

How should institutions help clinicians to practice greener anaesthesia: First and second-order responsibilities to practice sustainably

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Abstract

There is a clear need for all industries, including healthcare, to reduce their greenhouse gas emissions. In anaesthetic practice, this not only requires a reduction in resource use and waste, but also a shift away from inhaled anaesthetic gases and towards alternatives with a lower carbon footprint. As inhalational anaesthesia produces greenhouse gas emissions at the point of use, achieving sustainable anaesthetic practice involves individual practitioner behaviour change. However, changing the practice of healthcare professionals raises potential ethical issues. The purpose of this paper is two-fold. First, we discuss what moral duties anaesthetic practitioners have when it comes to practices that impact the environment. We argue that behaviour change amongst practitioners to align with certain moral responsibilities must be supplemented with an account of institutional duties to support this. In other words, we argue that institutions and those in power have second-order responsibilities to ensure that practitioners can fulfil their first-order responsibilities to practice more sustainably. The second goal of the paper is to consider not just the nature of second-order responsibilities but the content. We assess four different ways that second-order responsibilities might be fulfilled in healthcare systems: removing certain anaesthetic agents, seeking consensus, education, and methods from behavioural economics. We argue that, whilst each of these are a necessary part of the picture, some interventions like nudges have considerable advantages.

Introduction

We are currently living with 1.2°C of global warming compared to the period before the industrial revolution [1]. The Intergovernmental Panel on Climate Change is clear that global warming must be limited to no more than 1.5°C to avoid catastrophe, and notes that achieving this target will require drastic reductions in greenhouse gas emissions [2]. Healthcare has a substantial carbon footprint, accounting for 4-5% of global greenhouse gas emissions[3,4]. In 2020 the National Health Service (NHS) in England became the first healthcare system in the world to commit to become 'carbon net zero' for emissions directly under its control by 2040 [5].

Medicines make up 25% of the NHS carbon footprint and are an important area for mitigation efforts [5]. All commonly-used inhalational anaesthetic agents are potent greenhouse gases with a global warming potential many times greater than that of carbon dioxide [6,7]. Volatile agents are thought to account for between 0.01-0.1% of all greenhouse gas emissions, with around 2% of the NHS carbon footprint coming from inhalational anaesthesia alone [7–9]. The NHS Long Term Plan has committed to transform anaesthetic practice, with a target to reduce the carbon footprint of anaesthetic gases by 40%. Ostensibly, this is an ambitious target, but it is achievable in the presence of widely available alternative techniques, including total intravenous anaesthesia (TIVA) and regional anaesthesia. [10–12].

Inhalational anaesthesia is considered a ‘low hanging fruit’ in healthcare decarbonisation: for almost all patients there would be no disadvantage if alternatives were used, and the atmospheric concentrations of greenhouse gases would decline. As safe and effective alternatives exist with a magnitude smaller expected climate-mediated harms, it seems obvious that practice should change. Despite recent reductions in the use of the worst offender as measured by global warming potential, desflurane; and evidence of increasing use of total intravenous anaesthesia in practice worldwide, the move away from inhalational anaesthesia generally has been patchy and inconsistent [13].

The lynchpin of sustainable anaesthetic practice is individual practitioner behaviour change because (i) greenhouse gas emissions occur at the point of use, and (ii) anaesthetists practice with a high degree of professional autonomy. This raises a question of how healthcare systems can change an individual’s practice ethically? In this paper we build on previous, more practically focused work, [REDACTED] to build on the ethical underpinnings of sustainable anaesthetic practice. We argue that focusing on individual responsibilities to undertake actions that reduce the environmental impact of their practice alone is insufficient to effect behaviour change. We argue that, for practical and moral reasons, individual duties need to be supplemented with an account of institutional responsibilities to support behavioural changes. The first part of the paper takes up the task of sketching an argument for first and second-order responsibilities that fall to individuals and institutions respectively. In the second part of the paper, we explore four different policy levers that *could* be implemented for institutions to fulfil their responsibilities: banning inhalational anaesthetics, reaching consensus, education, and nudges. We discuss the strengths and potential pitfalls of each. We argue that some combination of each of these approaches is likely to be necessary, but we emphasise the merits of some interventions, like nudges, over others, like banning certain options and educating practitioners.

First- and second-order responsibility

To help articulate and frame the problem, it is useful to distinguish first- and second-order responsibilities [14]. The political philosopher Simon Caney distinguishes these in terms of climate change as follows [14]:

“First-order responsibilities, as I employ that term, are responsibilities that certain agents have to perform (or omit) certain actions. In the context of addressing climate change these first-order responsibilities include responsibilities to mitigate climate change (through reducing emissions and maintaining greenhouse gas sinks)”

“Second-order responsibilities, by contrast, refer to responsibilities that some have to ensure that agents comply with their first-order responsibilities.”

Reducing the emissions from anaesthetic gases relies on individual anaesthetists changing their practice meaning that, in this context, first-order responsibilities essentially translate into the responsibilities that individual anaesthetists have. Second-order responsibilities, as we discuss in more detail further down, are structural and tend to fall to institutions and those with power to shape the contexts in which practice occurs.

First-order responsibilities

Doctors' individual responsibilities are usually conceived of in narrow terms, as exemplified by the General Medical Council (GMC), such as: maintaining competence, providing a good standard of care and putting the patient first [15]. Historically, the GMC's standards were usually interpreted as applying, primarily, to those directly under a doctor's care, and are situated within the UK's medicolegal framework. In August 2023, the GMC shared a draft update of *Good Medical Practice* to apply from 2024.[16] This included two clauses which relate to managing resources effectively and sustainably. These say that doctors should “choose sustainable solutions when you're able to, provided these don't compromise care standards... [and] consider supporting initiatives to reduce the environmental impact of healthcare”. Whilst this does clearly broaden the scope of doctors professional duties, it offers little practical guidance on how to marry environmental concerns, which have an intergenerational and international aspect, with caring for individual patients. In the case of anaesthesia, numerous techniques could all be seen to 'put the patient first' in one respect or another, even if they have vastly different environmental impacts and the GMC does not offer clarity on when choosing between these might be seen to compromise care standards. These points regarding climate

change are elaborated upon below. For now, it is apparent that the GMC guidance remains lacking in this area. We therefore turn to an alternative principle to determine anaesthetists first-order responsibilities.

Following on from previous work on environmentally sustainable prescribing, a doctor's first-order responsibility can be described as [17]:

Principle of environmental prescribing: Where two or more treatment options are considered equally safe and effective, the one with a lesser impact on the environment should be preferred.

When first elaborated, this principle was defended in consequentialist terms. Here, we want to be careful not to tether our arguments to consequentialism, or any particular moral theory for that matter. Rather, we defend this principle in terms that should be acceptable to most moral theories.

This principle bears striking resemblance to 'the duty of easy rescue', first articulated by Peter Singer. [18] The duty of easy rescue is a principle of beneficence. It essentially states that where we can do something good, at minimal cost, we are morally obligated to do so. Singer first argued for this in the context of global poverty, but it clearly applies elsewhere in practical ethics.[19–21] Others have pointed out that this is a minimal requirement of morality broadly construed and that such a principle should be acceptable within any, or at least most, moral theories. [19]

In this light, the principle of environmental prescribing can be thought of as a principle of *very easy rescue*, for it states that where two or more options have similar properties and make little difference to the patient, the one with the minimal environmental impact should be preferred. This principle recognises that greenhouse gas emissions are of instrumental value and so we should be neutral in the how we achieve a certain valuable goals in so far as the various methods are broadly comparable in terms of important properties like efficiency, likelihood of success, risk profile and side effects. Unlike the duty of easy rescue that proposes we should be prepared to accept small costs in the pursuit of significant benefits, the principle of environmental prescribing points to accepting essentially no costs, or at least minimal costs, in the pursuit of environmental benefits. Consequently, this principle is the absolute minimum that could be morally required of healthcare professionals (and patients) in thinking about healthcare's contribution to tackling climate change. This is as opposed to a maximal theory of healthcare professionals (and patients) obligations to tackle climate change. A maximal theory would include, *inter alia*, an account of professionals' obligations to future individuals, an

account of individuals global obligations, an account of how to balance distant individuals' interests against local interests of those in front of the professional.

A maximal account might be necessary when we consider healthcare's contribution to global warming and the nature of climate change as distributed phenomena, but articulating a full account of what doctors and patients are owed both locally and against what temporally and spatially distant others are owed when their interests are threatened by healthcare activities is clearly complex. This can be sidestepped for our purposes by relying on the minimum that can be morally required: a duty of (very) easy rescue. All this requires is that we accept that when doctors and patients make decisions, if there are methods of meeting their goals that in all the relevant ways aside from emissions are essentially interchangeable, then emissions should be the tie-breaker. Of course, others may wish to turn the dial, arguing that morality demands accepting greater burdens in the pursuit of mitigating climate change. Our arguments do not hinge on anything other than the moral minimum, so we do not consider this further.

We can now flesh out what this principle means for anaesthetists in practice. In cases where alternatives to inhalational anaesthesia, like TIVA or regional anaesthesia, are at least as appropriate as an inhalational technique, the choice should be based on the environmental impact.^δ General anaesthesia is typically maintained with the use of inhaled volatile anaesthetic agents, however recent years have shown a transition towards the increased use of TIVA [24,25], where general anaesthesia is instead maintained with continuous infusions of intravenous medications. This offers some well-established benefits to individual patients, including a reduced incidence of postoperative nausea and vomiting. Currently, there is no strong evidence to suggest that TIVA (when delivered in accordance with established national guidance [26]) is *inferior* to inhalational anaesthesia for any significant clinical outcome, but there are studies underway to determine if either is *superior*. [27] In the absence

^δ A peer reviewer raised a concern that minimal-flow anaesthesia, good agent husbandry and introduction of new technologies such as volatile capture technology, will bring a lifecycle analysis of inhalational anaesthesia with sevoflurane much closer to that of TIVA compared to that found by Sherman *et al.* [6] It is possible to provide inhalational anaesthesia with sub-0.5l/min fresh gas flow rates, however this is rarely reflected in practice because of the need to use higher flows at induction of anaesthesia, and the potential to forget to reduce flows later. [22] The best available recent lifecycle analysis by Hu *et al* still favours TIVA over minimal-flow volatile, but obviously this is by less of a margin than with a higher-flow of volatile anaesthetic. [11] The authors did find that volatile capture technology and minimal flow anaesthesia, used in combination, may push the carbon footprint of sevoflurane-based anaesthesia below that of TIVA and so Hu *et al*'s work may be considered a best case scenario. But it is worth considering volatile-capture technology is years away from being able to be widely adopted, requires system-wide procurement to implement (not behavioural-level interventions which we are concerned with), and the clinical evidence so far indicates that the proportion of volatile captured is much lower than the manufactures (or Hu *et al*'s analysis) had assumed. [23] We therefore maintain that Sherman *et al* present data that is closer to the realities of clinical practice and the main switch to reduce the carbon footprint of anaesthesia is away from inhalational agents.

of large-scale population studies showing inhalational anaesthesia is superior, we assume that for the majority of patients these are essentially interchangeable. Similarly, many studies have compared outcomes following regional anaesthetic techniques, such as spinal anaesthesia or brachial plexus block, to general anaesthesia in a variety of amenable surgeries. Whilst these studies investigate an extremely diverse population of patients, studies fail to show generalisable population-level benefits to general anaesthesia over regional alternatives.[28–32] In cases where alternatives to inhalational anaesthesia like TIVA or regional anaesthesia are equally suitable as compared to an inhalational technique, we argue that the choice should be based on minimising the environmental impact. Finally, it is worth noting that, in broad terms these techniques have similar economic costs, and may even be less for regional anaesthesia.

Second-order responsibilities

Second-order responsibilities are those that help ensure individuals comply with first-order responsibilities. In distinguishing these orders of responsibility, Caney argues that second-order responsibilities fall to those with the power or with the ability to undertake certain tasks required for compliance with first-order responsibilities.[14] Those tasks might include incentivisation, enablement, or the creation of certain norms that propagate appropriate behaviour. Caney's view is that combining these perspectives is more likely to be effective in meeting climate targets. Effectiveness in bringing about the necessary behaviour changes is of course pivotal; however our view is that there can also be certain barriers to achieving certain targets which would make it unfair to hold responsible individual anaesthetists responsible to for failing to comply with first-order responsibilities in the absence of second-order responsibilities. That is, it would be unfair to say that a certain anaesthetist is blameworthy for not opting for using a more environmentally sustainable technique where techniques are essentially interchangeable, if institutions have not taken action to enable these behaviours or make them less effortful.

As the principle of environmental prescribing is a minimal requirement of morality, and there are various greener options for anaesthesia, we might ask why there has not been wholesale practice change? Clearly practical barriers like availability of equipment for certain techniques are important. However, the peculiar features of human psychology and climate change make it particularly challenging to effect change. Human psychology evolved to enable cooperation in small groups faced with medium sized, visually perceived, and relatively immediate problems [33]. Climate change is nothing like this. Stephen Gardiner highlights various 'moral storms' that together make climate change a 'perfect moral storm' [34]. Individually, each factor provides a challenge to addressing

climate change. Collectively, the confluence of these factors makes it particularly difficult to effect individual behaviour change.

According to Gardiner, climate change presents a global storm, an intergenerational storm and a theoretical storm. In turn, these result from the unique features of climate change – fragmentation of agency, dispersion of cause and effect, and institutional inadequacy – that challenge effective climate action. Climate change is a truly global phenomena with the causes distributed across countless actors and the effects rarely being realised at the source of emissions. Indeed, the effects can persist across centuries, making it an intergenerational phenomenon. Moreover, our moral and political theories, and institutions are rarely designed to think in these terms or on these kinds of scales. This is highlighted by our earlier discussion of the GMC, but we could also point to the relatively narrow scope and timescales that healthcare operates on as also reflecting this. [35]

The perfect moral storm is a barrier to effecting sustainable change in healthcare.[36] It helps to explain why first-order responsibilities alone are inadequate, why it may be unfair to hold individuals responsible in the absence of certain supporting mechanisms and why practice change in anaesthesia has been slow. Even if anaesthetists know that inhaled agents are ‘bad’ from an environmental point of view, it can be challenging to change practice when the harms are so vague, distant, probabilistic, reliant on the behaviour of countless others and institutional action to support this is frequently lacking. 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. Practitioners failing to fulfil their first-order responsibilities and deferring to the status quo is understandable considering their evolved psychology and the perfect moral storm.

If first-order responsibilities are to be supplemented, we need to ask who the duty-bearers of second-order responsibilities are? We take the position that this could be various individuals and entities. In the case of healthcare, this could fall at the level of a healthcare system, to hospitals, departments, to hospital management, or to various groups of practitioners (like a royal college). To identify the relevant duty-bearer, one must establish who is well-placed to effect support for individual anaesthetists to practice sustainably. This is a question of which actors have the power to effectively ensure individual behaviour change.

Changing individual practice – fulfilling first-order responsibilities

To summarise the discussion thus far, we have outlined a first-order responsibility to minimise the carbon footprint of practice where this has little impact for patients. Largely, this entails moving away from inhalational anaesthesia, but as we mentioned in the introduction, this has been patchy in the NHS. We have therefore argued that first-order responsibilities ought to be supplemented by second-order responsibilities where those with the power to help incentivise, enable or create norms that ensure first-order responsibility compliance. Four ways those with power could support anaesthetists to shift their practice towards greener anaesthesia are: remove inhalational anaesthesia, seek consensus, provide education or use nudges. We consider the relative merits of each policy in turn, as well as pointing to some ethical and practical issues. We conclude that some combination of these policies is most likely to be most effective.

'Banning' inhalational anaesthetic agents

The first policy is to simply ban inhalational anaesthesia. If inhaled anaesthetic gases have a noteworthy contribution to global warming and do not offer significant advantages over the alternatives, it may be thought that they should be made unavailable in anaesthesia. A similar argument has been made regarding forms of inhalers which contain greenhouse gases – that they should be taken 'off the menu'. [37]

A similar strategy has already been set in motion in two of the nations of the UK for a specific volatile anaesthetic medication, desflurane, which has the highest global warming potential of any anaesthetic agent, and no clear evidence of clinical benefit. The most recent (2023/24) NHS Standard Contract states that NHS organisations in England must *"reduce appropriately the proportion of desflurane to all volatile gases used in surgery to 2% or less... with a view to eliminating use of desflurane altogether, except as permitted by Guidance, with effect from 31 March 2024"*. [38] In NHS Scotland, the procurement of desflurane via the NHS Supply Chain was halted in March 2023. [39]

These policies make behaviour change amongst anaesthetists extremely straightforward. If volatiles are unavailable, professionals are forced to change practice. As such, this policy is highly likely to be effective at bringing about behaviour change. To be most effective, the duty-bearer here ought to be highly centralised. For instance, in Scotland, NHS procurement goes through a single source, so if desflurane is unavailable from here the change is universal and complete. This kind of second-order responsibility is likely to be taken nationally, but it could also occur at higher levels, across the European Union for instance. [40]

Removing inhalational anaesthetic agents is potentially morally questionable because it bumps up against an anaesthetist's ability to select what they believe would be best for the clinical situation at hand. Taking away the *choice* of what anaesthetic agents individual professionals can use in the care of their patients may be seen as an infringement of their professional autonomy. Professionals, by virtue of being part of a profession, are oftentimes given a wide latitude to make decisions based on their knowledge, skills and expertise. Professions tend to be marked by a high degree of control over a highly specialised body of knowledge and expertise which is put to work benefitting society. This allows professionals certain privileges including that of the freedom to make certain decisions. [41] Typically, exceptions to professional autonomy in healthcare are: (a) that there is no evidence of benefit to a patient; (b) that the decision would harm the patient; or, (c) that the decision would be very costly. It is under (c) that banning volatiles might be considered a justified infringement of professional choice. However, (c) is typically seen as relating to particularly expensive treatments as part of priority setting. Whether the environmental costs justify infringing professional autonomy is a matter of ongoing debate; the decisions on desflurane in the English and Scottish NHS may mark a watershed moment in this respect.

One noteworthy facet is that, amongst medical professionals, anaesthetists enjoy a particularly high degree of professional autonomy. This is borne out of anaesthesia as a practice with relatively clearly defined goals that tend to be intermediate goals in service of some greater purpose like enabling surgery or some other procedure to occur safely and comfortably. General anaesthesia, for example, is often described in terms of a 'triad' of goals: narcosis, analgesia and relaxation, induced to facilitate a further intervention.[42] Within practice there are numerous ways of successfully achieving these, all of which might appear equally safe and high-quality from the perspective of a practitioner who is focussed on the patient under their care. As we have already described, there is scant evidence of the clinical superiority of any anaesthetic agent over another. Simultaneously, there is overwhelming evidence of the efficacy of all anaesthetic agents to achieve the primary goal of rendering the patient unconscious (the risk of accidental awareness under general anaesthesia is 1:19,000, and is almost entirely attributable to human error or equipment problems rather than 'failure' of anaesthetic drugs). [43] As such, this gives practitioners a high degree of control in comparison to other areas of practice where the goals may be fuzzier and more difficult to achieve, and the evidence base may be more directive in favour of a particular intervention. Our point is not that this degree of professional autonomy is morally justified, nor that it would make banning inhalational anaesthesia especially morally problematic. Rather, we wish to point out that where professionals are typically accustomed to a degree of professional autonomy, having this removed may cause frustration and upset.

With this in mind, the question is whether removing anaesthetic options is proportionate to what the policy is trying to achieve. Banning inhaled anaesthetic agents is likely to be most justified where removing an option has a marginal impact on practice. Removing desflurane only, for example, still leaves many options for anaesthetic practice – lower carbon volatiles like sevoflurane and isoflurane, TIVA, regional anaesthesia and so forth. Whereas, removing volatiles entirely much more substantially affects professional autonomy. Indeed, whilst the infringement of professional autonomy may be justified, especially where the impact for patients is minimal, it is worth noting that forcing anaesthetists to change their practice may have backfire effects by creating disgruntled practitioners. As such, it may actually lessen the effectiveness of what should otherwise be a highly effective policy.

A final concern about removing volatiles entirely is the degree to which they may have a small but important role in practice. The principle of environmental prescribing demands that individuals weigh the options, and where there is little or no difference to the patient, opt for the one with the minimal environmental costs. However, if volatiles are clearly superior for a patient (such as the inhalational induction of anaesthesia for a patient who needle-phobic). Then they should be preferred. Removing them entirely limits this option where wholesale banning of inhalational anaesthesia overlooks that, whilst in many cases inhalational anaesthesia is substitutable, this is not always the case, and there may be instances where professionals need freedom to determine which is the superior option. We also note that the immediate availability of a volatile anaesthetic agent provides a layer of safety, in case of a failure of TIVA equipment, for example. The concern then is that, in a minority of cases, the absence of volatiles entirely poses an excessive risk of harm. Even if, in certain circumstances infringement of professional autonomy might be proportionate and justified, it would still be superior if behaviour change could occur without resort to this. Hence a further condition of proportionality might be that other autonomy preserving options have failed.

Consensus

An alternative to enforcing a switch to greener anaesthetics is to seek consensus. In broad terms, consensus can be understood as a general agreement over some decision or course of action. In our case, seeking consensus regarding sustainable practice changes means there is a general agreement to follow the environmental prescribing principle. Of course, consensus is not the same as unanimity, where *all* agree, even if what we are looking for is unanimity in individuals following the principle. Furthermore, consensus should be distinguished from compromise. Daniel Weinstock describes compromise as, “a course of action that we view as a sub-optimal response to some issue that requires a collective response, but with which we can live, and which we at any rate consider as better than

the absence of an agreement.” [44] For Weinstock, consensus is stronger, for he sees it as, “all parties agree that the position agreed upon is superior to the one they held at the outset, with respect to the issue at hand.” [44] If effectiveness in meeting climate change targets in anaesthetic practice requires unanimity, then a consensus in anaesthetic practice will follow on Weinstock’s view. All agree to practice sustainably and in doing so intimately acknowledge that anything less than this is inferior, including forms of compromise.

A potentially fruitful distinction here is between an explicit and an implicit consensus. An explicit consensus occurs where the consensus is publicly agreed. This might entail a formal mechanism that brings stakeholders together to deliberate, discuss, perhaps even vote, and ultimately reach a consensus. In anaesthetic practice if, within a department, or perhaps a national professional association, all anaesthetists publicly agree to change their practice then this would be an explicit consensus. An implicit consensus, on the other hand, is where individuals all coordinate their behaviour and act similarly even if there has been no public declaration. To give an example to illustrate the distinction, imagine residents along a private cul-de-sac are concerned about the speed that some people drive along the street. One way to reducing speeding might be to hold a meeting, discuss how they should approach this and, via a vote, agree to reduce their speed. This would be an explicit consensus. Consider, instead, that one resident posts on the street’s group messaging service suggesting that all residents limit their speed to 10 miles per hour. This strikes the members of the group as a good idea, and so they all limit their speed. There is no discussion or explicit agreement to do this, but there is an implicit agreement demonstrated by them changing how they drive. Alternatively, a small group of residents could reach a partial consensus where just they agree to reduce their speed and, seeing the benefits, others follow suit. There is no further discussion or declaration on this, but a consensus has been reached as evidenced by their behaviour.

The main advantage of reaching an explicit consensus is that this negates the need for second-order responsibilities and raises no concerns about professional autonomy. If a relevant group of stakeholders come together to agree to change their practice, ensuring compliance is unnecessary as agreement alone is sufficient. Moreover, where consensus relies on agreement, in so far as agreement is voluntary, there can be no concern over professional autonomy. Explicit consensus, therefore, is the ideal. Nevertheless, the threat to consensus is dissent. Under ideal circumstances, individuals would agree to comply with the environmental principle as it is a minimum requirement of morality. But, of course, in reality, individuals may not agree with the principle nor comply with it. Various reasons could be offered: they may not think the environment is a relevant consideration in healthcare, they may feel there is insufficient evidence to support the benefit of

switching, they may have fears about changing their ingrained practices, it may simply be easier to turn to methods they have always relied on and so forth. The risk is that if an explicit consensus is necessary, its absence will derail the project of trying to bring about behaviour change. Indeed, this has been the experience of authors of this paper who are anaesthetists. Relying on an explicit consensus then will also have to provide an account of how to deal with disagreement and non-compliance. It is likely that whatever is suggested will raise issues for professional autonomy, not to mention departmental harmony.

What we are looking for then is an account that preserves professional autonomy and does not rely on explicit consensus to help anaesthetists make their practice more environmentally sustainable by choosing options which minimise environmental impact where this makes no difference to the patient in front of them. Whilst an explicit consensus is the ideal goal, recognising the non-ideal conditions in which practice change must occur including the peculiarities of anaesthetic practice, we consider how to move towards an *implicit* consensus, where there is universal behaviour change even if there hasn't been general or formal public agreement. One way to achieve this is through norm creation as demonstrated by the speeding example; here we consider how education and nudges, as forms of enablement and perhaps incentivisation might contribute to and even accelerate norm creations. As such, generating an implicit consensus through these mechanisms might itself be seen as a second-order responsibility.

Education

Education is a straightforward response to the problem we pose. It is simple, practical, and low-cost. Unsurprisingly, education has been a dominant response in attempting to bring about this much needed behaviour change [8,10,45]. The idea being that educating anaesthetists about the environmental impact of their practice and what they can do to help will empower and enable them to make different and better choices. The belief that presenting anaesthesia providers with the right evidence in the right way leads to a natural change in practice is mirrored elsewhere in the NHS sustainability agenda [46,47]. In the longer term, the thought is that if enough anaesthetists understand the environmental consequences of their practice and their responsibilities, the culture and norms around anaesthetic practice will also shift. In this way, education provides a route to implicit consensus. Education, then, represents a form of second-order responsibility because, firstly, it enables individuals to comply with their first-order responsibilities by ensuring they understand these and are aware of them, and indirectly in the longer term through norm creation. Clearly

education does not *force* anybody to change their practice and so poses no threats to professional autonomy.

The idea that evidence and education lead to behaviour change assumes a rational choice theory of human behaviour. This postulates that individuals weigh the costs and benefits of a decision in order to bring about the right outcome [48,49]. When planning an anaesthetic, the anaesthetist weighs the various pros and cons of each option primarily to maximise the good of the patient in front of them. Deciding to use inhalational anaesthesia over more sustainable alternatives like TIVA is seen to represent a failure to fully weigh the costs according to a rational choice theory. Once any knowledge gaps – like the threats posed by climate change and the carbon footprints of various anaesthetic options – are filled via education, the theory predicts that practical change follows axiomatically now individuals have the correct knowledge to weigh options appropriately.

There are two core problems with this model. The first is that there is an extensive body of research, beyond the scope of this paper, that demonstrates that humans are not rational in the way assumed by rational choice theory. In short, humans show bounded rationality and their decisions are frequently affected by in-built biases, limiting the utility of education [50–52]. Rational choice theory takes it that a failure to maximise certain aims is due to a deficit in information and knowledge, yet humans are known to predictably fail to *utilise* information appropriately because of limitations in our evolved psychology. Providing education to ensure the correct knowledge is only part of the picture if there is a risk that even if practitioners *know* what the right thing to do is, that they predictably failure operationalise that knowledge because of the nature of their human psychology. The second issue is that, even if humans were perfectly rational, the combination of the features of climate change discussed above and the perfect moral storm make it particularly resistant to motivating individual behavioural change.

The education strategy operates by imploring individuals to fulfil certain responsibilities by providing the appropriate knowledge but makes no concessions for the relevant psychological factors or to the nature of climate change; both of which pose a substantial barrier to change. Whilst education might be part of how healthcare organisations fulfil their second-order duties, it is clearly inadequate. That said, it is worth noting one important example of education as a second-order responsibility. If there are anaesthetists who are less familiar with using TIVA or regional techniques, it is important to ensure competence and confidence. Indeed, in the *2021 Curriculum for a CCT in Anaesthetics*, the Royal College of Anaesthetists incorporated TIVA into the first stage of training.[53] Education will have an important role in ensuring anaesthetists have the knowledge and skills to provide greener techniques

and institutions will be central in facilitating this. Nevertheless, having these pre-requisite abilities is insufficient to bring about the behaviour change we are primarily concerned with here. We suggest structural changes that mitigate the limits of human rationality as these are likely to succeed in helping anaesthetists to fulfil their individual responsibilities to bring about changes in practice.

Green nudges and sustainable practice

A large body of scholarship demonstrates how human biases can either drive harmful behaviours, or be leveraged to encourage individuals to make positive choices [48,49]. This approach – known as ‘nudging’ – has been replicated by ‘nudge units’ around the world [54].

Every decision occurs within a context. The various elements of that context, including but not limited to, the framing, timing or options presented, can subtly influence behaviour [48]. Taken together, these elements are known as the ‘choice architecture’. Many different ways to modify the choice architecture and alter the decisions individuals are likely to make or, put another way, to change the proportions of decision-makers who select each exist. Nudges harness individual bias and bounded rationality to draw individuals towards certain choices, whilst leaving alternatives open [55]. In this sense, changes to the choice architecture are importantly distinct from coercion. Nudges present a complement to traditional information-focused policies. Indeed, others have argued that changing the choice architecture through nudges is effective at bringing about environmentally-friendly behaviour change in society generally [56].

A key corollary of the choice architecture is that there is no neutral: every element within a choice architecture has implications for behaviour. [48] As the choice architecture has important implications for individual behaviour, those with power to shape the choice architecture have a second-order responsibility to make considered decisions about which behaviours to encourage, and which to discourage. Given every choice architecture encourages or discourages some options, this second-order responsibility impacts every choice. Those maintaining structures and systems – “choice architects” – should first decide which behaviours they want individuals to model and then build the choice architecture accordingly. If they wish to promote greener choices then choice architects should make changes to incentivise, enable, or create norms that increase the frequency of green choices. For example, one study on a university campus demonstrated a dramatic increase the proportion of students who recycled plastic cups simply by making the recycling bin larger and more prominent than the general waste bin [57].

In a similar way, when anaesthetists choose an anaesthetic technique, they do so within a choice architecture that may amplify behavioural biases that lead anaesthetists away from fulfilling their first-order responsibilities towards sustainability. For example, vaporisers (the devices that deliver volatile anaesthetics such as desflurane and sevoflurane) are generally topped-up by operating theatre staff and are permanently installed on every anaesthetic machine, whilst the target-controlled infusion (TCI) pumps and administration sets recommended for the safe delivery of TIVA are often in short supply or kept behind closed doors in equipment storerooms. As inhalational options are readily available this makes it much easier for anaesthetists: there is effectively a “default” nudge encouraging anaesthetists to select the more environmentally harmful option. However, by altering the choice architecture, healthcare organisations can fulfil their second-order responsibilities by making it easier for individual anaesthetists to make sustainable choices.

Imposing change by prohibiting certain approaches risks failure by making anaesthetists feel disenfranchised and threatening their professional choice. Understandably, departments often therefore seek to reach explicit consensus before implementing new policies. However, when agreement is unattainable it presents an obstacle to change. A significant advantage of nudges is that, while they encourage certain behaviours by making them easier, they do not prohibit alternatives, hence professional choice remains intact. Whilst 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.

Elsewhere, a number of nudges have been suggested: labelling, positioning green alternatives as the default, creating a departmental environment of pro-sustainable anaesthesia, peer comparison and social commitments.[58] As these shift the choice architecture, what is ultimately required is structural change. Again, these are second-order responsibilities that incentivise, enable or create certain norms that ensure individuals fulfil their first-order responsibilities. Changing this requires that those with the power to make these changes do so.

Conclusions

Efforts to address climate change require individuals and institutions to make changes, including to their behaviours. Changes aimed at individuals’ anaesthetic practice focus on the first-order responsibility that environmentally sustainable options should be preferred where they are otherwise clinically equivalent. There continues to be a widespread belief that bringing about the necessary

behaviour change is simply a case of providing training: armed with the facts, anaesthetists will become greener. Whilst informing doctors of the wider consequences of their practice and how they can change is of course valuable, it is insufficient. It is well-understood that humans are not perfectly rational and under certain conditions predictably fail to act in line with their first-order responsibilities. This is especially true with respect to climate change. In this paper we have responded to this problem by suggesting that second-order responsibilities should also be an area of focus and propose that nudges could help. These have the advantage of increasing the likelihood of behavioural change whilst granting anaesthetists the space to choose how to practice. It is also noteworthy that consensus should not be necessary to implement these changes. Whilst the nudges we suggest have evidence of effectiveness in multiple settings, further study in the specific context of anaesthetic practice is welcome and is an ideal basis for quality improvement work.

References

1. Allan RP, Cassou C, Chen D et al. Climate Change 2021: The Physical Science Basis. Summary for Policymakers. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom, 2021: 3–32.
2. IPCC, ed. Summary for Policymakers. *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-Industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. Cambridge: Cambridge University Press, 2022: 1–24.
3. 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. *The Lancet* 2021; **398**: 1619–62.
4. Lenzen M, Malik A, Li M et al. The environmental footprint of health care: a global assessment. *The Lancet Planetary Health* 2020; **4**: e271–9.
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 October 3, 2022).
6. Sherman J, Le C, Lamers V, Eckelman M. Life cycle greenhouse gas emissions of anesthetic drugs. *Anesthesia and Analgesia* 2012; **114**: 1086–90.
7. Sulbaek Andersen MP, Sander SP, Nielsen OJ, Wagner DS, Sanford TJ, Wallington TJ. Inhalation anaesthetics and climate change. *British Journal of Anaesthesia* 2010; **105**: 760–6.
8. McGain F, Muret J, Lawson C, Sherman JD. Environmental sustainability in anaesthesia and critical care. *British Journal of Anaesthesia* 2020; **125**: 680–92.

9. Slingo ME, Slingo JM. Climate impacts of anaesthesia. *British Journal of Anaesthesia* 2021; **126**: e195–7.
10. White SM, Shelton CL. Abandoning inhalational anaesthesia. *Anaesthesia* 2020; **75**: 451–4.
11. Hu X, Pierce JT, Taylor T, Morrissey K. The carbon footprint of general anaesthetics: A case study in the UK. *Resources, Conservation and Recycling* 2021; **167**: 105411.
12. McGain F, Sheridan N, Wickramarachchi K, Yates S, Chan B, McAlister S. Carbon Footprint of General, Regional, and Combined Anesthesia for Total Knee Replacements. *Anesthesiology* 2021; **135**: 976–91.
13. MacNeill AJ, Lillywhite R, Brown CJ. The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems. *The Lancet Planetary Health* 2017; **1**: e381–8.
14. Caney S. Two Kinds of Climate Justice: Avoiding Harm and Sharing Burdens. *Journal of Political Philosophy* 2014; **22**: 125–49.
15. General Medical Council. Good Medical Practice. 2013. https://www.gmc-uk.org/-/media/documents/good-medical-practice---english-20200128_pdf-51527435.pdf?la=en&hash=DA1263358CCA88F298785FE2BD7610EB4EE9A530.
16. General Medical Council. Good Medical Practice 2024. 2023. <https://www.gmc-uk.org/ethical-guidance/good-medical-practice-2024>.
17. Parker J. Barriers to green inhaler prescribing: ethical issues in environmentally sustainable clinical practice. *Journal of Medical Ethics* 2022: medethics-2022-108388.
18. Singer P. Famine, Affluence, and Morality. *Philosophy and Public Affairs* 1972; **1**: 229–43.
19. Giubilini A, Douglas T, Savulescu J. The Moral Obligation to Be Vaccinated: Utilitarianism, Contractualism, and Collective Easy Rescue. *Medicine, Health Care and Philosophy* 2018; **21**: 547–60.
20. Savulescu J. Future People, Involuntary Medical Treatment in Pregnancy and the Duty of Easy Rescue. *Utilitas* 2007; **19**: 1–20.
21. Giubilini A, Douglas T, Maslen H, Savulescu J. Quarantine, Isolation and the Duty of Easy Rescue in Public Health. *Developing World Bioethics* 2018; **18**: 182–9.
22. Pinder A, Eusuf D, Gardner AL et al. Carbon footprinting of anaesthetic practice - the need to consider work as done. *Resources, Conservation and Recycling* 2021; **173**: 105743.
23. Hinterberg J, Belfart T, Gabriel A et al. Efficiency of inhaled anaesthetic recapture in clinical practice. *British Journal of Anaesthesia* 2022; **129**: e79–81.
24. Watts N, Moonesinghe R, Foreman C. NHS England » Putting anaesthetic emissions to bed: commitment on desflurane. 2023.

<https://www.england.nhs.uk/blog/putting-anaesthetic-emissions-to-bed/> (accessed January 24, 2023).

25. Kane AD, Soar J, Armstrong RA et al. Patient characteristics, anaesthetic workload and techniques in the UK: an analysis from the 7th National Audit Project (NAP7) activity survey. *Anaesthesia* 2023; **78**: 701–11.

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

27. 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 January 9, 2023).

28. Miller D, Lewis S, Pritchard M et al. Intravenous versus inhalational maintenance of anaesthesia for postoperative cognitive outcomes in elderly people undergoing non-cardiac surgery. *Cochrane Database of Systematic Reviews* 2018; doi 10.1002/14651858.CD012317.pub2.

29. Chhabra A, Chowdhury AR, Prabhakar H et al. Paravertebral anaesthesia with or without sedation versus general anaesthesia for women undergoing breast cancer surgery. *Cochrane Database of Systematic Reviews* 2021; doi 10.1002/14651858.CD012968.pub2.

30. Guay J, Parker MJ, Gajendragadkar PR, Kopp S. Anaesthesia for hip fracture surgery in adults. *The Cochrane Database of Systematic Reviews* 2016; **2**: CD000521.

31. Afolabi B, Lesi F. Regional versus general anaesthesia for caesarean section. *Cochrane Database of Systematic Reviews* 2012; doi 10.1002/14651858.CD004350.pub3.

32. Jones L, Craven P, Lakkundi A, Foster J, Badawi N. Regional (spinal, epidural, caudal) versus general anaesthesia in preterm infants undergoing inguinal herniorrhaphy in early infancy. *Cochrane Database of Systematic Reviews* 2015; doi 10.1002/14651858.CD003669.pub2.

33. Jamieson D. *Reason in a Dark Time: Why the Struggle Against Climate Change Failed -- And What It Means for Our Future*. Oup Usa, 2014.

34. Gardiner SM. *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*. Oup Usa, 2011.

35. Munthe C, Fumagalli D, Malmqvist E. Sustainability principle for the ethics of healthcare resource allocation. *Journal of Medical Ethics* 2021; **47**: 90–7.

36. Wardrope A. Health justice in the Anthropocene: medical ethics and the Land Ethic. *Journal of Medical Ethics* 2020; **46**: 791–6.

37. Herlitz A, Malmqvist E, Munthe C. ‘Green’ bioethics widens the scope of eligible values and overrides patient demand: comment on Parker. *Journal of Medical Ethics* 2023; **49**: 100–1.

38. NHS England. *NHS Standard Contract 2023/24: Service Conditions (Full Length)*., 2023.
39. NHS Scotland. NHS Scotland first in world to 'clean up' anaesthetic gases. 2023. <https://www.nhscfsd.co.uk/news/nhs-scotland-first-in-world-to-clean-up-anaesthetic-gases/> (accessed July 2, 2023).
40. 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.
41. Hoogland J, Jochemsen H. Professional autonomy and the normative structure of medical practice. *Theoretical Medicine and Bioethics* 2000; **21**: 457–75.
42. Rees GJ, Gray TC. Methyl-n-propyl ether. *British Journal of Anaesthesia* 1950; **22**: 83–91.
43. NAP5. Accidental awareness during general anaesthesia in the United Kingdom and Ireland. *Journal of the Royal College of Physicians of Edinburgh* 2014; **44**: 289–90.
44. Weinstock D. Compromise, pluralism, and deliberation. *Critical Review of International Social and Political Philosophy* 2017; **20**: 636–55.
45. Devlin-Hegedus JA, McGain F, Harris RD, Sherman JD. Action guidance for addressing pollution from inhalational anaesthetics. *Anaesthesia* 2022; **77**: 1023–9.
46. Dobson J, Cook S, Frumkin H, Haines A, Abbasi K. Accelerating climate action: the role of health professionals. *BMJ* 2021; **375**: n2425.
47. Maxwell J, Blashki G. Teaching About Climate Change in Medical Education: An Opportunity. *Journal of Public Health Research* 2016; **5**: 673.
48. Thaler RH, Sunstein CR. *Nudge: Improving Decisions about Health, Wealth, and Happiness*. New Haven, CT, US: Yale University Press, 2008:x, 293.
49. Kahneman D. *Thinking, Fast and Slow*. Macmillan, 2011.
50. Brown G, Hagen DA. Behavioral economics and the environment. *Environmental and Resource Economics* 2010; **46**: 139.
51. Van Den Bergh JC, Ferrer-i-Carbonell A, Munda G. Alternative models of individual behaviour and implications for environmental policy. *Ecological Economics* 2000; **32**: 43–61.
52. Thaler RH, Ganser L. *Misbehaving: The making of behavioral economics*. 2015.
53. Royal College of Anaesthetists. 2021 Curriculum for a CCT in Anaesthetics. 2021. <https://www.rcoa.ac.uk/sites/default/files/documents/2023-02/2021%20Curriculum%20for%20a%20CCT%20in%20Anaesthetics%20v1.1.pdf>.
54. Halpern D. *Inside the Nudge Unit: How Small Changes Can Make a Big Difference*. Random House, 2015.

55. Ariely D, Loewenstein G, Prelec D. Tom Sawyer and the construction of value. *Journal of Economic Behavior & Organization* 2006; **60**: 1–10.
56. Schubert C. Green nudges: Do they work? Are they ethical? *Ecological economics* 2017; **132**: 329–42.
57. Cosic A, Cosic H, Ille S. Can nudges affect students' green behaviour? A field experiment. *Journal of Behavioral Economics for Policy* 2018; **2**: 107–11.
58. Green nudges for sustainable anaesthetic practice: institutional support to make individual change easier - Parker - *Anaesthesia* - Wiley Online Library. <https://associationofanaesthetists-publications.onlinelibrary.wiley.com/doi/10.1111/anae.15991> (accessed June 21, 2023).