 Types of Infectious Waste

Infectious wastes may be classified as isolation wastes, cultures and stocks of infectious agents and associated biologicals, human blood and blood products, pathological wastes, contaminated sharps, contaminated carcasses, body parts, and bedding, or miscellaneous contaminated wastes. Each of these categories is discussed briefly as follows:
- **Isolation wastes** are those generated by patients who are isolated because of communicable diseases.

- **Cultures and stocks of infectious agents and associated biologicals** include specimen cultures from medical and pathological laboratories, cultures and stocks of infectious agents from research and industrial laboratories, wastes from the production of biologicals, discarded live and attenuated vaccines, and culture dishes and devices used to transfer, inoculate, and mix cultures.

- **Human blood and blood products** include blood as well as serum, plasma, and other blood products.

- **Pathological wastes** include tissues, organs, body parts, and body fluids that are removed during surgery and autopsy.

- **Contaminated sharps** are hypodermic needles syringes, Pasteur pipettes, broken glass, and scalpel blades. These items should be considered infectious wastes because of the possibility of contamination with blood-borne pathogens.

- **Contaminated carcasses, body parts, and bedding** emanate from animals intentionally exposed to pathogens during research, the production of biologicals, or the in vivo testing of pharmaceuticals.

- **Miscellaneous wastes** that are not designated as infectious should be assumed to be infectious and should be managed as such to maintain consistent levels of protection for both the environment and for persons handling these wastes. Miscellaneous wastes include those from surgery and autopsies, contaminated laboratory wastes, dialysis unit wastes, and contaminated equipment.
  - **Wastes from surgery and autopsies** include soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves.
  - **Contaminated laboratory wastes** include specimen containers, slides and cover slips, disposable gloves, laboratory coats, and aprons.
  - **Dialysis unit wastes** include contaminated disposable equipment and supplies such as tubing, filters, disposable sheets, towels, gloves, aprons, and laboratory coats.
  - **Contaminated equipment** refers to discarded equipment and parts that are used in patient care, medical and industrial laboratories, research, and the production and testing of certain pharmaceuticals.

### 6.1.3 Treatment and Disposal Methods

Several methods are used for infectious waste treatment, depending on the type of waste material. These treatment methods include steam sterilization, incineration, thermal inactivation, gas/vapor sterilization, chemical disinfection, and sterilization by irradiation. After treatment, the wastes or their ashes can be disposed of by discharge into sanitary sewer systems (for liquid or ground-up waste) or burial in sanitary landfills. Acceptable treatment methods for the various types of wastes are listed in Table 6-1.

**Table 6-1. Recommended techniques for treatment of infectious wastes***

<table>
<thead>
<tr>
<th>Recommended treatment techniques</th>
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<tr>
<td>Type of infectious waste</td>
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<td>--------------------------------------------------------------</td>
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<tr>
<td>Isolation wastes</td>
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<tr>
<td>Cultures and stocks of infectious agents and associated biologicals</td>
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<tr>
<td>Human blood and blood products</td>
</tr>
<tr>
<td>Pathological wastes</td>
</tr>
<tr>
<td>Contaminated sharps</td>
</tr>
<tr>
<td>Contaminated animal wastes:</td>
</tr>
<tr>
<td>Carcasses and parts</td>
</tr>
<tr>
<td>Bedding</td>
</tr>
</tbody>
</table>

*Taken from EPA (1986).

†The recommended treatment techniques are those that are most appropriate and are generally in common use; an alternative treatment technique may be used to treat infectious waste if it provides effective treatment.

§Chemical disinfection is most appropriate for liquids.

**Discharge to the sanitary sewer for treatment in the municipal sewage system (provided that secondary treatment is available).

††For aesthetic reasons, steam sterilization should be followed by incineration of the treated waste or by grinding with subsequent flushing to the sewer system in accordance with State and local regulations.

§§Handling by a mortician (burial or cremation).

6.1.3.1 Steam Sterilization, Autoclaving

Steam sterilization, autoclaving, involves the use of saturated steam within a pressure vessel at temperatures high enough to kill infectious agents in the waste. Sterilization is accomplished primarily by steam penetration. Steam sterilization is most effective with low-density material such as plastics. An alternative treatment method, e.g. incineration, should be used on high-density wastes such as large body parts or large quantities of animal bedding or fluids because they inhibit direct steam penetration and require longer sterilization times.

Containers that can be used effectively in steam sterilization are plastic bags, metal pans, bottles, and flasks. High-density polyethylene and polypropylene plastic should not be used in this process because they do not facilitate steam penetration to the waste load. Heat-labile plastic bags allow steam penetration of the waste, but they may crumble and melt. If heat-labile plastic bags are used, they should be placed in another heat-stable container that allows steam penetration, such as a strong paper bag, or they should be treated with gas/
The following precautions should be taken when using steam sterilization:

- Plastic bags should be placed in a rigid container before steam treatment to prevent spillage and drain clogging.

- To facilitate steam penetration, bags should be opened and caps and stoppers should be loosened immediately before they are placed in the steam sterilizer.

- Care should be taken to separate infectious wastes from other hazardous wastes.

Infectious waste that contains noninfectious hazards (see Section 5) should not be steam-sterilized because of the possibility that the equipment operator will be exposed to toxic, radioactive, or other hazardous chemicals.

Waste that contains antineoplastic drugs, toxic chemicals, or chemicals that would be volatilized by steam should not be steam-sterilized.

Persons involved in steam sterilizing should be trained in handling techniques to minimize personal exposure to hazards from these wastes. Some of these techniques include:

- Use of protective equipment
- Minimization of aerosol formation
- Prevention of waste spillage during autoclave loading and unloading
- Prevention of burns from handling hot containers
- Management of spills

The autoclave temperature should be checked with a recording thermometer to ensure that the proper temperature is being maintained for a long enough period during the cycle.

Steam sterilizers should be routinely inspected and serviced, and the process should be routinely monitored to ensure that the equipment is functioning properly.
6.1.3.2 Incineration

Incineration converts combustible materials into noncombustible residue or ash. Gases are ventilated through the incinerator stacks, and the residue or ash is disposed of in a sanitary landfill. If incinerators are properly designed, maintained, and operated, they are effective in killing organisms present in infectious waste. Although all types of infectious waste can be disposed of by incineration, the process is especially useful for anesthetic disposal of pathological wastes such as tissues and body parts. Incineration also renders contaminated sharps unusable. The principal factors to consider when incinerating infectious wastes are variations in waste composition, the waste feed rate, and the combustion temperature. Infectious wastes containing antineoplastic drugs should be disposed of in an incinerator that provides high temperatures and enough time for the complete destruction of these compounds. The incinerator’s effectiveness in disposing of chemical wastes should be documented before such use.

6.1.3.3 Thermal Inactivation

Thermal inactivation involves the treatment of waste with high temperatures to eliminate the presence of infectious agents. This method is usually used for large volumes of infectious waste. Liquid waste is collected in a vessel and heated by heat exchangers or a steam jacket surround the vessel. The types of pathogens in the waste determine the temperature and duration of treatment. After treatment, the contents can be discharged into the sewer in a manner that complies with State, Federal, and local requirements. Solid infectious waste is treated with dry heat in an oven, which is usually electric. This method requires higher temperatures and longer treatment cycles than steam treatment.

6.1.3.4 Gas/Vapor Sterilization

Gas/vapor sterilization uses gaseous or vaporized chemicals as the sterilizing agents. Ethylene oxide is the most commonly used agent, but should be used with caution since it is a suspected human carcinogen, see sec 5 for a discussion of ethylene oxide toxicity and work practices. Because ethylene oxide may be adsorbed on the surface of treated materials, the potential exists for worker exposure when sterilized materials are handled.

6.1.3.5 Chemical Disinfection

Chemical disinfection is the preferred treatment for liquid infectious wastes, but it can also be used in treating solid infectious waste. The following factors should be considered when using chemical disinfection:

- Type of microorganism
- Degree of contamination
- Amount of proteinaceous material present
- Type of disinfectant
- Contact time
- Other relevant factors such as temperature, pH, mixing requirements, and the biology of the microorganism

Ultimate disposal of chemically treated waste should be in accordance with State and local requirements.
6.1.3.6 Sterilization by irradiation

Sterilization by irradiation is an emerging technology that uses ionizing radiation. Advantages over other treatment methods are as follows:

- Electricity requirements are nominal.
- Steam is not required.
- No heat or chemicals remain the treated waste.

The principal disadvantages are as follows:

- Capital costs are high.
- Highly trained operating and support personnel are required.
- Space requirements are great.
- The potential exists for worker exposure as a result of leaks in seals or poor work practices.
- Ultimate disposal of the radiation source may pose problems.
6.1.4 Separation of Infections and Noninfectious Wastes

Infectious and noninfectious wastes should be separated at the point of generation. If the infectious waste contains noninfectious hazards, it should be identified and subjected to additional treatment.

Infectious waste should be discarded into clearly identifiable containers or plastic bags that are leakproof and puncture-resistant. Red or orange bags are usually used for infectious waste. The containers should also be marked with the universal symbol for biological hazards (see Figure 6-1).

6.1.5 Packaging

Infectious wastes should be contained from the point of origin to the point at which they are not longer infectious. The packaging should be appropriate for the type of waste involved, and it must endure handling, storage, transportation, and treatment.

Liquid infectious wastes can be placed in capped or tightly stoppered bottles or flasks. Large quantities may be placed in containment tanks.

Solid or semisolid wastes may be placed in plastic bags, but the following recommendations should be
heeded:

- Select tear-resistant bags. Plastic bags are judged by their thickness or durability as evaluated by the ASTM dart test (ASTM 1975). Use one or both of these criteria in the procurement process. The most important consideration is tear-resistance.

- Do not place sharps, sharp items, or items with sharp corners in the bags. (Place sharps in impervious rigid, puncture-resistant containers made of glass, metal, rigid plastic, or wood.)

- Do not load a bag beyond its weight or volume capacity.

- Keep bags from coming into contact with sharp external objects.

- Consider double bagging.

Some treatment techniques required special packaging characteristics. For example, incineration required combustible containers, and steam sterilization requires packaging materials such as low-density plastics that allow steam penetration and evacuation of air.

6.1.6 Handling and Transportation

When the waste is to be moved about for treatment or storage, special handling or packaging may be necessary to keep bags intact and to ensure containment of the waste. The following procedures are recommended:

- Single-bagged waste and containers of sharps and liquids should be placed within a rigid or semirigid container such as a bucket, box, or carton lined with plastic bags.

- Containers should be covered with lids during transportation and storage.

- When handling or transporting plastic bags of infectious waste, care should be taken to prevent tearing the bags. Instead of chutes or dumbwaiters, carts should be used for transporting bags of infectious waste within the facility.

- Carts and recyclable containers that are used repeatedly for transport and treatment of bagged waste should be disinfected after each use. Single-use containers should be destroyed as part of the treatment process.

- Infectious waste should not be compacted before treatment. This process could damage the packaging and disperse the contents, or it could interfere with the effectiveness of treatment.

- Outside the hospital, infectious waste should be transported in closed, leakproof dumpsters or trucks.

- The waste should be placed in rigid or semirigid, leakproof containers before being loaded onto trucks.

6.1.7 Storage

- Infectious waste should be stored for a minimum amount of time and should be packaged securely enough to ensure containment of the waste and to prevent penetration by rodents and vermin.
- Limited access to the storage area is recommended.

- The universal biological hazard symbol (Figure 6-1) should be posted on the storage area door, waste containers, freezers, or refrigerators.

- Containers for biohazardous material should be a distinctive red or orange color.

### 6.1.8 Contingency Measures

Contingency measures should be developed to deal with emergencies that occur during the handling, transportation, or disposal of infectious waste. Emergencies include spills of liquid infectious waste, ruptures of plastic bags or other containers holding infectious waste, and equipment failures.

### 6.1.9 Ultimate Disposal

For ultimate disposal of treated infectious waste, EPA recommends contacting state and local governments to identify approved disposal options. EPA also recommends (1) The discharge of treated liquids and ground solids, e.g. pathological wastes or small animals, to the sewer system, and (2) Landfill disposal of treated solids and incinerator ash. Landfilling of infectious wastes is allowed in some states and prohibited in others. EPA recommends that only treated infectious wastes be buried in landfills. They further recommend that facilities secure the services of reputable waste handlers to ensure, to the extent possible, that ultimate disposal of hazardous wastes is performed according to applicable Federal, state and local regulations.

### 6.1.10 Training

All workers who handle infectious waste should receive infectious waste management training that includes (1) Explanation of the infectious waste management plan, and (2) Assignment of roles and responsibilities for implementation of the plan. Refresher courses should also be given periodically.

### 6.1 Noninfectious Wastes

#### 6.2.1 Chemical Wastes

Chemical wastes include toxic chemicals, cytotoxic drugs, radioactive materials, and flammable and explosive wastes. These wastes should be classified at the time of collection to avoid mixing chemicals that are incompatible (NFPA 1983). Disposal of chemical wastes should be handled in accordance with good safety practices and applicable government regulations. Persons or agencies involved with the removal of these wastes should be informed of their characteristics and hazards.

#### 6.2.2 Cytotoxic Wastes

OSHA has issued work practice guidelines for workers who deal with cytotoxic (antineoplastic) drugs (OSHA 1986). These guidelines are reproduced as Appendix 7 of this document. They address drug preparation, drug administration, waste disposal, spills, medical surveillance, storage and transport, training, and information dissemination.

#### 6.2.3 Radioactive Wastes
Three classes of radioactive wastes may be found in hospitals: solids, liquids and gases. This section summarizes the recommendations of the National Council on Radiation Protection and Measurements (NCRP 1976).

Solid radioactive wastes may include rags or papers from cleanup operations, solid chemicals, contaminated equipment, experimental animal carcasses, and human or experimental animal fecal material. Human and animal fecal material may generally be disposed of through the sanitary sewer system (NCRP 1976). For other solid wastes, disposal depends on the half-life of the radionuclide. For those nuclides with short half-lives, the solid material may be stored in a secure place until decay has occurred. Solid waste contaminated by nuclides with long-half-lives should be disposed of by a licensed commercial disposal company. Contaminated equipment should be cleaned with large amounts of water, which should be disposed of as radioactive liquid waste.

Radioactive urine may generally be disposed of immediately through the sanitary sewer system, but the toilet should be flushed several times after each use (Stoner et al. 1982). In cases in which the patient has received a large dose of radioactive iodine, urine is generally collected for the first 48 hr after administration, taken to the laboratory for analysis, and flushed down the sanitary sewer system with large quantities of water. Other liquid wastes can be handled in the same manner as solid wastes. Those with short half-lives can be stored in a sealed container until the radioactivity decays; those with long half-lives should be disposed of by a licensed disposal company.

Gaseous radioactive wastes should be vented to the outside of the hospital so that recirculation of the exhaust air does not occur.

6.2.4 Flammable Wastes

Refer to Sections 3.1.3 and 3.1.4 for discussion of flammable and explosive wastes.
6.3 REFERENCES


6.4 ADDITIONAL RESOURCES


Phillips OF (1972). When is infectious waste not infectious waste? Hospitals 46(9)56.


7. GOVERNMENT AGENCIES AND ORGANIZATIONS

The standard-setting and enforcement responsibilities of government agencies and private accreditation organizations are described in Section 2.4. The present section lists occupational safety and health agencies and resource organizations that may be helpful in obtaining information on hospital safety and health hazards. Most of this assistance is in the form of written materials such as individual publications, newsletters, journals, and other periodicals. Some organizations also provide consultation, education conferences, and other forms of assistance. A listing of this nature is necessarily incomplete, and NIOSH welcomes information regarding organizations and publications not listed.

7.1.1 National Institute for Occupational Safety and Health (NIOSH)

One of the main functions of NIOSH is to conduct research on workplace hazards and to develop recommendations for exposure limits and safe working procedures. Many NIOSH publications are therefore applicable to hospital hazards. All requests for information concerning NIOSH publications should be sent to the following address:

National Institute for Occupational Safety and Health  
Attention: Publications Dissemination  
Robert A. Taft Laboratories  
4676 Columbia Parkway  
Cincinnati, OH 45226  
Telephone: (513) 533-8287

NIOSH regional offices are listed below:

REGION I  
Regional Program Consultant,  
NIOSH DHHS/PHS/Prevention - Region I  
Government Center  
JFK Federal Building, Room 1401  
Boston, MA 022034

REGION IV  
Regional Program Consultant,  
NIOSH DHHS/PHS/Prevention - Region IV
7.1.2 Occupational Safety and Health Administration (OSHA)

OSHA has both State and Federal offices (see the listing at the end of this section). Twenty-three States plus Puerto Rico and the Virgin Islands have their own OSHA programs. The remaining States are covered under Federal OSHA standards.

The primary function of OSHA is to see that employers comply with the health and safety provisions of the Occupational Safety and Health Act. OSHA should be contacted to:

- Request a workplace inspection
- Review records of previous inspections and citations
- Obtain information on current standards

OSHA also provides employers with a free consultation service to advise them on eliminating potential workplace hazards.

7.1.2.1 Regional Offices for the Federal Occupational Safety and Health Administration

<table>
<thead>
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<td>16-18 North Street</td>
<td>525 Griffin Street</td>
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<tr>
<td>Boston, MA 02109</td>
<td>Federal Building, Room 602</td>
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<td>Dallas, TX 75202</td>
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<td>1515 Broadway Street, Room 3445</td>
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<tr>
<td>New York, NY 10036</td>
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<td>Gateway Building, Suite 2100</td>
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<td>3535 Market Street</td>
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<tr>
<td>1375 Peachtree Street, N.E., Suite 587</td>
<td>Box 36017</td>
</tr>
<tr>
<td>Atlanta, GA 30367</td>
<td>450 Golden Gate Avenue, Room 11349</td>
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<td>San Francisco, CA 94102</td>
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### Offices for States that have OSHA-Approved State Plans

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<tr>
<td>ALASKA</td>
<td>Alaska Department of Labor</td>
<td>P.O. Box 1149, Juneau, AK 99802</td>
</tr>
<tr>
<td>ARIZONA</td>
<td>Occupational Safety &amp; Health Division</td>
<td>Industrial Commission of Arizona P.O. Box 19070, 800 W. Washington, Phoenix, AZ 85007</td>
</tr>
<tr>
<td>CALIFORNIA</td>
<td>Department of Industrial Relations</td>
<td>525 Golden Gate Avenue, San Francisco, CA 94102</td>
</tr>
<tr>
<td>CONNECTICUT</td>
<td>Connecticut Department of Labor</td>
<td>200 Folly Brook Boulevard, Wethersfield, CT 06109</td>
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<tr>
<td>HAWAII</td>
<td>Labor &amp; Industrial Relations</td>
<td>825 Mililani Street, Honolulu, HI 96813</td>
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<tr>
<td>IOWA</td>
<td>Department of Employment Services Division of Labor Services</td>
<td>307 E. 7th Street, Des Moines, IA 50319</td>
</tr>
<tr>
<td>KENTUCKY</td>
<td>Kentucky Labor Cabinet</td>
<td>U.S. Highway 127 South, Frankfort, KY 40601</td>
</tr>
<tr>
<td>MARYLAND</td>
<td>Department of Licensing &amp; Regulation Division of Labor &amp; Industry</td>
<td>501 St. Paul Place, Baltimore, MD 21202</td>
</tr>
<tr>
<td>MICHIGAN</td>
<td>Michigan Department of Labor</td>
<td>7150 Harris Drive, Lansing, MI 48909</td>
</tr>
<tr>
<td>MICHIGAN (continued)</td>
<td>Michigan Department Of Public Health</td>
<td>P.O. Box 30035, 3500 North Logan Street, Lansing, MI 48909</td>
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<tr>
<td>MINNESOTA</td>
<td>Department of Labor &amp; Industry</td>
<td>444 Lafayette Road, St. Paul, MN 55101</td>
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<tr>
<td>NEVADA</td>
<td>Department of Occupational Safety and Health Nevada Department of Industrial Relations Capitol Complex</td>
<td>1370 S. Curry Street, Carson City, NV 89710</td>
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<tr>
<td>NEW MEXICO</td>
<td>Environmental Improvement Division</td>
<td>P.O. Box 968, Sante Fe, NM 87504-0968</td>
</tr>
<tr>
<td>NEW YORK</td>
<td>NORTH CAROLINA</td>
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<tr>
<td>New York Department of Labor</td>
<td>North Carolina Department of Labor</td>
<td></td>
</tr>
<tr>
<td>One Main Street</td>
<td>214 W. Jones Street, Shore Building</td>
<td></td>
</tr>
<tr>
<td>Brooklyn, NY 11201</td>
<td>Raleigh, NC 27603</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OREGON</th>
<th>PUERTO RICO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers’ Compensation Department</td>
<td>Puerto Rico Department of Labor and Human Resources</td>
</tr>
<tr>
<td>Labor and Industries Building</td>
<td>Prudencio Reveria Martinez Building</td>
</tr>
<tr>
<td>Salem, OR 97310</td>
<td>505 Munoz Reveria Avenue</td>
</tr>
<tr>
<td></td>
<td>Hato Rey, Puerto Rico 00918</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOUTH CAROLINA</th>
<th>TENNESSEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Carolina Department of Labor</td>
<td>Tennessee Department of Labor</td>
</tr>
<tr>
<td>3600 Forest Drive</td>
<td>501 Union Building</td>
</tr>
<tr>
<td>P.O. Box 11329</td>
<td>Suite A, Second Floor</td>
</tr>
<tr>
<td>Columbia, SC 29211-1329</td>
<td>Nashville, TN 37219</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UTAH</th>
<th>VERMONT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utah Occupational Safety and Health</td>
<td>Department of Labor &amp; Industry</td>
</tr>
<tr>
<td>160 E. 3rd South</td>
<td>120 State Street</td>
</tr>
<tr>
<td>P.O. Box 5800</td>
<td>Montpelier, VT 05602</td>
</tr>
<tr>
<td>Salt Lake City, UT 84110-5800</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIRGIN ISLANDS</th>
<th>VIRGINIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virgin Islands Department of Labor</td>
<td>Department of Labor &amp; Industry</td>
</tr>
<tr>
<td>P.O. Box 890</td>
<td>P.O. Box 12064</td>
</tr>
<tr>
<td>Christainsted</td>
<td>Richmond, VA 23241-0064</td>
</tr>
<tr>
<td>St. Croix, Virgin Islands 00820</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WASHINGTON</th>
<th>WYOMING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Labor &amp; Industries</td>
<td>Occupational Health and Safety Department</td>
</tr>
<tr>
<td>General Administration Building</td>
<td>604 E. 25th Street</td>
</tr>
<tr>
<td>Room 334-AX-31</td>
<td>Cheyenne, WY 82002</td>
</tr>
<tr>
<td>Olympia, WA 98504</td>
<td></td>
</tr>
</tbody>
</table>

### 7.1.3 The Centers for Disease Control (CDC)

The Centers for Disease Control (CDC) in Atlanta, GA, collects statistics on hospital infection control programs and publishes guidelines for infection control in hospital workers and for hospital environmental control.

### 7.2 HOSPITAL ASSOCIATIONS AND ORGANIZATIONS

#### 7.2.1 American Hospital Association (AMA)

840 North Lake Shore Drive
Chicago, IL 60611

The AHA has numerous publications of interest, including those on hospital infection control, anesthetic waste gas, and hospital safety. They also sponsor conferences on hospital health and safety.

#### 7.2.2 Federation of American Hospitals (FAN)
The FAN is an organization of privately-owned and investor-owned hospitals.

7.2.3 Joint Commission on Accreditation of Healthcare Organizations (JCAHO)

875 North Michigan Avenue
Chicago, IL 60611

The JCAHO evaluates hospitals who choose to apply for accreditation every 3 years. Although their concern is primarily patient care, they have also established criteria for hospital health and safety activities.

7.3 SAFETY AND HEALTH ORGANIZATIONS

7.3.1 National Fire Protection Association (NFPA)

Batterymarch Park
Quincy, MA 02269

The NFPA has developed publications on various aspects of fire safety (e.g., extinguishers, sprinkler systems, and electrical codes). Many of their guidelines are enforced by local and State fire marshals.

7.3.2 National Safety Council (NSC)

444 North Michigan Avenue
Chicago, IL 60611

The NSC publishes general recommendations for safety standards, with particular concern for fire safety. Health care concerns are emphasized.

7.3.3 Committees on Occupational Safety and Health (COSH)

COSH groups are coalitions of workers and health professionals who are concerned about hazardous work environments. Among the services often provided by these groups are health and safety information hotlines, educational materials, conferences, research on workplace hazards, and the sharing of experiences in investigating and controlling workplace hazards. COSH groups now exist in more than 30 cities in the United States.

7.4 HEALTH PROFESSIONAL AND WORKER ORGANIZATIONS

7.4.1 American Federation of Government Employees (AFGE)

80 F Street, N.W. Washington,
DC 20001

AFGE represents several hundred thousand workers in the Veterans Administration system. They have a health and safety program.
7.4.2 American Federation of State, County, and Municipal Employees (AFSCME)

1625 L Street N.W.
Washington, DC 20036

AFSCHE maintains an active health and safety staff and publishes material on hospital health and safety.

7.4.3 American Association of Occupational Health Nurses (AAOHN)

3500 Piedmont Road,
N.E. Atlanta, QA 30305

AAOHN consists of registered nurses and other health professionals interested in occupational health issues.

7.4.4 American Occupational Medical Association (AOMA)

2340 South Arlington Heights Road
Arlington Heights, IL 60005

The AOMA Committee on Occupational Health in Medical Centers has recently published guidelines.

7.4.5 Association of Hospital Employee Health Professionals

P.O. Box 2029
Chula Vista, CA 92012-2029

The members of this professional and educational organization are involved with health and safety issues in hospitals. The organization is working to establish guidelines for hospital employee health. The association publishes the Journal of Hospital Occupational Health and sponsors a 3-day national conference annually.

7.4.6 Association of Operating Room Nurses (AORN)

10170 East Mississippi Avenue
Denver, CO 80231

This organization consists of registered nurses employed in operating rooms. Their goal is to improve operating room standards.

7.4.7 Hospital Workers Union 1199, AFL-CIO

625 Broadway
New York, NY 10012

Hospital Workers Union 1199 was one of the first hospital unions to develop a full health and safety staff and program. The Union has produced many publications and holds conferences on health and safety on a regular basis.

7.4.8 College of American Pathologists (CAP)
CAP has published guidelines for the operation of clinical laboratories.

7.4.9 Service Employees International Union (SEIU)

1313 L Street, N.W.
Washington, DC 20005

The SEIU maintains an active health and safety staff and publishes many materials on hospital health and safety.

7.5 MANUFACTURER'S ASSOCIATIONS

7.5.1 American Association for the Advancement of Medical Instrumentation (AAMI)

1901 North Fort Dyer Drive, Suite 602
Arlington, VA 22209

The AAMI is concerned with worker safety and health in the handling of medical instruments. The association has published recommended guidelines for the use of ethylene oxide.

7.5.2 Health Industry Manufacturers Association (HIMA)

1030 15th Street, N.W.
Suite 1100
Washington, DC 20005

The HIMA represents domestic manufacturers of hospital devices and diagnostic products. They develop programs and sponsor activities on matters affecting the industry.

7.6 PUBLICATIONS

7.6.1 Newsletters

Hospital Infection Control

Published monthly by American Health Consultants, Inc., 67 Peachtree Park Drive N.E., Atlanta, GA 30309.

Infection Control Digest

Published monthly by the American Hospital Association, 840 North Lake Shore Drive, Chicago IL 60611.

Hospital Employee Health

Published monthly by the American Health Consultants, Inc., 67 Peachtree Park Drive N.E., Atlanta, GA
7.6.2 Checklists and Manuals

**Health and Safety Manual for Hospitals**

Prepared by the Health and Safety Department, Canadian Union of Public Employees, March 1981.

**Hospital Workers: Who Cares About Your Health on the Job?**

Prepared by the Public Employee Department, AFL-CIO, 815 16th Street N.W., Washington, DC 20006.

**Safety and Health Hazards on the Job: A Manual for Health Care Employees**


**OSHA and the Hospital Manager: Checklist of OSHA Regulations for Health Care Institutions**

Prepared by the Catholic Hospital Association, St. Louis, MO 63104.


Prepared by the Hospital Safety Training Program Committee, Bureau of Safety and Regulation, Michigan Department of Labor, February 1977.

**Regulations for Health Care Workers**

Available from the Labor Occupational Health Project (LOHP), 2521 Channing Way, Berkeley, CA 94720.

**How to Look at Your Workplace**

Prepared by Urban Planning Aid, 120 Boylston Street, Boston, MA 02116.

7.6.3 Journals

- American Journal of Industrial Medicine
- American Journal of Public Health
- Hospitals
- Infection Control
- Journal of Hospital Occupational Health
- Journal of Occupational Medicine
- Occupational Health and Safety
- Occupational Health Nursing
- Scandinavian Journal of Work, Environment and Health
### DISTRIBUTION OF HOSPITAL WORKERS (SIC 806) BY OCCUPATION*

<table>
<thead>
<tr>
<th>Type of worker</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Professional and technical workers:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professionals, technicals</td>
<td>883,029</td>
<td>22.64%</td>
</tr>
<tr>
<td>Dentists</td>
<td>3,140</td>
<td>0.08%</td>
</tr>
<tr>
<td>Dietitians</td>
<td>23,708</td>
<td>0.61%</td>
</tr>
<tr>
<td>Pharmacists</td>
<td>6,292</td>
<td>0.42%</td>
</tr>
<tr>
<td>Physicians and osteopaths</td>
<td>111,406</td>
<td>2.86%</td>
</tr>
<tr>
<td>Podiatrists</td>
<td>392</td>
<td>0.01%</td>
</tr>
<tr>
<td>Registered nurses</td>
<td>652,054</td>
<td>16.72%</td>
</tr>
<tr>
<td>Therapists</td>
<td>74,552</td>
<td>1.91%</td>
</tr>
<tr>
<td>Other</td>
<td>1,485</td>
<td>0.04%</td>
</tr>
<tr>
<td><strong>Health technologists, technicians</strong></td>
<td>302,047</td>
<td>7.74%</td>
</tr>
<tr>
<td>Clinical laboratory technologists, technicians</td>
<td>143,610</td>
<td>3.68%</td>
</tr>
<tr>
<td>Dental hygienists</td>
<td>368</td>
<td>0.01%</td>
</tr>
<tr>
<td>Occupation</td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Health record technologists</td>
<td>14,279</td>
<td>.37</td>
</tr>
<tr>
<td>Radiologic technologists</td>
<td>73,971</td>
<td>1.90</td>
</tr>
<tr>
<td>Therapy assistants</td>
<td>4,130</td>
<td>.11</td>
</tr>
<tr>
<td>Other</td>
<td>65,739</td>
<td>1.69</td>
</tr>
<tr>
<td>Other professional, technical</td>
<td>157,913</td>
<td>4.05</td>
</tr>
<tr>
<td>Total professional and technical workers</td>
<td>1,342,989</td>
<td>34.43</td>
</tr>
<tr>
<td>Managers, professionals, proprietors</td>
<td>120,833</td>
<td>3.10</td>
</tr>
<tr>
<td>Sales workers</td>
<td>2,234</td>
<td>.06</td>
</tr>
<tr>
<td>Clerical workers</td>
<td>628,533</td>
<td>16.11</td>
</tr>
<tr>
<td>Crafts and kindred workers</td>
<td>98,355</td>
<td>2.52</td>
</tr>
<tr>
<td>Operatives</td>
<td>89,802</td>
<td>2.30</td>
</tr>
<tr>
<td>Service workers:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning service workers</td>
<td>207,598</td>
<td>5.32</td>
</tr>
<tr>
<td>Food service workers</td>
<td>155,988</td>
<td>4.00</td>
</tr>
<tr>
<td>Miscellaneous service workers</td>
<td>67,645</td>
<td>1.73</td>
</tr>
<tr>
<td>Health service workers</td>
<td>1,152,104</td>
<td>29.54</td>
</tr>
<tr>
<td>Dental assistants</td>
<td>2,939</td>
<td>.08</td>
</tr>
<tr>
<td>Health aides excluding nursing</td>
<td>120,971</td>
<td>3.10</td>
</tr>
<tr>
<td>Health trainees</td>
<td>13,600</td>
<td>.35</td>
</tr>
<tr>
<td>Nursing aides and orderlies</td>
<td>667,517</td>
<td>17.11</td>
</tr>
<tr>
<td>Practical nurses</td>
<td>347,077</td>
<td>8.90</td>
</tr>
<tr>
<td>Total service workers</td>
<td>1,583,335</td>
<td>40.59</td>
</tr>
<tr>
<td>Laborers</td>
<td>34,253</td>
<td>.88</td>
</tr>
<tr>
<td>Total hospital workers</td>
<td>3,900,334</td>
<td>99.99</td>
</tr>
</tbody>
</table>


†Figures may not add because of rounding.
An effective hospital occupational health program should provide, but is not limited to, the following services:

A. Preplacement physical examinations, including a complete medical history
B. Periodic health appraisal examinations
C. Health and safety education
D. Immunizations
E. Care for illness and injury at work
F. Health counseling
G. Environmental control and surveillance
H. Health and safety records system
I. Coordinated planning with hospital departments and services

The established guidelines are outlined as follows.

A. PREPLACEMENT PHYSICAL EXAMINATIONS

1. Physical examinations should be given to all new workers and should include:
   a. Routine blood tests
      (1) Complete blood count
(2) Fasting blood sugar or 2-hr postprandial
(3) Renal function tests
(4) Creatinine
(5) SGOT
(6) SGPT
(7) Serology for syphilis
(8) Serology for rubella
(9) Others at the physician's discretion, guided by the worker's medical history

b. Routine urinalysis

c. Electrocardiogram for workers over age 35 at the physician's discretion

d. Chest X-ray, posterior and anterior and lateral

e. Skin testing for TB

f. Vision tests (near and far, with and without correction) and tonometry

g. Audiogram, speech range

h. Cervical cytology (Pap smear) for females

2. A record of the occupational history of the worker should be included in the preplacement examination.

B. PERIODIC HEALTH APPRAISAL EXAMINATIONS

Periodic health appraisal examinations should be provided for the following:

1. Workers who are exposed to hazardous environments,

2. Workers who are returning from an absence caused by illness or injury,

3. Workers who are being transferred to another department or service, and

4. Workers who are retiring.

C. HEALTH AND SAFETY EDUCATION

In addition to job orientation, a program instructed by a knowledgeable person should provide health, safety, and environmental information for all workers on a continuing basis.

The instruction should include information on safe working habits, relevant health information, and use of the occupational health unit for reporting injuries and illnesses.

D. IMMUNIZATIONS
1. Immunizations should be provided in accordance with the Centers for Disease Control (CDC) policy for hospital workers.**

2. Elective immunizations should be considered for special situations such as epidemics, unusual laboratory conditions, or accidental exposures (e.g., HBV needlestick accident).

3. A suspense system for updating immunizations should be maintained.

E. CARE FOR ILLNESS AND INJURY AT WORK

1. A specific site within the hospital should be available for workers to receive medical, psychological, and other consultative services on a 24-hr basis.

2. An adequate facility should be provided to give medical, surgical, psychological, and rehabilitative services to all workers.

3. A competent consulting staff should be maintained.

4. A formal procedure should be outlined for contacting a family or a private physician.

5. Adequate followup measures for facilitating continuity of care should be maintained for all workers.

6. Treatment and reporting of occupational injuries and illnesses should conform to the State compensation laws and to OSHA standards under Public Law 91-596, the Occupational Safety and Health Act of 1970.

F. HEALTH COUNSELING

1. A program should be made accessible and available to provide medical, psychological, and social counseling. Such counseling should include help for workers with various addictive problems (i.e., tobacco, drugs, food, and alcohol), as well as for those with problems associated with HIV infection and the HIV epidemic.

2. A formal system for referral and review should be provided for workers with problems that need professional intervention unavailable in the facility.

3. Where a social service or psychiatric department is not available, persons with special interests or training should be designated to assist in counseling sessions.

G. ENVIRONMENTAL CONTROL AND SURVEILLANCE

1. An environmental control and surveillance program should be part of the occupational health program and should be directed by an individual or consultant capable of managing harmful exposures in the hospital.

2. A single individual should be responsible for nuclear medicine and radiological activities.

3. Conformance should be maintained to State and Federal rules and regulations pertaining to radiation and safety hazards.
H. HEALTH AND SAFETY RECORDS SYSTEM

1. Each worker should have a health record maintained in the health unit. The record should include all examinations, reports of injuries and illnesses, reports to and from physicians, and all other safety and health matters.

2. Reports should be kept on a monthly and yearly basis to indicate injury and illness rates, accident facts, and reports on the monitoring and control of environmental hazards.

3. Records should be confidential and should be available only to appropriate personnel.

I. COORDINATED PLANNING WITH HOSPITAL DEPARTMENTS AND SERVICES

1. A committee that represents all hospital departments and services should advise the hospital administration on the policy, direction, and requirements of the occupational health program.

2. A safety committee and an infection control committee should consider the health of all workers in their planning.

3. A member of the hospital's occupational health program should be on both the safety committee and the infection control committee.


**See Appendix 8 of this document.
## APPENDIX 3

### OCCUPATIONAL HAZARDS
BY LOCATION IN THE HOSPITAL*

<table>
<thead>
<tr>
<th>Location</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central supply</td>
<td>Ethylene oxide</td>
</tr>
<tr>
<td></td>
<td>Infection</td>
</tr>
<tr>
<td></td>
<td>Broken equipment (cuts)</td>
</tr>
<tr>
<td></td>
<td>Soaps, detergents</td>
</tr>
<tr>
<td></td>
<td>Steam</td>
</tr>
<tr>
<td></td>
<td>Flammable gases</td>
</tr>
<tr>
<td></td>
<td>Lifting</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
</tr>
<tr>
<td></td>
<td>Asbestos insulation</td>
</tr>
<tr>
<td></td>
<td>Mercury</td>
</tr>
<tr>
<td>Dialysis units</td>
<td>Infection</td>
</tr>
<tr>
<td></td>
<td>Formaldehyde</td>
</tr>
<tr>
<td>Dental service</td>
<td>Mercury</td>
</tr>
<tr>
<td></td>
<td>Ethylene oxide</td>
</tr>
<tr>
<td></td>
<td>Anesthetic gases</td>
</tr>
<tr>
<td></td>
<td>Ionizing radiation</td>
</tr>
<tr>
<td></td>
<td>Infection</td>
</tr>
<tr>
<td>Food service</td>
<td>Wet floors</td>
</tr>
<tr>
<td></td>
<td>Sharp equipment</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
</tr>
<tr>
<td></td>
<td>Soaps, detergents</td>
</tr>
<tr>
<td></td>
<td>Disinfectants</td>
</tr>
<tr>
<td></td>
<td>Ammonia</td>
</tr>
<tr>
<td></td>
<td>Chlorine</td>
</tr>
<tr>
<td></td>
<td>Solvents</td>
</tr>
<tr>
<td></td>
<td>Drain cleaners</td>
</tr>
<tr>
<td></td>
<td>Oven cleaners</td>
</tr>
<tr>
<td></td>
<td>Caustic solutions</td>
</tr>
<tr>
<td></td>
<td>Pesticides</td>
</tr>
<tr>
<td></td>
<td>Microwave ovens</td>
</tr>
<tr>
<td></td>
<td>Steam lines</td>
</tr>
<tr>
<td></td>
<td>Ovens</td>
</tr>
<tr>
<td>Heat</td>
<td>Electrical hazards</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Housekeeping</td>
<td>Soaps, detergents</td>
</tr>
<tr>
<td></td>
<td>Disinfectants</td>
</tr>
<tr>
<td></td>
<td>Infection</td>
</tr>
<tr>
<td></td>
<td>Wastes (chemical, radioactive infectious)</td>
</tr>
<tr>
<td></td>
<td>Lifting</td>
</tr>
<tr>
<td></td>
<td>Slips, falls</td>
</tr>
<tr>
<td>Laboratory</td>
<td>Infectious diseases</td>
</tr>
<tr>
<td></td>
<td>Benzene</td>
</tr>
<tr>
<td></td>
<td>Formaldehyde</td>
</tr>
<tr>
<td></td>
<td>Flammable and explosive agents</td>
</tr>
<tr>
<td></td>
<td>Teratogens</td>
</tr>
<tr>
<td></td>
<td>Cryogenic hazards</td>
</tr>
<tr>
<td></td>
<td>Radiation</td>
</tr>
<tr>
<td>Laundry</td>
<td>Wet floors</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
</tr>
<tr>
<td></td>
<td>Burns</td>
</tr>
<tr>
<td></td>
<td>Needle punctures</td>
</tr>
<tr>
<td></td>
<td>Bleaches</td>
</tr>
<tr>
<td></td>
<td>Solvents</td>
</tr>
</tbody>
</table>
| Maintenance and engineering | Electrical hazards  
|                            | Tools, machinery    
|                            | Noise              
|                            | Welding fumes       
|                            | Asbestos           
|                            | Flammable liquids   
|                            | Solvents           
|                            | Mercury            
|                            | Pesticides         
|                            | Cleaners           
|                            | Ammonia            
|                            | Carbon monoxide    
|                            | Ethylene oxide      
|                            | Freons             
|                            | Paints, adhesives   
|                            | Water treatment chemicals 
|                            | Sewage             
|                            | Heat stress         
|                            | Cold stress (refrigeration units) 
|                            | Falls              
|                            | Lifting             
|                            | Climbing            
|                            | Strains and sprains |
| Nuclear medicine           | Radionuclides       
|                            | Infection           
|                            | X-irradiation       |
| Office areas and data processing | Video display terminals |
|                            | Air quality         
|                            | Ergonomic/body mechanics |
|                            | Chemicals           
|                            | Ozone              |
| Operating rooms            | Anesthetics         
|                            | Antiseptics         
|                            | Methyl methacrylate |
|                            | Compressed gasses   
|                            | Sterilizing gases   
|                            | Infection           
|                            | Electrical          
|                            | Sharp instruments   
|                            | Lifting             |
| Pathology                  | Infectious diseases |
|                            | Formaldehyde        
|                            | Glutaraldehyde      
|                            | Flammable substances|
|                            | Freons              
|                            | Solvents            
<p>|                            | Phenols             |</p>
<table>
<thead>
<tr>
<th>Location</th>
<th>Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient care</td>
<td>Lifting</td>
</tr>
<tr>
<td></td>
<td>Pushing, pulling</td>
</tr>
<tr>
<td></td>
<td>Slips, falls</td>
</tr>
<tr>
<td></td>
<td>Standing for long periods</td>
</tr>
<tr>
<td></td>
<td>Infectious diseases</td>
</tr>
<tr>
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*Although this list is not exhaustive, it demonstrates the variety of hazards that can exist in a hospital environment. Stress is reported by hospital workers in all job categories and is not listed separately by location.*
### APPENDIX 4
#### CHEMICALS ENCOUNTERED IN SELECTED HOSPITAL OCCUPATIONS*

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*Data from various sources*
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<td>Propylene glycol monomethyl ether</td>
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<tr>
<td>Ethylenediaminetetraacetic acid, tetrasodium salt</td>
<td></td>
</tr>
</tbody>
</table>

**Practical nurses (OC 926):**

| Acetic acid | Isopropyl alcohol | Quartz  |
| Acetone | Isopropyl myristate | Salicylic acid  |
| Aluminum hydroxide | Lactose | Silver nitrate  |
| Ammonium chloride | Menthol | Sodium acetate  |
| Ammonium hydroxide | Mercuric chloride | Sodium carbonate  |
| Benzene | Mercury, ((o-carboxyphenyl) thio) ethyl-, sodium salt | Sodium chloride  |
| Biphenyl, 2-, sodium salt | Methanol | Sodium dodecylbenzenesulfonate  |
| Citric acid | Methoxyfluran | Sodium hypochlorite  |
| Chlorpromazine hydrochloride | Methyl salicylate | Sodium iodide  |
| Copper sulfate | Methylparaben | Sodium lauryl sulfate  |
| Coumarin | Nitriltri-2-propanol, 1,1’1”- | Sodium metasilicate  |
| Dichloromethane | Nitrilotriethanol, 2,2’,2”- | Sodium nitrate  |
| Ethyl alcohol | Nitrofurazone | Sodium nitrite  |
| Ethyl ether | Pentanediol, 1,5- | Stearic acid  |
| Ethylene oxide | Phenol | Styrene  |
| Ethylenediaminetetraacetic acid | Phosphoric acid | Tetrachloroethylene  |
| Ethylenediaminetetraacetic acid, tetrasodium salt | Potassium hydroxide | Toluene  |
| Formaldehyde | Potassium permanganate | Trichloroethane, 1,1,1- |
| Glycerol | Propylene glycol | Urea  |
| | | Zinc oxide  |


**Bureau of Census occupational code.**

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“This page was last updated: May 4, 1998”

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NIOSH
1. Background:
Hepatitis B (previously called serum hepatitis) is the major infectious occupational health hazard in the health-care industry, and a model for the transmission of blood-borne pathogens. In 1985 the Centers for Disease Control (CDC) estimated [1] that there were over 200,000 cases of hepatitis B virus (HBV) infection in the U.S. each year, leading to 10,000 hospitalizations, 250 deaths due to fulminant hepatitis, 4,000 deaths due to hepatitis-related cirrhosis, and 800 deaths due to hepatitis-related primary liver cancer. More recently the CDC estimated the total number of HBV infections to be 300,000 per year with corresponding increases in numbers of hepatitis-related hospitalizations and deaths. The incidence of reported clinical hepatitis B has been increasing in the United States, from 6.9/100,000 in 1978 to 9.2/100,000 in 1981 and 11.5/100,000 in 1985 [2]. The Hepatitis Branch, CDC, has estimated [unpublished] that 500-600 health-care workers whose job entails exposure to blood are hospitalized annually, with over 200 deaths (12-15 due to fulminant hepatitis, 170-200 from cirrhosis, and 40-50 from liver cancer). Studies indicate that 10% to 40% of health-care or dental workers may show serologic evidence of past or present HBV infection [3].

Healthcare costs for hepatitis B and non-A, non-B hepatitis in health-care workers were estimated to be $10 - $12 million annually [4]. A safe, immunogenic, and effective vaccine to prevent hepatitis B has been available since 1982 and is recommended by the CDC for health-care workers exposed to blood and body fluids [1,2,5-7]. According to unpublished CDC estimates, approximately 30-40% of health-care workers in high-risk settings have been vaccinated to date.

According to the most recent data available from the CDC [8], acquired immunodeficiency syndrome (AIDS) was the 13th leading cause of years of potential life lost (82,882 years) in 1984, increasing to 11th place in 1985 (152,595 years). As of August 10, 1987, a cumulative total of 40,051 AIDS cases (of which 558 were pediatric) had been reported to the CDC, with 23,165 (57.8%) of these known to have died [9]. Although occupational HIV infection has been documented [10], no AIDS case or AIDS-related death is believed to be occupationally related. Spending within the Public Health Service related to AIDS has also accelerated.
rapidly, from $5.6 million in 1982 to $494 million in 1987, with $791 million requested for 1988. Estimates of average lifetime costs for the care of an AIDS patient have varied considerably, but recent evidence suggests the amount is probably in the range of $50,000 to $75,000.

Infection with either HBV [1,2] or human immunodeficiency virus (HIV, previously called human T-lymphotrophic virus type III/lymphadenopathy associated virus (HTLV III/LAV) or AIDS-associated retrovirus (ARV)) [11,12] can lead to a number of life-threatening conditions, including cancer. Therefore, exposure to HBV and HIV should be reduced to the maximum extent feasible by engineering controls, work practices, and protective equipment. (Engineering controls are those methods that prevent or limit the potential for exposure at or as near as possible to the point of origin, for example by eliminating a hazard by substitution or by isolating the hazard from the work environment.)

II. Modes Of Transmission: In the U.S., the major mode of HBV transmission is sexual, both homosexual and heterosexual. Also important is parenteral (entry into the body by a route other than the gastrointestinal tract) transmission by shared needles among intravenous drug abusers and to a lesser extent in needlestick injuries or other exposures of health-care workers to blood. HBV is not transmitted by casual contact, fecal-oral or airborne routes, or by contaminated food or drinking water [1,2,13]. Workers are at risk of HBV infection to the extent they are exposed to blood and other body fluids; employment without that exposure, even in a hospital, carries no greater risk than that for the general population [1]. Thus, the high incidence of HBV infection in some clinical settings is particularly unfortunate because the modes of transmission are well known and readily interrupted by attention to work practices and protective equipment, and because transmission can be prevented by vaccination of those without serologic evidence of previous infection.

Identified risk factors for HIV transmission are essentially identical to those for HBV. Homosexual/bisexual males and male intravenous drug abusers account for 85.4% of all AIDS cases, female intravenous drug abusers for 3.4%, and heterosexual contact for 3.8% [9]. Blood transfusion and treatment of hemophilia/coagulation disorders account for 3.0% of cases, and 1.4% are pediatric cases. In only 3.0% of all AIDS cases has a risk factor not been identified [9]. Like HBV, there is no evidence that HIV is transmitted by casual contact, fecal-oral or airborne routes, or by contaminated food or drinking water [12-14], and barriers to HBV are effective against HIV. Workers are at risk of HIV infection to the extent they are exposed to blood and body fluids. Even in groups that presumably have high potential exposure to HIV-contaminated fluids and tissues, e.g., health-care workers specializing in treatment of AIDS patients and the parents, spouse, children, or other persons living with AIDS patients, transmission is recognized as occurring only between sexual partners or as a consequence of mucous membrane or parenteral (including open wound) exposure to blood or other body fluids [10,11,13-16].

Despite the similarities in the modes of transmission, the risk of HBV infection in health-care settings far exceeds that for HIV infection [13,14]. For example, it has been estimated [14,17,18] that the risk of acquiring HBV infection following puncture with a needle contaminated by an HBV carrier ranges from 6% to 30% far in excess of the risk of HIV infection under similar circumstances, which the CDC and others estimated to be a less than 1% [10,13,16].

Health-care workers with documented percutaneous or mucous membrane exposures to blood or body fluids of HIV-infected patients have been prospectively evaluated to determine the risk of infection after such exposures. As of June 30, 1987, 883 health-care workers have been tested for antibody to HIV in an ongoing surveillance project conducted by CDC [19]. Of these, 708 (80%) had percutaneous exposures to blood, and 175 (20%) had a mucous membrane or an open wound contaminated by blood or body fluid. Of 396 health-care workers, each of whom had only a convalescent-phase serum sample obtained and tested 90 days or more post-exposure, one for whom heterosexual transmission could not be ruled out -- was seropositive for HIV antibody. For 425 additional health-care workers, both acute- and convalescent-phase serum samples
were obtained and tested; none of 74 health-care workers with nonpercutaneous exposures seroconverted, and three (0.9%) of 351 with percutaneous exposures seroconverted. None of these three health-care workers had other documented risk factors for infection.

Two other prospective studies to assess the risk of nosocomial acquisition of HIV infection for health-care workers are ongoing in the United States. As of April 30, 1987, 332 health-care workers with a total to 453 needlestick or mucous-membrane exposures to the blood or other body fluids of HIV-infected patients were tested for HIV antibody at the National Institutes of Health [20]. These exposed workers included 103 with needlestick injuries and 229 with mucous-membrane exposures; none had seroconverted. A similar study at the University of California of 129 health-care workers with documented needlestick injuries or mucous-membrane exposures to blood or other body fluids from patients with HIV infection has not identified any seroconversions [21]. Results of a prospective study in the United Kingdom identified no evidence of transmission among 150 health-care workers with parenteral or mucous-membrane exposure to blood or other body fluids, secretions, or excretions from patients with HIV infection [22].

Following needlestick injuries, one health-care worker contracted HBV but not HIV, and in another instance a health-care worker contracted cryptococcus but not HIV from patients infected with both [14]. This risk of infection by HIV and other blood-borne pathogens for which immunization is not available extends to all health-care workers exposed to blood, even those who have been immunized against HBV infection. Effective protection against blood-borne disease requires universal observation of common barrier precautions by all workers with potential exposure to blood, body fluids, and tissues [10,13].

HIV has been isolated from blood, semen, saliva, tears, urine, vaginal secretions, cerebrospinal fluid, breast milk, and amniotic fluid [10,23], but only blood and blood products, semen, vaginal secretions, and possibly breast milk (this needs to be confirmed) have been directly linked to transmission of HIV [10,13]. Contact with fluids such as saliva and tears has not been shown to result in infection [13-15]. Although other fluids have not been shown to transmit infection, all body fluids and tissues should be regarded as potentially contaminated by HBV or HIV, and treated as if they were infectious. Both HBV and HIV appear to be incapable of penetrating intact skin, but infection may result from infectious fluids coming into contact with mucous membranes or open wounds (including apparent lesions) on the skin [14,16]. If a procedure involves the potential for skin contact with blood or mucous membranes, then appropriate barriers to skin contact should be worn, e.g., gloves. Investigations of HBV risks associated with dental and other procedures that might produce particulates in air, e.g., centrifuging and dialysis, indicated that the particulates generated were relatively large droplets (spatter), and not true aerosols of suspended particulates that would represent a risk of inhalation exposure [24-26]. Thus, if there is the potential for splashes or spatter of blood or fluids, face shields or protective eyewear and surgical masks should be worn. Detailed protective measures for health-care workers have been addressed by the CDC [10,13,23,27-33]. These can serve as general guides for the specific groups covered, and for the development of comparable procedures in other working environments.

HIV infection is known to have been transmitted by organ transplants [34] and blood transfusions [35] received from persons who were HIV seronegative at the time of donation. Falsely negative serology can be due to improperly performed tests or other laboratory error, or testing in that "window" of time during which a recently infected person is infectious but has not yet converted from seronegative to seropositive. (Detectable levels of antibodies usually develop within 6 to 12 weeks of infection [36]. A recent report [37] suggesting that this "window" may extend to 14 months is not consistent with other data, and therefore requires confirmation.) If all body fluids and tissues are treated as infectious, no additional level of worker protection will be gained by identifying seropositive patients or workers. Conversely, if worker protection and work practices were upgraded only following the return of positive HBV or HIV serology, then workers would be inadequately protected during the time required for testing. By producing a false sense of safety
with "silent" HBV- or HIV-positive patients, a seronegative test may significantly reduce the level of routine vigilance and result in virus exposure. Furthermore, developing, implementing, and administering a program of routine testing would shift resources and energy away from efforts to assure compliance with infection control procedures. Therefore, routine screening of workers or patients for HIV antibodies will not substantially increase the level of protection for workers above that achieved by adherence to strict infection control procedures.

On the other hand, workers who have had parenteral exposure to fluids or tissues may wish to know whether their own antibody status converts from negative to positive. Such a monitoring program can lead to prophylactic interventions in the case of HBV infection, and CDC has published guidelines on pre- and post-exposure prophylaxis of viral hepatitis [1,2]. Future developments may also allow effective intervention in the case of HIV infection. For the present, post-exposure monitoring for HIV at least can release the affected worker from unnecessary emotional stress if infection did not occur, or allow the affected worker to protect sexual partners in the event infection is detected [10,36].

III. Summary:

The cumulative epidemiologic data indicate that transmission of HBV and HIV requires direct, intimate contact with or parenteral inoculation of blood and blood products, semen, or tissues [10,11,13,14,16,23]. The mere presence of, or casual contact with, an infected person cannot be construed as "exposure" to HBV or HIV. Although the theoretical possibility of rare or low-risk alternative modes of transmission cannot be totally excluded, the only documented occupational risks of HBV and HIV infection are associated with parenteral (including open wound) and mucous membrane exposure to blood and tissues [2,10,13,14,16].

Workers occupationally exposed to blood, body fluids, or tissues can be protected from the recognized risks of HBV and HIV infection by imposing barriers in the form of engineering controls, work practices, and protective equipment that are readily available, commonly used, and minimally intrusive.

IV. Recommendations:

General

"Exposure" (or "potential exposure") to HBV and HIV should be defined in terms of actual (or potential) skin, mucous membrane, or parenteral contact with blood, body fluids, and tissues. "Tissues" and "fluids" or "body fluids" should be understood to designate not only those materials from humans, but also potentially infectious fluids and tissues associated with laboratory investigations of HBV or HIV, e.g., organs and excrete from experimental animals, embryonated eggs, tissue or cell cultures and culture media, etc.

As the first step in determining what actions are required to protect worker health, every employer should evaluate all working conditions and the specific tasks that workers are expected to encounter as a consequence of employment. That evaluation should lead to the classification of work-related tasks to one of three categories of potential exposure (Table 1). These categories represent those tasks that require protective equipment to be worn during the task (Category I) tasks that do not require any protective equipment (Category III); and an intermediate grouping of tasks (Category II) that also do not require protective equipment, but that inherently include the predictable job-related requirement to perform Category I tasks unexpectedly or on short notice, so that these persons should have immediate access to some minimal set of protective devices. For example, law enforcement personnel or firefighters may be called upon to perform or assist in first aid or to be potentially exposed in some other way. This exposure classification applies to tasks rather than to individuals, who in the course of their daily activities may move from one exposure category to another as they perform various tasks.

For individual Category I and II tasks, engineering controls, work practices, and protective equipment should be selected after careful consideration, for each specific situation, of the overall risk associated with the task.
Factors that should be included in that evaluation of risk include:

1. Type of body fluid with which there will or may be contact (e.g., blood is of greater concern than urine),
2. Volume of blood or body fluid likely to be encountered (e.g., hip replacement surgery can be very bloody while corneal transplantation is almost bloodless),
3. Probability of an exposure taking place (e.g., drawing blood will more likely lead to exposure to blood than will performing a physical examination),
4. Probable route of exposure (e.g., needlestick injuries are of greater concern than contact with soiled linens), and
5. Virus concentration in the fluid or tissue. The number of viruses per milliliter of fluid in research laboratory cultures may be orders of magnitude higher than in blood. Similarly, viruses have been less frequently found in fluids such as sweat, tears, urine, and saliva.

Engineering controls, work practices, and protective equipment appropriate to the task being performed are critical to minimize HBV and HIV exposure and to prevent infection. Adequate protection can be assured only if the appropriate controls and equipment are provided and all workers know the applicable work practices and how to properly use the required controls or protective equipment. Therefore, employers should establish a detailed work practices program that includes standard operating procedures (SOPs) for all tasks or work areas having the potential for exposure to fluids or tissues, and a worker education program to assure familiarity with work practices and the ability to use properly the controls and equipment provided.

It is essential for both the patient and the health-care worker to be fully aware of the reasons for the preventive measures used. The health-care worker may incorrectly interpret the work practices and protective equipment as signifying that a task is unsafe. The patient may incorrectly interpret the work practices or protective garb as evidence that the health-care provider knows or believes the patient is infected with HBV or HIV. Therefore, worker education programs should strive to allow workers (and to the extent feasible, the clients or patients) to recognize the routine use of appropriate work practices and protective equipment as prudent steps that protect the health of all.

If the employer determines that Category I and II tasks do not exist in the workplace, then no specific personal hygiene or protective measures are required. However, these employers should ensure that workers are aware of the risk factors associated with transmission of HBV and HIV so that they can recognize situations which pose increased potential for exposure to HBV or HIV (Category I tasks) and know how to avoid or minimize personal risk. A comparable level of education is necessary for all citizens. Educational materials such as the Surgeon General's Report can provide much of the needed information [12,38].

If the employer determines that work-related Category I or II tasks exist, then the following procedures should be implemented.

<table>
<thead>
<tr>
<th>TABLE 1. EXPOSURE CATEGORIES</th>
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<tr>
<td>CATEGORY I. Tasks That Involve Exposure To Blood, Body Fluids, Or Tissues.</td>
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</table>

All procedures or other job-related tasks that involve an inherent potential for mucous membrane or skin contact with blood, body fluids, or tissues, or a potential for spills or splashes of them, are Category I tasks. Use of appropriate protective measures should be required for every employee engaged in Category I tasks.
CATEGORY II. Tasks That Involve No Exposure To Blood, Body Fluids, Or Tissues, But Employment May Require Performing Unplanned Category I Tasks.

The normal work routine involves no exposure to blood, body fluids, or tissues, but exposure or potential exposure may be required as a condition of employment. Appropriate protective measures should be readily available to every employee engaged in Category II tasks.

CATEGORY III. Tasks That Involve No Exposure To Blood, Body Fluids, Or Tissues, And Category I Tasks Are Not A Condition Of Employment.

The normal work routine involves no exposure to blood, body fluids, or tissues (although situations can be imagined or hypothesized under which anyone, anywhere, might encounter potential exposure to body fluids). Persons who perform these duties are not called upon as part of their employment to perform or assist in emergency medical care or first aid or to be potentially exposed in some other way. Tasks that involve handling of implements or utensils, use of public or shared bathroom facilities or telephones, and personal contacts such as handshaking are Category III tasks.

Administrative

The employer should establish formal procedures to ensure that Category I and II tasks are properly identified, SOPs are developed, and employees who must perform these tasks are adequately trained and protected. If responsibility for implementation of these responsibilities is delegated to a committee, it should include both management and worker representatives. Administrative activities to enhance worker protection include:

1. Evaluating the workplace to:
   a. Establish category of risk classifications for all routine and reasonably anticipated job-related tasks.
   b. Identify all workers whose employment requires performance of Category I or II tasks.
   c. Determine for identified Category I or II tasks those body fluids to which workers most probably will be exposed and the potential extent and route of exposure.

2. Developing, or supervising the development of, Standard Operating Procedures (SOPs) for each Category I and II task. These SOPs should include mandatory work practices and protective equipment for each Category I and II task.

3. Monitoring the effectiveness of work practices and protective equipment. This includes:
   a. Surveillance of the workplace to ensure that required work practices are observed and that protective clothing and equipment are provided and properly used.
   b. Investigation of known or suspected parenteral exposures to body fluids or tissues to establish the conditions surrounding the exposure and to improve training, work practices, or protective equipment to prevent a recurrence.

Training and Education

The employer should establish an initial and periodic training program for all employees who perform Category I and II tasks. No worker should engage in any Category I or II task before receiving training pertaining to the SOPs, work practices, and protective equipment required for that task. The training program should ensure that all workers:

1. Understand the modes of transmission of HBV and HIV.
2. Can recognize and differentiate Category I and II tasks.
3. Know the types of protective clothing and equipment generally appropriate for Category I and II tasks, and understand the basis for selection of clothing and equipment.
4. Are familiar with appropriate actions to take and persons to contact if unplanned Category I tasks are encountered.
5. Are familiar with and understand all the requirements for work practices and protective equipment specified in SOPs covering the tasks they perform.
6. Know where protective clothing and equipment is kept, how to use it properly, and how to remove, handle, decontaminate, and dispose of contaminated clothing or equipment.
7. Know and understand the limitations of protective clothing and equipment. For example, ordinary gloves offer no protection against needlestick injuries. Employers and workers should be on guard against a sense of security not warranted by the protective equipment being used.
8. Know the corrective actions to take in the event of spills or personal exposure to fluids or tissues, the appropriate reporting procedures, and the medical monitoring recommended in cases of suspected parenteral exposure.

**Engineering Controls**

Whenever possible, engineering controls should be used as the primary method to reduce worker exposure to harmful substances. The preferred approach in engineering controls is to use, to the fullest extent feasible, intrinsically safe substances, procedures, or devices. Substitution of a hazardous procedure or device with one that is less risky or harmful is an example of this approach, e.g., a laser scalpel reduces the risk of cuts and scrapes by eliminating the necessity to handle the conventional scalpel blade. Isolation or containment of the hazard is an alternative engineering control technique. Disposable, puncture-resistant containers for used needles, blades, etc., isolate cut and needlestick injury hazards from the worker.

Glove boxes, ventilated cabinets, or other enclosures for tissue homogenizers, sonicators, vortex mixers, etc. serve not only to isolate the hazard, but also to contain spills or splashes and prevent spatter and mist from reaching the worker.

After the potential for exposure has been minimized by engineering controls, further reductions can be achieved by work practices and, finally, personal protective equipment.

**Work Practices**

For all identified Category I and II tasks, the employer should have written, detailed Standard Operating Procedures (SOPs). All employees who perform Category I or II tasks should have ready access to the SOPs pertaining to those tasks.

1. Work practices should be developed on the assumption that all body fluids and tissues are infectious. General procedures to protect healthcare workers against HBV or HIV transmission have been published elsewhere [1, 2, 23, 28-33]. Each employer with Category I and II tasks in the workplace should incorporate those general recommendations, as appropriate, or equivalent procedures into work practices and SOPs. The importance of handwashing should be emphasized.
2. Work practices should include provision for safe collection of fluids and tissues and for disposal in accordance with applicable local, state, and federal regulations. Provision must be made for safe removal, handling, and disposal or decontamination of protective clothing and equipment, soiled linens, etc.
3. Work practices and SOPs should provide guidance on procedures to follow in the event of spills or personal exposure to fluids or tissues. These procedures should include instructions for personal and area decontamination as well as appropriate management or supervisory personnel to whom the
incident should be reported.

4. Work practices should provide specific and detailed procedures to be observed with sharp objects, e.g., needles, scalpels. Punctureresistant receptacles must be readily accessible for depositing these materials after use. These receptacles must be clearly marked and specific work practices provided to protect personnel responsible for disposing of them or processing their contents for reuse.

**Personal Protective Equipment**

Based upon the fluid or tissue to which there is potential exposure, the likelihood of exposure occurring, the potential volume of material, the probable route of exposure, and overall working conditions and job requirements, the employer should provide and maintain personal protective equipment appropriate to the specific requirements of each task.

For workers performing Category I tasks, a required minimum array of protective clothing or equipment should be specified by pertinent SOPs. All Category I tasks do not involve the same type or degree of risk, and therefore all do not require the same kind or extent of protection. Specific combinations of clothing and equipment must be tailored to specific tasks. Minimum levels of protection for Category I tasks in most cases would include use of appropriate gloves. If there is the potential for splashes, protective eyewear or face shields should be worn. Paramedics responding to an auto accident might protect against cuts on metal and glass by wearing gloves or gauntlets that are both puncture-resistant and impervious to blood. If the conditions of exposure include the potential for clothing becoming soaked with blood, protective outer garments such as impervious coveralls should be worn.

For workers performing Category II tasks, there should be ready access to appropriate protective equipment, e.g., gloves, protective eyewear, or surgical masks, specified in pertinent SOPs. Workers performing Category II tasks need not be wearing protective equipment, but they should be prepared to put on appropriate protective garb on short notice.

**Medical**

In addition to any health-care or surveillance required by other rules, regulations, or labor-management agreement, the employer should make available at no cost to the worker:

1. Voluntary HBV immunization for all workers whose employment requires them to perform Category I tasks and who test negative for HBV antibodies. Detailed recommendations for protecting health-care workers from viral hepatitis have been published by the CDC [1]. These recommendations include procedures for both pre- and post-exposure prophylaxis, and should be the basis for the routine approach by management to the prevention of occupational hepatitis B.
2. Monitoring, at the request of the worker, for HBV and HIV antibodies following known or suspected parenteral exposure to blood, body fluids, or tissues. This monitoring program must include appropriate provisions to protect the confidentiality of test results for all workers who may elect to participate.
3. Medical counseling for all workers found, as a result of the monitoring described above, to be seropositive for HBV or HIV. Counseling guidelines have been published by the Public Health Service [1, 2, 36].

**Recordkeeping**

If any employee is required to perform Category I or II tasks, the employer should maintain records documenting:
1. The administrative procedures used to classify job tasks. Records should describe the factors considered and outline the rationale for classification.
2. Copies of all SOPs for Category I and II tasks, and documentation of the administrative review and approval process through which each SOP passed.
3. Training records, indicating the dates of training sessions, the content of those training sessions along with the names of all persons conducting the training, and the names of all those receiving training.
4. The conditions observed in routine surveillance of the workplace for compliance with work practices and use of protective clothing or equipment. If noncompliance is noted, the conditions should be documented along with corrective actions taken.
5. The conditions associated with each incident of mucous membrane or parenteral exposure to body fluids or tissue, an evaluation of those conditions, and a description of any corrective measures taken to prevent a recurrence or other similar exposure.

References


References Not Cited


For further information call: National OSHA Information Office, (202) 523-8148.
# APPENDIX 6

MORBIDITY AND MORTALITY WEEKLY REPORTS CONTENTS

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<td>Recommendations of the Immunization Practices Advisory Committee Update on Hepatitis B Prevention</td>
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<td>Recommendations for Prevention of HIV Transmission in Health-Care Settings</td>
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<td>Tuberculosis, Final Data - United States, 1986</td>
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<td>Update: Acquired Immunodeficiency Syndrome and Human Immunodeficiency Virus Infection Among Health-Care Workers</td>
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*Please obtain from your local library.
APPENDIX 8

GUIDELINES FOR THE PREVENTION AND CONTROL OF NOSOCOMIAL INFECTIONS

CDC GUIDELINE FOR ISOLATION PRECAUTIONS IN HOSPITALS

Julia S. Garner, RN, MS
Bryan P. Simmons, MD

AND

CDC GUIDELINE FOR INFECTION CONTROL IN HOSPITAL PERSONNEL

Walter W. Williams, IBID, MPH

Part of the Manual Entitled
Guidelines for Prevention and Control of Nosocomial Infections

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
Center for Infectious Diseases
Hospital Infections Program
Atlanta, Georgia 30333

Preface to the Guidelines Series

The Guidelines for the Prevention and Control of Nosocomial Infections is a series of guidelines intended for use by hospital personnel who are responsible for infection surveillance and control activities. The guidelines have been derived from a variety of sources, including studies conducted by the Centers for Disease Control and by others and have undergone extensive review by experts, many of whom are engaged in the daily
practice of infection surveillance and control. The guidelines are assembled in loose-leaf form to allow for periodic revisions and additions, since we fully expect the guidelines to change as new knowledge is acquired.

The titles of the various guidelines are listed below. Others may be added in the future. Within each guideline the date of original publication and subsequent revision, if any, appear at the bottom of each page. Additional copies of all guidelines are available from:

National Technical Information Service
U.S. Department of Commerce
Springfield, Virginia 22161

Titles of Published Guidelines

Guideline for Prevention of Catheter-associated Urinary Tract Infections
Guideline for Hospital Environmental Control
Guideline for Prevention of Intravascular infections
Guideline for Prevention of Surgical Wound Infections
Guideline for Prevention of Nosocomial Pneumonia
Guideline for Isolation Precautions in Hospitals
Guideline for Infection Control in Hospital Personnel

Proposed Guideline Topics

Guideline for Prevention of Infections during Total Parenteral Nutrition
Guideline for Surveillance of Nosocomial Infections
Guideline on the Role of the Microbiology Laboratory in Infection Control

All comments, suggestions, and criticisms of the guidelines should be sent to:

Guidelines Activity
Hospital Infections Program
Center for Infectious Diseases
Centers for Disease Control
Atlanta, Georgia 30333