HCHSA
Health Care Health & Safety Association of Ontario

NITROUS OXIDE – NOTHING TO LAUGH AT

Since Connecticut dentist Horace Wells discovered the anaesthetic properties of nitrous oxide (N_2O) in 1844, the gas has played an important role in the health care sector. It is now the most commonly administered inhalation anaesthetic gas for medical and dental procedures. Either on its own or in combination with other anaesthetic agents, nitrous oxide is routinely used as a painkiller for a variety of medical procedures.

While nitrous oxide is commonly known as laughing gas, the potential risk it poses is no laughing matter. Workers in many health care settings are exposed to it during their daily routines, especially when dealing with anaesthetized patients. Studies have suggested that exposures in some settings are 12-40 times higher than recommend limits, even with scavenging systems in place. During medical procedures, great emphasis is placed on patient care and safety. Unfortunately, worker safety is often overlooked.

Who Is at Risk?

Across Canada, thousands of health care workers may unknowingly be exposed to dangerous and harmful levels of nitrous oxide. As the gas is colourless and has just a slight odour even at high concentrations, occupational overexposures may not be noticed. Workers most commonly exposed include:

- anaesthetists
- surgeons
- dentists
- dental assistants
- nurses
- midwives
- technicians
- multi-skilled support workers in hospitals
- porters
- housekeeping and maintenance staff
- veterinarians and animal technicians

It is important for employers to identify all workers at risk of nitrous oxide exposure. In some cases exposure may not be obvious. For example, health care workers in recovery rooms may be at risk from gases exhaled by their patients for hours, in some cases days, after being anaesthetized, depending on the duration of anaesthesia, the combination of gases used and physiology of the patient. In smaller clinics, administrative and secretarial staff may also be at risk of nitrous oxide exposure, especially if the building is served by a common ventilation system that uses return air.

Most exposures to anaesthetic gases occur during operations, birthing or post-operative patient care. Worker exposure to nitrous oxide can come from a variety of sources, including:

- gas escape during the initial hookup and check of the scavenging system
- leakage between the patient's face and the mask
- leakage in the anaesthesia system components
- purging of the system upon conclusion of the procedure
- patient exhalation during or after surgery
- poor work practices demonstrated by anaesthetists and other health care staff

THE HEALTH RISKS

Occupational exposures to nitrous oxide in excess of 50 ppm can lead to reduced dexterity, cognition, motor and audiovisual skills. Other acute health effects may include dizziness, headache, fatigue, irritability and depression. Just remember, the acute effects experienced by the patient are no different for the health care worker. The last thing you want is a surgeon as anaesthetized as the patient!

For the past 30 years, there has been substantial research into the chronic health effects associated with nitrous oxide exposures. A number of epidemiological studies have linked occupational overexposures with spontaneous abortions, congenital abnormalities and reduced rates of fertility. Other evidence has suggested that nitrous oxide exposure could cause neurologic, renal and liver disease. Although controversy surrounds some of these studies, the results have played a substantial role in setting the occupational exposure limits (OELs).

The exposure limit for nitrous oxide can be found in regulation 833 – the Control of Exposure to Biological or Chemical Agents section of the Ontario Occupational Health and Safety Act (OHSA). It is presented as a time-weighted average exposure value (TWAEV) – the average airborne concentration of a biological or chemical agent determined from air samples to which a worker is exposed for an eight-hour day or a 40-hour work week without experiencing any adverse health effect. The regulation may also assign a short-term exposure value (STEV) and/or a ceiling exposure value (CEV) to some substances. A STEV is the maximum concentration of a substance to which a worker can be exposed in any 15-minute period; a CEV is the maximum concentration of a substance that a worker can be exposed to at any time. The TWAEV for nitrous oxide is currently set at 25 ppm. While no STEV or CEV values have been assigned to nitrous oxide, the occupational hygiene rule of thumb suggests that three times the TWAEV be used as a STEV, and five times the TWAEV be used as a CEV.

METHODS OF CONTROL

Like any other workplace hazard, anaesthetic gases warrant their own program. In fact, if your organization is covered under the Health Care and Residential Facilities (HC&RF) regulation 67/93 of the OHSA, a program must be in place. For those organizations not covered under the health care regulations, it is the duty of the employer to ensure that workers are not being overexposed to anaesthetic gases, and that all reasonable precautions are taken for the workers' protection. That requires the implementation of an effective anaesthetic gas management program. At a minimum, it should include: air monitoring, engineering controls, safe work practices, regular preventive maintenance and hazard communication and training.

• Air Monitoring

Exposure monitoring should be the first and foremost step in determining what controls, safe work practices and training are required in your workplace. Three types should be conducted: leak testing of equipment, monitoring of air in the workers' breathing zone, and ambient (room) air monitoring. Air monitoring should be conducted prior to the implementation of new anaesthetic gas equipment, and then at least every three months. If feasible, leak testing should be conducted monthly. In addition, the monitoring schedule should be written and incorporated into the anaesthetic gas program.

All monitoring should be conducted by experienced individuals such as occupational hygienists or engineering staff with training and knowledge of air sampling methods. The National Institute of Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) in the United States offer sampling methods for nitrous oxide. It is recommended that all testing results be shared with your organizations Joint Health and Safety Committee (JHSC) for review.

• Engineering controls

The first line of defence for controlling nitrous oxide exposure is at the source, using a well designed scavenging system. These systems are important because the breathing zone of the individual administering the nitrous oxide is within centimetres of the mask. NIOSH research has reported worker breathing-zone concentrations in excess of 1,000 ppm in uncontrolled environments. While properly operating scavenging systems can reduce nitrous oxide concentrations by 70%, many studies have found that, even then, air concentrations can remain above 100 ppm. For these reasons it is important to emphasize that scavenging systems are only one aspect of a total control program. Both the Canadian Standards Association (CSA) and the International Organization for Standardization (ISO) offer guidelines to aid in the proper design, maintenance and use of scavenging systems. Section 96(3) of the HC&RF regulation states that a maintenance program must be in place and that monthly leak checks must be conducted for all scavenging systems, anaesthetic respirators and machines.

The heating, ventilating, and air conditioning (HVAC) system can play in integral role in decreasing workplace exposures. HVAC systems act by diluting and collecting gases that are not collected by the scavenging system. A CSA standard – Special Requirements for Heating, Ventilation, and Air Conditioning (HVAC) in Health Care Facilities – spells out the number of air exchanges required for various health care facilities. Areas within health care facilities at risk of anaesthetic gas exposure require a minimum of 20 room air exchanges per minute. This is especially important in areas such as birthing centers, post-anaesthetic care units (PACU), recovery rooms, and surgical daycares where no scavenging equipment is used.

As part of the engineering controls, preventive maintenance should be conducted for all scavenging systems, anaesthetic respirators and machines, and ventilation systems in accordance with the manufacturer's recommendations. As outlined in section 19(2) of the HC&RF regulation, mechanical ventilation systems must be inspected at least every six months.

• Safe work practices

One of the best ways workers can protect themselves is by performing safe work practices. Prior to conducting any procedures, a complete inspection of the anaesthetic delivery system and all connections should be completed. Ensure that all bags, hoses and clamps are in place prior to turning on the anaesthetic gas machine. Other safe work practices should include:

- selecting an appropriate mask that suits the patient and the procedure
- ensuring that airway devices (e.g., tracheal tubes) are properly positioned
- ensuring that nitrous oxide is not turned on until
    - the mask is secured to the patient's nose or mouth during procedure
    - the scavenging system is running at the recommended flow rate of 45 l/min
- Not allowing the nitrous oxide breathing bag to over inflate
- Encouraging patients to minimize talking and movement during procedures
- Flushing the nitrous oxide out of the system by administering oxygen to the patient for five minutes before disconnecting the system
- Making sure the mask is not removed from the patient's face while the nitrous oxide is still running
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• Hazard communication and training

Employers must ensure that employees working with nitrous oxide are trained to recognize, understand, monitor and reduce the health and safety risks associated with exposure. To ensure that workers are adequately protected and informed of hazards, employers should develop and implement a training program that may include:

- review of standard operating procedures for all tasks involving nitrous oxide
- information about air monitoring, safe work practices, control measures
- emergency procedures to contain spills
- observable indicators to identify the presence and release of nitrous oxide
- health effects associated with anaesthetic gas exposure

As an added control, pregnant workers should be informed of the risks associated with nitrous oxide and be given the option to work in areas where no exposure would occur.

CONCLUSION

Nitrous oxide can pose a serious risk to employees if proper controls are not implemented. It is the responsibility of the employer to ensure that all reasonable precautions are taken to decrease the level of exposure to all workers. All anaesthetic gas programs should be continually evaluated and reviewed annually to ensure they are still effectively protecting workers. Use the following checklist to evaluate your anaesthetic gas program.

References:

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Websites:

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Anaesthetic Gas Checklist

Has nitrous oxide been overlooked in your workplace? Use this tool to assess the strengths and weaknesses of your anaesthetic gas program.

Applicable areas: Operating rooms, recovery rooms, procedure rooms (i.e., cystoscopy, cardiac catheterization labs), labour and delivery suites, dental operatories, medical clinics, emergency departments

Unit/ Department:			
Date:			
Assessment Completed by:			
Checklist	**Yes**	**No**	**Explanation**
An anaesthetic gas program is in place and there are policies and procedures to support all activities			
Anaesthesia respirators and machines are installed and in use to reduce contamination of the air in the room during administration of anaesthetic gases			
An effective scavenging system is in place to collect, remove and dispose of waste gases			
Adoption and use of safe work practices to reduce contamination of the room air during the administration of anaesthetic gases			
Education for anaesthetists regarding how individual anaesthesia techniques can result in overexposure of workers has been completed			
Education and training for all workers exposed to or potentially exposed to anaesthetic gases has been completed			
Pre-start up inspections of anaesthesia machine – including a supply of properly fitting and inflating masks and tubes and ensuring the vaporizers are properly filled with liquid anaesthetic – are conducted daily			
Inspection of scavenging systems and anaesthesia respirators and machines for leakage occurs monthly			
A preventive maintenance program for scavenging systems and anaesthesia respirators and machines is implemented and in use			
There is regular maintenance of the ventilation system including filters every six months or more often if necessary			
The general exhaust ventilation provides at least 20 AC/hr for operating rooms and surgical day care. There should be no recirculation of air.			
There is a regular air monitoring program in place to ensure workers are not overexposed, including personal, area, source and leak testing. OSHA recommends sampling for nitrous oxide every three months. Need for air monitoring should be assessed in all work environments where workers are exposed or potentially exposed to anaesthetic gases.			
Communication of air monitoring results is recorded. Medical follow-up and surveillance occur if necessary.			
Liquid and compressed gas anaesthetics are stored safely			
A spill response protocol is in place, including the use of appropriate PPE			