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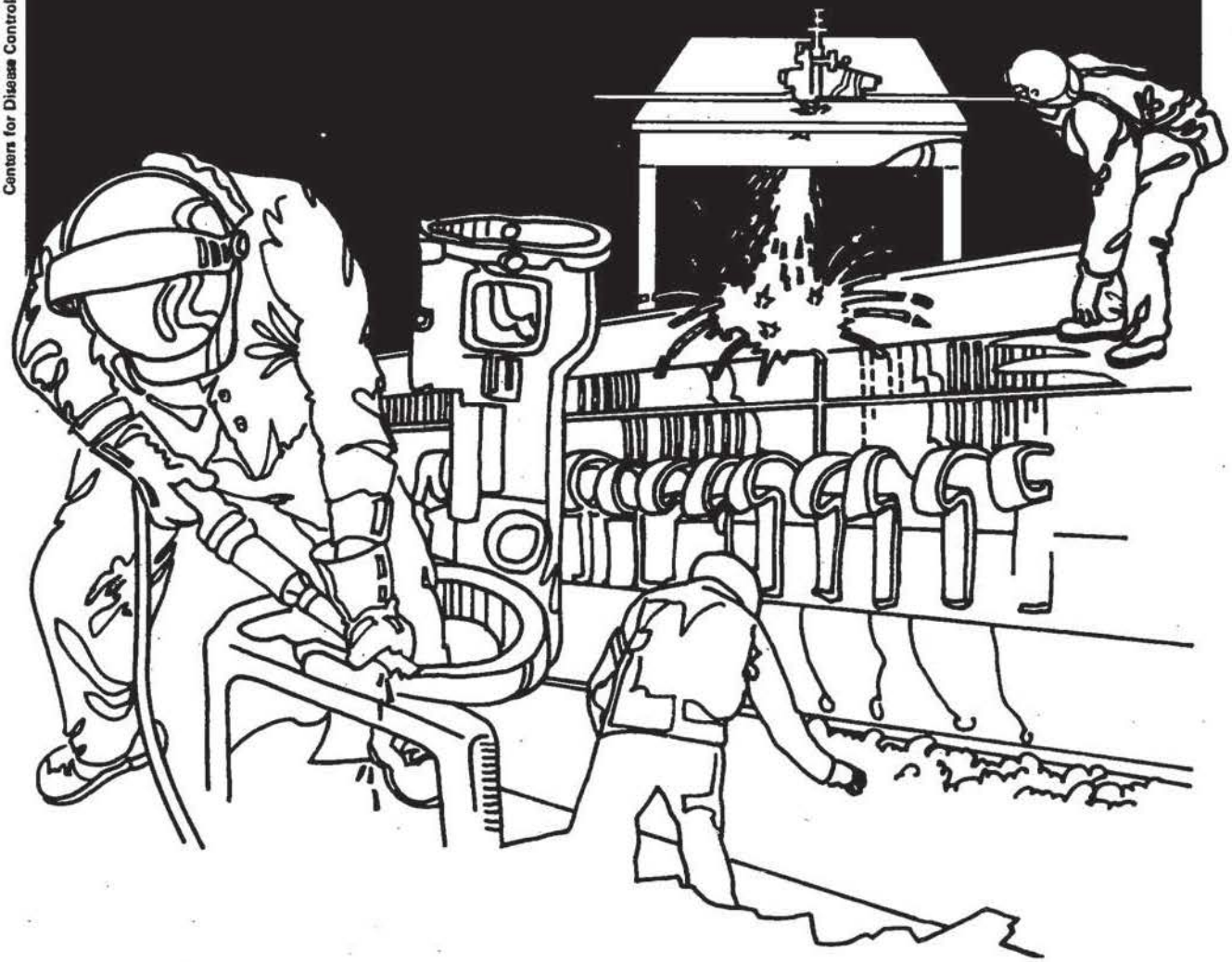

Health Hazard Evaluation Report

HETA 82-242-1234
OLYMPIC PENINSULA KIDNEY CENTER
BREMERTON, WASHINGTON

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.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 82-242-1234
November 1982
Olympic Peninsula Kidney Center
Bremerton, Washington

NIOSH INVESTIGATORS:
Arvin G. Apol

I. SUMMARY

In May, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the management of Olympic Peninsula Kidney Center to determine the employees' exposure to formaldehyde.

On June 30, and July 21, 1982, NIOSH collected nine breathing zone and general area environmental air samples to determine the workers' exposure to formaldehyde vapors. The employees were interviewed regarding current and past adverse health effects.

All the workers except the one who flushes the artificial kidneys had formaldehyde exposures that were from 0.04 to 0.12 ppm. During the one hour he flushed the kidneys his average exposure was 0.36 ppm and during the 10-minute period he emptied and refilled the carboy with formaldehyde his exposure was 1.75 ppm. This worker stated that when he empties and refills the carboy his eyes burn and tear and his nose burns.

On the basis of the data collected for this investigation, NIOSH determined that one worker had a formaldehyde exposure of 0.36 ppm when he flushed the artificial kidneys and 1.75 ppm when he emptied and refilled the carboy with formaldehyde. The other employees had formaldehyde exposure of 0.04 to 0.12 ppm. Since NIOSH recommends that formaldehyde be considered a potential occupational carcinogen, as a prudent public health measure, engineering controls and stringent work practices should be employed to reduce occupational exposures to the lowest feasible limit. Recommendation involving exhaust ventilation and work practices have been included in the report.

KEYWORDS: SIC 8071 (Medical Laboratories) Dialysis, Formaldehyde

II. INTRODUCTION

In May 1982 the the National Institute for Occupational Safety and Health (NIOSH) received a request form the management of Olympic Peninsula Kidney Center, Bremerton, Washington, to determine employees' exposure to formaldehyde. An environmental survey was conducted on June 30, and July 21, 1982. An interim report including the environmental results and recommendations was submitted to the requester on September 2, 1982.

III. BACKGROUND

Olympic Peninsula Kidney Center is an outpatient dialysis facility in Bremerton, Washington, where 30 patients are put on dialysis machines 3 times a week for periods up to 4 hours. There are six dialysis machines at the center. There are 7 employees who work in the facility over 2 10-hour shifts 6 days a week.

Artificial kidneys can be reused several times. Formaldehyde is used in the preservation of the kidneys until the same patient returns and reuses it. Before dialysis begins, the artificial kidney is hooked up to the dialysis unit. The formaldehyde solution is flushed out of the system and piped to a small raised drain pipe. After dialysis the artificial kidney is removed from the unit. It is then flushed with deionized water. When flushing is complete one liter of 2% formaldehyde solution is passed through the kidneys. The kidney is sealed with the formaldehyde solution in it until it is reused during the next visit of the patient. The formaldehyde that is flushed through the kidney is drained into an open sink. This flushing procedure takes about 25 to 30 minutes per artificial kidney. Those that can be reused are flushed, one after the other. This occurs once or twice per shift. The 2% formaldehyde solution is stored in a in a 20 liter carboy directly over the sink. When there is one liter of solution left, the carboy is removed from the shelf and the remaining liter is poured in the sink. The 37% formaldehyde stock solution is measured out in a graduated beaker and added to the carboy. It is then filled to the 20 liter capacity. This refilling takes about 10 minutes.

The formaldehyde exposure occurs when the formaldehyde is flushed through the artificial kidney and when the carboy of 2% formaldehyde is refilled, which occurs several times a week. These jobs are done by one person each shift.

The room where the kidneys are flushed is 10' by 12' in size. Above the sink area is a small ceiling fan. Smoke tube tests show that the exhaust rate is very low and it has no effect on formaldehyde vapors released from this area. Any vapor released in this room can migrate out to the patient dialysis area.

IV. EVALUATION DESIGN AND METHODS

The environmental survey consisted of measuring the employees' exposure to airborne vapors of formaldehyde in their breathing zone and the general work area. Nine samples for formaldehyde vapors were collected in 1% sodium bisulfite solution in inpingers at a flow rate of 1 lpm. The chemical analysis was performed according to NIOSH analytical method P&CAM 125 (1). The employees were questioned regarding symptoms during the use of formaldehyde.

V. EVALUATION CRITERIA

A. Environmental

The environmental criteria for exposure to toxic substances used in this evaluation are based on the NIOSH Criteria Documents, Recommended Standard for Occupational Exposure to Formaldehyde (2,3) and the Washington State Department of Labor and Industry General Occupational Health Standards (4). The Washington State Standard has a permissible 8 hour time weighted average exposure level of 2 ppm which is also a ceiling value not to be exceeded at any time. In 1976 NIOSH recommended a permissible exposure level of 1 ppm for any 30 minute period. However, in 1981, based on reasearch that indicated formaldehyde is a potential occupational carcinogen, NIOSH recommended that formaldehyde exposure be reduced to the lowest feasible limit.

B. Toxicology of Formaldehyde (3)

"Formaldehyde has induced a rare form of nasal cancer in both Fischer 344 rats and in B6C3F1 mice as reported in an ongoing study by the CIIT. In a second study by NYU, formaldehyde appears to have induced the same type of cancer in Sprague-Dawley rats. Although humans and animals may differ in their susceptibility to specific chemical compounds, any substance that produces cancer in experimental animals should be considered a cancer risk to humans. Formaldehyde has also demonstrated mutagenic activity in several test systems. Although a substance cannot as yet be designated a potential occupational carcinogen based solely on results of mutagenicity tests, positive results in mutagenicity tests should be used as supporting evidence for identifying a potential occupational carcinogen.

Based on these results, NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen. Safe levels of exposure to carcinogens have not been demonstrated, but the probability of developing cancer should be reduced by decreasing exposure. An estimate of the extent of the cancer risk to workers

exposed to various levels of formaldehyde at or below the current 3 ppm (U.S. Department of Labor, OSHA Standard) standard has not yet been determined. In the interim, NIOSH recommends that, as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit."

Other Health Effects - "The first signs or symptoms noticed on exposure to formaldehyde at concentrations ranging from 0.1 to 5 ppm are burning of the eyes, tearing (lacrimation), and and general irritation to the upper respiratory passages. Higher exposures (10 to 20 ppm) may produce coughing, tightening in the chest, a sense of pressure in the head, and palpitation of the heart. Exposures at 50 - 100 ppm and above can cause serious injury such as collection of fluid in the lungs (pulmanary edema), inflamation of the lungs (pneumonitis), or death.

In one report, five nurses working near an artificial kidney (hemodialysis) machine developed wheezing and recurrent episodes of productive cough. The attacks generally occurred in winter and often followed colds. The formaldehyde used to sterilize the machine was found to have caused this respiratory distress.

Dermatitis due to formaldehyde solutions or formaldehyde-containing resins is a well-recognized problem. After a few days of exposure, a worker may develop a sudden inflammatory (eczematous) reaction of the skin of the eyelids, face, neck, scrotum, and flexor surfaces of the arms. An eczematous reaction may also appear on the fingers, back of the hands, wrists, forearms, and parts of the body that are exposed to the rubbing of clothing. This sometimes occurs after years of repeated exposure."

VI. RESULTS AND DISCUSSION

The results of the environmental sampling are shown in Table 1. The area samples collected in the patient areas were representative of the workers' exposures. The formaldehyde concentration in the patient dialysis area was 0.04 ppm when there was no formaldehyde being used in the adjacent lab room. This background level is probably the result of the formaldehyde that is piped directly to the drain from the dialysis unit when an artificial kidney is being prepared for reuse. During the time periods that the artificial kidneys were being flushed and the carboys refilled with formaldehyde in the adjacent lab room, the formaldehyde concentration in the patient areas were 0.09 and 0.12 ppm. The slight increase is probably the result of inadequate local exhaust ventilation in the lab. For the employees, these exposures are very low and should not produce any irritation of the eyes or respiratory system, however, it may affect some patients. Since many of the patients on dialysis have other health problems even concentrations as low as 0.12 ppm may cause an adverse health effect.

The concentration in the lab while 4 artificial kidneys were flushed with formaldehyde was 0.36 ppm. During the 1 1/2 hours before and during the flushing of one kidney, the concentration was 0.23 ppm and during a 2 1/2 hour period that included the flushing of three kidneys and the refilling of the 20 liter carboy with formaldehyde, the concentration was 0.51 ppm. It takes ten minutes or less to empty the last liter of solution from the 20 liter carboy and to refill it. During this operation the worker's exposure was 1.75 ppm. The worker stated that when he does this job his eyes will burn and tear and his nose will burn.

VII. CONCLUSION

All the workers except one have formaldehyde exposures that are less than 0.12 ppm. The employee who flushed the artificial kidneys has a low exposure (about 0.12 ppm or less) for all but one hour during which time he is flushing the kidneys and then the average concentration is 0.36 ppm. During the period he empties and refills the carboy with formaldehyde his ten minute exposure went to 1.75 ppm. Since NIOSH recommends that formaldehyde be considered a potential occupational carcinogen, as a prudent public health measure, engineering controls and stringent work practices should be employed to reduce occupational exposures to the lowest feasible limit.

VIII. RECOMMENDATIONS

1. A new exhaust system should be designed and installed in the area where the artificial kidneys are flushed.

2. When installing a new exhaust hood the following items should be taken into consideration.

   a. Enclose the hood on all sides as much as possible. The object is to take all the available exhaust air and have it enter the hood over the point of work. This concept gives a greatly increased capture efficiency.

   b. The hood can be constructed out of quarter inch clear acrylic plastic that permits light to enter and also provides visibility.

   c. The air entering any open area of the hood should have a velocity of 100 - 150 fpm. Stated another way, the volume of air exhaust should be 100 - 150 cfm per square for square foot of open hood area. As an example if the hood has 4 square feet of open area then the total volume of exhaust air should be 400 to 600 cfm.

3. A lateral exhaust slot hood can be used. Again, baffles on the sides and the top increase the capture efficiency.

4. The exhaust hood should include the sink area. All work with formaldehyde should be done under local exhaust ventilation.

5. The exhaust of the system should not terminate near any door or window that can be opened.

6. Employees should be informed as to the hazard of formaldehyde, its control and appropriate personal hygiene procedure.

IX. REFERENCES

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2. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to formaldehyde. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW publication no. (NIOSH) 77-126).

3. NIOSH Current Intelligent Bulletin #34
April 15, 1981 Formaldehyde: Evidence of Carcinogenicity.

4. State of Washington, Department of Labor and Industries:
Chapter 296-62 WAC, General Occupational Health Standards

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Olympic Peninsula Kidney Center, Bremerton Washington
2. Washington State Department of Labor Olympia Washington
3. the National Institute for Occupational Safety and Health (NIOSH) Region X
4. the Occupational Safety and Health Administration (OSHA) Region X

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

TABLE 1

FORMALDEHYDE AIR CONCENTRATIONS

OLYMPIC PENINSULA KIDNEY CENTER
BREMERTON, WASHINGTON
HETA 82-242

JOB OR LOCATION	DATE	SAMPLE TIME MIN.	TIME OF DAY	FORMALDEHYDE CONCENTRATION PPM
GA* - Above sink in lab before any artificial kidneys were flushed	6-30-82	145	9:25A - 11:50A	0.13
GA - Above sink in lab during time 4 artificial kidneys were flushed	6-30-82	53	11:52A - 12:45P	0.38
BZ** Of worker during time 4 artificial kidneys were flushed	6-30-82	53	11:52A - 12:45P	0.36
BZ - Emptied formaldehyde solution into sink and refilled carboy	6-30-82	10	12:45P - 12:55P	1.75
GA - In patient dialysist area. Four kidneys were flushed and one carboy of formaldehyde was mixed in adjacent lab	6-30-82	120	11:15A - 1:15P	0.12
GA - In patient dialysist area (No artificial kidneys were flushed during this time)	7-21-82	125	9:18A - 11:23P	0.04
GA - In patient dialysist area. Four artificial kidneys were flushed and one carboy of formaldehyde was mixed in adjacent lab	7-21-82	142	11:23A - 11:45P	0.09
GA - Above sink in lab. Time before and during the flushing of one kidney	7-21-82	114	9:18A - 11:12P	0.23
GA - Above sink in lab. Three kidneys were flushed and one carboy of formaldehyde was mixed.	7-21-82	153	11:12A - 1:45P	0.51

* GA - General Area
** BZ - Breathing Zone Personal Sample

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