

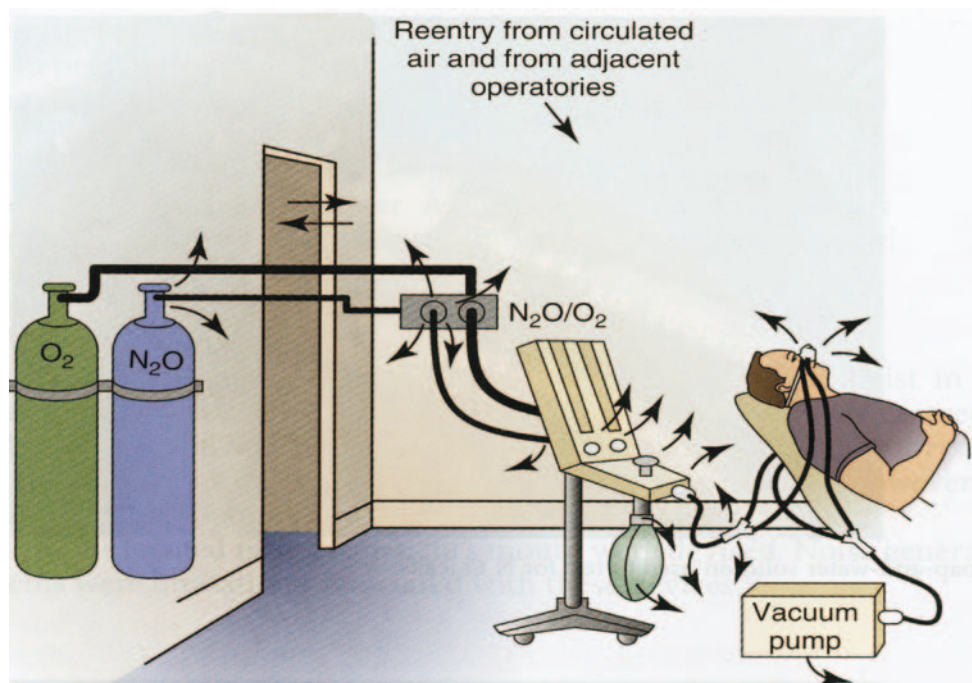


Figure 4. Potential leakage risks in a surgery setting

minimising exposure to nitrous oxide includes:

- Use an appropriate (i.e. dedicated) sedation flowmeter with active dental scavenging i.e. 45 L/min
- The breathing system should have a variety of mask sizes available, which can be cleaned in an autoclave, or are disposable
- Assess the surgery ventilation available—i.e. natural or mechanical. Enhance if necessary
- Monitor exposure on a regular basis—at least once a year
- Always employ a machine pre-use checklist
- Inspect cylinder connections, hoses, tubings and reservoir bag for holes and/or leaks and replace at recommended intervals (Figure 4)
- Ensure regular equipment maintenance by the original equipment manufacturer's approved provider at least once a year
- Careful patient management—e.g. discourage the patient from talking.

Summary

All members of the dental team have a

responsibility to ensure that the working environment is safe. There is no excuse for ignorance or mismanagement. A wealth of information is now available—both in printed form and on the internet—and all staff should ensure they are well-educated on the subject. Nitrous oxide exposure is unlikely to cause major health problems during normal working conditions where correct, active dental scavenging, is employed. If in doubt, seek specialist advice.

Brodsky JB, Cohen EN (1986) Adverse effects of nitrous oxide. *Med Toxicol* 1(5): 362–374
 Department of Health (2006) Health Technical Memorandum 02-01: Medical gas pipeline systems. DH, London
 Malamed SF (2010) *Sedation: A Guide to Patient Management*. 5th edn. St Louis, Mosby Elsevier
 Ostreicher JS (1994) Vitamin B12 supplements as protection against nitrous oxide inhalation. *NY State Dent J* 60: 47–49
 Rowland AS, Baird DD, Weinberg CR, Shore DL, Shy CM, Wilcox AJ (1992) Reduced fertility among women employed as dental assistants exposed to high levels of nitrous oxide. *N Engl J Med* 327(14): 993–997

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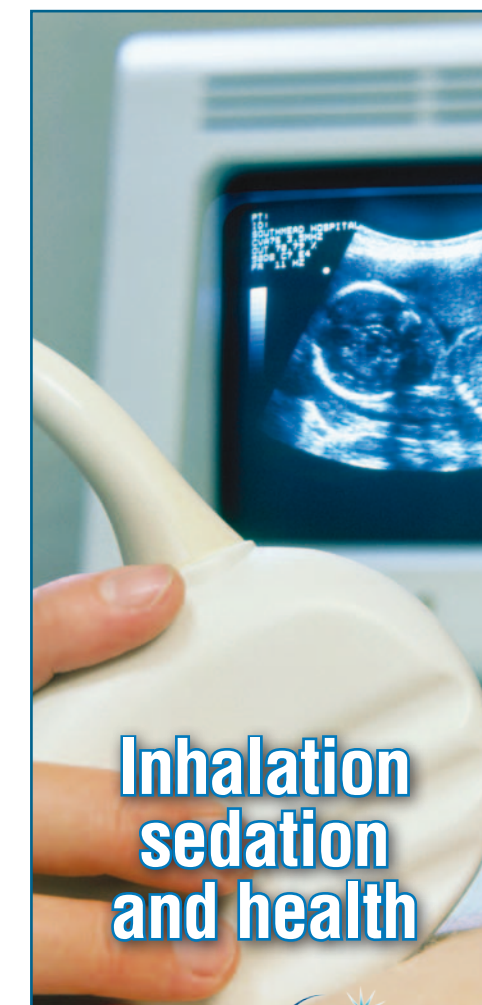
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Learning outcomes

After reading this 'Guide to Inhalation Sedation', you should:

- Recognise specific biological issues and health concerns associated with exposure to nitrous oxide
- Identify methods for detection and monitoring of nitrous oxide gas in ambient surgery air
- Understand exactly what is meant by a nitrous oxide scavenging system and its components
- Be able to identify best practice in order to minimise exposure to nitrous oxide

GUIDE
TO...



Inhalation
sedation
and health

This guide is supported by an educational grant from

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GUIDE TO... Inhalation sedation and health

This edition of the popular Guide To series is intended as a ‘follow on’ to the previous edition *Guide to inhalation safety*, and discusses the effects of nitrous oxide on pregnancy

There is some evidence to suggest that chronic exposure to high levels of nitrous oxide can have an effect on reproduction, and it is generally agreed that female dental staff should not be exposed to nitrous oxide in the first trimester (3 months) of pregnancy. This is mainly due to the significant demand for folic acid during organogenesis in the first three months and, therefore, avoidance of nitrous oxide sedation is recommended during this period.

There is some suggestion that taking a vitamin B12 supplement gives some protection and reduces fetotoxic effects (Ostreicher, 1994). However, as yet, there has been no definitive study and it remains a suggestion only.

Certainly, for a pregnant female employed in a setting that uses nitrous oxide it is important to know the exposure levels. Therefore, safeguards should be in place, including regular maintenance and documented monitoring.

Overview of health risks

A great deal has been written over the years with regard to health hazards that may be associated with any chronic exposure (or

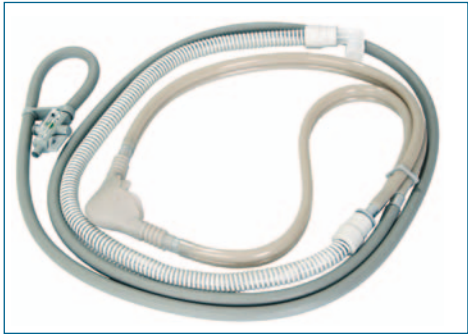


Figure 1. Porter Brown breathing system

indeed, overexposure) to nitrous oxide. The USA has led the research into this subject with a number of articles from the 1970s specifically dealing with anaesthetic gas hazards in a dental setting.

One article (Rowland et al, 1992) contained a study that surveyed more than 50000 dentists and dental staff who were exposed to trace anaesthetics. These results suggested that long-term exposure to these gases could be associated with an increase in general health problems, with an emphasis on disease of the reproductive system in particular. However, the whole study was retrospective in nature and only fuelled the concern regarding the safety of nitrous oxide in the dental setting. The whole study was criticised for lack of adequate data on the trace gases involved.

Specific biologic issues

Nitrous oxide interferes with cobalamin (vitamin B12) and prevents efficient methionine synthetase. This is vital for normal DNA production and cellular reproduction (Brodsky and Cohen, 1986). Although most emphasis is towards female dental staff, male fertility can also be affected.

It is sometimes difficult to establish that a clear connection between nitrous oxide and biohazardous effects exists. Stanley Malamed's (2010) book *Sedation: A Guide to Patient Management* states: ‘The relation between anesthetic gas exposure and spontaneous abortion remains unresolved’. This section discusses the results of a questionnaire sent to 7000 dental assistants between the age of 18–39 in the 1980s. It indicated that ‘An elevation in risk of spontaneous abortion was seen among women who worked with nitrous oxide for 3 or more hours per week in offices not using scavenging equipment’. Of



Figure 2. DMDM on a 4-cylinder stand

course the key here is ‘not using scavenging equipment’. Scavenging definitely seems to be the key element to protecting reproductive health in women.

Managing the risks

All recent articles published from the 1990s onwards refer to scavenged vs unscavenged nitrous oxide levels. Efficient scavenging systems were not really much in evidence before the mid 1990s when the Porter Brown Double Mask system was introduced into the UK (Figure 1). Before that, most dental operatives were using a variety of non-scavenging/passive scavenging systems with only a few actually using what we nowadays term ‘active’.

At that time, the vast majority of clinicians were using a non-scavenging system composed of grey side tubes and a single nasal mask with an exhaling valve. Some had the Matrx Passive System: clear 22 mm corrugated tubes attached to a single mask with a blanking cap, with the hose frequently being hung out of the window or left to lie on the surgery floor. A very small amount employed the Active Nitrous Scavenger—the only breathing system at that time with an active draw. The definition of an active dental draw both in the UK and USA has been determined as 45 L/minute.

The Porter Brown Double Mask was a radically different system, but a problem soon arose. It required a steady and sustainable

draw on the mask and tubings to prevent leakage from the nasal mask upon patient exhalation. In the USA, most systems were connected to chairside suction, but this was not always possible here. In larger health care establishments, a connection could be established to the central anaesthetic gas scavenging system by removing the air brake and fitting an anaesthetic gas scavenger adapter—but not everybody had access to this. Therefore in the early 2000s, the Miniscav was developed to meet the gap (Figure 2).

Since that time, apart from a disposable double mask, there has been no further enhancement in scavenger breathing systems until now.

In July 2015 at the International Association of Paediatric Dentistry in Glasgow, the new Silhouette nasal mask was launched. This is a radical design, being more akin to a nasal cannula. It is a very lightweight and form-fitting mask—with an adhesive strip and a single nasal prong—which fits like a glove over the nose. Available in four sizes, it allows a better fit to be achieved. The low profile tubing connects to the sedation flowmeter and then is scavenged in the usual fashion. The major difference being that no reservoir bag is required with this system. This may require some training, as most dental staff are taught to closely observe the reservoir bag. However, it is felt that the ongoing efficiency of this mask may well outweigh the problems caused.



Figure 3. Diffusion tube for personal monitoring of nitrous oxide levels

Other risk management methods

Other risk management methods that can be implemented are:

- Regular, documented equipment maintenance, according to the original equipment manufacturer's recommendations and by manufacturer-approved engineers
- Use of an approved ‘pre-use checklist’, as this will identify any leaks in the equipment or system. It should include inspection of the reservoir bag by gently pulling down on the body of the bag and looking closely at the area of the ferrule neck. Spare bags should be kept and damaged or worn ones replaced immediately
- In the case of a mobile 4 cylinder stand being used, spare bodox seals should also be kept. It is vitally important that a seal is always in placed between the stand and the cylinder. Worn seals should be replaced immediately as these can allow gas to escape
- Regular ongoing training
- Monitoring of nitrous oxide (Figure 3)—there are no specific recommended periods for this, although once a year appears to be the accepted norm. However, if high or unexpected levels are encountered, then equipment and techniques should be considered and following remedial action, and/or training, the monitoring should be repeated.

Know your exposure levels

In the UK, the permitted exposure level for nitrous oxide is 100 parts per million (ppm) over an 8-hour time weighted average. This allows for time both in the surgery and rest breaks.

With modern scavenging that is correctly employed, it is possible to limit exposure to single figures. Contrast this with permitted exposure levels in other countries:

- Australia: 25 ppm
- Canada: 25 ppm
- USA: 25 ppm (NIOSH) and 50 ppm (ACGIH)
- Sweden: 100 ppm
- Germany: 100 ppm.

It is sometimes considered that the USA equivalent of our Health and Safety Executive— The National Institute for Occupational Safety and Health—are much more ‘on the ball’ when it comes to enforcing the controls on exposure to nitrous oxide.

While we are pretty good here in the UK, it could be considered that we fall behind other countries who are much more proactive with their approach and enforcement. The current standards and recommendations in place— among which is the ageing *Health Technical Memorandum 02-01: Medical gas pipeline systems* (Department of Health, 2006), do not always make it absolutely compulsory to have the best and most efficient scavenging in place, or even explain fully what is required.

Nitrous oxide sedation is an extremely safe and effective method of pain relief across many medical procedures, being the most widely used in dentistry at the present time and, if the correct equipment and training is used, then occupational exposure levels should normally be extremely low.

However, as a safety factor, it is always advisable that female dental staff, while undergoing fertility or IVF treatment or in the first trimester of pregnancy, should avoid contact with nitrous oxide as a precaution. It is generally accepted that the second and third trimesters are safe for occupational exposure, as long as efficient scavenging measures are in place.

Protocol for minimising exposure

An easy-to-follow suggested protocol for

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