# Chemical Safety in Animal Care, Use, and Research

*Wayne R. Thomann*

## Abstract

Chemical safety is an essential element of an effective occupational health and safety program. Controlling exposures to chemical agents requires a careful process of hazard recognition, risk assessment, development of control measures, communication of the risks and control measures, and training to ensure that the indicated controls will be utilized. Managing chemical safety in animal care and use presents a unique challenge, in part because research is frequently conducted in two very different environments—the research laboratory and the animal care facility. The chemical agents specific to each of these environments are typically well understood by the employees working there; however, the extent of understanding may not be adequate when these individuals, or chemicals, cross over into the other environment. In addition, many chemicals utilized in animal research are not typically used in the research laboratory, and therefore the level of employee knowledge and proficiency may be less compared with more routinely used materials. Finally, the research protocol may involve the exposure of laboratory animals to either toxic chemicals or chemicals with unknown hazards. Such animal protocols require careful review to minimize the potential for unanticipated exposures of the research staff or animal care personnel. Numerous guidelines and regulations are cited, which define the standard of practice for the safe use of chemicals. Key chemical safety issues relevant to personnel involved in the care and use of research animals are discussed.

**Key Words:** anesthetic agents; chemical safety; disinfectants and sterilants; engineering controls; hazard recognition; hazardous drugs; personal protective equipment; respiratory protection

## Introduction

Chemicals are ubiquitous in the laboratory and animal room environments. They are used, for example, to disinfect surfaces, anesthetize/euthanize animals, and process tissue samples. Research protocols may involve the introduction of toxic chemicals into animals, and the agents and/or their metabolites will enter into the animal facility environment and waste streams (NRC 1997). Controlling exposures to these chemicals requires a careful process of hazard recognition, risk assessment, development of control measures, communication of the risks and control measures, and training to ensure that the indicated controls will be utilized.

Chemical safety in animal research represents a unique challenge because the research activities typically cross over two very different environments—the animal care facility and the research laboratory. The chemical agents specific to each of these environments are typically well understood by the employees working there; however, the broader extent of understanding may not be adequate when these environments overlap in the conduct of research involving laboratory animals. For example, the chemical hazards that are specific to the research protocol may be introduced into the animal care facility during the housing of research animals, or the laboratory personnel may be exposed to chemicals associated with the management of the animal care operations while monitoring the animals housed in that facility. In both cases, employees may experience chemical exposures because of inadequate information or communication regarding risks in the less familiar environment.

One mechanism to minimize the potential for such exposures is to conduct a collaborative assessment of the animal care related hazards and the protocol-related hazards. This assessment should involve the investigator, the institutional veterinarian, the animal care supervisor, and a health and safety professional.

## Hazard Recognition

The introduction to *Occupational Health and Safety in the Care and Use of Research Animals* (NRC 1997) includes the statement that "our task is to promote occupational health and safety by recognizing and considering hazards and health risks associated with the care and use of animals." Hazard recognition is the cornerstone of an effective chemical safety program. Everyone is responsible for hazard identification/recognition. One effective way to enhance hazard recognition is to request an expert review and/or audit of the animal care program and the research program by an environmental health and safety professional who is trained in the recognition, measurement, and control of chemical hazards. Through a collaborative assessment, focusing on actual animal research activities, the hazards can

Wayne R. Thomann, Dr.P.H., is Director, Environmental Safety Office, Duke University, Durham, North Carolina.

be adequately identified and evaluated to ensure that appropriate controls are defined and applied.

## Regulatory Requirements

Chemical safety in research involving animals is governed by numerous local, state, and federal regulations, as well as, numerous "standards of practice." Such standards of practice are generally guidance or guidelines issued by nonregulatory organizations such as the National Institute for Safety and Health (NIOSH[1]), the Centers for Disease Control and Prevention, the National Research Council, and so forth. These guidelines identify specific hazards or hazardous operations and are "quasiregulatory," being enforced under OSHA's "General Duty" clause that requires a workplace free of recognized hazards. A number of these agent-specific guidelines are referenced and discussed below.

The primary chemical safety regulation for the animal care facility is the Hazard Communication Standard (OSHA 1996), and the research laboratory is subject to the requirements of Occupational Exposure to Hazardous Chemicals in Laboratories (OSHA 1991). The requirements of these two OSHA standards are actually quite different, as discussed in more detail below. Additional Environmental Protection Agency and individual state regulations govern the management of chemical and animal wastes generated from animal care and use.

### *Animal Care Facility*

The Hazard Communication Standard of the Occupational Safety and Health Administration (OSHA[1]) applies to chemical use in the animal care facility. It is intended to address the issue of evaluating the potential hazards of chemicals and the need to communicate information concerning the hazards and appropriate protective measures to employees. The Standard is a prescriptive regulation that mandates developing and maintaining a written hazard communication program for the workplace and includes the following: maintaining a list of hazardous chemicals present; labeling containers of chemicals in the workplace as well as containers of chemicals being shipped to other workplaces; compiling, preparing, and/or distributing material safety data sheets to employees and customers; and developing and implementing an employee training program regarding hazards of chemicals and available protective measures. Animal care and use managers should consult their institutional hazard communication program and environmental health and safety professional regarding compliance.

[1]Abbreviations used in this article: IACUC, institutional animal care and use committee; MSDS, material safety data sheet; NIOSH, National Institute for Occupational Safety and Health; OSHA, Occupational Safety and Health Administration; PPE, personal protective equipment; ppm, parts per million; RTECS, Registry of Toxic Effects of Chemical Substances; SOP, standard operating procedure; STEL, short-term exposure limit; TWA, time-weighted average.

### *Laboratory Environment*

The primary chemical safety standard for laboratory operations is described in OSHA's *Occupational Exposure to Hazardous Chemicals in Laboratories* Standard (OSHA 1991). This "performance-based" standard was specifically designed to address the unique and variable aspects of the laboratory environment. It requires the development of a "Chemical Hygiene Plan" to define how the laboratory will protect both personnel and the environment from hazardous chemical exposures. The specific provisions for labeling, for material safety data sheets, and for training are different from the requirements of the Hazard Communication program. Additional requirements include the writing of agent-specific standard operating procedures (SOPs[1]) for each "particularly hazardous substance" classified as select carcinogens, reproductive toxins, and substances that have a high degree of acute toxicity. The SOPs must include information regarding the establishment of a designated control area (controlled access), use of containment devices (engineering controls), appropriate waste management procedures, and decontamination procedures. In addition, more generalized SOPs must be developed to cover procurement, distribution, storage, safe usage, and disposal; and emergency procedures must be developed for all other groups of hazardous chemicals (e.g., flammable materials, corrosive materials, oxidizers).

## Hazard Information Resources

### *Material Safety Data Sheets (MSDSs[1])*

MSDSs are OSHA-mandated documents that provide health and safety information, including the hazards of exposure, health effects, physical and chemical characteristics, and recommended protective measures for hazardous chemicals. Chemical manufactures and importers are required to obtain or develop MSDSs for each hazardous chemical they produce or import. Chemical distributors are, in turn, responsible for ensuring that their customers are provided with the MSDS for all hazardous chemicals that are purchased.

The requirements regarding the availability of MSDSs vary depending on the classification of the workplace. In the animal care facility, a current MSDS must be acquired for all hazardous chemicals that are being used (OSHA 1996) although researchers are only required to retain any MSDSs that are received in the laboratory (OSHA 1991).

The process for accessing MSDSs may vary significantly among institutions. Many facilities utilize electronic MSDS databases, whereas others depend on the "hard copies" that are received from the distributor. Electronic databases are available directly from many chemical suppliers. There are also web-based resources, such as MSDSSEARCH (⟨www.msdssearch.com⟩), which provide access to multiple MSDS repository sites. Whichever method is used, the key issue is that the MSDSs must be readily available on all work shifts if an employee requests it.

### *Registry of Toxic Effects of Chemical Substances (RTECS[1])*

The RTECS database is a valuable source of toxicological information on more than 152,000 chemicals. RTECS is a compendium of data extracted from the open scientific literature and includes toxicity data on primary irritation, mutagenic effects, reproductive effects, tumorigenic effects, acute toxicity, and other multiple dose toxicity. Specific numeric toxicity values such as median lethal dose, lethal concentration, 50% kill ($LC_{50}$), lowest published toxic dose (TDLo), and toxic concentration (TC ) are noted, as well as species studied and route of administration used. For each citation, the bibliographic source is listed thereby enabling the user to access the actual studies cited.

The database was originally developed and maintained by NIOSH, but in 2001 the responsibility for managing RTECS was transferred to MDL Information Systems, Inc, a wholly owned subsidiary of Elsevier Sciences, Inc. Therefore, it is a commercial product that is no longer available at no cost.

## Specific Hazards

Certain hazardous chemicals used in animal research deserve special consideration because they may be used infrequently, only during the animal research activities, or by "junior" personnel. Any of these factors may lead to a lack of understanding of the potential risk and inadequate use of the appropriate control measures.

### Hazards Associated with General Animal Care and Use

#### *Disinfectants and Sterilants*

Disinfectants and sterilants are agents intended to destroy or irreversibly inactivate specific pathogenic microorganisms on inanimate surfaces (Van Swearingen and Shoaf 2001). Many different classes of disinfectants and sterilants are used in animal care. Each of these toxic compounds has specific potential health effects, standards and recommendations for safe use, recommended environmental monitoring, and exposure control methods. Both manufacturer-supplied information and the NIOSH *Guidelines for Protecting the Safety and Health of Health Care Workers* are excellent references for detailed information on safe handling for the full array of disinfectants and sterilants (USDHHS 1998).

Special care should be used when a disinfectant or sterilant must be diluted or activated before use. The concentrated agents are more toxic, corrosive, or irritating that the "use-dilution" concentration employed for routine processing. The use of concentrated product may require additional engineering controls, personal protective equipment (PPE[1]), or specialized work practices.

Glutaraldehyde is commonly used as a high-level disinfectant for heat-sensitive equipment. It is also used as a tissue fixative in histology and pathology laboratories and as a hardening agent in the development of x-rays (USDHHS 2001). Common trade names for glutaraldehyde disinfectants/sterilants include Cidex®, Sonacide®, Sporicidin®, and Wavicide®. Exposure to glutaraldehyde can result in both acute and chronic symptoms, including throat and lung irritation, asthma and asthma-like symptoms, nose irritation, sneezing, wheezing, nosebleeds, burning eyes, rashes, staining of hands, and other symptoms.

Exposures can result from inhalation or skin contact while preparing or activating glutaraldehyde solutions, disinfecting equipment, fixing tissues, or developing x-ray films. Glutaraldehyde should never be used for general disinfection/decontamination of environmental surfaces. Controls include containing (fume hoods and ventilation) operations using glutaraldehyde; using gloves, goggles, or face shield and aprons to avoid skin contact; and sealing or covering all containers.

#### *Corrosive Substances (Strong Acids and Bases)*

A corrosive substance is a chemical that causes visible destruction of, or irreversible alteration in, living tissue by chemical action at the site of contact (Young 2001). Corrosive substances can be solids, liquids, or gases. Corrosive effects can occur not only on the skin and eyes but also in the respiratory tract and, in the case of ingestion, in the gastrointestinal tract (NRC 1995). Corrosive substances are commonly encountered in both the laboratory and the animal care environment. Examples of corrosive liquids include bromine, sulfuric acid, phosphoric acid, aqueous sodium hydroxide solution, and hydrogen peroxide. Common corrosive solids include sodium hydroxide and phenol. Chlorine, ammonia, and nitrogen dioxide are some of the corrosive gases that may be encountered in the animal research environment.

When planning work that will involve the use of corrosive substances, basic prudent handling practices should be reviewed to ensure that the skin, face, and eyes are protected adequately by proper choice of corrosive-resistant gloves and protective clothing and eyewear, including in some cases face shields (NRC 1995). In addition, OSHA requires that employers provide suitable facilities for quick drenching or flushing of the eyes and body when employees may be exposed to injurious corrosive materials (OSHA 1998b). Special consideration of the severity of injury, time of exposure, and number of employees potentially exposed must be given to determine the required number of eyewash stations, shower stations, or both eyewash and shower stations. The emergency eyewash and shower equipment must meet the specifications of ANSI 358.1-1990 to be acceptable to OSHA.

#### *Euthanizing Agents*

One of the essential criteria in evaluating methods for euthanasia is the "safety of personnel" (AVMA 2001). Most of

the inhalants used as euthanzing agents are hazardous to personnel because of the risk of explosion (e.g., ether), narcosis (e.g., halothane), hypoxemia (e.g., nitrous oxide and carbon dioxide), addiction (e.g., nitrous oxide), or health effects resulting from chronic exposure (e.g., nitrous oxide and carbon monoxide) (AVMA 2001). Adequate local ventilation control (chemical fume hood or scavenging system) should be applied to control potential exposures. Additional information on controlling exposures to the inhalant anesthetics used for euthanasia can be found in *Anesthetic Gases: Guidelines for Workplace Exposures* (OSHA 1999a).

The noninhalant pharmaceutical agents for euthanasia present a percutaneous or contact exposure risk, and it is important for personnel performing this technique to be trained, knowledgeable, and competent. In addition to wearing gloves, special precautions should be used to avoid needlestick injuries, including the use of safe-needle devices.

### Tissue Fixatives

Formaldehyde and glutaraldehyde are frequently used as tissue fixatives. However, formaldehyde is designated as "reasonably anticipated to be a human carcinogen," based on limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in laboratory animals (USDHHS 2001b). The US Environmental Protection Agency and the International Agency for Research on Cancer classify formaldehyde as a "probable human carcinogen," under conditions of unusually high or prolonged exposure. Partially based on this carcinogenic potential, OSHA developed new regulations in 1987 to lower the national standard for formaldehyde exposure from 3 parts per million (ppm[1]) to 1 ppm, averaged over an 8-hr workday (time-weighted average, or TWA[1]). This exposure limit was again decreased to 0.75 ppm in 1992 (OSHA 1992). OSHA has also established a short-term exposure limit (STEL[1]), which requires that no employee be exposed to an airborne concentration of formaldehyde that exceeds 2 ppm during any 15-min period.

In addition to the carcinogenic potential, formaldehyde can cause severe injury and corneal damage if splashed into the eye. Airborne concentrations exceeding 0.1 ppm can cause irritation of the eyes, nose, and throat. Higher-level airborne concentration may cause coughing, chest tightness, and increased heart rate. The severity of irritation increases as concentrations increase; at 100 ppm, it is immediately dangerous to life and health. Repeated exposure to formaldehyde may also 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 (USDHHS 1998).

OSHA requires exposure monitoring for all employees who may be exposed to formaldehyde except when the employer can document, using objective data, that the presence of formaldehyde or formaldehyde-releasing products in the workplace cannot result in airborne concentrations of formaldehyde that would cause any employee to be exposed at or above the action level or the STEL under foreseeable conditions of use (OSHA 1992). In addition, OSHA also mandates that the employer institute engineering and work practice controls to reduce and maintain employee exposures to formaldehyde at or below the TWA and the STEL. General guidance for exposure control includes performing work with formaldehyde in a chemical fume hood or with local exhaust ventilation. It is important for workers to wear goggles and a face shield to protect the eyes and face and to wear chemical resistant gloves. Spills present a significant increased risk because of the volatility of formaldehyde. Special respiratory protection and other PPE are required for spill cleanup, which should be undertaken only by specially trained personnel.

The toxicity and control measures for glutaraldehyde are discussed in Disinfectants and Sterilants above.

### Waste Anesthetic Gases

Inhalation anesthetics (e.g., ether, halothane, methoxyflurane, isoflurane, nitrous oxide) constitute a human health hazard. Spontaneous abortion and congenital anomalies have been associated with exposure of women to trace amounts of inhalation anesthetic agents during early stages of pregnancy (AVMA 2001). Moreover, there is biological plausibility that adds to the concern that high levels of unscavenged waste anesthetic gases present a potential for adverse neurological effects or reproductive risks to exposed workers or developmental anomalies in their offspring (OSHA 1999a).

Specific guidelines and controls to help reduce occupational exposures to waste anesthetic gases are provided in *Anesthetic Gases: Guidelines for Workplace Exposures* (OSHA 1999a). These guidelines include information specific to the veterinary hospital and clinic and have direct relevance to biomedical research involving animals. Specific recommendations include providing adequate maintenance of the anesthesia equipment to prevent leaks, selecting the optimal size endotracheal tube for the animal, utilizing appropriate scavenging, and exercising care throughout the procedure to minimize fugitive emissions of anesthetic gases.

### Hazardous Drugs

"Hazardous drugs" are pharmaceutical agents that are considered hazardous by the American Society of Hospital Pharmacists (ASHP 1990). Hazardous drug characteristics include genotoxicity, carcinogenicity, teratogenicity or fertility impairment, and serious organ or toxic manifestation at low doses in experimental animals or treated patients. Much of the data regarding the toxicity and efficacy of hazardous drugs is derived from animal research, and special precautions are required for such research. The OSHA technical manual titled *Controlling Occupational Exposure to Hazardous Drugs* (OSHA 1999b) provides detailed in-

formation on prevention of employee exposures, which includes the provision for a written Hazardous Drug Safety and Health Plan. Such a plan would be an excellent addendum to an animal protocol and would further enhance the safety of research staff who work with hazardous drugs.

#### *Hazards Associated with Experimental Protocols*

Hazards associated with experimental protocols are influenced by two principal factors: the dangerous qualities of the experimental agent and the complexity and type of the experimental procedures. The complexity and type of procedure have a direct impact on the extent of potential exposure an employee receives when carrying out or participating in an experimental protocol. For example, during the incorporation of a test chemical into feed for ingestion studies, a contaminated dust created during mixing and during transfer of the diet could result in respiratory or dermal exposures. Test material applied to the skin of experimental animals might be disseminated by handling of animals, clipping of hair, changing of bedding, or sweeping of the animal room floor. Vapors are potential sources of exposure during the application of test materials to the skin. Exposing an animal to an agent by injection creates a risk of accidental self-inoculation. Inhalation challenges are particularly hazardous and should be conducted only by investigators who have appropriate experience and containment equipment (NRC 1997).

#### *High-Risk Experimental Agents*

There is no definitive definition of high-risk chemical agents; however, OSHA has established a "baseline" of agents that necessitate additional evaluation as to the need for special control measures (OSHA 1991). Protocols involving high-risk chemical agents should undergo additional institutional review to ensure that the health and safety issues have been adequately addressed. Specific issues that should be reviewed include the capacity of the laboratory to work safely with the agent, the safety and security of the animal housing facility, communication between the research and animal care personnel to ensure adequate definition and understanding of responsibilities, and participation by the Occupational Health and Safety team. At many institutions, such review and approval are required before protocols involving high-risk chemicals will be reviewed by the institutional animal care and use committee (IACUC[1]).

#### *Chemicals of Unknown Hazard*

In many cases, complete hazard/toxicity information may not be available for chemical agents used in animal research, and a comprehensive, rigidly followed plan is necessary for experimental testing of chemicals of unknown hazard for their toxic properties (NRC 1997). It should be presumed that a chemical is hazardous to humans, and the plan should prescribe specific procedures for handling the chemical from receipt through disposal. It is important not to underestimate the risk presented by experimental drugs (NRC 1997).

## Controlling Occupational Exposures to Chemicals

Controlling exposures to hazardous chemicals is based on a hierarchical approach involving the use of engineering controls, work practices (administrative controls), and PPE. The selection of these control measures depends on a complete understanding of the physical properties of the chemical and the potential routes of exposure.

### Engineering Controls

Engineering controls "isolate" the hazard from the worker and may involve modifying the workplace or equipment to reduce or eliminate worker exposures. Such modifications may include installing both general and local exhaust ventilation (chemical fume hood), isolating work processes from the hazard (e.g., splash barriers), or enclosing equipment or work processes (as in glove-box cabinets). Engineering controls are the first line of defense and the preferred method of minimizing potential chemical exposures.

### Administrative Controls and Work Practices

Administrative controls and work practices make up the most critical element of the chemical exposure control process because the failure of employees to work safely, with appropriate use of engineering controls, administrative controls and work practices, and PPE, may result in unnecessary exposures to themselves, coworkers, and/or the environment. Employee education and training are critical to their personal investment in utilizing appropriate work practices. Employees must understand the rationale, risks, and procedures for safe handling of hazardous chemicals.

Animal research introduces different processes and practices that may require considerable experience for real proficiency. Training and mentoring of research and animal care staff are essential.

### Personal Protective Equipment

PPE is the last measure that should be implemented to control exposures to any hazardous agent. The use of PPE is indicated only when engineering controls and work practices cannot limit exposures to an acceptable level. PPE provides a "barrier" between the employee and the hazardous agent, thus minimizing potential exposures (Sargent and Gallo 2003). PPE relies on proper fit, use, and maintenance by the wearer. In other words, a mistake due to a lack of knowledge on the proper use and limitations of the equipment could render the PPE ineffective (Mansdorf 2001).

The process of evaluating the need for and selecting PPE is part of a hazard assessment (OSHA 1994a). All employers are required to assess the workplace to determine whether hazards are present, or are likely to be present,

which necessitates the use of PPE. If such hazards are present or likely to be present, the employer must select and have each affected employee use the types of PPE that will protect the employee from the hazards identified in the hazard assessment. The PPE must be changed or replaced whenever it becomes contaminated or damaged.

### *Gloves (Hand Protection)*

Gloves are the most commonly used type of PPE in research laboratories and animal care facilities. According to OSHA, employers are required to select and employees are required to use appropriate hand protection when the employees' hands are potentially exposed to hazards such as those from the following: skin absorption of harmful substances, severe cuts or lacerations, severe abrasions, punctures, chemical burns, thermal burns, and harmful temperature extremes (OSHA 1994c). The selection of the appropriate hand protection must be based on an evaluation of the performance characteristics of the hand protection relative to the task(s) to be performed, the work conditions, the duration of use, and the hazards and potential hazards that are identified. In short, the gloves must be appropriate for the hazard and the conditions of use.

Special attention is required in assessing the degradation and permeation characteristics of the glove material selected, in relation to chemicals being handled. Glove selection guides (available from most manufacturers) should be consulted, with careful consideration given to the permeability of any material, particularly when working with organic solvents, which may be able to permeate or dissolve the glove materials (NRC 1995). Gloves should be inspected before and during use for evidence of discoloration, punctures, or tears. Gloves should be replaced immediately whenever there are indications of damage or failure.

Another important consideration in the selection of protective gloves is the risk of latex allergies associated with natural latex rubber. In 1997, NIOSH published a "warning," which cautioned that workers exposed to latex gloves and other products containing natural rubber latex may develop allergic reactions such as skin rashes; hives; nasal, eye, or sinus symptoms; asthma; and (rarely) shock (USDDHS 1997). Prevalence studies demonstrate that 8 to 12% of regularly exposed health care workers are sensitized to latex (Liss et al. 1997). Based on this current knowledge and a common-sense approach to minimizing latex-related health problems, NIOSH recommends the use of nonlatex gloves whenever possible. In addition, when latex gloves are indicated, powder-free low-protein gloves are recommended to minimize latex exposures.

### *Protective Clothing*

Protective clothing includes laboratory coats, gowns, and aprons designed to cover and protect the parts of the body that may be exposed as a consequence of a procedure or operation. Clothing that leaves large areas of skin exposed is inappropriate in areas where hazardous chemicals are in use (NRC 1995). Protective clothing for chemical exposures must provide an adequate barrier against exposure.

In most routine laboratory operations, a buttoned laboratory coat with the sleeves rolled down will provide an adequate barrier against exposure. Laboratory coats or aprons made of special materials are available for high-risk activities (NRC 1995). Materials that are woven, stitched, or otherwise porous (not resistant to liquid penetration or permeation) should not be used in situations in which protection against a liquid or gas is required (Mansdorf 2001). Individuals should remove laboratory coats and other protective clothing before leaving the work area.

### *Eye and Face Protection*

Eye and face protection is required when there is a risk of injury from flying objects or particles or from chemical vapors or splashes (Mansdorf 2001). Eye and face protection includes approved eye glasses, goggles, and face shields. Specific protection should be selected based on the procedure being conducted.

### *Respiratory Protection*

Respiratory protection is generally not required in the animal research environment to protect against chemical exposure. Engineering controls and work practices should effectively eliminate conditions that necessitate the use of respiratory protection. However, when atmospheric contamination with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors cannot be adequately controlled, respiratory protection must be provided. The use of respiratory protection is rigidly regulated by an OSHA standard that mandates that "any workplace where respirators are necessary to protect the health of the employee or whenever respirators are required by the employer, the employer shall establish and implement a written respiratory protection program with worksite-specific procedures" (29CFR 1910.134). The written program must include procedures for the following: selecting respirators for use in the workplace; medical evaluations of employees required to use respirators; fit testing procedures for tight-fitting respirators, procedures for proper use of respirators in routine and reasonably foreseeable emergency situations; procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators; and training of employees in the respiratory hazards to which they are potentially exposed. Sargent and Gallo (2003) provide a detailed discussion of PPE for respiratory protection.

### *Voluntary Use of Respirators*

The use of respiratory protection is typically mandated by either OSHA or the employer, and in these situations, full compliance with OSHA regulations is required (OSHA 1998a). However, there are certain exposure situations in which an employer may choose to permit employees to wear a respirator even though respiratory protection is not required. OSHA provides specific guidance for such "vol-

untary" uses of respirators (OSHA 1998a), which emphasizes employee education and assurances that the respirator itself does not create a hazard (medical or maintenance issues). Voluntary use of a filtering facepiece (N95 respirator) to reduce particulate exposures only requires providing information to the employee but does not require a written respiratory protection program or medical examination. A good example of the voluntary use of respirators is in controlling exposures to animal allergens. Allergic reactions to animals are among the most common conditions that adversely affect the health of workers involved in the care and use of animals (NRC 1997). It has been estimated that up to 46% of laboratory animal workers develop allergies to laboratory animals (Wolfle and Bush 2001). Respiratory protection can help reduce personal exposure to animal allergens (Harrison 2001). Additional information on the impact and control of animal allergen exposures is presented elsewhere in this issue (Bush and Stave 2003).

### *Foot Protection*

Special foot protection is usually not necessary for work in the research laboratory but may be required for some operations in the animal care facility (e.g., cage wash area). OSHA requires the use of protective footwear when working in areas where there is a danger of foot injuries due to falling and rolling objects or objects piercing the sole of the shoe (29 CFR 1910.136) (OSHA 1994b). Specific guidance on the selection of foot protection is provided in the American National Standards Institute consensus standard Z41.1, Protective Footwear.

## Conclusion

There are numerous guidelines and regulations regarding the control of potential chemical exposures. However, a critical consideration in the care and use of research animals is the collaborative effort of assessing the hazards and communicating the indicated risks and controls. The IACUC plays an important role in this effort. The IACUC review should include an evaluation of the proposed controls of hazardous chemicals. In many cases, the controls will simply require compliance with general institutional policies on chemical safety. However, when high-risk chemical hazards or chemicals of unknown hazard are being used, a comprehensive review should be conducted to ensure that the health and safety issues have been addressed adequately. The recommendations from such reviews must be integrated into the research protocol and the specific hazards and specialized controls must be communicated to all personnel who work with, or may be exposed to, hazardous materials or wastes.

## References


ASHP [American Society of Hospital Pharmacists]. 1990. ASHP Technical Assistance Bulletin on Handling Cytotoxic and Hazardous Drugs. Am J Hosp Pharm 47:1033-1049.

AVMA [American Veterinary Medical Association]. Panel on Euthanasia. 2001. Report of the AVMA Panel on Euthanasia. J Am Vet Med Assoc 218:28-51.

Bush RK, Stave GM. 2003. Laboratory animal allergy: An update. ILAR J 44:28-51.

Harrison DJ. 2001. Controlling exposure to laboratory animal allergens. ILAR 42:17-36.

Liss GM, Sussman GL, Deal K, Brown S, Cividino M, Siu S, Beezhold DH, Smith G, Swanson MC, Yunginger J, Douglas A, Holness DL, Lebert P, Wasserman S, Turjanmaa K. 1997. Latex allergy: Epidemiology study of 1351 hospital workers. Occup Environ Med 54:335-342.

Mansdorf SZ. 2001. Personal protective equipment. In: Alaimo AJ, ed. Handbook of Chemical Health and Safety. Washington DC: American Chemical Society. p 322-337.

NRC [National Research Council]. Committee on the Study of Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories. 1995. Prudent Practices in the Laboratory: Handling and Disposal of Chemicals. Washington DC: National Academy Press.

NRC [National Research Council]. Institute of Laboratory Animal Resources Committee on Occupational Safety and Health in Research Animal Facilities. 1997. Occupational Health and Safety in the Care and Use of Research Animals. Washington DC: National Academy Press.

OSHA [Occupational Safety and Health Administration]. 1991. 29 CFR 1910.1450, Occupational Safety and Health Standards, Occupational Exposure to Hazardous Chemicals in Laboratories. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1992. 29CFR 1910.1048, Formaldehyde. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1994a. 29 CFR 1910.132, Personal Protective Equipment. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1994b. 29 CFR 1910.136, Foot Protection. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1994c. 29 CFR 1910.138, Hand Protection. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1996. 29 CFR 1910.1200, Occupational Safety and Health Standards, Hazard Communication. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1998a. 29 CFR 1910.134, Respiratory Protection. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1998b. 29CFR 1910.151(c), Medical Services and First Aid. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1999a. Anesthetic Gases: Guidelines for Workplace Exposures. Washington DC: GPO.

OSHA [Occupational Safety and Health Administration]. 1999b. Controlling Occupational Exposures to Hazardous Drugs. Washington DC: GPO.

Sargent EV, Gallo F. 2003. Use of personal protective equipment for respiratory protection. ILAR J 44:52-56.

USDHHS [US Department of Health and Human Services]. National Institute for Occupational Safety and Health. 1997. NIOSH Alert: Preventing Allergic Reactions to Natural Rubber Latex in the Workplace. Cincinnati: NIOSH.

USDHHS [US Department of Health and Human Services]. National Institute for Occupational Safety and Health. 1998. Guidelines for Protecting the Safety and Health of Health Care Workers. Cincinnati: NIOSH.

USDHHS [US Department of Health and Human Services]. National Institute for Occupational Safety and Health. 2001a. Glutaraldehyde: Occupational Hazards in Hospitals. Cincinnati: NIOSH.

USDHHS [US Department of Health and Human Services]. 2001b. National Toxicology Program. Ninth Report on Carcinogens: Formaldehyde.

Van Swearingen FL, Shoaf AR. 2001. Biological safety: Emergency response and decontamination procedures. In: Alaimo AJ, ed. Handbook of Chemical Health and Safety. Washington DC: American Chemical Society. p 478-479.

Wolfle TL, Bush RK. 2001. The science and pervasiveness of laboratory animal allergy. ILAR J 42:1-3.

Young JA. 2001. Corrosives and irritants. In: Alaimo AJ, ed. Handbook of Chemical Health and Safety. Washington DC: American Chemical Society. p 343-344.