Original Article

Assessment of Nitrous Oxide (N2O) Concentration in the Air of Operating and Recovery Rooms of Hospitals of Babol University of Medical Sciences

Yusef Mortazavi[1] Asieh Khalilpour[2] ***Abdoliman Amouei**[3,4] Aram Tirgar[5]

1- Department of Anesthesia and Operating Room, Babol University Of Medical Sciences, Babol, Iran.
2- PhD student of Organic chemistry, Babol University of Medical Sciences.
3- Department of Environmental Health Engineering, Babol University of Medical Sciences, Babol, Iran.
4- Health Sciences Research Center, Mazandaran University of Medical Sciences, Sari, Iran.
5- Department of Social Medicine, Babol University of Medical Sciences, Babol, Iran.

*** iamouei1966@gmail.com**

Abstract

Background and purpose: There are occupational hazards to Nitrous Oxide (N_2O) in operating and recovery rooms of hospitals. These hazards include, decrease mental performance and audio-visual ability, and cause reduced fertility, spontaneous abortion and neurological, renal, and liver diseases. In this survey, concentration of Nitrous Oxide in indoor air of operating and recovery rooms in hospitals of Babol University of medical sciences was determined.

Materials and Methods: This descriptive study was performed in 23 operating rooms and 3 recovery rooms in 3 educational hospitals of Babol University of medical sciences. The rooms with continuous usage of N_2O with 2-3 lit/min of flow for general anesthesia were studied. For sampling and detection of N_2O concentration as part per million (ppm), a portable IR spectrophotometer (3015 model of Bacharach Inc.) was used. The sampling was performed in 5 different points of the operating rooms and 1 point of recovery room in 3 different hours of work time (8:30-9AM, 10:30-11AM and 12:30-1:00PM. One-way ANOVA by SPSS 18 were used to analyze of data and compare the means.

Results: Mean of N_2O concentration in 5 different points of the operating rooms were 318± 22.6, 325.5± 24.1, 299± 21.8, and 301± 22, 314± 23.7 ppm and in recovery room were 51± 15 ppm. There was no significant difference between the means of N_2O concentration in different points of the operating rooms, but between the means of N_2O concentration in different points of the operating rooms and recovery room were significant ($p<0.05$).

Conclusion: Considering to the high average concentration of Nitrous Oxide in different operating and recovery rooms with maximum contamination levels of N_2O, this situation puts at risk the health personnel. Therefore, further research and application protection utilizations are recommended. *[Mortazavi Y. Khalilpour A. *Amouei A. Tirgar A.* **Assessment of Nitrous Oxide (N2O) Concentration in the air of operating and recovery rooms of hospitals of Babol University of Medical Sciences.** *IJHS 2013; 1(2):95-99] http://jhs.mazums.ac.ir*

***Key words*:** Nitrous Oxide, Operating and Recovery Rooms, Concentration

1. Introduction

Anesthetic gas nitrous oxide, the most commonly used anesthetic gases in operating rooms as a weak analgesic and anesthetic agent used along with other medicines. The nitrous oxide N_2O gas was also called as laughing gas, nitrous oxide, dinitrogen monoxide in the mid-seventeenth century. Nitrous oxide gas is a colorless, odorless, tasteless that will not ignite, but it can help ignite the fire. It is about 1.5 times heavier than air and naturally exists in atmosphere with 0.5 ppm concentration. This gas pollutes the operating and recovery rooms and this pollution is connected to the improper operation of ventilation system and to the exhale of patients after surgery and to the gas leakage from anesthesia machines and cylinders. Operating room staff reported several effects of chronic inhalation of nitrous oxide gas such as decrease of brain efficiency, reduce of vision and hearing abilities, abnormalities of reproductive system, megaloblastic anemia, increase of spontaneous abortions, liver and kidney diseases (1). The inhalation of this combination can be harmful like the other industrial gases. The allowance limit of nitrous oxide in air inhalation for humane is 25 ppm according to National Institute for Occupational Safety and Health (NIOSH) in America. More than 50000 staff of operating room is exposed to nitrous oxide pollution in a year as reported (2). In America and most European countries as the maximum amount of exposure to the gas had been reported to vary from 25 to 100 ppm by taking the time = TWA (Time - Weighted-Average) (3). For decreasing this exposure, the National Occupational Safety and Health was recommended the average of exposure was 25 ppm and 50 ppm for operating room and dental centers respectively by considering the time (4). And this average was considered 50 ppm for operating room and higher than 100 ppm was acceptable shorter than 15 minutes in Denmark (15). Up to now in different countries, many studies have been done in the field of using the standard of nitrous oxide in operating and anesthesia rooms. The present research aimed at determining the rate of N_2O concentration in the air of operating and recovery rooms of hospitals of medical sciences university of Babol because the health and safety of staff is very important.

2. Materials and Methods

In the description-sectional study, the concentration of nitrous oxide from six different places of operating and recovery rooms which were equipped with air conditioning system was investigated. The samples were operating and recovery rooms of medical-training hospitals of medical sciences university which used N_2O with 2-3lit/min during 6 hours continuously in the morning. The time for collecting the samples was randomly. Totally, 1164 samples were collected from 23 operating and 3recovery rooms during 6 months. There was no changing in operating and recovery rooms by researcher. The portable system named an infrared spectrophotometer model 3015 from Bacharach Company. The error of system was ±5 ppm in per measurement. The sampling was performed in three times of morning, 8.30-9, 10.30-11, and 12.30-13.

The places of sampling were:

1- From 5-cm distance of exhaust releasing anesthetic

2- From 5-cm distance of patient's chip tube or anesthesia mask

3- From 30-cm distance of surgeon's face

4- From 30-cm distance of nurse's face in operating room

5- From 30-cm distance of anesthesia technician's face

6- From 30-cm distance of nurse's face in recovery room

Data analysis was performed by ANOVA and SPSS version 18.

3. Results

The maximum and the minimum temperature of operating and recovery rooms were between 20-24 during the different times of sampling and the area of operating and recovery rooms were 38.87 and 90 square meters respectively. 11 of operating rooms were equipped with standard air conditionings, 8 of them had semi- active air conditionings and 4 of rooms contained inactive air conditionings. Also on the basis of findings in this research, there was no significant difference for N_2O concentration in different places of operating rooms, While there was statically significant difference for N_2O concentration in different places of recovery rooms (P value < 0.05) (Table 1).

Table 1. The average of N_2O concentration in different places of recovery and operating rooms

The place of measurement	Number	Mean± SD	Maximum	Minimum
Point 1	194	318± 22.6	362.4	273.5
Point 2	194	325.5± 24.1	373	278
Point 3	194	298.9± 21.8	342	256
Point 4	194	301± 22	344.1	257.3
Point 5	194	314.3±23.7	361	267.5
Point 6	194	50.7±15	80.4	30

4. Discussion

Chronic inhalation of anesthetic nitrous oxide by operating and recovery staff resulted from improper working of air conditionings, high concentration of this gas from patients' exhalation after anesthesia and gas leakage from anesthesia machines and cylinders. The first step of omitting this pollution is determination of the exact concentration of nitrous oxide in staff inhalation. This research showed that 23 operating rooms had air conditioning system from which 11contained standard air conditioning system. The exhausts were located in all anesthesia machines and the results indicated that the average concentration of N_2O was higher than the standard. Kanmura and et al verified the ventilation with mask is the most common cause of N_2O pollution of the operating room (6). Chang and et al showed that general anesthesia mask had the highest pollution of N_2O. Induction of anesthesia with masks or

induction of anesthesia with intravenous drugs and continuing it with endotracheal tube without cuff produces considerable pollution in operating room. These measures cause to produce and contact to concentrations higher than 25 ppm which is more than the standard of NIOSH. These researchers recognized the best way of decreasing the pollution of operating rooms was induction of anesthesia with intravenous drugs with cuff tube (7). Raj and et al indicated that induction of anesthesia or airway control methods had no effect on N_2O pollution of operating room. Anesthesia system was considered as one of the most effective factor in the research (8). Also, the pollution decreased 80% by using of induction of anesthesia with intravenous drugs or double-mask induction rather than using of induction of anesthesia with general anesthesia mask (9). While this research showed that the kind of anesthesia system used , the kind of used anesthesia (mask or endotracheal tube with or without cuff) and round of working had no effect on the average of N_2O concentration in different places. Perhaps one of the reasons why this study is not to show the differences between these variables, there was a high concentration of N_2O gas. High concentration of N_2O causes to decrease the importance of little changes that other variables can produce in N_2O concentration. The results of this study explained that the only variable had significant effect on the average of N_2O gas in different places was the type of recovery. Disconnecting the scavenging system leads to the highest concentrations of pollutions. To reduce pollution with anesthetic gases, proper use of scavenging systems are required (10). Chang and et al also showed that using proper tools and ventilation hood dramatically reduced the pollution. Borganelli and et al in their study expressed the increase of ventilation in the operating room and the use of appropriate scavenging system with high suction rate, N_2O concentration would be significantly reduced in the operating room. They also recommended that the ventilation of operating room and the suction rate of scavenging system were the most important controls to reduce N_2O pollution to levels recommended by NIOSH (11). Raj and et al said that scavenging system could be effective on the rate of N_2O pollution and contact of this gas. Using a convenient and proper scavenging system or entering the fresh air to operating room (replaced at least 10 times) reduced the rate of contact with pollution to 85% (9). Finally, it is obvious that all anesthetists expose to N_2O and using the proper tools can significantly reduce the pollution (7). In this study, the error rate was decreased to minimum by using the precision systems and calibrating the equipment before each measurement and reading the values by a person. In the study although the shifts were considered, working days were not considered too. And it was likely that there was more pollution at the weekend and less pollution at the first days of week. Also, the accumulation of polluter gases increased after work days with long general anesthesia or repeated general anesthesia with semi-open systems in a special room. There was no way to test the air conditioning systems and the researchers only relied on officials in the study. N_2O gas leaks during anesthesia with mask or intubation will be significantly altered.

Among which the following items can be mentioned:

1- Check leakage of the anesthetic machine.
2- Improving general ventilation in the operating room: Operating room air 20-10 times per hour with no circulation of air is replaced. The average of N_2O concentration will be lower than standards for anesthetist and adults and pediatric surgical specialists by using air conditioning in modern conditions even in airway surgeries that can be directly operated such as ear, nose and throat surgery.
3- Improving the scavenging systems
4- Using double mask
5- Avoiding of frequent use of N_2O during induction
6- The size of operating room
7- Avoiding of intermittent ventilation with mask and using the LMA Instead of anesthesia with mask
8- decreasing fresh gas flow
9- Frequent controlling of endotracheal tube cuff pressure

The average of N_2O concentration in different places of operating rooms of university hospitals is higher than the defined standard range. So, all efforts should be made to minimize occupational exposure. In this regard, particular cautions and reducing the exposure time to the nitrous oxide pollution in operating rooms must be considered for people at risk like pregnant women.

Acknowledgments

Hereby we are extremely grateful to the Research and Technology department of Medical Sciences University who sponsored this project and to Mrs. Shirkhani for her statistical analysis and to operating room personnel of these hospitals- Shahid Beheshti, Shahid Yahyanejad and Ayatollah Ruhani.

References

1.Hoerauf k, Hosemann w. Exposure of operating room personnel to anesthetic gass during ENT interventions , HNO , 1996 , 44(10): 567-71.
2. Moeen K. Panni., Stephen B. Corn. The use of a uniquely designed anesthetic scavenging Hood to reduce operating room anesthetic gas contamination during genered anesthesia, Aneth Analg, 2002, 95: 656-60.
3. Hoerauf K., Koller C., Wiesner G., Taeger K., Hobbhahn J. Nitrous oxide exposure of operating room personnel in intubation anesthesia. Gesundheitswesen 1995 Feb; 57(2):92-6.
4. Li SH, Li SN, Shih HY, Yi HD, Chiang CY. Personnel exposure to waste sevoflurane and nitrous oxide during general anesthesia with cuffed endotracheal tube. Acta Anaesthesiol Sin 2002; 40(4): 185-90.
5. M. Jenstrup., K.O. Fruergaard. Pollution with nitrous oxide using laryngeal mask or face Mask. Acta anaesthesiologica scondinavica, 1999, 43(5): 663-66.
6.Kanmura Y, Sakai J, Yoshinaka H, Shirao K. Causes of nitrous oxide contamination in operating rooms. Anesthesiology 1999; 90(3): 693-6.
7. Chang WP, Kau CW, Hseu SS. Exposure of anesthesiologists to nitrous oxide during pediatric anesthesia. Ind. Health 1997; 35(1): 112-8.
8. Raj N, Henderson KA, Hall JE, Aguilera IM, Harmer M, Hutchings A, et al. Evaluation of personal,environmental and biological exposure of pediatric anaesthetists to nitrous oxide and sevoflurane. Anaesthesia 2003; 58(7): 630-6.
9. Meier A, Jost M, Ruegger M, Knutti R, Schlatter C Narcotic gas burden of personnel in pediatric anesthesia Anaesthesist 1995;44(3): 154-62.
10. Kanmura Y, Sakai J, Yoshinaka H, Shirao K. Causes of nitrous oxide contamination in operating rooms. Anesthesiology 1999;90(3): 693-6
11. Borganelli GN, Primosch RE, Henry RJ. Operatory ventilation and scavenger evacuation rate
influence on ambient nitrous oxide levels. J Dent Res 1993; 72(9):1275-8.