Healthcare facility nitrous oxide infrastructure

Position statement

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About Doctors for the Environment Australia

Doctors for the Environment Australia (DEA) is an independent, non-government organisation of medical doctors and students in all Australian states and territories.

DEA's work is based on the premise that humans need a future with clean air and water, healthy soils capable of producing nutritious food, a stable climate, and a complex, diverse and interconnected humanity whose needs are met in a sustainable way. We are therefore interested in environmental protection and restoration to promote human health and social stability.

Acknowledgement of Country

Doctors for the Environment Australia's members live and work around Australia. We would like to acknowledge Aboriginal and Torres Strait Islander peoples as the Traditional Owners of these lands, in the spirit of reconciliation.

We recognise that First Nations peoples have cared for Country and lived sustainably for millennia, and that sovereignty of this land was never ceded. We pay our respects to First Nations Elders past and present, and to emerging leaders.

Summary

Nitrous oxide (N_2O) is a powerful greenhouse gas that leaks in significant quantities from piped (reticulated) N_2O systems in healthcare facilities, before use in patient care. This causes unnecessary harm, for no clinical gain.

There are viable clinical alternatives to piped N_2O systems that do not adversely impact patient care, including point of care N_2O.

Doctors for the Environment Australia recommends

- Healthcare facilities **without birthing suites**:
    - existing facilities should decommission existing piped N_2O systems.
    - new facilities do not have piped N_2O infrastructure.
- Healthcare facilities **with birthing suites**:
    - existing facilities consider decommissioning piped N_2O infrastructure to areas other than birthing suites.
    - new facilities should install piped N_2O to birthing suites only and should consider including destruction technology infrastructure in initial plans.
- If piped nitrous oxide infrastructure is to remain, increased leak monitoring and accountability protocols should be developed to adequately detect and address leaks.

- Healthcare facility management, engineers and clinical providers are informed of the amendment to the Australasian Healthcare Facilities Guidelines regarding nitrous oxide infrastructure.

Background

Nitrous oxide is a medical gas that has a current role in labour analgesia, and a limited role in procedural sedation and paediatric anaesthesia. It is also a greenhouse gas and contributes to the climate crisis.[1,2] It has an atmospheric lifetime of over 100 years and a direct destructive effect on atmospheric ozone. Evidence suggests that a large proportion of medical N_2O (often over 90%) purchased by healthcare facilities leaks into the environment from the N_2O reticulation infrastructure before it is used for patient care.[1,2] Hu et al estimated the amount of N_2O Australian public hospitals (including four public dental hospitals) procure every year is the equivalent of 64,144 tonnes of carbon dioxide (CO_2e).[3] Minimising the environmental harm and financial cost from leaked N_2O is a significant opportunity to reduce healthcare greenhouse gas emissions that needs to be urgently addressed. N_2O infrastructure leaks are being addressed internationally without impacting patient care, yet Australian healthcare facilities are slow to act.

The problem

N_2O is commonly piped through a healthcare facility via a reticulation system that is pressurised and supplied by a gas cylinder manifold, also referred to as a medical gas pipeline system. The clinical areas supplied depend on the individual site, but generally these areas include operating theatres, procedure rooms, emergency departments and birthing suites. The leak fraction is the volume of N_2O leaked compared to the volume that is purchased.[4] Piped N_2O systems are associated with high leak fractions (often >90%), with reported leaks having been identified at varying points across the system.[4-7] Notably, these leaks have been found to be present despite appropriate maintenance and adherence to Australian Standard 2896.[5,6,8,9]

N_2O infrastructure leaks are not a local problem, with significant healthcare facility leaks described in New Zealand, America, and the United Kingdom.[5,8,9] In Melbourne, The Alfred and Footscray Hospitals both identified leaks equating to the CO_2 emission equivalent of close to 600,000 km of car driving every year.[5,7] *Detecting and reducing nitrous oxide leaks in healthcare facilities: a practical guide* has been published by the Interim Australian Centre for Disease Control and Department of Health and Aged Care in collaboration with the University of Melbourne, and details the four key methods of leak identification.[10]

N_2O reticulation systems are dynamic, leaks are prone to recurrence and leak testing is time-consuming as well as expensive. Importantly, medical N_2O can be safely provided for patient care using methods associated with lower leak rates.[11]

The solution: decommissioning piped N_2O systems

Decommissioning piped N_2O systems has environmental, financial and social benefits and has been implemented successfully in Australia and internationally.[8,11] Clinical administration needs are met with point of care cylinder supply.

Supported by the Royal College of Obstetricians and Gynaecologists and the Royal College of Anaesthetists, the United Kingdom and Ireland have agreed to decommission reticulated N_2O

infrastructure in their healthcare facilities. Their consensus statement advocates that 'continuous supply of nitrous oxide to theatre suites via a pipelined supply is no longer essential' and intend to have completed the switch to point of care cylinders by the end of the 2026/2027 financial year.[12] Presently, 27 sites have decommissioned their N_2O reticulation systems and 19 are scheduled for decommissioning with this number expected to grow.[8]

An American health provider, Providence Health, has moved to point of care N_2O cylinder supply across 50 sites.[9]

Three healthcare facilities in Australia (Modbury, SA; The Prince Charles Hospital, QLD; and Sir Charles Gairdner Hospital, WA) have decommissioned their N_2O manifolds and associated N_2O reticulated infrastructure. The Prince Charles Hospital case study is presented below.[13]

Although a large number of international healthcare facilities, providing a wide range of services, have safely demonstrated significant environmental benefits and short-term return on investment by decommissioning their piped N_2O systems, Australian healthcare facilities have unfortunately been slow to take action.

A recent change to the Australasian Health Facilities Guidelines in 2024 for operating rooms and birthing suites has further enabled the decommissioning of piped N_2O:

> The use of nitrous oxide in operating theatres, procedural suites and emergency departments is declining due to a range of clinical and environmental concerns. It is, however, still commonly used in maternity and paediatric services. With the exception of maternity and paediatric services, reticulated nitrous oxide and associated scavenging outlets are to be considered optional. Where found to be clinically necessary, provision of nitrous oxide via piped outlets or via cylinder is to be determined at a project level, based on an assessment of expected clinical needs, security of gas sources, operational considerations such as monitoring and measurement of usage, and management of leakage.

This would indicate that healthcare facilities that do not have maternity or paediatric services can decommission their reticulation systems. Disappointingly, this change does not distinguish between paediatric anaesthesia in operating theatres and sedation in procedure rooms. This guidance is currently under revision to provide further clarity. International projects have demonstrated safety in point of care N_2O in paediatric anaesthesia.[9,14]

Australian Case Study: decommissioning of N_2O reticulated infrastructure by The Prince Charles Hospital, Brisbane

The Prince Charles Hospital decommissioned its N_2O reticulation infrastructure and manifold in January 2024.[13] The Prince Charles Hospital is a major cardiothoracic centre in Queensland with no birthing facilities. By switching from piped N_2O to point of care cylinders, the N_2O volumes purchased decreased by 93%, realising immediate environmental and cost savings with a return on investment of just over 2 years. In 2019-2020, The Prince Charles Hospital procured a total of 584,000 L of N_2O via manifold and point of care cylinders compared to 19,200L in point of care cylinders only for 2023-2024. The emissions of 584,000 L and 19,200 L of N_2O are approximately 300 and 10 tonnes (t) of CO_2e respectively. Therefore, decommissioning the reticulated N_2O and moving to point of care cylinders prevented the emission of 290 t CO_2e per annum. The inferred 93% reticulated N_2O leak at

The Prince Charles Hospital is in keeping with international data and likely to be the case for many healthcare facilities in Australia.

Steps taken by The Prince Charles Hospital included:

1. Confirming which departments were using piped N_2O – in this case, it was only the department of anaesthesia.
2. Canvassing the department of anaesthesia and confirming the declining use of N_2O.
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. Approaching the hospital executive to provide funding for decommissioning of the N_2O reticulated infrastructure after demonstrating no change in clinical case.
5. Biomedical engineering liaising with the BOC Medical Gas section and obtaining a quote of $23,000 for decommissioning. Projected savings from eliminating the leaks were approximately $10,000 annually resulting in a return on investment of just over 2 years.
6. Approval of capital funding expenditure.
7. Decommissioning of the reticulation system after-hours to minimise interruption to clinical care. It involved de-activating pressure alarms in the N_2O pipes/infrastructure, capping off the wall outlets permanently and clear labelling where required.
8. Supplying all clinically required N_2O via portable cylinders.

These steps are similar to the playbook developed by Cascadia Collaborative.[11]

The Prince Charles Hospital Emergency Department already used portable N_2O. The Royal Melbourne Hospital Emergency Department has also transitioned to portable cylinders, demonstrating the feasibility of this approach in adult emergency departments. This process should translate to procedural sedation performed outside theatre environments.

Discussion

While the current Australasian Healthcare Facilities Guidelines state that maternity and paediatric services still require reticulated N_2O, DEA believes that there is sufficient evidence for paediatric anaesthetic services to meet clinical demand with point of care supply, particularly when paediatric cases are not encountered in each operating theatre on an intensive basis. Specialised paediatric-only centres may still benefit from reticulated N_2O and nuanced consideration is required when determining the balance between expected leaks and other efficiencies. It is worth noting that project SPRUCE (Saving our Planet by Reducing Carbon Emissions) at Seattle Children's Hospital has made substantial gains in this area.[14] This group has concluded that drawing attention to the issue and disconnecting the anaesthetic machines from the N_2O supply have both decreased clinical usage and leak rates.[14]

While N_2O is a common form of labour analgesia in the United Kingdom's NHS, it is most often delivered in the form of Entonox®, a 50:50 oxygen:nitrous oxide blend, via a manifold or point of care supply.[16] As such the NHS can decommission N_2O infrastructure and leave Entonox® infrastructure

intact. North America has greater rates of epidural analgesia and N_2O analgesia is less common.[15] In contrast, most Australian hospitals are built with N_2O reticulation, and do not have piped Entonox®. As it is estimated in Australia that each labour on average requires 500 L of N_2O,[16] it appears practical for birthing suites to maintain piped N_2O infrastructure with enhanced leak prevention processes in place. However, portable delivery devices allow a person in labour to move more freely around the room, and still meet necessary clinical volumes.

Healthcare facilities that manage relatively few births or paediatric cases are suited to point of care N_2O, and facilities that support large numbers of births or paediatric cases may be suited to keeping reticulated N_2O with additional leak monitoring in place. However, waste of such large quantities of an environmentally harmful gas is increasingly unacceptable when an alternative exists and decommissioning piped N_2O infrastructure has been demonstrated to decrease purchased volumes by up to 80-95%.[8,9]

N_2O destruction technology may assist in addressing the greenhouse gas impact of exhaled N_2O, despite not addressing leaks in piped N_2O infrastructure. Destruction technology could also have a key role in birthing suites by reducing occupational exposure to N_2O[17] and should be considered in new birthing suites after implementation of other N_2O leak mitigation methods.

Conclusion

There is now strong evidence that reticulated N_2O systems are a source of unnecessary environmental harm through undetected leaks. Point of care cylinder supply can mitigate this leak whilst still meeting clinical requirements for patients, particularly in labour analgesia with limited roles in anaesthesia and procedural sedation. The intent of this position statement is to limit environmental harm through decreasing wasteful emissions rather than influencing clinical practice, while appreciating that the role of N_2O in healthcare is now mainly in labour analgesia, with limited roles in anaesthesia and procedural sedation.

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