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NOTE AND COMMENT

Climate-friendly healthcare: reducing the impacts of the healthcare sector on the world's climate

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Abstract
If the global healthcare sector were a country, it would be the fifth-largest carbon emitter, also producing massive volumes of waste. A revolutionary transition to an environmentally sustainable model of healthcare is required. Decarbonisation efforts are initially focused on transitioning to renewable energy sources and improving energy efficiency in healthcare facilities (Scopes 1 and 2). One of the major challenges is to reduce the carbon intensity of the broader healthcare sector, especially operational and supply chain-related emissions, which represent 71% of the sector's worldwide emissions (Scope 3). This comment briefly describes the connections between the healthcare sector and climate change and describes several high-impact decarbonisation opportunities, focusing on transitioning from current resource and waste-intensive procurement models and highlighting the planetary co-benefits of fostering low-emissions healthcare. To succeed, this transition will require high-level advocacy and policy changes supported by international collaboration at the global level.

Keywords Healthcare · Greenhouse gas emissions · Climate change · Decarbonisation · Sustainable procurement · Planetary health

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Healthcare and its connections with climate change

Hospitals and all healthcare services are responsible for protecting health, treating patients, and saving lives. Increasingly, this also means helping humans to handle the effects of climate change on their health (Malik et al. 2018). Paradoxically, healthcare systems are highly energy and resource intensive (Duindam 2022; Qin et al. 2022) and are responsible for 4.4% of global greenhouse gas (GHG) emissions (Karliner et al. 2020). Thus, healthcare systems are facing the dual challenge of dealing with the health impacts of climate change, while at the same time reducing their own emissions. The Greenhouse Gas Protocol (GHGP) classifies emissions emanating from healthcare systems into three 'scopes'. Table 1 below reflects the categories included within the three scopes (NHS England 2020) and the pathways through which they contribute to climate change (Karliner et al. 2021).

Table 1 Healthcare pathways impacting climate change

Emissions	Categories included	Emissions contribution
Direct emissions		
Scope 1: 17% of the sector's worldwide footprint Directly controlled or owned by the healthcare facilities	Fossil fuels Hospital fleet	Fossil fuels, predominantly coal combustion onsite in hospital facilities, including the fuel to power hospital equipment and fleet, generate the primary drivers of climate change. Resultant air pollution is the greatest source of morbidity and mortality (Karliner et al. 2021)
	Anaesthetic and propellent gases	Anaesthetic and propellant gases such as nitrous oxide have 268 times the global warming potential of carbon dioxide (Karliner et al. 2019)
Indirect emissions		
Scope 2: 12% of the sector's worldwide footprint Indirectly generated through purchased electricity	Purchased electricity	The large amount of energy for heating, cooling, lighting, and operating medical equipment massively contributes to GHG emissions (Das and J 2023)
Scope 3: 71% of the sector's worldwide footprint Indirect emissions from the healthcare organisations' value chain, outside of the organisations' operations	Waste	Improper disposal of significant volumes of hazardous and infectious materials leads to environmental contamination and, in the case of organic waste releasing methane, constitutes a major source of GHG emissions (Ezeudu et al. 2022)
	Water	Large quantities of water used for patient care, sanitation, and cleaning require energy and contribute to GHG emissions (Lenzen et al. 2020)
	Manufacturing, pharmaceuticals, and medical devices	Manufacturing medical products, including medications, medical devices, and consumables, requires significant amounts of energy and raw materials, which generate GHG emissions (Meister et al. 2023)
	Food and catering	Meat-rich food options in hospital menus, food waste disposal, and emissions associated with food transport within hospitals, substantially contribute to GHG emissions (NHS England 2020)
	Information and communication technology (ICT)	The manufacture, distribution, daily use, and disposal of ICT within healthcare services bears a crucial cost to the environment, including through production, transportation, use, and disposal (NHS England 2020)
	Business services and staff and patient travel	The transportation of patients, medical supplies, and healthcare workers also contributes to GHG emissions, especially when long distances are involved (Dacones et al. 2021)

Given that manufacturing, operating, and disposing of medical equipment contribute to greenhouse gas emissions, improved design for recyclability, longer equipment life spans, and sharing equipment among facilities may mitigate these emissions.

High-impact actions to reduce the healthcare sector's share of GHG emissions

As part of the process of handling the contribution of the health sector to climate change, decarbonisation—the process of reducing CO_2 emissions resulting from human activity with the eventual goal of eliminating them (Chen et al. 2022)—is an important factor. Pursuing it, however, will require high-impact actions across key areas. Figure 1 below highlights the pathways through which healthcare impacts climate change, categorised into Scopes 1–3 (Table 1) and key decarbonisation actions. The ways through which high-impact decarbonisation actions may benefit society are elaborated below in the same Fig. 1.

In an era marked by escalating environmental concerns, the healthcare sector emerges as a significant contributor to carbon emissions and resource consumption. Addressing this pivotal challenge demands a proactive approach towards high-impact decarbonisation strategies. There is a pressing need to transition healthcare systems towards sustainability, focusing on areas with the potential for substantial carbon reduction, described in detail below:

1. *Invest in lower embodied energy builds and energy-efficient infrastructure.* Healthcare facilities investing in good building design, master planning, and site selection could lower operational carbon attributed to energy and transport (Pitman and Rolf n.d.). This includes 'Clean design' principles such as installing double-glazed windows, shading, energy-efficient lighting, using low-energy heating, ventilating and air conditioning (HVAC) systems, and utilising solar energy (Health Care Without Harm 2023). Incorporating energy efficiency and material planning through a holistic design approach could help achieve solutions that balance clinical needs and achieve reductions in operational energy (Pitman and Rolf n.d.).
2. *Transition to zero emissions sustainable transport.* Investing in an electric fleet and developing capacity for charging infrastructure within hospitals can further help reduce carbon emissions. Onsite electric vehicle (EV) parking may also provide hospital power backup. Future research into vehicle-to-grid technologies could poten-

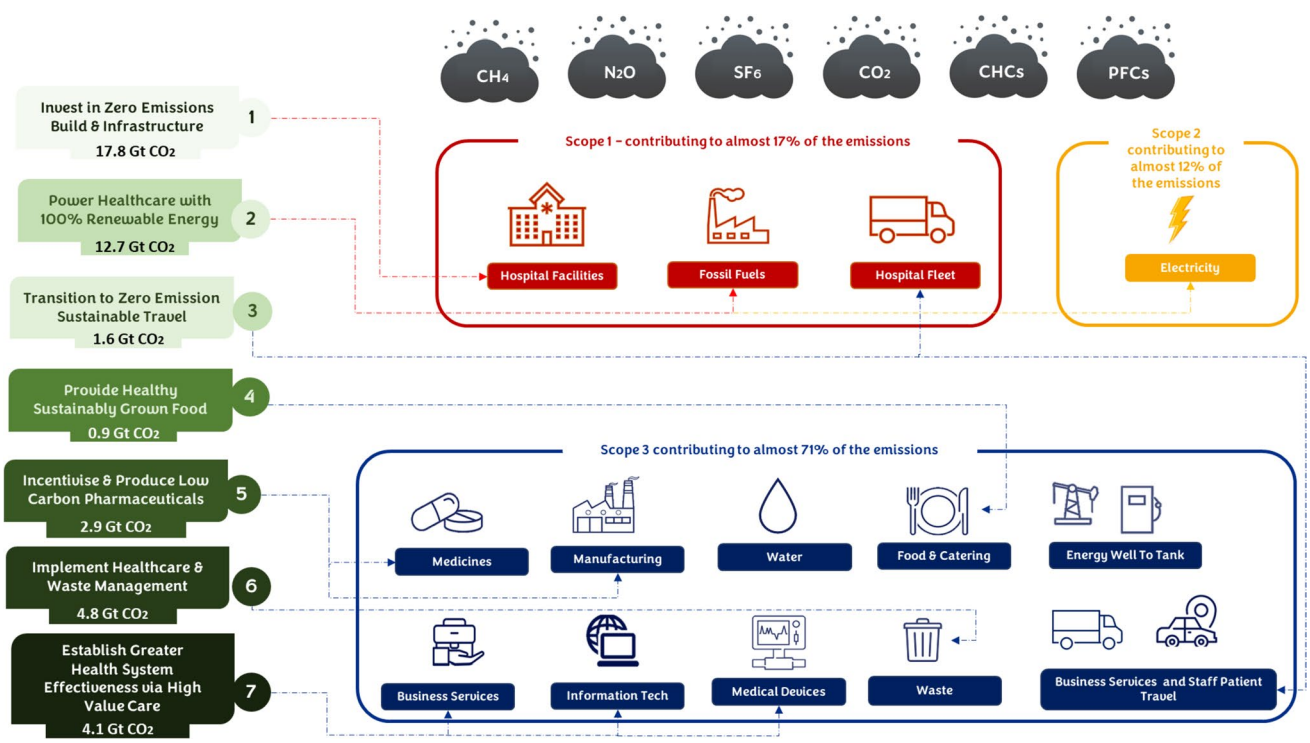

Fig. 1 High-impact decarbonisation actions to reduce the healthcare sector's share of GHG emissions; mapped from HealthCare Without Harm's decarbonisation roadmap and based on data from NHS England (2020) and Karliner et al. (2021)

tially help reduce emissions from grey fleets (Greater Manchester Combined Authority 2021).

3. *Power healthcare systems with 100% renewable energy*. Healthcare facilities should make the switch to renewable energy sources, such as wind, solar and geothermal energy, including for hospital heating and cooling requirements and to power medical equipment. Clean energy use harmonises with the healthcare sector's pro-health focus and raison d'être (Burch et al. 2021).
4. *Provide sustainably grown food*. Healthier, locally sourced food could improve patient health and well-being. Additionally, food that is cooked on-site within health services could further help reduce GHG emissions related to agriculture, transportation, storage, and waste across the supply chain and healthcare services sector.
5. *Low-carbon pharmaceuticals*. A small number of pharmaceuticals account for a large portion of GHG emissions. This includes anaesthetic gases and inhalers. Interventions to reduce the emissions from their point of use and supply chain include optimising prescription standards, opting for lower carbon alternatives, and working alongside pharmaceutical companies to encourage carbon transparency reporting.
6. *Waste management*. Implementing the principles of circular economy involves designing waste out of the system. This offers the healthcare sector a range of methods for reducing GHG emissions and other pollutants in producing, transporting, and disposing of healthcare-linked waste, conserving resources, reducing costs, and minimising waste while maintaining healthcare standards. This requires an interdisciplinary, whole-of-supply-chain approach to healthcare system redesign.
7. *Healthcare system effectiveness*. Healthcare services need to increase capacity and mobilise resources to mainstream digitally enabled care, thereby developing sustainable healthcare models. This could be achieved through an increase in green transportation and a reduction in hospital visits by encouraging more patients to stay in their homes and receive medical care via teleconferencing, text messaging, or phone calls, thus reducing the need for transportation to and physical stays in healthcare facilities. This would significantly streamline patient care and reduce patient travel-related GHG emissions (Lattie et al. 2022; Teachman et al. 2022).

The above roadmap is briefly summarised in Fig. 2. The convergence of healthcare and environmental consciousness presents an unprecedented opportunity for holistic change. The roadmap illuminates high-impact decarbonisation domains, underscoring the pivotal role played by different healthcare stakeholders in fostering a sustainable future. The journey towards sustainable healthcare is underpinned by interdisciplinary collaboration, innovation, and a shared commitment to environmental stewardship at different levels.

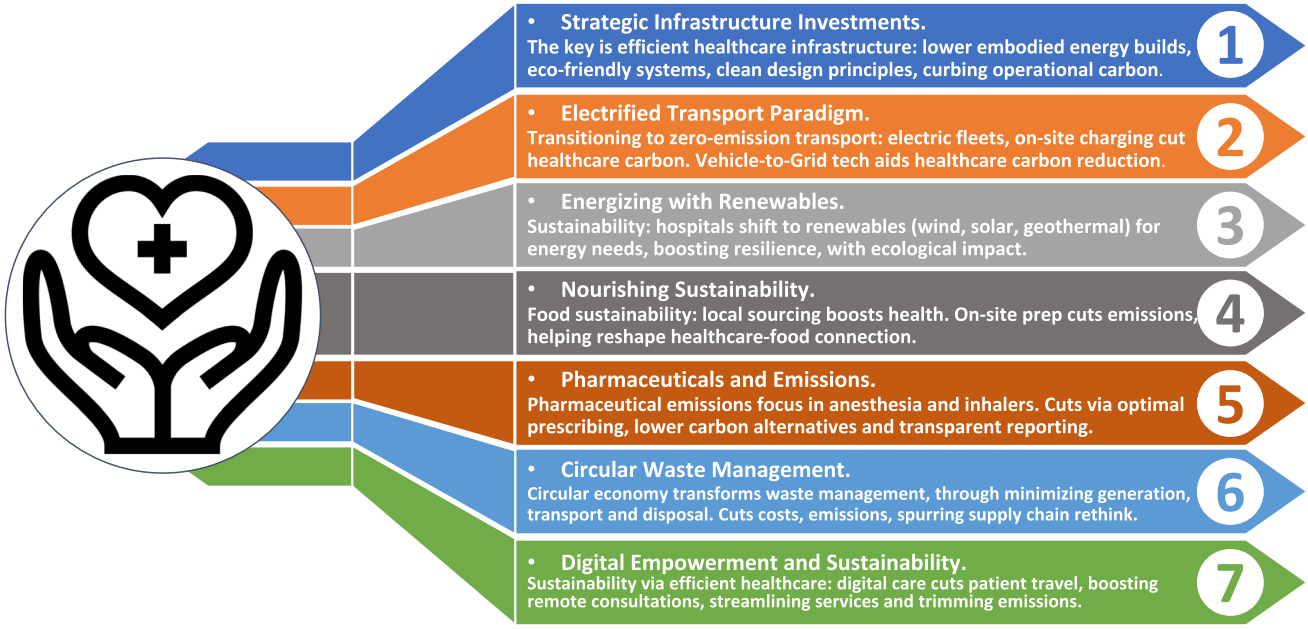

Fig. 2 Convergence areas to decarbonising healthcare systems and services

Maximising sustainable procurement and minimising low-value patient care

Global healthcare systems need to recognise and redress climate change-related threats by designing new climate resilience programs with a focus on mitigation strategies (Scott et al. 2019). As shown in Table 1 and Fig. 1, these should emphasise the development of net zero roadmaps and decarbonisation pathways, thus lowering GHG emissions from direct and purchased operations, i.e. Scopes 1 (17% of the sector's worldwide footprint) and 2 (12% of the sector's global footprint) (The Global Climate Health Alliance 2021). Although these initiatives are critical, the transition to renewable energy alone will only address 29% of the overall healthcare sector footprint (Das and J 2023; Karliner et al. 2019, 2021). In consequence, the remaining 71% will need to come from Scope 3 categories, which are generated while delivering care and using medical products and materials (Pickles 2022). This highlights two crucial decarbonisation Scope 3 action areas for attention:

(i) *Sustainable procurement decisions*. Currently, most medical products are single-use stock and designed to be disposed of after use, generating a massive amount of waste that is often toxic to human health and the environment (McGain et al. 2017). To counter this trend, current healthcare service and procurement approaches must transition from a linear to a circular economic model (Alfina et al. 2023; Health Care Without Harm 2023).

(ii) *Emission reduction co-benefits of minimising dependencies on low-value healthcare*. Within developed countries, 30% of healthcare is estimated to be wasteful, low value or duplicative, and a further 10% is considered burdensome or harmful (Jeffrey et al. 2020). This includes screening or diagnostic tests that have not been clinically recommended. Specific examples include the unnecessary prescribing of antibiotics and spinal imaging or fusion for uncomplicated back pain, procedures that result in significant costs to patients and healthcare systems while at the same time burdening planetary health (Brownlee et al. 2017). Efforts to change clinical behaviour away from reliance on low-value care could result in multiple co-benefits, including reduced inpatient hospital stays, outpatient visits, catering costs, laundering, and avoided GHG emissions linked to patient admissions, among others (Barratt et al. 2022; Pickles 2022).

The way ahead

Due to climate change progressively impacting people's lives, the healthcare sector has an opportunity and a moral duty to be a climate mitigation leader. By playing this role, it may foster both planetary health and promote better health outcomes (Herrmann et al. 2022; WBGU 2023). Three high-level action areas that could help the healthcare system drive decarbonisation, leading to climate-friendly and healthier future generations, are recommended:

Action 1: Unifying the healthcare sector's voice and leveraging its purchasing power. Mandating role-specific training of healthcare service staff would inform and authorise staff on how to co-create and support context-specific sustainable solutions. Healthcare workers could leverage their knowledge and use their influence to advocate to their professional associations, significantly impacting behaviour change and clinical guidelines (Herrmann et al. 2022; Karliner et al. 2021).

Action 2: Monitoring research-based decarbonisation progress. Healthcare services lack research-based evidence to accurately monitor the implementation and assessment of carbon emission reduction initiatives over time and across healthcare facilities (Herrmann et al. 2022). To enhance health data monitoring, it is essential to measure and monitor healthcare emissions on a national level and include them in national GHG reporting inventories. An example of this is the annual sustainability reporting in the United Kingdom (UK), which includes key indicators across clinical care and delivery, such as anaesthetics and inhalers, that are reported through the Greener National Health System (NHS) Dashboard and included in annual reports (NHS England 2020).

Action 3: Mobilising high-level policy action. A collaborative global procurement strategy with clear directives for healthcare suppliers and a long-term vision to reduce waste is crucial to minimise the harmful impact of procured products on human and planetary health. All governments can start by issuing a declaration that the climate crisis is a health emergency and requires global action. This can obligate health authorities to take action and prepare healthcare systems for the impacts of climate change while at the same time lowering their own climate footprint. Ministries of health and national healthcare systems should make public commitments following the best practice example set by the NHS in the UK, which has declared its intent to reach net zero across Scopes 1–3 by 2045 and has released its initial action plan (NHS England 2020). Finally, the development of national-level sustainable healthcare units comprising environmental scientists, researchers, health professionals, administrators, and policymakers, is key to developing these action

plans. These may be patterned after the Sustainable Development Unit (SDU) in the UK, under whose guidance the NHS reduced the healthcare sector's CO_2e emissions by 11% between 2007 and 2015, despite an 18% increase in inpatient admissions over the same period, saving 90 million pounds per annum (NHS England 2020). The climate-friendly road ahead will be significantly easier to traverse when the vision and responsibility to comprehensively decarbonise the healthcare sector is shared by all nations, thus increasing the cumulative capacity of stakeholders to take concerted action on climate change.

As this comment has shown, globally the healthcare sector is characterised by waste and inefficiencies that combine to perpetuate both climate change and environmentally unsustainable operations and practices. Perversely, while aspiring to safeguard human health, the international healthcare sector presently propagates actions that directly compromise or even jeopardise human health through corollary climate change and environmental impacts (WBGU 2023). Misalignment is reflected in several areas, including via the sector's production of massive volumes of waste that is often toxic to human health and the environment. In addition, the global healthcare sector ranks as the fifth-largest emitter of carbon dioxide, thus manifesting the sector's enormous contribution to climate change and directly contradicting and undermining its role and self-conception as a champion and propagator of health. A comprehensive transition to an environmentally sustainable healthcare model is urgently required—one that better coheres with the sector's pro-health mission and "systematically addresses planetary health issues" (Herrmann et al. 2022, p. e184).

Many developing countries face various challenges in implementing climate-friendly healthcare. These are associated with economic, structural, technological, and policy-related obstacles. These difficulties are compounded by the inherent vulnerability of these nations to climate change impacts, which places additional strains on healthcare systems already under stress. One major challenge is related to the fact that developing countries often have limited financial resources, making it difficult to invest in green technologies and sustainable infrastructure for healthcare. The high upfront costs associated with renewable energy sources, energy-efficient buildings, and eco-friendly medical supplies can be prohibitive in many cases. Also, many healthcare facilities in developing countries operate with outdated infrastructure that is ill-suited to integrate modern, climate-friendly technologies. Upgrading these facilities requires significant investment, which is often not available. Moreover, it should be noted that there is a technological gap seen in developing countries, which often lack access to the latest eco-friendly technologies due to high costs or intellectual property restrictions. This limits their ability to adopt innovations in renewable energy, waste management, and other areas critical to climate-friendly healthcare. To address the above limitations, effective policy and regulatory frameworks are needed (WHO ATACH 2023). These need to be complemented by capacity building among staff working in the health sector, so that they may be able to implement climate-friendly healthcare practices.

This article sheds light on the urgency for a transformative shift toward more sustainable healthcare. The imperative for a revolutionary shift towards environmentally sustainable healthcare is noted via a range of required actions, including decarbonisation, adopting renewable energy sources, and improving energy efficiency within healthcare facilities, among other actions that point to the sector's responsibility to adopt green practices to mitigate its environmental impact. The complexity of the climate-friendly healthcare challenge is emphasised through the main contributors to the sector's carbon footprint. Significantly, GHG emissions tied to the broader care and supply chain account for 71% of the sector's overall footprint (Scope 3, see Table 1 and Fig. 1). This comment adds to the body of similar literature by highlighting the necessity of a comprehensive approach that targets GHG emissions from across the entire healthcare ecosystem, stressing the need for systemic change and cooperation on a global scale (Setoguchi et al. 2022). In this context, adopting sustainable practices, integrating renewable energy sources, reducing waste, and considering the life cycle impact of medical equipment are crucial steps towards building a climate-friendly and climate-resilient healthcare system.

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Data availability The authors declare that all data supporting this study are available within the paper (data sources that conceptually underpin Table 1 and Fig. 1 have been provided in the respective legends).

Declarations

Conflict of interest The authors declare no conflicts of interest.

References

Alfina KN, Ratnayake RMC, Wibisono D, Mulyono NB, Basri MH (2023) On the necessity for planning and integration of manufacturing tasks to align with health sector needs and CE goals: a systematic literature review. In: Kim KY, Monplaisir L, Rickli J (eds) Flexible automation and intelligent manufacturing. Springer, Cham

Barratt AL, Bell KJ, Charlesworth K, McGain F (2022) High value health care is low carbon health care. Med J Aust 216(2):67–68. https://doi.org/10.5694/mja2.51331

Brownlee S, Chalkidou K, Doust J, Elshaug AG, Glasziou P, Heath I et al (2017) Evidence for overuse of medical services around the world. Lancet 390(10090):156–168. https://doi.org/10.1016/S0140-6736(16)32585-5

Burch H, Anstey MH, McGain F (2021) Renewable energy use in Australian public hospitals. Med J Aust 215(4):160. https://doi.org/10.5694/mja2.51197

Chen L, Msigwa G, Yang M, Osman AI, Fawzy S, Rooney DW, Yap P-S (2022) Strategies to achieve a carbon neutral society: a review. Environ Chem Lett. https://doi.org/10.1007/s10311-022-01435-8

Dacones I, Cave C, Furie GL, Ogden CA, Slutzman JE (2021) Patient transport greenhouse gas emissions from outpatient care at an integrated health care system in the Northwestern United States, 2015–2020. J Clim Change Health 3:100024. https://doi.org/10.1016/j.joclim.2021.100024

Das KP, J C (2023) A survey on artificial intelligence for reducing the climate footprint in healthcare. Energy Nexus 9:100167. https://doi.org/10.1016/j.nexus.2022.100167

Duindam D (2022) Transitioning to sustainable healthcare: decarbonising healthcare clinics, a literature review. Challenges 13(2):68. https://doi.org/10.3390/challe13020068

Ezeudu OB, Ezeudu TS, Ugochukwu UC, Tenebe IT, Ajogu AP, Nwadi UV, Ajaero CC (2022) Healthcare waste management in Nigeria: a review. Recycling (Basel) 7(6):87. https://doi.org/10.3390/recycling7060087

Greater Manchester Combined Authority (2021) Hospital vehicles give back to the grid. https://social-innovation.hitachi/en-eu/stories/energy/manchester-energy-market/. Accessed 25 Mar 2024

Health Care Without Harm (2023) Global green and healthy hospitals. GGHH guidance documents. https://greenhospitals.org/guidance-documents. Accessed 25 Mar 2024

Herrmann A, Lenzer B, Müller BS, Danquah I, Nadeau KC, Muche-Borowski C, Traidl-Hoffmann C (2022) Integrating planetary health into clinical guidelines to sustainably transform health care. Lancet Planet Health 6(3):e184–e185. https://doi.org/10.1016/S2542-5196(22)00041-9

Jeffrey B, Paul G, Johanna W (2020) The three numbers you need to know about healthcare: the 60–30-10 challenge. BMC Med 18(1):1–8. https://doi.org/10.1186/s12916-020-01563-4

Karliner J, Slotterback S, Boyd R, Ashby B, Steele K (2019) Health care's climate footprint. Health Care Without Harm & Arup. https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf. Accessed 25 Mar 2024

Karliner J, Slotterback S, Boyd R, Ashby B, Steele K, Wang J (2020) Health care's climate footprint: the health sector contribution and opportunities for action. Eur J Public Health. https://doi.org/10.1093/eurpub/ckaa165.843

Karliner J, Roschnik S, Boyd R, Ashby B, Steele K, Guinto R (2021) Global road map for health care decarbonization. Health Care Without Harm. https://healthcareclimateaction.org/sites/default/files/2021-08/Global%20Road%20Map%20for%20Health%20Care%20Decarbonization.pdf. Accessed 25 Mar 2024

Lattie EG, Stiles-Shields C, Graham AK (2022) An overview of and recommendations for more accessible digital mental health services. Nat Rev Psychol 1(2):87–100. https://doi.org/10.1038/s44159-021-00003-1

Lenzen M, Malik A, Li M, Fry J, Weisz H, Pichler P-P, Chaves LSM, Capon A, Pencheon D (2020) The environmental footprint of health care: a global assessment. Lancet Planet Health 4(7):e271–e279. https://doi.org/10.1016/S2542-5196(20)30121-2

Malik A, Lenzen M, McAlister S, McGain F (2018) The carbon footprint of Australian health care. Lancet Planet Health 2(1):e27–e35. https://doi.org/10.1016/S2542-5196(17)30180-8

McGain F, Story D, Lim T, McAlister S (2017) Financial and environmental costs of reusable and single-use anaesthetic equipment. Br J Anaesth 118(6):862–869. https://doi.org/10.1093/bja/aex098

Meister JA, Sharp J, Wang Y, Nguyen KA (2023) Assessing long-term medical remanufacturing emissions with life cycle analysis. Processes 11(1):1–27. https://doi.org/10.3390/pr11010036

NHS England (2020) Delivering a 'net zero' national health service. https://www.england.nhs.uk/greenernhs/publication/delivering-a-net-zero-national-health-service/. Accessed 25 Mar 2024

Pickles K (2022) Decarbonising clinical care in Australia. Deeble Institute for Health Policy Research. https://ahha.asn.au/system/files/docs/publications/deeble_issues_brief_no_48_decarbonising_clinical_care_final_0.pdf. Accessed 25 Mar 2024

Pitman D, Rolf (n.d.) A. Net zero carbon healthcare. Arup. https://www.arup.com/perspectives/publications/research/section/net-zero-carbon-healthcare. Accessed 25 Mar 2024

Qin RX, Velin L, Yates EF, El Omrani O, McLeod E, Tudravu J, Samad L, Woodward A, McClain CD (2022) Building sustainable and resilient surgical systems: a narrative review of opportunities to integrate climate change into national surgical planning in the Western Pacific region. Lancet Region Health Western Pac 22:100407–100407. https://doi.org/10.1016/j.lanwpc.2022.100407

Scott V, Benjamin KS, Marilyn B (2019) Empowering the great energy transition: policy for a low-carbon future. Columbia University Press, New York

Setoguchi S, Leddin D, Metz G, Omary MB (2022) Climate change, health, and health care systems: a global perspective. Gastroenterology 162(6):1549–1555. https://doi.org/10.1053/j.gastro.2022.02.037

Teachman BA, Silverman AL, Werntz A (2022) Digital mental health services: moving from promise to results. Cogn Behav Pract 29(1):97–104. https://doi.org/10.1016/j.cbpra.2021.06.014

The Global Climate & Health Alliance (2021) Are national climate commitments enough to protect our health?: global climate and health alliance. https://climateandhealthalliance.org/initiatives/healthy-ndcs/ndc-scorecards/. Accessed 25 Mar 2024

WBGU—German Advisory Council on Global Change (2023) Healthy living on a healthy planet. Summary. WBGU, Berlin

WHO ATACH—World Health Organization Alliance for Transformative Action on Climate and Health (2023) 2022–2024 workplan of the ATACH low carbon sustainable health systems working group (LCSHS WG), 15 pp. https://cdn.who.int/media/docs/default-source/climate-change/atach_lcshs_wg_workplan.pdf. Accessed 26 Mar 2024