

with better evidence, education, and advocacy. Furthermore, although surgical activity has declined during the pandemic, there is likely to be a rebound increase in resource use and waste as the backlog of elective surgical cases is addressed.

Conversely, other trends could well improve environmental sustainability in anaesthesia. Several authors have advocated the clinical, financial, and environmental benefits of regional anaesthesia over general anaesthesia during the pandemic and into the future,<sup>3,4</sup> and there is evidence that practice is already changing in this direction (e.g. in hip fracture repair).<sup>3–6</sup> Similarly, greater familiarity with use of i.v. infusions of sedatives and opioids during secondment to critical care could yield environmental benefits if clinicians go on to administer total i.v. anaesthesia more commonly.

Innovating more widely, the pandemic might stimulate, for example, multidisciplinary reconsideration around the use of finite healthcare resources (e.g. by rationalising preoperative investigations<sup>7</sup>); wider use of telemedicine (e.g. in assessment and follow-up clinics); closer engagement with colleagues in infection control when designing single-use equipment, packaging, and infection protocols; development of online education resources; and partnership with industry.<sup>8</sup> All of these aim to minimise travel and optimise resource management, whilst maintaining or improving the quality of patient care and experience.

COVID-19 is an ongoing global disaster, but tragedy can lead to innovation and opportunity. Internationally, anaesthetists need to engage urgently and comprehensively in a consensus environmental research and implementation agenda. With this in mind, is the current ‘anthropopause’ likely to have a positive or a negative effect on environmental processes and behaviours in anaesthesia? And what are the most important opportunities for advancing environmentally sustainable healthcare arising from the COVID-19 pandemic? These are not only questions for the authors, but priorities for the profession to address as we emerge from COVID-19.

## Declarations of interest

The authors declare that they have no conflicts of interest.

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## Effects of the COVID-19 pandemic on environmental sustainability in anaesthesia. Response to *Br J Anaesth* 2021;126:e118–e119

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Editor—We thank White and Shelton<sup>1</sup> for their interest in our review article in the *British Journal of Anaesthesia*,<sup>2</sup> and for enquiring whether the current *anthropopause* as a result of coronavirus disease 2019 (COVID-19) is likely to have positive or negative effects on environmentally sustainable practices in anaesthesiology.

### Positive and negative environmental effects of COVID-19

The *Anthropocene* epoch is used to describe the most recent period of Earth's history, when human activity first began to have significant impact on the planet's biosphere, hydrosphere, lithosphere, and atmosphere.<sup>3</sup> The Rockefeller Commission recently noted in *Safeguarding Human Health in the Anthropocene Epoch* that 'we have been mortgaging the health of future generations to realise economic and development gains in the present by unsustainably exploiting nature's resources'.<sup>3</sup> Humanity is exceeding Earth's resource capacity, and the wealthiest nations are disproportionately consuming more resources than poorer ones.

The COVID-19 pandemic has markedly constrained society's travel, production, and resource consumption. This COVID-19 *anthropopause* has led to a worldwide reduction in greenhouse gas emissions by almost 9% for the first half of 2020 compared with 2019.<sup>4</sup> Is this a silver lining to an otherwise worldwide tragedy? Consider though that worldwide greenhouse gas emissions need to fall by 7.5% *each and every year* for this decade if we are to have any hope of meeting the stark warning of the Intergovernmental Panel on Climate Change to limit average surface temperature rise by no more than 1.5°C above pre-industrial levels by 2050<sup>5,6</sup> to avoid the collapse of civilisation as we know it by the end of this century.

Table 1 summarises actual and potential positive and negative effects upon the environment that the COVID-19 pandemic has had that are relevant to anaesthetists and critical care physicians, our professions, and healthcare delivery. There are many unknowns, but most importantly (i) positive and negative effects will occur across several domains, (ii) changing our behaviour is vital to achieving environmentally sustainable workplaces, and (iii) COVID-19 has shown us that rapid global transformation of society is possible if people work together and will it so. We can face the existential challenges of climate change and environmental degradation with as much verve as many nations have faced the COVID-19 pandemic.

### Psychological and moral effects of COVID-19-associated waste

Beyond the human tragedy, the COVID-19 pandemic has been an alarming environmental disaster, most noticeable through both surges in demand and service interruptions, leading to shortages of the single-use disposable personal protective equipment (PPE) that we depend on and mountains of their physical waste. Whilst PPE is essential for protecting clinicians, many of us go through cognitive dissonance, remarking that one can easily use dozens of single-use plastic gowns, surgical and respirator face masks,

and hundreds of gloves for one patient with COVID-19 (suspected or actual) per shift whilst experiencing shortages and facing ecosystem collapse.<sup>9</sup>

It is surprising how often each of us has heard our clinical colleagues note that the COVID-19 pandemic has made us realise how wasteful we are now that we have experienced our own vulnerability to medical supply shortages. The fallacy of unlimited resources for rich healthcare settings has been lifted. We realise our need to prepare for shortages of oxygen, i. v. fluids, drugs, and medical devices. We need to review and revise regulations and protocols that drive wasteful practices to preserve resources and meet basic anaesthetic requirements for the most people possible. It is necessary to focus on restoring the foundational elements that support minimal needs. Locally made, robust, reusable medical equipment shifts healthcare away from a linear 'take–make–waste' high-carbon economy towards the circular economy that keeps materials in use as long as possible and eliminates waste.<sup>10</sup> An environmentally sustainable healthcare system is resilient, financially responsible, and ethical.

We believe we have a moral obligation to conserve resources, always. Further discussion by national and world medical bodies (e.g. WHO and the World Federation of Societies of Anaesthesiologists) to harmonise and provide basic criteria worldwide, defining what resource conservation is best practice, is challenging but plausible and necessary to ensure equitable, universal access to basic healthcare in accordance with the United Nations Sustainable Development Goals.

### Infection prevention: collaborating with others

COVID-19 has revealed the necessity of engaging with our infection prevention and control colleagues to consider best infection prevention practice, whilst considering environmental repercussions and supply chain resilience. The default for infection prevention is routinely 'single use is better'; yet, we must address protection of both the patient and public health, including preservation of resources and pollution prevention.<sup>11,12</sup> Antimicrobial stewardship, now a mainstream part of infectious diseases, exists to protect the patient and the people. Why is overconsumption of single-use disposable medical supplies any different? Could we research ways to protect the patient and healthcare workers without sacrificing our environmental health, or unfairly competing for limited resources? Such a pathway opens many opportunities to collaborate in fields as disparate as anaesthesia, infectious diseases, materials science, supply chain management, medical anthropology, and behavioural sciences.

### Post-COVID-19: an opportunity to accelerate to carbon net zero

Advocating for more environmentally sustainable anaesthesiology and critical care, both as individuals and as members of professional societies, is vital to a resilient, sustainable

**Table 1** Effects of coronavirus disease 2019 (COVID-19) on environmental anaesthesiology. PPE, personal protective equipment.

Negative environmental effects of COVID-19	Positive environmental effects of COVID-19
<p><b>Behaviour</b> Maximal effort and resources to combat COVID-19, regardless of environmental costs Fear-based excessive consumption, even as evidence became available to the contrary</p>	<p>Greater awareness of need for and efforts to conserve resources Innovation on safe extended/reuse of some medical devices (notably PPE)</p>
<p><b>Patient care</b> Initially, high intubation and critical care rates for COVID-19 patients, leading to increased consumption of single-use disposable supplies and anaesthetic drugs, with associated environmental emissions</p>	<p>Avoiding intubation with greater reliance on noninvasive ventilation, and high-flow O<sub>2</sub> is often better for patients and preserves resources Use of dexamethasone reduces length of/need for critical care</p>
<p><b>Virtual telehealth visits and meetings</b> Increased technological and energy requirements Decreased access for low-income patients and family Ongoing need for pre-admission investigations (virology swabs, blood, and imaging)</p>	<p>Reduced travel with reduced emissions and more time for other activities/improved quality of life for patients and staff<sup>7</sup> Increased access to (specialist) care for those in rural communities and with impaired mobility Social investments to distribute electronics and internet access, and improve access to health services</p>
<p><b>Postponed non-emergency surgery</b> Impaired quality of life (untreated cancer, pain, and mobility impairments), psychosocial impacts (anxiety/depression), and financial strains (lost vocational activity)</p>	<p>Fewer elective cases caused some patients to question need for/cancel elective surgery altogether, reducing procedure environmental emissions A new focus on preventive medicine (diet, exercise, and stress reduction) rather than surgical cure may improve health and wellness</p>
<p><b>COVID-19 PPE</b> Dramatic increase in consumption of PPE and increased solid waste generation Increasing demand for negative-pressure rooms with higher air exchange rates compared with standard rooms (leading to increased energy consumption) Increased use of chemical disinfectants, with terrestrial and water pollution and occupational exposures Halting of waste segregation efforts and overtreating waste as biohazardous</p>	<p>Extending the use of single-use disposable PPE conserves resources and reduces environmental emissions Reprocessing single-use disposable respirators and impermeable gowns Shifting to reusable PPE, such as respirators (elastomeric P100s, powered air-purifying respirators, etc.) and reusable impermeable and contact precaution gowns Use of steam/mechanical cleaning procedures in lieu of chemical disinfectants Rapid research and protocol development for safe reprocessing and reuse of PPE marked as single use<sup>8</sup></p>
<p><b>Other COVID-19 waste</b> Increased mandate for single-use disposable equipment (gowns, hats, laryngoscope blades and handles, etc.) Shortages of single-use equipment, leading to extended use/reuse of single-use disposables Single-use food and drink packaging and utensils</p>	<p>Development of safe protocols to extend use of/reprocess medical devices marked as single use and reduce their waste Societal norms challenging the need to use disposable packaging and to treat as biohazardous/clinical waste</p>
<p><b>Resilience</b> Surges in patients with respiratory failure, leading to ventilator and i.v. sedative shortages Emergency use of anaesthesia machines and inhaled anaesthetics, leading to excessive consumption of CO<sub>2</sub> absorbers necessitating high-flow anaesthesia</p>	<p>Revision of ICU protocols on i.v. drug and tubing changeovers to minimise drug waste Augmented local manufacturing leading to reduction of 'carbon miles' for transportation and improved supply chain resilience</p>
<p><b>Research</b> Distraction from all other non-COVID-19 research, including environmentally sustainable anaesthesiology No planning for a circular economy</p>	<p>Recognition of the value of reusable medical devices from both a supply chain resiliency and environmental sustainability perspective Innovation to conserve resources, including policies to reduce waste and safely reclaim and reuse materials</p>

healthcare system post-COVID-19. We would like to commend the very recently announced National Health Service (NHS) commitment to achieving 'net zero' greenhouse gas emissions by 2040.<sup>13</sup> The NHS net zero 2040 plan is grand in its stated

aims, requires substantial upfront investment, is likely fraught with potential setbacks and halfway achievements, and will be challenging to maintain with required enthusiasm and dedication. Yet, if humanity is to reach a safe(r) climate, a

net zero plan is necessary for every nation's healthcare system, particularly the wealthier nations that contribute disproportionately more to global environmental emissions.

COVID-19 has taught us that in the face of imminent disaster, we can abruptly mobilise vast sums of money, alter behaviours of the majority of the populace, and prepare healthcare systems for the worst. Compared with this pandemic, a decade is a very long time to transition to a sustainable economy and avert the worst anticipated impacts from climate change.<sup>14</sup> Anaesthetists and critical care physicians can continue to serve as leaders in the path to a healthier, environmentally sound pandemic recovery. To paraphrase Rabbi Hillel, 'If not us, who? If not now, when?'

## Declarations of interest

The authors declare that they have no conflicts of interest.

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## Impact of an aerosol box on time to tracheal intubation: systematic review and meta-analysis

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