AMA Journal of Ethics®
October 2022, Volume 24, Number 10: E951-958

MEDICAL EDUCATION: PEER-REVIEWED ARTICLE

How Should Health Systems Science Promote Health Systems' Sustainability?

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Abstract

An expanded sustainability framework for health systems science (HSS) could promote health systems' capacity to deliver efficient, effective care for patients and to care for the planet by decreasing emissions and solid waste while cutting costs. This framework aligns well with the HSS mission to reform curricula and practice and has direct implications for patient care and systems-based practice competency development. Training clinicians to think critically about health system function, resilience, and sustainability will help prepare trainees to lead, innovate, and transform current health systems to prioritize planetary health, resource stewardship, and patient outcomes in a circular supply chain with low emissions.

Sustainable Health Professions Education

Health systems contribute significantly to climate change and greenhouse gas emissions.[1] The US health system is responsible for an estimated 8.5% of national annual carbon emissions,[1] producing more than 29 pounds of waste per hospital bed each day and more than 5 million tons of solid waste annually.[2] Health systems' waste and emissions result directly from health care facilities' infrastructure and operations (scope 1) and indirectly from purchased sources of energy, heating, and cooling (scope 2), and the supply chain of health care services (scope 3).[1] Pollution from solid waste and emissions is well known to adversely affect acute and chronic health outcomes—from cardiorespiratory diseases and birth defects to mental health disorders.[1,3] Eckelman and Sherman argue that the health sector's contributions to the climate crisis should be addressed in efforts to improve health care quality and safety.[4] We believe that mitigating direct and indirect harms of health system waste to clinical practice and public health requires applying the health systems science (HSS) framework to stewardship.

HSS is the study of how care is delivered, how health professionals work together, and how the health system can improve patient care and health care delivery.[5] Along with clinical and basic science, HSS has become a cornerstone of medical education, encouraging clinicians and trainees to be "systems citizens" who steward health systems and influence patients' health.[6,7,8] Specificallly, HSS links health care's

emissions and waste—environmental determinants of health—with poor outcomes for current and future patients and communities. Here, we build on current evidence in HSS to redefine value in health care delivery and education and to encourage development of a sustainability-centered health system.[4]

Lean Six Sigma

A health care system built on sustainability requires 2 key considerations: an HSS framework that implements the principles of Lean Six Sigma (LSS) methodologies and redefining *value* in our constantly evolving health system.

Value. Traditionally, waste in health care has fallen into 6 categories: overtreatment, failures of care coordination, failures in execution of care processes, administrative complexity, pricing failures, and fraud and abuse.[9] Yet this traditional HSS framework only accounts for waste as "wasteful medical practice" and does not account for waste from the outputs of care and health system functioning. This limited view of medical waste is in part due to value in health care being defined as outcomes relative to cost, which is achieved by maximizing the efficiency with which interventions are delivered.[10] However, given the large contribution of the health sector to global climate change and consequent adverse health outcomes, the definition of waste in health care must include solid waste and emissions.

LSS. Alignment of an expanded HSS framework that accounts for waste from medical outputs with existing HSS infrastructure (eg, medical education curricular design) can be achieved by applying LSS, which provides the tools by which the health care sector can rectify the harms to health from emissions and waste outputs. LSS is the combination of 2 process improvement methods—*lean* and *six sigma*. Lean seeks to minimize waste at all levels of system functioning while limiting costs and adding value for patients.[11] Six sigma is a metrics-driven approach used to reduce medical errors, eliminate defects in system processes (eg, in wait times, reimbursements, transportation flows, over-processing, and workforce hours), and control variation in health care delivery.[11] These methodologies optimize operations and patient outcomes.

There is untapped potential in using LSS methodologies to reduce solid waste production and decelerate health systems' dependency on fossil fuels. LSS methodologies have been successfully used by nonhealth care corporations and companies as a tool to improve emission and solid waste management and system efficiency at the operations, production, and supply chain levels.[12] As a result, some manufacturing companies have reduced their resource and energy consumption and carbon emissions, leading to cost savings. For example, 3M's corporate pollution prevention program, Pollution Prevention Pays (3P), prevented more than 2.6 billion pounds of pollutants and saved more than $1 billion in its first 31 years.[13] 3M's success lies in its use of LSS to improve operations and product quality, reduce process variation, and reuse and reduce waste materials.[13] While 3M's program targets manufacturing, the health sector can also use LSS to address sustainability, just has it has used LSS to reduce patient wait times, minimize inventory, increase reimbursements, improve quality of care, decrease transportation (eg, of patients, supplies, and medical equipment), prevent injuries, minimize overproduction, and decrease unneeded tests.[11] However, LSS has not been widely employed in health care to reduce each of the aforementioned areas of medical waste by employing principles of sustainability (eg, carbon reduction, waste output reduction, and reduced public health harms).

Employing LSS methodologies is a vital step in a path to sustainable health care. The US health system's exponential rise in demand for single-use disposable medical supplies in a linear supply chain system—coupled with natural resource depletion, crippled global supply chains, and a poorly equipped national recycling infrastructure plan—have placed the system at a tipping point.[14,15] This situation has resulted in increased system expenditures and health system-related waste and pollution, largely driven by facility operations and the supply chain of services and goods (eg, pharmaceuticals and medical devices).[14,15,16]

A sustainable health care system achieved through application of LSS would reduce the costs of health care delivery, benefiting the patient and the environment.[4] Health systems often run on narrow operating margins, and a significant contributor to limited profitability is energy costs.[16] Decarbonizing health care, reducing solid waste production, and curbing pollution can lower costs as well as reduce pollution-associated disease burdens and curb the health sector's contribution to climate change.[16,17] Such measures have saved academic health centers millions of dollars per year.[18] For example, Kaiser Permanente's progressive environmental standards for medical products and equipment has resulted in tens of millions of dollars in annual savings.[11] Individual hospitals' sustainability efforts have also proved lucrative. The Carolinas Medical Center, for example, saved an estimated $158 000 annually by "reusing foam padding, reprocessing single-use devices, and powering down equipment overnight."[19] Practice Greenhealth and Health Care Without Harm offer health systems best practices for employment of LSS methodologies to reduce solid waste and emissions from anesthetic gas use, increase operating room system efficiency, and reduce energy use.[20]

Redefining Value in Service Delivery

Redefining value-based care within the HSS framework is essential to developing sustainable health care delivery in 2 important respects. Firstly, costs or resources (eg, anesthetic gases) in sustainable health care systems weigh patient outcomes against the triple bottom line of environmental, social, and economic costs or impacts.[4] Secondly, including sustainability considerations in value-based care can reduce resource consumption to sustainable levels since, over time, high-value services (eg, operating room services) will not be available if resources are depleted.[4] This resource stewardship approach maximizes high-value care by matching supply of and demand for health services (eg, eliminating unnecessary use of hospital services, resources, and materials), thereby mitigating environmental and public health harm.[15] Reducing health care emissions and waste, however, requires intervening on both health infrastructure and the factors driving demand, which can be achieved by ensuring that incentives align to promote fiscal and environmental stewardship.[21]

Redefining value-based care to include sustainable levels of resource use and applying HSS and LSS methodologies can reduce emissions and solid waste at both macro and micro levels of health system functioning. Practice Greenhealth identifies several macro processes to reduce carbon usage and increase climate-smart health care, such as infrastructure development (eg, increased energy efficiency, decreased dependency on fossil fuels), supply chain management (eg, using local resources that reduce transportation), and purchasing (eg, decreased single-use disposable products and increased investment in reusables).[22] At the micro level, sustainability can be achieved

through patient care (eg, emissions budgets for anesthesia or asthma care, telemedicine) and administrative functioning (eg, videoconferencing).[23]

Redefining Value in Education

Medical education has evolved over the past 30 years from the traditional 2-pillar model of basic and clinical sciences to an interdisciplinary, 3-pillar model that includes HSS.[24] More than 20 HSS competencies aim to prepare physicians to work in interprofessional teams within increasingly complex health care infrastructures.[24,25] These competencies, which evolve over time, center on high-value care, improvement of health systems, population health, social determinants of health, and stewardship.[24,26] Inherent to these competencies—but often left out—are climate change and sustainable health system development. For example, health care waste intersects with the aforementioned foci of health system functioning (eg, through energy expenditure) and high-value patient care (eg, through development of resilient systems).

Education for sustainable health care refers to pedagogical and learning approaches that develop learners' knowledge, skills, and attitudes about the interdependence of ecosystems and human health, including the effects of environmental change on health, the health sector's impact on the environment, and sustainable solutions to both problems.[27,28] One tenet of HSS is preparing trainees to understand their evolving roles as caregivers within the increasingly overburdened health system.[5] Indeed, medical students themselves are increasingly demanding that climate change impacts on health and health care sustainability be included in their curricula, as they believe that environmental stewardship is vital to their duty of care.[15] Trainees realize that the current health system is functioning on a fossil fuel-based, high-waste model, ultimately at the expense of current and future patients' health; they are passionate about advocacy and driving meaningful action to transform the health sector into a net-zero, closed-loop system.[29] Many trainees believe this goal starts with their HSS education.[29]

The rapid pace at which health system functioning is evolving demands an equally rapid inclusion of health care waste and sustainability in trainee HSS education. In 2020-2021, 97 medical schools covered value-based care in their preclerkship curriculum.[30] In the same period, only 54 schools covered climate change during the preclerkship years.[30] While medical curricula are missing a critical component that shapes health system functioning in the 21st century, HSS offers an existing structure through which these factors can be incorporated in medical curricula.[31,32]

Expanded models of value-based, sustainable health care centered on improving outcomes for patients, families, and communities can be woven into HSS curricula in several ways.[5] The core domains for HSS curricula are (1) structure and process; (2) policy and economics; (3) informatics and technology; (4) population, public, and social determinants of health; (5) value; and (6) system improvement.[5] These domains, which map onto traditional HSS content areas,[5] align with practical actions that clinicians and health care leaders can take to achieve health sector sustainability, as proposed by Sherman et al.[15]

Table. Health Systems Science Curricular Domains and Associated Traditional and Sustainability Content Focus

HSS Curricular Domain	Traditional HSS Content Focus	Sustainability Content Focus
Health care structure and process[a]	Processes, fragmentation, and insufficiencies occurring within patient settings.[5]	Increased energy efficiency, solid waste generated during patient encounters, and patient flows (eg, decreased transportation).
Health care policy and economics[b]	Principles of health care policy, health care financing, and various US payment models.[5]	How Medicare could establish "green loan" fund for energy efficiency to incentivize health systems to decarbonize, reducing costs and pollution long-term.[16]
Clinical informatics and health care technology[c]	Principles of informatics, patient security, and challenges facing health information exchange.[5]	Assess energy efficiency of information exchange systems.
Population, public, and social determinants of health[d]	Identifying patient risks and vulnerabilities (eg, low socioeconomic status, lack of insurance or transportation).[5]	How emissions and solid waste pollution disproportionately impact the health of vulnerable and marginalized populations.[33]
Value in health care[e]	Stakeholder perspectives on value in care and components of high-value health care systems.[5,30]	Placing value on reduced emissions and sustainable resource use for health system functioning.
Health system improvement[f]	Quality improvement plans (eg, Plan-Do-Study-Act and Lean Six Sigma methodologies).[5]	How investing in sustainable infrastructure ultimately builds health system capacity through system resilience and increased preparedness.

[a] Focuses on how health care is provided through individuals, resources, and processes of delivery of care.[5]
[b] Involves decisions undertaken to achieve specific health care functions.[5]
[c] Application of information technology to delivery health care services, decision making, documentation, and electronic medical records.[5]
[d] Focuses on improvement strategies to address gaps in care through public health, preventative medicine, and social determinants of health.[5]
[e] Focuses on quality-of-care delivery, cost, and process waste through timeliness, efficiency, and patient-centeredness.[5]
[f] Focuses on improving health system efficiency.[5]

Conclusion

Health systems science, value-based care, and LSS are proven tools by which the health sector can develop a sustainable system that maximizes value and outcomes for patients and decreases the unsustainable financial and environmental toll of health care.[11] An expanded sustainability framework for HSS ultimately brings our health care system closer to providing efficient and effective care for patients and to caring for the planet by decreasing emissions and solid waste while cutting costs. This outcome aligns well with the HSS mission to reform curricula and practice over time in the context of our evolving world and has direct implications for patient care and systems-based practice competencies.[34] Training the rising generation of clinicians to think critically about health system functioning, resilience, and sustainability will pay dividends in the future.

It will prepare trainees to lead, innovate, and transform the current health system into one that wholly prioritizes planetary health, resource stewardship, and patient outcomes through a circular supply chain and low-emissions system.

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Citation
AMA J Ethics. 2022;24(10):E951-958.

DOI
10.1001/amajethics.2022.951.

Conflict of Interest Disclosure
The author(s) had no conflicts of interest to disclose.

The viewpoints expressed in this article are those of the author(s) and do not necessarily reflect the views and policies of the AMA.

ISSN 2376-6980