Industry Guide

Health Care

The National Institute for Occupational Safety and Health (NIOSH) reports that health care is the second-fastest growing sector of the U.S. economy, employing over 12 million workers. Unfortunately, rates of occupational injury among health-care workers are also on the increase. Needlestick injuries are the most prevalent type of injury, but many other occupational hazards exist in this industry [1]:

Chemical agents
- Sources include anesthetic gases, sterilant gases, solvents and disinfectants, surgical smoke, and hazardous drugs.

Biological agents
- Including blood-borne pathogens and infectious aerosols

Physical agents
- Including ionizing and non-ionizing radiation and ergonomic/human factor hazards

This publication is designed to assist health and safety professionals in choosing the appropriate equipment and methodology to assess the major chemical agents found in the health-care industry.

For USP Chapter 797 sampling in pharmacy areas or for general infection control evaluations, SKC offers active air samplers for viable airborne microorganisms. Contact SKC Inc. at 724-941-9701 or visit www.skcinc.com.

Anesthetic Gases

Trace levels of anesthetic gases in operating rooms and other areas of health care facilities can result from equipment leaks, anesthetic technique, exhalation of residual gases by patients, and waste gases. To ensure the safety of health-care workers, a monitoring program for trace anesthetic gas levels is recommended by several organizations including the Joint Commission on Accreditation of Health Care Organizations and the American Hospital Association.

Nitrous oxide is frequently used as an anesthetic in operating rooms, emergency rooms, or inpatient settings. Low levels of this chemical have been associated with central nervous system, cardiovascular, and reproductive effects in humans along with a decrement in audiovisual performance. NIOSH has a recommended exposure limit of 25 ppm as a time-weighted average (TWA) for the duration of the exposure. OSHA does not have a permissible exposure limit (PEL) for this compound.

Halogenated anesthetic gases including enflurane, halothane, isoflurane, and desflurane are frequently administered in conjunction with nitrous oxide. These compounds can cause eye, nose, and throat irritation. In addition, chronic exposure to halogenated anesthetic gases has been linked to an increased risk of reproductive hazards along with hepatic and renal disease. OSHA has no PELs for halogenated anesthetic gases, but NIOSH has recommended a 60-minute ceiling value of 2 ppm. [2] For details on sampling specific anesthetic gases, reference the following SKC publications:

SKC Chemical Fact Files®

Nitrous Oxide
by NIOSH 6600 (using a sample bag and portable infrared spectrophotometer)
SKC Publication 1028

Enflurane, Halothane, and Isoflurane
by OSHA 103 (using a sorbent tube)
SKC Publications 1347, 1348, and 1349

Desflurane
by OSHA 106 (using a sorbent tube)
SKC Publication 1760

SKC also offers passive samplers for anesthetic gases. See www.skcinc.com.

Nitrous Oxide Passive Sampler (Cat. No. 590-300)

Enflurane, Halothane, Isoflurane, and Desflurane Passive Sampler (Cat. No. 575-002)

Publication 1755 Rev 0907

SKC Inc. 724-941-9701 **SKC South** 434-352-7149 **SKC Gulf Coast** 281-859-8050 **SKC West** 714-992-2780
www.skcinc.com

Sterilant Gases

Ethylene oxide is routinely used in health-care facilities to sterilize medical devices and equipment. This chemical agent is critical in the hospital environment as it can be used to sterilize heat and moisture-sensitive items that can not be sterilized effectively by steam. The OSHA standard was based on data that indicated ethylene oxide presents a carcinogenic, mutagenic, genotoxic, reproductive, neurologic, and sensitization hazard to workers. OSHA established a PEL of 1 ppm as an 8-hour TWA and an excursion limit of 5 ppm determined during a 15-minute exposure period. For details on sampling ethylene oxide, reference the following SKC publications:

Chemical Fact Files

Ethylene Oxide
by OSHA 1010 (using a sorbent tube)
SKC Publication 1751

Ethylene Oxide
by NIOSH 3702 (using a sample bag and portable gas chromatograph)
SKC Publication 1031

Also, see www.skcinc.com for information on SKC 575-005 passive samplers for ethylene oxide.

Solvents and Disinfectants

Glutaraldehyde is used in health-care settings as a cold sterilant to clean heat-sensitive equipment. Glutaraldehyde is also used as a tissue fixative in histology and pathology labs and as a hardening agent in X-ray departments. [3] Exposure to glutaraldehyde vapors can lead to irritation and burning of eyes, nose, and throat along with breathing difficulties and asthma-like symptoms. NIOSH has a recommended exposure level of 0.2 ppm as a ceiling value. OSHA has no PEL for glutaraldehyde at this time.

Formaldehyde is a chemical agent most commonly used in health-care facilities to fix and preserve tissue. In this application, formaldehyde is typically mixed with methanol to produce formalin solutions of various concentrations. Worker exposure to formaldehyde can occur in operating rooms, pathology and research labs, and morgues. Exposures can also occur in dialysis units during disinfection procedures.

Formaldehyde is an allergen and susceptible individuals can become sensitized leading to irritation and breathing difficulties. The International Agency for Research on Cancer (IARC) now classifies formaldehyde as a human carcinogen. OSHA has issued a PEL of 0.75 ppm for formaldehyde as an 8-hour TWA and 2 ppm as a 15-minute short-term exposure limit (STEL).

For details on sampling these chemical agents, reference the following SKC publications:

Chemical Fact Files

Glutaraldehyde
by NIOSH 2532 (using a sorbent tube)
SKC Publication 1346

Glutaraldehyde
by OSHA 64 (using a treated filter)
SKC Publication 1241

Formaldehyde
by OSHA 52 (using a sorbent tube)
SKC Publication 1020

Formaldehyde
by NIOSH 2541 (using a sorbent tube)
SKC Publication 1015

SKC also offers passive samplers validated for formaldehyde air sampling. ***Note: If sampling in an atmosphere containing formalin, see www.skcinc.com/instructions/1795.pdf for field study information and Reference 8 in this publication.***

SKC Inc. 724-941-9701 **SKC South** 434-352-7149 **SKC Gulf Coast** 281-859-8050 **SKC West** 714-992-2780
www.skcinc.com

Surgical Smoke

During laser and electrocautery surgical procedures, a plume of smoke is generated. Surgical smoke can contain chemical agents in addition to tissue, blood, and microorganisms. A 2006 NIOSH Health Hazard Evaluation established that formaldehyde, acetaldehyde, and toluene were found to have measurable levels in air from surgical smoke. [4] Exposed employees indicated irritation of the eyes and upper respiratory tract and annoyance from the odor. Long-term chronic effects from formaldehyde are described in the section on solvents and disinfectants. OSHA has issued the following PELs for the 3 chemical agents found in surgical smoke during the NIOSH study:

Formaldehyde
- 0.75 ppm as an 8-hour TWA
- 2 ppm as a 15-minute STEL

Acetaldehyde
- 200 ppm as an 8-hour TWA

Toluene
- 200 ppm as an 8-hour TWA
- 300 ppm as a ceiling value

For details on sampling chemicals in surgical smoke, reference the following SKC publications:

Chemical Fact Files

Formaldehyde
by OSHA 52 (using a sorbent tube)
SKC Publication 1020

Formaldehyde
by NIOSH 2541 (using a sorbent tube)
SKC Publication 1015

Formaldehyde
by NIOSH 2016 (using a sorbent tube)
SKC Publication 1761

Acetaldehyde
by OSHA 68 (using a sorbent tube)
SKC Publication 1007

Toluene
by OSHA 111 (using a sorbent tube or passive sampler)
SKC Publication 1748

SKC also offers passive samplers validated for chemicals in surgical smoke. See www.skcinc.com.

Formaldehyde Passive Sampler (Cat. No. 500-100)
by OSHA 1007

Toluene Passive Sampler (Cat. No. 575-002)
by OSHA 111

Technical Note: Passive samplers are normally clipped to a worker's shirt collar to sample air in the breathing zone. In operating rooms, however, placement of the sampler on the front of the scrub cover gown may not be permitted. This is due to concerns that the device might drop into the surgical site. Health and safety professionals may prefer to attach the passive sampler to the top of the shoulder to address this concern.

Hazardous Drugs

Hazardous drugs used to treat certain medical conditions can pose a health risk to employees who administer them on a regular basis. Examples of hazardous drugs include anti-neoplastic drugs for cancer and anti-viral drugs such as ribavirin. Health-care workers who work with or near these drugs may be exposed to harmful chemical agents through the inhalation and dermal routes. Health effects range from skin rash and dizziness to reproductive and genotoxic effects. [5]

There are typically no established regulations for occupational exposure to specific drugs and no sampling and analytical methods published by government agencies. Health and safety professionals should consult the MSDS and contact the pharmaceutical company for assistance. A search of scientific literature may also yield valuable information on this subject. The California Department of Health Services reported on a sampling method for ribavirin using glass fiber filters followed by HPLC analysis with a modified NIOSH Method 5027.[6] Personal sampling pumps were used to assess TWA exposures of nurses handling these drugs. Another method developed at the University of Alabama at Birmingham utilized sorbent tubes instead of filters for evaluations of Cyclophosphamide and other antineoplastic agents. [7]

For more information on handling hazardous drugs in health-care settings, reference a NIOSH alert on this subject (Publication No. 2004-165) at www.cdc.gov/NIOSH.

SKC Inc. 724-941-9701 **SKC South** 434-352-7149 **SKC Gulf Coast** 281-859-8050 **SKC West** 714-992-2780
www.skcinc.com

References

[1] *Charney, W., Handbook of Modern Hospital Safety, CRC Press LLC, Boca Raton, Florida, 1999, p. 3*

[2] *NIOSH Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors, U.S. Department of Health and Human Services, CDC, NIOSH, Cincinnati, Ohio, 1977, DHHS (NIOSH) Publ. 77-140*

[3] *Glutaraldehyde: Occupational Hazards in Hospitals, Department of Health and Human Services, CDC, NIOSH, Cincinnati, Ohio, 2001, DHHS (NIOSH) Publ. 2001-115*

[4] *NIOSH Health Hazard Evaluation Report, Department of Health and Human Services, CDC, NIOSH, Cincinnati, Ohio, 2006, DHHS (NIOSH), HETA #2001-0066-3019*

[5] *Antineoplastic Agents-Occupational Hazards in Hospitals, Department of Health and Human Services, CDC, NIOSH, Cincinnati, Ohio, 2004, DHHS (NIOSH) Publ. 2004-102*

[6] *Charney, W., Handbook of Modern Hospital Safety, CRC Press LLC, Boca Raton, Florida, 1999, p. 544-545*

[7] *Larson, R. R., Khazaeli, M. B., and Dillon, H. K., A New Monitoring Method Using Solid Sorbent Media for Evaluation of Airborne Cyclophosphamide and Other Antineoplastic Agents, Applied Occupational and Environmental Hygiene, Vol. 18, No. 2, 2003, p.p. 120-131*

[8] *Levin, J. O., Lindahl, R., and Andersson, K., "A Passive Sampler for Formaldehyde in Air Using 2,4-Dinitrophenylhydrazine-coated Glass Fiber Filters," Environmental Science and Technology, Vol. 20, No. 12, 1986, pp. 1273-1276*

Publication 1755 Rev 0907

SKC Inc. 724-941-9701 **SKC South** 434-352-7149 **SKC Gulf Coast** 281-859-8050 **SKC West** 714-992-2780
www.skcinc.com