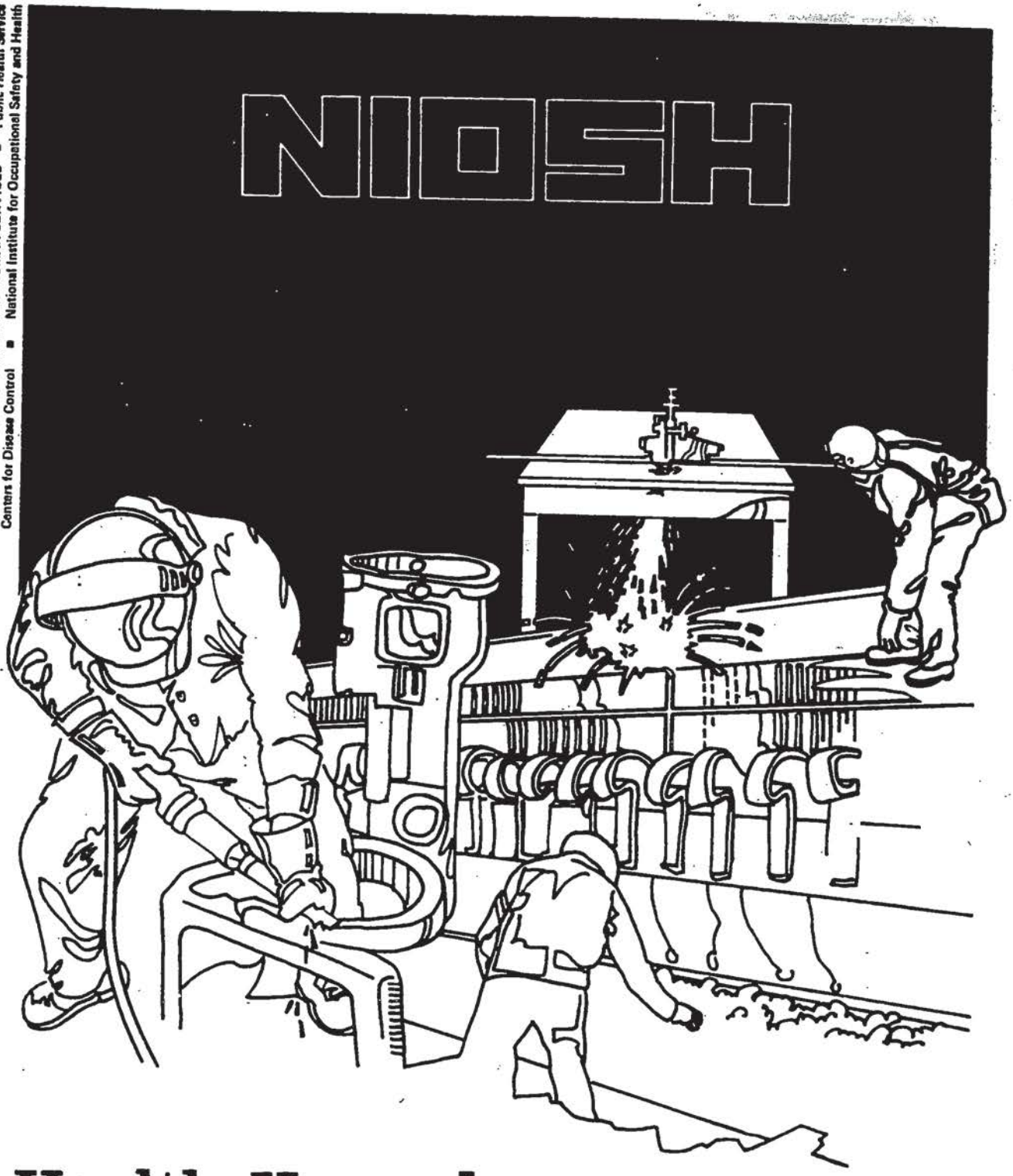
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 83-284-1536
DIALYSIS CLINIC INC.
ATLANTA, GEORGIA

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 83-284-1536
NOVEMBER, 1984
DIALYSIS CLINIC INC.
ATLANTA, GEORGIA

NIOSH INVESTIGATORS:
Stanley Salisbury, C.I.H.

I. SUMMARY

In May 1983, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate exposures to formaldehyde and other chemicals generated during sterilizing and disinfecting of dialyzers (artificial kidneys) and dialysis treatment equipment with formalin solutions and other disinfectants. Employees had reported experiencing multiple upper respiratory infections, skin rashes, and various other adverse health complaints when at work.

In August 1983, a NIOSH investigator conducted an initial screening survey to interview employees and to observe the Clinic's work practices and to inspect building ventilation systems. NIOSH industrial hygienists completed a follow-up environmental survey in September 1983 to collect personal and general area air samples for measurement of occupational exposures to formaldehyde and glutaraldehyde (the active ingredient of Cidex® sterilizing and disinfecting solution).

No airborne glutaraldehyde was detected. Employees were exposed to formaldehyde at levels ranging from 0.09 to 0.43 parts per million (ppm). Nurses who sterilized peritoneal dialysis equipment once a week had the highest exposures. Their personal exposures were 1.77 and 1.57 ppm during the 1-hour sterilizing procedure. These exposures occurred even though formalin was contained in a closed system designed to prevent formaldehyde release. Lack of outside makeup air to the Peritoneal Dialysis Clinic was also partially responsible for the build up of formaldehyde during this period. Because formaldehyde is now considered a suspect carcinogen, NIOSH recommends reducing exposures to the lowest feasible level (less than 0.1 ppm).

The most frequent health complaints from exposed employees were runny nose/watery eyes, throat irritation, nose or eye irritation, and headache.

Based on the results of air samples collected and the level of symptoms reported by the clinic staff during confidential interviews, it was determined that a health hazard did exist for personnel working with formalin solutions in support of dialysis treatment procedures at the Dialysis Clinic Inc. Insufficient ventilation, equipment leaks, and spills have exposed clinic staff to formaldehyde concentrations considered by the investigators to exceed the lowest levels feasible.

KEYWORDS: SIC 8081 (Outpatient Care Facility), formaldehyde, dialysis, glutaraldehyde, artificial kidney sterilization, respiratory irritation

II. INTRODUCTION

On May 19, 1983, the National Institute for Occupational Safety and Health (NIOSH), received a confidential employee request for a health hazard evaluation (HHE) of the working environment at the Dialysis Clinic, Inc., Atlanta, Georgia. Several employees had reported problems with multiple respiratory infections and other symptoms of upper respiratory irritation, as well as skin rashes and headaches believed to be caused by exposures to formaldehyde and other chemicals used for sterilizing dialyzers and dialysis treatment equipment.

A NIOSH investigator conducted an initial environmental survey on August 9, 1983 to conduct confidential interviews with the nurses and technicians who operate and maintain the dialysis equipment, and to observe work practices and obtain background information on the use of formaldehyde and other cleaning and sterilizing materials. Preliminary findings and recommendations were provided to the employee requesters and the Clinic's director in a interim report submitted by the NIOSH investigator on August 16, 1983.

NIOSH industrial hygienists conducted a follow-up environmental survey on September 30, 1983. The air monitoring results and recommendations for controlling formaldehyde exposures were provided in a report sent to the director of the clinic and to the HHE requesters on November 25, 1983.

III. BACKGROUND

This clinic is one of 24 outpatient clinics owned and operated by the Dialysis Clinic Inc. of Nashville, Tennessee. Dialysis Clinic Inc. operates three facilities in the Atlanta metro area. The clinic evaluated by NIOSH has facilities for both hemodialysis and peritoneal dialysis treatments. About 14 nurses and two re-use technicians staff the hemodialysis clinic from 6:30am to 5:30pm on staggered schedules. Patients receive 3-hour treatments in the morning from 7:00 a.m. to 11:30 a.m. and in the afternoon from 12:15 p.m. to 4:30 p.m. Two nurses staff the Peritoneal Clinic during the hours of 7:30 a.m. to 6:00 p.m.

A. Hemodialysis Clinic

The Hemodialysis Clinic occupies the entire top floor of the building. With eight treatment rooms, each having four dialysis treatment stations, the clinic can treat up to 32 patients. Two of the treatment rooms, reserved for patients who had tested positive for hepatitis, were called "positives rooms" by the clinic staff. The clinic operated only six treatment rooms (including the positives rooms) at the time of the NIOSH survey. When treating patients, two clinic staff members are assigned to each treatment room.

Cleaning and sterilizing dialyzers is done in the "Re-use" room. A "Centrals" room contains an electric pumping system which internally flushed and sterilized dialysis treatment stations with a solution of 37% formalin and 12-15% methanol. Each morning the Charge Nurse turns on the centrals pump to flush formalin/methanol solution from all treatment stations with sterile saline solution. At the end of the day another nurse runs the centrals again, this time to flush out the saline solution with the formalin/methanol. The formalin/methanol is left in the treatment stations overnight.

B. Peritoneal Dialysis Clinic

Located on the first floor at the opposite end of the building, the Peritoneal Dialysis Clinic does not use dialyzers. The peritoneum of the abdomen is used as the transfer membrane. This is accomplished by pumping solutions into the patient's abdominal cavity where the exchange occurs. About 30 minutes later the contaminated solution is removed and the process is repeated. Complete treatment requires about 10 hours. Only patients unable to receive conventional dialysis treatment undergo this procedure.

On Friday, at the end of the shift, staff nurses clean and sterilize equipment with 37% formalin solution. All formalin containers are equipped with special connectors and valves. Nurses connect the containers to a receiving line on the machine, open the container valve and pump formalin directly into the machine. The treatment machines are manufactured by Physio Control Inc.

Although designed to be a closed system, nurses experienced frequent eye and throat irritation during this process. Nurses complained the many connections and fittings inside the machines were not properly sealed, allowing formaldehyde to escape.

C. Dialyzer Re-use Cleaning Procedures

The Re-use Technician places the dialyzer in a sink and flushes water and a 2% solution of hydrogen peroxide through the dialyzer to remove residual blood. The dialyzer is then filled with a solution of 2% formalin that flows into the dialyzer by gravity from an overhead 5 gallon jug. When filled, excess formalin flows down the drain. The dialyzer is then capped, the formalin solution flow is turned off, and the dialyzer is submerged in a tank containing a 2% bleach solution. After 30 minutes the dialyzer is removed and placed on a shelf for re-use in providing dialysis treatment to the patient to which this dialyzer is assigned.

D. Heating, Ventilation, and Air-conditioning (HVAC) Systems

Three self-contained, roof mounted, HVAC units served the Hemodialysis Clinic. All makeup air dampers were kept in the full-open position allowing the maximum amount of make-up air to mix with air recirculated from the HVAC. HVAC fans were not operated continuously. The clinic staff had often set thermostats to the "auto" position, allowing the HVAC fans to shut down when heating or cooling was not needed. Occasionally, when a patient complained of drafts, the HVAC was turned off. The HVAC serving the Peritoneal Clinic had no outside makeup air system. Supply air delivered from the HVAC was 100% recirculated.

IV. EVALUATION DESIGN AND METHODS

To obtain additional information on adverse health effects experienced by employees, the NIOSH investigator administered a two-page questionnaire to 16 employees. Employees selected from the Hemodialysis Clinic included nine nurses, three technicians, and two re-use technicians. Two nurses from the Peritoneal Dialysis Clinic also completed the questionnaire. Confidential interviews were then conducted with ten of these 16 employees. Employees were asked to identify the symptoms experienced which they believed to be work related and to describe which work practices or conditions, in their opinion, were the most likely cause of these health problems.

Based on information provided during the confidential employee interviews, NIOSH monitored formaldehyde levels during times when employees had noted formaldehyde odors or had experienced eye or upper respiratory irritation. Personal and area air samples were collected to measure airborne formaldehyde concentrations (1) when the centrals were turned on at the start of the shift, (2) when the Re-use Technician prepared a batch of formalin solution and cleaned dialyzers, (3) near an automatic dialyzer cleaning machine (used to clean dialyzers for "positives" patients), (4) when the centrals unit was cleaned and operated to sterilize treatment stations at the end of the shift, and (5) when nurses cleaned and sterilized peritoneal dialysis machines before closing the clinic on Friday evening.

Airborne formaldehyde was sampled by drawing a known volume of air through two midget impingers connected in series, each containing 20 milliliters (mL) of 1% sodium bisulfate absorbing reagent. A battery-operated air sampling pump was connected to the impingers with plastic tubing. Air was pulled through the absorbing solution at a rate of one liter per minute (Lpm). Personal samples were collected by attaching the sampling equipment to the person sampled, with impingers located near the breathing zone. Sixteen samples were collected. The NIOSH laboratory analyzed the impinger collection solution by spectrophotometry methods according to NIOSH method P & CAM 125.[1] The limit of detection by this method was 0.1 micrograms per mL of collection reagent.

NIOSH sampled airborne glutaraldehyde vapors released from activated Cidex solution used in the Hemodialysis Clinic by drawing a known volume of air through a small glass tube filled with a XAD-2 resin coated with 5% 2,4-dinitrophenyl hydrazine in hydrochloric acid (DNPH·HCL) to trap the glutaraldehyde vapor present. A battery-powered personal sampling pump was connected to the tube to pull air through the sorbent at a flow rate of 0.2 Lpm. After collection, the tubes were capped and sent to a NIOSH contract laboratory. The laboratory extracted the tubes with acetonitrile and analyzed the extracted solution by High Performance Liquid Chromatography (HPLC) using an ultraviolet detector. The limit of detection by this method was 4.5 micrograms per sample. Four samples were collected. One of these was taken directly above a sterilizing boat filled with activated Cidex.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff use environmental evaluation criteria for assessment of many 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. However, 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, 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 potentially increase the general exposure. Lastly, 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 (TLVs),[2] and (3) the U.S. Department of Labor (OSHA) occupational safety and health standards.[3] Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs 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 standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. When considering the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that employers are legally required to meet only those levels specified by an OSHA standard.

For those compounds with established occupational exposure limits, the various criteria proposed by OSHA, ACGIH, and NIOSH for airborne concentrations of the chemical substances measured in this evaluation are listed in Table 1. 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 high short-term exposures.

For the purposes of this evaluation, NIOSH has selected the most stringent exposure limits as our evaluation criteria. The major health effects anticipated for workers exposed above these evaluation criteria are summarized in Table 1. A brief review of the toxicity for chemical compounds listed are presented below.

FORMALDEHYDE--has a pungent, offensive odor generally perceived at about 1 ppm. Some people have reported odors at concentrations as low as 0.05 ppm.[4] The first signs or symptoms noted on exposure are irritation of the eye and upper respiratory tract (burning eyes, tearing or lacrimation, rhinnorhea or runny nose, mild throat irritation). For some people these symptoms may occur from exposures as low as 0.1 ppm.[4] Dermatitis associated with formaldehyde vapor, solutions or formaldehyde based resins has been documented. On the other hand, some people who are repeatedly exposed to low concentrations of formaldehyde seem to develop a physical tolerance to the irritant effects. Although skin irritation seldom results from exposure to formaldehyde gas in the air, allergic or sensitized persons may show dermatitis symptoms from exposures easily tolerated by nonallergic persons.[5] Asthma or asthma-like symptoms have been described as a possible allergic response to low-level formaldehyde exposure from formalin solutions.[6,7]

The OSHA Permissible Exposure Limit (PEL) for formaldehyde is 3 ppm for an 8-hour TWA, with a ceiling limit of 5 ppm permitted for no more than 30 minutes. At no time is the concentration allowed to exceed 10 ppm. OSHA adopted this standard from an old American National Standards Institute (ANSI) Standard Z 37.16 - 1967.

In 1976, NIOSH issued a publication "Criteria for a Recommended Standard for Occupational Exposure to Formaldehyde," NIOSH Publication No. DHEW (NIOSH) 77-126. In this document, NIOSH recommended, based on the irritant effects of formaldehyde, that exposures to formaldehyde in the work environment be controlled to

a concentration no greater than 1 ppm for any 30-minute sampling period. The carcinogenic potential of formaldehyde was not known at that time, and therefore was not considered in developing this recommendation.

Evidence for the carcinogenic potential of formaldehyde was first reported in October 1979, when researchers released preliminary data from an inhalation study, sponsored by the Chemical Industry Institute of Toxicology (CIIT), documenting exposures of 15 ppm formaldehyde in air for 6 hours per day, 5 days per week for 16 months were carcinogenic in rats. In April 1981, NIOSH issued a current intelligence bulletin, which highlighted the CIIT study and a companion study done by New York University which found that formaldehyde can induce nasal cancer in rats and mice.[8] 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. Based on these results, NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen. Because safe levels of exposure to carcinogens have not been demonstrated, NIOSH recommends reducing exposures to the lowest feasible level.

GLUTARALDEHYDE--the active ingredient in Cidex sterilizing and disinfecting solution, is a strong irritant of the eyes, nasal passages, upper respiratory tract and skin. It can cause skin sensitization (allergic contact dermatitis) from occasional or incidental occupational exposures. Aqueous solutions of glutaraldehyde maintained at a mildly acid pH are stable for long periods and have a negligible odor. By the addition of sodium bicarbonate, glutaraldehyde is activated and its antimicrobial activity is greatly enhance for up to 14 days. The strong irritant effects of glutaraldehyde are slightly enhanced when this dialdehyde is activated.

Based on human response testing performed by Colwell[9], where trained odor panelists judged the odor recognition threshold of glutaraldehyde to be 0.04 ppm and the irritation response level to be 0.3 ppm, the ACGIH has recommended a ceiling limit of 0.2 ppm for glutaraldehyde vapor whether from activated or unactivated solutions.[10] OSHA standards do not include a PEL for glutaraldehyde.

VI. RESULTS AND DISCUSSION

A. Employee Interviews

From the 16 employees who completed questionnaires, the most frequently reported symptoms were runny nose/watery eyes (63%), throat irritation (56%), nose and eye irritation (44%), and headache (44%). Except for headaches, at least 67% of the

employees reported experiencing these symptoms only during working hours. The average length of employment for this group was 4 years, 2 months. The more serious symptoms and health problems reported by some of the employees interviewed included: a 40% loss of pulmonary function; a throat ulcer near the vocal cord in a non-smoker; during the past year, a skin rash on the face and nasal sores with scabbing; a lesion in the left palate which has remained unchanged for over 1 year; and allergic contact dermatitis when working with formalin, even when wearing latex gloves.

B. Formaldehyde Sampling Results

As shown in Table 2, the Re-use Technician and the nurses who operated the centrals had the highest exposures to formaldehyde in the Hemodialysis Clinic. Formaldehyde levels detected ranged from 0.09 to 0.43 ppm. These levels are consistent with the sampling results obtained by other NIOSH investigators conducting hazard evaluations at various dialysis treatment facilities.[11,12,13]

The highest formaldehyde exposures were detected in the Peritoneal Dialysis Clinic. The two nurses monitored were exposed during a one-hour period to concentrations of 1.77 and 1.57 ppm respectively. The results show that the closed system which used special containers, valves, fittings, and drain line caps to contain the 37% formalin solution did not adequately control formaldehyde exposures. The lack of outside make-up air from the HVAC probably contributed to the formaldehyde buildup in the clinic. Although these concentrations are not above the OSHA PEL for short term exposure (5 ppm for 30 minutes), they are above the NIOSH evaluation criteria. Formaldehyde is now considered a suspect carcinogen by NIOSH; therefore, sample results show a need for lowering formaldehyde exposures.

C. Glutaraldehyde Sampling Results

Glutaraldehyde was sampled at four locations: (1) the personal exposure for the Re-use Technician mixing the activator with a gallon of unactivated Cidex, (2) an area sample in the Re-use Room when Cidex was being activated, (3) an area sample above a sink holding a small pan of activated Cidex, and (4) a sample taken directly above the surface of an open pan of activated Cidex. Glutaraldehyde vapor was not detectable in these samples. However, the short sample collection time of 15 minutes, and the low sensitivity of the analytical method used could only detect concentrations above 0.25 ppm. Short-term exposures (15 minutes) to concentrations above 0.2 ppm would have exceeded the NIOSH evaluation criteria.

Although the detection limit of the sampling and analytical method was higher than expected by the NIOSH investigators, the sample taken directly above the surface of the activated Cidex represents a worse-case exposure condition. Since glutaraldehyde vapors were

less than 0.25 ppm at this location, in the judgement of the NIOSH investigators it is unlikely that personal exposures would have exceeded the 0.2 ppm exposure limit. (The NIOSH laboratory now recommends a minimum air sample volume of 15 liters to insure the limit of detection will be no greater than 0.1 ppm for a 15 minute sample.)

VII. CONCLUSIONS

Based on the results of air samples collected and the level of symptoms reported by clinic staff during confidential interviews, it has been determined that a health hazard does exist for personnel working with formalin solutions in support of dialysis treatment procedures at the Dialysis Clinic Inc. Insufficient building ventilation, equipment leaks, and spills have exposed clinic staff to formaldehyde concentrations above the lowest levels feasible.

VIII. RECOMMENDATIONS

The following recommendations are offered to further reduce formaldehyde exposures. These recommendations are specific examples for controlling airborne formaldehyde concentrations through improved building ventilation, improved containment of formalin dispensing and drainage systems, and proper selection and use of effective respiratory protection equipment when exposures cannot otherwise be prevented through engineering controls. Further education and training of clinic staff are also needed to improve work practices and increase employee awareness of health hazards associated with exposure to formaldehyde.

1. An outside makeup air system for the HVAC serving the Peritoneal Dialysis Clinic should be installed. The amount of outside air provided should be sufficient to maintain exposures to below 0.1 ppm formaldehyde.

2. Fittings, valves, containers, seals, and drain covers should be sealed to provide the most effective containment system possible to prevent leakage of formaldehyde gas when equipment is being sterilized with 37% formalin solution.

3. If exposures to formaldehyde are expected to exceed 0.5 ppm such as when cleaning up formalin spills, employees should wear chemical cartridge type respirators with full face masks to prevent eye irritation. The cartridges used with these respirators should be NIOSH-approved for protection against formaldehyde. A list of the NIOSH-approved respirators, as found in the NIOSH Certified Equipment List[14] was enclosed with the NIOSH interim report to the Dialysis Clinic Director on November 15, 1983.

4. All thermostat fan switches should be kept in the "on" position to maintain constant air circulation and ventilation when the building is occupied.

5. The centrals room and re-use room exhaust fans should be kept on 24 hours a day or automatic timer switches should be installed to vent these areas before the start of the work shift.

6. Drain caps similar to the type used in the Peritoneum Dialysis Clinic should be installed for all treatment station drains in the Hemodialysis Clinic.

7. All employees should be informed about the adverse health effects associated with formaldehyde exposure, and trained in techniques and work practices which will reduce their exposures to the lowest possible level.

8. Housekeeping personnel should insure that bleach solutions are consistently mixed to the proper strength. Many clinic staff members interviewed felt that sometimes bleach solutions were irritating.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and Report Prepared By:	Stanley A. Salisbury, C.I.H. Regional Industrial Hygienist NIOSH Region IV Atlanta, Georgia
Field Assistance	Bill Daniels, C.I.H. Regional Industrial Hygienist NIOSH Region V Chicago, Illinois
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies NIOSH Cincinnati, Ohio
Laboratory Analyses:	Staff Measurements Research Support Branch, NIOSH Cincinnati, Ohio

X. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications 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 22161. 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:

1. Director, Dialysis Clinic Inc, Atlanta, GA
2. Employee requesters (confidential)
3. NIOSH Region IV
4. OSHA Region IV
5. Designated State Occupational Safety and Health Representatives

For the purpose of informing the approximately 50 "affected employees", the employer will promptly "post" this report for a period of thirty (30) calendar days in a prominent place(s) near where the affected employees work.

XI. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 1, 2nd ed. Cincinnati, OH: National Institute for Occupational Safety and Health, 1977. [DHEW (NIOSH) publication no. 77-157-A].

2. American Conference of Governmental Industrial Hygienists (ACGIH). Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1984-85. Cincinnati, Ohio: ACGIH, 1983.

3. U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA). CFR Title 29, Part 1910--Occupational Safety and Health Standards, Subpart Z--Toxic and Hazardous Substances.

4. Committee on Aldehydes, Board of Toxicology and Environmental Health Hazards. Formaldehyde and other aldehydes. National Research Council, National Acaademy Press. Washington, D.C.: 1981.

5. Working with formaldehyde, DHEW Publication No. (NIOSH 74-119), 1975.

6. Hendrick D.J., Lane D.J., Formalin asthma in hospital staff. Br Med J, 1975; 1:607-608.

7. Hendrick D.J., Lane D.J., Occupational formalin asthma. Br Med J, 1977; 34:11-18.

8. NIOSH Current Intelligence Bulletin (CIB) No. 34, Formaldehyde, evidence of carcinogenicity, DHHS (NIOSH) Publication No. 81-111, April 1981.

9. Colwell C.E., Communication to the TLV Committee from Union Carbide Co., Tarrytown, N.Y., April 1976.

10. American Conference of Governmental Industrial Hygienists. Documentation of the threshold limit values. 4th. ed., with supplemental documentation for 1983. Cincinnati, Ohio: ACGIH, 1980.

11. National Institute for Occupational Safety and Health (NIOSH). Health Hazard Evaluation Report HETA 81-211-984, U.S. PHS Hospital, San Francisco, California. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH, Cincinnati, Ohio, 1981.

12. National Institute for Occupational Safety and Health (NIOSH). Health Hazard Evaluation Report HETA 82-303-1271, St. Francis Hospital, Honolulu, Hawaii. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH, Cincinnati, Ohio, 1983.

13. National Institute for Occupational Safety and Health (NIOSH). Health Hazard Evaluation Report HETA 82-205-1314, North Central Dialysis Centers, Chicago, Illinois. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH, Cincinnati, Ohio, 1983.

TABLE 1

HETA 83-284

SUMMARY OF EXPOSURE LIMITS* and HEALTH EFFECTS
for SUBSTANCES MEASURED at the
DIALYSIS CLINIC INC.
ATLANTA, GEORGIA

September 30, 1983

SUBSTANCE	OSHA PEL**	ACGIH TLV***	NIOSH RECOMMENDATION	HEALTH EFFECTS CONSIDERED	REFERENCE
Formaldehyde	3 ppm 5 ppm (30 min) 10 ppm (ceiling)	1 ppm 2 STEL	1 ppm (30 min) (1976) LFL (1978)	Upper respiratory irritation, suspect carcinogen	8
Glutaraldehyde	None	0.2 ppm (ceiling)	None	Upper respiratory irritation	9, 10

* Limits are 8-hour time-weighted averages (TWA) unless otherwise stated.
** For OSHA standards, see Reference No. 3
*** For ACGIH TLV°s, see Reference No. 2

ppm = parts per million parts of air
STEL = Short Term Exposure Limit (15-minute TWA exposure)
Ceiling = concentration limit that should not be exceeded
LFL = lowest feasible limit

TABLE 2

DIALYSIS CLINIC
ATLANTA, GEORGIA
HETA 83-284

FORMALDEHYDE SAMPLING RESULTS
September 30, 1983

Job Classification	Type Sample	Start	Stop	minutes	Flow Rate Lpm	Sample Vol liters	Results micro gm	Conct mg/M^3	Conct ppm
Turning on Centrals									
Station 146, Room 8	Area	0615	0715	60	1.00	60.00	8.75	0.15	0.12
Station 51, Room 4	Area	0615	0715	60	1.00	60.00	12.18	0.20	0.17
Centrals Room	Area	0615	0715	60	1.00	60.00	31.86	0.53	0.43
Asst. Head Nurse	Personal	0615	0715	60	1.00	60.00	8.90	0.15	0.12
Re-Use Tech. Mixing Formaldehyde and Cleaning Kidneys									
Re-Use Room	Area	0951	1051	60	1.00	60.00	23.56	0.39	0.32
Re-Use Tech - mixing	Personal	0951	1051	60	1.00	60.00	16.56	0.28	0.22
Re-Use Tech - cleaning	Personal	1052	1149	57	1.00	57.00	6.60	0.12	0.09
Re-Use Tech - cleaning	Personal	1617	1654	37	1.00	37.00	16.00	0.43	0.35
Above Auto-dialyzer	Area	1041	1151	70	1.00	70.00	15.75	0.23	0.18
Cleaning centrals	Personal	1623	1652	29	1.00	29.00	12.32	0.42	0.35
Peritoneum Dialysis Area									
Cleaning equipment	Personal	1641	1744	63	1.00	63.00	136.65	2.17	1.77
Cleaning equipment	Personal	1647	1744	57	1.00	57.00	110.08	1.93	1.57

Evaluation Criteria - NIOSH recommends exposures be reduced to the lowest feasible limit. ---------- (LFL)

)EPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
IATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE. $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396