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Is there a future for nitrous oxide in anaesthetic practice?

Although nitrous oxide is widely used for analgesia and anxiolysis, its use is under scrutiny because of concerns about its environmental impact and potential implications for mental health. This article discusses the advantages and disadvantages of this agent.

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Introduction

Nitrous oxide is an important tool for anaesthetists. Following its synthesis in 1799 and first clinical use in 1844 (Emmanouil and Quock, 2007), it has been widely administered for analgesia and anxiolysis. Often delivered in combination with 50% oxygen (as Entonox), nitrous oxide is used in maternity services for labour analgesia, in theatre anaesthesia for gas inductions and maintenance, as well as in dental, burns and trauma units for procedural sedation.

However, the use of nitrous oxide in hospitals is under scrutiny. Given its age and having been used since very early anaesthetic practice, nitrous oxide is considered outdated compared to alternatives such as remifentanil which also provide effective, short-acting analgesia. The UK government banned the recreational possession of nitrous oxide in 2023, given fears about misuse and lasting mental health issues. At the same time, several hospitals have removed nitrous oxide from piped supply for environmental reasons. Is this the beginning of the end for nitrous oxide?

Benefits of using nitrous oxide

There are a number of advantages to the use of nitrous oxide in hospitals. It is widely available, easy to store and simple to use. There is a large evidence base for its effectiveness and it has a good safety profile. Using nitrous oxide allows the administration of reduced doses of other anaesthetic agents and opioids, thus improving cardiovascular stability and reducing cost. Nitrous oxide is safe to use in patients with malignant hyperthermia, and does not cause nephrotoxicity or hepatotoxicity.

The popularity of nitrous oxide stems from its reliable analgesic properties and minimal side effects. Studies from as early as the 1940s report analgesia equivalent to 10–15 mg of morphine when delivered at 30% concentration (Emmanouil and Quock, 2007).

The huffing sound of a demand valve will take many doctors straight back to a maternity ward, as 76% of women in the UK use Entonox during labour (Care Quality Commission, 2024). These women benefit from analgesia comparable to that of a paracervical block or opioids, but without the risk profile of the block or side effects of the opiate, especially sedation of the newborn (Emmanouil and Quock, 2007). Nitrous oxide does not interfere with uterine contractions nor does it have any adverse effects on physiology of labour and the labouring woman. It therefore appears to be an ideal labour analgesic.

For the developing world, nitrous oxide provides a cheaper alternative to other short-acting anaesthetic or analgesic agents, such as remifentanil. It also has a role in pre-hospital emergency medicine both in ambulances and in the field.

Nitrous oxide should be replaced

There are a number of clinical effects of nitrous oxide which mean that its use should be phased out. These include megaloblastic anaemia and immunosuppression, teratogenicity, neurotoxicity, increased intracranial and pulmonary arterial pressures, increased myocardial ischaemia, postoperative nausea and vomiting, and expansion of air-filled spaces. There is also a risk of delivery of a hypoxic mixture.

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There is evidence that nitrous oxide increases the risk of spontaneous abortion, as demonstrated among female dental assistants in California. The direct cause of this is unknown but a study saw a relative risk elevation of 2.6% in those exposed to nitrous oxide for 3 or more hours a week in areas without scavenging equipment (Rowland et al, 1995), although these risks can be mitigated by adherence to workplace limits. There is a need for more contemporaneous studies to review the risk reduction with current safety measures.

Nitrous oxide is a greenhouse gas and contributed over 80% of the total carbon footprint for anaesthetic gases in 2019–20 (Association of Anaesthetists, 2021). It has a global warming potential 100 of 310 (United National Climate Change, 2020), which means that, over a 100-year period, nitrous oxide will contribute 310 times more to global warming than the same volume of carbon dioxide.

Conclusions

Use of nitrous oxide will remain common in the NHS, since few other agents offer its flexibility of use, ease of set up, low cost and narrow side-effect profile. It has been used for almost two centuries to provide analgesia, anaesthesia and anxiolysis, but for how much longer?

Given the NHS plans to reach net zero carbon dioxide emissions by 2040, the use of such a significant culprit should be reviewed in terms of its cost to the environment vs benefit to the patient. The nitrous oxide project (Association of Anaesthetists, 2021) encourages hospitals to review their stored and piped supplies of the gas in an effort to reduce system waste, educate about greener practice and apply catalytic cracking technologies. The latter works to split nitrous oxide into nitrogen and oxygen using catalytic destruction. This reduces occupational exposure as well as environmental damage and could keep nitrous oxide available for clinical practice for years to come.

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