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I. SUMMARY

In November l986 the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate potential exposures to chemicals in the histology department at Colorado State University (CSU) in Fort Collins, Colorado.

On December ll, l986 a medical and environmental investigation was performed in the CSU veterinary tissue fixing and histology laboratories, collectively called the histopathology laboratory. One general room air sample and five breathing zone samples were collected and analyzed for toluene, xylene, acetone, and ethanol. Toluene was measurable in two of the six samples with levels of 1.8 and 0.6 mg/M^3. The evaluation criteria is 375 mg/M^3. Xylene was measurable in four of the six samples with levels of 1.6, 1.8, 2.0, and 3.9 mg/M^3. The evaluation criteria for xylene is 435 mg/M^3. Acetone was not detected in any of the six samples. Ethanol was found in all six samples with concentrations ranging from l.8 to 35.7 mg/M^3 and an average of l3.6 mg/M^3. The evaluation criteria for ethanol is l900 mg/M^3. The ventilation system was evaluated in all areas of the laboratory. Exhaust laboratory hoods and work station hoods need to be upgraded and improved for better local exhaust ventilation.

All workers in the histopathology laboratory were interviewed by a NIOSH physician and asked to complete a questionnaire designed to elicit solvent exposure symptoms. Compared to the buildings' other laboratory employees, the histopathology employees complained of excessive constitutional, cognitive, respiratory/irritant, and emotional symptoms. In addition, the six histopathology technicians had their medical records reviewed, including recent results of their complete blood counts (CBC), automated serum chemistries (SMA-22), chest radiographs (CXR), electrocardiograms (EKG), urinalysis, and serum xylene and toluene levels. Results of these tests showed no evidence of work-related injury or illness.

Based on medical and environmental data a health hazard did not exist at the time of this evaluation, however exposures may have been higher when the laboratory was operating at full capacity.

KEYWORDS: SIC 8071 (Medical laboratories) xylene, toluene, acetone, ethanol

II. INTRODUCTION

NIOSH received a request from the Director, Environmental Health Services at CSU in November of l986 to evaluate chemical exposures in the tissue fixing and histology laboratory. An environmental and medical evaluation was conducted on December ll, l986. Results of the environmental and medical evaluation were discussed with the University in January and February of 1987.

III. BACKGROUND

The CSU histopathology laboratory employs six full-time technicians and one veterinary resident who rotates through the lab for a period of two months. The laboratory occupies five rooms: one for storing animal tissues and organs, one for tissue fixing, one for microtoming, one for staining and mounting the histological specimens, and one used as an office and for coffee breaks. Most symptoms occurred in the tissue fixing room. The room was equiped with two automated tissue processing machines (Technicons) until July 1, 1986 when two additional machines were installed. On this same date, July 1, 1986, all four technicons changed solvents, from chloroform to toluene. When employees of the laboratory repoted health problems occurring at work, the lab was closed from November 3, 1986 to approximately November 15, 1986, and re-opened with only one technicon unit in operation. The environmental component of this evaluation was to document exposures to toluene, xylene, and ethanol, and the medical component was to determine if the workers' health had been affected from previous and current exposures to these chemicals.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

One general room air sample and five personal samples were collected in the histopathology laboratory. These samples were collected on workers doing routine activities using organic vapor charcoal sampling tubes and vacuum pumps operated at approximately l00 cc/minute.

Ventilation measurements were made in each of the rooms in the department and on each of the fume hoods to evaluate the average capture velocity. A thermo-anemometer air velocity meter was used to perform the reading on hoods, doorways, and other entrys. A flowhood was used to evaluate the intake and exhaust air vents. The flowhood has different size attachments that can be easily assembled that enable one to use the instrument on almost any size air vent. Direct readings can be made for both exhaust and intake air in cubic feet per minute.

B. Medical

All seven histopathology laboratory employees were interviewed confidentially. The interview contained questions regarding work history, smoking history, current health conditions, past medical history, and any medication usage. In addition to medical interviews, all seven employees completed a questionaire designed to elicit solvent exposure symptoms. This questionnaire was also given to three technicians working in the adjacent laboratory and four technicians working one floor above the histopathology laboratory. One technician from the adjacent laboratory refused to complete the questionnaire. The control laboratories had not

previously reported work-related symptoms.

The questionnaire consisted of seven categories of symptoms: constitutional, cognitive, emotional, gastrointestinal, respiratory/irritant, peripheral nervous system, and skin symptoms. Each category contained four questions (except skin condition symptoms, which contained two questions). An individual was considered to be suffering from a categories' symptom if he or she reported three of the four symptoms for each category occurring at work "moderately" or "quite a lot" two months prior to the interview. For skin symptoms, if the individual reported one of the two symptoms she/he was considered to be suffering from skin symptoms.

The NIOSH medical officer reviewed the medical records of the six histopathology technicians in the affected laboratory, including recent results of their complete blood counts (CBC), automated serum chemistries (SMA-22), chest radiographs (CXRs), electrocardiograms (EKGs), urinalysis, and serum xylene and toluene levels. Most of these tests were performed on ll/3/86, the day the histopathology laboratory closed following the health complaints. The remainder of the tests were completed during the following two weeks during which time the laboratory remained closed.

V. EVALUATION CRITERIA

A. Environmental

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for 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 if 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 at the level set by the evaluation 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 Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits, by contrast, are based primarily on concerns relating to the prevention

of occupational disease. In evaluating the exposure levels and the recommendations for

reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

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 or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term expose.

Environmental Exposure Limits
Time-Weighted Average (TWA)
(mg/M**3)**

Toluene——————————375 NIOSH & OSHA
Xylene——————————435 NIOSH & OSHA
Acetone——————————590 NIOSH, 2400 OSHA
Ethanol——————————l900 NIOSH

B. Toxicological

Toluene Toluene is toxic by all three routes of entry into the human body. Acute exposure produces irritation of the eyes, respiratory tract and skin. At high concentrations it may cause fatigue, weakness, confusion, headache, dizziness, and drowsiness. Chronic exposure will lead to cracking of the skin. Examination of the central nervous system, liver and kidneys should be stressed on physicals provided to workers exposed to toluene.[1]

Xylene Xylene exposure may cause irritation of the eyes, nose and throat. Repeated or prolonged skin contact with xylene may cause drying and defatting of the skin which may lead to dermatitis. Liquid xylene is irritating to the eyes and mucous membranes, and aspiration of just a few milliliters may cause chemical pneumonitis, pulmonary edema, and hemorrage. Repeated exposure to the eyes to high concentrations of xylene vapor may cause reversible eye damage. Acute exposure to xylene vapor may cause central nervous system depression and minor reversible effects upon liver and kidneys. At high concentrations, xylene vapor may cause dizziness, staggering, drowsiness, and unconsciousness.[2]

Acetone Acetone has been considered to be a low hazard to health, since few adverse health effects have been reported, despite widespread use for many years. Awareness of mild eye irritation occurs at airborne concentrations of about l000 parts per million (ppm). Very high concentrations (l2,000 ppm) depress the central nervous system, causing headache, drowsiness, weakness, and nausea. Repeated direct skin contact with the liquid may cause redness and dryness of the skin.[2] However, at least six studies have been reported in the literature which have documented possible adverse effects on humans at exposures below l000 ppm. Additional evidence indicates that occupational exposure to acetone may lead to its accumulation in the body. NIOSH has recommended lowering the current exposure limit from l000 ppm to 250 ppm (590 mg/M^3).

Ethanol Ethyl alcohol is an irritant to the eyes and respiratory tract. Very high exposures may cause defatting dermatitis, headache, dizziness, drowsiness, mental confusion, fatigue, anorexia, nausea, tremors, narcosis and repeated exposure may lead to liver damage. Occupational overexposures to ethyl alcohol are rare.

VI. RESULTS AND DISCUSSION

A. Environmental

On December ll, l986 NIOSH conducted an evaluation of the histopathology laboratory at CSU, Fort Collins, Colorado. One general room air sample and five personal samples were collected for toluene, xylene, acetone, and ethyl alcohol. Toluene was found in two of the breathing zone samples at concentrations of 1.8 and 0.6 mg/M^3. Xylene was found in three breathing zone samples at concentrations of l.6, 2.0, and l.8 mg/M^3, and in one general room air sample at a concentration of 3.9 mg/M^3. Acetone was not found in any of the air samples. Ethyl alcohol was found in all the air samples at concentrations ranging from 35.7 to l.8 mg/M^3, with an average of l3.6 mg/M^3. The evaluation criteria for ethyl alcohol is l900 mg/M^3. All environmental sampling performed at the time of this survey indicated that there were no overexposures.

Ventilation measurements were made on all exhaust hoods, the exhaust vents and the intake air vents. Ventilation measurements were made throughout the five rooms. All rooms where tissue fixing, staining, microtoming and other specimen preparation was occurring had positive air pressure. The quantity of fresh dilution air was sufficient at the time of this survey as indicated by the levels of chemicals found in the air samples. The hood over the four technicons needs to be vented directly out of the building and not into another hood as it is now. All the hoods need to be enclosed as much as possible so that the capture velocity will be more effective.

B. Medical

The SMA-6, SMA-22, urine tests, EKGs, and CXRs performed between ll/3/86 and ll/l8/86 showed no evidence of work-related injury or illness. The serum xylene and toluene levels, drawn one week after laboratory closure, showed no detectable levels.

Compared to the building's other laboratory employees, the histopathology employees had higher prevalences of constitutional, cognitive, respiratory/irritant, and emotional symptoms (Table l). The reported prevalences of gastrointestinal, peripheral nervous system, and skin symptoms were not significantly different between the two groups.

VII. CONCLUSIONS

Environmental air monitoring indicated that there were no overexposures to toluene, xylene, acetone, and ethyl alcohol at the time of this evaluation. There was sufficient fresh, clean, dilution air entering the building to prevent a build up of the solvents used in the laboratory.

Compared to employees in the building's other laboratories, the histopathology employees have an increased self-reported prevalences of constitutional, cognitive, emotional, and respiratory irritant

symptoms. This difference may be due to reporting bias, or previous exposure to workplace solvents when the laboratory was operating at full capacity.

VIII. RECOMMENDATIONS

1. The facilities engineers at CSU should adjust the intake air handlers so that each lab has an adequate volume of make up air to compensate for the air exhausted by the hoods.

2. All exhaust hoods, both large laboratory hoods, and the small hoods used for tissue mounting and staining should be enclosed as much as possible.

3. If the histopathology laboratory resumes full production capacity, and the medical symptoms recur in this group of employees, and environmental sampling for toluene and xylene is not available, all individuals in the histopathology laboratory should by biologically monitored to estimate their solvent exposure. This can be accomplished by obtaining serum xylene and toluene levels prior to and following an 8-hour workshift, or collecting urine hippuric acid and methylhippuric acid concentrations at the end of the workshift. A group average below 2 grams of hippuric acid or methylhippuric acid per 2 grams of creatinine suggest that the atmosphere probably contains less than l00 ppm toluene or xylene[3]. Exposure to l00 ppm of toluene at rest and light exercise (NIOSH l0-hour evaluation criteria is l00 ppm), corresponds approximately to serum toluene levels of 40 ug/l00 ml, respectively[3]. Exposure to 90 ppm of xylene at rest and light exercise (NIOSH 10-hour evaluation criteria is l00 ppm) corresponds approximately to serum xylene levels of l30 ug/l00 ml and 2l0 ug/l00ml, respectively.[3]

IX. REFERENCES

1. NIOSH/OSHA occupational health guideline for toluene, pp. 1-5.

2. Occupational Health Guidelines for Chemical Hazards, DHHS (NIOSH) No. 81-123, January 1981.

3. Lauwerys, R.R. Industrial chemical exposure: guidelines of biological monitoring, Davis, CA: Biomedical Publications, 1983, p.57-69.

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XI. DISTRIBUTION AND AVAILABILITY:

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through the NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Colorado State University.
2. U.S. Dept. of Labor/OSHA/Region VIII.
3. NIOSH, Denver Region.
4. Colorado State Health Department.

For the purpose of informing affected employees, a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1

Reported Symptoms of Laboratory Employees
Colorado State University
Ft. Collins, Colorado
October-December 1986
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SYMPTOMS	HISTOPATHOLOGY LABORATORY (N=7)		OTHER LABORATORIES (N=6)		SIGNIFICANCE*
	#	%	#	%	
Constitutional	6/7	86%	0/6	0	p=.004
Cognitive	4/7	57%	0/6	0	p=.049
Emotional	5/7	71%	0/6	0	p=.017
Gastrointestinal	0/7	0	0/6	0	p=1.00
Skin	6/7	86%	2/6	33%	p=.082
Respiratory/Irritant	5/7	71%	0/6	0	p=.017
Peripheral Nervous System	1/7	14%	0/6	0	p=.539

*Fisher's Exact Test (One-tailed)

Table 2

Breathing Zone and General Room Air Concentrations of
Toluene, Xylene, Acetone, and Ethyl Alcohol at
Colorado State University,
Veterinary Tissue Fixing and Histology Laboratory
Ft. Collins, Colorado
December 11, 1987

Sample #	**Job**	**Location**	**Sampling Time**	**Tol**	**XYL (mg/M^3)**	**ACE**	**ETOH**
A	Medical Tech.	Staining	7:37a - 1:00p	*	1.6	*	13.8
B	Histo. Tech.	Microtome	7:45a - 1:00p	*	2.0	*	5.5
C	Histo. Tech.	Embedding	7:50a - 1:05p	1.8	*	*	1.8
D	Lab Coordinator	Microtome	7:53a - 1:05p	0.6	1.8	*	4.0
E	Histo. Tech.	Microtome	8:45a - 1:10p	*	*	*	26.7
F	General Room	Staining	8:45a - 1:15p	*	3.9	*	35.7
Evaluation Criteria				375	435	590	1900
Laboratory Limit of Detection				0.01	0.01	0.01	0.01