



EVIDENCE SEARCH RESULTS

Question/subject of request:	Why should we care about Entonox? The importance of climate change for midwives.
Date requested:	01/05/2025
Date completed:	13/05/2025
Compiled by:	Veronica Price

CITING THIS SEARCH

If you reference this search in any paper, publication or presentation, please let us know.

The citation format is:

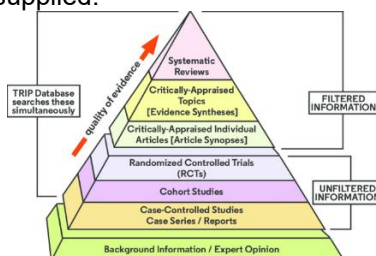
- Price, V., (2025). *Evidence summary: Why should we care about Entonox? The importance of climate change for midwives*. Taunton, UK: Somerset Foundation Trust Knowledge and Library Services.

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The results are presented according to the hierarchy of evidence which is used to rank the relative strength of results obtained from scientific research.

The design of the study and the endpoints measured affect the strength of the evidence.

Evidence hierarchies are often applied in evidence-based practices and are integral to evidence-based medicine.



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Contents (click to jump to each section):

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Summary of search results:

The [2020 NHS report: Delivering a net zero national health service](#) states the following aims:

“Two clear and feasible targets emerge for the NHS net zero commitment, based on the scale of the challenge posed by climate change, current knowledge, and the interventions and assumptions that underpin this analysis:

- for the emissions we control directly (the NHS Carbon Footprint), net zero by 2040, with an ambition to reach an 80% reduction by 2028 to 2032
- for the emissions we can influence (our NHS Carbon Footprint Plus), net zero by 2045, with an ambition to reach an 80% reduction by 2036 to 2039

One of the proposed steps taken to achieve this will be to ensure that medicines and supply chain meet or exceed the commitment on net zero emissions.

I have included links to useful resources from professional bodies as well as journal articles which discuss the climate impact of nitrous oxide and the steps being taken to minimise the impact of anaesthetic gases on the environment. These include the [Nitrous Oxide project](#) which seeks to remove piped nitrous oxide, as well as the use of [nitrous oxide ‘cracking’ technology](#).

I have included the article by [Martindale et al. 2022](#) (although not specifically looking at Entonox use in the maternity setting) because it contains a useful graphic comparison on the climate change impact of analgesics including Entonox:

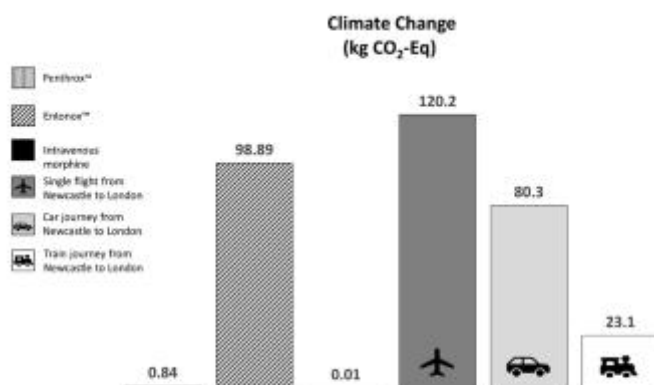


Figure 5 Comparison of climate change impact of Pentrox and other analgesics. Other analgesics include Entonox continuous use for 30 min at rate of 14 L/min and 7 mg of 100 mg in 100 mL morphine sulfate. In addition to this, we have included comparative data for a flight, car journey and train journey between Newcastle and London.

Martindale AEV, et al. *Emerg Med J* 2024;41:69–75. doi:10.1136/emered-2022-213042

The qualitative studies of midwife and maternal attitudes to and knowledge of the environmental impact of Entonox point to mixed levels of awareness and consequently the need for education around this topic.





The abstract from [Emont, Wang and Wright \(2023\)](#) states that “newborns and pregnant individuals are likely to face some of the largest consequences from climate change” and the survey from an Irish hospital ([McGarrigle et al. 2024](#)) concludes that “Patients should be informed of the environmental impact of nitrous oxide antenatally, empowering them to make informed decision on a climate friendly analgesic option if they wish.”

For extra context, I have included reports by [RCPCH](#), [WHO](#) and [UN Women](#) about the gender inequalities in the impact of global warming, meaning that women and children are more likely to suffer negative consequences.

I hope this is helpful. Please do let us know if you need any further information or help in accessing any of the articles from journals which I have indicated will require inter-library loan requests.



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Online Reports

NHS England

[Delivering a ‘Net Zero’ National Health Service](#)

October 2020

Royal College of Anaesthetists

[Nitrous oxide: end of the \(pipe\)line](#) (accessible to members or fellows of the RCoA)

[Podcast: Sustainability – Anaesthesia 2024](#)

[COP26 more than just hot air](#) November 2021 (this blogpost contains the anaesthetic gases calculator developed by Dr Tom Pierce)



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American Society of Anesthesiologists

[Statement on Deactivating Central Piped Nitrous Oxide to Mitigate Avoidable Health Care Pollution](#) October 2024

Royal College of Paediatrics and Child Health

[Child health inequalities and climate change in the UK - position statement](#) October 2023

UN Women

[How Gender Inequality and Climate Change are Interconnected](#) February 2022

WHO

[Climate change is an urgent threat to pregnant women and children](#) November 2023

Journal Articles

1. Environmental and occupational risks with use of nitrous oxide (Entonox®) for labour analgesia: a qualitative analysis of midwives' attitudes in the United Kingdom
[requires ILL request]

DOI: <https://libkey.io/10.1016/j.ijoa.2025.104359>

Authors: Craig, R.;O'Carroll, J.;Bampoe, S.;Odor, P. M. and Kamming, D.

Publication Date: Mar 23 ,2025

Journal: International Journal of Obstetric Anesthesia 62, pp. 104359

Abstract: BACKGROUND: Nitrous oxide carries significant environmental impact and has been linked to harm related to occupational exposure. In the United Kingdom, midwives are primarily responsible for administering nitrous oxide in the form of Entonox®. The aim of this study was to understand midwives' perceptions related to the effects of nitrous oxide and barriers to change in the pursuit of net zero emissions. METHODS: This qualitative study was conducted at a single teaching hospital. An interview guide was developed for the conduct of this study with thematic analysis conducted using an inductive approach to determine common themes. A total of 10 participants consented and participated in semi-structured interviews. RESULTS: Three themes were identified; mixed awareness of environmental and occupational risk; midwifery culture as a barrier to change; and the identification of drivers for innovation and change. CONCLUSIONS: Efforts to mitigate the environmental and occupational effects of nitrous oxide may require focused early educational policies and engagement with midwives to co-design demand- and supply-side mitigations to reduce harmful emissions from Entonox® delivery.



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[2. Environmental impact of low-dose methoxyflurane versus nitrous oxide for analgesia: how green is the 'green whistle'?](#)

Authors: Martindale, Aleksis Ev;Morris, Daniel S.;Cromarty, Thomas;Fennell-Wells, Amarantha and Duane, Brett

Publication Date: Jan 22 ,2024

Journal: Emergency Medicine Journal 41(2), pp. 69–75

Abstract: BACKGROUND: The NHS has the target of reducing its carbon emission by 80% by 2032. Part of its strategy is using pharmaceuticals with a less harmful impact on the environment. Nitrous oxide is currently used widely within the NHS. Nitrous oxide, if released into the atmosphere, has a significant environmental impact. Methoxyflurane, delivered through the Pentrox 'green whistle' device, is a short-acting analgesic and is thought to have a smaller environmental impact compared with nitrous oxide. **METHODS:** Life cycle impact assessment (LCIA) of all products and processes involved in the manufacture and use of Pentrox, using data from the manufacturer, online sources and LCIA inventory Ecoinvent. These data were analysed in OpenLCA. Impact data were compared with existing data on nitrous oxide and morphine sulfate. **RESULTS:** This LCIA found that Pentrox has a climate change effect of 0.84 kg carbon dioxide equivalent (CO₂e). Raw materials and the production process contributed to majority of the impact of Pentrox across all categories with raw materials accounting for 34.40% of the total climate change impact. Pentrox has a climate change impact of 117.7 times less CO₂e compared with Entonox. 7 mg of 100 mg/100 mL of intravenous morphine sulfate had a climate change effect of 0.01 kg CO₂e. **CONCLUSIONS:** This LCIA has shown that the overall 'cradle-to-grave' environmental impact of Pentrox device is better than nitrous oxide when looking specifically at climate change impact. The climate change impact for an equivalent dose of intravenous morphine was even lower. Switching to the use of inhaled methoxyflurane instead of using nitrous oxide in certain clinical situations could help the NHS to reach its carbon emission reduction target. Copyright © Author(s) (or their employer(s)) 2024. No commercial re-use. See rights and permissions. Published by BMJ.

[3. The Nitrous Oxide Project: assessment of advocacy and national directives to deliver mitigation of anaesthetic nitrous oxide](#)

Authors: Chakera, A.;Harrison, S.;Mitchell, J.;Oliver, C.;Ralph, M., et al

Publication Date: Mar ,2024

Journal: Anaesthesia 79(3), pp. 270–277

Abstract: The environmental emissions attributed to anaesthetic nitrous oxide across the NHS are comparable to the carbon dioxide released by 135,000 flights from Frankfurt to New York. Much of these emissions are attributable to cumbersome and inadequately managed piped systems, resulting in excessive loss and waste. Since 2020, multiple hospital sites have been engaging with the Nitrous Oxide Project, a quality improvement method supporting a 'lean systems' approach to the provision of nitrous oxide. This review considers the frameworks supporting medical gas management in UK healthcare systems, and the impact of professional advocacy and medical gas stewardship to drive anaesthetic nitrous oxide mitigation in the NHS. Nitrous oxide mitigation efforts by grassroots and professional advocacy networks are enhanced through national centralised emission



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monitoring, distribution of data, technical information and provision of quality analysis. Given the climate harms of nitrous oxide, concerted efforts should be made to rationalise its use, and resources should be committed to supporting this at local, regional and national levels.

4. Perspectives on sustainable practices in the use of nitrous oxide for labour analgesia: A patient and staff survey

[requires ILL request]

DOI: <https://libkey.io/10.1097/EJA.0000000000002005>

Authors: McGarrigle, Conor;Hartigan, Sean;Duffy, Oscar and Tan, Terry

Publication Date: Jul 1 ,2024

Journal: European Journal of Anaesthesiology 41(7), pp. 473–479

Abstract: BACKGROUND: Climate change has emerged as the single biggest global health threat of the twenty-first century. Nitrous oxide accounts for the largest carbon footprint amongst our use of anaesthetic gas. It is a potent greenhouse gas possessing a global warming potential of approximately 265 times that of carbon dioxide. Despite recent curtailment of its use, it remains extensively employed as an analgesic for women in labour. OBJECTIVES: Assessment of the opinions of post-natal women and staff on nitrous oxide use and to investigate whether knowledge of its environmental harm would influence their choice of labour analgesia. DESIGN: Postnatal women and healthcare staff were invited to participate in a survey of nitrous oxide use as a labour analgesic and knowledge of its effect of the environment. SETTING: A single-centre study in a major obstetric tertiary referral centre in Ireland in 2021. MAIN OUTCOME MEASURES: To evaluate the awareness and perceptions of postnatal women and staff regarding the environmental impact of nitrous oxide and if it would affect their decision to use it in the future. RESULTS: One hundred postnatal women and 50 healthcare staff completed the survey. One hundred and six post-natal women were invited to complete the survey, resulting in a response rate of 94%. Knowledge of nitrous oxide's environmental impact was low. After receiving information, 46% of patients were more inclined to seek epidural or request it earlier (54%) to limit their nitrous oxide use, while 51% would choose an alternative analgesia to avoid nitrous oxide altogether. Overwhelmingly, 99% believed they had the right to know about these harmful effects when choosing an analgesic option. CONCLUSIONS: Patients should be informed of the environmental impact of nitrous oxide antenatally, empowering them to make informed decision on a climate friendly analgesic option if they wish.

5. Entonox® use for labour analgesia in the context of environmental impact and occupational exposure: a national survey of UK midwives

[requires ILL request]

DOI: <https://libkey.io/10.1016/j.bja.2024.07.021>

Authors: Salih, Tom;Elgie, Laura;Acheampong, Yaa and Moonesinghe, S. Ramani

Publication Date: Dec ,2024

Journal: British Journal of Anaesthesia 133(6), pp. 1435–1438

6. [The carbon footprint of different modes of birth in the UK and the Netherlands: An exploratory study using life cycle assessment](#)



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Authors: Spil, Nienke A.;van Nieuwenhuizen, Kim E.;Rowe, Rachel;Thornton, Jim G.;Murphy, Elizabeth, et al

Publication Date: Apr ,2024

Journal: BJOG : An International Journal of Obstetrics and Gynaecology 131(5), pp. 568–578

Abstract: OBJECTIVE: To compare the carbon footprint of caesarean and vaginal birth. DESIGN: Life cycle assessment (LCA). SETTING: Tertiary maternity units and home births in the UK and the Netherlands. POPULATION: Birthing women. METHODS: A cradle-to-grave LCA using openLCA software to model the carbon footprint of different modes of delivery in the UK and the Netherlands. MAIN OUTCOME MEASURES: 'Carbon footprint' (in kgCO₂ equivalents [kgCO₂ e]). RESULTS: Excluding analgesia, the carbon footprint of a caesarean birth in the UK was 31.21 kgCO₂ e, compared with 12.47 kgCO₂ e for vaginal birth in hospital and 7.63 kgCO₂ e at home. In the Netherlands the carbon footprint of a caesarean was higher (32.96 kgCO₂ e), but lower for vaginal birth in hospital and home (10.74 and 6.27 kgCO₂ e, respectively). Emissions associated with analgesia for vaginal birth ranged from 0.08 kgCO₂ e (with opioid analgesia) to 237.33 kgCO₂ e (nitrous oxide with oxygen). Differences in analgesia use resulted in a lower average carbon footprint for vaginal birth in the Netherlands than the UK (11.64 versus 193.26 kgCO₂ e). CONCLUSION: The carbon footprint of a caesarean is higher than for a vaginal birth if analgesia is excluded, but this is very sensitive to the analgesia used; use of nitrous oxide with oxygen multiplies the carbon footprint of vaginal birth 25-fold. Alternative methods of pain relief or nitrous oxide destruction systems would lead to a substantial improvement in carbon footprint. Although clinical need and maternal choice are paramount, protocols should consider the environmental impact of different choices.

7. [Health system decarbonization on obstetric and newborn units](#)

Authors: Emont, Jordan;Wang, Melissa and Wright, Kelly

Publication Date: 2023

Journal: Seminars in Perinatology 47(8), pp. N.PAG

Abstract: The healthcare industry makes up 4.6 % of greenhouse gas (GHS) emissions worldwide. Although it is not known what proportion of GHGs come from obstetric and newborn units, newborns and pregnant individuals are likely to face some of the largest consequences from climate change. We review the literature in the areas of decarbonization on labor and delivery (L&D) and neonatal units and describe innovations from the fields of surgery and anesthesia. Best practices for L&D include refining disposable equipment packs, decreasing the use of single-use medical devices, adequately triaging waste, and decreasing the use of potent anesthetic gases such as nitrous oxide and desflurane. In neonatal settings, similarly triaging waste and decreasing the use of plastics containing endocrine disrupting chemicals can lower the carbon and environmental footprint and improve neonatal health. Additionally, avoiding unnecessary cesarean deliveries and increasing breastfeeding practices are also likely to improve the carbon footprint of L&D and neonatal units.

8. [Sustainability of Entonox in obstetrics: a qualitative study](#)

Authors: Kelly, Catherine;Raju, Pavan;Smith, Tim and Fioratou, Evridiki



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Publication Date: 2023

Journal: British Journal of Midwifery 31(2), pp. 74–80

Abstract: Background/Aims: Nitrous oxide is a potent greenhouse gas widely used in childbirth in the form of Entonox. In this study, its use was investigated because of its negative climate effect. The study aimed to identify and investigate midwives' use of Entonox in the labour ward of a tertiary Scottish hospital. Methods: This qualitative service evaluation was conducted using semi-structured interviews with 10 midwives and an environmental sustainability manager. Thematic analysis using combined deductive and inductive approaches were used to analyse the data. Results: Deductive analysis revealed all six work systems factors from the system engineering initiative for patient safety framework to be pertinent to Entonox use in the labour ward, with specific influences and perceived outcomes of Entonox use found through inductive analysis. Conclusions: A reduction in Entonox use would be difficult, but changes have been recommended to raise awareness among healthcare staff of Entonox risks and create a more environmentally sustainable work system.

9. [The use of nitrous oxide 'cracking' technology in the labour ward: a case report and patient account](#)

Authors: Khan-Perez, J.;MacCarrick, T. and Martin, F.

Publication Date: Sep 15 ,2022

Journal: Anaesthesia Reports 10(2), pp. e12182

Abstract: Nitrous oxide is a common choice of labour analgesia in many countries. However, its use is associated with significant cost to the environment as well as potential risks of long-term occupational exposure. Our hospital is one of a small number of healthcare providers in the United Kingdom trialling technology which catalytically destroys ('cracks') nitrous oxide to reduce greenhouse gas emissions and occupational exposure. When used in the setting of inhaled analgesia, cracking technology relies on capturing the patient's exhaled breath via a facemask or mouthpiece, a technique which requires some user skill and may be challenging for patients. In this report, we present the case of a primiparous 35-year-old consultant anaesthetist, who used nitrous oxide cracking technology with inhaled nitrous oxide analgesia (via a facemask) during labour. We present the patient's experiences and discuss the implications of using such technology on ambient nitrous oxide levels in the delivery room. Notably, despite this patient's professional expertise and familiarity with facemask use, nitrous oxide remained detectable throughout her labour, although generally at low levels. This illustrates that whilst this technology has the potential to reduce ambient nitrous oxide levels, its efficacy may vary depending on how it is used, with implications for patient education and support.

10. [Implementing nitrous oxide cracking technology in the labour ward to reduce occupational exposure and environmental emissions: a quality improvement study\(\)](#)

DOI: <https://libkey.io/10.1111/anae.15838>

Authors: Pinder, A.;Fang, L.;Fieldhouse, A.;Goddard, A.;Lovett, R., et al



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Publication Date: Nov ,2022

Journal: Anaesthesia 77(11), pp. 1228–1236

Abstract: Nitrous oxide, a potent greenhouse gas, is a common labour analgesic. One method which may reduce its carbon footprint is to 'crack' the exhaled gas into nitrogen and oxygen using catalytic destruction. In this quality improvement project, based on environmental monitoring and staff feedback, we assessed the impact of nitrous oxide cracking technology in the maternity setting. Mean ambient nitrous oxide levels were recorded during the final 30 minutes of uncomplicated labour in 36 cases and plotted on a run chart. Interventions were implemented in four stages, comprising: stage 1, baseline (12 cases); stage 2, cracking with nitrous oxide delivered and scavenged via a mouthpiece (eight cases); stage 3, cracking with nitrous oxide via a facemask with an air-filled cushion (eight cases); stage 4, cracking with nitrous oxide via a low-profile facemask, and enhanced coaching on the use of the technology (eight cases). The median ambient nitrous oxide levels were 71% lower than baseline in stage 2 and 81% lower in stage 4. Staff feedback was generally positive, though some found the technology to be cumbersome; successful implementation relies on effective staff engagement. Our results indicate that cracking technology can reduce ambient nitrous oxide levels in the obstetric setting, with potential for reductions in environmental impacts and occupational exposure.

11. [Pro-Con Debate: Nitrous Oxide for Labor Analgesia](#)

Authors: Vallejo, Manuel C. and Zakowski, Mark I.

Publication Date: Aug 20 ,2019

Journal: BioMed Research International 2019, pp. 4618798

Abstract: This Pro-Con debate will provide the practitioner with an evidence-based knowledge approach to assist the clinician in determining whether to employ (Pro) or not to employ (Con) this technique in the obstetrical suite for labor analgesia. Nitrous oxide has been used safely in dentistry and medicine for many centuries. However, accumulating preclinical and clinical evidence increasingly suggests previously unrecognized adverse maternal and fetal effects of nitrous oxide, which warrants reconsideration of its use in pregnant women and a more detailed informed consent. Nitrous oxide is associated with metabolic, oxidative, genotoxic, and transgenerational epigenetic effects in animals and humans that may warrant limiting its usefulness in labor. This debate will discuss and review the clinical uses, advantages, and disadvantages of nitrous oxide on occupational effects of nitrous oxide exposure, neuroapoptosis, FDA warning on inhalational anesthetics and the developing brain, research limitations, occupational exposure safety limits, effects on global warming, and potential for diversion.

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PURPOSE OF SEARCH			
	Patient info/health & well being	✓	Clinical decision making (inc. patient care)
	Executive Team support		Research/Education/Professional development
✓	Quality Improvement		Primary Care & Neighbourhoods Directorate support
	KM/Management decision making		Other

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	Nurses/Midwives		Other
	Allied Health professionals		

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✓	YES - share		NO – do not share





KEY WORDS/SEARCH STRATEGY INCLUDING MESH HEADINGS	LIMITS USED
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