Guiding principles for the next generation of health-care sustainability metrics

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Metrics for health-care sustainability are crucial for tracking progress and understanding the advantages of different operations or systems as the health-care sector addresses the climate crisis and other environmental challenges. Measurement of the key metrics of absolute energy use and greenhouse gas emissions now has substantial momentum, but our overall measurement framework generally has serious deficiencies. Because existing metrics are often borrowed from other sectors, many are unconnected to the specifics of health-care provision or existing health system performance indicators, the potential negative effects of health care on public health are largely absent, a consistent and standardised set of health-care sustainability measurement concepts does not yet exist, and current dynamics in health systems such as privatisation are largely ignored. The next generation of health-care sustainability metrics must address these deficiencies by expanding the scope of observation and the entry points for interventions. Specifically, metrics should be standardised, reliable, meaningful, integrated with data management systems, fair, and aligned with the core mission of health care. Incentives with the potential to contradict sustainability goals must be addressed in future planning and implementation if the next generation of metrics is to be effective and incentivise positive systemic change.

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Introduction

Health care is in the midst of a sustainability revolution, supported by both internal and external actors who are calling for change and pledging action.[1] Over the past decade, work has quantified the scale of health care's environmental footprint, including from individual medical devices,[2,3] treatments,[4,5] facilities,[6,7] and entire national health systems.[8,9] Some institutions, such as the National Health Service (NHS) in England,[10] have had long-standing sustainability programmes that are being emulated around the world. Numerous health-care organisations are now benchmarking their emissions, setting decarbonisation targets, and instituting programmes to realise these goals. Systems to collect and process data are being instituted and, in some cases, integrated with enterprise management software or electronic medical records, enabling unprecedented insight into the environmental performance of products, clinical practices, services, and facilities.[11] Nearly all systems are focused on estimating greenhouse gas (GHG) emissions using the scopes framework of the GHG Protocol,[12] using a variety of accounting methods.[13] This progress is substantial and should be praised.

Carbon accounting is in widespread use in many sectors, especially in manufacturing; however, a health-care system is not a factory, and health-care sustainability must be broader than GHG emissions. Now that motivation and action towards sustainability are increasing, the metrics being used should be meaningful and align with the core mission of health care: to facilitate health and wellbeing and do no harm. Traditional sustainability metrics that quantify energy use and GHG emissions at the facility scale are a good and necessary first step, but not sufficient. As more GHG emissions data are becoming available, whether measurement concepts fully reflect the environmental sustainability challenges that health care is facing should be determined. In this Personal View, we review the utility of current metrics and reflect on what the next generation of metrics should look like in terms of scopes, measures, and intentions.

Traditional energy-focused metrics

Reducing direct energy use and attendant emissions has been the area of health-care decarbonisation that has seen the greatest investment and progress by far. Health-care facilities are energy-intensive to run due to high requirements for lighting and ventilation, narrow windows of acceptable temperature and humidity, electricity-intensive diagnostic and therapeutic medical equipment, vehicle fleets, and often non-stop operation. As such, they have been the target of energy efficiency efforts for decades.[14,15] Example projects include upgrading to more efficient lighting, boilers, pumps, and fans; introducing motion sensors and advanced heating, ventilation, and air conditioning controls; and improving insulation. Some facilities have completely switched sources of energy for heating and cooling by connecting to district heating networks or investing in on-site heat pumps that use electricity that can be procured from renewables.

Such projects correspond to the reduction of scopes 1 and 2 emissions (ie, on-site emissions [scope 1] and upstream emissions from the procured electricity and heat [scope 2]). These projects have taken advantage of the large, well established global industry for building energy management. Although energy efficiency or electrification projects can require substantial capital, saving energy also reduces operational costs for health-care facilities such that environmental and financial goals align. Investing in energy efficiency is particularly important in low-income countries where energy prices can be multiple times those of high-income countries, and where energy supply is less reliable. In view of the current energy crisis and worsening air pollution, increasing energy efficiency and moving away from dependence on fossil fuels are also becoming increasingly pressing issues for high-income countries.[16]

Reducing direct energy use, electrification, and switching to renewable energy supplies are ideal starting points for health-care decarbonisation because in-house projects are under the direct control of administrators and facility managers. Projects are typically planned and executed by facility energy managers and engineering firms, and improvements are largely unnoticeable to physicians, staff, or patients; these projects often require no change in behaviour and do not affect medical decisions. Because energy is billed in physical units (eg, kWh, MJ, or litres of fuel), institutions can easily calculate their direct energy-related emissions over time, report on them, and set decarbonisation goals based on a schedule of planned investments.

Many health-care entities are beginning to report on absolute scopes 1 and 2 GHG emissions. Reporting is useful for tracking progress internally, but to conduct benchmarking or compare institutions of different sizes and identify best practices, locations, and type of health service provision, some normalisation is necessary. One option is to normalise by unit of floorspace, which is common practice in the buildings industry in general but can lead to misaligned incentives. Health-care facilities are not generic buildings; rather, they serve very specific functions that must be represented in the metrics we use to evaluate them. If a large hospital or clinic (by floor area) sees very few patients, it will have a low environmental footprint per unit area but a high environmental footprint per patient, setting the wrong standard for sustainable practices. Some health-care services are space-intensive, some are high-volume, some are highly specialised, and some have patients that are treated for months or years. Effective normalisation schemes must account for inherent differences in health-care services and the types of care being offered at a given facility.

Moving to a system-wide understanding

National studies of health-care GHG footprints have consistently shown that scopes 1 and 2 emissions are eclipsed by indirect scope 3 emissions, largely from the production of purchased goods and services.[8,17,18] Many tens of thousands of individual products flow through health-care systems, making product-by-product accounting of these emissions impractical. Therefore, top-down economic models are most commonly used to quantify these scope 3 emissions, and most prominently used are environmentally extended multiregional input–output models. These models can track emissions generated anywhere along global supply chains, allowing for a comprehensive understanding of how a sector, such as health care, in one country induces emissions in other sectors, both within that country and internationally.

Low-income countries often have small per-capita environmental footprints and health expenditures but have a high environmental intensity (ie, the ratio of the health carbon footprint to health expenditure), and high-income countries often have high per-capita environmental footprints and health expenditures but lower environmental intensities. For example, the USA is responsible for more than a quarter (~27%) of global health-care emissions and produces 57 times more emissions per person than India does, but the environmental intensity of Indian health care is nearly 3 times higher compared with the USA.[9]

Metrics for decarbonisation actions

Typically, 20–30% of health-care GHG emissions are on-site (scope 1) or result from producing purchased electricity (scope 2), and the remaining 70–80% of these emissions are along domestic and international supply chains (scope 3),[17] which means that successful decarbonisation strongly depends on mitigation strategies outside the health sector, particularly decarbonisation of upstream manufacturing and transport. This situation does not mean, however, that health-care organisations have no control over their supply chain emissions. Many demand-side actions can be taken by health-care organisations to reduce these emissions, from specific interventions (eg, improving inventory practices and shifting to more reusable devices to reduce waste) to systemic improvements (eg, addressing low-value care, engaging in better preventive care and effective use of primary care, and shifting treatment from hospitals to clinics and home care where appropriate).[19-22] Any action that reduces demand for unnecessary goods and services will avoid emissions associated with the supply chains of those items, regardless of whether suppliers are themselves engaged in decarbonisation programmes. These demand-side actions can also have substantial benefits in terms of reduced costs and improved health-care access and quality.[23,24]

Metrics that measure physical progress of such specific decarbonisation actions are rarely linked to established reporting systems and are also difficult to reconcile with top-down calculations of GHG footprints that use health expenditures. Footprinting provides a reliable benchmark for the monitoring of the environmental performance of entire national health-care systems, and a limited breakdown into a few highly aggregated subsectors (hospitals, ambulatory care, consumption of pharmaceuticals, etc); however, this information is usually too coarse to inform the actions of individual health-care providers and guide environmental performance improvement where it is safe to do so.[25] To operationalise sustainability plans and track progress, different and more granular metrics are needed.

Some national GHG footprint studies have been able to achieve higher granularity by taking advantage of detailed accounts of health expenditures.[10,19,26,27] Here, expenditure data of individual procurement categories (eg, pharmaceuticals, medical non-durables, business services, and food) are combined with GHG intensities of the related sector in the top-down analyses. Such hybrid approaches can also be applied to individual health-care organisations and their product expenditures.

Even greater detail can be achieved by tracking mass rather than expenditures, as is done in lifecycle assessments (LCAs), and the mass-based approach is generally preferred in the GHG Protocol guidance.[12] LCAs are product-specific, and this granularity provides adequate information to select less environmentally harmful product and care pathway alternatives. LCAs are time-consuming to compile, however, and are prone to uncertainty, especially when generalised outside of their intended scope. A major problem is that LCAs exist for only a few of the hundreds of thousands of medical devices and pharmaceuticals. This number is beginning to change as researchers develop new streamlined approaches for generating product assessments and manufacturers begin to publish more information.[28] A major step forward would be to require standardised, per-unit product emissions disclosures by manufacturers, in order to provide the data basis to support environmentally sound procurement and use decisions and to track performance improvements.[29] Policy efforts in the UK and elsewhere to compel supplier reporting of embodied carbon are encouraging.[30]

Emissions from induced private travel of staff, patients, and visitors is not included in any of the previously mentioned metrics, as they are not part of the health sector as defined by the System of Health Accounts;[31] however, such estimates, as shown by NHS England,[10] can reveal important information about emissions reduction potentials through better spatial health-care provision planning, providing access to low-carbon modes of transport to health services, telehealth visits, or home care alternatives, when appropriate. Changing models of care delivery, including the implementation of multidisciplinary integrated care, can save time and reduce the need for repeat visits, lowering travel demands.[23] Actions such as these are systemic in nature, rather than being discrete decarbonisation interventions such as upgrading a boiler, but the potential environmental benefits (and health co-benefits) are substantial. For example, in Austria, health-care sector private travel caused about the same amount of carbon emissions as direct energy consumption.[19]

Metrics that matter to health

The argument that health systems are counteracting the core mission of health care by contributing to threats to human health is widely used to encourage health actors to provide health services sustainably;[25,32] however, evidence on the magnitude and distributional effects of these environmental impacts is sparse.[33] Worldwide, 4·4–5·2% (or ~2 Gt CO_2 equivalent [CO_2e]) of GHG emissions are attributable to health care,[16] but other environmental impacts that are harmful to health, such as air pollution, use of scarce water resources, and the generation of plastic waste, are also concerning.[17,34]

To estimate health risk associated with a specific pollutant or stressor, comparative risk assessment or derived methods are used, whereby emission data are linked with epidemiological data on the relationship between exposure to a risk factor as a cause and a specific health outcome as an effect (eg, relative risks from dose–response function). Effects or damages are quantified in disability-adjusted life-years (DALYs) or premature deaths and can be translated in relative metrics (eg, DALY/kg CO_2e). Such estimates depend on the availability of reliable, population-specific risk factors for the pollutant or stressor under consideration, derived from longitudinal observational epidemiological studies, as well as methods to attribute health burdens to climate change specifically.[35]

Estimating the burden of disease from GHG emissions is subject to severe uncertainties due to globally unequally distributed effects of the broad range of direct and indirect climate impacts on different populations, the time lag between emissions and climate impacts, and uncertainties regarding exposure and vulnerability. WHO concludes that, although climate change is undoubtedly a threat to human health, accurately estimating the scale and impact of many climate-sensitive health risks remains challenging.[36] The environmental disease burdens caused by health care have thus been estimated only selectively.

As with GHG footprints, environmental health risks are mainly associated with indirect emissions from health-care supply chains. In a globalised economy, these emissions often occur far from places of health-care consumption and include both local, near-term health impacts such as respiratory diseases from air pollution, and global, long-term health impacts from climate change, which are unevenly distributed across the world. Country-level studies for the USA[18,26] and Canada[27] have shown public health damages that are directly and indirectly attributable to health-care emissions. Across the studies, emissions of particulate matter are responsible for the largest portion of pollution-related health damages.[37,38]

Previous global health-care footprint research has included seven heterogeneous environmental pollutants and stressors associated with health care: GHG emissions, fine particulate matter ($PM_{2·5}$), nitrogen oxides, sulphur dioxide, reactive nitrogen in water, scarce water use, and malaria risk (the only candidate which directly refers to a disease).[17] For future assessments, additional stressors with known effects on population health could also be considered explicitly, such as exposure to extreme heat or climate-sensitive respiratory allergens and their interrelation with existing disease burden such as asthma and chronic obstructive pulmonary disease, cardiovascular and cerebrovascular emergencies (eg, myocardial infarctions or stroke), or acute renal failure stemming from heat-related dehydration.

A comprehensive assessment of the health impacts from health care's environmental footprints must take into account that impacts are shifted from places of consumption to places of production (mostly from high-income countries to low-income and middle-income countries).[39,40] The 2023 *Lancet* Countdown on health and climate change made a global estimate of 4 million DALYs lost annually due to health care-associated emissions.[41] Still, this measurement concept is generally under-represented in the current sustainable health-care field.

Goals for the next generation of health-care sustainability metrics

The sustainable health-care community is moving quickly to set performance improvement targets, conduct assessments, take decarbonisation actions, and share best practices, but behind all the recent momentum lies a looming problem: the metrics being used, which are primarily national or organisational carbon footprinting of absolute emissions, only reflect a narrow aspect of health-care sustainability. The next generation of metrics must be oriented to the broad mission of health care and the specifics of how health care is delivered in different settings. Health-care organisations should at a minimum normalise results based on the volume of clinical service activity (eg, inpatient hospitals could report emissions per bed day, or even against measures of health outcomes). NHS England used finished admission episode as their service measure; between 1990 and 2019, absolute emissions decreased by 26% but emissions per finished admission episode decreased by 64%.[10] Such indicators, however, do not reflect the performance of the health-care systems in delivering their services.

A basic goal of sustainability benchmarking is to be able to compare performance across systems that provide comparable services and learn from top performers. To do this in the health-care sector, environmental outcomes and health outcomes must be combined. Consider, for example, the GHG footprint of a phacoemulsification cataract surgical procedure performed in India and in the UK:[5,42] the UK-based procedure was estimated to produce nearly 130 kg CO_2e, whereas the Indian procedure was only approximately 6 kg CO_2e. Separate research indicates that both countries have comparable clinical outcomes (post-surgical visual acuity) for this procedure.[43] Health systems in low-income settings have in many cases been forced to innovate to serve patient needs with high volumes under resource-constrained circumstances. Sustainability and health outcomes metrics must be coupled in order to make balanced comparisons across facilities, products, or procedures and to highlight sustainable innovations and quality care, meaning that we also need to focus on creating standardised, validated consensus measures of health-care volume, quality, and access at micro and macro levels. Established, standard quality metrics that are routinely tracked are the ideal starting point (eg, 30-day readmissions and mortality rates, hospital acquired infection rates, and patient waiting times).

Feasibility, comparability, and transparency

For sustainability metrics to drive performance improvement, they must be useful for health systems and the people who work within them. Sustainability metrics should ease identification of environmentally preferable goods and services, improve efficient consumption of resources, and facilitate environmental reporting both for external accounting and internal strategic management. Environmental performance improvement should never be at the expense of safety and quality, and the next generation of sustainability metrics in health care must reflect that imperative.[23]

Procurement and clinical staff require reliable information on the environmental performance of the products used to deliver patient care. Due to an absence of such data, the potential for greenwashing by manufacturers and distributors is a legitimate concern.[44,45] Internationally standardised, transparent reporting methods and independent certifications are essential at the level of products and services to reliably aid product selection criteria (in addition to efficacy, safety, cost, and supply chain resilience).[25,29] Product-level emissions data can be integrated into procurement and clinical databases to ease selection and facilitate clinician and departmental emissions accounting, organisational reporting, and strategic mitigation.

For those health systems with electronic health records, integrating product-level emissions can also enable strategic reductions of the emissions from clinical care delivery. For example, electronic anaesthesia records with automated data collection on the type, quantities, and efficiency of inhaled anaesthetics used (which are potent GHGs) can generate automated benchmarking reports at regular intervals. Measures can be presented both in absolute CO_2e and normalised by hour of anaesthetic, and compare clinicians within care divisions and between institutions to drive improvement.[25]

Metrics should also be understandable to non-sustainability experts. For example, grams or kilograms of carbon dioxide equivalents are virtually meaningless to most health-care administrators and clinicians. Furthermore, CO_2e values for individual items or in particular units can appear exceedingly small and seem unimportant, but low emissions per product combined with high product consumption multiplies to large emissions. For benchmarking reports, providing equivalent results such as miles or kilometres driven, numbers of cars or homes powered per annum, or results relative to totals per capita or per institution, in addition to absolute emissions values, will be more relatable and motivating for non-experts.[46]

Detailed normalisation factors such as emissions by patient encounter type and standard clinical outcome measures (eg, readmissions) can further aide comparisons between clinicians within a division and between organisations to enable identification of leading performers along environmental and clinical criteria. Sustainability metrics should be integrated with diagnostic codes (eg, ICD-10) and procedure codes (eg, Current Procedural Terminology), to ease pairing with clinical accounting.

Normalisation is important for national studies as well. In the past several reports of the *Lancet* Countdown on health and climate change, authors made a concerted effort to provide information on international health-care system GHG emissions accompanied with measures of health-care access and quality performance.[16,25,47–49] Analogous to the relation between energy consumption and the Human Development Index,[50] per-capita GHG emissions from the health-care sector increase with increasing health-care quality, as measured by the Healthcare Access and Quality Index.[47] With more than 400 kg CO_2e per capita, however, further increases of the per-capita health-care GHG footprints do not lead to further increases in health-care quality.[47] Although these results are too aggregated to reveal specific strengths and weaknesses of health-care delivery and thus cannot be used to identify intervention points for improvement, they suggest a large decarbonisation potential of health care in highly GHG-emitting countries that could be realised without compromising health outcomes and that might even improve health. As health systems decarbonise over the coming decades and maintain or improve quality and access, such thresholds will also decrease.

Guiding principles

The next generation of health-care sustainability metrics must broaden their scope to avoid underestimating the negative impacts of health care on the environment and on human health. Four areas for improvement are crucial for addressing existing deficiencies in sustainability reporting and to identify untapped opportunities to move towards health-care sustainability.

Scope of emissions

Metrics should reflect the full scope of emissions that are caused by health care, both directly and indirectly. Many institutions are moving to account for and report scope 3 emissions. This reporting should be facilitated and encouraged as much as possible. The scopes framework is a useful scheme for standardised emissions accounting but should not impede the development of metrics and inclusion of sustainability concerns or emissions categories that are tied to the actual actions that health-care actors can take, which might encompass multiple scopes. For example, metrics related to preventive medicine, telemedicine, or social prescribing would have systemic effects on emissions that are complicated to measure but are important for promoting health and enabling health-care access.

Scope of impacts

Metrics should reflect not just GHG emissions, but also other environmental pressures and their potential health impact. Planetary health care requires embracing an expanded notion of the principle to first, do no harm, beyond care for individual patients, to a duty to protect the Earth's natural systems on which intergenerational health and wellbeing depend.[23] In addition to additional analyses of both local near-term and global long-term climate-related public health impacts from health-care GHG emissions, all types of health care-related environmental pressures that contribute to the global burden of disease should also be assessed. Estimating the disease burden associated with the unequal environmental pressures caused by national health-care systems is required in order to define a global health inequity that is still unknown. Current emissions metrics are highly aggregated and do not reflect the distributional differences between who is emitting and who is causing the emissions through consumption. Opportunities also exist for incorporating measures that reflect intergenerational inequities in when environmental burdens will be felt.

Scope of performance

As a guiding principle, environmental metrics should systematically connect to the specifics of health-care delivery. This principle suggests linking environmental metrics to the core mission of health systems (ie, to the health outcome of the system under consideration), which varies across scales including clinical outcomes of treatments (eg, surgical revision rates or survival rates of specific medical interventions), quality performance of health-care organisations (eg, unplanned readmissions or waiting time for health-care services), national health systems (eg, vaccination coverage, efficient use of pharmaceuticals, or antibiotic resistance), and overall population health (eg, prevalence of diseases and other epidemiological and public health metrics), as outlined in the WHO health system performance assessments and related literature.[51] Only metrics that connect environmental footprints of health care with considerations of access to care and health service performance will allow proper assessment and comparability of the sustainability of health systems. This explicit connection is to ensure that health systems with a low or declining footprint are not simply caused by severe financial or health personnel constraints and that insufficient health-care services are therefore not misinterpreted as environmentally well performing. Conversely, wasteful spending and other system inefficiencies in high-income countries with good health outcomes should be represented in health-care sustainability metrics.[52] Sustainable health-care measurement frameworks must also expand beyond static operations considerations to large-scale infrastructural health-care provision planning associated with reducing demand for care through investments in primary disease prevention, and changing how care is delivered—for example, by considering emissions from induced private travel.

Scope of entities

Metrics should recognise the wide diversity of health care globally. Many health-care organisations are among the largest organisations in existence, but some clinics have just a single caregiver. Some are well resourced and have the most modern equipment and facilities available, but others are just a single examination room or a mobile clinician with a bag. Top-down analyses have considered national health sectors as single entities, but tremendous variation in circumstances exists within and across systems and in their physical environments. Some environmental challenges, such as climate change, are global in scale and pressing in time, and should be included in sustainability programmes everywhere. Even for these universal metrics, however, we must allow for different types of tools and data sources to generate estimates as befits each organisation's situation.

Reorientating health care towards sustainability

Health-care organisations have shown remarkable success with fairly easy-to-implement sustainability measures in areas where environmental and financial goals coincide; however, as soon as costly or medical decisions are involved, the success of sustainability managers is dependent upon collaboration with medical and financial management. Even more challenging is the fact that individual health-care organisations are often not in the position to decide on far-reaching sustainability strategies that affect national health economics, access to public health services and other health policies, and, particularly, the influence of the global health market and the financial structure of health-care systems around the world. Evidence increasingly suggests that the large-scale transformation from public, non-profit-oriented health-care entities to private, profit-oriented health-care entities create disincentives for high-value care, universal coverage, and environmentally friendly health-care systems.[53,54]

Health-care sustainability metrics do not always align with other metrics that have traditionally driven decision making around health-care operations, investments, and policy. Market-driven concerns and other incentives that might contradict sustainability goals must also be transparently contrasted when crafting the next generation of health-care sustainability metrics if they are to be effective and incentivise positive systemic change.

Contributors

MJE and UW led in drafting the Personal View. All authors edited the submitted version of the manuscript. All authors had full access to all the data in the Personal View and had final responsibility for the decision to submit for publication.

Declaration of interests

We declare no competing interests.

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