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Towards planetary health systems: a manifesto for a revised quadruple aim for healthcare improvement

Alessio Perilli[1], Andrea Adduci[1], Walter Ricciardi[1], Antonio Giulio de Belvis[2,3] and Chiara Cadeddu[4]

[1]Section of Hygiene, Department of Life Sciences and Public Health, Università Cattolica del Sacro Cuore, Rome, Italy; [2]Interfaculty of Economics – Medicine and Surgery, Università Cattolica del Sacro Cuore, Rome, Italy; [3]Clinical Pathways and Outcome Evaluation Unit, Fondazione Policlinico Universitario A.Gemelli IRCSS, Rome, Italy and [4]Erasmus School of Health Policy and Management, Erasmus University Rotterdam, Rotterdam, Netherlands

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Corresponding author:
Chiara Cadeddu;
Email: cadeddu@eshpm.eur.nl

Abstract

Non-technical summary. Healthcare systems significantly impact the environment, which in turn affects human health. To address this, we propose to revise a popular framework for healthcare improvement, by introducing the advancement of planetary health (the health of both humans and the natural systems) among the aims that health systems should pursue. This approach suggests reducing medical service needs through disease prevention, minimizing environmental impacts, and supporting global efforts to protect planetary health. Practical applications to bring about these pathways are documented in the literature.

Technical summary. Restoring the health of the planet, with concurrent benefits for human civilization, is paramount. Healthcare systems play a crucial role in this regard, considering the environmental impact of health services. Widely recognized approaches to designing healthcare systems for the optimization of their performance are based on the pursuit of multiple aims, such as the Triple Aim and Quadruple Aim frameworks. The objective of this work is to revise the latter by substituting 'Advance Planetary Health' for 'Improve Population Health'.

The objective of advancing planetary health supports all other pre-existing objectives: lowering costs, enhancing patient experience, team wellbeing, and population health, which directly relates to planetary health. Health systems promoting planetary health reduce the need for medical services through disease prevention and health promotion, pursue the provision of appropriate care, minimize the overall environmental impact of medical services, and support planetary health initiatives across all sectors and society. Multiple interconnected pathways exist to operationalize the above components.

A revised quadruple aim for healthcare improvement, aligned with social and economic goals of sustainable prosperity and wellbeing, may be a desirable step toward constructing planetary health systems capable of maximizing the health of humans and natural systems.

Social media summary. It's time for new 'planetary health systems': focusing on planetary health to enhance healthcare performance. #PlanetaryHealth #ClimateCrisis #HealthcareImprovement.

1. Introduction

The current state of planetary health is alarming on multiple levels (Atwoli et al., 2021; McKay et al., 2022; Rockström et al., 2023; Rocque et al., 2021). This translates into a pressing need to restore the health of the planet, symbiotically benefiting the health of the human civilization. Healthcare systems, through their environmental footprint, are themselves co-responsible for the progressive deterioration of planetary health, in terms of climate breakdown, air pollution, scarce water use, and biogeochemical flows (Lenzen et al., 2020). The environmental disruptions to which they contribute ultimately damage human health (Eckelman et al., 2018, 2020a). Hence, they cannot be considered, by any means, exempt from the global effort to transition to sustainability, especially considering their overarching mission to improve health (Health Care Without Harm & Arup, 2019). Furthermore, they must be climate-resilient, anticipating, responding to, coping with, recovering from and adapting to environmental and climate-related shocks (WHO, 2015). This scenario underscores the necessity to revise health system goals and operations, integrating the objective of promoting the health of the planet as essential to enhancing human health. The immense scale and severity of challenges confronting healthcare systems today elevate environmental sustainability, which previously received fragmented attention and relied largely on commendable yet isolated initiatives by various

stakeholders, to a pivotal role. Ultimately, promoting planetary health must become a common denominator for all care processes, from prevention to treatment.

An established approach to designing healthcare systems, in order to optimize their performance, consists in the pursuit of multiple aims. In 2008, Berwick and colleagues introduced the Triple Aim framework (Berwick et al., 2008) outlining three goals that a health system must pursue simultaneously: improving population health, enhancing the patient experience of care, and reducing per capita costs related to health care, with the latter two outlined as symmetrically complementing the former. The disruptive importance of the triple aim theory lies essentially in a paradigm shift related to optimizing care performance and the strategy for improving the quality of care. While with the second aim, the purely individual perspective of the patient care experience, focused on the care process itself (in line with the six 'improvement goals' proposed by the Institute of Medicine (US) Committee on Quality of Health Care in America: Safety, Effectiveness, Patient-Centeredness, Timeliness, Efficiency, Equity) (Institute of Medicine (US) Committee on Quality of Health Care in America, 2001) remains, the first and third aims shift toward a systemic view.

Further versions emerged in 2014, with Bodenheimer and Sinsky's introduction of the Quadruple Aim (Bodenheimer & Sinsky, 2014), and in 2022 with the inclusion of health equity in the framework (Nundy et al., 2022).

Bodenheimer and Sisnski enriched the model with an additional component: improving care team well-being (Bodenheimer & Sinsky, 2014). They identify the health care workforce burn-out as a disruptive element and a substantial obstacle to achieving patient-centeredness and triple aim. In fact, burn-out is linked to overutilization of resources with increased costs and worsening clinical outcomes.

The novel fifth aim, which proposes to advance health equity (Nundy et al., 2022), highlights that quality improvement without equity represents a hollow victory. Accordingly, policymakers and practitioners ought to develop and put into practice evidence-based strategies to minimize health inequities, make investments in measuring them, and provide incentives.

The key question the most renowned Triple Aim framework attempts to answer is: what goals should a healthcare system strive for, from the perspective of the society it serves? The seemingly contradictory goals of improving population health and reducing per capita care costs suggest a revolutionary assumption of responsibility by the healthcare system. In a world with finite resources, the needs and well-being of the population extend beyond the boundaries of healthcare, necessitating an emphasis on social determinants of health such as education, housing, and transportation, to improve overall health and minimize disparities. This declaration of responsibility, thus, implies a moral obligation for health systems to combat the current climate and environmental crisis, which poses significant threats to global health and well-being. Population health inevitably depends on the health of Earth's natural systems: the climate crisis, among other planetary health crises, has a significant impact on human health. Rising temperatures increase heat-related mortality and morbidity, while increased frequency and intensity of storms result in increased injury, death, and psychological stressors (Romanello et al., 2022). In all, 22–39% of the global population is projected to be out of the human climate niche by 2080–2100, if current climate policies persist (Lenton et al., 2023). Climate variability may impact the distribution and abundance of vertebrate host species, leading to an increase of vector-borne and zoonotic diseases (Haines & Ebi, 2019). Carbon emissions and climate breakdown also affect global health via multiple direct and indirect pathways, including effects on agriculture and nutrition, notably contributing to the global burden of disease (Smith et al., 2022; Weyant et al., 2018). Parallelly, air pollution, which largely shares both sources and solutions with the climate crisis (Campbell-Lendrum et al., 2023), is linked to a variety of health outcomes (WHO, 2021), with 6.67 million deaths attributed to it in 2019 (Fuller et al., 2022). Furthermore, recent evidence suggests an association between PM2.5 and clinical antibiotic resistance, which itself represents a major challenge for health systems as well as a threat to public health (Zhou et al., 2023). Consistent with the 'do no harm' principle of medical professionals and ethical foundations, there can be no goal of health systems that does not take into account the effects that health interventions have on the environment.

Environmental sustainability of healthcare systems has been at the center of scientific debate for several years now. Scientific evidence and individual initiatives to improve the sustainability of healthcare interventions by healthcare organizations, at multiple levels, are numerous (Cook et al., 2023; Keil et al., 2023; Patel et al., 2023; Sala et al., 2017; Somner et al., 2008; Storz, 2020). Indeed, it is now recognized that environmental impacts should be considered when measuring the value of health care. For example, sustainability in quality improvement (SusQI) is a framework that assesses the quality and value of health care not only through the lens of economic sustainability, but also that of social and environmental sustainability (Stanford et al., 2023).

Though environmental sustainability has been suggested as an additional objective within a sextuple aim framework (Alami et al., 2023), we stress that human health is inherently intertwined with the health of natural systems. For health systems, the primary objective of enhancing population health, as put forth by the Triple Aim framework, cannot be detached from a contextual and targeted action to preserve planetary health. By revisiting the first objective of the Quadruple Aim and enriching it with the more comprehensive notion of planetary health – 'a solutions-oriented, transdisciplinary field and social movement focused on analyzing and addressing the impacts of human disruptions to Earth's natural systems on human health and all life on Earth' (Planetary Health Alliance, n.d.) – we could provide a theoretical framework within which health systems can prioritize the array of activities aimed at mitigation of and adaptation to the multiple threats to earth system stability. This theoretical framework reflects a systemic approach that does not merely provide healthcare systems with the objective of promoting environmental sustainability (as suggested in the sextuple aim model), but rather, sustainability becomes a means through which to achieve the primary goal of any healthcare system: promoting and restoring health (both of the population and the planet).

The centrality of such a significant goal (and responsibility) is evident in how it decisively integrates and supports the pursuit of other objectives, from reducing healthcare costs to prioritizing the patient and their perspective in the care process, to enhancing the well-being of the care team. Continuous improvement in the quality of healthcare in the 21st century cannot disregard the pursuit of planetary health objectives. Our framework compellingly encompasses the wide-ranging aspects of the role of health systems in transitioning to societies aligned with planetary boundaries, propelling them to the core of the planetary health movement. Indeed, such a comprehensive approach, while holding healthcare

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systems fully accountable to their patients, their natural interlocutors, may generate mutual benefits in the interaction with other sectors, notably the economic sector, thus acting as a catalyst for comprehensive societal change.

2. Advancing planetary health as an aim for healthcare improvement

A health system that advances planetary health requires a systems-thinking approach, based on four main principles, contributing to tackling the current crisis of value and purpose that affects health systems worldwide (Larsson et al., 2023): decreasing the demand for health services through health promotion and disease prevention; pursuing the delivery of appropriate care; abating the overall environmental footprint of health services (MacNeill et al., 2021); endorsing planetary health action across other sectors and the overall society (Karliner et al., 2021) (Figure 1).

In relation to the first principle, evidence-based health promotion and disease prevention programs, powered by engaging stakeholders from multiple sectors (Claflin & Aloia, 2010), alleviate disease burden (Bandosz et al., 2020; Rasella et al., 2014; Soltani et al., 2021; Wang et al., 2021) and, consequently, its environmental footprint (Bi & Hansen, 2018). Smart governance for health and wellbeing provides the framework for such an intense cross-sectoral cooperation to thrive (Kickbusch & Gleicher, 2012). Additionally, 16.4% of the world population is projected to be 65 years or older by 2050, nearly doubling the current share (Gerland et al., 2022), which is likely to push demand for health services even further. Investing in public health interventions is deemed an effective way to put a cap on this process, thus allowing health systems to effectively deliver services still needed, while curbing not only their attributable footprint on natural systems but also economic, social and personal costs (Masters et al., 2017; McDaid, 2018). Despite that, across countries belonging to the Organisation for Economic Co-operation and Development, preventive care expenditure accounted for just 0.24% of gross domestic product and 2.59% of current health expenditure in 2019, on average (OECD, 2023). Interventions addressing tobacco, meat consumption, obesity, and air pollution are projected to save approximately 1.5 gigatons of CO_{2e} from 2014 to 2050 (Karliner et al., 2021). The push for integrated public health policies must address the challenges presented by short-sighted public systems and private healthcare systems in which diseases can unfortunately be perceived as revenue generators (McDaid, 2018; Missoni & Galindo, 2020).

The second principle consists in delivering appropriate healthcare that responds to health needs according to evidence-based practice. This entails the cessation of superfluous exams and prescriptions (Kherad & Carneiro, 2022), as well as service delivery in the most efficient setting. Hospital care, which is intrinsically energy- and resource-intensive, has a larger carbon footprint than primary care (Malik et al., 2018; Nicolet et al., 2022; Pichler et al., 2019; Tennison et al., 2021). Hence, striving to limit hospitalizations through appropriate care, ensuring accessibility and continuity across primary and community care settings, within the framework of secondary and tertiary prevention community-based programs, is in turn beneficial to the environment, as opposed to frequent hospital accesses, resulting from inadequate and chaotic care. Healthcare systems with Beveridge models and ex-ante reimbursement strategies tend to favor appropriate care, given the need to contain expenditure, whereas it may undermine profitability in private health care. Professionals' culture, specific patient requests, conflicts of interest, and care fragmentation all have a role in over-prescribing and over-treatment (Missoni & Galindo, 2020).

The third principle is concerned with reducing the environmental impact of the high-value health services still needed to meet population health needs. The main production sectors responsible for that encompass energy supply, operational emissions, manufacturing, agriculture, and transport (Health Care Without Harm, 2019). Assessments of the healthcare environmental impact have been conducted on national and global scales, much as further methodological improvements are warranted (Eckelman et al., 2020b; Steenmeijer et al., 2022). Globally, the environmental footprint of health care amounts to 4.4% of greenhouse gas emissions, 2.8% of particulate matter, 3.4% of nitrogen oxides, and 3.6% of sulfur dioxide (Lenzen et al., 2020).

Lastly, health systems are in a strong position to steer societies and economies toward planetary health goals. Intensive climate action would lead to large health co-benefits (Campbell-Lendrum et al., 2023; Whitmee et al., 2024) and thoroughly accomplish the system's mission. Health systems with a strong commitment to environmental sustainability can exert a guidance role, influencing other companies and the civil society, while leveraging their remarkable purchasing power (Howard et al., 2023). Societies and economies, in turn, striving to operate within planetary boundaries, contribute to the health care's own sustainability and human health goals, as social and economic determinants improve and any-grade suppliers decarbonize. This influence is integral to a comprehensive process to augment and emphasize connections between health and other sectors.

3. How the planetary health goal contributes to other aims

The proposed aim of advancing planetary health contributes to each of the other interdependent aims (Bodenheimer & Sinsky, 2014) (Figure 2). In fact, planetary health encompasses the health of human civilization, thus embracing the original aim of improving population health, while further expanding on it and acknowledging its being intertwined with the health of natural systems (Whitmee et al., 2015).

While equity was proposed as an aim for healthcare improvement (Nundy et al., 2022), applying an equity and social justice lens to issues being addressed is a cornerstone of planetary health. This concept was proposed in 2023 by Rockström et al., as a set of safe and just Earth system boundaries (ESBs) (Rockström et al., 2023). These boundaries aim to maintain the resilience and stability of the Earth system (safe ESBs) while minimizing human exposure to significant harm from Earth system changes, a necessary but not sufficient condition for justice (Rockström et al., 2021). The consideration of health equity is linked to the widespread exposure to significant harm from planetary crises, with greater impacts on vulnerable populations, exacerbating existing inequities in disease burdens and premature mortality, and potentially leading to social unrest (Friel, 2022; Intergovernmental Panel on Climate Change (IPCC), 2023). As a matter of fact, the brunt of environmental disruptions is primarily felt by low-income countries and individuals as well as racial minorities, who contribute less to causing them (Deivanayagam et al., 2023; Gore, 2020; Hickel et al., 2022; Lenton et al., 2023; Vicedo-Cabrera et al., 2021). A foundation that ensures minimum access to basic needs, including health, for all humans, alongside a safe and just ESB ceiling of maximum allowed human pressure on biophysical domains, could constitute a safe and just 'corridor'

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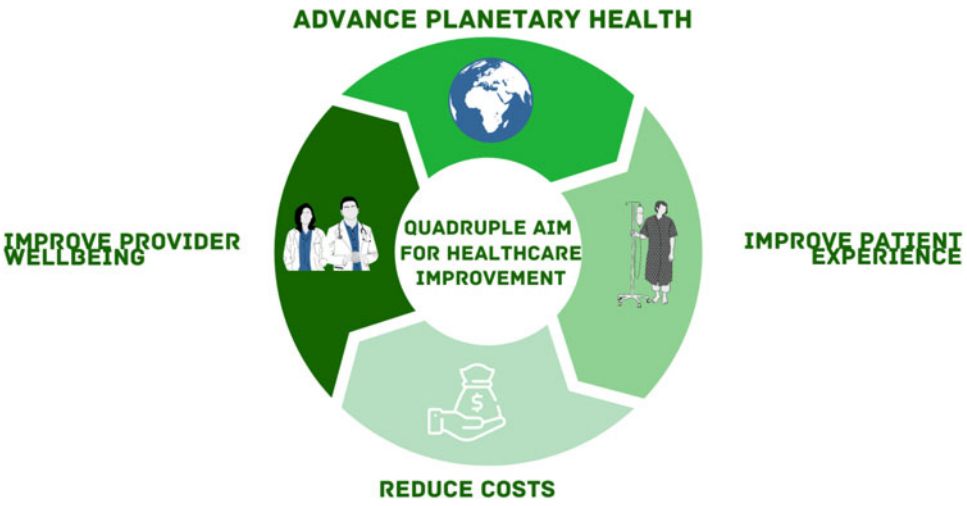

Figure 1. A revised quadruple aim for healthcare improvement, centered on the advancement of planetary health.

over time (Rockström et al., 2023). Hence, the uneven distribution of the effects of planetary crises calls for just and equitable solutions to advance planetary health.

Planetary health interventions are also associated with cost reduction. Evidence suggests that both improving the environmental sustainability of healthcare facilities and disease prevention and health promotion lead to cost savings (Ashton et al., 2020; Masters et al., 2017; McCullough, 2018; NHS England and NHS Improvement, 2022; Pisters et al., 2017; Storz, 2020; Sullivan et al., 2023).

In terms of patient experience, several associations are highlighted. Patient experience is associated with preventive care (Doyle et al., 2013) and nature exposure within the healthcare context (Tseung et al., 2022; Weerasuriya et al., 2018). For

Figure 2. How advancing planetary health contributes to other healthcare improvement aims.

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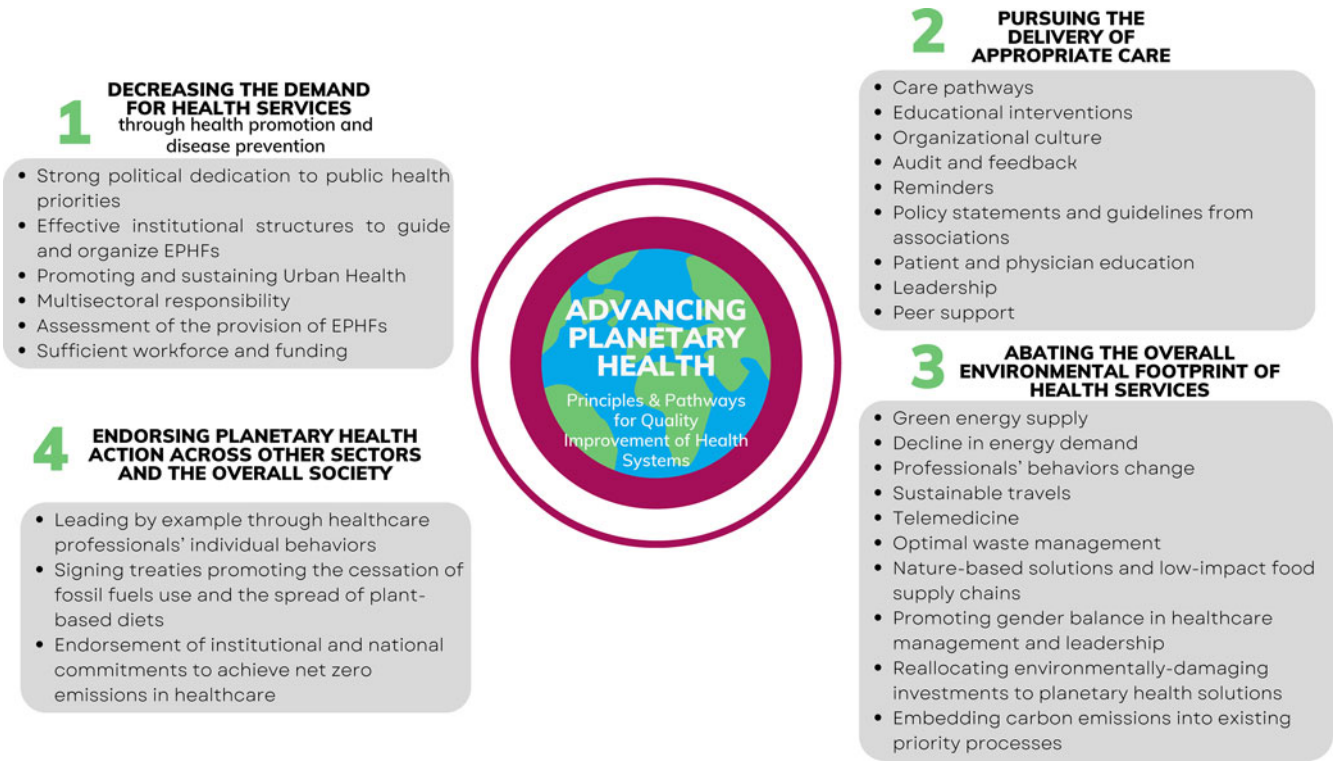

Figure 3. Main principles and pathways to advancing planetary health as the leading aim for quality improvement in healthcare systems.

example, having access to hospital green spaces significantly improves overall satisfaction with the facility, a sentiment shared by both patients and staff members alike (Kim et al., 2015; O'Hara et al., 2022; Sadatsafavi et al., 2015).

Reducing unnecessary visits and exams and green delivery of drugs also enhance patient experience (El-Hallal et al., 2021; Kelendar et al., 2020; NHS, n.d.; Rizan et al., 2019). Patients aware of planetary health issues might find comfort in receiving care in facilities transitioning to environmentally sustainable processes.

Pursuing the promotion of planetary health also affects the wellbeing of health professionals. Accessing green spaces and reducing workload by avoiding unwarranted care are suggested as positive drivers of health and wellbeing in the healthcare community (Centre for Sustainable Healthcare, 2020; Marusic, 2023).

The climate breakdown is already impacting health in a myriad of ways, including by leading to death and illness from increasingly frequent extreme weather events, such as heatwaves, storms, and floods, the disruption of food systems, increases in zoonoses and food-, water-, and vector-borne diseases, and mental health issues. Health professionals are at the forefront of responding to these health impacts, and their own wellbeing is also affected by the changing climate. They are exposed to the same health risks as the general population, but they also face additional stressors, such as increased workload, longer working hours, and exposure to traumatic events (Agache et al., 2022). As with patients, professionals with environmental values may find sustainable work practices more rewarding, easing potential discomfort and anxiety generated by the environmental footprint of their working practices. Further links, in this space, can be identified by reviewing the Covid-19 experience. Indeed, Covid-19 is regarded as an Anthropocene disease (O'Callaghan-Gordo & Antó, 2020), spurred by the degraded status of planetary health (Myers & Frumkin, 2020). It heavily strained healthcare systems worldwide, with consequences being felt in terms of healthcare professionals' mental health, as well (Aymerich et al., 2022; Galanis et al., 2021). Protecting the health of nature and humans through large-scale solutions may help avoid similar disastrous events and their wide-ranging aftermath (Myers & Frumkin, 2020).

4. Pathways for health systems to advance planetary health

Aiming to foster planetary health as a health system operationally translates into a series of intertwined pathways (Figure 3).

With regard to disease prevention and preventable disease burden, enablers can be identified in strong political dedication to public health priorities, effective institutional structures to guide and organize essential public health functions (EPHFs), multisectoral responsibility, assessment of the provision of EPHFs, sufficient workforce and funding (WHO, 2022a, 2022b). Given the increasing urbanization and the need to enhance disease prevention at the city level, political engagement, addressing urban determinants of health, policy debate and institutional reforms are demanded for the shift to health-promoting cities (WHO, 2020).

To increase care appropriateness, active multi-component initiatives proved their effectiveness in reducing unnecessary care (George & Joshi, 2022; Rose et al., 2021). Effective elements, either as single or multi-interventions, include care pathways, educational interventions, organizational culture, audit and feedback and reminders (Pereira et al., 2022). Policy statements and guidelines from associations, patient and physician education, leadership and peer support feature among the facilitators of

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the patient–planetary health co-benefit prescribing framework (Redvers et al., 2023).

Pathways toward decarbonized and low-pollution healthcare broadly encompass green energy supply across both own operations and supply chain, decline in energy demand, professionals' behaviors change, shift to low-impact drugs and devices (Andersen et al., 2023; Blom et al., 2024; Keil et al., 2023; Pernigotti et al., 2021), sustainable travel, telemedicine, optimal waste management, nature-based solutions, and low-impact food supply chains (Karliner et al., 2021; Purohit et al., 2021). Promoting gender balance in healthcare management and leadership generally, reallocating environmentally damaging investments to planetary health solutions (Howard et al., 2023), embedding carbon emissions into existing priority processes (Bhopal & Norheim, 2021), all fall under the scope of returning healthcare to a healthy balance with natural systems. In addition, integrating environmental information into Health Technology Assessment could help refine health system decision making about technologies or interventions. These decisions would be based on data on environmental effects as well as clinical outcomes and costs (Pinho-Gomes et al., 2022; Toolan et al., 2023).

The advocacy function of health systems spans leading by example through healthcare professionals' individual behaviors, signing treaties promoting the cessation of fossil fuels use and the spread of plant-based diets, the endorsement of institutional and national commitments to achieve net zero emissions in healthcare, including the implementation of procurement policies, of a 100% renewables energy strategy within nations, of ambitious nationally determined contributions complying with the Paris Agreement, of enhanced climate finance (Howard et al., 2023).

The implementation of circular economy (CE) strategies could provide a significant boost toward achieving all four of the described aims (advancing planetary health, enhancing the patient experience of care, reducing costs in the long-term and improving care team well-being), thus playing a central role in improving the quality of healthcare. CE can be described as an economic system that supplants the traditional 'end-of-life' concept ('take-make-waste') by emphasizing the reduction, reuse, recycling, and recovery of materials throughout the production, distribution, and consumption processes (Kirchherr et al., 2017). The traditional linear model has been shown to be inherently unsustainable because large-scale production and consumption play a significant role in global environmental degradation, producing excess solid waste, greenhouse gases, and other harmful emissions (MacNeill et al., 2020). These effects threaten public health through air pollution, water and soil contamination, ozone layer depletion, biodiversity loss, and devastating climate change. The CE transformative concept, which strives to eliminate waste through the continual use of resources, is reshaping industries and business models across the board (Sohal & Vass, 2022), with the healthcare sector being no exception (Kane et al., 2017). In healthcare, CE is interpreted as an inclusive economic system that adopts the principles of designing out waste and pollution (Lansink, 2018; Stewart & Niero, 2018), keeping products and materials in use, and regenerating natural systems. These principles permeate all facets of healthcare, from the design and manufacture of medical devices and equipment to the operation of healthcare facilities and the management of health-related waste. A comprehensive and collaborative approach is key in successfully implementing circularity in healthcare. These include end-of-life management (Lansink, 2018), business model innovation (Han et al., 2020), circular product design (MacNeill et al., 2020), localization of food chains (Health Care Without Harm, 2016), sustainable supply chain practices (United Nations Development Programme, 2020), resource recovery (Stewart & Niero, 2018), education (Soares et al., 2023), and collaboration.

5. Conclusion

We argue that shifting to a revised quadruple aim for healthcare improvement, as warranted in the present paper, is quintessential to health systems at the current time. However, while advocacy from health systems may be powerful, the current planetary emergencies are best tackled through shared goals in other adaptive complex systems, such as society, economy, and politics. We assert that advancing planetary health should be at the core of policies that address societal and economic issues (Campbell-Lendrum et al., 2023). Framing this with a focus on mutual benefits between sectors may increase feasibility and amplify successes (European Observatory on Health Systems and Policies, 2023; WHO, 2023).

Despite their inner contradictions, the sustainable development goals, along with an economy anchored to a degrowth and post-growth vision, aspiring to wellbeing and sustainable prosperity (Brand-Correa et al., 2022; D'Alessandro et al., 2020; Wiedmann et al., 2020) – rather than to perpetually inflate gross domestic product – are desirable partners of a renewed health system. Recently, the Covid-19 pandemic reaction illustrated the viability of significant and quick changes that demand the participation of governments, private businesses, civil society, and households (Myers & Frumkin, 2020; Ringsmuth et al., 2022). Such coordination between systems, on a national and international level, with the shared goal of enhancing planetary health, may lay the foundation of an authentic planetary health system (Prasad, 2023).

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