

Assessing Operating Room Nurses Occupational Exposure to Nitrous Oxide

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ABSTRACT: A large population of health care workers is potentially exposed to nitrous oxide which can cause decrease in mental performance, audiovisual ability, and reduced fertility, neurological, renal, and liver disease. Nitrous oxide exposure assessment in operating room has been not been done in Korean hospitals. To explore the nitrous oxide exposure among nurses in operating room, area sample and personal sampling methods were used. Air samples were taken while nitrous oxide was in use for over six hours where the surgeon and nurses were present for operation. There was a significant difference by type of anesthesia, type of surgery involved, and room structure. The author concludes that a health hazard from excessive exposures to nitrous oxide exists in the operating room. It is recommended to minimize the hospital workers' exposure to the chemical agent. The authors also recommend that the ventilation system should be adjusted each time nitrous oxide is going to be used. Routine maintenance checks should be performed on all anesthetic and suction equipment.

Keywords: *Operating Room Nurse, Nitrous Oxide Exposure, Occupational Hazards*

1. INTRODUCTION

Nitrous Oxide (N₂O) has been used as an anesthetic agent in operating room to control patients' pain. The gas possesses many of the ideal anesthetic attributes. Low solubility and the consequent kinetic benefits are complemented by a stability of respiration and circulation. It is an easily breathed and widely used safe and effective anesthetic agent [Kim, D, 1993, The Korean Society of Anesthesiologists, 1991].

Nitrous oxide has the ability to depress the central nervous system. Nitrous oxide has effect on cerebral blood flow, intracranial pressure and oxygen consumption. Evidence of injury to the nervous system has been shown in cases of chronic exposure to nitrous oxide. Also, but less well known, the state of B12 deficiency caused by regular use of nitrous oxide produces hyperhomocysteinemia, an accumulation in the blood of the amino acid homocysteine. Hyperhomocysteinemia is a risk factor for vascular disease of all sorts. Furthermore, hyperhomocysteinemia, B12 deficiency and folic acid deficiency early in pregnancy all increase the risk of getting a child with a neural tube defect (spina bifida and anencephaly, children with no brains or open spinal cord) [The Korean Society of Anesthesiologists, 1991, Wiesner, G., et al, 2001, Accorsi, A. et al, 2001, De-Amici, D et al., 1996]. Therefore, National Institute for Occupational Safety and Health (NIOSH) and Australia recommended a maximum time-weighted average (TWA) of nitrous oxide exposure to 25 ppm per procedure as recommended exposure limits (REL). American Conference of Governmental Industrial Hygienists (ACGIH), Belgium, Denmark, New Zealand, Singapore, Vietnam, Columbia, Jordan, Argentina, Bulgaria, and Korea recommend the TWA of 50 ppm as the threshold limit value (TLV). Occupational Safety and Health Administration (OSHA), NIOSH, and American Industrial Hygiene Association (AIHA) also have guideline on recommend exposure limits and Permissible Exposure Limits (PELs). European countries such as Germany, Italy, Norway, Sweden, Switzerland, England and Finland recommend TWA of REL as 100 ppm (180mg/m³) [<http://www.cdc.gov/niosh/rtecs/qx149970.html> retrieved March 22, 2009, <http://www.osha.gov/dts/sltc/methods/inorganic/id166/id166.html> retrieved March 22, 2009. Wiesner, G., et al, 2001].

Nitrous oxide exposure assessment in operating room has been not been done in Korean hospitals. Study objective is to assess nurses' possible hazardous exposure to nitrous oxide before and during operation.

2. METHODS

The study was conducted in a general hospital in Korea and focused on the exposure of

Table 1. Description of operating rooms

OR	A	B
	AESTIVA/5	Seneca 1272
Equipment	(Datex Ohmeda, USA, 2001)	(Drägerwerk AG LUBECK, Germany, 1987)
SD	Natural scavenging	None
A/C	None	Yes
Circulation	Fan	Fan
AG	Enflurane (5ℓ/min→1.5~2ℓ/min)	Sevoflurane (8ℓ/min→2ℓ/min)
Dimension	580cm×790cm×280cm	480cm×580cm×280cm

OR: Operating Room; SD: Scavenging Device;

A/C: Air Conditioning; AG: Anaesthetic gas

hospital workers in operation room. Two out of five most frequently used operating rooms were chosen. Description of the operation rooms are listed in Table 1.

Area sampling as well as personal sampling was collected. Personal sampling was performed in the breathing zone of affected personnel during the operation period. The levels of nitrous oxide were measured various locations around the operating room pre and during surgery. The molecular sieve 5A (60/80 mesh, Supelco Inc., Bellefonte) is the best adsorbent for

nitrous oxide. Measurement of nitrous oxide in occupational environments was collected by the air samples in Tedlar[®] bag(10ℓ) and analysis by Gas Chromatography with Electron Capture Detector (GC-ECD). Chromatographic conditions of GC-ECD is presented in Table 2.

Table 2. The operating condition of GC-ECD

Description	Condition
Detector Temperatures	330°C
Injector Temperatures	150 °C
Column Temperatures	160 °C
Injection Volume	200 µℓ
Column	Capillary column, Mol Sieve 5A Plot (0.53mm×30m, Supelco Inc., Bellefonte)
Nitrogen(Carrier gas)	11 Mℓ/min
Nitrogen(make-up gas)	30 Mℓ/min
Split ratio	2 : 1

the social science) 10.0. All statistical tests were 2-tailed, and a P value of <0.05 was considered significant.

Table 3. Desorption efficiency

concentration (ppm)	desorption efficiency (%)
10	90.75
25	89.09
50	97.16
100	98.50
200	98.38

Mean : 94.78; SD : 4.50

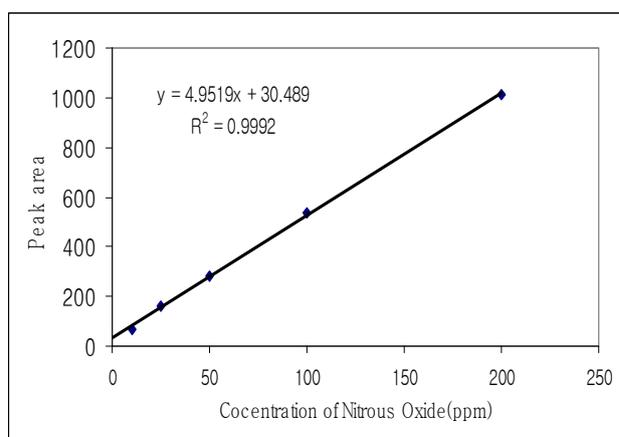


Figure 1. Calibration curve of Nitrous Oxide by GC-ECD

Desorption efficiency:

Desorption efficiency of the sampling units were tested at 10, 25, 50, 100, and 200 ppm nitrous oxide concentration. Overall mean desorption efficiency was 94.78% (Table 3).

Statistical Methods

Paired t-test was used to test the difference in pre and during surgery nitrous oxide measurement. All statistical tests were performed by using SPSS (Statistical package for

3. RESULTS

A calibration curve is constructed. It represents the amounts of nitrous oxide spiked to the standard tube versus the mean values of the chromatographic peak areas. Figure 1 shows a calibration curve obtained.

Pre and during surgery exposure to Nitrous Oxide: area sampling

There was a significant difference in Nitrous Oxide concentration pre and during surgery ($P < 0.01$)

(Figure 2, 3). Both room showed significant difference in pre and during surgery Nitrous Oxide concentration. No significant difference by location within operation room was found. Room B with Air conditioning system showed lower mean concentration of Nitrous Oxide than Room B with Natural Scavenging Device.

Exposure to Nitrous Oxide by location in operation room: Personal Sampling

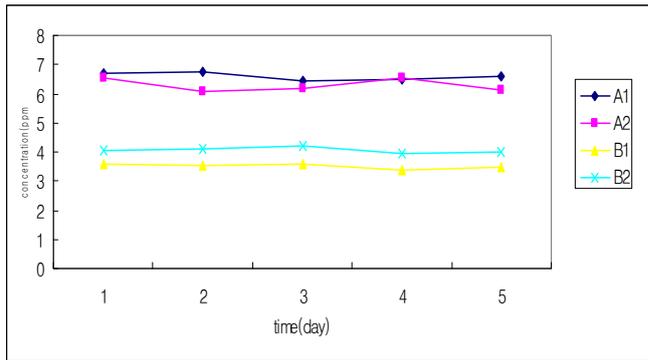


Figure 2. Concentration of N₂O pre- operation

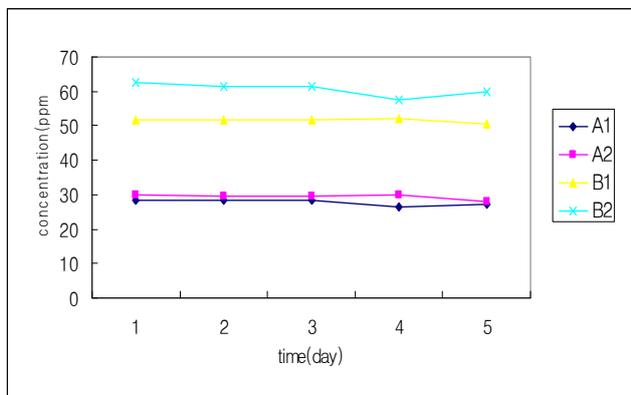


Figure 3. Concentration of N₂O during operation

Nurse who administer Anesthesia were exposed to higher concentration of Nitrous Oxide than Scrub Nurse (Table 4). General surgery and Obstetric and gynecologic nurses were exposed to higher level Nitrous Oxide than Neurosurgery nurses. Within room B, Obstetric and gynecologic nurses were exposed to slightly higher level of Nitrous Oxide concentration than General surgery nurses.

4. DISCUSSION

Room A with natural scavenging device revealed higher Nitrous Oxide concentration during operation. On the other hand, workers' exposure to Nitrous Oxide was lower in Room B with air conditioning system. Installing active scavenging devices can reduce the air contamination by 10 percent [The Korean Society of Anesthesiologists, 1991, <http://www.osha.gov/dts/sltc/methods/inorganic/id166/id166.html> retrieved March 22, 2009, Kumagai. S., Koda, S. 1999].

Within Operation room, higher exposure to Nitrous Oxide depended on medical specialty

Table 4. Concentration of workplace position by active Sampling

operating specialty	Room	TWA		
		(ppm)	(mg/m ³)	
Nurse Anesthetists	GS1	B	252.57	455
	GS2	B	231.43	417
	NS	A	26.67	48
	OBGYN	B	282.86	509
Scrub Nurse	GS1	B	35.78	64
	GS2	B	14.39	26
	NS	A	47.88	86
	OBGYN	B	75.43	136

GS: General Surgery; NS: Neurosurgery;

OBGYN: Obstetric and gynecologic

of dealing with anesthesia. Higher exposure to Nitrous Oxide was shown in specialty of dealing with anesthesia than room configuration or operating specialty. The authors conclude that a health hazard from excessive exposures to nitrous oxide exists in the operating room. The exposure level differs by room configuration as well as operating specialty within the room during operation. Adverse health effects may result from the exposure of the hospital workers in the operation room to high levels of nitrous oxide. It is recommended to minimize the hospital worker's exposure to this chemical agent in order to reduce their health risk. Also, the ventilation system should be adjusted each time nitrous oxide is going to be used. Routine maintenance

checks should be performed on all anesthetic and suction equipment. The installation of a large fan in the room as well as on the roof of the building is suggested.

5. REFERENCES

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