HETA 97-0224-2740
University of Iowa Hospitals and Clinics
Iowa City, Iowa

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PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by J. Clinton Morley, Sue Ting and Eric J. Esswein of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by Ardith Grote of ARDB, NIOSH, Cincinnati, Ohio, and Mark Swanson, Mayo Clinic, Minneapolis, Minnesota. Desktop publishing was performed by Nichole Herbert, Cincinnati, Ohio, and Joyce Woody of the Denver Field Office. Review and preparation for printing was performed by Penny Authur.

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Iowa City, Iowa
June 1999

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SUMMARY

On May 28, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request from the American Federation of State, County, and Municipal Employees (AFSCME) Local 12 for a health hazard evaluation (HHE) at the University of Iowa Hospitals and Clinics (UIHC). The request asked NIOSH to assess perceived indoor air quality (IAQ) problems, and air handling/temperature control (excessive heat) problems in the decontamination suite of the central sterilization service in the John W. Colloton Pavilion. Reported health effects included bronchitis, upper respiratory problems, and sinus problems. During December 10-12, 1997, NIOSH investigators interviewed employees, sampled for latex proteins, enzymes, and volatile organic compounds (VOCs), evaluated heat stress, and inspected the heating, ventilating and air-conditioning (HVAC) system.

An air handling unit (AHU) was found to have gross mold contamination and a damaged damper, and a lack of negative pressure was found in one part of the decontamination suite. Airborne glutaraldehyde concentrations ranged up to 0.047 parts per million (ppm), all below the NIOSH recommended exposure limit (REL) of 0.2 ppm and the American Conference of Governmental Industrial Hygienists (ACGIH®) threshold limit value of 0.05 ppm. All air samples for latex protein were below the analytical limit of detection (LOD) (5 nanograms per cubic meter of air). Major compounds detected from the qualitative VOC air sampling included propane, butane, ethanol, acetonitrile, acetone, isopropanol, and 2-butoxyethanol. While the average wet bulb globe thermometer temperature was 55.9^{N} F (with fluctuations of less than 1.5), wide fluctuations in relative humidity (20-80%) can contribute to perceptions of thermal discomfort. Differences in self-reported upper respiratory irritation or physician diagnosed asthma in the decontamination suite, compared to the set assembly area (the comparison area) were minimal.

NIOSH returned to the hospital on February 3-4, 1999, to collect additional samples for enzymes and glutaraldehyde and re-inspect the air handler for the presence of mold. Concentrations of airborne glutaraldehyde were lower than those measured during the initial survey. Airborne concentrations of the Savanase™ type enzyme were below ACGIH criteria; the Asepti-zyme™ enzyme was not detected in the air. Mold in the AHU was removed, the return air damper was repaired, and engineering controls were installed on a scope washer. However, the decontamination suite was determined to be under positive pressure compared to adjacent areas (hospital ventilation guidelines recommend negative pressure).

A health hazard was not determined from exposure to glutaraldehyde, enzymes, latex proteins, VOCs, or heat stress. The decontamination suite, however was found to be under positive pressure, which is inconsistent with accepted ventilation performance guidelines for hospitals. Recommendations for improved ventilation are provided on page 9 of this report.

Keywords: SIC 8062 General Medical and Surgical Hospitals, hospitals, medical centers, central sterilization, decontamination units, subtillisins, latex, glutaraldehyde, mold, fungi, ventilation, occupational health, heat stress.

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INTRODUCTION

On May 28, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request from the American Federation of State, County, and Municipal Employees (AFSCME) Local 12 for a health hazard evaluation (HHE) at the University of Iowa Hospitals and Clinics (UIHC). The requesters asked NIOSH to investigate indoor environmental quality (IEQ) , air handling, temperature, and humidity problems in the decontamination suite of the central sterilization service in the John W. Colloton Pavilion. Health effects reported by employees included bronchitis, upper respiratory problems, and sinus problems. On December 10-12, 1997, two NIOSH industrial hygienists and a NIOSH physician conducted a site visit to investigate the concerns expressed in the request. An interim letter dated December 29, 1997, reported the initial findings of the site visit and provided recommendations to remove mold from the air handler and discontinue recirculating air into the decontamination suite and other areas. NIOSH investigators returned to the hospital on February 3-4, 1998, to collect additional air samples for enzymes, glutaraldehyde, and to inspect the heating, ventilating, and air conditioning (HVAC) system for mold in the air handler. NIOSH investigators also inspected a previously damaged return air damper and evaluated pressurization in the decontamination suite.

BACKGROUND

Complaints from AFSCME about upper respiratory symptoms reported to be associated with working conditions in the decontamination suite began in January of 1996. In response to an AFSCME request the Iowa Division of Labor, Iowa Occupational Safety and Health (IOSH) conducted a site visit in August of 1996, from which no violations were issued. IOSH closed-out the complaint in a letter dated December 18, 1996.

Due to continued employee complaints about working conditions in the decontamination suite, AFSCME requested a NIOSH HHE on May 28, 1997.

The central sterilization service (CSS) cleans and sterilizes medical equipment for the surgical suites and specialty clinics at the UIHC. Equipment sterilization is a three-stage process, each stage is completed in a different suite within the basement of the John W. Colloton Pavilion. The first stage is decontamination, the second is set assembly, and the third is sterilization.

The goal of equipment and instrument decontamination is to eliminate microbial contamination so employees working in the set assembly suite can work without using universal precautions. The decontamination suite is commonly referred to as the "dirty side," because all equipment and instrumentation entering this suite are considered bio-hazardous. Personnel working in this area wear personal protective equipment (PPE) consistent with the universal precautions recommended by the Centers for Disease Control and Prevention (CDC) when working with bio-hazardous material. The PPE includes shirt and pant scrubs, over-the-cuff non-powdered latex gloves, long-sleeve smocks, polyethylene aprons, paper booties, hair nets, and plastic disposable face shields. Equipment brought into the decontamination suite is separated by instrument type and manually prepared for decontamination. Most equipment is cleaned in one of seven automatic washers. The washers have a three- or four-step decontamination process involving an alkaline detergent, a citric acid neutralizer, an enzymatic detergent (one washer), and a lubricant. Bio-hazardous items placed into the washers in the decontamination suite are removed from the automatic washers by personnel in the set assembly suite who wear no PPE. Equipment containing electronics, fiber optics, or soft rubber can be damaged by the hot water cycles of the washers so these are prepared for hand cleaning using chemical disinfectants or cold sterilization

using a glutaraldehyde bath. Once disinfected, the equipment cleaned by hand is passed from the decontamination suite to the set assembly suite through one of two windows connecting the two work areas.

The second stage of equipment sterilization is set assembly. The set assembly suite is commonly referred to as the "clean side," and personnel are required to wear only scrubs and a hair net. Set assembly is the packaging of equipment and instrumentation for sterilization according to the type of procedure the package will eventually be used for. Once the equipment is packaged, it is placed on a cart for transportation to the sterilization suite.

The equipment sterilization suite contains ethylene oxide (EtO) sterilization chambers, steam sterilization chambers, and plasma sterilization chambers. Personnel working in the sterilization suite wear scrubs and a hair net. Once sterilized, equipment is returned to the hospital surgical suites and clinics. Although the decontamination suite and set assembly suite are directly adjacent to one another, the sterilization suite is separate from these two rooms and serviced by a completely separate air handling system.

Ascepti-zyme™, Avenaclense 800™, and Orthozyme™ are three enzyme-containing products used in the decontamination suite. Ascepti-zyme is the most commonly used enzymatic cleaner. It is supplied in one gallon containers and is dispensed in squirts using a small hand pump on the container. The cleaner is mixed into water in washbasins and sinks. Orthozyme is a trial product which is not normally stocked. Occasionally samples of a Orthozyme are received by manufacturers reps and the cleaner is used. Avenaclense 800™ is only used in one automatic washer for specific cleaning tasks. Avenaclense 800™ is supplied in 5-gallon plastic containers which are connected to the washers by plastic hosing. Avenaclense 800™ is used in a closed system in the automatic washer. The ventilation system for the automatic washers exhausts directly to the outside.

In December 1997, NIOSH collected three high volume area air samples and two wipe samples to evaluate for the presence of subtilisin enzymes. Two of the air samples were collected from the decontamination suite and one air sample was collected from the set assembly suite. The wipe samples were collected from ventilation system exhaust grilles. The Ascepti-zyme™ enzymatic cleaner was identified as the most likely potential contributor to the overall concentrations of subtilisin enzyme in the air because it is the most commonly used, and is used mixed with water in open sinks and basins. A sample of the pure enzyme used in the product was obtained and analyzed to determine the specific enzyme(s) used in Ascepti-zyme cleaner. These tests determined that the enzyme was a Savinase™ type enzyme detectable using a Savinase™ immunoassay. This assay was run on the samples collected from the decontamination suite. In February 1999 two more high volume area air samples were collected and analyzed for Savanase™ enzyme.

Approximately 100 employees work in the CSS, most of whom rotate through the decontamination suite periodically. The schedule was reported to rotate employees through the decontamination suite on a weekly or biweekly basis; however, employees report that they work in the decontamination suite for extended periods of time when they become proficient at decontamination processes and suitable replacements cannot be found. Approximately 25 employees work in the decontamination suite at any one period of time, 10-15 on the first shift and 10 on the second shift. NIOSH investigators observed 4-6 employees working in the decontamination suite on both the first and second shifts during the site visits.

Previously, independent consultants were contracted by the UIHC to evaluate the decontamination suite air handling system. A letter dated November 19, 1996, from one ventilation consultant to the UIHC indicated that

the decontamination suite was supplying ventilation at a rate of 10.66 air changes per hour. Guidelines published by the American Institute of Architects Academy of Architecture indicate that the appropriate number of room air changes per hour for a decontamination suite is 6.[1] This indicates that the decontamination suite provided an acceptable quantity of air and appropriate numbers of air changes. Subsequent to that study, another consultant conducted an evaluation of air handling system. A letter dated December 4, 1997, from the consultant to the UIHC indicated that the exhaust air from the decontamination suite was being partially recirculated. Recirculation of air from a decontamination suite is not a recommended practice.[1] The aforementioned guidelines specify that exhaust air from a decontamination suite be 100% exhausted, not recirculated.

METHODS

Occupational Hygiene

A thorough review of historical information pertaining to the decontamination suite at the UIHC was conducted from files maintained by the AFSCME and the IOSH. The historic industrial hygiene surveys, correspondences between parties, and material safety data sheets (MSDSs) from products currently in use in the decontamination suite were reviewed. This information was used to determine the industrial hygiene sampling plan for the NIOSH survey. Sampling for enzymes, glutaraldehyde, and latex was conducted to evaluate exposures to those substances and because the symptoms reported by the requesters could have occurred from those exposures.

Air samples for glutaraldehyde were collected using either treated silica gel cartridges (coated with 2,4-dinitrophenylhydrazine HCl [DNPH]), treated filters in 37 millimeter (mm) closed face filter cassetttes, and treated sorbent tubes. Sampling was performed at approximately 1 Liter per minute (Lpm) for treated sorbent tubes and filter cassettes, or approximately 0.1 Lpm using the treated silica gel cartridges. All samples were analyzed using NIOSH Method 2532 "Glutaraldehyde."[2] The samples were analyzed for a derivative of glutaraldehyde by high performance liquid chromatography with ultraviolet detection. Samples collected using silica gel cartridges were configured with two cartridges in-line to help identify if any breakthrough of glutaraldehyde occured.

Long term area air samples were collected at the scope washer, directly above the glutaraldehyde tanks. Three personal breathing zone (PBZ) samples were collected while different employees worked at the scope washer. Short-term (15-25 minute) area samples were also collected at the scope washers directly above the covers of the glutaraldehyde tanks at various points in the glutaraldehyde bath cycle. A 15-minute area sample was collected after an employee used compressed air to dry a scope which had been removed from a glutaraldehyde soaking bath. The sample was collected for 15 minutes but drying the instruments took no more than 1 minute.

Area air samples were collected for subtilisin enzymes using a 4 inch square 0.3-micrometer (μm) pore size polytetrafluoroethylene (PTFE) filter at a flow rate of approximately 7.2 liters per second. To confirm sampler flow rates, the samplers were calibrated (with new filters in–line) using a recently calibrated TSI VeliCicalc® Plus Model 8360 thermoanemometer. The 8360 was first programmed to measure air flow in a 3" (7.6 centimeter [cm]) round duct in units of liters per second. To calibrate the samplers a 61 cm length of schedule 40 PVC pipe (7.6 cm in diameter) was connected to a flange on top of the sampler using a standard circular PVC connector sleeve. A small amount of vacuum grease was used to insure a good seal between the PVC pipe and the sampler head. The pipe was attached to the sampler only temporarily for use as an extended intake plenum so that airflow calibration could be conducted. Two 1.3 cm ports had been

drilled into the plenum at 90 degrees to insert the probe of the 8360 to measure airflow. To insure smooth flow in the duct, the ports were located 2.5 duct diameters from the end of the plenum and 5.5 duct diameters from the filter. The tip of the VeliCicalc® Plus was inserted in each port and five flow measurements were made across the diameter of the to the plenum. Ten flow measurements were taken in total and the results averaged to determine nominal flow rates in liters per second. The samples were analyzed for subtilisin enzymes using two immunoassay systems, a competitive Savinase™ immunoassay and an Alkalase™ 2-site immunoassay, each with a sensitivity of 100 picograms (pg) per sample. Wipe samples were also collected from the return air grilles to determine if airborne subtilisin enzymes had collected onto the return air grille. Five air samples were collected for qualitative volatile organic compounds (VOCs) analysis. Two samples were collected in the scope washing area of the decontamination suite, one sample was collected in the set assembly suite, one sample was collected in an office area directly outside the decontamination suite, and one background sample was taken in a separate area of the hospital. Area air samples for airborne chemical vapors were collected with thermal desorption tubes at a flow rate of approximately 0.05 Lpm using the protocol from NIOSH Method 2549, "Volatile Organic Compound (Screening)."[2] The air samples were analyzed for VOCs using gas chromatography-mass spectrometry (GC-MS). This method is a very sensitive analytical procedure that provides for qualitative identification of VOC's present in minute quantities (generally the parts per billion [ppb] range).

Three air samples and two wipe samples were collected for latex protein. Two air samples were collected from the decontamination suite and one sample was collected from the set assembly suite. The wipe samples were collected from two separate exhaust air diffusers in the decontamination suite.

Area air samples were collected for latex protein using a 4-inch by 4-inch 0.3-µm pore size PTFE filter at a flow rate of approximately 180 Lpm. The samples were analyzed for latex protein using a human IgE inhibition latex immunoassay with a sensitivity of 200 nanograms per sample (ng/sample).[3] Wipe samples collected from the return air grilles were used to evaluate the presence of latex proteins which may have accumulated on this surface.

The air handling unit (AHU) supplying air to the decontamination suite, the set assembly suite, and surrounding office areas is AHU 23. This AHU was inspected as were the supply and exhaust air systems. Pressure measurements were taken at each entrance or opening (i.e., doors and sliding glass windows) to the decontamination suite. A micromanometer (Electronic Digital Micromanometer by EDM Neotronics) and chemical smoke tubes were used to determine the degree of negative pressure relative to the surrounding areas at doors, windows, offices, corridors, and cart washers.

Heat stress monitoring was performed for four continuous hours. Measurements were recorded every 30 minutes. Heat stress was evaluated using a standard wet bulb globe thermometer (Wibget® Heat Stress Monitor by Rueter-Stokes).

Medical

The medical survey included a review of the Occupational Safety and Health Administration (OSHA) Log and Summary of Occupational Injuries and Illnesses (form 200) for 1996-1997; a review of 1996-1997 medical records from the University of Iowa Occupational Medicine Clinic; and medical interviews with staff. All employees from first and second-shifts who worked in decontamination, set assembly, and sterilization areas were invited to attend a medical interview.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled to the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs)[4], (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®)[5], and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).[6] NIOSH encourages employers to follow the OSHA PELs, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and that the OSHA PELs included in this report reflect the 1971 values.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Glutaraldehyde

Glutaraldehyde is a colorless liquid with a pungent odor with a reported odor threshold of 0.04 ppm.[7] It is used at the UIHC as a 2.6% aqueous solution for cold sterilization of endoscopic equipment. Glutaraldehyde solutions have no flash point, are non-flammable, are stable for long periods of time, have a mildly acidic pH, negligible odor, and are not antimicrobial. However, when solutions of glutaraldehyde are buffered to a pH of 7.5-8.0 through the addition of sodium bicarbonate, the glutaraldehyde is activated and has antimicrobial activity for a period of up to 14 days.

Glutaraldehyde is a mucous membrane, skin, and eye irritant that can cause skin sensitization (allergic contact dermatitis).[8] The strong irritant effect of pure glutaraldehyde is enhanced when it is activated for use as an antimicrobial disinfectant. In 1997, the ACGIH revised its TLV-ceiling for glutaraldehyde to 0.05 ppm due to several studies which demonstrated nose, throat, skin, and eye irritation at or below 0.1 ppm with short-term (15-minute) personal sampling results.[6] Due to lack of a clear dose-response relationship, the ACGIH recommends that exposures be kept as low as possible. Additionally, skin exposure should be kept to a minimum to prevent allergic sensitization.

In 1989, OSHA adopted a PEL-ceiling exposure for glutaraldehyde of 0.2 ppm based upon human

evidence that clearly demonstrated a significant risk of eye, nose, and throat irritation associated with short-term exposures greater than 0.3 ppm. However, the 1989 OSHA PELs were vacated in the 11th Circuit Court of Appeals and there is currently no PEL for glutaraldehyde exposure. The NIOSH REL is a ceiling concentration of 0.2 ppm.

Subtilisins

The term subtilisins refers to a group of enzymes derived from the bacteria *Bacillus subtilis*or, and closely related organisms. Subtilisins are proteins used in the decontamination suite as catalysts for the breakdown of proteinaceous material (blood and body fluids) on instruments. Subtilisins are known primarily as dermal and respiratory tract irritants and have been shown to cause broncho constriction and respiratory allergies.[9] Signs and symptoms of subtilisins exposure include sore throat, nasal congestion, headache, and persistent cough. The ACGIH TLV-ceiling for pure crystalline subtilisin enzyme is 0.06 micrograms per cubic meter (ug/m^3). This is believed to be sufficiently low to prevent allergic respiratory sensitization in persons without immune dysfunction. In the decontamination suite the subtillisin is a liquid form containing solubilized subtilisins enzyme.

Latex

There are no OSHA or ACGIH criteria for occupational exposures to latex proteins. In 1997, NIOSH published an Alert entitled "Preventing Allergic Reactions to Natural Rubber Latex in the Workplace."[10] The Alert discusses occupational latex allergy in industry, particularly in health care. The NIOSH Alert states that workers exposed to latex gloves and other products containing natural rubber latex (NRL) can develop allergic reactions such as skin rashes; hives; nasal, eye, or sinus symptoms; asthma; and (rarely) shock.

Latex products are manufactured using the milky fluid of the rubber tree. NRL is chemically processed into latex products including gloves, surgical masks, goggles, rubber aprons, endotracheal tubes, oral and nasal airways, blood pressure cuffs, and other medical devices. The allergen in NRL-containing products are various latex proteins, which can cause mild to severe symptoms, depending upon the individual. Latex proteins have been shown to bind to the cornstarch powder applied to powdered latex gloves. Glove powder can become airborne and latex protein can then be inhaled, contributing to the overall exposure of the individual.

Three types of reactions can occur in persons who wear gloves and/or who are exposed to latex proteins; irritant contact dermatitis, allergic contact dermatitis, and latex allergy. Irritant contact dermatitis is a common occupational skin disorder which is characterized by dry, itchy, and irritated areas on the skin. Irritant contact dermatitis results from repeated hand washing and drying, the use of cleaners and sanitizers, incomplete hand drying, etc. It is not a true allergy. Allergic contact dermatitis is characterized by skin rashes and can be somewhat similar to the rash caused by poison ivy. One a person is sensitized (which usually takes repeated exposures) the rash usually begins 24-48 hours after contact. Latex allergic reactions can also involve more serious reactions to latex proteins which can occur within minutes to hours of exposure. Mild reactions involve runny nose, sneezing, itching eyes, redness, or hives; more severe reactions can include asthma, and shock, although the latter is uncommon.

Microrganisms

Microorganisms (including fungi and bacteria) are normal inhabitants of the environment. The saprophytic varieties (those utilizing non-living organic matter as a food source) inhabit soil, vegetation, water, or any reservoir that can provide an ample supply of a nutrient substrate. Under the appropriate conditions (optimum

temperature, pH, and with sufficient moisture and available nutrients) saprophytic microorganism populations can be amplified. Through various mechanisms, these organisms can then be disseminated as individual cells or in association with soil/dust or water particles. In the outdoor environment, the levels of microbial aerosols will vary according to the geographic location, climatic conditions, and surrounding activity. In a "normal" indoor environment, the level of microorganisms may vary somewhat as a function of the cleanliness of the HVAC system and the numbers and activity level of the occupants. Generally speaking indoor levels are expected to be below the outdoor levels (depending on building pressurization and HVAC filter efficiency) with consistently similar ranking among the microbial species.[11,12]

Some individuals manifest increased immunologic responses to antigenic agents encountered in the environment. These responses and the subsequent expression of allergic disease is based, partly, on a genetic predisposition.[13] Allergic diseases typically associated with exposures in indoor environments include allergic rhinitis (nasal allergy), allergic asthma, allergic bronchopulmonary aspergillosis (ABPA), and extrinsic allergic alveolitis (hypersensitivity pneumonitis).[14] Allergic respiratory diseases resulting from exposures to microbial agents have been documented in agricultural, biotechnology, office, and home environments.[15,16,17,18,19,20,21,22] Individual symptomatology varies with the disease. Allergic rhinitis is characterized by attacks of sneezing; itching of the nose, eyes, palate, or pharynx; nasal stuffiness with partial or total airflow obstruction; and rhinorrhea (runny nose) with postnasal drainage. Allergic asthma is characterized by episodic or prolonged wheezing and shortness of breath in response to bronchial (airways) narrowing. Allergic bronchopulmonary aspergillosis is characterized by cough, lassitude, low-grade fever, and wheezing.[13,23] Heavy exposures to airborne microorganisms can cause an acute form of extrinsic allergic alveolitis which is characterized by chills, fever, malaise, cough, and dyspnea (shortness of breath) appearing four to eight hours after exposure. In the chronic form, thought to be induced by continuous low-level exposure, onset occurs without chills, fever, or malaise and is characterized by progressive shortness of breath with weight loss.[24]

Acceptable levels of airborne microorganisms have not been established, primarily because allergic reactions can occur even with relatively low airborne concentrations of allergens, and individuals differ with respect to immunogenic susceptibilities. The current strategy for on-site evaluation of environmental microbial contamination involves an inspection to identify sources (reservoirs) of microbial growth and potential routes of dissemination. In those locations where contamination is visibly evident or suspected, bulk samples may be collected to identify the predominant species (fungi, bacteria, and thermoactinomycetes). In limited situations, air samples may be collected to document the presence of a suspected microbial contaminant. Air sample results can be evaluated epidemiologically by comparing those from the "complaint areas" to those from non-complaint areas, or by relating exposure to immunologic findings.

Heat Stress

Humans function efficiently only in a vary narrow range of core body temperatures. Core body temperatures are measured deep inside the body, not on the surface of the skin. Fluctuations in core body temperature exceeding about 2°F below or 3°F above normal core temperature (99.6°F, or 98.6°F mouth temperature) are considered a health hazard.[25] Signs and symptoms of heat stress include heat exhaustion, heat cramps, and finally, heat stroke. Heat exhaustion is characterized by mildly elevated temperature, pallor, weak pulse, dizziness, profuse sweating, and cool, moist skin. Heat cramps are characterized by excess loss of salt and moisture from the body inducing cramping in addition to the above signs and symptoms. Heat stroke

results when the body's normal thermoregulating mechanisms are insufficient, resulting in a rapid body temperature rise. Heat stroke is characterized by a cessation of the sweating mechanism, and accompanying hot, dry skin. This condition can be fatal and immediate steps to reduce the core body temperature must be taken.

Due to the difficulty in obtaining core body temperatures from workers, environmental measurements are made to estimate the impact the environment will have on the body's ability to thermoregulate. These measurements are made for indoor environments using a natural wet-bulb thermometer (NWB), a globe thermometer (GT), and the formula for wet-bulb-globe temperature (WBGT). The TLV is then expressed as a maximum WBGT and is based upon the environmental temperature (GT), the humidity (NWB), employee working pace, PPE, and work load.

There are a number of heat stress guidelines that are available to protect against heat-related illnesses such as heat stroke, heat exhaustion, heat syncope, and heat cramps. NIOSH and the ACGIH have established criteria for permissible heat exposure in the workplace.[6] These include, but are not limited to, the Belding-Hatch heat stress index (HSI)[26], and effective temperature (ET). The underlying objective of these guidelines is to prevent a worker's core body temperature from rising excessively. Many of the available heat stress guidelines, including those proposed by NIOSH and the (ACGIH), also use a maximum core body temperature of 38°C as the basis for the environmental criterion.

Both NIOSH and ACGIH recommend the use of the WBGT index to measure environmental factors because of its simplicity and suitability in regards to heat stress. Overall, there is general similarity of the various guidelines; hence, the WBGT index has become the standard technique for assessment of environmental conditions in regards to occupational heat stress.

The WBGT index takes into account environmental conditions such as air velocity, vapor pressure due to atmospheric water vapor (humidity), radiant heat, and air temperature, and is expressed in terms of degrees Fahrenheit (or degrees Celsius). Measurement of WBGT is accomplished using an ordinary dry bulb temperature (DB), a natural (unaspirated) wet bulb temperature (WB), and a black GT as follows:

$$WBGT_{in} = 0.7\ (WB) + 0.3\ (GT)$$

for inside or outside without solar load,

OR

$$WBGT_{out} = 0.7\ (WB) + 0.2\ (GT) + 0.1\ (DB)$$

for outside with solar load.

Originally, NIOSH defined excessively hot environmental conditions as any combination of air temperature, humidity, radiation, and air velocity that produced an average WBGT of 79°F (26°C) for unprotected workers. However, in the revised criteria for occupational exposure to hot environments, NIOSH provides diagrams showing work-rest cycles and metabolic heat versus WBGT exposures which should not be exceeded.[5] NIOSH has developed two sets of recommended limits: one for acclimatized workers (REL), and one for unacclimatized workers (recommended alert limit [RAL]).

Similarly, ACGIH has TLVs for environmental heat exposure permissible for different work-rest regimens and work loads.[6] The NIOSH REL and ACGIH TLV criteria assume that the workers are heat acclimatized, are fully clothed in summer-weight clothing, are physically fit, have good nutrition, and have adequate salt and water intake. Additionally, they should not have a pre-existing medical condition that may impair the body's thermoregulatory mechanisms. For example, alcohol use and certain therapeutic and social drugs may interfere with the body's ability to tolerate heat.

Modifications of the NIOSH and ACGIH evaluation criteria should be made if the worker or

conditions do not meet the previously defined assumptions. The following modifications have been suggested:

1. Unacclimatized or physically unconditioned - subtract 4°F (2°C) from the permissible WBGT value for acclimatized workers.

2. Increased air velocity (above 1.5 meters per second or 300 feet per minute) - add 4°F (2°C). This adjustment can not be used for air temperatures in excess of 90-95°F (32-35°C). This correction does not apply if impervious clothing is worn.

3. Impervious clothing which interferes with evaporation:

   a. Body armor, impermeable jackets - subtract 4°F (2°C).

   b. Raincoats, turnout coats, full-length coats - subtract 7°F (4°C).

   c. Fully encapsulated suits - subtract 9°F (5°C).

4. Obese or elderly - subtract 2-4°F (1-2°C).

5. Female - subtract 1.8°F (1°C). This adjustment, which is based on a supposedly lower sweat rate for females, is questionable since the thermoregulatory differences between the sexes in groups that normally work in hot environments are complex. Seasonal and work rate considerations enter into determining which sex is better adapted to work in hot environments.

Selection of a protective NIOSH WBGT exposure limit is contingent upon identifying the appropriate work-rest schedule and the metabolic heat produced by the work. The work-rest schedule is characterized by estimating the amount of time the employees work to the nearest 25%. The ACGIH heat exposure TLVs are published for light, moderate, and heavy work load categories.

The heat stress determination in the UIHC decontamination suite involved the definition of job requiring walking, with moderate body work. Moderate body work is defined as work such as cleaning a floor or beating a carpet. The next step up would be heavy body work such as laying railroad tracks or manual digging. Work involving the entire body was used due to the carts which are pushed around and the trays which are lifted and moved by hand. With the addition of basal metabolism, the estimated work load was 560 kilocalories (kcal) per hour. This defined a maximum WBGT of approximately 25°C or 77°F. A correction factor of 6°C was subtracted from the maximum WBGT to account for the water barrier PPE worn by personnel in the decontamination suite. This is the most conservative estimate of a WBGT exposure criteria possible for this worksite and defined a maximum WBGT of approximately 19°C or 66.2°F.

RESULTS

Glutaraldehyde

Analytical results from the glutaraldehyde monitoring are presented in Tables 1 and 2. Glutaraldehyde concentrations in the six area samples collected during the December 1997 survey were in a range of 0.0078 ppm to 0.047 ppm. Seven area and three PBZ samples for glutaraldehyde were collected in February 1998. These samples were in a range of a trace amount (a concentration between the limit of detection [LOD] and the limit of quantitation [LOQ] which NIOSH considers to be a non-numerical number) to 0.017 ppm. Glutaraldehyde concentrations in the three PBZ samples collected in February 1998 were all not detected (ND).

No exposures exceeded the NIOSH REL of 0.2 ppm or the ACGIH TLV of 0.05 ppm. Two short term area air samples (0.047 ppm, and 0.038 ppm) collected at the glutaraldehyde tanks approached the ACGIH TLV of 0.05 ppm which

is a threshold intended to protect against sensitization and the notable irritant effects of glytaraldehyde.

Subtilisins

Analytical results from the subtilisins assays are presented as Table 3. Results from the December 1997 survey are for the Alkalase™ type enzyme found only in the Orthozyme product. Small quantities of enzyme were detectable in all air samples collected in the decontamination suite. The airborne concentrations of this enzyme were well below the TLV. Determining the type of immunoassay system that could detect the Ascepti-zyme subtilisin delayed the analytical work for that enzyme, and it is likely that the original samples were partially denatured by the time of analysis. No definitive results or conclusions can thus be made from those samples. Two long term area samples were collected for the Asepti-zyme™ Savanase™ enzymes during the February 1999 site visit. Asepti-zyme™ was not detected to a LOD of 0.4 nanograms per cubic meter of air (ng/m^3).

Volatile Organic Compounds (VOCs)

Major compounds detected in the decontamination suite were propane, butane, ethanol, acetonitrile, acetone, isopropanol, and 2-butoxyethanol. Other compounds identified include some chlorofluorocarbons, methyl isobutyl ketone, propylene glycol, dipropylene glycol methyl ether, diethyl ether, limolene, eucalyptol, menthol, phenyl phenol, and glutaraldehyde.

Latex

All samples were below the method detection limit for latex allergen. The sensitivity of the latex assay was 200 ng/sample, which equates to a minimum detectable airborne concentration of 5 ng/m^3 latex based upon a sample volume of 40 cubic meter (m^3).

Heat Stress

The average indoor WBGT measured in the decontamination suite was 55.9°F, with a fluctuation of less than 1.5 °F. A review of data from 1995 submitted by UIHC to IOSH indicates that the temperature in the decontamination suite is kept between 60 and 70°F. This is a globe temperature and is consistent with the globe temperatures determined by the NIOSH WBGT monitoring conducted on this survey. The environment montiored during the NIOSH site visit indicates that workers are not exposed to an environment that is likely to cause heat stress. However, historic data submitted by the UIHC to IOSH indicates that wide humidity fluctuations (20-80% relative humidity) can occur within the decontamination suite. These higher fluctuations of relative humidity could contribute to the perception of working in a hot environment.

Ventilation

During the initial investigation, all doors, passageways, windows, etc. leading to the decontamination suite were under negative pressure with the exception of double doors on the north side of the decontamination suite. During the follow up investigation all doors to the decontamintion suite were determined to be under slight *positive* pressure.

In the December 1997 investigation, a visual inspection of AHU 23 identified damage to the return air damper housing frame. The damage looked to be caused from increased static pressure in this duct behind the damper. Mold growth was

evident on the mist eliminator, throughout the sound liner in the maintenance access chamber between the location of the mist eliminator and bank of final filters. Mold was also found downstream of the final filters in the plenum section preceding the first segment of supply duct leading to the decontamination suite. An estimated 125 square feet of area of fibrous glass sound liner was approximately 80-90% contaminated with mold in this area. Since filters do not exist in the ductwork leading to the decontamination suite mold contamination in this area is a concern because release of mold spores could entrain into the air supplied to the decontamination suite, the set assembly suite, hospital stores, and several offices. The hospital reported to NIOSH that AHU 23 was last evaluated in late 1996; therefore, it is not known how long this mold contamination had been present. When NIOSH visited the hospital in February 1998, the damage to the supply air damper had been repaired. Recirculation of supply air was no longer occurring. This was evaluated by watching as the return air damper moved to the closed position when the air handling system was turned on and also by seeing that the direct digital control monitor had been programmed to close the return air damper when the system was brought on-line. A complete inspection of the AHU was performed and no mold contamination was found. All filters were in place and were clean and no filter bypass was evident. The AHU was in good operational condition. The mold growth appeared to be caused (at least in part) by the mist eliminator not removing a sufficient amount of moisture (in the form of water droplets) from the airstream. Moisture droplets trailing off the coil and into the supply airstream could be related to a high face velocity across the coil which can result in the moisture carryover. The AHU 23 is configured to maximize cooling of supply air to the decontamination suite. The design incorporates a chilled water coil placed after the fan so that the cooled air is not reheated by the fan motor prior to supplying ventilation to the indoor environment. Mist eliminators are installed to remove moisture from an airstream, and in this case, moisture carryover from the coil. The mist eliminator failed to remove a sufficient amount of moisture (in the form of water droplets) to prevent moisture accumulation in the acoustical and thermal lining of the last section of this AHU.

During the initial survey NIOSH collected four samples of the mold-contaminated fibrous glass sound liner to subculture for identification. Laboratory analysis identified the presence of the fungi *Verticillium*, *Penicillium*, and *Penicillium corylophilum* with trace amounts of the fungi *Cladosporium*. No bacterial growth was identified and none of the fungi identified are documented to be associated with human mycotoxicosis illness (exposures to toxic metabolites in certain fungi).

Medical

No reports of respiratory illness were noted among central sterilization workers in either the review of the OSHA 200 logs or the medical records from the Occupational Medicine Clinic. During the site visit, 42 of the approximately 100 employees who work in the decontamination and set assembly areas volunteered to be interviewed. Thirty-nine (93%) of the 42 employees worked in both decontamination and set assembly, 2 (5%) worked only in set assembly, and 1 (2%) worked only in the decontamination suite. Sixteen (55%) of the 29 employees working in the sterilization area were also interviewed. Therefore, a total of 58 employees was interviewed. Twenty-three (40%) of the 58 interviewed were men. Twenty-six (45%) of the 58 worked on the first shift, the remainder worked on the second shift.

Among the 39 employees working in the decontamination and set assembly areas, respiratory and mucous membrane symptoms were the most common symptoms related to working in both areas. Twelve (30%) of 40 employees interviewed reported either dermal, respiratory, or mucosal symptoms while working

in the decontamination suite. Eight (44%) of 18 employees who did not work in the decontamination suite reported respiratory and mucosal symptoms while at work. Eleven (28%) of the 39 employees reported symptoms only when working at the decontamination suite; those symptoms were mainly nasal irritation, nasal congestion, and skin conditions. Nine (23%) of the 39 employees reported symptoms only when working in set assembly, and those symptoms were mostly nasal irritation and nasal congestion. Several employees reported more than one symptom. Eleven (28%) of the 39 employees reported no symptoms. Seventeen (44%) of the 39 employees reported symptoms both at work and while away from work, and they attributed their symptoms to seasonal allergies or infections. Three (8%) of 40 employees who worked in the decontamination suite reported they had physician diagnosed asthma, while 18 (46%) employees reported physician diagnosed sinusitis.

Eighteen of the interviewed employees worked in areas other than the decontamination suite, 16 in the sterilization suite and 2 in set assembly area. Of these employees, 8 (44%) reported symptoms of cough, wheeze, and sneeze when working. Six (33%) employees reported no symptoms at all. Several other employees reported symptoms of nasal irritation and congestion from presumed non-work related causes. One (6%) employee reported physician-diagnosed asthma, while 8 (44%) employees reported physician-diagnosed sinusitis.

DISCUSSION

Industrial hygiene monitoring for subtilisin enzymes revealed very low concentrations of subtilisins from Orthozyme, a product not commonly used in the decontamination suite. The more commonly used enzymatic cleaner Aseptizyme was initially not identified because by the time that enzyme determination was confirmed, any enzymes on the air samples would have been denatured and were likely to have changed, and no enzymatic activity could have been determined by analysis. An exposure assessment in this case would be inaccurate. In a follow up investigation enzymes were sampled again and Aseptizyme enzymes (the most commonly used enzyme) were not detected using an assay sensitive and specific for that enzyme.

The investigation in December of 1997 identified two short-term area samples for glutaraldehyde that approached the ACGIH-ceiling TLV of 0.05 ppm (instantaneous exposures to glutaraldehyde could have exceeded the ACGIH criteria). Glutaraldehyde concentrations measured in February of 1999 were well below any current exposure limits. This is explained by the fact that the hospital installed engineering controls (a filter system designed for glutaraldehyde vapor) on the scope washer between the times of the NIOSH investigations. Qualitative VOC samples revealed very low airborne concentrations of many common disinfectants and antimicrobial agents that are commonly used in hospital settings. Perfumes and odorants in these cleaners and disinfectants were identified as well. Whether the various chemicals in these products might react with each other (and possibly cause respiratory irritation) is unclear. It is more plausible that these mixed exposures along with (past) exposures to glutaraldehyde, may have contributed to irritant upper airway symptoms in the work areas investigated. Household cleaners, disinfectants, and fragrances for example, can be upper respiratory irritants. In fact, many household cleaning products carry a label which cautions users of the possible hazards of these products.

Although historic hospital temperature records are consistent with the heat stress monitoring performed on this investigation, previous humidity measurements made by the hospital indicate relative humidity variation in a range of 20-80% (most measurements were between 40-50%). High humidity inhibit's the body's ability to thermoregulate by preventing the evaporation of sweat. This increases one's perception of heat and heat stress. For office-type environments, the

American Society of Heating, Refridgerating, and Air-Conditioning Engineers, Inc (ASHRAE). recommends maintaining relative humidity levels to between 30-60%.[27] Tighter control and decreasing relative humidity within the decontamination suite to a range of 30-40% would decrease worker's perception of heat and heat stress.

Penicillium, Verticullium, and Cladosporium were the genera of fungi identified in bulk samples from the sound liner in AHU 23. *Penicillium corylophilum* was the species identified from the bulk samples collected from AHU 23. *Penicillium corylophilum* is found throughout the world, most commonly associated with moldy food. *Penicillium coryphilum* is also found in contaminated fiberglass sound liners of air handling units and in water-damaged areas of indoor environments. It is not known to produce mycotoxins.[28] The species of Verticillium and Cladosporium identified in this investigation are not known to cause illness in humans.

Mold contamination in the sound liner of AHU 23 was remediated by the UIHC after the initial site visit. NIOSH sent an interim letter dated December 29, 1997, providing guidance on remediation procedures.

The return air damper for AHU 23 had been repaired at the time of the second NIOSH site visit. This damage was almost certainly caused from the increase in static pressure when the damper was closed to prevent recirculating air into the decontamination suite. Closing the damper forced a system designed to operate with a certain degree of recirculated air to operate as a single pass system, increasing the static pressure load on the closed return damper, pulling the damper frame from the housing.

An explainable cause of the positive pressure at the north doors of the decontamination suite is the configuration of a return air duct in the corridor directly outside the north double doors, acting in concert with a supply duct located directly inside the double doors. Slight pressure differential appears to cause a slight pressure differential for air movement from inside the decontamination suite to the outside corridor. Reasons for a slight overall positive pressurization of the decontamination as identified during the second NIOSH investigation may be a malfunctioning return air damper somewhere in the system which may be causing increased supply ventilation to be be provided to the decontamination suite.

CONCLUSIONS

Employees working in the decontamination suite reported fewer work-related health symptoms (respiratory and skin symptoms, and diagnosed asthma and sinusitis) than did other CSS employees. Low-level exposures to glutaraldehyde, cleaners, disinfectants, fragrances from cleaning products, and possibly mold could have caused or contributed to some of the work-related symptoms reported by all employees. Extensive mold contamination in an AHU serving the investigated area was identified as a condition not acceptable by current building ventilation practices. Samples of mold collected from AHU 23 did not specifically identify toxicogenic mold, but molds should not be present in building ventilation systems. Partial recirculation of supply ventilation from the CSS was a contributor to an occupational health hazard. The decontamination unit was not operating under negative pressure as current guidelines suggest.

RECOMMENDATIONS

1. The specific reason(s) for positive pressurization in the decontamination suite should be identified and pressurization should be corrected to slightly negative, relative to the adjoining corridors. Possible reasons include malfunctioning return air dampers in AHU 23 or blocked supply diffusers in one of the system's zones.

2. Humidity levels within the decontamination suite should be better controlled. Maintaining 30-40% relative humidity may help to alleviate a perceived heat stress problem. Controlling moisture carryover from the AHU coils may help reduce humidity and can help to prevent mold growth in AHUs.

3. Other air handlers in the hospital configured similar to AHU 23 should be periodically inspected to check for the presence of mold such as occurred in AHU 23. If moldy sound liner is discovered, the mold should be carefully removed following the guidelines provided by NIOSH.

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Table 1
Area monitoring for Glutaraldehyde
University of Iowa Hospitals and Clinics
Iowa City, Iowa
HETA 97-0224-2740
December 10-11, 1997

Sampling Date	*Area Sampled*	*Cycle*	*Sampling Time (minutes)*	*Glutaraldehyde Concentration (ppm)*
12/10/97	Glutaraldehyde	Pre-glutaraldehyde	17	0.0078
12/10/97	Glutaraldehyde	Glutaraldehyde Bath	22	0.038
12/11/97	Glutaraldehyde	Glutaraldehyde Bath	22	0.047
12/11/97	Glutaraldehyde	Glutaraldehyde Bath	22	0.033
12/11/97	Glutaraldehyde	All day sample	540	0.013
12/11/97	Scope Drying	Blowing off scope using compressed air	15	0.02

Evaluation Criteria	
NIOSH REL-ceiling	0.2
OSHA PEL	N/A
ACGIH TLV-ceiling	0.05

Notes:

ppm -parts per million

Table 2
Area and personal monitoring for Glutaraldehyde
University of Iowa Hospitals and Clinics
Iowa City, Iowa
HETA 97-0224-2740
February 3-4, 1999

Sample # and sample media	***Sample type and location***	***Activity***	***Time (time in minutes/hr.)***	***Parts per million (ppm)***
UIHC1 (filter)	Scope washer, Area sample	washer operated at various times	10 hrs	0.0073
UIHC2 (filter)	Scope washer Area sample	washer operated at various times	10 hrs	0.0098
UIHC3 (filter)	Scope washer, PBZ sample	adding Aseptizyme, scopes to washer	7 minutes	ND
UIHC4 (filter)	Fume hood PBZ sample	removing items from glutaraldehyde basins	1.5 minutes	ND
UIHC5 (filter)	Above scope washers left tank (lid closed), Area sample	washer operating	26 minutes	0.0073
UIHC6 (filter)	Scope washer right tank Area sample	washer operating	62 minutes	0.017
UIHC7 (filter)	Scope washer (lids closed) PBZ sample	technician replacing a switch on the controls panel	7 minutes	ND
UIHC8 (filter)	Scope washer left tank, Area sample	washer operating	21 minutes	trace
UIHC- T1 (tube)	Scope washer left tank, Area sample	washer operating	21 minutes	trace
UIHC- T2 (tube)	Scope washer left tank, Area sample	washer operating	206 minutes	0.0049

Notes:
PPM=parts per million
ND= not detected
PBZ = personal breathing zone

Table 3
Area monitoring for Subtilisins
University of Iowa Hospitals and Clinics
Iowa City, Iowa
HETA 97-0224-2740
December 10-11, 1997

Sampling Date	*Area Sampled*	*Sampling Time (minutes)*	*Subtilisins Concentration (ug/m^3)*	*Subtilisins Concentration (ug/sample)*
12/10/97	Decontamination Suite in the Clinics Area	205	3.5×10^{-5}	1.2765×10^{-3}
12/11/97	Decontamination Suite in the Scope Cleaning Area	230	1.57×10^{-5}	6.5149×10^{-4}
12/11/97	Set Assembly Suite	302	ND	ND
12/11/97	Wipe sample Ceiling exhaust diffusers in Scope Cleaning Area	NA	NA	9.6×10^{-5}
12/11/97	Wipe sample Ceiling exhaust diffusers in Clinics Area	NA	NA	6.2×10^{-5}
Evaluation Criteria for full-shift PBZ exposure:				
ACGIH TLV-ceiling	**Pure Enzyme**		6.0×10^{-2}	

Notes:
NA = not applicable

Table 4
Quantitative Pressure Measurements in the Decontamination Suite
University of Iowa Hospitals and Clinics
Iowa City, Iowa
HETA 97-0224-2740
December 10-11, 1997

Measurement Date	*Opening Monitored*	*Measured Pressure (inches of water)*	*Pressure Status of Decontamination Suite*
12/10/97	Door # 327	-0.002 to -0.003	Negative to Corridor
12/11/97	Door # 327	-0.005	Negative to Corridor
12/10/97	Door # 327-2	0.000	Equal to Corridor
12/11/97	Door # 327-2	0.003	Positive to Corridor
12/10/97	Door # 313-1	-0.002	Negative to Interior Room
12/11/97	Door # 313-1	-0.000	Equal to Corridor
12/10/97	Door # 327-1	-0.002	Negative to Corridor
12/11/97	Door # 327-1	-0.002	Negative to Corridor
12/10/97	South Window	-0.001	Negative to Set Assembly Suite
12/11/97	South Window	-0.006	Negative to Set Assembly Suite
12/10/97	North Window	-0.001	Negative to Set Assembly Suite
12/11/97	North Window	-0.002	Negative to Set Assembly Suite

Table 5
Qualitative Pressure Measurements in the Decontamination Suite
University of Iowa Hospitals and Clinics
Iowa City, Iowa
HETA 97-0224-2740
February 3-4, 1999

Measurement Date	***Opening Monitored***	***Visual (chemical smoke) Pressure Status of Decontamination Suite***
2/14/99	Door # 327 (S. Door)	Positive to Corridor
2/14/99	Door # 327-1 (W. Door)	Positive to Corridor
2/14/99	Door #327-2 (N. Door)	Positive to Corridor
2/14/99	South pass-through window	Negative to Set Assembly area
2/14/99	North pass-through window	Negative to Set Assembly area

National Institute for Occupational Safety and Health (NIOSH) Health Hazard Evaluation at the University of Iowa Hospitals and Clinics Decontamination Suite

What NIOSH Did

Sampled for glutaraldehyde enzymes, latex proteins, and volatile organic compounds.

Measured for heat stress.

Inspected air handling units, evaluated pressure differences in the decontamination suite, set assembly, and corridor areas.

Administered a health questionnaire to employees.

What NIOSH Found

A health hazard was not found for exposures to glutaradehyde, enzymes, latex protein, volatile organic compounds or heat stress.

The decontamination suite was under positive pressure.

Mold was found in air handling unit 23 and a damper on that unit was damaged. Mold was removed and the damper was fixed by the hospital.

Employees working the decontamination suite reported almost the same amounts of health symptoms as employees in the set assembly area.

The hospital installed a filter on the scope washer which reduced glutaraldehyde concentrations.

What University of Iowa Hospital Managers Can Do

Correct pressurization in the decontamination suite.

Maintain better control of humidity in the decontamination suite.

Periodically inspect air handlers to insure proper operation and inspect for the presence of mold.

What University of Iowa Hospital Employees Can Do

Continue to use safe work practices when using glutaraldehyde.

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report # 97-0224-2740

NIOSH

For Information on Other
Occupational Safety and Health Concerns

Call NIOSH at:
1–800–35–NIOSH (356–4674)
or visit the NIOSH Homepage at:
http://www.cdc.gov/niosh/homepage.html

National Institute for Occupational Safety and Health
NIOSH

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