U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT HE 78-61-497

CAMP HILL ANIMAL HOSPITAL
CAMP HILL, PENNSYLVANIA

JUNE 1978

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) on April 27-28, 1978, at the Camp Hill Animal Hospital in Camp Hill, Pennsylvania. Breathing zone and general area samples were taken for halothane - the anesthetic agent used at the facility. In addition, the anesthesia machines were evaluated for leakage with a portable infrared analyzer. Eight of nine personal breathing zone samples exceeded the level recommended by NIOSH for exposure to halothane. General area samples obtained indicated that ambient levels in areas of the hospital sampled were also above this criteria.

The levels of halothane to which the employees were exposed on the days sampled are due to the method of anesthetic administration and leakage from the systems. Recommendations for the alleviation of this health hazard are presented in this report.

II. DISTRIBUTION AND AVAILABILITY

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

Copies of this report have been sent to:

a. Camp Hill Animal Hospital

b. U.S. Department of Labor, Region III

c. NIOSH, Region III

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

III. INTRODUCTION

Section 20 (a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

NIOSH received such a request from the employer to evaluate the potential for exposure of his employees to halothane and to provide any information on the chronic effects of halothane.

IV. HEALTH HAZARD EVALUATION

A. Description of Facilities/Operation

The Camp Hill Animal Hospital is a one-story structure consisting of veterinarians' offices and examination rooms and a reception area; and, of primary interest for this study, one operating room, one x-ray/ treatment room, one preparation room and one room designated as the laboratory. The O.R., in approximate dimensions, is 15 by 23 feet with a ceiling height of 9 feet. The lab, x-ray and prep room are all the same approximate dimensions - 10 by 16 feet with a ceiling height of 9 feet. Figure I is a schematic of the areas of evaluation.

This hospital uses only halothane to anesthetize the animals, mostly dogs and cats. Initial anesthesia is induced by intravenous injection of a barbituate; anesthesia for the operation is maintained by inhalation. There were two methods for inhalation anesthesia observed - endotracheal intubation (with or without recirculation) and face mask. The face mask is reserved for smaller animals which are initially anesthetized by enclosing them in a glass box and filling the space with anesthetic gas. The anesthetic gas is generally delivered in concentrations of 2-3 percent at a flow rate of 2-3 liters per minute.

The O.R. can accomodate two operations simultaneously, hence there are two anesthesia machines in the O.R. There is also an anesthesia machine in the x-ray/treatment room for an occasional operation performed there.

There are generally two people involved in each operation - one veterinarian and one technician. Totally, there are three veterinarians and two technicians routinely exposed to anesthetic gas; one receptionist and two other animal care personnel are intermittently exposed. Normal operating time is from approximately 8:15 a.m. to approximately 11:30 a.m. During the survey an average of 2 operations were performed by each veterinarian.

B. Evaluation Design

Personal breathing zone samples were obtained using Sipin pumps calibrated for a flow rate of 200 cc per minute. Activated charcoal was the adsorbing medium. Since the duration of anesthetic administration was so short, charcoal tubes were not changed for each operation but were kept in place for the duration of the operating schedule. General area samples were obtained by the method described above. Analysis of charcoal tube samples was by gas chromatography. General area samples were also obtained by using a flow-through vacuum pump to fill mylar bags with ambient air. Analysis of bag samples was accomplished directly on the instrument described in the following paragraph.

In order to trace leaks from the anesthetic systems and to obtain peak measurements of halothane, the Wilks Miran 1A general purpose gas analyzer was used. The operating parameters used for halothane analysis were: analytical wavelength 8.7 micrometers, pathlength 14.75 meters and slit width of 0.25 millimeters. (Mention of products by Trade Name does not constitute an endorsement by NIOSH.)

C. Evaluation Criteria

In the NIOSH publication entitled "Criteria for a Recommended Standard... Occupational Exposure to Waste Anesthetic Gases"[1], NIOSH recommends that "occupational exposure to halogenated anesthetic agents be controlled so that no worker is exposed at concentrations greater than 2 parts per million (ppm) based on the weight of the agent". However, this "environmental limit should be regarded as the upper boundary of exposure and every effort should be made to maintain exposures as low as is technically feasible".

The literature concerning the chronic health effects of halothane exposure to humans is slight. Halothane is generally used with other anesthetic agents (notably nitrous oxide) and rarely by itself. However, there are some animal studies on chronic exposure to halothane and they will be summarized below along with what little human data that is available.

1. Liver and kidney effects

Most human data on kidney and liver effects are derived from patients suffering complications from clinical anesthesia. It is unknown whether or not effects from chronic exposures will be the same as that from acute exposures. Most cases of hepatic or renal complication could be explained by some other reason; however, halogenated anesthetics as etiological agents could not be ruled out.

Animal studies[2,3,4,5] have shown ultrastructural changes in the liver and kidney and an increase in liver-to-body-weight ratios in rats following low level exposure to halothane. Subcellular changes have also been documented[6]. Similar effects have been demonstrated in pups born to female rats exposed to halothane during pregnancy.[7]

2. Carcinogenicity

"Mortality and epidemiological studies have raised the question of possible carcinogenicity of anesthetic gases, but sufficient data are lacking to list halothane as a suspect carcinogen."[8]

3. Psychologic Effects

The literature mentions two studies performed with human volunteers to assess the effect of nitrous oxide plus halothane on performance. In one study[9], subjects exposed to 500 ppm nitrous oxide plus 15 ppm halothane showed statistically significant decrements in performance (memory tests, auditory-visual signals divided tasks and a visual tachistoscopic test) over both the control group and the group exposed only to nitrous oxide. The other study[10] involved exposure to 50 ppm nitrous oxide plus 1 ppm halothane during testing. Significant decrements occurred in four of seven tests administered (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). No human studies have been done where halothane was the sole agent studied.

4. Central Nervous System and Behavioral Effects

Investigators[11] were able to produce abnormal synaptic complexes in fetal rats exposed to halothane. They hypothesized that these abnormalities, if persisting through adulthood, could "contribute to behavioral changes and poorer learning abilities". A further study[12] was able to substantiate this.

5. Spontaneous Abortions and Congenital Abnormalities

Several epidemiological studies[13,14,15,16,17] have indicated an increased incidence of spontaneous abortions and an increased incidence of congenital malformations among the children of exposed females and wives of exposed males. These studies have not implicated halothane specifically nor were concentrations identified.

D. Evaluation Results

Table I shows the results of the nine personal breathing zone samples taken for halothane. All but one sample exceeded the recommended criteria of 2 ppm. Table II shows the results of the area samples taken by charcoal tube samples and by air bag samples. The reception area had an average concentration of 1.3 ppm (two samples), the lab had an average of 2.8 ppm (one sample), the x-ray/treatment room an average of 3.8 ppm (five samples), the preparation room an average of 2.5 ppm (five samples), and the operating room an average of 4.7 ppm (3 samples).

The Miran 1A was used to locate sources of anesthetic gas from the three machines used. Table III lists the concentrations measured at various points on the machines. As expected, the major sources of waste anesthetic gas are the exhalation bags used with the "T" tubes, the "T" tube itself, and face mask. Other significant sources are the pop off valve and connections with the vaporizer outlet hoses.

E. Summary and Conclusions

The results of this survey indicate that all personnel, with the exception of the receptionist and auxiliary animal care personnel, are exposed to concentrations of halothane at or in excess of NIOSH's recommended criteria. The sources of halothane contamination are judged to be leaks from the anesthesia machines - pop off valves, metal to rubber connections, seepage of gas through rubber hoses, the breathing bag on the "T" tube and the lack of a scavenging system on the machines. The small fan in the side wall does not do an adequate job of removing contaminants since high levels of halothane were found in areas of the building other than the O.R.

V. RECOMMENDATIONS

It is the opinion of the investigator that the source of halothane contamination in this hospital is caused by three things - the lack of a scavenging system to remove waste anesthetic gas, the type of breathing circuits used, and work practices - in order of importance. The following recommendations are presented in order to provide guidelines for the elimination of waste anesthetic gas.

1. When possible, use the circle absorber to administer the anesthetic and recirculate unused gas. If it is necessary to use the exhalation bag instead, a method of disposing of exhaled gases should be implemented, such as the "funnel to ceiling exhaust fan" described during the survey. Other scavenging systems are described in the bibliography of the criteria document. These articles are numbered 159, 173, 183, 184, 188, 191, and 211.

2. Use only the concentration (flow rate) of anesthetic necessary to keep the animal anesthetized. Shut off the flow of gas prior to removing the animal from the breathing circuit. This will eliminate the escape of excess anesthetic gas.

3. Perform routine maintenance checks on the integrity of seals, hoses, etc. Replace hoses when they become cracked or worn. Halothane evidently will deteriorate rubber to some extent, so periodic replacement of hoses is probably necessary.

4. Metal to rubber connections can be tightened with hose clamps. These are available at hardware stores.

5. The general room fan in use in the O.R. should be rur for a considerable time after all operations are completed in order to reduce ambient concentrations of halothane.

It is recommended that a fan of greater exhaust capacity be installed. The fact that detectable concentrations of halothane were found in the reception area indicates that air movement is moving out of the operating theater in opposition to the fan's intended direction; therefore, the fan is only marginally effective. Although exposure to the clients in the reception room is not significant (due to their brief and infrequent periods of exposure), this should not occur.

Also, when exhausting waste anesthetic outside, be sure that you are not reintroducing contaminated air back into the building by way of another nearby window or door.

6. All administration of inhalation anesthetic should be done in the O.R. The x-ray room has no provision for waste gas removal. If the x-ray room must be used for anesthetic administration, then a scavenging system should be used.

7. Section VI in the criteria document should be consulted when considering engineering controls.

VI. REFERENCES

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Table I

Employee Exposure to Halothane
Environmental Data
Camp Hill Animal Hospital
Camp Hill, Pennsylvania

April 27-28, 1978

Job Description	Time Sampled (Min)	Volume of Air Sampled(M^3)	Employee Exposure(ppm)
Operating Room			
Veterinarian	111	0.02	19
Veterinarian	102	0.02	21
Veterinarian	116	0.02	4
Veterinarian	109	0.02	6
Veterinarian	131	0.02	7
Operating Room			
Assistant	112	0.02	18
Assistant	184	0.04	9
Assistant	116	0.02	13
Assistant	85	0.02	2
NIOSH Criteria			2

Table II

Area Concentrations of Halothane

Camp Hill Animal Hospital
Camp Hill, Pennsylvania

April 27-28, 1978

Location	Type Sample*	Sample Duration (min)	Concentration (ppm)
Reception Room	CT	204	1.7
" "	CT	109	0.8
Laboratory	CT	205	2.8
Preparation Room	CT	199	3.1
" "	CT	104	3.6
" "	Bag	35	1.0
" "	Bag	53	2.5
" "	Bag	31	2.5
X-Ray Treatment Room	CT	201	5.6
" " "	CT	31	3.5
" " "	CT	99	5.7
" " "	Bag	70	1.0
" " "	Bag	33	3.0
Operating Room	Bag	58	8.0
" "	Bag	Unrecorded	1.5
" "	CT	86	4.6

*CT - Charcoal Tube
Bag - Mylar bag with direct analysis on Miran 1

Table III

Peak Concentrations of Halothane
by Infrared Measurement

Camp Hill Animal Hospital
Camp Hill, Pennsylvania

April 27-28, 1978

Location Location	Surgical Procedure	Approximate Concentration (ppm)*
Old Anesthesia Machine in O.R.	hysterectomy	
Above pop-off valve		16
Above vaporizer outlet dome valve		9
Above vaporizer outlet hose		16
Above inlet dome valve		10
Near patient's mouth		38
Breathing zone of surgeon		8
Near mask on cat		45
Above exhalation bag		>60
Above cat mask at tube connection		59
Above vaporizer inlet hose		9
Above vaporizer		9
New Anesthesia Machine in O.R.	hysterectomy	
Above vaporizer inlet valve		11
Above pop-off valve		>60
Under vaporizer outlet hose		24
Under vaporizer inlet hose		15
Under soda/lime canister		27
Above canister seal		21
Above vaporizer		7
Above vaporizer inlet hose		15
Above vaporizer outlet hose		12
Anesthesia Machine in x-ray Room	ear resection	
Above vaporizer inlet valve		5
Ambient after procedure		2
Breathing zone of surgeon		8
Above vaporizer outlet valve		7
Above exhalation bag		>60
Above vaporizer		8

*Concentrations are indicated as approximate since the degree of error inherent in the technique is uncertain, and since ambient air movements cause fluctuations in the instruments' readout. However, values presented may be considered upper limit values.

Figure I

Layout of Camp Hill Animal Hospital
Camp Hill, Pennsylvania