Operating room pollution—Or is it contamination?

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Chronic exposure to waste anesthetic gases is a problem which affects all operating room personnel. This article provides a review of the background of the problem, encompassing the nature of the hazard, surveys, government standards, mortality, and what can be done to control pollution in order to reduce the hazard to those working in the operating room.

Numerous studies and surveys have been conducted in an attempt to find a cause-effect relationship between the exposure to waste anesthetic gases and certain disease states. These disease states include spontaneous abortion, congenital abnormalities, cancer, renal disease, hepatic disease, and a variety of physiological complaints ranging from fatigue, headache, irritability, pruritus, nausea, respiratory tract inflammation, central nervous system disturbances, and gastrointestinal disturbances, to effects such as disturbances of perceptual, cognitive, and motor skills.

It is estimated that 16-million anesthetics are administered annually in the United States, 11-million of which have a gaseous component. Some 214,000 workers, including surgeons, anesthesiologists, nurse anesthetists, operating room nurses, technicians, dentists, and veterinarians, are potentially exposed to waste anesthetic gases. Given the number of persons that are exposed to waste anesthetic agents could pose a significant problem.

By simple definition, pollutants are substances present in sufficient concentrations to damage health, resources, or the environment of man; if these substances are present in harmless concentrations, however, they are considered contaminants.

This article considers the potential harm of chronic exposure to inhalation anesthetics as well as what can be done to reduce the potential pollution of operating rooms to concentrations where no biological reaction can be demonstrated.

Background

It was as early as 1839 when Hewitt noted that chloroform, when administered in the presence of open gas lights, decomposed into hydrochloric acid and phosgene gas. The effects that it produced upon doctors and nurses exposed to this gas were paroxysmal cough, throat inflammation, and headache.

Hirsh, in 1929, was one of the first to measure concentrations of ambient ether vapors in poorly ventilated operating rooms. These concentrations varied from 20 to 500 ppm (parts per million).

In 1949, Wertham observed symptoms of chronic ether intoxication in surgeons, nurses, and anesthetists who had worked for many years in operating rooms where ether was the primary anesthetic agent. Symptoms included de-
pression, fatigue, headache, anorexia, nausea, loss of memory, and periodontal disease. One surgeon who had had 15 years of exposure to ether, exhibited electrocardiogram changes, which disappeared after he had undergone a six-week vacation. His symptoms did not recur once proper ventilation of the operating suite was initiated.

These studies did not seem to affect the administration of anesthetic agents or the techniques that were being used until 1967, when Vaisman\textsuperscript{1,3,4,5,6} published the results of his survey of 354 Russian anesthesiologists. Vaisman found that most Russian anesthesiologists worked in poorly ventilated operating rooms, where they primarily used semiopen or semiclosed ether techniques (98%), along with some nitrous oxide administration (59%), and a small amount of halothane administration (28%).

Complaints of the Russian anesthesiologists varied, encompassing fatigue (85% experiencing), headaches (78%), pruritus (8%), nausea, respiratory tract inflammation and irritability. There were other vague complaints of central nervous system and gastrointestinal system disturbances. One fact that has interested many since the publication of this report was the high incidence of spontaneous abortion among the female anesthesiologists surveyed. Eighteen of 31 pregnancies ended in spontaneous abortion,\textsuperscript{3,4,5,6} two ended in premature delivery,\textsuperscript{3,5,6} one ended in congenital malformation,\textsuperscript{3,5,6} and only seven were uneventful.\textsuperscript{8,4}

Vaisman conducted his survey primarily to investigate unpleasant working conditions and did not indicate that pollution was the single cause of all the ills of the anesthesiists. Prominent causes were also the long working hours, excessive work load, emotional strain, and the prolonged inhalation of concentrated anesthetic gases which was aggravated by poor ventilation, defective equipment, and poor building design. As a result of Vaisman's survey, Russian anesthesiologists were awarded a 20% pay bonus due to hazardous working conditions.\textsuperscript{1}

This report stimulated scientists in the United States, Denmark, Hungary, and Britain to do studies of workers employed in the operating room. Their aim was to seek a cause-effect relationship between the inhalation of waste anesthetic gases and spontaneous abortions, congenital abnormalities, cancer, hepatic disease, renal disease, and mortality.

**Mortality**

In 1968, Bruce\textsuperscript{8,15} published a 20-year survey of causes of death among anesthesiologists. The survey was based on 441 deaths of members of the American Society of Anesthesiologists (ASA) from 1947 to 1966, as compared to two groups of white males, the first from policy holders of Metropolitan Life Insurance Co., and the second group from the Bureau of Vital Statistics. Bruce recorded more deaths from lymphoid and reticuloendothelial system malignancies in the anesthesiologist group than in the control groups.

Suicide, however, was found to be the leading cause of death in anesthesiologists, one- and a-half times that of the U.S. male population in general, and almost two- and three-quarter times the rate of Metropolitan policy holders. However, deaths due to coronary heart disease and malignancies of the gastrointestinal tract and respiratory system were found lower in incidence in anesthesiologists than in the control groups.\textsuperscript{8} A more recent survey of Bruce published in 1974,\textsuperscript{9} covering mortality for the years 1967 to 1971, failed to substantiate the previous finding of a higher rate of death due to lymphoid and reticuloendothelial system malignancies in anesthesiologists. The only observation of this study at all significant, was that the overall mortality of anesthesiologists is low, this being con-

\*See the abstract of this survey in the December, 1974 issue of the AANA Journal.
sistent with other studies showing favorable mortality in the higher socioeconomic bracket.

Foreign studies

In 1970, Askrog and Harvald of Denmark surveyed approximately 570 persons in anesthetic service and found the rate of spontaneous abortion was 20% of all pregnancies of working anesthetists as compared to 10% among the same group prior to entering into anesthesia service.

In addition, it was found that the birth rate of female infants was higher among operating room personnel, and especially high in wives of working male anesthetists. Thus posing the possibility that chronic exposure to waste anesthetic gases increases male lethality. In another study, Askrog reported average concentrations of waste gas at 85 ppm for halothane and 7,000 ppm for nitrous oxide in the anesthetists' inhalation zone.

Lencz and Nemes of Hungary reported in 1970 that of 31 pregnancies in 24 anesthetists, ten resulted in spontaneous abortion, nine were pathologic (not defined as to pathology), two were premature deliveries, and only ten resulted in normal deliveries.

U.S. studies

These reports from abroad further stimulated United States researchers, and surveys were conducted on the incidence of pregnancy, miscarriage, cancer, and birth defects due to the influence of chronic exposure to waste anesthetic gases. Reports on the distribution of waste gases within the operating room were also done.

Linde and Bruce in 1969 assessed the exposure of operating room personnel to anesthetic vapors. They collected environmental air samples in operating rooms, and focused in on the vicinity of the anesthetist's nose in order to analyze the concentrations which were breathed by the anesthetist, and in the area of the "pop off" valve of the anesthesia machine. Urine samples were also obtained from anesthetists to ascertain the excretion of metabolic products of halothane from the body. Specimens of the expired air from anesthetists and nurses working in the operating room were also obtained.

During these tests, no attempt was made to alter the normal patterns of anesthesia practice, and it was found that high gas flows were normally used. The following results were obtained from the tests within the operating room, halothane concentrations ranged from 0.5 ppm to 49 ppm (average 8.5 ppm) and nitrous oxide had a range of 20 ppm to 428 ppm (average 130 ppm). Concentrations in the corridors were 0 to 4 ppm (average 0.5 ppm) for halothane.

Samples of end expired air of anesthetists (halothane levels) were taken either during the administration of anesthesia or immediately after the anesthetist left the operating room. These tests yielded a range of 0.5 ppm to 12.2 ppm depending upon the length of exposure time. Urine specimens contained an average of 1.3 μg/ml of fluoride ions and 8.1 μg/ml of total fluorine (normals: 1.0 μg/ml fluoride ions and 5.0 μg/ml total fluorine).

An active search for the effects of high concentrations of waste anesthetic gases appeared to begin in 1971. Cohen, Bellville, and Brown published a study aimed at determining a possible cause-effect relationship between spontaneous miscarriage and operating room exposure. Between 1966 and 1970, they surveyed 67 operating room nurses and 92 general duty nurses, and found that the incidence of miscarriage in the operating room nurses was 29.7% of all pregnancies, as compared to 8.8% in the control group.

Cohen, between 1965 and 1970, also surveyed a second group, consisting of 50 anesthetists and 81 physicians in other specialty areas. The rate of miscarriages in anesthetists was 37.8% as compared to 10.3% in the control group. Of particular interest is
the fact that loss of fetus occurred approximately two weeks earlier in both of the groups exposed to anesthetic gases, usually around the eighth week of pregnancy as compared to the tenth week in unexposed personnel.

Corbett, Cornell, Lieding, and Endres surveyed a total of 621 female nurse anesthetists from Michigan to ascertain the incidence of cancer and birth defects (appearing in children born to mothers exposed to waste anesthetic gases). They found a higher incidence of birth defects among the working nurse anesthetists, 16.4% as compared to 5.7% incidence of birth defects in nonworking mothers. There were 33 malignancies reported in 31 anesthetists; 10 of which were diagnosed in 1971.

Of the tumors reported, several were unusual types, including malignant thymoma, hepatocellular carcinoma, and leiomyosarcoma of subcutaneous tissue. Comparison data used was from the Connecticut Tumor Registry. The statistics showed that the Michigan nurses had a higher incidence of malignancies diagnosed in 1971 than did all the women of Connecticut during a three-year period from 1966 to 1969.

In addition to the surveys on the results of exposure (cancer, birth defects, or abortion), tests were conducted to determine concentrations of waste gases found in operating rooms. Corbett and Ball studied chronic exposures to methoxyflurane, as a possible occupational hazard to anesthetists. The techniques which they used in the collection of samples were similar to those of Linde and Bruce. Samples were taken from both the operating room air and expired air of anesthetists. Urine samples were also tested for fluoride concentrations.

Room air levels taken from the vicinity of the anesthetist ranged from 1.3 ppm when a 0.2% gas flow was used, to a 9.8 ppm reading when the gas flow was 1.0%. End expired air showed levels of methoxyflurane still present 29 hours after administration of anesthesia, and there was a five-fold increase in the urine fluoride concentration six hours after anesthetic administration.

It might be pointed out that this was the first study to document the use of gas-trapping systems as a way of decreasing ambient waste gases. By using a balloon device that was fitted over the "pop-off" valve of the anesthesia machine and connected to a wall suction via conductive tubing, the waste concentrations were reduced dramatically (0.015 ppm to 0.095 ppm).

Another study done during this time was by Whitcher, Cohen, and Trudell on scavenged and unscavenged systems. Scavenging is the process of conducting all waste anesthetic gases to the outside of the operating room suite. To compare the anesthetic techniques most frequently used, samples were taken from nonrebreathing systems (Lewis-Leigh valve) and semiclosed circle filter systems (Heidbrink). Halothane 1% was used for all cases tested, and gas flow rates were 10 L/M for the nonrebreathing system and 4 to 5 L/M for the semiclosed circle system.

Halothane levels were normally below detection prior to the start of anesthesia administration, but shortly thereafter, a rapid rise in concentration of waste gases appeared—regardless of the type circuit used. However, with the use of scavenging systems, the mean concentrations of halothane in the air were reduced 91% in the nonrebreathing system and 85% in the semiclosed circle system. End tidal air of anesthetists showed measurable halothane content up to 64 hours after they had administered anesthesia.

Until 1972, most studies of waste anesthetic agents had been done on a relatively small scale. In that year, however, the American Society of Anesthesiologists (ASA) entered into a contract with the U.S. Department of Health, Education and Welfare's (HEW's) National Institute for Occupational Safety
and Health (NIOSH), and appointed an ad hoc committee to study the effects of trace anesthetics on the health of operating room personnel.

A national survey was instituted with questionnaires being sent to 49,585 operating room personnel in four professional societies, including ASA, American Association of Nurse Anesthetists (AANA), Associations of Operating Room Nurses and Operating Room Technicians (AORN/T). These individuals represented nearly all the personnel in the U.S. who are continuously exposed to trace anesthetics in an operating room environment. Questionnaires were also sent to 23,911 individuals who served as the unexposed control group, from the American Academy of Pediatrics (AAP) and the American Nursing Association (ANA).

The survey was completed in 1974, and revealed that only 21% of the exposed group worked in scavenged operating rooms. Data was tabulated for five major areas of concern: (1) spontaneous abortion (loss of products of conception prior to the 20th week of gestation), (2) congenital abnormality, (3) cancer, (4) hepatic disease, and (5) renal disease.

The rates of spontaneous abortion for the participating groups were: ASA 17.1%, AANA 17.0%, AORN/T 19.5%, AAP 8.9%, and ANA 15.1%. Interestingly enough the abortion rate was higher in the AORN/T group than for either group directly administering anesthesia, but it was concluded from these results that the risk of spontaneous abortion for exposed personnel was two times greater than the risk of unexposed personnel.

Congenital abnormalities were slightly higher in the exposed groups, but it was difficult to determine the incidence of specific abnormalities given the small number of abnormalities reported. The rates for cancer showed an incidence of lymphoma and leukemia three times higher in exposed females, but no difference was found for exposed males. No significant differences were found in other types of cancer for either exposed or unexposed men and women. Hepatitis (excluding serum hepatitis) was reported more frequently in both exposed males and females, the range of increase was up two-fold.

The survey indicated that nurse anesthetists and operating room nurses and technicians have a higher risk of kidney disease than do nurses outside the operating room environment. These differences were not observed in the physician groups.

**Nature of the hazard and problems encountered**

Epidemiologic surveys have shown that persons working in the operating room experience an unusually high incidence of headache, fatigue, irritability, nausea, and pruritus among other side effects which may be attributed to trace concentrations of anesthetic gases. Bruce and Bach attempted to prove anesthetic gases hazards in their papers on "Trace Anesthetic Effects on Perceptual, Cognitive, and Motor Skills," and "Psychological Studies of Human Performance as Affected by Traces of Enflurane and Nitrous Oxide."

They investigated both halothane and enflurane as combined with nitrous oxide and the effects of nitrous oxide alone. Volunteers were exposed to 15 ppm halothane with 500 ppm nitrous oxide or the same quantities of enflurane and nitrous oxide, or simply 500 ppm nitrous oxide in air. Exposure time was four hours for all tests, and immediately thereafter the subjects were given a battery of audiovisual and memory recall tasks.

Significant findings of these studies indicate that there is an increase in reaction times after exposure to trace concentrations of anesthetic gases as well as diminished ability to recall word pairs. Enflurane and halothane both affected performance in much the same way, but nitrous oxide used as a sole agent did not appear to be as significant
a detriment to memory recall and reaction time as the other agents were. These reports would seem to confirm the fact that operating rooms without proper scavenging systems may interfere with the optimum performance of the anesthetist, as well as the performance of other employees exposed.

Other types of individual reactions to trace gas exposure have been observed. In 1971, Elder reported the exacerbation of subclinical myasthenia gravis in a nurse anesthetist, from occupational exposure to methoxyflurane, but not to halothane, cyclopropane, or nitrous oxide. In 1976, Schwettmann reported a case of an anesthesiology resident who had delayed asthmatic responses to enflurane following occupational exposure. There was no reaction during the actual administration of anesthesia, but eight to twelve hours after the exposure, a severe asthmatic reaction occurred, which required hospitalization.

Cascorbi has proposed that halothane metabolites may be damaging to the liver in man. Enzyme induction is an enhancement of metabolism to foreign substances entering the body, suggesting another possible hazard to anesthetists. Immune response is another of the body's mechanisms which might be impaired rather than enhanced by chronic exposure to trace concentrations of anesthetic gases.

Lofstrom and Schildt reported impairment of reticuloendothelial phagocytic action in man only one hour after the induction of anesthesia, using cyclopropane, halothane, ether, neurolept analgesia, or epidural analgesia.

Investigations have revealed startling evidence that operating room personnel who have worked only one year receive a cumulative exposure of nitrous oxide greater than that received by a patient undergoing 24 hours of anesthesia. This is a dose greater than that needed to induce nitrous oxide leukopenia or bone marrow depression.

It should be pointed out that nitrous oxide is not the "inert gas" it was once thought to be, it may be detected in the expired air of an anesthetist for seven hours following the administration of anesthesia. It was recognized in 1956 that prolonged clinical concentrations of nitrous oxide could cause fatal leukopenia. At one time, nitrous oxide was used as a cytotoxic agent in leukemia patients.

There is little doubt that the rate of spontaneous abortions in operating room personnel and anesthetists is higher than in control groups, but the precise etiologic factors are yet to be determined. None of the studies to date have been able to derive a direct cause-effect relationship between disease states and trace anesthetic concentrations. It has been proved that significant levels of these trace agents are present in operating room atmospheres not equipped with scavenging systems. The possibility exists that chronic exposure to low doses of anesthetics may be carcinogenic, embrotoxic, teratogenic and/or mutagenic.

Numerous physiological complaints of operating room personnel (headache, irritability, fatigue, nausea, weight loss, infertility, reduced mental acuity, pruritus, chloracne, respiratory infections, and personality changes) may be caused by waste anesthetic gases, but the proof is not available. "Halothane headache" is a common complaint of patients and is possibly due to the direct effect of the agent on the brain or cerebral vessels, but this does not account for the various other complaints.

It is possible that periods of unusual high stress, special solvents and sprays, antiseptic solutions, exposure to radiation, as well as other unknown factors may cause higher incidence of miscarriage as well as other problems in operating room personnel. Infections, especially serum hepatitis may be acquired from patients, and there is the possibility that working conditions may affect susceptibility to infection.
Stress is a relevant factor in the operating room since the anesthetist is continually under pressure in caring for the patient under general anesthesia. He or she must be always alert and ready to cope with an emergency that may or may not occur. Stress may be generalized, or it may be exacerbated by the anxieties of uncertainty and anticipation, or by interpersonal relationships, by irregular routine, by inadequate sleep or rest, or by long working hours.

The anesthetist may not even be aware of stress until release from it actually occurs. Evidence of effects due to stress are as nebulous as those of trace concentrations of anesthetics. Most would agree that circumstances of undue personal challenge cause anxiety and "stress" to be increased, which in turn may decrease the safety factor because of reduced ability to think clearly and act quickly and confidently.

Controls to prevent pollution

Pollution reduction can be effective only if the sources are recognized, and effective control efforts are initiated. Some of the sources of possible pollution include leaks in poorly fitted components, worn seals in high pressure hoses and connectors; faults within anesthesia machine piping, flow meters, vaporizers, or cannister absorbers. The ventilator and "pop-off" valve are potentially one of the greatest sources of pollution if not scavenged properly.

However, the single most correctable source of pollution is careless anesthesia technique. Care must be taken to avoid spillage when filling vaporizers, mask-fit should be snug in order to avoid leakage of vapors into the atmosphere, and continued flow of anesthetics after cessation of anesthesia is wasteful as well as potentially harmful to all personnel in the operating room suite.

Other controls to prevent pollution include the reduction of high gas flows (most systems today can be very efficient and accurate at a 4 to 5 L/M gas flow), periodic inspection of the anesthesia machines for deterioration of metal or rubber parts, and the availability of a nonpolluting backup machine in the event that a problem is encountered with a machine in use. Probably the best method of control, however, is the installation of an effective gas scavenging system.

There are many scavenging systems available, but all include two major components. The first joins the breathing system with the scavenging trap ("pop-off" valve) and the second component causes the waste gases to be transported from the operating room to the outside atmosphere. Several dispersal routes may be used. Non-recirculating air conditioning systems allow the disposal of waste gases into the air conditioning system at the exhaust grill. From there they are pumped to the outside atmosphere; care must be taken in order to avoid occlusion of the exhaust hose since this would prevent the conduction of gases and could cause increased pressure at the breathing circuit.

Problems may be encountered with recirculating air conditioning systems if the disposal of waste gases is not downstream of the recirculated air. Halogenated compounds may be dispersed in activated coconut charcoal, unfortunately this is expensive and does not absorb nitrous oxide. Hookups to wall suction have been devised for non-explosive gases, but this method, too, is not without potentially hazardous side effects. The suction may be unable to handle high flows of gases, especially encountered with mechanical ventilation, or negative pressure may be transferred directly to the patients’ lungs if a pressure balancing valve is not installed properly.

Whatever means of scavenging system is used, it should be safe, effective, reliable, economic, and acceptable to all anesthetists. No scavenging system is 100% effective and invariably there
will be trace concentrations present in the atmosphere. These concentrations may be eliminated to some degree by the air conditioning system, but its effectiveness will depend upon the number of fresh air changes per hour. Non-recirculating air conditioning is recommended with a minimum of ten total air changes per hour.14,16

Anesthesia practices should be reviewed to obtain an awareness of the areas of excessive pollution and to institute control measures. Once this is accomplished, air quality monitoring is the key to achieving the desired levels of trace concentrations. There are several independent laboratories available to analyze air samples, but their accuracy can be no better than the accuracy of calibration which may vary from center to center. Sampling of sites, timing, and analysis should be chosen with a purpose if the results are to be effective. Probable reasons for analyzing air samples are:

1. To assess the exposure of the anesthetist.
2. To assess the exposure of the operating room personnel.
3. To define factors influencing removal of anesthetic gases.
4. To compare contamination in different areas.
5. To compare contamination with recommended standards.
6. To assess effectiveness of scavenging devices.

If concentrations are repeatedly in excess of the recommended levels, an infra-red analyzer for nitrous oxide or halogenated agents may be used in order to locate the exact source of pollution.

Government standards

The National Institute for Occupational Safety and Health (NIOSH) was created by the Occupational Safety and Health Act of 1970. The major responsibility for this agency is to conduct research for new occupational safety and health standards. Specifically, the agency is to develop criteria for recommended standards which describe exposure levels that are safe for various periods of employment, including but not limited to the exposure level at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience.2

The Department of Labor, Occupational Safety and Health Administration (OSHA) has the responsibility of development, promulgation, and enforcement of standards. Based upon the data obtained by many surveys, NIOSH recognized the need for a safe level of exposure to trace concentrations of waste anesthetic agents, but has not defined this level in exact amounts.

Recommendations have been made that concentrations of ambient gases equal or are less than 25 ppm for nitrous oxide and 0.5 ppm for halogenated agents. This may be obtained by the use of any control procedure that is effective.

NIOSH has also recommended standards for work practices including quarterly equipment maintenance programs, high and low pressure leak testing schedules, air monitoring programs, the availability of information on possible effects of exposure to all personnel working in the operating room, and medical monitoring programs to record and update medical information on exposed employees.2

It is, however, the responsibility of OSHA to write the specific standards to be followed and to enforce these standards once they are adopted. Though the standards described are not yet official, it would behoove all personnel in anesthesia to adopt safe anesthesia practices and institute the use of efficient scavenging equipment as a preventive measure from the possible hazards of waste anesthetic gases.

Hospital procedure

Using St. Mary’s General Hospital in Lewiston, Maine, as an example, demonstrates one institution’s ongoing effort to reduce operating room con-
tamination to the lowest levels possible. Each anesthesia machine is equipped with a “pop-off” valve which is connected to the scavenging hose, the other end is attached to the air conditioning exhaust vent, that carries the anesthetic gases outside the operating room suite. These hoses are checked weekly for leaks and replaced whenever necessary. A non-recirculating air conditioning system is used which has a total of eight fresh air changes per hour.

Quarterly checks of the anesthesia machines by the company representative are also a part of the steps taken to assure use of the highest quality equipment available. Malfunctioning equipment is taken out of service until fixed or replaced. Air samples from each of the operating rooms are obtained monthly and sent to a commercial laboratory for gas chromatography studies of levels of nitrous oxide, halothane, and enflurane. With few exceptions the air samples test below or equal to the recommended levels for all agents.

Care is taken to avoid spilling liquid anesthetics when vaporizers are filled. Anesthetics are discontinued promptly upon completion of the administration of anesthesia, preventing overflow into the atmosphere. It cannot be overemphasized that careful anesthesia technique is the most necessary factor if the contamination of the operating room environment is to be kept at the lowest possible level.

Conclusion

The evidence that occupational exposure to the operating room environment induces microsomal activity does not carry universal agreement. Experience in both man and animal experiments has provided some evidence of the potential harmfulness of prolonged exposure to inhalation anesthetics; however, many doubts are still present about the magnitude of the problem or even about its reality. The causes are still really unknown, and other potential causes aside from exposure should not be overlooked. The burden of proof, therefore, is on demonstrating the innocence, which would be even more difficult than seeking the actual contribution of anesthetics to the morbidity of anesthetists.

In 1974, only 21% of operating rooms in the United States were equipped with scavenging systems, leaving 79% either unaware of the potential dangers of chronic exposure to waste anesthetic gases or unwilling to install scavenging systems without mandatory government requirements. It is hoped that by the time government standards for levels of contamination are mandatory, most hospitals will have installed scavenging equipment to protect their employees' health as well as to promote optimal operating room function. Employees have the right to know that they are working in a safe environment where there is no danger to their health or life expectancy as a result of their working conditions.

Perhaps, a nationwide reduction in concentrations of ambient anesthetics in the atmosphere by the installation of effective gas scavenging equipment, followed by further surveys of virtually all personnel employed in operating rooms, is probably the only way of finding out if the control of trace concentrations might improve the health and performance of anesthetists, surgeons, nurses, and technicians employed in the nation's operating rooms.

REFERENCES

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