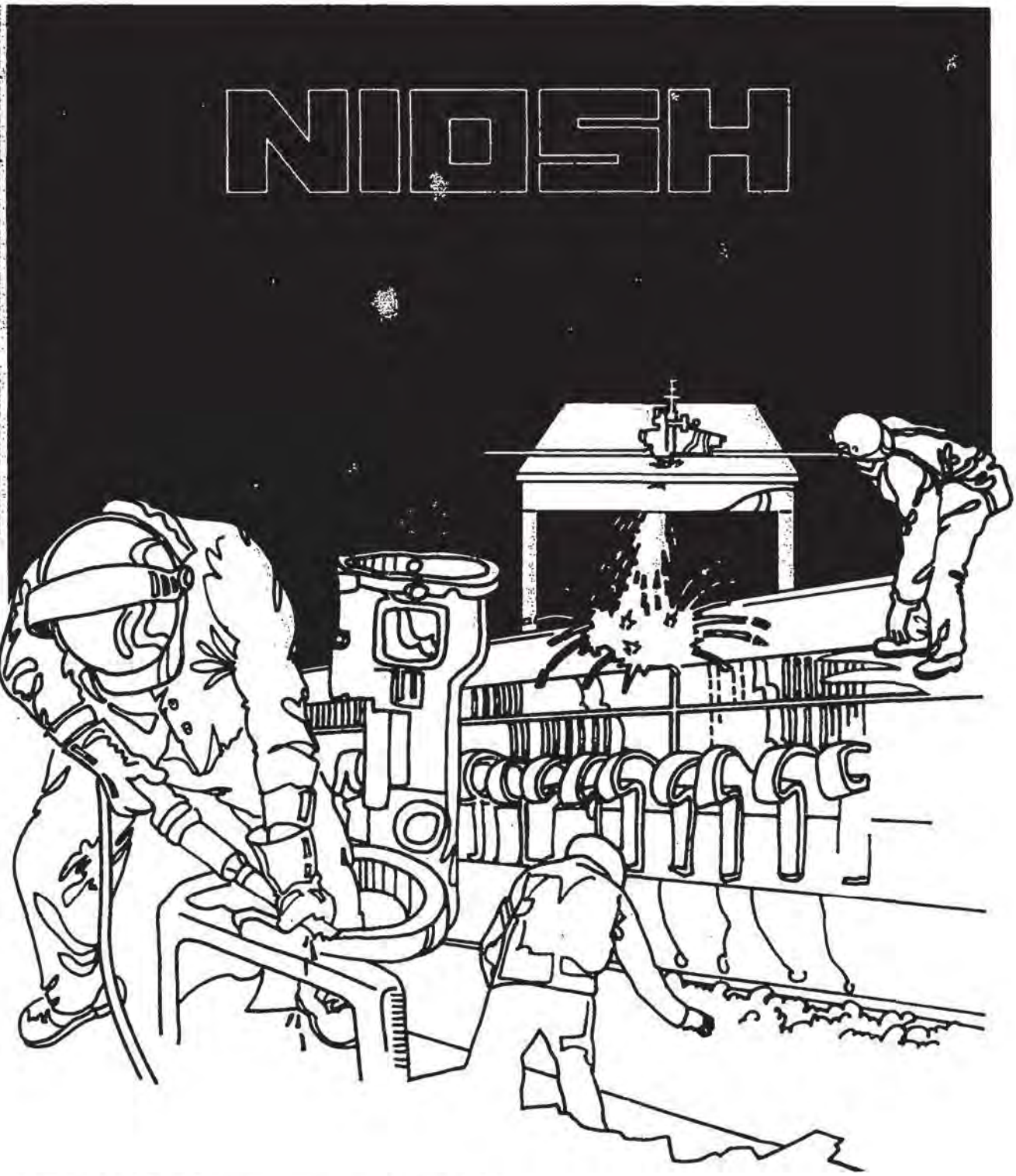
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 82-209-1245
CHILDREN'S HOSPITAL
MEDICAL CENTER
BOSTON, MASSACHUSETTS

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 82-209-1245
February 1983
Children's Hospital Medical Center
Boston, Massachusetts

NIOSH INVESTIGATORS:
Kevin P. McManus, I.H.
Richard Gorman, I.H.
Wesley E. Straub, I.H.
Mitchell Singal, M.D.

I. SUMMARY

On April 7, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request at the Children's Hospital Medical Center, Boston Massachusetts, to evaluate: (1) the exposure of operating room personnel to waste anesthetic gases, and (2) the recent outbreak of conjunctivitis and sore throats among operating room personnel.

On May 12 and 13, 1982, NIOSH investigators conducted an initial survey at the hospital. Twelve general area and 25 personal breathing-zone samples for measurement of nitrous oxide, and 4 personal samples for measurement of halothane exposure were collected. Two area air samples were also collected for qualitative analysis of organic chemicals.

Thirteen of 25 personal exposures (52%) were above the NIOSH criterion for nitrous oxide. Each of the operating rooms had at least one employee exposed to nitrous oxide in excess of the NIOSH recommendation to control exposures to 25 parts per million (ppm) on a time-weighted average basis during anesthetic administration. The range of exposures measured was 4 ppm to 200 ppm.

Two of four personal exposures (50%) for halothane were above the NIOSH criterion. The halothane results would have been within the NIOSH-recommended criterion of 2 ppm if it were the only anesthetic being used. However, when used in conjunction with nitrous oxide, as it is at CHMC, NIOSH recommends that the halothane levels be controlled to 0.5 ppm. In most cases this can be achieved by controlling nitrous oxide exposure to 25 ppm.

A NIOSH medical officer reviewed the report of the hospital's epidemiologic investigation of the outbreak of conjunctivitis. The results of this review were inconclusive as to an etiologic agent; however, exposure to anesthetic gases did not appear to be the cause of the outbreak.

The data collected during this evaluation indicated that approximately half of the operating room personnel were being exposed to concentrations of nitrous oxide and halothane in excess of the NIOSH-recommended maximum levels. Recommendations for reducing waste anesthetic gas levels are included in the body of the full report. No etiology was determined for the conjunctivitis outbreaks. Since no additional cases of conjunctivitis have occurred since May, further investigation of the outbreak of conjunctivitis by NIOSH does not seem warranted at this time.

KEYWORDS: SIC 8069 (Specialty Hospitals, Except Psychiatric), pediatric, hospital, waste anesthetic gases, nitrous oxide, halothane, conjunctivitis.

II. INTRODUCTION

On April 7, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from an authorized representative of employees of the Children's Hospital Medical Center, Boston, Massachusetts, to evaluate: (1) the exposure of operating room personnel to waste anesthetic gases, and (2) the recent outbreak of conjunctivitis and sore throats among operating room personnel. Concern was expressed in the request about the possibility of air duct contamination, and about the operation of the air scavenging system.

III. BACKGROUND

Children's Hospital Medical Center specializes in pediatric medical care and thus utilizes pediatric anesthesia systems for most cases in the Main Operating Room Suite. These systems rely heavily on mask application of anesthesia, which is known to produce high concentrations of waste gases as compared to other methods of anesthesia application. Also unique to pediatric anesthesia techniques is the method of endotracheal intubation. In small children, a cuff is not used around the endotracheal tube so that a pressure problem is not created in the lungs. This allows escape of anestiesia gases around the tube, and thus into the room.

For the three months prior to this evaluation, several Operating Room employees had complained of eye irritation sometimes accompanied by a sore throat.

Results of previous area air monitoring conducted by Technology In Medicine, Incorporated, in August 1981, showed levels of nitrous oxide ranging from 8 ppm in the Recovery Room, to 150 ppm in one of the Operating Rooms. All of the Operating Rooms exceeded the NIOSH-recommended maximum exposure level of 25 ppm for the period of anesthesia administration. Halothane levels ranged from negligible to 1.7 ppm (below the NIOSH criterion of 2 ppm when used as the sole anesthetic agent, but above the NIOSH recommendation of 0.5 ppm when used in conjunction with nitrous oxide).

As a result of the above survey, the scavenging system was rebalanced, all "soft" circuits including hoses and connectors were replaced, and a preventive maintenance schedule was established.

IV. EVALUATION DESIGN AND METHODS

On May 12 and 13, 1982, NIOSH investigators conducted an initial survey at the hospital. Twelve general area and 25 personal breathing-zone samples were collected for nitrous oxide, and 4 personal samples for halothane. Two bulk area samples were collected for qualitative analysis of organic chemicals.

Nitrous oxide concentrations were determined using a Wilks Miran 1A* infrared gas monitor after the air samples were collected in 20-liter milar bags. Halothane samples were collected on activated charcoal and analyzed by gas chromatography using NIOSH Method[1] P&CAM 127. The two bulk air samples also were collected on activated charcoal. These samples were desorbed with carbon disulfide and initially screened by gas chromatography (FID). The samples were reanalyzed using GC/MS.

NIOSH reviewed the ventilation design specifications and examined the humidification system for potential sources of irritant chemicals.

The infectious disease control department of the hospital had conducted an epidemiologic investigation of the conjunctivitis outbreak. A NIOSH medical officer reviewed the report of the hospital's investigation.

V. EVALUATION CRITERIA

ANESTHETIC GASES

Reports by Vaisman[2] and Askrog and Harvald[3] were among the first to identify an increased incidence of spontaneous abortion in women exposed to anesthetic gases and in wives of men exposed to anesthetic gases. Results of a more recent and comprehensive nationwide survey of occupational disease among operating personnel were published in 1974 by the American Society of Anesthesiologists (ASA)[4]. The results of this study indicate "that female members of the operating room-exposed group were subject to increased risks of spontaneous abortion, congenital abnormalities in their children, cancer, and hepatic and renal disease." This report also showed an increased risk of liver disease and congenital abnormalities in offspring of male operating room personnel. No increase in cancer was found among the exposed males, but an increased incidence of hepatic disease similar to that in the female was found.

In a study published by NIOSH[5], "nitrous oxide and halothane in respective concentrations as low as 50 parts per million (ppm) and 1.0 ppm caused measurable decrements in performance on psychological tests taken by healthy male graduate students. Nitrous oxide alone caused similar effects. The functions apparently most sensitive to these low concentrations of anesthetics were visual perception, immediate memory, and a combination of perception, cognition, and motor responses required in a task of divided attention to simultaneous visual and auditory stimuli." Headache, fatigue, irritability, and disturbance of sleep were also reported[6,7].

Mortality and epidemiological studies have raised the question of possible carcinogenicity of anesthetic gases, but sufficient data are presently lacking to list nitrous oxide or halothane as suspected carcinogens.

In an epidemiological study among dentists, Cohen et al.[8] compared exposed persons in that profession who used inhalation anesthetic more than 3 hours per week with a control group in the same profession who used no inhalation anesthetic. The exposed group reported a rate of liver disease of 5.9 percent, in comparison with a rate of 2.3 percent in the control group. Spontaneous abortions were reported in 16 percent of pregnancies of the wives of exposed dentists, in comparison with 9 percent of the unexposed. This difference was statistically significant. This study did not identify the specific anesthetic being used by the dentists surveyed, that is, whether they used N_2O alone or a halogenated agent. However, in a review of that study, NIOSH[9] concluded that "the halogenated anesthetics alone do not explain the positive findings of the survey and N_2O exposure must be an important contributing factor, if not the principal factor." This conclusion is based on a calculation which assumed that as many as 1 in 10 of the dentists using an inhalation anesthetic employes a halogenated agent. If the actual fraction is less than 1 in 10, then this conclusion would be even more significant.

In a document recommending a standard for occupational exposure to waste anesthetic gas[6], NIOSH recommended that exposure to nitrous oxide, when used as the sole anesthetic agent, be controlled to 25 ppm TWA during the anesthetic administration. Halogenated anesthetic agents should be controlled to 2 ppm when used alone, or to 0.5 ppm when used in combination with nitrous oxide.

In a recent study, Cohen et al.[10] reported results on questionnaires sent to 64,000 dentists and dental assistants. Respondents were asked to estimate their occupational exposure to anesthetic gases, e.g., N_2O, halothane, etc., and to complete a health history for the period 1968 to 1978.

Over 22,000 dental assistants and 23,000 pregnancies which occurred during the sample period were reported.

Among the dentists who responded, 42 percent said they used anesthetic gases regularly in their practices. Approximately one-third of that group were "heavy users," using agents more than 9 hours per week. The study concluded that:

> (1) Among heavily anesthetic-exposed dentists, an increase in liver disease from 1.9 to 3.2 cases per 100, an increase in kidney disease from 2.4 to 2.9 cases per 100, and an increase from 0.35 to 1.35 cases per 100 in nonspecific neurological disease (numbness, tingling, and weakness) were reported relative to the group reporting no exposure to the anesthetic gases;
>
> (2) Among heavily exposed female dental assistants, an increase in liver disease from 1.0 to 1.6 cases per 100, and an increase in nonspecific neurological disease from 0.45 to 1.98 cases per 100 were reported relative to the non-exposed group of assistants;
>
> (3) The rate of spontaneous miscarriage was increased from 6.7 per 100 in the control to 11.0 per 100 among wives of heavy anesthetic-exposed dentists, and from 7.6 cases per 100 in the non-exposed to 17.5 cases per 100 in heavily exposed female dental assistants;
>
> (4) Birth defects increased from 3.6 to 5.9 per 100 among children of exposed female assistants; however, no increase in birth defects was reported in children of exposed male dentists; and
>
> (5) Cancer incidence was unchanged among male dentists, but the rate among exposed female assistants appeared somewhat higher than among those unexposed.

Finally, because dentists work close to the patient's mouth, and tend to use larger volumes of the gases to maintain effective anesthetic, they may receive two to three times the dose of anesthetic gases as operating room personnel. Also, a study of individual anesthetic gases used in dental offices revealed that nitrous oxide was the sole agent reported by 81 percent of those dentists using anesthetic gases. Cohen concluded that nitrous oxide, commonly known as "laughing gas," has always been considered to be inert and nontoxic. However, this study indicated that "significant health problems appear to be associated with the use of nitrous oxide alone."

VI. RESULTS AND DISCUSSION

The results of the environmental monitoring are summarized in Tables I, II, and III. Thirteen of 25 personal exposures (52%) were above the NIOSH criterion of 25 ppm for nitrous oxide. Air concentrations ranged from 4 ppm to 200 ppm. Each of the operating rooms had at least one employee exposed to nitrous oxide in excess of the NIOSH recommendation.

Two of 4 personal exposures (50%) were above the NIOSH criterion for halothane. The halothane results would be within the NIOSH-recommended criterion of 2 ppm if it were the only anesthetic being used. However, when used in conjunction with nitrous oxide, as it is at CHMC, NIOSH recommends that the halothane levels be controlled to 0.5 ppm. In most cases this can be achieved by controlling nitrous oxide exposure to 25 ppm.

Only very small amounts (less than 0.5 mg/m^3) of any organic contaminants were detected on the two bulk samples. The major component detected was thrichloroethylene. Other compounds detected included MIBK, toluene, xylene, a series of mostly C_9-C_{12} alkanes, and smaller amounts of ethanol, isopropanol, and 1,1,1 trichloroethane. The qualitative analysis is not remarkable in terms of occupational exposure.

TABLE I
NITROUS OXIDE SAMPLING RESULTS
OPERATING ROOM SUITE
5/13/82
(Grouped by Room#)

Room	Job Title	Times	Anesthesia Method	Operation	Exposure (ppm)
4	Scrub	7:17-9:19	Mask/Endo Tube	Oral Cyst	115
4	Circulating	6:58-8:59	Mask/Endo Tube	Oral Cyst	50
4	Scrub	9:19-11:35	Mask/Endo Tube	T&A	68
4	Circulating	9:20-11:41	Mask/Endo Tube	T&A	91
4	Circulating	11:41-12:10	Endo Tube	T&A	47
5	Anesthetist	7:30-10:14	Spinal		4
5	Scrub	7:22-9:05	Spinal		5
5	Circulating	7:11-9:23	Spinal		5
5	Anesthetist	10:14-11:42	IV/Mask	Knee Biopsy	10
5	Scrub	9:05-11:15	IV/Mask	Knee Biopsy	18
5	Circulating	9:23-11:41	IV/Mask	Knee Biopsy	33
7	Scrub	7:18-9:30	Mask/Endo Tube	Uret Reimpl	12
7	Circulating	9:32-11:52	Endo Tube	Uret Reimpl	30
7	Scrub	9:30-10:55	Endo Tube	Uret Reimpl	26
7	Scrub	10:55-11:51	None	Clean up	10
7	Circulating	11:52-12:20	Mask Induction	Nephrectomy	47
9	Circulating	9:41-12:18	Endo Tube	Mid Face Adv	18
4&9	Circulating	8:59-11:23	Endo Tube	T&A/Mid Face	42
9	Circulating	12:10-1:38	Endo Tube	Mid Face Adv	18
Plast	Circulating	7:21-8:57	Set up		12
Plast	Circulating	8:57-10:44	Mask	Body Cast	155
Recov	Nurse	10:30-11:42			15
Recov	Nurse	11:42-1:03			18
Amb	Anesthetist	7:38-10:15	Mask	????	83
Amb	Anesthetist	10:15-12:20	Mask	????	200

	Area Samples	
Nurses' Station	8:00-9:45	10
	9:45-11:55	21
	11:55-1:33	8
Ellies Office	8:00-10:33	3
	10:33-1:45	3
Back Office	8:21-10:12	17
	10:12-11:46	11
	11:46-1:34	10
Recovery Office	8:21-10:25	25
	10:25-1:08	26
Workroom Old Side	8:22-11:01	22
	11:01-1:07	18

Table II
(Grouped by Exposure)

Room	Job Title	Times	Anesthesia Method	Operation	Exposure (ppm)
Amb	Anesthetist	10:15-12:20	Mask	????	200
Plast	Circulating	8:57-10:44	Mask	Body Cast	155
4	Scrub	7:17-9:19	Mask/Endo Tube	Oral Cyst	115
4	Circulating	9:20-11:41	Mask/Endo Tube	T&A	91
Amb	Anesthetist	7:38-10:15	Mask	????	83
4	Scrub	9:19-11:35	Mask/Endo Tube	T&A	68
4	Circulating	6:58-8:59	Mask/Endo Tube	Oral Cyst	50
7	Circulating	11:52-12:20	Mask Induction	Nephrectomy	47
4	Circulating	11:41-12:10	Endo Tube	T&A	47
4&9	Circulating	8:59-11:23	Endo Tube	T&A Mid Face	42
5	Circulating	9:23-11:41	IV/Mask	Knee Biopsy	33
7	Circulating	9:32-11:52	Endo Tube	Uret Reimpl	30
7	Scrub	9:30-10:55	Endo Tube	Uret Reimpl	26
		NIOSH STANDARD			25
Recov	Recov Nurse	11:42-1:03	??	??	18
5	Scrub	9:05-11:15	IV/Mask	Knee Biopsy	18
9	Circulating	9:41-12:18	Endo Tube	Mid Face Adv	18
9	Circulating	12:10-1:38	Endo Tube	Mid Face Adv	18
Recov	Recov Nurse	10:30-11:42	???	??	15
Plast	Circulating	7:21-8:57	Set up	??	12
7	Scrub	7:18-9:30	Mask/Endo Tube	Uret Reimpl	12
7	Scrub	10:55-11:51	None	Clean up	10
5	Anesthetist	10:14-11:42	IV/Mask	Knee Biopsy	10
5	Circulating	7:11-9:23	Spinal	??	5
5	Scrub	7:22-9:05	Spinal	??	5
5	Anesthetist	7:30-10:14	Spinal	??	4

Table III
HALOTHANE SAMPLING RESULTS
OPERATING ROOM SUITE
5/13/82

(with corresponding nitrous oxide levels)

Room	Job Title	Times	Anesthesia Method	Operation	ppm Nitrous	ppm Halothane
4	Circulating	6:58-8:59	Mask/Endo Tube	Oral Cyst	50	
4&9	Circulating	8:59-11:23	Endo Tube	T&A/Mid Face	42	1.14
9	Circulating	12:10-1:38	Endo Tube	Mid Face Adv	18	
9	Circulating	9:41-12:18	Endo Tube	Mid Face Adv	18	0.57
5	Circulating	7:11-9:23	Spinal	??	5	
5	Circulating	9:23-11:41	IV/Mask	Knee Biopsy	33	0.07
7	Circulating	9:32-11:52	Endo Tube	Uret Reimpl	30	
7	Circulating	11:52-12:20	Mask Induction	Nephrectomy	47	0.20

As previously noted, the anesthesia technique significantly affects the occupational exposure levels in the Operating Rooms. Other factors that also affect the levels to which employees may be exposed include the operation, maintenance of the scavenging system, and the ventilation system supporting the Operating Rooms.

The scavenging system employs a positive pressure feed from the anesthesia machine to the exhaust duct, and a negative pressure exhaust from that point to the air handler. If all hose and coupling fittings on the positive pressure end are not air tight, then leakage will be into the room. One such case was noted in the Plaster Room. The end of the hose that leads to the exhaust duct had to be crimped to fit into the T-connector at the anesthesia machine. The gaps left by crimping allowed the waste gases to escape into the room. A simple solution would be to seal this connection with duct tape. It should not be interpreted that this will bring the exposure levels below 25 ppm, as other factors also contribute to the employee exposure. In the Plaster Room, for example, there is significant patient movement (changing of body casts) that allows the mask seal to be broken, and thus increases employee exposure.

Proper balancing of the scavenging system is also very important. Although NIOSH did not test the system, it was obvious that the flow control dampers were not tamper proof. Improper settings on these dampers will place the entire scavenging system in an imbalanced state. The system should be balanced by the CHMC Engineering Department, and the proper settings either locked in or permanently marked.

The ventilation system which supports the Main Operating Room Suite is designed to supply 100% fresh air at a rate ranging from 15 air changes per hour in Room 5 to 26.5 air changes per hour in Rooms 9-12. These rates are more than adequate to meet the standard (40 cfm/person) set by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) for hospital operating rooms. Proper operation of this system should be periodically checked.

The humidification system was examined as a possible source of an irritant that could explain the conjunctivitis. The cooling water treatment chemicals (algicide and conditioner) were determined and were researched to see if they possess irritant properties. One of the components of the boicide, nabam, is reported to be an irritant to skin and mucous membranes. The levels of these chemicals in the cooling water were measured on May 5, 1982, by the manufacturer and determined to be low by their standards. However, as a precautionary measure, the water treatment chemicals were removed from the cooling system and, therefore, could not be measured during this evaluation.

Conjunctivitis

The hospital's report of the outbreak of conjunctivitis identifies 12 cases among OR nurses and office personnel. (The report does not describe symptoms or examination findings, nor does it specify a case definition.) Four cases had onset between March 5 and 7; three were in OR nurses. Two of the three had eye cultures positive for Streptococcus pneumonia; the third had no culture. A single case, in an office worker, occurred April 2. The remaining seven cases, five of them in office workers, occurred between April 25 and May 4. Four of the seven had eye cultures; three were negative for bacteria and viruses, and one was positive of Staphylococcus (not S. aureus). None of the 12 cases reported "contact" with other cases. Most reported no allergies, most did not wear contact lenses, and none used hand cream at work. Information on use of various hand cleaners was obtained, but neither of the two most commonly used could be implicated as a risk factor (or the others as protective) since there was not information on use of hand cleaners by OR personnel without conjunctivitis. The overall attack rates were 50% among OR office workers and 6.6% among OR nurses.

Although the report analyzes the cases as though they constituted a single outbreak, the NIOSH medical officer interprets them as two separate clusters. The data in the report suggest a small cluster of cases in early March, apparently of bacterial etiology, involving OR nurses, and another cluster in late April and early May involving mostly OR office personnel. These latter cases are apparently not of bacterial or viral etiology. Furthermore, neither the NIOSH environmental findings nor the higher attack rate among office workers (compared to nurses) suggest anesthetic gases as the etiology.

It should be noted that waste anesthetic gases have not been reported to cause conjunctivitis, but have been linked to dry, sore throats and excessive thirst.

VII. CONCLUSION

The data collected during the time of this evaluation indicated that about half of the operating room personnel were being exposed to concentrations of nitrous oxide and halothane in excess of the NIOSH-recommended levels. Although it is not felt that these levels contributed to the conjunctivitis outbreaks, steps should be taken to reduce the exposures. No etiology was determined for the conjunctivitis outbreaks. Since no additional cases of conjunctivitis have occurred since May, further investigation of the outbreak of conjunctivitis by NIOSH does not seem warranted at this time.

VIII. RECOMMENDATIONS

1. The interim recommendations included in the above Discussion section should help reduce employee exposure to waste anesthetic gases. These include repairing leaks at all hose and coupling fittings of the scavenging system, and proper balancing of the system.

2. Careful attention to technique, on the part of the person administering the anesthesia, appears to be the most effective way of reducing the exposures of the entire operating room staff.

IX. REFERENCES:

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

2. Vaisman AI. Working conditions in surgery and their effect on the health of anesthesiologists. Eksp Khir Anesteziol 1967;3:44-9.

3. Askrog V, Harvald B. Teratogen effeckt of inhalations-anestetika. Nord Med 1970:83:498-504.

4. Cohen EN, Brown BW, Bruce DL, Cascorbi HF, Corbett TH, Jones TW, Whitcher C. Occupational disease among operating room personnel: a national study. Anesthesiology 1974:41:321-40.

5. National Institute for Occupational Safety and Health. Effects of trace concentrations of anesthetic gases on behavioral performance of operating room personnel. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1976. (DHEW publication no. (NIOSH) 76-179).

6. National Institute for Occupational Safety and Health. Criteria for a recommended standard--occupational exposure to waste anesthetic gases and vapors. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW publication no. (NIOSH) 77-140).

7. Uhlirova A, Pokorny J. Results of questionnaire survey of health damage to anesthesiologists. Rozhl Chir 1976:53:761-70 (Cze).

8. Cohen EN, Brown BW, Bruce DL, Cascorbi HF, Corbett TH, Jones TW, Whitcher C. A survey of anesthetic health hazards among dentists: report of an american society of anesthesiologists ad hoc committee on the effect of trace anesthetics on the health of operating room personnel. JADA 1975;90:1291.

9. National Institute for Occupational Safety and Health. Control of occupational exposure to N_2O in the dental operatory. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW publication no. (NIOSH) 77-171).

10. Cohen EN, et al. Occupational disease in dentistry and exposure to anesthetic gases. 1980. This research supported by the National Institutes of Health OH-00775, and a grant in aid from the American Dental Association.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

Kevin P. McManus, I.H.
USPHS, NIOSH, Region I
Boston, Massachusetts

Environmental Assistance:

Richard Gorman, I.H.
Industrial Hygiene Section
Hazard Evaluations and Technical Assistance Branch
Cincinnati, Ohio

Wesley E. Straub, I.H.
Regional Program Consultant
USPHS, NIOSH, Region I
Boston, Massachusetts

Medical Review:

Mitchell Singal, M.D.
Medical Section
Hazard Evaluations and Technical Assistance Branch
Cincinnati, Ohio

Originating Office:

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies

Report Typed By:

Marylou Louse, Secretary
USPHS, NIOSH, Region I
Boston, Massachusetts

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. Children's Hospital Medical Center, Boston, Massachusetts
2. Massachusetts Department of Labor and Industries, Division of Occupational Hygiene, Boston, Massachusetts
3. NIOSH, Region I
4. OSHA, Region I

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.