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CRANSTON GENERAL HOSPITAL (OSTEOPATHIC)
CRANSTON, RHODE ISLAND

NIOSH INVESTIGATORS
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I. SUMMARY

On October 26, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Assistant Administrator of the Cranston General Hospital (Osteopathic), Cranston, Rhode Island, to conduct a Health Hazard Evaluation (HHE), and to provide technical assistance in assessing operating room employee exposures to the anesthetic gas, nitrous oxide, (N_2O). Operating room personnel complaints consisted of frequent headaches and tiredness. Specifically, the request sought to determine if improvements made to the operating room anesthetic gas scavenging systems were adequate in protecting employees from the harmful health effects associated with nitrous oxide exposure.

On October 27, 1988, NIOSH investigators conducted a site visit (to gather background information) and on March 27, 1989, conducted environmental air-monitoring.

Five area samples were collected while three different surgical procedures were being performed in the three different operating rooms being evaluated. All samples reported nitrous oxide levels of less than or equal to 10 PPM. There are presently no OSHA standards for nitrous oxide anesthetic gas. The NIOSH Recommended Exposure Limit (REL) for nitrous oxide is 25 PPM, time-weighted average, (TWA), during the time of anesthetic agent administration.

Based on the results of the environmental survey, the investigators concluded that a health hazard did not exist from employee exposure to waste anesthetic gases. Concentrations of waste anesthetic gas and vapors were detected during all the surgical operative procedures which were monitored. For all values obtained, reported exposures were 10 PPM or less. Recommendations are included in the body of this report, which are designed to strengthen the hospital's existing program for controlling employee exposure to this waste anesthetic gas and vapor.

KEYWORDS: SIC 8062 (General Medical & Surgical Hospitals) nitrous oxide, waste anesthetics, scavenging systems

II. INTRODUCTION

On October 26, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Assistant Administrator of the Cranston General Hospital (Osteopathic), Cranston, Rhode Island, to conduct a Health Hazard Evaluation (HHE) and to provide technical assistance in assessing operating room employee exposures to the anesthetic gas, nitrous oxide. Operating room personnel complained of frequent headaches and excessive tiredness. Specifically, the request sought to determine if improvements made to operating room anesthetic gas scavenging systems were adequate in protecting employees from the harmful health effects associated with nitrous oxide exposure. NIOSH conducted site visits on October 27, 1988 (to gather background information) and on March 27, 1989 (to conduct an environmental air-monitoring survey).

III. BACKGROUND

Cranston General Hospital (Osteopathic) is a general osteopathic hospital. This hospital has three active operating rooms. When in operation, each operating room has 2 nurses and 1 anesthesiologist on each surgical case. Therefore, at any time, there are as many as 9 employees potentially exposed to nitrous oxide. Two operating rooms are usually in operation concurrently; each operating room is in use daily for between 4-6 hours.

Operating room personnel first began to complain of excessive anesthetic gas exposures in November, 1987. Initially, hospital management requested that the supplier of the anesthesia machines evaluate potential nitrous oxide leaks and employee exposure levels. The company supplying the anesthetic equipment was Onehda. Onehda personnel conducted an on-site evaluation of the equipment and stated that leaks were detected at the absorber gauges, and also recommended that all rubber hose connections be changed. Further, they suggested that operating room personnel insure that all hose connections be tight, as well as all swivel Y-yoke connections on the individual nitrous oxide gas cylinders.

The hospital management next requested that their liability insurance company (St. Paul Property and Liability Insurance Co., Hamden, CT) conduct air monitoring for nitrous oxide gas in the three operating rooms. These tests were conducted on February 25, 1988, by hospital staff using air-monitoring equipment supplied by St. Paul Property and Liability Insurance Co. Follow-up air-monitoring was conducted by hospital staff on July 22, 1988, and again on August 25, 1988. In each survey, nitrous oxide concentrations were above the NIOSH Recommended Exposure Limit (REL) of 25 PPM. St. Paul Property and Liability Insurance Co. performed the sample analysis for the nitrous oxide samples taken in the operating rooms by hospital staff. All samples taken by the hospital staff were area samples; there was no personal breathing zone air-monitoring conducted for operating room personnel during these evaluations. The reported levels for nitrous oxide for these area air-monitoring evaluations were:

February 25, 1988:

operating room 1	54 - 440 PPM
operating room 2	50 - 650 PPM
operating room 3	18 - 63 PPM

July 22, 1988:

operating room 1	120 - 2400 PPM
operating room 2	120 - 3800 PPM
operating room 3	NOT DETERMINED

August 25, 1988:

operating room 1	75 - 190 PPM
operating room 2	8.8 - 130 PPM
operating room 3	NOT DETERMINED

After receiving these air-monitoring determinations, hospital management installed new disposable hoses on the scavenger systems, initiated the installation of a new scavenger interface for the older anesthesia machines, and replaced all swivel Y-yoke connectors with solid connectors. Retraining of operating room employees was also initiated, with particular emphasis on the need to close the valves on nitrous oxide cylinders when not in use.

After these changes had been instituted, hospital management requested that Creative Environmental Corporation, East Providence, Rhode Island, conduct repeat environmental air-monitoring in the three operating rooms at this facility. Air-monitoring was conducted on September 19 and 28, 1988, using a portable Miran #010, Foxboro Analytical Specific Vapor Analyzer. Technical personnel from Creative Environmental Corporation conducted the air testing, which included both personal breathing zone and area air-monitoring samples. Nitrous oxide levels for the operating rooms were as follows:

September 19, 1988:

operating room 1	9-150 PPM	150 PPM at pop-off valve 150 PPM at employee breathing zone
operating room 2	2-300 PPM	300 PPM at pop-off valve 300 PPM at employee breathing zone

operating room 3	0-80 PPM	30 PPM at pop-off valve 80 PPM at employee breathing zone

September 28, 1988:

operating room 1	2-30 PPM	30 PPM at pop-off valve 30 PPM at employee breathing zone
operating room 2	12-35 PPM	35 PPM at pop-off valve 35 PPM at employee breathing zone
operating room 3	6-800 PPM	800 PPM at pop-off valve 210 PPM at employee breathing zone

Creative Environmental Corporation stated in their report that the repairs made on September 21, 1988, significantly lowered the environmental nitrous oxide levels in operating rooms 1 and 2. However, they were unable to determine why the readings were still elevated in operating room 3. Their suggestion for these elevated levels was that the newly installed scavenging system in operating room 3 was faulty, that there was an incorrect operational procedure, or possibly supply and exhaust ventilation were not operating within specifications.

After their survey, Creative Environmental Corporation recommended that the following suggestions be initiated to eliminate the existing nitrous oxide concentrations:

1) Eliminate the source of nitrous oxide by correcting leaks in the scavenging system, anesthesia machine, nitrous oxide bottles, pop-off valves and other points determined to be leaking.

2) Conduct additional ventilation measurements in operating room 3 to assess current parameters, and recommend possible changes as necessary.

As a further measure, hospital management requested that Creative Environmental Corporation conduct extensive ventilation measurements on the ventilation system supplying operating rooms 1, 2 and 3. Operating room ventilation measurements by Creative Environmental Corporation in conjunction with R.D. Searle & Associates were made, and the following findings and recommendations were reported:

1) The supply air grilles, located in the wall near the ceiling

are not the correct type for this application. These grilles are designed for ceiling installation, one-way air flow, and cannot provide the desired air distribution pattern or flow.

2) The exhaust air for operating rooms 1 and 2 is intended to be drawn through the door grilles at the back of the rooms into the room between operating room 1 and 2, and then through the ceiling grille to the exhaust fan. No flow through the door grilles could be detected.

3) Air flow calculations based on air flow measurements were 866 CFM (18 air changes/hour) in operating room 1, 666 CFM (14 air changes/hour) in operating room 2, and 780 CFM (18 air changes/hour) in operating room 3. The guidelines suggested for supplying ventilation air to hospital operating rooms is 20 air changes per hour. This guideline, cited by R. D. Searle and Associates, was established by B.O.C.A. (The Building Officials Code Administrators, National Plumbing Code of Regulations, 1984). To achieve this air exchange rate, operating rooms 1 and 2 should have 950 CFM of supplied air and operating room 3 should have 866 CFM of supplied air.

4) Change supplied air grilles in operating rooms to appropriate type and size.

5) Increase the size of the exhaust grille in operating room 3.

6) Install new exhaust grilles in operating rooms 1 and 2 where they are currently located in the wall, at floor level. Install new exhaust ductwork from these grilles to the central exhaust fan system.

7) Remove the old A/C unit and install a new A/C unit with new ductwork from the unit to the three zone ducts.

8) Rebalance the system.

IV. MATERIALS AND METHODS

NIOSH conducted an initial site visit and opening conference on October 27, 1988. Those in attendance were a hospital Administrative Assistant, an Operating Room Nurse Supervisor, and the Operating Room Nurses Union Representative. During the opening conference, NIOSH procedures and activities were discussed, and all pertinent operating room information and past air-monitoring reports were obtained.

Following the opening conference, a walk-through tour of the three operating rooms was conducted. Also, an evaluation of the HVAC units supplying ventilation air to the operating rooms was performed.

Upon returning to the first floor hospital conference room, all walk-through observations were discussed. Also, a date was established for conducting operating room air monitoring for nitrous oxide gas during operative procedures, since no halogenated agents are used. The tentative date for this return visit for air monitoring was March 27, 1989.

On March 27, 1989, NIOSH Regional Industrial Hygienists, Dr. Edward A. Kaiser and Mr. Kevin P. McManus returned to Cranston General Hospital to conduct the scheduled air-monitoring survey for nitrous oxide. A Miran Infra-Red Vapor Analyzer, Model 1A, was used for these procedures. Air-monitoring in the three operating rooms was conducted by securing low-flow Du Pont air sampling pumps and collection bags to both the head (anterior end of the surgical table) and foot areas (posterior end of the surgical table) of the operating tables.

Air samples collected for the assessment of N_2O concentrations in the operating rooms consisted of area samples,

which were collected in the operating rooms during the different surgical procedures. Samples for nitrous oxide were collected using battery-powered portable sampling pumps which were set at approximately 200 cubic centimeters of air per minute (cc/min). The exhaust port of each pump was attached, via Tygon tubing, to an inert Tedlar bag. Samples were collected for the duration of the surgical procedures. Bags were then immediately analyzed at a location outside the operating room area, using an infra-red analyzer (Foxboro Miran 103, Specific Vapor Analyzer) in accordance with NIOSH analytical method 6600.[1] Samples were collected in each of the operating rooms being evaluated, where nitrous oxide was used.

No personal sampling was conducted since operating room staff felt they would be hindered in their operating room procedures and functions by the bulkiness of the sampling pump and collection bag. However, the area samples were located in order to approximate personal exposure levels (i.e.; same distance from the source as the operating room employees). Both operating room personnel and nursing management stated that there had been no operating room staff complaints for over two months regarding nitrous oxide exposures, and that improvements to the anesthesia delivery and scavenging systems had effectively eliminated all employee concerns related to exposure.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects, even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, thus, such contact may contribute to the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes 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), and 3) the United States Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards (Permissible Exposure Limits (PELs)). 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 exposure limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels, it should be noted that industry is required by the Occupational Safety and Health Act of 1970 (29 CFR 1910) to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentrations of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits (STELs) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high, short-term exposures.

A brief discussion of the toxicity and evaluation criteria for anesthetic gases is provided as follows:

In a study published by NIOSH,[2] "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 have also been reported in another study.[3]

Furthermore, 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.

A review of available literature on health aspects of nitrous oxide reveals a number of reports suggesting that N_2O should be suspected of causing embryofetal toxicity in humans (resulting in an increase of spontaneous abortions). Some epidemiological studies have also indicated an increased incidence of congenital abnormalities among children of exposed personnel.

Reports by Vaisman, and by Askrog and Harvard were among the first studies to identify an increased incidence of spontaneous abortion in women exposed to anesthetic gases and in wives of men exposed to anesthetic gases.[4,5] In 1974, the American Society of Anesthesiologists (ASA)[7] published the results of a study suggesting that the female members of operating room exposed employees were more prone to the increased risks of spontaneous abortion, and congenital abnormalities in offspring, than to non-operating room female employees.[6] Also, in this study, it was reported that no increase in cancer was found among the males exposed to anesthetic

gases, but an increased incidence of hepatic disease similar to that in females was found.[7]

In a study of dentists, Cohen, et al, compared exposed persons who used inhalation anesthetics more than three hours per week with a control group 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 wives of exposed dentists, in comparison with 9 percent of the unexposed. This difference was statistically significant; however, it should be noted that the rate of spontaneous abortions for all pregnancies ranges from 10 to 20 percent.[7] This study did not identify the specific anesthetic gas being used by the dentists surveyed, that is, whether they used N_2O alone or in combination with a halogenated agent. However, in view of that study, NIOSH 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."[8] This conclusion is based on a calculation which assumed that as many as one in ten of the dentists using an inhalation anesthetic employed a halogenated agent. If, in actuality, less than one in ten employed a halogenated agent, the conclusion has added strength.

In a document recommending a standard for occupational exposure to waste anesthetic gas, NIOSH recommended a maximum exposure of 50 PPM N_2O on a time-weighted average basis during the anesthetic administration in dental offices.[9] This recommendation is based primarily on available technology for reducing waste anesthetic gas levels in these environments.

When N_2O is used as the sole anesthetic agent in medical procedures, NIOSH recommends that occupational exposure be controlled so that no worker is exposed at TWA concentrations greater than 25 PPM during the entire period of administration. NIOSH recommends that occupational exposure to halogenated anesthetic agents be controlled so that no worker is exposed at concentrations greater than 2 PPM of any halogenated anesthetic agent during the period of anesthesia administration. When used in combination with N_2O, halogenated anesthetic agents should be controlled to 0.5 PPM, which generally can be accomplished by controlling N_2O to a TWA concentration of 25 PPM during the period of anesthetic administration.[9] There are presently no OSHA standards for nitrous oxide or the halogenated anesthetic agents. The ACGIH recommends a TLV of 75 PPM for ethrane and 50 PPM for halothane. In addition, in its "Notice of Intended Changes" for 1988-89, ACGIH proposes a TLV of 50 PPM for nitrous oxide.[10]

VI. RESULTS

The results of the environmental samples collected for N_2O during the surgical procedures monitored are presented in Table I. The values presented in Table I are for area air-monitoring samples. Nitrous oxide concentrations in the three operating rooms evaluated ranged from a low value of 6 PPM to a high value of 10 PPM. These values are all below the NIOSH REL of 25 PPM.

VII. DISCUSSION AND CONCLUSIONS

As evidenced by the results of this environmental air-monitoring survey, concentrations of waste anesthetic gases and vapors were below the NIOSH Recommended Exposure Limits in the surgical procedures monitored.

As previously noted, the anesthesia technique significantly affects the occupational exposure levels in operating rooms. Other factors that also affect the levels to which employees may be exposed to anesthetic gases include the type of operation being performed, maintenance and state of repair of the anesthetic gas 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 occur into the operating room.

Proper balancing of the scavenging system is also very important. NIOSH investigators did not test the system. There are flow control dampers, however, which can be manually adjusted. Improper settings on these dampers will place the entire scavenging system in an imbalanced state. The system should be balanced by the Engineering Department, or the system's supplier, and the proper settings should be either locked-in or permanently marked.

The ventilation system which supports the Main Operating Room Suite is designed to supply 100% fresh outside air at a potential rate ranging from 15 to 25 air changes per hour. This rate is more than adequate to meet the standard (40 CFM/person) set by the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE) for hospital operating rooms. Proper operation of this system should be periodically checked.

Previous air-monitoring results, however, did report waste anesthetic gas levels which exceeded the NIOSH recommended levels. Several factors may have played an important role in allowing the buildup of these waste gases in the operating rooms which were examined. These factors include: leakage from anesthetic cart fittings and components, an ineffective scavenging system, poor work practices, and inadequate exchange rates of the general ventilation system. Since the degree to which these and other factors may have influenced employee exposures cannot be accurately determined by the data collected in this survey, it is necessary that hospital staff regularly examine all areas for potential sources of employee exposure, and also attempt to identify any areas where further improvements can be instituted.

VIII. RECOMMENDATIONS

A brief discussion of some of the key areas necessary for controlling employee exposures is presented below:

(A) Equipment Maintenance

Of primary importance in maintaining waste anesthetic gas concentrations within acceptable levels is the regular maintenance of anesthetic equipment in order to prevent leakage. Recent data indicate that leaks from the high and low pressure anesthetic delivery system resulting from poor maintenance practices of the anesthetic unit are a primary source of employee exposures in operating rooms.[11] Background N_20 levels of 5 PPM and greater generally have been associated with leaks in the high pressure gas delivery system, which includes the N_20 supply lines, the connections at and between the ceiling and anesthesia machine, and the connector-control valve from the flowmeter.[11] During anesthetic administration, low pressure leaks occurring between the flowmeters and breathing hoses (including the flowmeter, vaporizer, reservoir bag, pop-off valve, endotrachial tube, automatic ventilator, and CO_2 absorber) can be a significant source of employee exposure.

(B) Scavenging Systems

Inefficient or faulty scavenging systems are another source for employee exposures to waste anesthetic gases. Scavenging systems consist of a collecting device, means of disposal, and pressure balancing device, if necessary. Depending on the particular type of anesthetic equipment in use, scavenging adapters should be be located at the pop-off valve for the circle absorber, non-breathing valve, T-tube, and ventilator. In addition, scavenging may also be necessary at locations such as the exit port of the CO_2 meter, which may also be a source of waste anesthetic gases in the operating room. As with all scavenging systems, it is important to ensure proper pressure balancing so that the gas system does not interfere with the proper operation of the anesthetic delivery system.

(C) General Ventilation

While local exhaust ventilation (such as scavenging) is the preferred means of eliminating waste gases at their point of generation, general room ventilation also plays an important role in maintaining acceptable waste gas levels in the operating room. Reasons for maintaining good general ventilation exchange rates include the rapid removal of wasted gases generated as a result of anesthesia induction, poorly fitting face masks, improperly inflated endotrachial tubes, and low or high pressure leaks which may occasionally develop in the system. While increasing the number of air exchanges does not eliminate the source of the anesthetic gases, it does lead to the more effective removal of the waste gases and vapors, thereby reducing the magnitude of employee

exposures. As a minimum, operating rooms should be provided with at least 20 air changes per hour.[12] The ASHRAE guideline for operating room ventilation requirements states that supply air be 40 CFM/person. The ASHRAE guideline is dependent on the number of occupants in the operating room, whereas the guidelines recommended by the Health Resources and Services Administration (Guidelines for Construction and Equipment of Hospitals and Medical Facilities) are for general operating room conditions, and are not occupant dependent.

(D) Work Practices

Proper work practices are also a key element in controlling waste anesthetic gas exposures. One study estimated that 94 to 99 percent of all waste gas exposure in operating rooms equipped with properly designed scavenging components may be the result of poor work practices of the anesthesia administrating employees.[13] Improper work practices include the use of poorly fitting face masks, insufficient inflation of endotrachial tubes, and spillage of volatile anesthetic agents while filling vaporizers. Despite constant attention to good anesthetic techniques, it is not always possible for the anesthesiologist to be aware of possible leakage from these sources. Therefore, it is important that the general ventilation be adequate to remove any waste anesthetics that might result from this source.

(E) Exposure Monitoring

To determine the effectiveness of the overall exposure control program within the hospital, it is necessary to periodically monitor employee exposures as well as monitor equipment for leakage. This could easily be accomplished since the hospital has staff experienced in monitoring for these waste anesthetic gases, as well as access to monitoring equipment. Sampling and analytical procedures, such as those provided in NIOSH methods 6600 and 1003, should be referenced for further guidance in the conduct of personal monitoring.[1]

In order to effectively control employee exposures in the operating room, a comprehensive program which addresses all of the previously discussed areas is necessary. Detailed recommendations regarding specific control procedures, work practices, and air-monitoring procedures are included in the NIOSH Criteria for a Recommended Standard....Occupational Exposure to Waste Anesthetic Gases and Vapors.[9] Adherence to the recommendations specified in this document should help to maintain exposures within acceptable levels and protect the health of employees in hospital operating rooms.

As a result of the findings from this NIOSH survey, it is currently apparent that a health hazard, resulting from exposure to N_2O, does not presently exist in operating rooms 1, 2 or 3 at this hospital.

From the five (5) area samples collected, no values were obtained above 10 PPM nitrous oxide. The surgical procedures monitored included: (1) microlarynx/ENT procedure, (2) a general intubation procedure, and (3) a surgical foot procedure.

Based on the conditions which were observed and the air-monitoring data which was collected, it appears that the improvements which were made to the anesthesia delivery, recovery and scavenging systems, have effectively lowered the nitrous oxide environmental air concentrations in the three operating rooms evaluated. These changes included the installation of the new waste gas scavenging interface valves, new yokes, improving ventilation air exchange rates, and the replacement of disposable connecting hoses. Also, the re-instructing/training of operating room personnel, relative to work practices (i.e. closing of nitrous oxide cylinder valves when not in use) and nitrous oxide cylinder maintenance (coupling and bushing replacement), have been responsible for attaining the significantly lowered nitrous oxide concentrations which were recorded in these operating rooms.

At the time of this evaluation, a health hazard to operating room personnel was not identified since nitrous oxide concentrations were not detected at or above the NIOSH Recommended Exposure Limit.

IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to the following:

A. Cranston General Hospital (Osteopathic), Cranston, Rhode Island
B. U.S. Department of Labor, OSHA - Region I.
C. NIOSH Regional Offices/Divisions

For the purposes of informing the affected employees, copies of this report should be posted in a prominent place, accessible to those employees, for a period of 30 calendar days.

Mention of commercial or product names does not constitute endorsement by NIOSH.

TABLE I
Nitrous Oxide Exposure Data
Cranston General Hospital (Osteopathic)
Cranston, Rhode Island
March 27, 1989

Sample #	Location of Pump/ Sample Collection	Time (Minutes)	Result (PPM)	Surgical Procedure Performed
L-101	O.R. - 2 (anterior)	59	10	(2)
L-102	O.R. - 3 (posterior)	45	6	(1)
L-103	O.R. - 3 (anterior)	60	10	(1)
L-28	O.R. - 1 (anterior)	51	7	(3)
L-107	O.R. - 2 (posterior)	48	10	(2)

1) Microlarynx, ENT Procedure
2) General Intubation Procedure
3) Foot Surgical Procedure