U. S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT HE 80-31-693

EMORY UNIVERSITY PATHOLOGY DEPARTMENT
Atlanta, Georgia 30322

June 1980

I. SUMMARY

On October 10, 1979, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate exposure of histology and cytology technologists at the Emory University Pathology Department in Atlanta, Georgia to determine whether airborne xylene vapors from tissue slide preparation procedures posed any health hazard to the technologists. To evaluate the exposure, we conducted an industrial hygiene survey on November 8, 1979 in both the Histopathology and Cytopathology Laboratories. Six personal and four area samples for xylene and other solvent vapors were obtained.

Average daily exposures to xylene vapors were found to be well below the permissible exposure limit of 100 ppm. Short-term exposures to vapors during the manual slide preparation procedures were also found to be below the 150 ppm limit for brief (15-minute) exposures.

On the basis of the airborne vapor exposure data obtained by NIOSH during this investigation, NIOSH determined that no health hazard was caused by exposure to xylene vapors at levels measured during the survey. However, xylene may also be absorbed into the body through the skin, and technologists did have substantial skin contact with liquid xylene during the final stages of tissue slide preparation, particularly when applying the coverslips to the slides. For this reason, NIOSH recommends further improvements in ventilation and work practices which are detailed in page 6 of this report.

II. INTRODUCTION

On October 10, 1979, an Administrative Assistant in the Emory University Pathology Department (SIC 8061), Atlanta, Georgia, submitted a letter to NIOSH requesting a survey to evaluate exposures of histology and cytology technologists (SIC 8071) to xylene vapors to determine whether new hood systems were effective in controlling exposure. NIOSH is authorized by the Occupational Safety and Health Act of 1970* to investigate the toxic effects of substances found in the workplace.

* Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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.

In response to this request, an industrial hygiene survey was conducted on November 8, 1979, at which time an official Request for Health Hazard Evaluation form was completed. Both average daily exposure and short-term exposure during coverslipping were assessed using personal and area vapor sampling techniques.

III. BACKGROUND

The health hazards of exposure to xylene vapor have been recognized and documented in the scientific and medical literature in regard to histology and cytology technologists who process tissue samples and slides for pathological exaination.[1] Local exhaust ventilation and proper work practices have been suggested for controlling exposure, particularly during the final stage of processing the tissue and during the placement of coverslips (a procedure called "coverslipping").

At the Emory University Histopathology Laboratory, it is reported that the coverslipping process is performed on the average of 2 hours/day, 5 days/week. One histology technologist is assigned all the laboratory's coverslipping duties for a given week, along with seven technologists who share the duties on a rotating basis, one week each.

In the Cytopathology Laboratory, it is reported that the coverslipping process is performed on the average of 3 times per week by each of the three cytology technologists, and that the process normally requires an average of 1 hour and 15 minutes each time. This amounts to approximately 4 hours of direct exposure per technologist per week.

IV. EVALUATION METHODS AND MATERIALS

Both personal and area air samples for xylene vapors were collected. Some personal samplers were worn most of the day by selected technologists to evaluate average daily expoure. Other samples were worn only during the coverslipping procedures to evaluate the magnitude of the short-term exposures. These samples were collected by drawing air by means of a small battery operated pump through a collector containing activated charcoal. The airborne xylene vapor was absorbed on the charcoal and sent to an analytical chemistry laboratory, where the collected xylene was quantitated using a gas chromatographic technique. [2,3]

Short-term exposures were also monitored using Drager direct-reading gas indicator tubes Toluene 25/a which measure both toluene and xylene vapors.

V. EVALUATION CRITERIA

PERMISSIBLE EXPOSURE LIMITS [4,5]
for xylene vapor:
100 ppm Daily average
150 ppm Short exposures of 15 minutes or less

HARMFUL EFFECTS[6]

Local--

Xylene vapor 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 few milliliters may cause chemical pneumonitis, pulmonary edema, and hemorrhage. Repeated exposure to the eyes to high concentrations of xylene vapor may cause reversible eye damage.

Systemic--

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. Also at very high concentrations, breathing xylene vapors may cause pulmonary edema, anorexia, nausea, vomiting, and abdominal pain.

The Permissible Exposure Limits listed above refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at concentrations at or below the permissible limit; a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness.[5]

The daily average limit refers to the time-weighted average concentration for a normal 8-hour workday or 40-hour work-week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

The Short Term Exposure Limit refers to the maximal concentration to which workers can be exposed for a period up to 15 minutes continuously without suffering from 1) irritation, 2) chronic or irreversible tissue change, or 3) narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency, provided that no more than four excursions

per day are permitted, with at least 60 minutes between expousre periods, and provided that the daily average limit also is not exceeded. The short-term limit should be considered a maximal allowable concentration, or ceiling, not to be exceeded at any time during the 15-minute excursion period.

VI. RESULTS

Results of personal and area air samples revealed that exposure was less than the 100 ppm daily average limit as well as the 150 ppm short-term exposure limit. Individual sample results are shown in Table 1.

Instantaneous vapor concentrations measured with the direct-reading indicator tubes were also generally within acceptable limits. These samples were taken during the coverslipping operations when levels were at their highest. Because the accuracy of these tubes are generally within a plus-or-minus 25% range, and because of the age of the tubes used, these readings should only be considered approximate indications of vapor concentrations.

The indicator tube readings are presented below:

Histopathology Laboratory
Xylene Breathing Zone Vapor Concentrations During Coverslipping

Begin	11:40 A.M.	0 ppm
	11:45 A.M.	69 ppm
	12:00 Noon	138 ppm
	12:15 P.M.	184 ppm
	12:30 P.M.	104 ppm
	12:45 P.M.	115 ppm
Finish	1:25 P.M.	115 ppm

Cytopathology Laboratory
Xylene Breathing Zone Vapor Concentrations During Coverslipping

Begin	2:38 P.M.	0 ppm
	2:50 P.M.	less than 23 ppm
End	2:57 P.M.	
Begin	3:45 P.M.	
	4:05 P.M.	less than 46 ppm
End	4:12 P.M.	

VII. DISCUSSION AND CONCLUSIONS

Airborne exposure levels to xylene vapors were within recommended limits. Therefore, it is believed that no long-term or serious short-term health effects will result from exposure to airborne xylene vapors. Other vapors such as toluene, ethanol and isopropanol were also detected in the air samples. However, as shown in Table II, the levels were far below the exposure limits. Even if all the solvent vapors are considered additive in their potential for producing narcosis, the summed exposures are still well below the exposure limit, and no short-term narcotic effects would be expected from airborne vapor exposure.

During the coverslipping process, the technologists place a cloth or paper towel on the surface beneath the slides they are processing. Liquid solvents containing xylene drip onto the towel. As the work proceeds, the towel becomes increasingly wet with xylene, and the evaporation rate increases. This trend can be seen in the gradual rise in airborne xylene levels in the technologist's breathing air as measured by the direct-reading indicator tubes. If the towels were changed and removed from the area several times during the coverslipping, this needless exposure could be reduced.

In addition to the airborne exposure where technologists inhale xylene vapors, there is substantial skin contact, since wearing of protective gloves is considered impractical by the technologists. Xylene can be percutaneously absorbed into the body, increasing exposure. Therefore, the technologists may be absorbing more xylene than one would expect based on airborne exposure alone. This may have contributed to the occasional symptoms of headache, nose and eye irritation experienced in the past.

The lab has installed small hoods marketed under the name of Fume-Gard^{R} by Lerner Laboratories. These consist of small hoods enclosed on 3 sides and equipped with a fan and disposable charcoal filters to collect xylene vapor prior to discharge of air back into the laboratory. Two problems were observed with this system, as designed and installed.

1. Hood not available for coverslipping in the Histology Lab

   In the Histology Lab, a dual hood system is installed above the slide processing trays. When the trays are open, the evaporation of solvent quickly saturates the charcoal filter.

   The coverslipping procedure is not performed under the hood, but on the open bench top in front of the hood. Therefore, the person coverslipping is not protected by the hood from xylene vapors arising from the coverslipping procedure.

2. Saturation of the charcoal filters

   The filters in the hoods were saturated and therefore ineffective in removing xylene and other vapors. Detector tube samples taken above the filter exhaust measured 69 ppm xylene in the Histology Lab and 172 ppm in the Cytology Lab at times during the coverslipping procedure. Charcoal tubes samples taken at these filter exhausts for longer time periods measured 28 ppm in the Histology Lab and 32 ppm in the Cytology Lab.

In order for the Fume-Gard System to be effective, filters must be changed prior to saturation. In these labs, this may require changing the filters weekly or more often. Whenever the odor of xylene may be detected at the filter discharge, the filters should be changed.

A preferable method of control, which would not require as much attention and maintenance by the technologists would be to connect the filter outlet to a duct where the exhaust air could be discharged into a permanent hood discharge duct or to the outdoors. The supplier of the hoods also markets an outside vent adapter which can be used for this purpose. If discharged outdoors, it is advisale to insure that no air pollution problem is created by the discharged vapors.

The manufacturer's literature is explicit regarding both of the above problems. Furthermore, the instruction booklet states "The hood is not designed to be used as a storage cabinet for open containers."[7]

VIII. RECOMMENDATIONS

If direct dermal exposure to liquid xylene cannot be avoided during coverslipping, then it may be prudent to lower airborne exposure as much as is practical. This can be done by more efficient operation of the hood system and through improved work practices. Specifically, it is recommended that the Histology coverslipping operator perform this procedure inside a hood. The charcoal filters should be changed more frequently to avoid saturation, and certainly whenever xylene odors begin to penetrate through the filter and into the exhaust air. Preferably, the hoods could be equipped with outside adapters so that the discharged air will not re-enter the room

The cloth or paper towels placed beneath the coverslipping procedures should be changed and removed from the area at 15 minute intervals to reduce the xylene evaporation rate. This is a simple work practice which could lower the exposure level significantly.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and Report Prepared by:	Paul Roper Regional Program Consultant NIOSH Region IV Atlanta, Georgia
Originating Office:	Hazard Evaluations and Technical Assistance Branch NIOSH Cincinnati, Ohio
Industrial Hygiene Survey Assistance:	Thomas McKinley Acting Chief Occupational Health Unit Georgia Department of Human Resources Atlanta, Georgia
Laboratory Analysis of Air Samples:	Utah Biomedical Test Laboratories Salt Lake City, Utah (a NIOSH contractor)
Report Typing and other: Clerical Suppoort	Barbara Rice Secretary NIOSH, Region IV Atlanta, Georgia

X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

Copies of this report have been sent to:

a) Emory University Pathology Dept.
b) U.S. Department of Labor, OSHA, Region IV
c) NIOSH, Region IV
d) Georgia Department of Human Resources
e) Occupational Safety and Health Consultation Program, Georgia Institute of Technology

For the purpose of informing the approximately 15 "affected employees", the employer will promptly "post" the Determination Report for a period of thirty (30) calendar days in a prominent place(s) near where the affected employees work.

XI. REFERENCES

1. Bush, Capt. Conrad L., and Capt. George E. Nelson, USAF, "Xylene-Dangers of Its Use in the Histology and Cytology Laboratory", Laboratory Medicine, Vol. 8 No. 4, p. 16, April 1977.

2. NIOSH Manual of Analytical Methods, Second Edition, Volume 2, pgs S59-1 through S59-9, 1977.

3. NIOSH Manual of Analytical Methods, Second Edition, Volume 1, pgs. 127-1 through 127-7, 1977.

4. General Industry OSHA Safety and Health Standards (29 CFR 1910), U.S. Dept. of Labor, OSHA Publication 2206, Subpart Z Section 1910.1000, Revised, November 7, 1978.

5. "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1979", American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

6. Occupational Diseases - A Guide to Their Recognition, NIOSH, Cincinnati, Ohio, Revised Edition, June 1977.

7. Fume-Gard^{R} Odor Control Instructions, Lerner Laboratories, Stamford, CT, 1977.

TABLE I

AIRBORNE XYLENE VAPOR CONCENTRATIONS

EMORY UNIVERSITY PATHOLOGY DEPARTMENT
Atlanta, Georgia

HE 80-31

November 8, 1979

HISTOPATHOLOGY LABORATORY

Sample No.	SAMPLE DESCRIPTION	DURATION	CONCENTRATION
H-1	Technologist who did not perform coverslipping; sat at opposite end of the lab	9:04 a.m.-1:35 p.m.	2.5 ppm
H-2	Technologist who coverslipped; sample for daily average exposure	9:18 a.m.-1:32 p.m.	20.5 ppm
H-3	Technologist; while coverslipping tissue slides	11:37 a.m.-1:28 p.m.	72.6 ppm
H-4	Area of benchtop where coverslipping is performed; during coverslipping	11:33 a.m.-1:26 p.m.	18.3 ppm
H-5	Area in the exhaust air from Fume-Gard filter over slide prep. trays	10:47 a.m.-1:26 p.m.	28.3 ppm
	CYTOPATHOLOGY LABORATORY		
C-1	Technologist; daily average	9:23 a.m.-4:23 p.m.	1.6 ppm
C-2	Technologist; daily average	9:25 a.m.-4:21 p.m.	1.8 ppm
C-5	Technologist; during coverslipping	2:38 p.m.-2:57 p.m. and 3:48 pm.-4:12 p.m.	12.8 ppm
C-3	Area at Fume Gard filter air discharge	2:35 p.m.-2:58 p.m. and 3:49 p.m.-4:12 p.m.	32 ppm
C-4	Area of benchtop near coverslipping	2:35 p.m.-2:57 p.m. and 3:49 p.m.-4:15 p.m.	15 ppm
OSHA Exposure Concentration Limit (8-hour average)			100 ppm

TABLE 2

AIRBORNE SOLVENT VAPOR CONCENTRATIONS

EMORY UNIVERSITY PATHOLOGY DEPARTMENT
Atlanta, Georgia

HE 80-31

November 8, 1979

HISTOPATHOLOGY LABORATORY

SAMPLE	XYLENE CONCENTRATION (ppm)	TOLUENE CONCENTRATION (ppm)	ETHANOL CONCENTRATION (ppm)	ISOPROPANOL CONCENTRATION (ppm)
H-1	2.5	2.0	12.6	4.9
H-2	20.5	2.6	9.0	3.6
H-3	72.6	4.2	10.9	2.8
H-4	18.3	2.8	12.9	4.3
H-5	28.3	2.5	94.3	4.1

CYTOPATHOLOGY LABORATORY

C-1	1.6	0.17	26.9	0.26
C-2	1.8	0.15	53.7	1.14
C-3	31.9	3.15	33.6	2.4
C-4	15.0	2.16	41.2	0.42
C-5	12.8	1.39	46.4	0.86
	100	200	1,000	400