NSW Health

Guidance for the Reduction of Nitrous Oxide Waste in Existing Healthcare Facilities

Current builds

Introduction

a) Purpose of the document

This guidance document provides evidence-based guidance and recommendations for the safe and effective reduction of Nitrous Oxide (N20) waste in healthcare facilities. It is designed to promote uniform practices, enhance safety measures, and promote the responsible management of nitrous oxide systems to prevent leaks and wastage.

Reducing nitrous oxide waste emerges as an effective strategy without necessitating large-scale changes to clinical practice. The document aims to guide healthcare settings in selecting appropriate methods for reducing nitrous oxide wastage and emphasises a multidisciplinary team approach for effective implementation.

This document provides guidance to reduce nitrous oxide waste from healthcare facilities, depending on the volume and frequency of use as well as other facility variables, and considerations. Strategies include the decommissioning of piped nitrous oxide when appropriate, encouraging safe alternatives for clinical use when appropriate, improving day to day awareness and prevention of leaks, as well as educating and informing staff about the environmental impact of nitrous oxide.

b) Context for NSW Health

Nitrous oxide, commonly used in healthcare facilities, poses significant environmental concerns due to its high global warming potential (GWP). With a GWP of 298 compared to carbon dioxide's GWP of 1, nitrous oxide is a potent greenhouse gas that contributes substantially to climate change when leaked into the atmosphere. The piped delivery systems in healthcare settings often result in unintended leaks when not in use, leading to unnecessary emissions of nitrous oxide. These leaks incur avoidable costs and offer no clinical benefit when the gas is not actively used for patient care. By removing piped nitrous oxide systems, facilities can mitigate their environmental impact, reduce operational costs associated with gas wastage, and demonstrate a commitment to sustainable healthcare practices.

c) Scope and applicability

This guidance applies to all healthcare facilities utilising nitrous oxide including hospitals and clinics. It is intended for:

- clinical staff that use nitrous oxide
- managers that oversee services using nitrous oxide and
- maintenance staff involved in the management and maintenance of nitrous oxide systems.

As nitrous oxide represents a substantial carbon hotspot in the hospital setting, this document addresses the critical role healthcare facilities play in addressing environmental concerns

associated with nitrous oxide use and waste. In recognition of their important role, clinicians are encouraged to raise awareness regarding the environmental impact of nitrous oxide and advocate for alternatives that are more environmentally sustainable, where appropriate.

d) Key performance indicators

The purpose of this guidance document is to facilitate the fulfillment of the KPI for the reduction in nitrous oxide waste to be incorporated into the Local Health District (LHD) Service Level Agreements1. The target of this KPI is a 5% reduction in the rate of emissions per admitted patient service event compared to the baseline rate as of 30 June of the previous year.

e) Key Recommendations

I. Mapping Nitrous Oxide Systems
II. Implement Alternatives to Piped Nitrous Oxide
III. Tracking Procurement Data
IV. Cylinder Trials
V. Raising awareness and engaging with clinical staff about the environmental impact of Nitrous Oxide

f) Additional Recommendations

VI. Supplier Consultations
VII. Nitrous oxide hardware care and management in clinical areas using piped systems
VIII. New Projects
IX. Case Studies

g) References

- University of Melbourne SPHAN Guidelines: Practical steps to reduce nitrous oxide (N2O) leaks.
- Australasian Health Infrastructure Alliance: Summary of Advice relating to the specification of Nitrous Oxide in the Australasian Health Facility Guidelines (AusHFG).
- Controlling Exposures to Nitrous Oxide During Anaesthetic Administration.
- Nitrous Oxide Use in Australian Health Care: Strategies to Reduce the Climate Impact.
- Environmental Accountability Working Group, Statewide Anaesthesia and Perioperative Care Clinical Network, Clinical Excellence Queensland - Queensland Health.
- Nitrous Oxide – Oxygen Mix, Clinical Practice Guidelines, The Royal Children's Hospital Melbourne.
- Entonox® System, Loss Mitigation and Management Technical Update, NHS Scotland Assure.

Key Recommendations

I. Mapping nitrous oxide systems

Hospitals should possess an accurate map of their nitrous oxide systems, as doing so will present opportunities to decommission pipework that is not in use. The following steps are recommended:

a. Engineering department responsibilities:

i. To gain an overview of the nitrous oxide infrastructure and supply, collaborate with the relevant engineering department to obtain a current servicing schedule for the nitrous oxide pipeline.

ii. Request a current map of the pipeline infrastructure to clearly identify each outlet and its associated department.

iii. If a map is not available, identify and document the buildings to which the nitrous oxide pipeline is connected.

b. Comprehensive nitrous oxide system awareness

i. Understand, document and make available the location of nitrous oxide systems by having an updated nitrous oxide map and identifying outlets.

ii. Conduct trials, explore alternatives, thoroughly investigate, and document the outcomes of alternative solutions.

c. Decommission unused or low usage nitrous oxide pipelines and outlets:

i. Where piped nitrous oxide outlets are not in use, or where it is used in low amounts, consider decommissioning pipes and enforce procedures to cap piped nitrous oxide outlets that are inactive.

ii. Regarding other active (non-maternity) piped outlets - facilities or health districts might consider decommissioning these on a case-by-case basis after due process.

These initial steps are essential for hospitals to establish a clear understanding of their nitrous oxide infrastructure, enabling them to make informed decisions to decommission and reduce the unnecessary use and wastage of nitrous oxide, optimising the use of nitrous oxide systems.

II. Implement alternatives to piped nitrous oxide

Following the decommissioning of piped nitrous oxide in clinical areas and facilities with low usage of nitrous oxide, consider areas where alternatives may be adopted, and where piped systems should remain in place. Areas that may be assessed for decommissioning and the adoption of alternatives may include but not limited to, oral health, operating theatres, emergency departments, burns units, paediatric procedural areas, and imaging and interventional suites, for example. Obstetric units, however, should continue to receive piped nitrous oxide where there are no alternative inhalational analgesic options with similar benefits and low side effects. Maternity services may have their own, dedicated reticulated nitrous oxide system, when other areas of a hospital don't require piped nitrous.

III. Tracking procurement data

Tracking procurement data will provide insight into the overall leakage within the healthcare facility. This approach involves assessing the variance between the quantities of nitrous oxide purchased and the amount used. Usage should be monitored, as any unexpected increase in nitrous oxide purchasing should prompt a recheck for leaks.

An effective method to track procurement data is by obtaining logbooks from the facilities engineering department. This method is efficient in demonstrating changes in ordering patterns and monitoring usage.

The following steps are an additional guide on how procurement data can be tracked if logbooks cannot be obtained:

a. **Determine annual nitrous oxide procurement**

i. Collaborate with relevant departments involved in nitrous oxide procurement. (For example, Facilities Management, Engineering, Finance, Procurement, Pharmacy, and/or Sustainability Management).

ii. Engage with external stakeholders, such as the medical gas supplier and external engineering contractors, for comprehensive data.

iii. If feasible, acquire monthly procurement data (preferably categorised by cost centre) and visually represent purchasing trends for effective tracking and to provide a cue for the presence of leakage, and for the most accurate estimates.

b. **Obtain nitrous oxide utilisation data**

i. Obtain anaesthesia use of nitrous oxide.

Obtain data from the anaesthetic machines by utilising the electronic records in anaesthetic machines.

Data may also be obtained by surveying anaesthetists on nitrous oxide usage and frequency, or per anaesthetic case.

ii. *Estimate anaesthesia use of nitrous oxide.*

If nitrous oxide is not being delivered via an anaesthetic machine that records the cumulative use or is delivered outside operating theatres, or by an older anaesthetic machine, estimation of nitrous oxide use may be required.

Use relevant data such as percentages and/or local activity data of nitrous oxide use, and/or employ formulas to estimate nitrous oxide use.

Adjust methodologies as per the services that are relevant to the healthcare facility. Use the most robust data that is accessible and available to the facility.

iii. *Estimating non-Anaesthesia use of nitrous oxide.*

Nitrous oxide for non-anaesthesia use in settings such as maternity units or paediatric procedural settings can represent most of the usage in many hospitals. These are often documented using standard hospital charts for sedation/analgesic use including medication charts. This may serve as the only method for estimating non-anaesthesia nitrous oxide use in these settings.

c. **Calculate the discrepancy:**

i. Determine the variance between purchased nitrous oxide and the clinical amount used.

Tracking procurement data will provide a historical picture of procurement and whether it has changed over time. It will provide insights into whether it is tracking steadily, increasing, or decreasing. If the pattern of use is changing, then we need to analyse it clinically. If there is no discernible change in the pattern of clinical use, then it is likely a leak.

IV. Cylinder trials

Based on the information gathered from the nitrous oxide maps, identify areas where cylinders may be easily adopted. Implement trials of cylinders to assess its efficacy and document trial procedures. If successful, decommission piped nitrous and switch to cylinder use.

When cylinder nitrous is adopted, facilities should implement strategies to avoid diversion of cylinder nitrous, given its increasing use as a recreational drug and local rates of nitrous oxide abuse.

V. Raising awareness and engaging with clinical staff about the environmental impact of nitrous oxide

Targeted education can facilitate the reduction of nitrous oxide waste by raising awareness on the environmental impact on nitrous oxide and engaging clinical staff on the availability of alternatives.

Education and quality improvement campaigns will also inform staff of the accurate monitoring and usage of nitrous oxide.

Additional Recommendations

The following recommendations are for the Ministry of Health to help support the reduction of unnecessary nitrous wastage in healthcare settings.

VI. Supplier consultations

The Ministry will engage with HealthShare NSW and medical gas suppliers of nitrous oxide to discuss the implications and potential solutions to restrict the release of nitrous waste to the atmosphere.

During these consultations, the Ministry will discuss product stewardship and recommend to suppliers that upon return of cylinders, suppliers seek alternative measures to venting cylinders to the atmosphere. The Ministry will also recommend to HealthShare that suppliers that are not venting cylinders to the atmosphere, are to be favoured in NSW Heath tenders. Another requirement that must be implemented is for anaesthetic machines to have yokes for nitrous cylinders. The Ministry will also engage with HealthShare to reflect these requirements into the tender process.

The Ministry will also seek to understand the supplier process with return cylinders, and if there is a requirement to empty cylinders before refill. If there is a legislative or CEC Infection Control requirement, the Ministry will then determine next steps.

VII. Nitrous oxide hardware care and management in clinical areas using piped systems

Regular assessment of flexible nitrous oxide hose attachments between wall outlets and equipment (such as anaesthesia machines or delivery suite nitrous/oxygen blender units) should be undertaken by clinical staff for firmness of screw connection - these connections can be a significant source of hidden leakage into clinical areas when even slightly loose. These assessments could form a part of regular daily equipment checks and may be documented.

User equipment that has an 'on/off' or 'open/closed' control, should be routinely left in the 'off' position between uses i.e. delivery suite oxygen/nitrous blending units.

When using point of care cylinders of nitrous oxide or 'Entonox' in any setting - these should be left turned off at the cylinder between uses to reduce the risk of leakage. Methods should be defined and deployed to minimise the risk of significant residual nitrous being left over in cylinders for return to the suppliers, for example - Entonox cylinders may still have significant remaining contents even when the gauge indicator enters the 'red zone'.

VIII. New projects

The Ministry will await feedback from The Children's Hospital at Westmead regarding the

use of hospital level nitrous oxide flow monitoring and may release advice to new projects and existing hospitals regarding monitoring flow, based on the results.

IX. Case studies:

1. Operating Theatre Pressure Testing at a large NSW Hospital
2. The Prince Charles Hospital, Brisbane

Case study 1

Operating Theatre Pressure Testing at a large NSW Hospital

This testing occurred in 8 Operating Theatres (OT), 2 Endoscopy Suites, 1 Catheterisation Laboratory, 1 MRI Suite, and the Emergency Department.

From these specific zones tested, there was estimated leak of:

- 24,723 litres/year = 13.3 tonnes eC02 = 130,700 km mileage/year equivalent emissions.
- Total annual manifold nitrous purchasing - 18 G size = 336,420 litres.
- Overall percentage of nitrous use leaked from the areas tested - 7.5%
- Non-birthing-suite nitrous oxide consumption was estimated to be around 100,000 litres (30% of total purchased), which would encompass the locations that were tested in this example. An estimate of approximately 70% of total manifold nitrous oxide consumption by birthing suite was used to obtain this figure.
- Leakage as a proportion of non-maternity use of nitrous oxide = 24.5%

Analysis

- Leak proportion vs clinical use would be up to 100% in some locations/rooms.
- This testing only covered a small overall proportion of the facility nitrous pipeline network with major exclusions i.e. maternity, isolation valve systems, main manifold, rigid pipeline and joints.
- OHS issues are a possible issue in maternity.
- These represent business as usual leaks, in a hospital that has a current regular maintenance regime in place, as per standards. The hospital is not 'old' and is otherwise well maintained and functional.
- Some of the newest parts (~4 years old) of the nitrous oxide infrastructure were found to be leaking
- There are no multi-articulated pendants in OT, only simple ceiling pendants. In endoscopy there are no pendants, only wall outlets. Where pendants are in use they are often cited as leakage weak points.
- Daily anaesthetic machine checks also consume nitrous.
- To reduce leakage, O-rings were replaced. The result was not uniform, in one room there was a slight improvement, in another the leak slightly worsened, in others it had minimal to no effect on the rate of leak. Worn O-rings are only one source of leakage so it is unsurprising that the result is not uniform, also when works are conducted on these connections there is a risk they are not fastened tightly once completed and can lead to worsened leakage.
- Flexible screw type (blue) hose connections to pipeline outlets are repetitively found to be loose. Tightening these sometimes improved the leak significantly, however they appear prone to loosening over time in general. The biggest beneficial effect noticed in this case study was from tightening loose nitrous oxide hose connections in some of the locations.
- Investigating these day-to-day leaks more invasively would be interruptive/expensive, subject to contractor availability, probably not deemed worthwhile by a facility - therefore unlikely to proceed.

Case study 2

The Prince of Charles Hospital, Brisbane

The Prince Charles Hospital decommissioned their nitrous oxide piped infrastructure manifold in January 2024(12). The Prince Charles is a major cardiothoracic centre in Queensland with no birthing facilities. By switching from piped nitrous oxide to stand alone cylinders the nitrous oxide volumes purchased decreased by 90%, realising immediate environmental and cost savings with a return on investment of just over 2 years. The inferred 90% leak is in keeping with international data and is likely to be the situation for many healthcare facilities in Australia.

Steps taken by The Prince Charles Hospital included:

1. Confirming which departments were using piped nitrous oxide, in this case it was only the department of anaesthesia.
2. Canvassing the department of anaesthesia and confirming the declining use of nitrous oxide.
3. Trialling a period of disconnection, where all anaesthetic machines were disconnected from the piped system and stand-alone cylinders were available for use instead.
4. After demonstrating no change to clinical care, the hospital executive team were approached to provide funding for decommission.
5. Biomedical engineering liaised with BOC medical gases and obtained a quote of $23,000 for decommissioning. Projected savings from eliminating the leak were approximately $10,000 annually resulting in a return on investment of just over 2 years. This capital funding was approved.
6. Decommissioning took place after-hours to minimise interruption to clinical care. Decommissioning involved de-activating pressure alarms in the nitrous oxide pipes/ infrastructure, capping off the wall outlets permanently and clear labelling where required.
7. All clinically required nitrous oxide is now provided via portable cylinders.

These steps are alike those taken by other institutions internationally.

The Prince Charles Hospital Emergency Department already used portable nitrous oxide.

The Royal Melbourne Hospital Emergency Department have also transitioned to portable cylinders, demonstrating the feasibility of this approach in adult Emergency Departments. This process could translate to paediatric sedation areas, and general and paediatric emergency departments.