Piped Nitrous Oxide Waste Reduction Strategy

Authors	**Alifia Chakera** *Lead pharmacist, Theatres and Anaesthetics, NHS Lothian* *Member of the Association of Anaesthetists' 2% Working Group* **Amarantha Fennell-Wells** *Welsh Clinical Leadership Fellow in Sustainable Healthcare with the Centre for Sustainable Healthcare, Cardiff* **Chris Allen** *Association of Anaesthetists and Centre for Sustainable Healthcare Fellow in Environmentally Sustainable Anaesthesia, Newcastle upon Tyne Hospitals*						
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Background

Nitrous oxide (N_2O) wastage is a significant contributor to the anaesthetic gas carbon footprint of the NHS. Anaesthetic gases are potent greenhouse gases, and their complete mitigation is essential in order to achieve net-zero emissions and avoid dangerous climate change. The NHS has now committed to achieving net-zero direct emissions by 2040, this specifically includes anaesthetic gases. Nitrous oxide confers the largest carbon footprint of the anaesthetic gases within the acute sector accounting for at least 75% of the total anaesthetic gas footprint.

Recent efforts within NHS Lothian to reduce the total contribution of theatre nitrous oxide has revealed that wastage from piped manifold systems is a far more significant problem than that of persistent clinical usage[1]. Nitrous oxide waste can manifest in a number of ways: (1) as a result of leaks which can occur at the manifold connection itself, and at outlets especially if an outlet valve is in situ or within the piped infrastructure; (2) losses occur due to wasteful clinical practice, flawed equipment design or by poor stock management; and (3) inadequate cylinder security can result in theft.

Lothian's waste reduction approach has relied on detailed audits of cylinder turnover per manifold and compared this to audits of clinical usage. Within NHS Lothian one acute site has decommissioned a manifold and reduced provision of another, reducing projected manifold cylinder turnover by 98% or 790,000 litres per annum. A second site has observed wastage of at least 80% or 685,000 litres per annum from one of its nitrous oxide manifolds and the site is working to mitigate this wastage. A third site is now under investigation and wastage has already been observed through poor stock rotation at three different manifolds. Data is presently being gathered on clinical usage against cylinder turnover.

The Association of Anaesthetists' Environmental Committee and 2% Working Group are addressing ways that all NHS acute sites could reduce their use of anaesthetic gases, including both nitrous oxide and Entonox in order to achieve net-zero direct emissions by 2040. This includes both reducing clinical use by using viable alternatives, and looking at other areas of wastage. The waste through leakages identified in NHS Lothian is a both a threat to planetary and occupational health as leaks can expose staff to persistent levels of nitrous oxide. Pharmacy Services, Estates, Medical Physics, Anaesthetists, Emergency Department clinicians, and Maternity Units should work together to understand cylinder turnover versus true clinical usage. By then reporting to this national project, a fuller understanding of the NHS's use of nitrous oxide can be produced, and collectively we can devise actions to mitigate this wastage.

NHS Lothian's lean approach can be adopted to address piped nitrous wastage oxide at any acute site. The project lead for NHS Lothian advises that once a nitrous oxide mitigation project team is established at an acute site, they should first discuss their investigative approach and draw on the Lothian methodology as an exemplar and not an absolute standard. An audit and analytics sheet has been included at the end of this document to facilitate investigation.

Method: A Lean Strategic Approach

Mapping (metrics) and Team Planning

1. Pharmacy: Understand and articulate the total cylinder turnover per year. This should be based on BOC, G or J sized cylinders for nitrous oxide manifolds and BOC, G or EW sized cylinders for Entonox® manifolds. This information should be determined by cylinder returns to BOC (or Air Liquide) and not from pharmacy or estate logs.

2. Pharmacy, Estates and Clinical teams: Understand the frequency of cylinder bank changes per nitrous oxide manifold. Acute sites with piped nitrous oxide may have more than one manifold. Soft facilities (porters) should keep detailed logbooks documenting each bank change within the manifold room, which can be reviewed. Often logbooks are not kept, and porter teams will need to be interviewed to understand the frequency of bank change, which is more challenging. Alternatively, Hospital Security may have a digital log identifying when the low-pressure alarm for nitrous oxide has been triggered indicating the need to change the cylinder bank.

3. Estates and Pharmacy: Review manifold cylinder management – is there good stock management in place, are the stored cylinders safely stored and are routine leak tests performed.

4. Estates and Clinical teams: Interrogate the piped schematics associated with each manifold and the number of corresponding outlets. A physical check against the schematics is also useful as work may have been done and the schematics are not updated.

5. Medical Physics and Clinical teams: Quantify clinical usage per service area. This can be done through accessing information directly from anaesthetic machine logs (which the medical equipment engineers can advise on), qualitative surveys of clinical usage and reviewing electronic records. We would also urge participants to take this opportunity to quantify clinical usage of other anaesthetic gases at this point and submit this data along with clinical nitrous oxide usage.

Analysis: Indicators of wastage

6. Clinical audit reveals areas of zero usage of piped nitrous oxide

7. Manifold turnover higher than clinical usage

8. Stock expiring on manifold, but clinical usage present

Potential Actions/Improvements

9. Areas of zero clinical usage - Estates and Clinical leads should work toward terminating supply of nitrous oxide as far up the supply chain as feasible and possibly decommission manifold(s)

10. Consistent clinical usage across all clinical areas but where cylinder turnover is greater suggests a leak in the system. Therefore, Estates must investigate and, should no resolution be forthcoming, the leak should be escalated to their NHS authorised medical gas engineer.

11. Where stock is expiring on the manifold, but consistent clinical usage is documented, the manifold requires reduced cylinder provision - Pharmacy, Estates and Clinical leads should establish a sensible provision and reduce cylinder bank size and cylinder stock levels. Alternatively, the manifold can be decommissioned, and a portable supply of nitrous oxide might be preferable and should be explored.

For more information please email: thenitrousoxideproject@gmail.com

References

1. Chakera, A. (2020) *Reducing the Impact of Nitrous Oxide Emissions within Theatres to Mitigate Dangerous Climate Change*. *Evidence-Based Policy Brief Dissertation*. University of Edinburgh

Nitrous Oxide and Entonox® Audit and Analytics Sheet				Doc	Audit Sheet	Version	1.0	Updated	N/A
Hospital Name:				National Project leads: Alifia Chakera, Amarantha Fennell-Wells & Chris Allen					
Date of Review Start:		Date Review End:		Queries contact: thenitrousoxideproject@gmail.com					
Clinical Audit Lead:				Pharmacy Lead:					
Anaesthetic Lead:				Facilities Lead:					
BOC regional contact:									

Key **N2O G cylinder = 9000L** **N2O J cylinder = 18,000L** **Entonox® G = 5000L** **Entonox® EW= 16,275L** ***Tip: take a photo of each manifold****	**Manifold management Audit**			**Corresponding Piped Schematics**	**Audit Clinical Usage (use secondary spreadsheet if needed)**	
	Stock management (rotation, provision)	**Bank Changes: review Logbook (photocopy) or question porter or security team Calculate: Volume per month and per year**	**Leak tests Evidence Yes/no Frequency**	**Identify location of outlets corresponding to manifold, review schematics and conduct visual inspection**	**Qualitative Survey Frequency per month and area used**	**Quantitative interrogation (extract from anaesthetic machine data logs) Calculate: Volume per month and per year**
Manifold name: **Type:** **Arrangement:**						
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