EDITORIAL

Green nudges for sustainable anaesthetic practice: institutional support to make individual change easier

J. Parker[1], P. Young[2], N. Hodson[3] and C. L. Shelton[4,5]

1 Doctoral Candidate, Lancaster Medical School, Faculty of Health and Medicine, Lancaster University, Lancaster, UK.

2 Specialty Trainee, North West School of Anaesthesia, Health Education England North West, Manchester, UK.

3 Academic Clinical Fellow, Unit of Mental Health and Wellbeing, University of Warwick, Coventry, UK

4 Consultant, Department of Anaesthesia, Wythenshawe Hospital, Manchester University NHS Foundation Trust, Manchester, UK.

5 Senior Clinical Lecturer, Lancaster Medical School, Faculty of Health and Medicine, Lancaster University, Lancaster, UK.

Correspondence to J. Parker

Email: joshua.parker@doctors.org.uk

Twitter: @joshp_j; @PaulAshYoung; @NathanHodson; @DrCliffShelton

Industrialised healthcare accounts for 4–5% of global greenhouse gas emissions, and inhaled anaesthetic agents account for 2–5% of this [1–3]. As healthcare systems attempt to mitigate their emissions, reducing or even abandoning the use of inhalational agents as the primary technique for the maintenance of general anaesthesia is essential [4]. In the UK, there has been particular emphasis on moving away from desflurane (which has by far the highest global warming potential of the inhaled anaesthetic agents), with specific national targets for its reduction [5].

Data from the NHS Business Services Authority presented in the Greener NHS Dashboard reveals that the recent dramatic reduction in desflurane use has not been accompanied by an increase in isoflurane or sevoflurane, implying that anaesthetists are choosing to move from desflurane to total intravenous anaesthesia (TIVA), rather than different volatile anaesthetic agents (Fig. 1) [6]. This may be explained by the rapid wake-up that can be achieved with some TIVA techniques [7], making it a viable alternative to desflurane. In the presence of safe and effective alternatives such as TIVA, reducing the use of inhalational anaesthesia might be considered 'low-hanging fruit' in a move towards more sustainable anaesthesia. However, though some healthcare systems have made significant progress, attempts to minimise the 'carbon footprint' of inhalational anaesthesia have been variable overall. As such, finding ways to support and accelerate the transition away from volatiles (especially desflurane) is a key element of sustainable anaesthesia practice [8].

At the 2023 Association of Anaesthetists Winter Scientific Meeting, NHS England announced a commitment to decommission desflurane from early 2024 [9]. This aligns with the commitment to remove desflurane from use in Scotland from February 2023, and the legislative proposal to remove it from use in the European Union from 2026 [10]. These measures point to a growing strategic and regulatory consensus around the decommissioning of desflurane. But these system level endeavours may place anaesthetic departments in a challenging position – there will be a need to smooth the transition away from desflurane and towards more sustainable alternatives. Outside of the UK and the EU there are no legislative requirements (as far as we are aware) to decommission desflurane, leaving the responsibility in the hands of departments and institutions.

Individual practitioner behaviour change has hitherto been the lynchpin of sustainable anaesthetic practice, and efforts to change behaviour have so far focused on education [4,11,12]. Once informed about the environmental impact of anaesthesia and what they can do to help, anaesthesia providers should theoretically make different, better, choices. But is education sufficient on its own? In this

editorial, we explore the limits of the education paradigm, arguing that it must be supplemented with alternative, evidence-based methods of promoting practice change.

Responsibilities for greener practice

Allow us first to sketch individual anaesthetists' responsibilities when it comes to sustainable practice. A full defence of this is outside the scope of this editorial, but others have advanced a *"principle of environmental prescribing"*, which can be summarised as [13]: *"Where two treatment options are considered equally safe and effective, prescribers should prioritise the one with a lesser impact on the environment."*

Thus, in cases where TIVA is deemed (by the anaesthetist and the patient) to be equivalent to an inhalational technique, environmental impact should be the deciding factor. On a population level, there is little to suggest the clinical superiority of any of these approaches for many procedures, though this may be revised when the results of large-scale studies become available [14]. Since there is currently equipoise, with no high-quality evidence to suggest clinically important patient benefits from inhalational anaesthesia, we take the position that more environmentally sustainable anaesthetic techniques are no worse for patients.

Drawing on the real-world data presented in the Greener NHS dashboard [6], we will discuss the switch from desflurane and towards TIVA in our worked examples, below, but much of the same logic could be applied to other decisions where there is clinical equipoise but an environmental benefit to one alternative (e.g. nitrous oxide vs. remifentanil, disposable devices vs. reusable devices).

The limits of the education paradigm

Education is theorised to work at the individual level by providing internal motivation for behaviour change. This model assumes a rational choice theory of human behaviour, postulating that individuals weigh the costs and benefits of decisions in order to bring about the best outcomes [15,16]. If this were true, failures to practice sustainably would represent either a failure to appropriately weigh environmental costs, or a failure to recognise one's obligations to environmental prescribing.

Two core problems arise with the education paradigm and its reliance on a rational choice theory of behaviour. First, there is an extensive body of research that demonstrates that humans are not

rational in the way assumed. In short, humans show bounded rationality and make decisions that are oftentimes affected by in-built biases [15]. Even where education reveals one's moral responsibilities and increases knowledge, if we predictably fail to utilise information appropriately because of limitations in our evolved psychology, education alone will be severely limited.

The second problem is that the nature of climate change makes it particularly difficult to motivate behaviour change. Climate change results from the actions of many individuals and institutions over time and produces harms that extend globally and across many years. Gardiner describes these peculiar aspects of climate change and the barriers to change they present as a "*perfect moral storm*" [17]. In the face of a problem of this scale, responsibility can appear diluted, especially as human psychology has evolved to enable co-operation among small groups faced with medium-sized, visually perceived and relatively immediate problems [18]. In addition, governments – limited by medium-term time horizons and national borders – are not optimised to respond to challenges like climate change. In the context of healthcare there are targets for reductions of some anaesthetic gases, but robust policies to achieve these and prevent individual anaesthetists simply practicing business as usual are lacking.

Together, these features help to explain why presenting evidence around the contribution of anaesthetic practice to climate change often fails to motivate wholesale changes in practice. Even if anaesthetists know that inhaled agents are environmentally 'harmful', change can be delayed by vague, distant, probabilistic harms, dependent on the behaviours of countless others. Where change requires effort, it is easy to ignore or discount the wider consequences of one's practice, given the scale of climate change; especially where practice is otherwise individually safe, effective and patient-centred, at least in the short-term.

Environmental-responsibilities can be separated into levels, where 'first-order' refers to the responsibility of individuals to practice sustainably, and 'second-order' denotes the responsibility of institutions to facilitate this [19]. Having considered the challenges of relying on individuals, we turn to second-order responsibilities. There are various ways that those in power might help individuals comply with first-order responsibilities, including incentivisation, enablement or the creation of pro-environmental norms [19]. These are all aimed at propagating certain behaviours. The extensive scholarship on so-called 'nudges' suggests several evidence-based tools that institutions can use to fulfil their second-order responsibilities to help anaesthetists make sustainable choices.

Green nudges for sustainable practice

'Choice architecture' describes all elements of the context where choices are made, including ease, timing and the available options [15]. Each of these elements can subtly influence behaviour, creating opportunities to modify the choice architecture and thereby harness behavioural biases to draw individuals towards certain choices, while leaving alternatives open [20]. In this sense, changes to the choice architecture are distinct from coercion and complement traditional information-focused policies. Indeed, others have found that nudges can be effective at bringing about environmentally-friendly behaviour change across society [21].

A key corollary of the choice architecture is that there is no neutral: every element has implications for behaviour [15]. A choice architecture that leads anaesthetists away from making greener choices undermines their first-order responsibility to practice sustainably. It follows that those with power to shape the choice architecture – the 'choice architects' – have a second-order responsibility to make considered decisions about which behaviours to encourage and which to discourage, and then build the choice architecture accordingly. As greener choices are desirable, choice architects should shape environments to incentivise, enable, or create norms that increase the likelihood of these happening. For example, if desflurane vaporisers are kept on anaesthetic machines while target-controlled infusion (TCI) pumps and TIVA administration sets are in short supply or kept in equipment storerooms, this makes it much harder for anaesthetists to turn to TIVA. One way that organisations can fulfil their second-order responsibilities is by altering the choice architecture to shift the default, in turn making it easier for individual anaesthetists to make sustainable choices. Nudges have been used to successfully change behaviour in other areas of healthcare, including antimicrobial stewardship [22,23].

Imposing change by prohibiting certain approaches risks backfiring by making anaesthetists feel disenfranchised and threatening their professional choices. Departments often therefore seek unanimous consensus before implementing new policies. However, when consensus is unattainable it presents an obstacle to change. A significant advantage of nudges is that, while they encourage certain behaviours, they do not prohibit alternatives, and professional autonomy remains intact. While achieving consensus is clearly desirable, nudges provide a route to changing practice when unanimous consensus cannot be reached because they change the structures within which decisions take place, rather than the decisions themselves.

We propose nudges as a way for healthcare systems to fulfil their second-order responsibilities and make it easier to give a greener anaesthetic. We suggest various behaviourally informed nudges with an evidence base in other areas, and those that are simple, achievable, cheap and auditable.

Labelling

Labelling is an effective nudge to bring about behaviour change, for example calorie labelling applied to foods [24,25]. Labelling interventions are not merely information provision; they alter the factors considered at the moment of decision-making, helping to frame salient information and highlight factors that do not readily come to mind [16]. Labelling vaporisers is a simple and cheap intervention that has been used at some centres to reduce the use of volatile anaesthetics, particularly desflurane [26,27]. A well-designed anaesthetic label could reframe the decision as an environmental choice, not just one of convenience and familiarity.

Defaults and creating an environmentally conscientious environment

Various nudges could position TIVA as the default for delivering general anaesthesia, effectively requiring anaesthetists to 'opt-in' to volatiles. Defaults have proven effective in personal finance decisions, income tax payments and organ donation [28,29]. They are based on the tendency to 'go with the flow'. Defaults leverage social influence by implying that the default choice is preferable in addition to capitalising on chooser inertia by making the choice easier, while also allowing other options.

A department could become 'TIVA-by-default' by ensuring the availability of appropriate medications, TCI pumps, Luer-lock syringes, TIVA administration sets and processed EEG monitors in every operating theatre [30]. These interventions would remove common barriers to TIVA, presenting it as a viable default technique.

Removing desflurane vaporisers from anaesthetic machines and storing them elsewhere also shifts the default, meaning anaesthetists must actively plan to use it. Several anaesthetic departments have successfully reduced their desflurane use this way. More radically, departments could treat desflurane like a controlled drug, requiring it to be signed out from locked storage. Not only does this provide a nudge towards more sustainable alternatives by making desflurane use inconvenient, but it also sends a powerful message: 'the use of desflurane is unnecessary in most circumstances.' The likely outcome is that most will dispense with desflurane. Whether and to what extent all vaporisers should be made less accessible is an open question that merits discussion considering

potential safety issues. In the meantime, the disproportionate environmental impact of desflurane (and in England and Scotland – its impending removal from use) makes this drug an excellent place to start.

Finally, hospitals must ensure that facilitating green decision-making is at the core of any change to the environment in which anaesthesia is provided. For example, redesigning anaesthetic charts with prioritised space for TCI and EEG data provides a constant reminder that TIVA is the departmental default.

Peer comparison

Where individual volatile consumption can be monitored, as with some electronic anaesthetic charting systems, peer comparison may be a useful means of driving social change. A randomised controlled trial found that peer comparison increased the number of doctors offering influenza vaccines [31]. As 'boomerang effects' are a known risk when peer comparisons are used in isolation, interventions are most effective when social approval for high performance is also demonstrated [32]. While the Greener NHS Dashboard effectively acts as a leaderboard, comparing different Trusts on their environmental credentials [5], there is some evidence that individual-level targets are more effective than group-level targets [33]. A regular email informing each anaesthetist of their volatile use alongside a comparison to an average for others in the department could inform individuals about their relative use of volatile anaesthetics, thereby motivating change while simultaneously celebrating the positive impact of switching from volatiles.

Social commitment

A group of anaesthetic trainees in Australia and New Zealand has supported hospitals to publicly pledge to remove desflurane from formularies by 2025 [34]. Similarly, departments could seek public commitments from staff to either eliminate or reduce their use of volatiles to a pre-specified level over a defined period. Pre-commitment has been shown to make people more likely to save for retirement, stop smoking and lose weight [35,36]. In some commitment arrangements, people stake money on meeting their commitment – introducing an element of risk [37], but it has also been noted that the 'social shame' of failure can have a similar effect, which might be especially effective among high-achieving medical professionals [38].

Where there are various safe and effective anaesthetic options the tiebreaker ought to be the more sustainable option. Fulfilling this first-order responsibility requires individual behaviour change.

While education regarding sustainable anaesthetic practice and the presence of this obligation is clearly important, it needs to be supplemented with institutional changes that encourage greener practices. Nudges fill this important gap of second-order responsibilities. Crucially, they do not rely on consensus to implement, nor on forced behavioural change. While the nudges we suggest have evidence of effectiveness in multiple settings, further study in the specific context of anaesthetic practice is welcome and would form an ideal basis for quality improvement work.

References

1. Romanello M, McGushin A, Napoli CD et al. The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. *Lancet* 2021; **398**: 1619–62.

2. Dobson J, Cook S, Frumkin H, Haines A, Abbasi K. Accelerating climate action: the role of health professionals. *British Medica Journal* 2021; **375**: n2425.

3. Maxwell J, Blashki G. Teaching about climate change in medical education: an opportunity. *Journal of Public Health Research* 2016; **5**: 673.

4. White SM, Shelton CL. Abandoning inhalational anaesthesia. *Anaesthesia* 2020; **75**: 451–4.

5. National Health Service. Delivering a 'Net Zero' National Health Service. 2020. https://www.england.nhs.uk/greenernhs/publication/delivering-a-net-zero-national-health-service/ (accessed 03/10/2022).

6. NHS Open Data Portal. Secondary Care Medicines Data (SCMD) - Open Data Portal BETA. https://opendata.nhsbsa.net/dataset/secondary-care-medicines-data (accessed 24/01/2023).

7. Lai H-C, Chan S-M, Lu C-H, Wong C-S, Cherng C-H, Wu Z-F. Planning for operating room efficiency and faster anesthesia wake-up time in open major upper abdominal surgery. *Medicine* 2017; **96**: e6148.

8. MacNeill AJ, Lillywhite R, Brown CJ. The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems. *Lancet Planetary Health* 2017; **1**: e381–8.

9. Watts N, Moonesinghe R, Foreman C. Putting anaesthetic emissions to bed: commitment on desflurane. 2023. https://www.england.nhs.uk/blog/putting-anaesthetic-emissions-to-bed (accessed 24/01/2023).

10. European Commission. *Proposal for a Regulation of the European Parliament and of the Council on Fluorinated Greenhouse Gases Amending Directive (EU) 2019/1937 and Repealing Regulation (EU) No 517/2014*. 2022.

11. McGain F, Muret J, Lawson C, Sherman JD. Environmental sustainability in anaesthesia and critical care. *British Journal of Anaesthesia* 2020; **125**: 680–92.

12. Devlin-Hegedus JA, McGain F, Harris RD, Sherman JD. Action guidance for addressing pollution from inhalational anaesthetics. *Anaesthesia* 2022; **77**: 1023–9.

13. Parker J. Barriers to green inhaler prescribing: ethical issues in environmentally sustainable clinical practice. *Journal of Medical Ethics* 2023; **49**: 92–8.

14. Yeung, Joyce, Jhanji, Shaman. VITAL - Volatile vs Total intravenous Anaesthesia for major non-cardiac surgery. 2022. https://warwick.ac.uk/fac/sci/med/research/ctu/trials/vital/ (accessed 09/01/2023).

15. Thaler RH, Sunstein CR. *Nudge: Improving Decisions about Health, Wealth, and Happiness*. New Haven, CT: Yale University Press, 2008: x, 293.

16. Kahneman D. *Thinking, Fast and Slow*. London: Allen Lane, 2011.

17. Gardiner SM. *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*. New York: Oxford University Press, 2011.

18. Jamieson D. *Reason in a Dark Time: Why the Struggle Against Climate Change Failed -- And What It Means for Our Future*. New York: Oxford University Press, 2014.

19. Caney S. Two kinds of climate justice: avoiding harm and sharing burdens. *Journal of Political Philosophy* 2014; **22**: 125–49.

20. Ariely D, Loewenstein G, Prelec D. Tom Sawyer and the construction of value. *Journal of Economic Behavior and Organization* 2006; **60**: 1–10.

21. Schubert C. Green nudges: Do they work? Are they ethical? *Ecological Economics* 2017; **132**: 329–42.

22. Meeker D, Linder JA, Fox CR et al. Effect of behavioral interventions on inappropriate antibiotic prescribing among primary care practices: a randomized clinical trial. *Journal of the American Medical Association* 2016; **315**: 562–70.

23. Patel MS, Volpp KG, Small DS et al. Using active choice within the electronic health record to increase influenza vaccination rates. *Journal of General Internal Medicine* 2017; **32**: 790–5.

24. Nikolaou CK, Hankey CR, Lean MEJ. Calorie-labelling: does it impact on calorie purchase in catering outlets and the views of young adults? *International Journal of Obesity* 2015; **39**: 542–5.

25. Dallas SK, Liu PJ, Ubel PA. Don't count calorie labeling out: calorie counts on the left side of menu items lead to lower calorie food choices. *Journal of Consumer Psychology* 2019; **29**: 60–9.

26. Zuegge KL, Bunsen SK, Volz LM et al. Provider education and vaporizer labeling lead to reduced anesthetic agent purchasing with cost savings and reduced greenhouse gas emissions. *Anesthesia and Analgesia* 2019; **128**: e97.

27. Wyssusek K, Chan KL, Eames G, Whately Y. Greenhouse gas reduction in anaesthesia practice: a departmental environmental strategy. *British Medical Journal Open Quality* 2022; **11**: e001867.

28. Hallsworth M, List J, Metcalfe R, Vlaev I. The behavioralist as tax collector: using natural field experiments to enhance tax compliance. 2014. https://www.nber.org/papers/w20007 (accessed 03/10/2022).

29. Johnson EJ, Goldstein D. Do defaults save lives? *Science* 2003; **302**: 1338–9.

30. Nimmo AF, Absalom AR, Bagshaw O et al. Guidelines for the safe practice of total intravenous anaesthesia (TIVA). *Anaesthesia* 2019; **74**: 211–24.

31. Kiefe CI, Allison JJ, Williams OD, Person SD, Weaver MT, Weissman NW. Improving quality improvement using achievable benchmarks for physician feedback: a randomized controlled trial. *Journal of the American Medical Association* 2001; **285**: 2871–9.

32. Schultz PW, Nolan JM, Cialdini RB, Goldstein NJ, Griskevicius V. The constructive, destructive, and reconstructive power of social norms. *Psychological Science* 2007; **18**: 429–34.

33. Halpern D. *Behavioural insights and healthier lives: VicHealth's inaugural Leading Thinkers Residency.* Victorian Health Promotion Foundation. 2016. https://www.bi.team/wp-content/uploads/2016/04/2016-Behavioural-Insights-and-Healthier-Lives.pdf (accessed 08/02/2023).

34. TRA$_2$SH. Why are we still using desflurane? https://www.tra2sh.org/refuse-desflurane (accessed 03/10/2022).

35. Thaler RH, Benartzi S. Save More Tomorrow™: using behavioral economics to increase employee saving. *Journal of Political Economy* 2004; **112**: S164–87.

36. Vlaev I, King D, Dolan P, Darzi A. The theory and practice of "nudging": changing health behaviors. *Public Administration Review* 2016; **76**: 550–61.

37. Hodson N. Commitment devices: beyond the medical ethics of nudges. *Journal of Medical Ethics* 2023; **49**: 125–30.

38. Bryan G, Karlan D, Nelson S. Commitment devices. *Annual Review of Economics* 2010; **2**: 671–98.

Caption for Figure

Figure 1: Monthly carbon-equivalent footprints associated with volatile anaesthetic agents in NHS England institutions, April 2018 to October 2022 [6]. Blue, desflurane; yellow, sevoflurane; purple, isoflurane. CO_2e, carbon dioxide equivalents (calculated by multiplying the mass of agent used by its 100-year global warming potential). Re-drawn from the Greener NHS Dashboard, with permission.