Healthcare in the era of climate change and the need for environmental sustainability

Nicholas Chin Hock Tee[1,2,3,4], MRCP, Jo-Anne Yeo[2,5], MBBS, FANZCA, Mahesh Choolani[3,6], PhD, FRCOG, Kian Keong Poh[3,7], FRCPEd, FACC, Tiing Leong Ang[1,2,3,4], FRCPEd, FAMS

[1]Department of Gastroenterology and Hepatology, Changi General Hospital, [2]Duke-NUS Medical School, [3]Yong Loo Lin School of Medicine, National University of Singapore, [4]Lee Kong Chian School of Medicine, Nanyang Technological University, [5]Department of Anaesthesia and Surgical Intensive Care, Changi General Hospital, [6]Department of Obstetrics and Gynaecology, National University Hospital, [7]Department of Cardiology, National University Hospital, Singapore

Abstract

Climate change is an existential threat to humanity. While the healthcare sector must manage the health-related consequences of climate change, it is a significant contributor to greenhouse gas emissions, responsible for up to 4.6% of global emission, aggravating global warming. Within the hospital environment, the three largest contributors to greenhouse gas emissions are the operating theatre, intensive care unit and gastrointestinal endoscopy. Knowledge of the health-related burden of climate change and the potential transformative health benefits of climate action is important to all health professionals, as they play crucial roles in effecting change. This article summarises the available literature on the impact of healthcare on climate change and efforts in mitigation, focusing on the intrinsic differences and similarities across the operating theatre complex, intensive care unit and gastrointestinal endoscopy unit. It also discusses strategies to reduce carbon footprint.

Keywords: Anaesthesia, climate change, gastrointestinal endoscopy, healthcare, sustainability

INTRODUCTION

Anthropogenic climate change has significant effects on the environment and human health. The reliance of the global energy system on fossil fuels and vast deforestation contributes a major part to greenhouse gas (GHG) emissions and global warming. The highest global temperature in history to date was recorded in 2023. At the current ten-year mean temperature of 1.14°C above preindustrial level, global warming and climate change pose an existential threat to humanity.[1] The anticipated local impact from global warming was highlighted in Singapore's 3rd National Climate Change Study, with very hot days (>35°C) expected to rise from 21 days annually to between 41 and 351 days by 2100.[2] The direct health impact of climate change includes heat and extreme weather-related health effects, whilst indirect effects include food insecurity and undernutrition, mental health stress and changing climactic conditions predisposing to transmission of infectious diseases.[1] Fossil fuels also cause air pollution, which increases the risk of respiratory and cardiovascular diseases, cancer, diabetes mellitus, neurological disorders and adverse pregnancy outcomes.[1,3] Beyond this, deforestation, water and soil pollution by plastic, medications and medical waste by-products impact ecosystems and eventually, health outcomes.

The Paris Agreement is an international treaty on climate change, with the participating countries pledging to reduce their contribution to GHG emissions through a series of action plans known as Nationally Determined Contributions.[4] The aim is to reduce and maintain GHG emissions at net zero by the middle of the century. However, global measures to curb GHG emissions remain inadequate. Health was highlighted as a key theme during the 28th Conference of the Parties to the United Nations Framework Convention on Climate Change, which brought into focus the impact of climate change on global health and the importance of focusing on the climate change–health nexus, rather than climate change in isolation.[5]

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Correspondence: Prof. Tiing Leong Ang, Clinical Professor, Department of Gastroenterology and Hepatology, Changi General Hospital, 2 Simei Street 3, 529889, Singapore. E-mail: ang.tiing.leong@singhealth.com.sg

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The energy sector is responsible for 75% of GHG emissions.[6] Fossil fuels contributed 80% of global energy use in 2022.[1] It is crucial to transition away from fossil fuels to renewable energy. There is an urgent need for definitive action by all stakeholders, whether at the international, national or individual level. Apart from targeting the energy sector, efforts must be made to ensure that all sectors reduce GHG emissions. While the healthcare sector must manage the health-related consequences of climate change, it also contributes to GHG emissions.[7] The global healthcare sector had a climate footprint of 2 billion carbon dioxide equivalent (CO_{2e}), about 4.6% of GHG emissions.[1] Overall, if the healthcare sector were a nation, it would be the fifth largest polluter in the world.[8] In response, the World Health Organization and professional organisations have issued recommendations for environmentally sustainable healthcare.[9-15] Healthcare professionals can play an important role in mitigating and adapting to climate change and improving health. This can be achieved through changing practices at the individual and organisational levels to reduce GHG emissions, as well as through advocacy and engagement of important stakeholders and policymakers to shape healthcare policies and improve environmental and socioeconomic conditions.

This narrative review provides a broad overview and summarises the available literature on the impact of healthcare on climate change and efforts in mitigation, focusing on the operating theatre (OT), which encompasses anaesthesia and surgery, intensive care unit (ICU), as well as gastroenterology and gastrointestinal (GI) endoscopy. These areas have the most significant impact on the environment in the hospital setting. The OT complexes are a disproportionate contributor to a hospital's carbon footprint, with utilisation of three to six times more energy and consumables than other areas within the hospital, and they are responsible for 20%–40% of a hospital's waste.[16-19] In addition, there are direct contributions to GHG emissions by anaesthetic gases and indirect contributions due to pre-, peri- and post-surgical processes.[16] The ICU is energy and resource intensive and generates significant waste.[20] The clinical burden of gastroenterological and liver disorders is high, and the management of these disorders often involves radiological imaging, endoscopy and surgery. All these factors contribute to a significant carbon footprint.[19] Gastrointestinal endoscopy ranks third in terms of generation of hospital waste, after the OT and ICU.[21] This review also highlights the common strategies that can be applied across the healthcare sector to reduce carbon footprint for environmental sustainability. Definitions of common technical terms are provided in Box 1.

Box 1. Key definitions.

1. **GHGs:** GHGs represent the critical link between human activities and global temperature increases due to the impact on energy retention in the atmosphere. Carbon dioxide (CO_2) represents the major contributor to all GHGs, while other gases that contribute to the 'greenhouse effect' are methane, nitrous oxide and fluorinated gases (including all anaesthetic gases). CO_2 equivalent (CO_{2e}) of a gas reflects its GWP relative to CO_2.
2. **GWP:** GWP is a metric commonly used in national and international agreements to assess the potential contribution of a GHG to climate change. The time horizon of 20 years (GWP_{20}), 100 years (GWP_{100}) or even 500 years (GWP_{500}) could be used as standard timeframes of reference, directed by the choice of focus on short-term, medium-term or long-term impact. IPCC uses GWP_{100} for standard comparisons of longer-lived effects. GWP is a function of both the radiative efficiency and atmospheric lifetime of a GHG. CO_2 is defined as having a GWP of 1. The CO_2 equivalent of an anaesthetic gas is calculated by multiplying the mass of gas (kg) with its GWP.
3. **Life cycle assessment:** This is an analytical tool that captures the overall environmental impact of a product, process or human activity throughout its life cycle. A full life cycle includes all phases from raw material acquisition through production and use, to disposal in a 'cradle-to-grave' model. ISO has provided a general framework for conducting a life cycle assessment, which includes goal setting, inventory analysis, impact assessment and interpretation to derive conclusion, recommendations and decision-making in accordance with the goal set.
4. **Carbon footprint:** Carbon footprint is the measure of the total amount of GHG emissions caused directly and indirectly by an individual, event organisation or product. It is quantified in research as kilograms of CO_{2e} released, a common unit of measurement of GWP during life cycle assessment.
5. **Scopes of GHG emissions:** Three 'scopes' (scope 1–3) have been defined primarily for GHG emission accounting and reporting purposes. Scope 1 is defined as direct GHG emission that occurs from sources that are owned or controlled by the organisation, for example, emissions from fuel combustion in owned or controlled boilers, furnaces, vehicles, as well as emissions from chemical production in owned or controlled process equipment. Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the organisation, which physically occur at the facility where electricity is generated. Scope 3 comprises all other indirect emissions that occur because of the activities of the organisation, but from sources not owned or controlled by the organisation. Some examples of scope 3 activities are manufacturing, processing, packaging and transportation of purchased products by an organisation.

GHG: greenhouse gas, GWP: global warming potential, IPCC: Intergovernmental Panel on Climate Change, ISO: International Organization for Standardization

IMPACT OF HEALTHCARE ON CLIMATE CHANGE

Operating theatre

The scope of GHG emissions from OT includes anaesthetic gases, CO_2 canisters used for insufflation (scope 1), energy usage, of which 90%–99% is from heating, ventilation and air conditioning (HVAC) systems (scope 2), as well as surgical supply chain and surgical waste (scope 3).[22]

All anaesthetic gases are potent GHGs. Waste anaesthetic gas is expired from the patient unchanged, scavenged from the OT and vented directly to the atmosphere. The two most used inhalational anaesthetics are sevoflurane and desflurane, while nitrous oxide (N_2O) is an analgesic or an adjuvant gas. The estimated 100 years global warming potential (GWP_{100}) of N_2O is 273, compared to 2590 for desflurane and 144 for sevoflurane. Beyond its GWP, which is almost double that of sevoflurane, N_2O is also responsible for most ongoing ozone depletion.[23] However, it has been estimated that anaesthetic N_2O use is responsible only for 1%–3% of worldwide N_2O emissions. For volatile general anaesthetics, based on mass, desflurane is almost 18 times more harmful than sevoflurane in terms of CO_{2e} emissions.[24] However, in measuring the carbon footprint of anaesthetic gases, one cannot simply consider GWP in isolation, but must also consider the clinical potency of the agent and the fresh gas flow (FGF) for delivery. The higher the FGF used, the more volatile anaesthetics will be used. Desflurane is also three times less potent than sevoflurane, thus requiring a larger volume for the same clinical effect. When considering clinically effective anaesthetic doses and similar FGF rates, the CO_{2e} emission of a general anaesthetic when N_2O was used as an adjuvant was about 10 and 20 times greater than that of isoflurane or sevoflurane, respectively, while the CO_{2e} emission for desflurane alone was 25–45 times greater than that of isoflurane or sevoflurane.[24] A study by Vollmer *et al*. estimated that desflurane contributed 80% of greenhouse effect from all measured volatile anaesthetic pollution (3 million tonnes of CO_{2e} per annum). The study also excluded that N_2O as anaesthetic/non-anaesthetic sources were indistinguishable.[25]

Surgery has been estimated to contribute 21%–33% of healthcare solid waste and as high as 70% when labour and delivery suites were included.[22] Surgery in the USA, UK and Canada emitted a combined 9.7 million tonnes of CO_{2e} per annum. China's annual medical waste was calculated to be anywhere from 1.4 to 2.29 million tonnes in 2019, with the volume increasing yearly.[26] An average surgical case was estimated to have emitted between 146 kg and 232 kg CO_{2e}.[27] Surgical techniques also have an impact on the amount of waste generated. Woods *et al*.[28] compared laparotomy (LAP), conventional laparoscopy (LSC) and robotically assisted laparoscopy (RA-LSC) for staging endometrial cancer. The total carbon footprint of an RA-LSC procedure was 40.3 kg CO_{2e} per patient, which is significantly higher than those of LSC (29.2 kg CO_{2e} per patient) and LAP (22.7 kg CO_{2e} per patient). Thiel *et al*.[29] utilised life cycle assessment (LCA) to quantify the environmental impact of vaginal, abdominal, laparoscopic and robotic hysterectomy. Robotic hysterectomy had the largest environmental footprint, while there was significant overlap with laparoscopic, abdominal and vaginal hysterectomies in the categories of smog, carcinogens, non-carcinogens and ecotoxicity.

Waste can be classified as non-regulated medical waste and regulated medical waste (RMW). Regulated medical waste is synonymous with biohazard waste and treated by incineration, which is environmentally costly. Medical waste incineration has been identified by the US Environmental Protection Agency as a leading case of production of dioxin, one of the most potent carcinogens.[30] At least 30% of waste could potentially be recycled, and hence, not all intraoperative waste should be treated as RMW. Up to 80% of OT waste is generated before the commencement of surgery, during the preparation phase before the patient enters the OT, and is not biohazardous.[19] Much surgical waste arises from single-use disposable materials and tools. When disinfection is possible, comparable safety of reusable devices has been demonstrated. In general, single-use items had higher carbon emissions than reusable items over their lifetime.[22] Life cycle assessment is required to truly compare the environmental costs of each item versus purchasing costs, and LCA will have geographical variations depending on transport and the energy source. While scope 2 emissions in OT are dominated by the energy-intensive HVAC systems that run 24 h daily in OT complexes, a large number of computers and other electrical equipment, such as patient warming devices, may be left on when OTs are empty. Beyond carbon emissions, environmental concerns also exist for drug waste, with 30%–50% of intravenous drugs in OT being discarded. If discarded inappropriately, these medications can enter landfills or water systems, affecting the ecosystem.[31,32]

Intensive care unit

There is high resource utilisation for critically ill patients in ICU as compared to the general ward. Prasad *et al*.[33] used a hybrid environmental LCA to quantify average GHG emissions associated with resource utilisation in an acute inpatient unit and the ICU. It was found that while an acute care unit generated 5.5 kg of solid waste and 45 kg CO_{2e} per hospitalisation day, the ICU generated 7.1 kg of solid waste and 138 kg CO_{2e} per bed day. Most emissions originated from purchase of consumable goods, building energy consumption, purchase of capital equipment, food services and staff travel. McGain *et al*.[20] used LCA to determine the environmental footprint of the care of patients with septic shock in the ICU in Australia and the USA. The carbon footprints were dominated by the energy use for HVAC. Other aspects of intensive care, such as usage of plastics, nutrition, laundering, daily chest X-ray, ventilators and other ICU machines, contributed only minor emissions. The average daily GHG emissions arising from treating patients was 178 kg CO_{2e} in the USA and 88 kg CO_{2e} in Australia. Energy consumption accounted for 155 kg CO_{2e} in the USA (87%) and 67 kg CO_{2e} in Australia (76%).

Gastroenterology and gastrointestinal endoscopy

Lacroute *et al*.[34] examined the carbon footprint of a GI endoscopy unit in France, where 8524 procedures were performed on 6070 patients, taking into account direct and indirect GHG emissions from energy consumption, medical gases, medical and non-medical equipment, consumables, freight, travel and waste. The GHG emissions in 2021 were estimated to be 241.4 tonnes CO_{2e}, which translated to an average carbon footprint of 28.4 kg CO_{2e} per GI endoscopy procedure. The causes of GHG emissions were travel by patients and staff (45%), medical and non-medical equipment (32%), energy consumption (12%), consumables (7%), waste (3%), freight (0.4%) and medical gases (0.005%). In the context of equipment, endoscopy-specific materials contributed 98% of GHG emissions. Henniger *et al*.[35] reported a somewhat lower carbon footprint of 62.72 tonnes of CO_{2e} for a centre in Germany, which could be accounted for by the utilisation of different models for waste treatment and the fact that the centre consumed green energy. Within the endoscopy unit, accessories are manufactured for single use, similar to the OT. In recent years, endoscopic retrograde cholangiopancreatography performed with single-use duodenoscope has been advocated, driven by concerns of transmission of multidrug-resistant infections. Namburar *et al*.[36] examined the environmental impact of disposable endoscopic equipment and endoscopes. They reported that an endoscopic procedure generated approximately 2 kg of disposable waste from periprocedural single-use disposable materials and supplies (excluding reprocessing waste). In addition, replacing reusable with single-use endoscopes and accounting for reduced waste from reprocessing of endoscopes increased total waste mass by 40%. Elli *et al*.[37] examined the environmental impact of inappropriate endoscopy in Italy, focusing on oesophagogastroduodenoscopy and colonoscopy. Their study found that the carbon cost of inappropriate endoscopy was 4133 tonnes of CO_{2e} per year. Extrapolating to the European population, the estimated carbon footprint of inappropriate endoscopy was 30,804 tonnes in Europe. In the USA, Desai *et al*.[38] analysed the total waste generation and energy consumption for 450 GI procedures performed in a single endoscopy unit. On average, each procedure resulted in about 3 kg of solid waste, 13.9 gallons of liquid waste and 19.8 kW h energy consumption, with 20% of waste being potentially recyclable with appropriate waste management.

EFFORTS IN MITIGATION

Mitigation and adaptation are complementary strategies to address the health challenges from climate change. Mitigation refers to the efforts to reduce GHG emissions, whereas adaptation refers to the efforts to adjust to the climate change and build a more resilient healthcare system. Mitigation is the cornerstone, as the ability to adapt will eventually be overwhelmed. A rapid and sustained shift away from fossil fuels to cleaner energy is crucial. At the same time, there must be concerted efforts at mitigation across all sectors, including the healthcare sector. There is now increasing awareness of the impact of healthcare on climate change and position statements addressing the climate change crisis, and proposals for mitigation have been issued by various healthcare professional organisations.[10-15] Implementation science is focused on improving the systematic uptake of evidence-based care into routine practice. Although there are various studies of interventions to reduce the carbon footprint in healthcare, reports of fully scaled implementation projects to reduce the environmental impact of healthcare remain lacking.[16]

Anaesthesia and surgery

On an individual level, anaesthetists can reduce GHG emissions by being conscious of the carbon burden of different modes of anaesthesia and being intentional with their choices to minimise the carbon footprint of their anaesthetics. In the context of inhalational anaesthesia, given the evidence available for the safety of ultra-low-flow and low-flow anaesthesia, this should be utilised over the traditional 1–2 litre FGF, with the use of desflurane avoided and N_2O minimised.[39-42] Leaks within N_2O manifolds and pipelines have been identified to be a major source of nitrous waste in some hospitals. It may require significant testing efforts to identify pipeline leaks, but this can be easily overcome with cylinder N_2O where required and the decommissioning of manifolds and pipelines.[43] In addition, where feasible, techniques that avoid inhalational agents, such as total intravenous anaesthesia (TIVA) and regional anaesthesia, could be used.[40] Propofol does not have direct impact on GHG emissions, with the GHG impact of propofol TIVA said to be four times lower than that of desflurane or N_2O.[44] However, carbon footprint must consider both the direct and indirect total GHG emissions. Propofol has an indirect impact from the following: electricity required for the syringe pump, the environmental impact of drug manufacturing, packaging and transportation, requirement for single-use plastic, drug wastage and disposal.[45] In addition, TIVA requires access to reliable pharmacokinetic programmable pumps and monitoring of depth of anaesthesia, with evidence of longer time to extubation, longer setup time and potentially higher fiscal costs of propofol. The comparable safety of TIVA in relation to inhalational anaesthesia is well known, as demonstrated in a recent randomised trial in the context of cardiac surgery.[46,47] Yet, in a 2018 survey of 1000 anaesthetists, while 80% of respondents felt that TIVA had a better environmental profile than inhalational anaesthetics, only 18% used TIVA for the majority of cases.[48] While it is without question that TIVA is a better environmental option than desflurane, studies comparing propofol versus sevoflurane do not necessarily reflect clinical practice and have not always been comprehensive in their LCA comparison, and hence the ongoing controversy between propofol TIVA and an ultra-low-flow sevoflurane anaesthetic. Firstly, in clinical practice, the amount of consumables used (syringes, infusion lines, taps, needles) and disposable plastic waste generated varies widely between anaesthetists. Secondly, some studies used higher FGF for inhalational anaesthetic calculations, leading to higher consumption and CO_2 emissions. Furthermore, propofol waste management is an issue that needs to be addressed, with up to 50% from OT discarded.[31] Propofol is known to be toxic to aquatic organisms and has been detected in hospital effluents, natural environments and drinking water. An Australian study comparing GHG emissions for general anaesthesia (GA) with sevoflurane, spinal anaesthesia and combination spinal anaesthesia–GA demonstrated a similar carbon footprint for all three anaesthetic modalities, despite regional techniques generally quoted as superior or equivalent to TIVA in terms of environmental impact.[49]

Nitrous oxide mixed with oxygen (Entonox) is frequently used for labour anaesthesia. Pearson *et al*.[50] compared different modes of analgesia delivery during labour and found that intermittent inhalation of Entonox was associated with the highest carbon emissions at 237.33 kg CO_{2e}, while epidural analgesia (1.2 kg CO_{2e}) and remifentanil (0.75 kg CO_{2e}) patient-controlled analgesia had comparable environmental impacts for a 4-h period. Clearly, clinical considerations and safety concerns, such as increased monitoring or the ability to convert to caesarean section, as well as patient preference will play a significant role in the labour analgesia of choice. Awareness of the potential of waste, and proactively minimising the overuse or waste of medications and equipment, energy and water are important and should not be neglected.[16]

In the case of surgery, clinical processes before the surgery as well as within OT would have to be considered for the mitigation steps. Minimising excessive tests, especially repeat radiological imaging, and appropriate case selection are important.[19] As the modality of surgery does have an impact on the carbon footprint generated, this must be judiciously balanced against the expected benefit to patients. Within OT, rationalising of equipment and consumables, reduction of waste, and appropriate waste management through recycling, reuse or reprocessing are important. Theatre packs can be streamlined by reducing the number of rarely used instruments or disposables.[51] Education on the medical waste stream versus general waste stream can minimise incorrect use of the biohazard medical waste stream, which is both fiscally and environmentally costly.[52] Most government and hospital regulations do not require small quantities of blood, such as smeared bloody gauze, to be discarded as medical waste. Simple installation of paper and cardboard recycling bins in the anaesthetic room and OT, respectively, resulted in 50% and 67% of the waste being recycled.[53] Studies have shown that reusable items could lead to a substantial improvement in sustainability, with 70% reduction in waste generation, three-fold lower water consumption and 2.5-fold lower energy consumption.[51] Reprocessing of single-use items for reuse is now underway in some countries, including Japan, Germany and the USA.[40,54,55] The OTs are energy intensive, and reduction of energy consumption can be achieved by reducing HVAC outputs for unoccupied rooms. Simple measures like reviewing OT complex temperature and increasing it from traditional cold temperatures have been shown to produce significant reduction in electricity consumption while also reducing patient hypothermia and complications. Air exchange frequency can be reduced after-hours without impact on infection risks and is a large factor in HVAC energy consumption. Water waste from hand disinfection can be reduced by choosing alcohol gel after the first scrub of the day before the second hand wash.[56] These are in line with recommendations from the Intercollegiate Green Theatre Checklist issued by the Royal College of Surgeons and Royal College of Anaesthetists.[57]

Intensive care unit

In the context of ICU, the main source of carbon footprint relates to HVAC rather than waste. Thus, infrastructure improvement, increased renewable energy generation and energy efficiency would be expected to have the most impact on achieving environmental sustainability.[20] However, it remains equally important to reduce the carbon footprint associated with consumables by adopting the core principles of 'reduce, reuse and recycle'. An example is to reduce the use of excessive gowning for routine patient care while avoiding cross-contamination. Other measures to reduce the carbon footprint of ICU include preventing the progression of illnesses and inpatient admissions, avoiding unnecessary ICU admissions, minimising overdiagnosis and over-investigation, and curtailing overtreatment.[58]

Gastroenterology and gastrointestinal endoscopy

Having an appropriate indication and adherence to clinical guideline with regards to surveillance intervals are crucial to reduce the carbon footprint from inappropriate endoscopy.[13,14] Technological advances in endoscopic imaging and artificial intelligence have greatly facilitated endoscopic diagnosis. This can decrease unnecessary endoscopic procedures and biopsies, which will reduce GHG emissions while maintaining high-quality patient care, thereby contributing to sustainable healthcare practices.[59] Apart from adopting general recycling measures within the endoscopy centre to manage waste, there is scope to further clarify the extent to which components of single-use accessories can be safely recycled and not discarded as RMW. A study looked at material composition analysis and LCA of forceps, snares and clips and actively identified parts that can be safely recycled. The pilot 1-week sustainability intervention could reduce the carbon footprint by up to 27.44%, allowing recycling of 61.7% of the instrument total weight.[60] Single-use endoscopic accessories have gradually replaced reusable devices over the last two decades. To minimise waste, endoscopic accessories should be carefully selected based on specific requirements of a case. Single-use duodenoscope was developed to address the small but important risk of reprocessing failure and disease outbreaks as the complex design of the elevator mechanism of the duodenoscope increases the difficulty of reprocessing. However, this risk is not high and can be mitigated using disposable elevator caps and high-level disinfection techniques. The usage of single-use endoscopes should be limited to selected cases, given the issues of cost and carbon footprint.[61]

COMMON THEMES IN STRATEGIES FOR CLIMATE CHANGE MITIGATION

There are common approaches that can be used to transit to healthcare practices that are environmentally sustainable. Foremost among them is awareness and education of the danger of climate change and its bidirectional relationship with healthcare, and knowledge of the carbon burden to underpin effective mitigating action. There must be advocacy by healthcare professionals as individuals and as part of a professional body to raise awareness and expand on the scientific basis to fine-tune further action. Consistent with other industry sectors, there has to be prudent energy consumption while aiming to transit to cleaner forms of energy, but this will be contingent upon the larger sociopolitical system at the national and global levels. The 5Rs principles of effective waste management, which are reduce, reuse, recycle, rethink and research, can be used to outline solutions for environmental sustainability in the healthcare setting, both for the individual professional as well as for the healthcare organisation.[19] The application of such principles was discussed earlier, but will be summarised for emphasis. 'Reduce' can be applied at the patient level to adherence to appropriate indications for procedures and treatment, to avoid overtreatment or futile interventions, and it can also be applied in the context of judicious use of equipment and accessories. 'Reuse' and 'recycle' are applicable to devices and equipment, emphasising the need to balance waste reduction against convenience and infection control. 'Rethink' can be applied to our work processes, such as reduction of N_2O for labour analgesia, a move towards regional anaesthesia and TIVA when appropriate, and careful weighing of benefit to patient, costs and carbon burden when selecting the modality of surgical and endoscopic interventions. What is crucial is being aware of the carbon footprint of specific procedures and being able to select an option of least carbon footprint without comprising safety and quality of care. In terms of 'research', there is a clear need to better understand the environmental impact of specific processes in complex systems, to better guide decisions and balance clinical efficacy against financial and environmental costs. Research is needed on the systematic uptake of evidence-based, environmentally friendly healthcare practices in routine practice.

CONCLUSION

There is an urgent need for climate action, and this will provide health co-benefits. The healthcare sector has an innate responsibility to uphold the Hippocratic Oath to 'first, do no harm' in relation to its own contribution to the climate crisis. It is imperative that a healthcare service is not only evaluated on a cost and benefit basis, but also weighed against long-term environmental costs in terms of carbon footprint. The healthcare sector has largely lagged behind other industry sectors with regards to corporate social responsibility and environmental sustainability. An Asian-Pacific survey reported that green endoscopy was well accepted but not widely implemented among healthcare professionals.[62] Healthcare professionals have an important role to play in terms of advocacy and change management. At the individual and organisational levels, implementation of environmentally sustainable healthcare practice must begin in tandem with ongoing research to achieve better understanding and to refine efforts at mitigation.

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