

How Can We Reduce the Environmental Impact of Obstetric Anaesthesia?

Climate change and environmental pollution have been receiving growing global attention in recent years as extreme weather events become more common and the environmental impact of waste is increasingly highlighted. A UK Government survey in 2018 found that 74% of respondents were fairly concerned or very concerned about climate change, with most believing human activity is playing a role in driving climate change (one in 10 believe it is due to natural processes) ^[1]. Growing public concern is highlighted by the increasing number of protest movements around climate change and sustainability, namely the School Strikes for Climate pioneered by Swedish teenager Greta Thunberg, and the Extinction Rebellion protests in London and other UK cities during 2019. The harmful impact of plastics, particularly for marine life, was highlighted by the BBC's Blue Planet documentary – a supermarket survey following the airing of this programme found nearly 90% of viewers had changed their behaviour regarding use of plastics after watching this ^[2].

Healthcare is known to have a significant environmental impact - it has been estimated that in England, Health and Social Care accounts for 6.3% of the national carbon footprint, and leads to the production of 590,000 tonnes of waste per year ^[3]. No data exists for the proportion of waste production and pollution generated by obstetrics, or more specifically obstetric anaesthesia, however in the United States it is estimated that operating theatres are responsible for approximately one third of hospital waste ^[4]. Anaesthetic waste has been estimated to account for 25% of operative waste ^[5]. Given that in the UK in 2016-17 there were 174,720 deliveries by caesarean section and 79,806 by instrumental delivery ^[6], it is

reasonable to assume that obstetrics as a whole contributes a significant proportion of UK Health and Social Care environmental impact. The environmental impact of anaesthesia itself has been well established, with all inhalational anaesthetic agents acting as greenhouse gases, and therefore contributing to climate change, to varying extents. Nitrous oxide also causes destruction of the ozone layer ^[7].

Sources of Environmental Impact in Obstetric Anaesthesia

Nitrous Oxide and Entonox

Nitrous oxide is a potent greenhouse gas with 310 times the global warming potential of carbon dioxide (CO₂), and in addition to this is an ozone destroying gas ^[7]. Medical use of nitrous oxide is thought to contribute to less than 5% of total global nitrous oxide emissions, however, given its high potency for climate change via both global warming potential and ozone destruction, reduction in its use is to be encouraged wherever feasible. A study has found that nitrous oxide makes up over 99% of the global warming impact of anaesthetic gases due to its large volumes of use – typically around 50% of fresh gas flow compared to much lower percentages for the other inhalational anaesthetic agents ^[8].

Obstetric anaesthetic use of nitrous oxide and Entonox (a 50:50 mix of oxygen and nitrous oxide) makes up a significant proportion of healthcare use - a Care Quality Commission (CQC) survey has found that over 75% of women will use Entonox at some point during their labour ^[9] resulting in significant environmental release of nitrous oxide. Nitrous oxide is more frequently used during general anaesthesia in obstetric anaesthesia than in other surgical specialties in order to reduce the amount of inhalational agent required, due to the tocolytic

effects of these agents on the uterus. A survey of UK obstetric anaesthetists found that 91% used nitrous oxide routinely in their obstetric practice in comparison to 44% in their non-obstetric practice^[10]. Reducing use of nitrous oxide in this setting has the potential to lead to increased blood loss during general anaesthetic caesarean sections therefore it is difficult to advocate this change without further study into comparative blood loss during caesarean with and without nitrous oxide, plus the use of uterotonic agents. My personal practice fits with the above data, in that I routinely use nitrous oxide for general anaesthetic caesarean sections - both to reduce the requirement for other inhalational anaesthetic use, and also in an attempt to increase the speed of onset of inhalational anaesthesia. I would be reluctant to change this without clear evidence that blood loss and outcomes are not worsened by the higher end tidal levels of volatile anaesthetic agents required in the absence of nitrous oxide.

Reduction of Entonox use during labour is not a simple task either, as it has a number of key benefits as a labour analgesic; it is safe, generally well tolerated, more effective than opioid analgesia, gives an increased level of control for the mother, and has rapid onset and offset. Given these factors Entonox should clearly continue to be offered to women in labour, however given increasing public interest in environmental issues, many women may prefer to know about the environmental impact of Entonox. It would not necessarily be appropriate to have this discussion during labour itself, when a patient's ability to weigh up information is impaired by pain; however information could be included in hospital educational resources given to women in the antenatal period, and organisations involved in the education of expectant mothers, for example the National Childbirth Trust, could be asked to include such information in their resources. This would allow patients to factor this into their birth plan and attempt to avoid Entonox if they were so inclined.

Other Inhalational Anaesthetic Agents

All inhalational anaesthetic agents contribute to global warming to differing degrees, but all with a greater potency than CO₂. It is increasingly recognised that desflurane is especially harmful to the environment, with a global warming potential 2540 times greater than CO₂, whereas sevoflurane has a global warming potential 130 times greater than CO₂ ^[7].

Strategies to reduce the environmental impact of inhalational anaesthetic agents in anaesthesia as a whole include:

1. Increasing the use of regional anaesthesia

- In obstetric anaesthesia, regional anaesthesia is most commonly the preferred option, with general anaesthesia generally reserved for cases when neuraxial anaesthesia is contraindicated, or the urgency of the case is felt to necessitate general anaesthesia. There would seem to be little to be gained from looking to increase rates of neuraxial anaesthesia for environmental reasons in obstetric anaesthesia, although in cases where there is a choice between general and regional anaesthesia, the environmental impact could be considered in the decision-making process.

2. Use of total intravenous anaesthesia (TIVA)

- In cases where general anaesthesia has been chosen for rapid anaesthesia, TIVA is not appropriate, hence again there seems to be little room for improvement with this strategy. TIVA, of course could be considered for cases where general anaesthesia is chosen for reasons other than urgency. I personally do not have any experience of using TIVA in obstetric anaesthesia but it is something I aim to discuss with consultant colleagues for their views on its use.

3. Encouraging use of low flow anaesthesia to reduce agent use

- Low flow anaesthesia can reduce the rate of consumption of inhaled anaesthetic agents in direct proportion to the reduction in fresh gas flow rate – i.e. halving the fresh gas flow rate from 2L/min to 1L/min will halve the use of inhalational anaesthetic used for a given dialled percentage. Low flow anaesthesia is easily achieved in the UK in obstetric anaesthesia as circle systems are almost universal in adult anaesthesia outside of specialist cases and inspired oxygen concentration monitoring is mandatory, allowing safe use of low fresh gas flows.
- General anaesthesia for emergency caesarean section is associated with a disproportionately high incidence of accidental awareness under general anaesthesia (AAGA) as reported in NAP5, which is multifactorial in origin^[11]. One of the recommendations to reduce this risk is “*rapidly attaining adequate end-tidal volatile levels after induction without delay*” which necessitates high fresh gas flow rates and overpressure initially. However once adequate anaesthesia has been well established, low flow anaesthesia can safely reduce the use of inhaled anaesthetic agents.
- In my personal practice I attempt to switch to low flow anaesthesia as soon as practicable during obstetric general anaesthesia, but this can be difficult due to the intensity of work at the start of a case. Early utilisation of the automatic gas control (AGC) on the Maquet Flow-i machines in my current trust does allow me to achieve low flow anaesthesia more rapidly than I tend to achieve with manual control of fresh gas flows.

4. Selecting the least environmentally harmful inhalational agent

- Of the commonly used inhalational agents, sevoflurane has the lowest global warming potential (130x CO₂), followed by isoflurane (510x CO₂), with desflurane by far the most harmful (2540x CO₂)^[7].
- We can all aim to reduce the environmental impact of our practice by utilising the least environmentally harmful agent available to us, unless there are compelling clinical reasons in a specific case.

5. Reusing captured inhalational anaesthetic agents

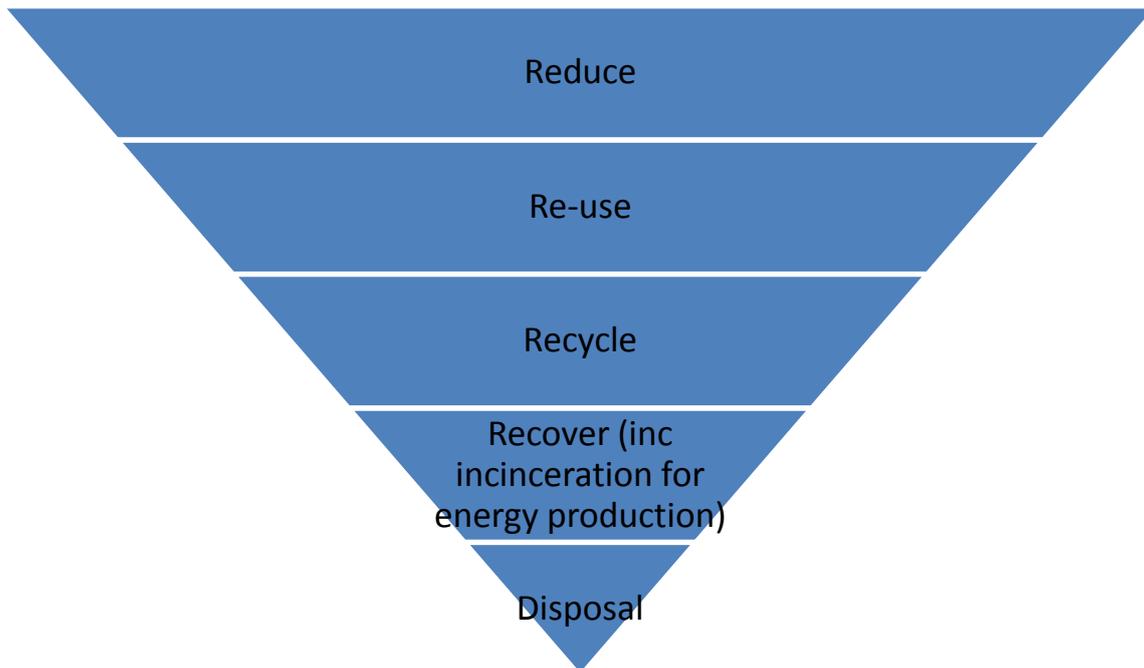
- Only a small proportion of inhaled anaesthetic agents are metabolised, with the rest being exhaled by patients, scavenged and released into the environment unchanged. Systems exist to collect and allow recycling of these exhaled anaesthetic agents, but none are in widespread use. Further development and utilisation of such systems could reduce the quantities of inhalational anaesthetic agents released into the atmosphere, as well as reducing the demand for production of these agents.

Waste Materials

As mentioned previously, NHS providers in England generated 590,000 tonnes of waste in 2016/17, of which it is estimated that 20-30% comes from operating theatres, and 25% of this is generated by anaesthetic practice.

The Department for the Environment, Food and Rural Affairs (DEFRA) sets out hierarchy of waste management options, ranking options from most- to least-preferable based on their

environmental impact ^[12]:



Reducing the amount of waste created in the first place is the most environmentally friendly approach to waste management. It eliminates the impact of the production, transport and disposal of waste. It however is the most difficult to achieve for an individual, and requires a multifaceted approach:

- For organisations:
 - Encourage manufacturers to reduce the amount of packaging supplied with products e.g. reducing the volume of plastic inserts
 - Encourage manufactures to use recycled and recyclable materials for packaging where possible
 - Evaluate pre-packaged kits – e.g. epidural/spinal kits – are there any superfluous items which are rarely or never used, for example in my current trust the neuraxial kits contain 2 handtowels that I have never seen used.
- For individual anaesthetists

- Only open equipment and drugs that are definitely required – rationalise emergency drugs by only drawing up those that would be required immediately, others could be drawn up as required.
- Use oral medication when no indication for IV medication exists as the environmental impact of the production of IV medications is higher.

Re-use of equipment is the next most environmentally friendly option. In obstetric anaesthesia the only piece of equipment that is currently single use that could realistically be reusable instead is the laryngoscope. The prevalence of single-use laryngoscope handles and blades has increased due to infection control and financial implications (presumed savings from reduced cost of sterilisation), however it has been calculated that the environmental impact of single use laryngoscopes is higher than reusable equipment, and the financial cost to institutions can actually be higher^[13]. A return to reusable laryngoscopes may make a small environmental impact improvement in obstetric anaesthesia, however it may meet resistance on infection control grounds. An alternative approach is to ensure recycling of steel single use laryngoscope blades, which has been successfully trialled in Southampton^[14]. An example method for segregating, sterilising and recycling blades is available in the American Society of Anaesthesiologists report “Greening the OR”^[4].

Much of the waste produced from anaesthesia consists of packaging materials including cardboard and plastics, which are widely recyclable. It has been estimated that between 40-60% of anaesthetic waste is recyclable^[5,15]. In my experience the major barriers to recycling of this waste tend to be concerns over potential contamination with infectious waste, resulting in waste being sent for incineration, and lack of available dedicated recycling bins. These barriers have been overcome in various units by introducing dedicated recycling bins to anaesthetic rooms and ensuring staff education around not only the environmental impact, but also cost savings which are achieved by reducing the incineration of recyclable waste^[16,17].

Recovery of energy from incineration is less environmentally harmful than both incineration without energy recovery, or landfill disposal of waste. In 2016/17 the NHS in England sent 88,000 tonnes of waste to landfill, compared to 148,000 tonnes to incineration and 137,000 to recycling^[18]. Encouraging appropriate segregation of waste and encouraging NHS organisations to reduce waste sent to landfill could impact these quantities.

Staff Members

Individual staff members can aim to reduce their personal environmental impact, particularly at work and whilst commuting. It is well known that transport plays a significant role in climate change by generating harmful emissions. Staff members can be encouraged to reflect on their individual commutes and assess whether they could be made less environmentally harmful:

- Could I walk or cycle to work?
- Could I take public transport?
- Could I lift-share?

Working in anaesthesia does create difficulties with the above options. Shift work sometimes means that lift-sharing and use of public transport are excessively inconvenient or are not viable options at all. The rotation of anaesthetic trainees around different hospitals in large geographical areas often results in long-distance commutes which can only be realistically achieved by individual car use. There are still ways for commuters to try to decrease their environmental impact by increasing their fuel efficiency – adopting an economical driving style, ensuring adequate tyre pressures, removing unnecessary luggage from the car etc.

These simple changes can make a small, but significant difference to our individual carbon footprints.

Whilst at work we can all try to make small changes to reduce unnecessary energy use, for example by turning off lights and electrical equipment such as computers when not in use.

Often in my experience computers in anaesthetic rooms and on call rooms are left on continuously, whereas mostly they could be turned off overnight. Seeking to recycle items when possible and avoiding use of single use plastics such as disposable cups and cutlery can reduce volumes of waste produced and reduce demand for these items, reducing their manufacture. I now try to remember to bring a reusable cup to work with me, and as much as possible I use this when I buy or make a hot drink at work.

Conclusions

The environmental impact of obstetric anaesthesia is significant; however attempts to reduce this impact must be balanced against the need to maintain the standard of care provided to individual patients. There are opportunities highlighted above for individual anaesthetists to reduce their occupational environmental impact without compromising patient care e.g. rationalising emergency drugs, selection of appropriate inhalational agent, low flow anaesthesia and more social changes. There are also areas in which anaesthetists can encourage their employing organisation to help reduce the environmental impact e.g. facilitating recycling of anaesthetic (and surgical) waste and potential recycling of laryngoscope blades. Other areas require a more concerted societal effort to reduce waste by encouraging manufacturers to reduce unnecessary packaging and increase use of recycled materials where appropriate. Unfortunately the greatest environmental impact from obstetric anaesthesia also happens to be potentially the most difficult to eradicate – environmental

pollution with nitrous oxide. Without development of a superior labour analgesic, use of nitrous oxide in obstetric anaesthesia will continue to be high, and so will the environmental impact of obstetric anaesthesia. This, of course, does not mean that we should not try to reduce the other sources of environmental impact associated with our work, as every little helps.

References

1. Department for Business, Energy and Industrial Strategy. *Energy and Climate Change Public Attitude Tracker Wave 25*. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/702640/Wave_25_Summary_Report.pdf. Accessed 19th September 2019
2. Waitrose. *Waitrose & Partners Food and Drink Report 2018-19*. Available at https://waitrose.pressarea.com/pressrelease/details/78/NEWS_13/10259. Accessed 19th September 2019
3. Sustainable Development Unit, NHS England. *Reducing the use of natural resources in health and social care 2018 Report*. Available at https://www.sduhealth.org.uk/documents/Policy%20and%20strategy/20180912_Health_and_Social_Care_NRF_web.pdf. Accessed 19th September 2019
4. American Society of Anesthesiologists. *Greening the Operating Room and Perioperative Arena: Environmental Sustainability for Anesthesia Practice*. Available at <https://www.asahq.org/about-asa/governance-and-committees/asa-committees/committee-on-equipment-and-facilities/environmental-sustainability/greening-the-operating-room>. Accessed 15th September 2019
5. McGain F, Hendel SA, Story DA. An audit of potentially recyclable waste from anaesthetic practice. *Anaesthesia and Intensive Care* 2009; 37(5): 820-3
6. NHS Digital. *NHS Maternity Statistics 2016-17*. Available at <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-maternity-statistics/2016-17>. Accessed 20th September 2019
7. Campbell M, Pierce JMT. Atmospheric science, anaesthesia, and the environment. *Continuing Education in Anaesthesia Critical Care & Pain* 2015; 15(4): 173–9
8. Gadani H, Vyas A. Anesthetic gases and global warming: Potentials, prevention and future of anesthesia. *Anesthesia Essays and Researches*. 2011; 5(1): 5–10
9. Care Quality Commission. *2017 survey of women's experiences of maternity care*. Available at https://www.cqc.org.uk/sites/default/files/20180130_mat17_statisticalrelease.pdf. Accessed 20th September 2019
10. Obstetric Anaesthesia Association. *Unpublished Posters: Obstetric Anaesthesia 2010 (Newcastle)*. Snaith R, McIntyre C, Young s, Kearns C. *National survey of nitrous oxide use among obstetric anaesthetists in the United Kingdom*. Available at www.oaa-

anaes.ac.uk/assets/_managed/editor/File/Courses/2010/10.92%20Poster%20abstracts%20non-IJOA%20only.pdf. Accessed 4th October 2019

11. Royal College of Anaesthetists and the Association of Anaesthetists of Great Britain and Ireland. *5th National Audit Project: Accidental Awareness during General Anaesthesia in the United Kingdom and Ireland*. Available at <https://www.nationalauditprojects.org.uk/NAP5report>. Accessed 23rd September 2019
12. Department for Environment, Food and Rural Affairs. *Guidance on applying the Waste Hierarchy*. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69403/pb13530-waste-hierarchy-guidance.pdf. Accessed 1st October 2019
13. McGain F, Story D, Lim T, McAlister S. Financial and environmental costs of reusable and single-use anaesthetic equipment. *British Journal of Anaesthesia* 2017; 118(6): 862-9
14. Enzor NA, Pierce JM. Recycling steel from single-use laryngoscope blades and Magill forceps. *Anaesthesia* 2013; 68: 115-6
15. Shelton CL, Abou-Samra M, Rothwell MP. Recycling glass and metal in the anaesthetic room. *Anaesthesia* 2012; 67: 195-6
16. Centre for Sustainable Healthcare. *Introducing recycling into the operating theatres - Oxford University Hospitals NHS Trust*. Available at <http://map.sustainablehealthcare.org.uk/oxford-radcliffe-hospitals-nhs-trust/introducing-recycling-operating-theatres>. Accessed 20th September 2019
17. Sustainable Development Unit. *Clinical Waste Reduction in Theatres - Barking, Havering and Redbridge University Hospitals NHS Trust*. Available at https://www.sustainabilityexchange.ac.uk/files/clinical_waste_reduction_in_theatres.pdf. Access 20th September 2019
18. NHS Digital. *Estates Return Information Collection, England, 2016-17*. Available at <https://digital.nhs.uk/data-and-information/publications/statistical/estates-returns-information-collection/estates-return-information-collection-2016-17#>. Accessed 20th September 2019