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FROM THE EDITOR

Why Health Care Needs Sustainable Waste Stream Management

Natasha Sood, MPH and Gaurab Basu, MD, MPH

Health Care Is a Major Polluter

Over the past 3 to 4 decades, evidence of climate change's adverse influence on health has amassed.[1,2] Climate change is fueled by burning fossil fuels, resulting in unprecedented, threatening atmospheric CO_2 concentrations.[2] The US health care sector is a significant contributor to global greenhouse gas (GHG) emissions, and, if it were its own country, it would be the 13th largest GHG emitter on the planet and the second largest industry contributing to landfill waste.[3,4,5,6,7] In 2018 alone, pollution output from US health systems translated to a loss of 388 000 disability-adjusted life years.[8] Health care not only contributes directly and indirectly to climate change, but also adversely influences communities' health through solid, liquid, and gas emissions.

Our Fractured Relationship With Nature

Our health systems and economies are built on the assumption of infinite natural resources and the continued existence of healthy ecosystems, which are critical to human health. Investing in evidence-based solutions to reduce health care systems' waste can safeguard the health of our planet now and in the future. The urgency to do this has never been clearer. The 2019 Intergovernmental Panel on Climate Change special report highlighted the need to make significant cuts in GHG—45% by 2030—in order to prevent temperature exceeding 1.5 °C above preindustrial levels.[2,9] Yet the Earth's surface has already warmed 1.1 °C relative to preindustrial levels.[10] Although the margin of error is slim, we have the solutions needed to prevent irreversible warming and cut emissions and solid waste production significantly; the health sector must do its part.[9] This issue of the *AMA Journal of Ethics* emphasizes that solutions needed to achieve a health system that is low waste and net-zero (ie, one in which GHG emissions released into and removed from the atmosphere are balanced) align with global sustainability targets and would incentivize fiscal and environmental stewardship.[9,11]

Health Care Must Do No Harm

When health professionals pledge to "do no harm" to patients, they seem to do so at the expense of local communities and the planet. Health professionals share ethical obligations to critically examine the sector's carbon footprint, divest from fossil fuels, and reduce solid waste production by investing in climate-smart health care. Given changing climate, health professionals must renew their commitment and redefine what it means to do no harm.

Given the adverse health consequences of pollution and waste, the health care sector should be the one to lead the way toward a sustainable economy; by framing waste reduction as a health issue, it is well poised to provide a shared language and universally agreed-upon values.[12] Sustainable health systems advance public health, promote equity, and respect planetary boundaries[13] by restructuring supply chains to reduce dependence on single-use, disposable health care items and by transitioning to a clean energy health care grid.[12,14]

The decision-making body of the United Nations Framework Convention on Climate Change—the Conference of the Parties (COP)—ended its 2021 conference (COP26) with small but significant commitments to health care sustainability.[12] While commitments to addressing the health impacts of climate change were not robust, for the first time in the history of the conference, climate-health issues had a large presence at the summit.[12] COP26 paved the way for 50 countries to commit to developing low waste, low-carbon health systems.[15] Furthermore, the US Department of Health and Human Services committed to reducing emissions at federal health facilities,[16] and 19 private US health systems committed to reducing GHG emissions.[16] We await meaningful action, but strides taken to include health system sustainability commitments at COP26 express growing understanding of the interdependence and interconnectedness of natural resource stewardship and successful, long-term health care.[12]

Environmental Injustice

Climate change exacerbates social inequity, disproportionately affecting marginalized and socioeconomically disadvantaged populations; its burdens fall heavily on the shoulders of Black, Indigenous, and people of color (BIPOC) around the world.[17] These communities contribute least to the pollution and waste that fuel the climate crisis yet suffer disproportionately from increased rates of cardiorespiratory illness, mental health disorders, adverse birth outcomes, and toxic exposures as a result of it.[1,2]

The health care industry should consider its role in contributing to—and address—the unequal impact of waste on BIPOC communities, which is rooted in a history of environmental and systemic racism. Despite BIPOC communities' efforts to address health consequences of environmental degradation during the US civil rights movement of the 1960s, the racial composition of communities continues to be the number one indicator of where toxic waste facilities, landfills, and waste processing centers are located in the United States.[17] While policies to combat waste and pollution are slowly being implemented, minoritized communities are the last to benefit, and inequity persists.[18,19]

This Theme Issue

We can reimagine a world in which we do not have to practice medicine at the expense of the planetary resources that sustain us. This issue articulates why building a health care system centered on sustainability, resource stewardship, low waste, and zero-emissions is one that invests in cost savings, resilience, expanded capacity, and equity. The contributors redefine what waste in health care means and reflect on public health values at the heart of a sustainable health care system that prioritize preventative medicine.[12] As the contributors illuminate, health systems must fully transform to meet sustainability standards and to uphold the commitment to safeguarding the health of patients, and must do so with an urgent sense of duty to future generations.[11]

Will the health sector rise to the occasion? This theme issue considers how to redesign our unsustainable health system to be one that delivers care not at the expense of future generations and our planet but *for* them. It explores how to use existing technologies to create a system well poised to adapt to the challenges that lie before us; discusses how a sustainable health system builds a resilient health care workforce and addresses environmental injustice; and investigates which entities bear ultimate responsibility for waste generated and consequent harms to patients and communities. Finally, the contributors outline mechanisms by which health systems science can prepare clinicians to become change agents, innovators, and sources of hope for a low-waste, net-zero health care system.

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Natasha Sood, MPH is a fourth-year year medical student at Penn State College of Medicine in Hershey, Pennsylvania. She is a co-founder of Medical Students for a Sustainable Future and is the project director of Climate Resources for Health Education. Her research and advocacy efforts focus on climate and health education, disaster preparedness, and climate-smart health care.

Gaurab Basu, MD, MPH is a physician and the founding co-director of the Cambridge Health Alliance Center for Health Equity Education and Advocacy in Cambridge, Massachusetts. He is also an instructor in the Department of Global Health and Social Medicine at Harvard Medical School; a health equity fellow at the Center for Climate, Health, and the Global Environment at Harvard University; and a faculty affiliate at the FXB Center for Health and Human Rights at the Harvard T.H. Chan School of Public Health.

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CASE AND COMMENTARY: PEER-REVIEWED ARTICLE

How Should Clinicians and Health Care Organizations Respond When Civic Planning Concentrates Waste Processing in Minoritized Communities?

Shanda Demorest, DNP, RN, PHN and Megan Chao Smith, RN

Abstract
US health care is responsible for 8.5% of the country's greenhouse gas emissions, contributes to nearly 30 pounds of waste per patient per day, and uses a vast array of toxic chemicals and pharmaceuticals that pollute our air and water. Communities are not affected equally by the volume and location of this waste: historically marginalized populations are hurt first and worst. This commentary on a case considers the irony that the health sector simultaneously responds to and produces environmental damage and argues that health professionals are ethically bound to protect patients' and communities' health.

Case

Primary care physician Dr G sees long-term patient Ms T (57 years old) for follow up to a radical nephrectomy performed 2 weeks ago. Ms T has seen several family members, friends, and neighbors—mostly people of color—in her rural community succumb to cancer and experience chronic illnesses during their lifetimes. High rates of morbidity, mortality, adverse birth outcomes, and diminished life expectancy relative to residents in other areas of the state have long been suspected to be linked to airborne emission and runoff exposures from a landfill that accepts solid waste from communities throughout half the state and from a facility that processes medical and chemical waste. Both are within a few miles of Ms T's neighborhood.

Dr G and her colleagues have long considered how to best support patients like Ms T, who live and die in communities where toxic waste exposures are higher than in communities where they live.

Commentary

The US health care industry contributes to 8.5% of the nation's greenhouse gas emissions,[1] produces on average more than 29 pounds of waste per patient bed per day,[2] and utilizes chemicals and pharmaceuticals that leach into drinking water supplies.[3,4] The health care system, which provides clinicians' paychecks, is a substantial polluter, producing nearly 5% of global greenhouse gas emissions in 2011.[5] Furthermore, 25 years of research demonstrates that civil planning consistently places waste management plants disproportionately in communities of people of color, resulting in disease and premature death due to toxic exposure, ie, environmental injustice.[6]

In light of her professional obligations to advocate for patients and “do no harm,”[7,8,9,10] how can Dr G respond to environmental racism and health inequity at work *and* in the community? In this commentary on the case of Dr G and Ms T, we discuss ways that health professionals and organizations can both advance racial justice and lead environmental change in health care. As elucidated by Annalise Norling, physicians’ professional obligation extends beyond the patient’s bedside to encompass health care pollution and its impact on the community at large.[11] We believe health professionals and organizations can—and must—create health equity from within their institutions by moving beyond “considering” to implementing a concrete praxis based on professional and critical self-reflection. How can that course be charted? First, clinicians must educate themselves about historical environmental racism and their own unconscious bias. Second, health organizations must implement protocols, training, and advocacy to address environmental injustice. Third, and most vitally, clinicians must take practical actions to initiate professional change at work.[12]

Environmental Racism and Unconscious Bias

On the road to transformative action and praxis, all of us clinicians must each look plainly at our own unconscious bias. It is when under stress that we resort to choices based on unconscious racial bias.[13] As clinicians, we frequently use personal discretion, and decisions made under pressure often amount to health care inequity.[13] Owning our own bias is the first step. Once clear on our own bias—and impelled by our code of ethics—we will be able to improve professional practice, even within an imperfect system. As stated by Camisha Russell in the context of racism and bioethics: “The deepest, most lasting change is likely to come from those people doing something from right where they are in their daily lives, both personal and … professional.”[12]

The second author (M.C.S.) relates how activism can spring from personal experience.

Despite the Twin Cities’ many decades-long record of inequitable waste management planning,[14] I, a Minnesota nurse, with light-skin privilege, in the midst of the health care COVID-19 crisis—and the murder of George Floyd within 10 blocks of my house—only recently became aware of this environmental crisis in a friend’s backyard. I attended a birthday party in St Cloud, Minnesota, for the daughter of a Black nursing colleague. Lost and circling, I found myself on a dead-end street at the gates of the St Cloud waste management site. Idling and dumbfounded by the heaps of trash, the hidden corner lot marked with warning signs, I viscerally felt the inequity of its placement in her neighborhood. In Minnesota, waste management plants are located in North Minneapolis, Duluth, and St Cloud, all communities largely populated by people with low incomes and people of color.[15] And, in the Twin Cities, zip codes with the largest percentage of residents of color had more than 5 times the rate of asthma emergency room visits in 2015 related to air pollution compared to areas with more White residents.[14] Yet the Minnesota Department of Health’s 2017 report merely seeks to educate community members about ways to reduce their own risks of environmental contamination.[16]

Like Dr G, I provide care within a health care system that pollutes communities I care for. My praxis is speaking up in interdisciplinary rounds when profit and efficiency sacrifice patient care; directly soliciting information from patients to ensure the *treatment plan is based on their narrative, not a biased one; and double-checking on patients so easily overlooked when nurses are understaffed. But the problem of environmental health inequity is not only for individual clinicians to tackle; it is also for hospital leadership to address.*

Responsibility for Change Extends Beyond the Clinician

Institutions. Health organizations can take responsibility for health inequity by providing antiracism educational sessions for employees and by establishing sanctioned environmental justice task forces at hospitals and clinics. They can implement health screenings for known toxic waste-related cancers, kidney diseases, and prenatal damage, as well as provide proactive care, such as free prenatal care to affected communities. Arguably, since toxic waste is an international problem, screening for toxic waste exposure should extend to all patients and become a routine assessment. Figure 1 summarizes practical steps for health systems to meaningfully address environmental health equity.

Figure 1. Health System Actions to Address Environmental Health Equity

- Partner with supply chain colleagues to increase local and sustainable purchasing.
- Engage with diverse suppliers to infuse minority-owned businesses and local economies with powerful health care dollars.
- Transition away from toxic chemicals in favor of green cleaners that still comply with infection prevention policies.
- Establish monitoring and care protocols for patients at risk for environmental exposure (eg, toxic waste-related cancers, kidney disease, prenatal and gestational harm).
- Provide antiracism educational sessions to address racial bias and educate clinicians about the impact of health care waste dumping in minoritized communities.
- Establish and maintain hospital and clinic environmental justice task forces.
- Advocate for public policy change.

We recognize that profit can come at a sacrifice. Waste is a global problem requiring new solutions. Individual clinicians and health organizations can choose—and are professionally bound—to move the needle on environmental health inequity despite loss of short-term profit.

Associations. The climate impact of the transport and disposal of goods and the generation and treatment of medical waste has gained international attention.[5] At the national level, physician leaders inspired the American Lung Association to support policies related to impact assessment and cleanup of environmental hazardous waste in recognition of the health inequity created when civic waste is managed in poorer community areas.[17] Other organizations, such as Physicians for Social Responsibility,[18] WE ACT for Environmental Justice,[19] and ecoAmerica,[20] have had success in building awareness of the environmental impact of health care and empowering health professionals to take action to promote justice.

National associations also support state-specific climate advocacy and national sustainability efforts. The Medical Society Consortium on Climate and Health website, for example, hosts a compendium of state clinician climate action groups.[21] In 2021, the

National Academy of Medicine established the Action Collaborative on Decarbonizing the US Health Sector, which, in partnership with leaders from the health sector and the federal government, aims to decarbonize health care across Scopes 1 (direct emissions from "operations of health care facilities"), 2 (indirect emissions from "purchased sources of energy, heating, and cooling"), and 3 (indirect emissions from the "supply chain of health care services and goods"); accelerate climate-smart health care; and develop sustainability metrics for the industry.[22] The Impact Purchasing Commitment partnership between the nonprofit, fee-based health care membership organizations Healthcare Anchor Network and Practice Greenhealth provides an example of sustainable procurement practices in action.[23,24] Twelve health systems across the country representing $1 billion of the health care economy have committed to establishing sustainable procurement policies that simultaneously reduce environmental impact and invest in the underinvested communities.[23,24] Moreover, in December 2021, the Biden Administration launched a national initiative aimed at decarbonizing all federal facilities by 2045.[25] With an increasing number of state and national bodies supporting environmental action, health systems and hospitals will have more opportunities to form partnerships that combine political and grassroots energy.

Clinicians and Health Sector Sustainability

By recognizing and committing to mitigating the unjust health effects of health care pollution, clinicians can simultaneously deliver more equitable care and reduce the health sector's impact on the environment by taking the following steps.

Practice sustainably. Every procedure, lab test, surgery, and medication draws from the earth's natural resources and produces waste. It is estimated that the upstream and downstream emissions and waste involved in manufacturing pharmaceuticals and chemicals, rubber and plastic products, electronic equipment, and agriculture within the health care sector constitute approximately 30% of health care's greenhouse gas footprint.[5] By being strategic in supply utilization in patient care (in everything from assessment to treatment), health professionals can reduce the environmental impact of care.

Change policy. Health professionals can and should engage at a legislative level to advocate for policies that honor the right to health of every individual. There are multiple examples of effective campaigns led by health professionals that have resulted in public health policy changes; here we discuss 2 cases.

In rural Parkersburg, West Virginia, health professionals compiled medical reports and expert testimony regarding DuPont's inappropriate disposal of C8, a polyfluoroalkyl substance (PFAS) chemical used in the water-resistant material Teflon.[26] PFAS are a category of "forever chemicals" that persist in water, soil, food, and other materials.[27] C8, which never fully degrades, is associated with increased rates of testicular and kidney cancer, ulcerative colitis, thyroid disease, and other diseases.[28,29] The DuPont class-action lawsuit included over 3500 plaintiffs citing health impacts of PFAS; an estimated 70 000 West Virginians drank C8-contaminated water.[26] The class-action settlement resulted in DuPont paying for a monitoring program that screens citizens for C8-related health impacts, and, in 2015, DuPont ceased the manufacturing of the chemical[30]; over $700 million in settlement fees were paid by DuPont.[31] However, DuPont continues to produce a multitude of other PFAS chemicals closely related to C8,[30] highlighting the need for further advocacy efforts that hold industrial manufacturers to account.

A less successful example of advocacy is the Minnesota state clinician climate action group Health Professionals for a Healthy Climate, which sought to educate the public and policymakers about health implications of fossil fuel pollution and water contamination resulting from building Line 3,[32] a short-term fracking pipeline, and to advocate against it.[33] The much-contested Line 3 was given approval by the Minnesota Pollution Control Agency in 2020.[33] Despite health professionals' and many other community organizers' efforts, the pipeline now extends across marshes and waterways within Anishinaabe tribal land, violating tribal treaties and putting the community's drinking water supply, wild rice lands, and all community members' health at risk.[32,34]

Like Ms T, individuals in these communities face dangerous health implications as a result of unethical extractive and poor waste practices. Clinicians can learn about local environmental atrocities, such as in the cases of C8 and Line 3, and become powerful advocates, fulfilling their ethical and professional responsibility to patient health and the planet. In the case of unsuccessful advocacy efforts, which are many, clinicians must learn from these attempts and reframe their approach. Advocacy and organizing—even when led by the health professional community—does not guarantee success. Figure 2 summarizes practical steps clinicians can take to address environmental health equity.

Figure 2. Clinician Actions to Address Environmental Health Equity

- Empower patients to learn about the health risks of toxic waste in their communities.
- Reduce material, pharmaceutical, and chemical waste during clinical shift.
- Participate in developing monitoring and care protocols for patients at risk for environmental exposure (eg, toxic waste-related cancers, kidney disease, prenatal and gestational harm).
- Advocate for public policy change.

Prioritize. In traditional clinical ethics, the patient comes first.[7] In cases such as Ms T's, do local environmental justice issues take precedence over global justice issues? If local health systems expand their scope to include the environment, should they prioritize local pollution impacts over broader decarbonization efforts? In the interest of creating a win-win situation, it will be paramount to redefine *health care* so as to facilitate a deeper understanding of the health sector's environmental impacts on patient care and local communities and of national and global efforts to address health equity.

Conclusion

It's clear that the provision of health care causes significant environmental damage. It will likely take decades for our ethically complex health system to significantly address these environmental challenges, despite our knowing that health care sector emissions and waste generation disproportionately affects communities in poverty and people of color. Guided by the AMA Principles of Medical Ethics[7]—but also by broader allied health disciplines, such as nursing,[8] pharmacy,[9] and social work[10]—we, as clinicians, must reconcile environmental impacts with patient and community care. Moving forward, we must be accountable as agents not only of health, but also of inequity and pollution; we must create and distribute sustainability tools, revamp practices to clean up our health systems, and redefine what it means to provide true health care.

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Shanda Demorest, DNP, RN, PHN is the associate director for climate engagement and education at Health Care Without Harm and leads the Nurses Climate Challenge in partnership with the Alliance of Nurses for Healthy Environments. With expertise in the intersection of environmental sustainability in health care and human health impacts of climate change, she has provided direct care cardiovascular nursing and served as an assistant clinical professor at the University of Minnesota School of Nursing.

Megan Chao Smith, RN is an adjunct faculty member in the School of Nursing at St Catherine University in St Paul, Minnesota. With expertise in addressing health care inequity on the hospital floor, they have served as an advocate for patients experiencing homelessness and have educated clinicians to address inequity through daily nursing practice. They have also provided cardiovascular nursing, direct care in medical surgical nursing, and hospice nursing.

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Dr Demorest works with Health Care Without Harm and its affiliate organization, Practice Greenhealth, a fee-based vendor to health care organizations interested in promoting their roles in sustainability. Megan Chao Smith had no conflicts of interest to disclose.

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CASE AND COMMENTARY: PEER-REVIEWED ARTICLE

How Should We Respond to Health Sector Emissions That Exacerbate Climate Change and Inequity?

Ava Ferguson Bryan, MD, AM, Elizabeth Yates, MD, MPH, and Neelima Tummala, MD, MSc

Abstract
A warming climate poses substantial risk to public health and worsens existing health inequity. As a contributor to greenhouse gas emissions and air pollution, the health sector has obligations and ample opportunities to protect health by decreasing waste and motivating more system-wide sustainable clinical practices. Such efforts will have important ethical implications for health equity.

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Case

City Y has ambient levels of particulate matter (PM) of 2.5, a rate 25% higher than most American cities. The American Lung Association had flagged Y as 1 of 2 cities that fail State of the Air evaluations[1] in ozone and PM pollution. Y's air pollution is due to wood burning, which is common in nearby rural communities; its geographical location downwind from plants that power and process solid waste for 4 larger metropolitan regions in nearby neighboring states; and 3 major academic health centers. Thirty percent of contemporary illnesses (eg, diabetes, asthma, cardiovascular disease, chronic obstructive pulmonary disease, and lung cancer) in Y are attributable to poor air quality. In the United States, communities of lower socioeconomic status are at risk of exposure to higher levels of air pollution than those of higher socioeconomic status,[2] and, worldwide, low- and middle- income countries are most at risk.[3] Moreover, diseases caused by pollution were estimated to be responsible for 16% of global mortality and 268 million disability-adjusted life years (DALYs) worldwide in 2015.[3]

Commentary

The evidence is clear that fossil fuel combustion is driving global temperatures upward through the emission of greenhouse gases (GHGs) and worsening air quality via air pollution, both of which pose a major threat to human health.[4] Higher levels of GHGs trap excess heat energy within the atmosphere, which has contributed to an approximately 1.01 °C rise in global temperatures since 1880.[5] Global warming threatens physical and mental health by increasing the risk of extreme weather events such as heat and drought, increasing the environmental suitability for infectious disease transmission, and threatening food and water availability.[4]

While GHGs, such as carbon dioxide, are at their highest levels ever recorded,[5] air pollution in the United States has improved over the last 50 years, thanks to regulatory legislation, such as the Clean Air Act of 1970.[6] Despite these air quality improvements, air pollution remains one of the greatest threats to health, both domestically and globally.[3] The Global Burden of Disease Study estimates that air pollution accounted for 6.5 million premature deaths and 167.29 million DALYs globally in 2015.[7]

Not only do clinicians treat the health sequelae of climate change and air pollution, but also the health care sector contributes to these problems. The US health care sector was responsible for approximately 8.5% of US GHG emissions in 2018, with an estimated median loss of 388 000 DALYs attributable to GHG emissions and toxic air pollutants.[8] Of these, health care-related PM and ozone pollution are estimated to have caused the loss of 133 000 to 188 000 DALYs.[8] Thus, the health care sector is contributing to an environment that poses a risk to health for those it is entrusted to protect. Here, we discuss the ethical imperative for clinicians to consider the environmental implications of health care waste and introduce several initial waste reduction strategies that align with the delivery of high-quality care.

Exposing Inequity

Global and national DALYs lost annually to diseases attributable to air pollution mask the inequitable distribution of harms. In City Y, the poor air quality relative to other American cities is a compound effect of multiple sources, including 3 major academic centers. But not every person living in City Y is subject to the same risk from air pollution. According to the American Lung Association 2022 State of the Air report, people of color are 3.6 times more likely than White people to live in a county with failing grades for PM and ozone.[9] Decades of environmental injustice in cities across the United States have led to inequities in exposure to environmental risk factors. For example, polluting facilities, such as the waste facility referred to in City Y, are more likely to be located close to Black or working-class communities.[10] People of low income are at higher risk from the health harms of air pollution not only because of where they live but also because they often have less access to expensive adaptation strategies, including air purifiers and advanced medical care. Outdoor workers, such as agriculture workers and construction workers, are also more vulnerable simply based on the extended amount of time they must spend in a potentially unhealthy environment in order to earn a living.[11]

City Y highlights a complex challenge for health care. Through care delivery, clinicians aim to improve patient health and reduce health inequity. Yet, like the 3 medical centers in City Y, each health care institution contributes GHG emissions and air pollutants that result in both health harms and worsened health inequity. The health care sector therefore has an ethical imperative to identify solutions that minimize environmental harm to population health while continuing to deliver high-quality care.

Innovative clinicians, policymakers, and administrators have developed and continue to implement a wide variety of strategies to reduce the environmental impact of health care delivery—from improving energy efficiency to reducing transport-associated emissions via telehealth implementation. In the remainder of this paper, we will focus on health care waste, a component of the larger challenge of minimizing environmental harm associated with the health care sector.

Waste Reduction Ethics

Misaligned incentives. In the United States, despite efforts to decouple reimbursement from volume, most health care systems still operate under a fee-for-service model that financially rewards volume. Because hospitals and physicians financially and professionally benefit from higher clinical volumes, clinical care efficiency strategies must be implemented. As highlighted above, unnecessary clinical activity harms the health and well-being of surrounding communities through GHG emissions and pollution. Such environmental harms in turn contribute to disease and injury, the treatment of which further benefits hospitals and physicians—financially and professionally—in a potentially never-ending cycle. Through the complexities of threat multiplication, the most vulnerable communities suffer the greatest health harms in this cycle. Thus, physicians and hospitals have an ethical obligation to minimize unnecessary care and to provide all care in the most environmentally sustainable manner possible.

Patients' rights and equity. Physician and hospital efforts to reduce waste and promote sustainability are necessary for the protection of patients' negative right not to be harmed. Endeavoring to minimize the environmental harm of health care waste must become an essential facet of how the medical profession conceptualizes clinician nonmaleficence. Moreover, the disproportionate harm borne by minoritized communities creates an imperative for physicians to curtail unnecessary health care waste to meet their obligation to offer all patients an equitable chance of achieving good health and freedom from disease and injury. Continuing to operate under the status quo is therefore doubly unjust. While the reality of health care delivery to the presenting patient necessitates generation of some waste, the harm associated with that waste disproportionately affects those least likely to access health services. Physicians and hospitals must therefore minimize such waste as much as feasible—by both minimizing unnecessary health care and offering necessary health care in the most sustainable way possible to uphold the standards of justice and equity.

One of the standards of ethical human subjects research, elaborated in the Belmont Report, dictates that the subjects of research must either directly benefit from that research or be meaningfully like future patients who might benefit from that research in order for that research to meet standards of justice.[12] We could imagine incorporating a similar criterion for judging the acceptability of a hospital's waste: if the externalities of a patient's care harm people meaningfully unlike that patient, the system of disposing of that waste is unjust. Such a conceptualization of equity could inform clinicians' and hospitals' engagement in efforts to reduce health care waste.

Waste Reduction Strategies

Health care waste can be conceived of in 2 categories. First, unnecessary or unindicted care is itself a form of waste, including commonplace practices like daily magnesium-level testing and antibiotic therapy for asymptomatic bacteriuria. Second, there is waste associated with appropriate, indicated care. From the byproducts of the manufacturing of necessary supplies to the food waste generated by admitted patients, there are many opportunities to minimize the environmental harms of waste from necessary care.

Unnecessary care. Hospitals and doctors are already regularly scored by the Centers for Medicare and Medicaid Services (CMS) for the quality of their patient outcomes, penalized for providing unnecessary care, and incentivized to provide more efficient care. Such scoring and reimbursement systems are often justified by financial imperatives and quality-of-care goals. But environmental sustainability provides another justification for bolstering and expanding these initiatives.

As clinicians, we can support this effort by implementing the best practices outlined by the Choosing Wisely campaign, which offers data-driven guidance on high-priority areas for reducing common, unindicated testing and therapies.[13] Within our institutions, we can work with our respective electronic medical records teams to integrate alerts that flag potential unindicated care choices. At a national level, reimbursement policies should reflect that excess unnecessary care not only reduces quality and increases costs, but also contributes to climate change-driven health inequities.

Solid waste associated with necessary care. As a first step, we can utilize existing guidelines on performing waste audits of our practice spaces to identify high-priority areas for waste reduction. Importantly, with our boots-on-the-ground perspective, we can ensure that any proposed changes align with, rather than impede, care quality and efficiency. Beyond identifying commonly wasted products, waste audits also provide insight into the proportions of different types of health care waste produced. Unlike standard waste, regulated medical waste (RMW), often placed in red bags, must be decontaminated prior to final disposal per Occupational Safety and Health Administration standards.[14] The decontamination process is energy intensive, and RMW is often transported off-site to undergo such processing, resulting in significant GHG emissions and air pollution[15] in contrast to landfilled standard waste, which slowly releases GHGs into the atmosphere but can leech into the surrounding soil and water sources.[16] Overuse of red bags for materials that could be processed in standard waste often occurs due to lack of education and convenience of receptacle positioning. As clinicians, we can help lead RMW education efforts and guide implementation of better waste receptacle positioning to reduce this misuse. Some best practice guidance recommends that institutions reduce RMW to 10% of their waste generation,[17] but more data on waste audits in different practice settings with varying case mixes could help define more nuanced targets.

At the institutional level, we can collaborate with administrative and purchasing teams to develop supplier contracts that reduce unnecessary waste from the start. Common examples include transitioning instruction manuals for commonly used disposable devices to electronic formats accessible via QR code and reducing excessive plastic packaging.

Equity in implementation. Regardless of disposal method, the location of disposal facilities is also crucial because nearby communities will always be most negatively affected. When considering the location of a waste incineration facility, equity issues arise when the electricity generated by incineration is distributed beyond the local community suffering the harms of air pollution. Like most heavy industries across the United States, many waste processing facilities are located in minority and poor communities.[18] Thus, tracking metrics on method and location of health care waste disposal in addition to overall volume of waste is crucial to building equitable health care waste mitigation policies on both the organizational (hospital or health system) and regulatory (state and federal) levels.

Incentivizing waste reduction. Of course, measuring and rewarding waste reduction would be sensitive to the same pitfalls as existing reimbursement incentives. Waste reduction is likely cost saving in the long-term but would require significant up-front capital costs. Resource-rich hospitals and health systems would be better able to provide sustainable care and therefore would benefit most from a pay-for-sustainability program modeled after CMS' current pay-for-performance programs. Thus, a sustainability perspective should also be added to efforts underway to measure and reward equity in health care. For instance, the collection and use of ICD-10 Z codes to document social determinants of health theoretically provides Medicare billing benefits to institutions and clinicians who care for marginalized communities, and, as a federal payer, Medicare has tremendous power to set standards within health care.[19] Such tracking methods could also be used to identify institutions that warrant financial and resource support in implementing waste reduction strategies.

A Future

We recognize that the ultimate solutions to the health inequities associated with climate change extend well beyond the management of health care waste. Such solutions require industry-wide changes and aligned national policies. We hope that clinicians will find guidance in this piece on meaningful steps they can take to reduce health care waste and that readers will be encouraged to lend their voice to advocating for larger sustainability efforts as a step toward health equity for communities like City Y that exist across the nation.

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Ava Ferguson Bryan, MD, AM is a general surgery resident at the University of Chicago, a research fellow at the Center for Surgery and Public Health at Brigham and Women's Hospital, an MPH candidate at the Harvard T.H. Chan School of Public Health, and an American College of Surgeons-MacLean Center surgical ethics fellow. Her research interests are the ethics and policy of equitable access to care.

Elizabeth Yates, MD, MPH is a general surgery resident at Brigham and Women's Hospital in Boston who plans to specialize in vascular surgery. Her research interests include improving the environmental sustainability of surgical care delivery and investigating how climate change impacts surgical outcomes.

Neelima Tummala, MD, MSc is an ear, nose, and throat surgeon who serves as a clinical assistant professor of surgery in the School of Medicine and Health Sciences at the George Washington University in Washington, DC, where she is also a co-director of the Climate and Health Institute. She has an interest in the public health impacts of climate change and has written and lectured on this issue.

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The people and events in this case are fictional. Resemblance to real events or to names of people, living or dead, is entirely coincidental. The viewpoints expressed in this article are those of the author(s) and do not necessarily reflect the views and policies of the AMA.

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CASE AND COMMENTARY: PEER-REVIEWED ARTICLE

What Would It Mean for Health Care Organizations to Justly Manage Their Waste?

Genevieve S. Silva and Cassandra Thiel, PhD

Abstract
Waste generated by health care includes harmful emissions and often disproportionately affects already vulnerable communities. Justly restructuring health care waste management involves better understanding key drivers of waste production, using sustainability as an ethical value to guide disposal decisions and practices, and reducing overall disposal quantity. Restructuring can be facilitated by making existing waste audit data transparent, incorporating waste accounting into social responsibility metrics used to evaluate health care organizational performance, and implementing policies that prioritize frontline workers' safety.

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Case

Prior to the COVID-19 pandemic, US hospitals produced 29 pounds of waste per bed per day—over 14 000 tons of waste per day.[1] Increasing numbers of clinicians, trainees, and students in a regional university academic health center have anonymously reported (via a hotline maintained by the organization's risk managers) inappropriate disposal of recyclable items, common refuse items, and red bag items (ie, medical waste, hazardous waste). Many students have also noted that applying disinfectant, donning personal protective equipment (eg, masks, gloves, gowns), and using high-volumes of water to thoroughly wash their hands and arms (colloquially known as "scrubbing in") is wasteful when they are seeming sufficiently distant from a sterile field protecting a surgical patient in an operating theater.

Health care organizations pay to decontaminate red bag waste to make it safe for disposal (ie, by microwave or steam sterilization, chemical disinfection, or other processes) and must comply with federal, state, and local regulations about how disposal is done.[2,3] Some hotline reporters have noted that incorrect placement of recyclable or municipal waste in red bags incurs unnecessary costs to organizations and that processing (primary) red waste generates (secondary) air- and waterborne emissions that inequitably influence health outcomes in minoritized communities;

nationally, people of color are exposed to 38% higher levels of outdoor nitrogen dioxide than White people.[4]

Two risk managers who field hotline concerns and inquiries also regularly apprise the organization's senior managers about these concerns and offer recommendations on how to respond. They wonder which recommendations to offer senior managers to help protect the short- and long-term interests of the organization.

Commentary

In addition to generating a significant amount of waste, the health care sector directly emits an estimated 7% of the United States' greenhouse gases.[5] Members of the medical community have grown increasingly uncomfortable with pollution's socioenvironmental impacts, with attempts being made to enact environmentally responsible change at the level of individual practices, medical specialist organizations, and medical education programs.[6,7,8] However, the power to most significantly decrease emissions and waste generation lies with large health care systems, which have become a focus of advocacy and sustainability efforts.

Aside from health care's contribution to climate change, the escalating ramifications of which already threaten global public health, the waste generated by health care systems exacts a more local toll on already disadvantaged populations. There is evidence that health care waste ends up in landfills disproportionately sited in communities with lower average incomes and higher percentages of residents identifying as minorities.[9,10] These marginalized populations often lack appropriate resources to advocate for more stringent environmental safety regulations in their neighborhoods and consequently face increased health hazards.[11] For example, poor air quality and associated increased asthma rates have been documented adjacent to land used in the Bronx to house waste transfer stations for solid waste and sharps from some New York City health care facilities.[12,13]

The medical profession is morally bound by the Hippocratic Oath to protect health and "do no harm," yet the very patient populations that large health care systems serve are often those that are inordinately harmed downstream by the byproducts and waste generated from medical care. This consequence is in direct conflict with the principles of justice and nonmaleficence, 2 of the 4 foundational tenets of medical ethics.[14] It is therefore in the interest of health care organizations to address their waste-associated environmental inequities.

What would it mean for health care organizations to ethically manage waste? Waste management that centers justice would seek to both minimize the quantity of waste generated and more sustainably dispose of unavoidable waste. Successfully enacting these steps requires better understanding of the technical, administrative, and cultural drivers of current waste production. Furthermore, equitably implementing these steps requires accounting for the health and safety of essential workers who handle hospital waste and ensuring that any workflow restructuring incorporates their perspectives.

We Can't Control What We Can't Measure: Waste Audits and Their Implications

Waste audits are a critical tool—with currently underutilized potential—for understanding the multifactor drivers of medical waste generation. They also represent a promising mechanism for leveraging systemwide change. In this discussion, we will use the term *waste audit* to refer to reviews of health care organizational waste management protocols and high-level accounting of categories and quantities of waste. This approach is distinct from *detailed* waste audits, which involve individuals sifting through trash bins to conduct manual counts and sorting and weighing waste.[15]

At present, waste audit data is collected by all major health care systems for legal, contractual, and taxation purposes. The regulations of the Resource Conservation and Recovery Act of 1976 stipulate that hospitals must ensure proper disposal of their hazardous or infectious waste, although interpretation and enforcement of the regulations is delegated to the state level.[16] States also utilize guidance from the Environmental Protection Agency (EPA) and the Centers for Disease Control and Prevention as the Medical Waste Tracking Act of 1988, which authorized the EPA to promulgate and enforce regulations, expired in 1991.[17,18] Some states or local municipalities require hospitals to report total quantities of waste generated annually to monitor waste management. Hospitals may be required to pay annual state taxes based upon these reported quantities (eg, New York University medical center's waste is taxed by the New York State Department of Environmental Conservation[19]). Although most health care systems track total quantities of waste generation, the data are typically not publicly available or even accessible upon request for research purposes. In some instances, such as in the case of hazardous chemical wastes, contracts between health care systems and waste haulers may stipulate that haulers may not share hospital disposal data with anyone (J. Kang, email, August 18, 2021).

The existing data collected by all health systems represent a wealth of untapped information that could aid researchers and policymakers in designing strategies for waste reduction. For example, audit information could demonstrate correlations between the ratio of red bag waste (which is more energy- and emissions-intensive to process) to white bag waste and numbers of patients or staff members, existence of staff training programs, supply expenses, acuity of patient care, or volumes of types of procedures performed. Such insights could inform targeted interventions at the hospital level, such as updating red or white bag guidelines and implementing additional training in departments with the greatest ratio of red to white bag waste generation. Differences between audit scores of floors with comparable acuity of patient care could be used to incentivize more sustainable practices, much as how metrics for preventable nosocomial infections by floor are leveraged to improve care. On a broader scale, understanding average waste generation of health care facilities by level of acuity or volume of procedure type could motivate accrediting bodies to reward systems of comparable size that produce lower volumes of waste. Therefore, more just waste management might involve loosening contractual limitations on data sharing, implementing laws requiring transparency of health systems' waste data, and incentivizing voluntary reporting in an accessible database. Doing so would not only facilitate development of research-backed strategies for waste reduction policy, but also allow health care systems to be rewarded for responsible waste management.

Most hospitals' waste reduction efforts are motivated solely by legal and financial obligations; however, some pioneering US health care systems have integrated environmental sustainability and social justice into their strategic priorities, making them more intrinsically motivated to reduce waste. Such systems embody the medical ethical principle of beneficence, which goes beyond nonmaleficence by not only avoiding harm but also actively promoting well-being by removing conditions that cause harm.[14] These health care systems are recognized for their sustainability milestones through organizations such as Practice Greenhealth.[20] However, equitable waste management requires that patient populations across the country and all health care districts receive the benefits of health care systems' sustainable practices. Public health benefits should not be limited to those communities served by internally motived green health care systems.

With access to waste data from all major US health care systems, Practice Greenhealth's Environmental Excellence Awards, for example, could be converted into a standardized metric considered by accrediting bodies like the Joint Commission, to which all hospitals are beholden. A "just waste management score" or "socioenvironmental sustainability score" could join respected standards like the Center for Medicare and Medicaid Services' Overall Hospital Quality Star Rating system or the American Hospital Association Annual Survey.[21,22] Such a metric could initially be based on data that hospitals already collect. It could eventually incorporate factors such as whether hospitals contract with sustainable waste haulers, invest in offsets, or advocate for the health of communities that receive their hazardous waste. Using existing waste audit data would be an excellent starting point for implementing just health care waste management that would not require a significant change in workstream.

Such efforts could lay the groundwork for embarking on detailed waste audits, which are significantly more resource- and labor-intensive. However, for accrediting or government bodies to require periodic detailed audits would be unfair to under-resourced health care systems, especially if the audit data were incorporated into a hospital grade that affected patient retention. Instead, detailed waste audits could be implemented within health care systems based upon findings of higher level audits. Moreover, the burden of conducting these detailed audits should not simply fall upon the building services staff, who are often poorly compensated and have little role in generating the waste to which they would be exposed while sorting.[23] An ethical distribution of labor might involve a multidisciplinary committee structure in which hospital staff across all levels of a department participate in sorting and weighing the waste. This arrangement would elevate the importance of waste analysis, increase intradepartmental engagement, and encourage everyone to consider their respective responsibilities and the potential impacts of their practices.

Doing Better

Data collected from waste audits would help eliminate unnecessary consumption and disposal by providing valuable insights and facts to inform policy and process changes. Internally, health care systems could use the data to motivate the reduction of extraneous supply waste from poor stocking practices, inefficient inventory rotation resulting in expired supplies, and outdated preference cards or surgical packs that consistently waste unused items, for example.[24,25]

It is inevitable that some waste will necessarily be generated during health care delivery. Beyond examining disposal alternatives to high emissions-generating landfills and waste incineration, such as electropyrolysis and chemical-mechanical systems, reusability should be a primary focus. This commitment can begin with stocking products already designed for reuse, such as washable isolation and surgical gowns. Most hospitals already use reusable-designated surgical instruments that are routinely disinfected in-house and reused after applying techniques like thermal microwave treatment and steam autoclaving. Furthermore, single-use disposable (SUD) medical devices may be reused after disinfection by third-party contractors; the reuse of SUDs is an expanding market and the subject of ongoing debate.[26,27,28]

Some eschew the reuse of SUDs and even reusable devices over concerns for patient safety due to infection risk and possible delays in care delivery.[29] It would certainly be unethical to significantly increase the risk of hospital-acquired infection in the name of waste reduction. However, concerns about insufficient sterility may be assuaged by the US Food and Drug Administration's (FDA's) oversight of and requirements for third-party SUD reprocessors.[30] SUD reprocessors test every single product that leaves their production line, whereas original manufacturers typically conduct batch testing (ie, sampling a small number of SUDs in a large batch). Manufacturers' use of long and complicated supply chains can result in safety oversights for individual products (such as surgical instruments that are sterile but not clean), not to mention potentially dangerous and unethical working conditions for those manufacturing SUDs.[31,32,33] In-house oversight of reusable medical device sterilization and quality control of SUD reprocessing arguably produce more consistent quality and safety in reusable supplies and reprocessed SUDs compared to many single-use items. Yet one may posit that increasing reliance on SUDs in the name of safety parallels the trend of overuse of medical care; overuse of testing and treatment in some contexts can lead to net patient harm.[34] Very few studies exist to justify the safety benefits of SUDs in light of their financial costs. However, recent studies in specific surgical specialties show that lower resource settings are safely and effectively reusing many medical supplies by systematically following specific safety and sterility protocols.[35,36]

These protocols, as well as supply chain flow, are important for hospitals to consider when planning SUD reusability. For example, operating room schedules can be thrown off when equipment kits are unavailable due to reprocessing delays, leading to later procedure start times or patients remaining intubated and under anesthesia longer than necessary while the required equipment is located. One must also consider that implementing a new workflow for reprocessing and reusability might initially worsen the quality of life of nursing and house staff and others who would be directly impacted by the change. To prevent staff dissatisfaction, reduced compliance with new policies, and resulting risk of detriment to patient care, early planning for reusability implementation must include delegates from all hospital stakeholder groups. It is critical to foster enthusiasm and to educate all hospital staff about the underlying motivation for implementing changes to workflow—to protect the health of local communities and to take responsibility for reducing the impact of escalating climate change, which was recently projected to lead to 83 million excess deaths by 2100.[37]

The importance of reusability has been further highlighted by the COVID-19 pandemic, which exacerbated environmental injustices and inequities in health care delivery. Health care-associated waste generation has increased globally during the pandemic and has overwhelmed waste treatment facilities, especially in countries under-resourced at baseline, leading to increased uptake of alternative disposal strategies that may release harmful byproducts.[38] Moreover, shortages of single-use personal protective equipment during the pandemic led to failure to protect health care workers from dangerous exposures.[39] Both of these problems could have been prevented by reusable supplies, although the rollback of single-use plastic restrictions in the United States during the pandemic contributed to increased waste.[40]

Finally, recycling supplies and equipment rather than disposing of them helps to divert medical waste from landfills. However, if done improperly, recycling can exacerbate health inequities.[41] Following similar transportation routes as other waste streams, recycling can contribute to air pollution at local waste transfer stations, and nonrecyclable wastes frequently contaminate recycling streams.[13] These nonrecyclable products are often inappropriately dumped in lower-income countries that have purchased the recyclable materials, contributing to waste-related environmental injustice internationally.[42] This injustice makes it all the more imperative that health care systems look for opportunities to justly engage in a circular economy and advocate for ethical practices even in the context of large-scale processes that do not account for local inequities.[43] Some have begun evaluating the idea of responsible redistribution, in which unused, discarded supplies from larger centers that are safe and suitable for use may be given to health care systems in need.[44]

Engaging in Policy Change

While health care systems and individuals working in the health care space have some control over what they consume, ultimately, the impact of their supply chains and waste streams depends upon how those industries are designed. Health care systems should use their purchasing power and community influence to demand more equitable and sustainable modifications to those industries. They should encourage local, state, and federal policymakers to create and enforce legislation that helps reduce or eliminate health care-related waste and emissions and, more broadly, encourages the adoption of a circular and low-carbon economy. For example, we should encourage policies to electrify a local municipality's waste collection fleet, which would reduce air pollution in communities where transfer stations are located.

In addition, health care systems and the individuals within them can challenge product representatives and existing hospital policies that blindly support the increased adoption and use of SUDs.[45] An example is the recent editorial written by the FDA's director of the Division of Ophthalmology, Wiley Chambers, which supports using multidose topical ophthalmic drugs on multiple patients until the expiration date on the bottle, even in an operating room.[46] The publication of this editorial followed Chambers' discussion with members of various US ophthalmology societies who disagreed with existing hospital policies to dispose of multidose topical drugs after each patient,[47] which still results in nearly 66% of eyedrops being wasted.[48,49] This example illustrates the critical role of ethics-guided advocacy within systems governed by sweeping policies that may leave practical gaps or overlook downstream effects at the ground level.

Conclusion

In an era of escalating climate change and businesses reckoning with environmental sustainability, the health care industry faces a unique conundrum: the volume of waste it generates in caring for patients paradoxically damages the health of the populations it seeks to serve. Determining how to justly manage health care waste is complex but must start with greater transparency concerning current waste trends to inform high-impact policies moving forward and to allow organizations to be recognized and held accountable for environmental sustainability. To be successful, processes of waste reduction, reuse, and sustainable disposal must ultimately achieve buy-in from stakeholders across the health care system and involve diverse perspectives in their implementation.

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Genevieve S. Silva is a fourth-year medical student at the Perelman School of Medicine at the University of Pennsylvania in Philadelphia. She earned a BS degree in ecology and evolutionary biology from Yale University in 2017. Her professional interests include the intersection between medicine and climate change, the human health impacts of the changing climate, and health care's contribution to global emissions.

Cassandra Thiel, PhD is an assistant professor at the New York University Grossman School of Medicine in New York City. She obtained a PhD in civil and environmental engineering from the University of Pittsburgh. Her research quantifies the waste, emissions, and resource consumption of health care services and medical technologies with the goal of making health care delivery more efficient.

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CASE AND COMMENTARY: PEER-REVIEWED ARTICLE

How Should Biocontainment Balance Infection Control With Practice Sustainaibility?

Abigail E. Lowe, MA, Aurora B. Le, PhD, MPH, CSP, CPH, and Shawn G. Gibbs, PhD, MBA, CIH

Abstract
This case and commentary canvasses clinical, ethical, and public health considerations about integrated infection control and sustainability efforts of biocontainment units (BCUs). BCUs protect the public's health during infectious disease outbreaks, including accounting for downstream health costs of byproducts of patient care that leave a system as waste. However, environmental costs of BCUs' operations tend to get less attention than BCUs' specialized design to contain and control highly infectious pathogens. Human health promotion and environmental protection are values that sometimes complement each other but sometimes conflict in BCU management. When these values conflict, stakeholders must mediate and balance their implications in terms of individuals' immediate short- and long-term needs for health care, public interest in pathogen control and containment, and environmental impact.

Case

Dr K is medical director of a 5-bed patient care biocontainment unit (BCU) within a 600-bed urban hospital. Dr K is ultimately responsible for all aspects of pathogen containment, which includes but is not limited to BCU design; policy and procedure implementation, evaluation, and modification; personal protective equipment (PPE) selection and policy and procedure evaluation; supply chain administration; and category A and B solid and liquid waste management. Dr K and BCU staff (eg, clinicians and infectious disease scientists) have designed BCU protocols focused solely on evidence-based infection prevention and control (IPC), which emphasize patient safety and risk reduction for health care workers (HCWs) above all else and have paid little attention to BCU operations' environmental impact.

Dr S was recently hired as the hospital's chief sustainability officer with a mandate to position the organization—through waste reduction and carbon footprint minimization—as a stewardship and sustainability leader. Dr S is considering multiple organizational changes to improve environmental impact and is collaborating with Dr K during regular meetings to discuss possible changes to BCU operations, such as transitioning to low-flow automatic faucets to save water, transitioning to automatic hand dryers to reduce paper waste, and reducing disposable personal protective equipment (PPE) use, each of which measures Dr S sees as key to sustainability. Dr K listens and considers Dr S's points but is, overall, convinced that long-term emphasis on stewardship and sustainability undermines evidence-based IPC's short-term prioritization of HCW risk reduction and patient safety.

Dr S wonders how to respond to Dr K's concerns.

Commentary

Health care is one of the leading polluting industries in the United States due to energy used in manufacturing hospital resources and hospitals' energy use, emissions, and waste volume.[1] If the earth's ecosystem is to continue to support human health, then each health care facility needs to provide care in ways that will sustain the earth's ecosystem and prevent further destruction.[2] The environmental costs of operating a BCU have never been fully evaluated, to our knowledge, but are likely to be substantially higher than standard medical care due to the higher energy usage in BCU engineering controls and BCUs' reliance on disposable PPE. These specialized treatment units have isolation capacity or negative pressure rooms designed for patients with highly infectious respiratory diseases and high-efficiency particulate air filtration systems to ensure that microorganisms do not spread beyond the patient rooms.

The United States currently has 10 regional treatment centers with high-level isolation units or BCUs, which are networked to provide an infrastructure of readiness for managing suspected and confirmed special pathogen incidents across our nation's public health and health care delivery system.[3] The Consolidated Appropriations Act of 2022 increased funding for the Office of the Assistant Secretary for Preparedness and Response of the US Department of Health and Human Services (HSS) to establish 3 new regional treatment centers,[4] and HSS' fiscal year 2022 budget justification included increased funding for other national programs (eg, the Strategic National Stockpile) that specialize in containment care readiness,[5] thus potentially increasing medicine's carbon footprint.

BCUs have the responsibility of designing IPC guidelines to ensure patient and staff safety and containment of highly infectious diseases, and BCU staff conduct regular trainings and annual exercises to test protocols.[6] However, the core requirements of containment care are not designed with sustainability in mind. The increased usage of disposable PPE, waste packaging, and patient personal items that are disposed of or destroyed rather than sterilized or decontaminated is associated with environmentally detrimental BCU policies that are designed to protect HCWs and patients.

Integrated IPC and sustainability planning for BCUs is critical. Climate change is a named cause of the decreasing interval between emerging infectious diseases,[7,8,9,10] making BCUs a central resource for health security even if they also contribute to environmental degradation. This case commentary examines the ethical tension inherent in environmentally responsible IPC practices, identifies several risk-neutral interventions to advance sustainability goals without a negative impact on IPC, and emphasizes the need for research and policy that enable BCUs to safely prioritize sustainability in containment care.

Environmentally Responsible Infection Prevention and Control

Dr S's concern about sustainability and protection of the earth's ecosystems underscores that BCUs should reassess their planning and protocols to mitigate environmental degradation. Balancing IPC with sustainability requires BCUs to consider environmentally responsible health care—efforts that include, but are not limited to, reducing waste incineration, recycling nonhazardous wastes responsibly, reducing water usage,[11,12] and reducing the use of disposable PPE. While Dr S highlights available environmentally sustainable practices, Dr K must grapple with whether the evidence base for sustainable practices is sufficient to secure health and safety.

Not all sustainability or product stewardship practices may be compatible within a BCU. Some BCUs may opt for automated faucets and hand dryers, which may be at odds with infection control and unintentionally increase the spread of infectious organisms.[13] Although automated faucets may conserve water, BCU care requires robust hand washing with ample soap and water, which can be negatively impacted by an automated faucet; a foot pedal-controlled faucet allows for greater control of the water and lessens the likelihood of cross-contamination of handles.[14,15,16] Additionally, although paper towels are wasteful and, when used in a BCU, cannot be recycled, they do not risk creating bioaerosols of the organism of concern as do hand dryers. Drs K and S must balance waste reduction against IPC by determining what changes they can feasibly implement without severely comprising one or the other.

Generally speaking, when promoting human health and protecting the environment are seemingly in conflict, stakeholders must mediate between and balance immediate health outcomes and long-term health implications.[17] Adequately addressing health means recognizing the interdependence of humans within a broader ecosystem, including the environment.[18] Sustainability in BCUs leans on some of the same core notions that are central to health security: a commitment to securing population health, whether through highly infectious diseases containment care or through IPC guidelines devised with safety and sustainability in mind.

While technologies for environmentally responsible IPC might not be available now, a commitment to funding research, innovation, and policies to address sustainability measures that can be integrated more robustly into BCU units is needed. However, in the case in question, the immediate health and safety of patients, BCU staff, and the community at large should take precedence over environmental sustainability, and the sustainability officer should respect the final judgment of the unit physician leader.

Waste Reduction and Product Stewardship

Waste reduction. There are several strategies to reduce waste and thereby the environmental burden of BCUs.

- When possible, items that are reusable and can be effectively decontaminated between uses should be substituted for nonreusable or single-use items (eg, scrubs, batteries, gowns, respiratory protection equipment).[19,20,21,22]

- Generally, once materials enter a BCU, they are either disposed of as waste or decontaminated for reuse; the nature of BCU care does not leave much room for recycling. However, prior to being taken into a BCU, excess packaging can be removed and recycled or disposed of as standard municipal waste.[23]

- Depending on which disease or pathogen BCU-associated waste contains, BCU waste is classified as category A (infectious substances) or category B (regulated medical waste).[23] Onsite BCU capabilities to transform category A waste into category B waste, either through incineration or autoclaving, allows suspected or confirmed highly infectious waste to be downgraded and processed with other medical waste. Reducing category A waste decreases the need for extensive, bulky, permit-approved packaging and reduces the energy and resources expended transporting it to a facility that accepts category A waste for ultimate disposal.[23]

Product stewardship. In recent years, product stewardship and sustainability have gained more traction among professionals (eg, sustainability officers, industrial hygienists, occupational health and safety specialists) responsible for product selection in their workplace. Product stewardship ensures that "those who design, manufacture, sell and use consumer products take responsibility for reducing negative impacts to the economy, environment, public health, and worker safety."[24] It entails creating and selecting a product with regard to not only its primary use but also its lifecycle impacts (eg, energy and material consumed in development and packaging, waste generation, toxic substances)—in what is known as an extended producer responsibility (EPR).[24] This is a mandatory product stewardship policy that incentivizes manufacturers to integrate environmental considerations into the product lifecycle and transfers financial and management responsibility for products from the public sector to the manufacturer with government oversight.[24] While EPR policies can be adopted at the state or federal level, in the United States they are far more common at the state level.[25] In the aggregate, these strategies can further decrease environmental burden.

Conclusion

At the institutional level, sustainability and IPC are not mutually exclusive but require coordination and collaboration between the departments responsible for them to arrive at mutually beneficial solutions. Sustainability solutions implemented within a BCU must not increase the risk of infection to BCU staff, patients, and the community, and, as such, not all sustainability solutions at this time are appropriate for the BCU space. At the federal level, continued expansion of BCU capacity must also be followed by appropriate preparedness planning that includes research on innovative protections designed with safety and sustainability in mind and that models how PPE and other workplace administrative and engineering controls can simultaneously be effective and sustainable. Currently, BCU operations are necessarily resource intensive, but, in the long-term, it is critical to integrate environmentally responsible initiatives into containment care to minimize the impacts on the environment and to safeguard the health of future generations.

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Abigail E. Lowe, MA is an assistant professor in the College of Allied Health Professions and a co-director of the National Disaster Medical System Infectious Disease Training Program for the Global Center for Health Security at the University of Nebraska Medical Center in Omaha. With interests at the intersection of ethics, health policy, and health security, she focuses on ethics in public health emergency preparedness in her research.

Aurora B. Le, PhD, MPH, CSP, CPH is the John G. Searle Assistant Professor of Environmental Health Sciences at the University of Michigan School of Public Health in Ann Arbor. Her research on occupational health and safety focuses on occupational health inequity, industrial hygiene, psychosocial factors of work, and intersections among the aforementioned with health behaviors.

Shawn G. Gibbs, PhD, MBA, CIH is the dean of the School of Public Health as well as the dean's chair of and a professor in the Department of Environmental and Occupational Health at Texas A&M University in College Station. Dr Gibbs is an industrial hygienist with expertise in disruption of highly infectious diseases, such as COVID-19 and Ebola virus disease. His research has informed national policies, procedures, and best practices for safe care of patients with highly infectious diseases.

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MEDICAL EDUCATION: PEER-REVIEWED ARTICLE

How Should Health Systems Science Promote Health Systems' Sustainability?

Natasha Sood, MPH and Arianne Teherani, PhD

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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Natasha Sood, MPH is a fourth-year year medical student at Penn State College of Medicine in Hershey, Pennsylvania. She is a co-founder of Medical Students for a Sustainable Future and the project director of Climate Resources for Health Education. Her research and advocacy efforts focus on climate and health education, disaster preparedness, and climate-smart health care.

Arianne Teherani, PhD is a professor of medicine in the University of California, San Francisco School of Medicine and the founding co-director for the University of California Center for Climate, Health and Equity. Her research focuses on the roles of climate education in community health engagement and sustainable thinking.

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HEALTH LAW: PEER-REVIEWED ARTICLE

How Should Regulations Help Health Care Organizations Manage Waste?

Ariel Levchenko, MA and Scott J. Schweikart, JD, MBE

Abstract

Health care waste is a global problem. While most health care waste is harmless, some of it is hazardous. The volume of hazardous waste generated worldwide is enormous, and its disposal can be environmentally damaging. This article discusses how such waste disposal is regulated and the problems that currently exist with waste disposal regulation. The article also offers possible national and international regulatory solutions.

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Background

Health care waste is simply the waste "generated by health-care activities."[1] Most health care waste is general or nonhazardous waste; only about 15% is classified as hazardous.[1] Hazardous health care waste may include infectious waste, chemical waste, pathological waste, and radioactive waste.[1] The volume of hazardous waste generated is quite large, with high-income countries generating "up to 0.5kg of hazardous waste per hospital bed per day" and low-income countries generating "on average 0.2kg" per bed per day.[1] The environmental impact of disposing this large volume of hazardous waste is profound and carries with it health risks. For example, "disposal of untreated health care wastes in landfills can lead to the contamination of drinking, surface, and ground waters."[1] Incineration of waste is a common disposal method, although inadequate or improper incineration "results in the release of pollutants into the air and in the generation of ash residue" and may also release human carcinogens and toxic metals into the environment.[1]

Internationally, the disposal of hazardous waste is governed by the Basel Convention, which focuses on "transboundary movements of hazardous wastes."[2] Hazardous health care wastes are included under the convention, which stipulates that such waste should be reduced in an efficient manner that protects people and the environment. However, there are limitations to the effectiveness of the Basel Convention. While being a primary producer of worldwide waste, the United States has not ratified the treaty and therefore is not bound by it.[3,4] Additionally, critics argue that, under the Basel Convention, some countries have become “garbage dumps,” as lower-income countries with lower waste disposal costs become attractive places for richer countries to dispose of their waste. The ambiguous language of the convention allows for loopholes in its application—for example, the definitions of *waste* and *hazardous* are not uniform, and nation states are left to interpret such key provisions as they see fit.[3] Such “shortcomings” under the Basel Convention are the result of the “unfair influence” that developed countries often hold over developing countries.[3]

In the United States, health care waste was regulated by the Environmental Protection Agency (EPA) from 1988 to 1991 under the Medical Waste Tracking Act (MWTA).[5] The MWTA was created in response to “concern for the potential health hazards of medical wastes [that] grew in the 1980s after medical wastes were washing up on several east coast beaches.”[5] However, the MWTA was only designed to last for 2 years, during which time the EPA gathered information on waste generation, concluding that “the disease-causing potential of medical waste is greatest at the point of generation and naturally tapers off after that point.”[5] After the expiration of the MWTA in 1991, “states largely took on the role of regulating medical waste under the guidance developed from the two year program.”[5] Funded by the EPA and informed by its findings, the guidance was published by the Council of State Governments,[6] and, while some states have adopted some of these guidelines, there remain significant differences in how states have decided to regulate management of health care waste.[5]

Current Problems
There are a series of interlocking issues arising from the current patchwork of legal and regulatory regimes associated with health care waste management. The chief issues are (1) lack of a unified regulatory regime—both in the domestic and international context—with sufficient power to create and enforce reasonable and effective regulations and (2) the inefficient, environmentally damaging health care waste disposal methods that governments currently employ.

Lack of a unified regulatory regime. A key example of decentralization is the United States, where regulatory authority is largely delegated to the states. The resultant patchwork of legal structures lacks a single schema for how to deal with health care waste. Unnecessary complexity in regulation is inefficient and yields ineffective waste policy. Every state has different rules—for example, Alabama requires medical waste generators to register with the state whereas Colorado does not[7,8]—allowing interstate commerce to become fraught and error prone, as waste technicians moving across state lines need to be retrained in order to be able to comply with their new home state’s regulations. Furthermore, a lack of a single regulatory framework makes it difficult for waste management programs to be scaled up because each state requires a particular program that is tailored to its particular set of rules; the first step to successful health care waste management is an integrated national policy,[9,10] which the current lack of scalability prevents.

Regulatory concerns also persist in the international context, as there is no regulatory body that can deal with international health care waste. Despite the existence of the Basel Convention, there is no international regulatory body that can successfully train personnel, issue proper policies for health care waste management, and monitor performance. Such a lack of global oversight produces methods of dealing with health care waste that fall short of agreed-upon international standards, especially in developing countries.[11,12,13,14,15,16] Furthermore, because developing countries lack the resources to properly deal with health care waste, they are disproportionately impacted by the waste's negative consequences, further highlighting global health equity concerns.[8,17,18,19] This inequity is compounded by the fact that, because of the aforementioned structural inequalities built into the Basel Convention, low-income and developing countries frequently absorb and handle the waste of developed and high-income countries as well.

Health care waste disposal methods. Currently, the most common waste disposal method globally is incineration.[20] However, in developing countries, incinerator malfunctions release large amounts of environmental pollutants, such as dioxins, furans, and antineoplastics, which are known carcinogens.[20,21] The risk to public health is profound considering that, in the United States, 49% to 60% of medical waste is incinerated and that incinerators are located in heavily populated areas.[21,22] This risk is an especially trenchant concern, given that 79% of all municipal solid waste incinerators in the United States are located in areas with low-income communities and communities of color.[23]

Landfills offer an alternative to incineration and are deemed both cheaper and safer, insofar as they are specifically engineered not to release polluted water and gases into the local environment.[24,25] However, a concern about landfills leaking pollutants into the surrounding environment remains a potential point of failure.[26] This concern is not unwarranted, as the EPA itself has concluded that all landfills will eventually leak due to the deterioration of their liners.[27] Finally, it is important to note that landfills—while possibly being better for the environment than incineration—are not the best solution for health waste disposal and possess their own unique environmental risks and harms.[28,29,30] Studies have shown that there are significant health issues associated with proximity to waste disposal sites, including reproductive problems, cancer, heart and neural tube defects and chromosomal anomalies in offspring, and congenital malformations and anomalies.[31,32,33,34,35,36,37,38]

Other methods of dealing with health care waste—such as autoclaving, pyrolysis, and using a steam augur—are superior to incineration or landfills. These alternatives do not lead to the emission of large amounts of carcinogens and allow the waste to be dealt with through the regular solid waste treatment system. However, because they may involve higher up-front costs, dedicated facilities cannot be located in hospitals, and they do not always reduce the actual amount of solid waste to be landfilled.[21,39] Hence, these more environmentally friendly measures are not always feasible or favored options.

Interlocking divergent and inconsistent regulations—at state, federal, and international government levels—complicate waste disposal procedures. For example, some states allow the use of landfills for disposing of medical waste and others do not.[24] Moreover, developing countries may not have the resources to adequately invest in the construction and regulation of medical waste landfills, which leads to disproportionately negative public health outcomes in poorer countries.[40,41,42]

Solutions

A possible solution to the current patchwork of regulation and enforcement is a single national organization—eg, a federal agency—that handles regulation and enforcement of health care waste management and a single international organization that would do the same on a global scale. The organizations could interface to produce reasonable rules that are standardized in order to minimize confusion and complexity yet specific to the circumstances of the country in which the national agency is located. For example, an international organization managing health care waste would ideally focus on developing intelligible, communicable, and enforceable rules in order to minimize confusion and mismanagement, as well as on training waste disposal technicians and clinicians in understanding and implementing these rules, as this kind of training has been shown to lead to much higher levels of efficiency in waste management.[43,44]

This kind of international organization could operate under the auspices of the United Nations in a manner similar to the World Health Organization (perhaps as a subagency of the latter) and would therefore be subject to international democratic oversight, facilitate international cooperation, and ensure that the goals of justice are served by advancing the voices of developing countries, which currently bear a disproportionate burden of medical waste.

Such an international organization and analogous national organizations would ideally jointly commit to investment in dealing with waste in environmentally conscious ways. Creating one global framework could create dedicated, safe facilities for dealing with waste in efficient and environmentally sound ways, such as autoclaving facilities, and furthermore allow for such environmentally friendly measures to operate at scale, thus obviating the need for landfills and incinerators. This global framework would also serve the goals of environmental justice, as the pooling of resources for such a framework would lighten the burden on developing and disadvantaged countries, which bear a disproportionate burden of negative health effects due to improper waste disposal.

Alternatively, to avoid the need to craft such an international organization from scratch with little in the way of example, a "test run" could be conducted in the United States, where an organization, perhaps even the EPA itself, would play a lead role in standardizing the current patchwork regulatory regime in order to facilitate economies of scale, address concerns of distributive justice, and so on. Such a system would serve as an example of how a more global system could be organized; furthermore, a more efficiently run health care waste management system in the United States would allow for more domestic handling of such waste, which would lessen the burden on developing countries. Finally, this kind of trial run would allow for research on what kinds of regulatory regimes do and don't work and on which policies are most effective for reducing both the amount and the hazards of medical waste, which could later be applied in a global framework.

Conclusion

In response to the current regulatory deficiencies of health care waste management, several important measures could be taken to improve current policies: simplify the regulatory regime and unify it globally; invest in developing countries to aid them with managing their health care waste; and fund environmentally cleaner disposal methods that reduce public health threats. While practically implementing these suggested measures may be difficult or impossible in some instances due to the challenges of global politics, these measures can provide a starting point for policymakers to consider. Global governmental investment in these key measures may help resolve the gaps and deficiencies that exist in current regulatory policies.

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Ariel Levchenko, MA is a research assistant at Baylor College of Medicine's Center for Medical Ethics and Health Policy in Houston, Texas. He received a master of arts degree in bioethics from New York University.

Scott J. Schweikart, JD, MBE is a senior policy analyst at the American Medical Association in Chicago, Illinois, where he is also the legal editor for the *AMA Journal of Ethics*. Mr Schweikart earned his MBE from the University of Pennsylvania, his JD from Case Western Reserve University, and his BA from Washington University in St Louis. He has research interests in health law, health policy, and bioethics.

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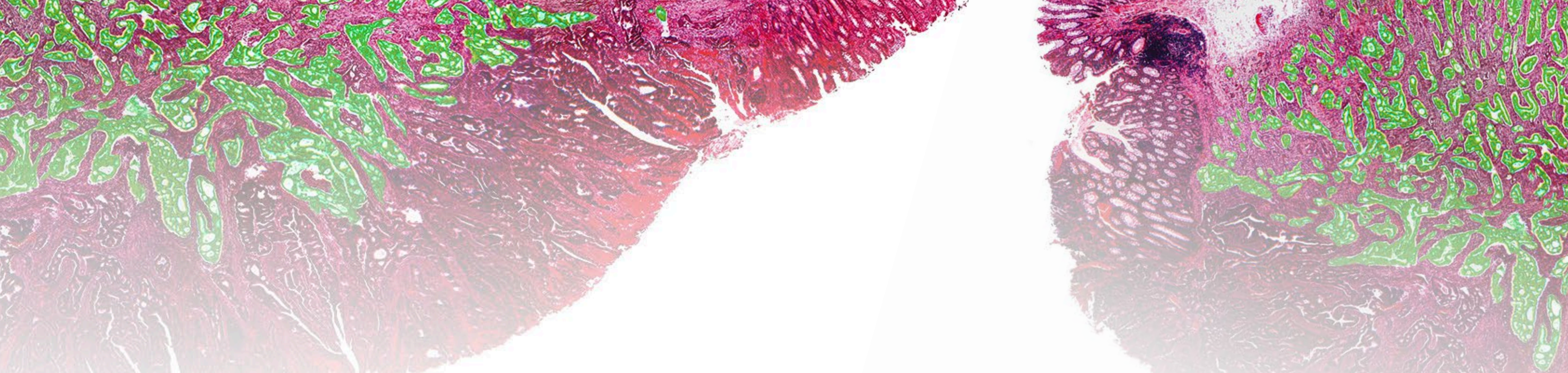

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AMA CODE SAYS

AMA *Code of Medical Ethics'* Opinions Related to Health Care Waste

Ariel Levchenko, MA and Danielle Hahn Chaet, MSB

Abstract

This article examines how the AMA *Code of Medical Ethics* addresses different kinds of waste generated by health care delivery streams. This summary considers AMA *Code* opinions about advocacy and access that can guide clinicians' and health care organizations' disposal and stewardship duties to patients and communities, especially in an era of climate change.

Health Care Waste

In the discussion of waste and the health care system, material waste (such as infectious waste, sharps, and general waste[1]) is only one part of the ethical issue; the other part is the waste of health care resources. Currently, an estimated 25% of annual spending in the US health care industry is wasted—totaling between $760 and $935 billion—with some of the biggest categories including pricing failures ($230.7 billion to $240.5 billion), overtreatment or low-value care ($75.7 billion to $101.2 billion), and fraud and abuse ($58.5 billion to $83.9 billion for the Medicare population).[2] This kind of waste is not just economically inefficient; it presents a particular ethical dilemma for doctors individually and for the health care profession more generally.

Opinion 11.1.2 of the American Medical Association (AMA) *Code of Medical Ethics*, "Physician Stewardship of Health Care Resources," "requires physicians to be prudent stewards of the shared societal resources with which they are entrusted."[3] Currently, however, the conditions of the health care industry are such that much of health care waste is caused by factors outside of the control of individual physicians,[2,4] as they are not directly responsible for the waste associated with, for example, pricing failures and administrative overhead. This waste represents an ethical failure—physicians cannot be responsible stewards of health care resources if the conditions that cause irresponsible stewardship happen upstream of them.

Advocacy

Beyond being out of physicians' control, the overarching issues of health care pricing and administrative overhead are at best opaque and at worst completely inscrutable to patients and many physicians. This ineffability only complicates the problem of waste that is upstream of physicians; accordingly, medical institutions must implement reforms that increase transparency and fairness in order to create an environment in which physicians can be capable of responsible stewardship. The AMA *Code* strongly suggests that physicians have a responsibility to advocate for policies that would enable this kind of change. Opinion 11.1.2 states:

> Physicians are in a unique position to affect health care spending. But individual physicians alone cannot and should not be expected to address the systemic challenges of wisely managing health care resources. Medicine as a profession must create conditions for practice that make it feasible for individual physicians to be prudent stewards by:
> (h) Encouraging health care administrators and organizations to make cost data transparent (including cost accounting methodologies) so that physicians can exercise well-informed stewardship….
> (j) Ensuring that physicians have the training they need to be informed about health care costs and how their decisions affect resource utilization and overall health care spending.
> (k) Advocating for policy changes, such as medical liability reform, that promote professional judgment and address systemic barriers that impede responsible stewardship.[3]

This idea—that there are preconditions that must be met within the system before physicians can be prudent stewards in individual cases—is echoed in Opinion 11.1.1, "Defining Basic Health Care," which states: "Individually and collectively as a profession, physicians should advocate for fair, informed decision making about basic health care that … is transparent."[5]

Access to Care

Inefficiencies, price failures (which occur "when there isn't a correlation between cost and value/quality [of care]"[6]), and the kind of fraud and abuse implicated in this discussion artificially drive up the costs of health care beyond what is reasonable or necessary for efficient distribution of scarce resources; waste is, by definition, inefficient. The unwarranted and unnecessarily inflated cost of care in turn creates barriers to access for many individuals, particularly those from historically marginalized populations, who are unable to get the health care they need. This lack of access to care makes relevant Opinion 11.1.4, "Financial Barriers to Health Care Access," which states: "Physicians, individually and collectively through their professional organizations and institutions, should participate in the political process as advocates for patients (or support those who do) so as to diminish financial obstacles to access health care."[7]

Physicians can be—and in fact have certain obligations to be—prudent stewards of the resources with which they are entrusted, including both the specific health care resources needed to treat patients and the more generalized administrative resources needed to make a health care system possible. Even though their primary responsibility is to effectively steward resources when dealing with individual patients, managing health care resources responsibly for the benefit of all patients can be compatible with physicians' primary obligation to serve the interests of individual patients. Opinion 11.1.2 states:

> To fulfill their obligation to be prudent stewards of health care resources, physicians should:
> (a) Base recommendations and decisions on patients' medical needs.
> (b) Use scientifically grounded evidence to inform professional decisions when available….
> (e) Use technologies that have been demonstrated to meaningfully improve clinical outcomes to choose the course of action that requires fewer resources when alternative courses of action offer similar likelihood and degree of anticipated benefit compared to anticipated harm for the individual patient but require different levels of resources.
> (f) Be transparent about alternatives, including disclosing when resource constraints play a role in decision making.

(g) Participate in efforts to resolve persistent disagreement about whether a costly intervention is worthwhile, which may include consulting other physicians, an ethics committee, or other appropriate resource.[3]

Conclusion

Since the waste caused by the kinds of structural inefficiencies outlined above causes unwarranted high prices, these inefficiencies in fact constitute financial obstacles to accessing health care and prevent physicians' responsible stewardship of scarce resources; the AMA *Code* suggests that physicians therefore ought to act collectively to advocate for reforms to the administrative and pricing structures of the health care industry so as to reduce this waste, ameliorate financial obstacles, and responsibly steward scarce resources in a way that best serves the needs of their individual patients and patients more generally.

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Ariel Levchenko, MA is a research assistant at Baylor College of Medicine's Center for Medical Ethics and Health Policy in Houston, Texas. He received a master of arts degree in bioethics from New York University.

Danielle Hahn Chaet, MSB works at the Center for Bioethics and Humanities at the University of Colorado Anschutz Medical Campus in Aurora. She received her master of science degree in bioethics with a focus on policy and clinical ethics consultation from the joint program of Union Graduate College and the Icahn School of Medicine at Mount Sinai.

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POLICY FORUM: PEER-REVIEWED ARTICLE

How Should Responsibility for Proper Medication Disposal Be Shared?

Ladan Karim-Nejad and Kayla Pangilinan

Abstract

Pharmaceutical companies' capital, influence, and labor force well equip them to assume responsibility for public medication disposal programs. Government- and industry-funded campaigns for medication disposal do work, but responsibility often falls on local health care organizations to provide education and services. Lack of public awareness about how to dispose of medications and the ramifications of contaminating our natural resources and ecosystems with pharmaceuticals suggest a need for collaboration among pharmaceutical companies, government officials, clinicians, and patients.

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Pharmaceutical Waste

Global pharmaceutical spending has risen from $887 billion in 2010 to $1.27 trillion in 2020.[1] The World Health Organization defines pharmaceutical waste as expired, unused, and contaminated drugs and vaccines.[2] In the United States, unused prescription medications cost the health care industry approximately $5.4 billion per year for adults who take one prescription medication daily.[3] Moreover, disposal of regulated medical waste, including pharmaceuticals, costs 119% more per pound than regular trash.[4]

As part of a recent shift toward a more environmentally conscious culture in global health care, reducing the environmental impact of pharmaceuticals has become imminently important to preserving soil and water quality and maintaining ecological balance.[5] National research studies have revealed the presence of pharmaceuticals in streams throughout the United States, including medicines from the following drug classes: antidepressants (eg, fluoxetine), antibiotics (eg, ciprofloxacin), antihypertensives (eg, lisinopril), and analgesics (eg, acetaminophen, ibuprofen), as well as hormone modulators (eg, estradiol-containing drugs).[6,7,8,9] Globally, 631 of 713 pharmaceuticals were found in concentrations above the detection limits, 16 of which were found to be in surface, drinking, and ground water in some countries in Africa, the Asia-Pacific region, Eastern Europe, Latin America and the Caribbean, and Western Europe (including North America, Australia, and New Zealand).[10] Diclofenac (a nonsteroidal anti-inflammatory drug) was among the top 5 most detected substances in all the regions tested.[10] Previously, Diclofenac was linked to critical endangerment of 3 species of vultures after causing widespread kidney failure.[11]

Designating responsibility for the source and removal of waste is challenging because there are multiple levels of waste generation throughout the life cycle of a pharmaceutical product—starting with manufacturing and extending through clinical use and patient excretion of active drug compounds. Minimizing pharmaceutical waste and increasing proper disposal involve collaborative efforts among stakeholders. Manufacturers are liable for improving packaging and procurement strategies, while governments must provide infrastructure and legislative enforcement. Lastly, clinicians must be more conscious when prescribing and dispensing, and patients must be more conscious when using pharmaceuticals. Throughout the pharmaceutical life cycle, all stakeholders have a responsibility within the scope of their expertise to reduce waste and pollution.

Packaging

A great deal of work is currently being done to reduce health care's plastic wastage, which constitutes approximately 30% of all health care waste.[12,13] Plastics used for medical purposes, such as inhaler actuators and bottles, are predominantly made of polypropylene (PP), which, due to its complicated composition, is seldom recycled (eg, less than 3% of the total PP used).[14,15] Updating current recycling standards from incineration and landfilling to methods with less environmental harm, such as fast pyrolysis and gasification, is crucial if plastic use continues.[16]

Pharmaceutical packaging is a growing industry that was valued at about $89 billion in 2019.[17] Pharmaceutical packaging includes plastic stock bottles, unit dose blister packs, medication delivery devices, and intravenous bags, among other items. Promoting the use of plastics that are more readily recycled, such as polyethylene terephthalate or high-density polyethylene, could improve the recyclability of pharmaceutical packaging and reduce costs through the use of recycled plastics.[18,19] Novel ways to recover aluminum and polyvinyl chloride from blister packages have also been explored using techniques such as electrohydraulic fragmentation, which can recover 88% of the aluminum used in blister packs.[20] Hydrometallurgy is another technique that can achieve 100% separation and recovery of blister pack components.[21] Given their ability to be recycled effectively, blister packs have the potential to become a sustainable alternative to dispensing medication in plastic bottles.

The optimization of product size based on clinical use offers another approach to reducing wasteful packaging. In 2016, cancer drugs alone accounted for $1.8 billion in wasted medication due to leftover drugs in single-dose vials.[22] Differentiating between outpatient and inpatient package sizes can also reduce wastage. Albuterol, a short-acting beta-2 agonist used to manage asthma exacerbations, is manufactured to deliver up to 200 doses per inhaler.[23,24] In most states, once a multidose medication has been opened for use in an inpatient setting, it cannot be given to patients to take home at discharge (unless it has a proper prescription label),[25] and, instead, discharged patients are given a list of medications that they must fill at an outpatient pharmacy.[26] Therefore, a used inhaler in an acute hospital setting can be discarded with viable doses left over.

Disposal

Stakeholder responsibility. The cradle-to-grave approach describing the life cycle of pharmaceutical products—resource extraction, manufacturing, transport, consumption, and disposal—supports the idea that pharmaceutical companies be held responsible for disposal of medications.[27] One successful manufacturer-led program, GlaxoSmithKline's Complete the Cycle program in the United Kingdom, recovered more than 2 million inhalers from 2011 to 2020, amounting to the equivalent of the carbon dioxide emissions produced by 8665 cars in one year.[28,29] The program ended with a call to other industry leaders to follow suit in creating long-lasting change.[29]

Health care professionals are also responsible for proper disposal of medications because they play an important role in patient education. Although most clinicians lack knowledge of recommended disposal methods and drug take-back programs,[30] the impact of environmental health on patient health is becoming a growing concern.[31] By increasing awareness of disposal services, the amount of potential medical waste can be reduced. Pharmacists, in particular, are uniquely positioned to educate the public on medication disposal, given their medication expertise, accessibility, and service as the usual last point of contact for patients.[32] However, there are major barriers to promotion of disposal services at the pharmacy, including cost, training, and workflow challenges.[33,34,35,36]

Although patients are major contributors to improper medication disposal due to lack of awareness or access to disposal services, misunderstanding of expiration dates, and medication stockpiling,[37] many patients are receptive to disposal services after learning about them.[38,39] Updating patients' prescription labels to include information such as disposal locations is worth exploring, as it has been reported that patients are interested in learning more about their medications.[40] However, doing so would require support from regulatory bodies, such as the US Food and Drug Administration (FDA), to ensure consistent enactment of policy.

The government can play a significant role in promoting proper disposal and should be held responsible for providing infrastructure for disposal, supporting public education campaigns to create awareness of disposal programs and to reduce waste, and enforcing environmental mandates for manufacturing. In Australia, the government-funded Return Unwanted Medicines (RUM) Project has collected unwanted medicine since 1998.[41] Utilizing pharmacists as the major workforce, the RUM Project collected over 704 tons of medication in 2016.[41] According to a 2016 survey, more than 82% of people previously did not know of the RUM Project, but more than 90% who were previously unaware stated they would use RUM after learning about it.[41] Environmental drug manufacturing mandates include the waste-minimizing packaging strategies mentioned earlier in addition to updating drug development strategies to include green chemistry techniques.[42] The Sustainable Chemistry Research and Development Act of 2019 marks an important step toward innovative drug discovery research by aiming to minimize environmental harm from emissions and harsh solvents, creating biodegradable active pharmaceutical ingredients (APIs), and other measures.[43] Although the bill, passed as part of the National Defense Authorization Act, is promising, its feasibility is questionable, as the law currently does not provide any federal research funding for sustainable chemistry research.[44]

Government approved disposal methods. The Environmental Protection Agency recommends that pharmaceuticals collected via take-back programs be incinerated at licensed facilities, but re-collected medication is currently not regulated under current federal hazardous waste laws.[45] Incineration is considered the most effective method for API destruction and is regarded as safe, given that emission controls are in place.[46] The FDA supports household disposal methods and offers general instructions to mix drugs with a noxious substance (eg, cat litter, coffee grounds) before disposing of them in a sealed container with normal trash.[47] However, household disposal of medications generally exposes drugs to the environment via landfill leachate, which can contaminate water and soil systems.[48]

The FDA also endorses a list of medications that are safe to be flushed down the toilet, given their high potential for diversion and unsafe ingestion.[49] Current research on APIs on the FDA's "flush list" indicates that there is negligible ecological risk associated with their release into the environment; however, it is unlikely that this method can be supported as a long-term solution.[50] Innovative at-home technologies have been developed, such as chemical degraders, which render APIs inert, but these options suffer from cost and accessibility limitations.[51]

Conclusion

Pharmaceutical disposal is an emerging concern with both economic and environmental implications.[3] Much of our understanding of the environmental impact of pharmaceuticals has come from recent advances in analytical technologies.[21] However, the low levels of pharmaceuticals in the environment being detected can also be attributed to overestimating the efficacy of current methods put in place to control waste. Treating waste as "out of sight, out of mind," allows continued waste production that may not stop until the problem becomes irremediable. Leaching of pharmaceuticals into the environment from manufacturing sites has impacted aquatic ecosystems and the health of communities around the world,[52,53] while the accumulation of pharmaceuticals via trash and sewer drains has also led to traceable levels of contamination in municipal waters.[54,55,56]

These findings suggest an important gap in stakeholders' knowledge of pharmaceutical pollution and their responsibility to reduce it. Overall lack of awareness among clinicians and patients remains a major reason why household pharmaceuticals are disposed of inappropriately.[57] Encouraging pharmacist education on proper disposal could lead pharmacists to think more critically about pharmaceutical waste production[58] while also empowering patients to take part in protecting their ecological communities. Patient education can be delivered by health care professionals at any stage of care, particularly at the stage of dispensing of medication by pharmacists, as the medication experts.[59]

All stakeholders have a responsibility to reduce pharmaceutical waste. Using innovative solutions to reduce the amount of pharmaceutical packaging predestined for landfill or incineration is a developing area that is the responsibility of pharmaceutical manufacturers.[21] Developing a better understanding of waste patterns through information learned from disposal programs can be used to reform product manufacturing, prescribing, and dispensing behaviors to improve safety and health outcomes by reducing the risks associated with polypharmacy and accidental ingestion when there are numerous drugs in the home.[60,61] Although medications are commonly disposed of via garbage, drains, or take-back programs,[62] returning medications to the pharmacy is medically responsible and should be the most recommended option. Governments should support disposal of pharmaceuticals as a medical service; manufacturers should produce pharmaceuticals with waste minimization and disposal in mind; and health care professionals should feel confident in their knowledge and training to carry out their role as stewards in reducing pharmaceutical waste. Given the accumulating evidence of pharmaceuticals' improper disposal and unintended contamination of ecosystems,[63,64,65] it is imperative to create collaborative solutions and to promote pharmaceutical stewardship to contain the problem while preventative strategies can still be effective.

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Ladan Karim-Nejad is a fourth-year pharmacy student at Virginia Commonwealth University in Richmond and co-founder of the Sustainable Pharmacy Project. Previously, she was a recipient of a research award from the American Association of Colleges of Pharmacy and a RISE DAAD Scholar.

Kayla Pangilinan is fourth-year pharmacy student at Virginia Commonwealth University in Richmond, an active leader in 4 pharmacy organizations, and a co-founder of the Sustainable Pharmacy Project. Previously, she worked as a pharmacy technician and research assistant in medicinal chemistry.

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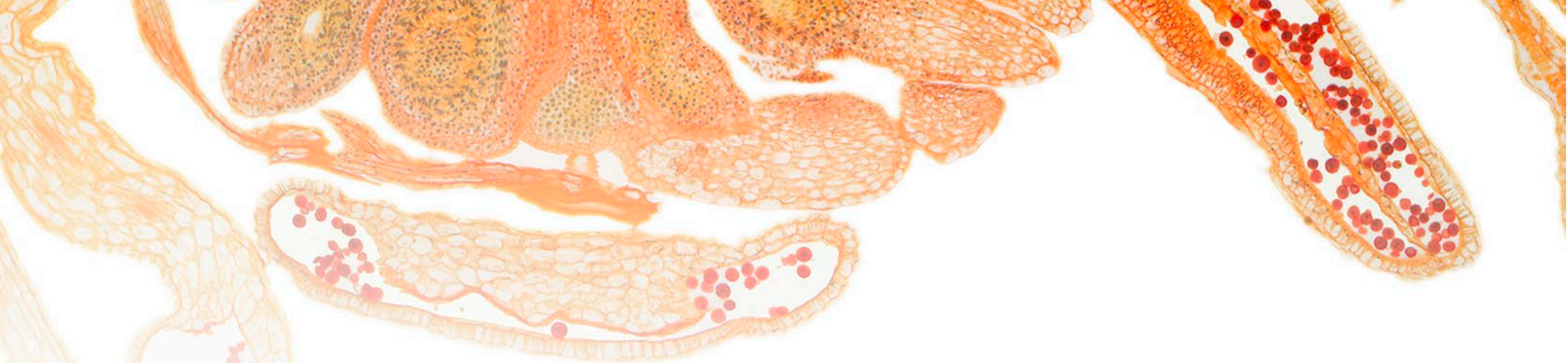

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POLICY FORUM: PEER-REVIEWED ARTICLE

How Should We Better Manage Human and Planetary Health in a Next Pandemic?

Lisa Patel, MD, MESc and Katie E. Lichter, MD, MPH

Abstract

Health care generates a lot of waste that enters landfills, oceans, and incinerators and adversely affects the health of persons and communities close to waste processing and disposal areas. This article considers the nature and scope of individuals' and organizations' disposal responsibilities and discusses personal protective equipment use and waste during the COVID-19 pandemic.

The American Medical Association designates this journal-based CME activity for a maximum of 1 AMA PRA Category 1 Credit™ *available through the* AMA Ed Hub™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.*

Introduction

Health care generates large amounts of medical waste.[1] Where does it go? Our health care products often find their way into landfills and oceans or are incinerated. Hazardous waste (ie, infectious, radioactive, or toxic), sharps waste, and nonhazardous waste (eg, disposable gowns, gloves, and shields) result in approximately 29 pounds of waste per hospital bed per day in the United States alone.[1] The COVID-19 pandemic has accelerated both production and use of disposable personal protective equipment, or PPE (eg, masks, gloves, eye protection, and face shields) in both health care and public settings, as the use of multilayer cloth or surgical masks has been found to substantially reduce infections.[2] At the same time, nations have reported a steep increase in medical waste since the onset of the pandemic,[3,4,5] with a November 2020 Catalonia government report noting a 350% increase in medical waste largely from masks and gloves.[3] An estimated 1.56 billion discarded face masks flooded oceans in 2020 due to overburdened or nonexistent waste management and improper disposal.[4]

Demand to protect oneself and others from a deadly pandemic while minimizing harmful waste highlights a tension in ethics and moral responsibility between public health and environmental sustainability. We will examine personal, professional, and societal obligations that guide decision making through 2 cases: an essential worker following public health masking mandates without thought for sustainability and a sustainability-conscious health care worker experiencing changing PPE rules within a health care institution.

Sustainable Masking?

Case 1. Serena works full time as a checker at her local grocery store where masking of both employees and customers is mandated by the store. She works 8-hour shifts wearing single-use disposable surgical masks that are provided by her employer. She will often change masks a few times per shift if she sneezes or otherwise soils the mask. And she often takes extra masks from work to use elsewhere (eg, the post office or the dentist), discarding the mask after use. She has noticed that trash bins are overflowing with masks and wonders where they go. Some of her friends have purchased reusable masks but, given the supply she has through work, she does not feel the need to purchase other masks.

Discussion. In the winter and spring of 2020, as the novel coronavirus, or SARS-CoV-2, spread worldwide, countries and municipalities introduced measures for public safety, including recommendations or mandates for mask use. To date, such regulations have been carried out to varying degrees.[5] As of August 2022, there have been more than 584 million cases of COVID-19 worldwide with more than 6.4 million deaths, making concerted efforts to mitigate spread of the virus a continued necessity.[6]

Public health guidance on mask wearing has had the unintended consequence of producing an overabundance of discarded face masks. An estimated 129 billion face masks are used, and presumably disposed of, globally per month, which is equivalent to 3 million masks-per-minute.[7] Nearly all single-use, disposable surgical masks are made from layers (20 or 25 grams per square meter in density) of microsize polypropylene fibers.[8] Disposal of these masks is known to have negative effects on environmental and public health. The plastic in the masks degrades into micro-and nano-plastics. When these enter the waste stream, the particles accumulate in marine organisms and later in humans through indirect ingestion.[9] Studies analyzing urine levels of chemicals found in some plastics (eg, bisphenol A [BPA]) have found an association between higher urine BPA levels and heart disease, suggesting potential harms of long-term exposure.[10] Prior to the pandemic, it was estimated that the average person consumed a credit card's worth of plastic (5 grams) per week because of increasing plastic disposal and subsequent ingestion.[9] It is reasonable to assume that this amount may rise with the accumulation of improper PPE disposal.

Alternatives to single-use masks are available. Although sustainability metrics can differ for reusable and disposable masks, analysis has shown that embedded filtration in reusable masks has a better sustainability profile than single-use disposable surgical masks.[11]

In the case presented above, Serena abides by public health regulations and the rules of her workplace by wearing the single-use, disposable surgical masks provided to her. She respects the value of these rules in protecting human health and saving lives by limiting the spread of COVID-19; yet she is not made aware of the environmental impact of her decision to dispose of several masks daily and thus is unable to perceive a need to mitigate—or to advocate for mitigation of—this impact.

Serena's case highlights how ease of use, availability of supplies, and lack of public education can direct individuals toward less sustainable choices. In addition to making an appropriate mask supply available to the general population, institutions and public health officials should appropriately counsel members of the public and guide them toward choices that additionally account for environmental sustainability. For example, while countries such as the United States and the United Kingdom provide basic guidelines on caring for reusable masks and disposing of single-use masks,[12,13] they miss an opportunity to provide advice regarding the sustainability or environmental impact of choosing disposable masks.

Case 2. Eddie is a nurse on a medical unit. When the pandemic started, he and others were worried they would not have enough N-95 respirators. They were told initially to reuse their masks, with each nurse assigned a plastic bin to store masks between shifts. The hospital then devised a decontamination strategy, and he and others began putting used masks into a bin to be reused after decontamination. Several months into the pandemic, he noticed that all these measures had stopped. He was instructed to use an N-95 once, then throw it into the waste bin, the contents of which were destined for incineration or a secure landfill. When he asked his nursing supervisor what had changed, he was told that the hospital administrators and supply chain directors had an abundant supply of masks, making decontamination and reuse measures unnecessary.

Discussion. The COVID-19 pandemic has changed the rules of mask and other PPE use. Infection mitigation strategies have required PPE for nearly every in-person patient encounter. As case numbers fluctuated and vaccination rates remained uneven across the country, the Centers for Disease Control and Prevention (CDC) recommended in February 2022 that health care professionals continue wearing masks in clinical settings.[14] Some also argue that respirator and mask usage will persist in health care settings beyond the pandemic.[15]

Unfortunately, such recommendations have environmental and financial costs. It is estimated that the COVID-19 pandemic generates approximately 7200 tons of medical waste per day globally, with a sizeable portion attributable to masks.[16,17] In most facilities, this (biohazardous) medical waste will be incinerated or routed to a secure landfill. Although better than unregulated disposal, both disposal routes have significant environmental impacts. Incineration is known to be a major contributor to freshwater aquatic ecotoxicity and human toxicity potential, whereas landfills have the potential to leak pollutants into groundwater.[18,19]

In the early months of the pandemic, N-95 respirator masks and disposable masks were in short supply. To maximize resources, health care professionals extended the use of masks, wearing one mask per day instead of switching to a new mask for each patient.[20] In 2020, many health care systems, including Stanford and Partners HealthCare, also implemented decontamination and repurposing strategies, such as ultraviolet germicidal irradiation (UVGI) and concentrated hydrogen peroxide vapor (H_2O_2), which were implemented at an outside facility (Battelle), allowing for N-95 respirator masks to be sterilized and reused.[21,22] The University of Nebraska designed a pilot UVGI system that was approved by the CDC, which encouraged hospitals with ultraviolet decontamination systems to implement the practice.[23,24] However, efforts to reuse respirator masks largely fell aside as supply increased.

It has been estimated that if each health care professional had used a new N-95 mask for each patient, 84 million kilograms of waste (an equivalent of 252 Boeing 747 airplanes) would have been produced during the first 6 months of the pandemic.[25] With reusable mask strategies, including both reusable N-95 masks and filters, waste production during the first 6 months of the pandemic could have been reduced by an estimated 98%—to as little as 1.6 million kilograms (5 747 airplanes).[25]

Eddie's case highlights how the definition of a "crisis" can be narrow and miss an opportunity to continue to improve resource use. With the Intergovernmental Panel on Climate Change declaring code red for humanity and an emerging international consensus on the need for national targets on the reduction and management of plastics production,[26,27] the end of the pandemic does not signal the end of crisis mode. We may finally confront a crisis that has loomed for too long.

Conclusion

If masks were reusable in perpetuity, there would be less ethical conflict regarding their use. As these cases highlight, disposable masks leave both a carbon footprint in production and an indelible imprint on the environment when disposed of due to the indestructible nature of plastics. Moreover, masks are often improperly discarded due to infrastructure constraints, with unsustainable amounts of waste ending up in oceans. Although disposable masks can be easier to procure or manage as they do not require washing or maintenance, individuals seeking to follow public health or institutional directives may choose them without cognizance of their unintended environmental consequences.

The COVID-19 pandemic has exacerbated social and cultural tendencies to use single-use PPE products that have enormous environmental impact. Responding to pandemic use patterns, however, now presents opportunities to reassess assumptions and habits and encourage public health measures that effectively protect us all from threatening infectious diseases while prioritizing environmental impact minimization.

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Lisa Patel, MD, MESc is an assistant clinical professor of pediatrics at the Stanford School of Medicine in Stanford, California, and the deputy executive director of the Medical Society Consortium on Climate and Health in collaboration with the Sean N. Parker Center for Allergy and Asthma Research. She is passionate about mobilizing health professionals to use their trusted voice to advocate for just and sustainable solutions to the climate crisis.

Katie E. Lichter, MD, MPH is a resident physician at the University of California, San Francisco (UCSF) Department of Radiation Oncology and a UCSF Climate Health Fellow. Her clinical and research interests involve delivering high-quality, resilient, and equitable care through reducing clinical waste and helping clinics identify and implement sustainable, climate-smart health care solutions.

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POLICY FORUM: PEER-REVIEWED ARTICLE

How Should US Health Care Lead Global Change in Plastic Waste Disposal?

Navami Jain and Desiree LaBeaud, MD

Abstract
Disposal of health care waste is one of the biggest threats to global sustainable health care. Current practices of dumping domestic and international health care waste into the earth's *terra firma* and oceans also undermine global health equity by adversely affecting the health of vulnerable communities. While the United Kingdom works toward circular health care economy streams that produce minimal waste, the United States continues to amplify downstream environmental and health effects of health care organizational waste management decisions. This article suggests how to reframe social and ethical responsibility for health care waste production and management by assigning strict accountability to health care organizational leaders, incentivizing circular supply chain implementation and maintenance, and encouraging strong collaborations across medical, plastic, and waste industries.

Introduction
Waste management in the United States is both unethical and unsustainable. In 2018, the United States produced 292.4 million tons of municipal solid waste (MSW)[1] and sent 157 000 shipping containers of MSW to lower income countries (eg, Vietnam, Malaysia, Thailand, and China), dumping 1.07 million tons of plastic waste outside US borders.[2] In this article, we discuss the projected influence of plastic waste on planetary and population health. We also propose concrete changes in health policy, clinical practice, and industrial relationships, specifically in health care and waste sectors.

Plastic's Consequences
Inconsistent values across health systems enable the US medical supply chain to externalize the consequences of its plastic consumption and disposal. Under-resourced countries have historically imported plastic waste to create economic opportunities through waste collection and recycling services, and their weak regulations are exploited by wealthier countries. The direct influence on human health from mismanaged (eg, burning) plastic waste includes exposures to toxic pollutants and microplastic ingestion, flooding (eg, due to water flow blockage), and disease transmission (eg, by flies, mosquitoes, rats).[3,4] Between 400 000 and 1 million lives are lost each year in low- and

middle-income countries (LMICs) due to mismanaged waste.[4] As harms of plastic waste accumulate, we might hope for international pressure to mitigate waste importation and exportation. China, for example, once imported more than a quarter of the world's mismanaged waste, but in July 2017, it closed its doors to 24 categories of consumer waste, including postconsumer plastics and paper products.[5] Malaysia and Vietnam banned importation of plastic waste shortly thereafter,[6] and we can expect more countries to follow.

With only 633 materials recycling facilities in the United States and with the US's heavy dependence on plastic waste exportation, we can expect that importation bans will disrupt domestic waste processing.[7] US unpreparedness to manage waste generated internally, combined with a projected doubling in plastic production globally over the next 2 decades,[8,9] will also exacerbate negative health consequences. Moreover, LMICs, particularly those in South and Southeast Asia, are production sites of virgin plastic polymer and plastic products that meet demand in global and domestic markets. China leads in global production; and India, Bangladesh, Thailand, Pakistan, and the Philippines have increased investment in such plastic manufacturing.[10] In the United States, too, 30 petrochemical complexes lie close to poor neighborhoods and communities of color from the Ohio River Valley to the Gulf Coast, contributing to "asthma, lung cancer, brain and organ damage, vomiting, diarrhea, and cardiovascular diseases."[11]

Plastics in Health Care

Aside from a tremendous emissions footprint—accounting for 8% of total US emissions[12]—health care remains one of the largest waste-producing sectors. Hospital patients in the United States generate about 33.8 pounds of waste each day, which leads to about 6 million tons of waste annually.[13] While various materials (eg, metals, glass, food, paper) are used in health care, none have revolutionized the medical industry over the past century as have plastics used in syringes, intravenous bags, catheters, test kits, and gloves.[14] Plastic possesses several properties favored by the biomedical industry: it is low in cost, easy to process, and easy to sterilize.[15] Of the 14 000 tons of waste generated daily in US health care facilities, about 20% to 25% is plastic,[15] but 91% of plastics, including those used in health care, are not recycled and either reside in landfills or have infiltrated natural environments.[16,17]

At the beginning of the COVID-19 pandemic in March 2020, the World Health Organization projected monthly demand of 89 million medical masks, 76 million gloves, and 1.6 million goggles alone, leading to a 40% increase in disposable personal protective equipment (PPE) production.[18] Hazardous COVID-19 biomedical waste is contributing to plastic waste generation worldwide,[19] although there exists no compelling evidence that using single-use disposables reduce health care-acquired infections.[20]

Despite repercussions of plastic production and disposal, industrial disincentives to reuse plastics have proliferated plastic waste. Current regulations, such as US Food and Drug Administration (FDA) requirements for design and reprocessing of reusable medical devices, discourage reuse and motivate manufacture of single-use devices to avoid liability and generate profit.[21,20] Producers of single-use devices remain unpenalized for the excessive environmental impact of the waste they generate. Tremendous opportunity to remove unnecessary plastic in health care exists, but demand for single-use plastics continues to grow,[22] suggesting a misalignment between waste generation practices in health care and the ethical obligation of the profession to do no harm.

Obligation to Do No Harm

In an updated version of the Hippocratic Oath, physicians swear: "I will abstain from all intentional wrong-doing and harm."[23] Yet, currently, the health care sector faces little liability for consequences of its supply chain decisions. As discussed above, the costs of its practices are passed to LMICs and communities of color, who experience increased health care costs, quality of life decline, and ecosystem degradation. When the health sector externalizes costs in ways that degrade health in marginalized communities across the world, it defeats health professional aims.

Some countries have recognized climate health action as part of health care's obligation to protect health, as demonstrated by the recent commitment signed by 50 countries at the 2021 COP26 United Nations Climate Conference.[24] The National Health Service (NHS) of Great Britain has set targets that include an 80% reduction in carbon emissions between 2036 and 2039 and a goal of net-zero by 2045.[25] This initiative includes a continued commitment to the NHS Plastics Reduction Pledge and a 10% reduction in clinical single-use plastics.[26] Nevertheless, the US health sector remains largely tethered to a "take-make-waste" economy that extracts resources, forms them into products, and disposes of them.[20]

Call for Action

Clinicians cannot remain complacent. We must speak up and apply pressure to hold health care organizations and manufacturers accountable to make supply chain decisions that prioritize environmental sustainability and incentivize use of quality, durable materials that can be easily reused or recycled. Institutionalizing these changes could enable transition from an unethical system of US health care waste disposal to a more sustainable one (see Table). Such strategies need to be shared across sectors to promote swift implementation and action. Collaboration among stakeholders is required to apply pressure on the Occupational Safety and Health Administration and the FDA to levy penalties for waste in health care supply chains.

Table. Opportunities to Transform the Health Care Waste Stream

Infrastructure and Operations	Policy	Research and Partnerships
• Implement stronger methods to predict and manage supply needs. • Develop pipelines to distribute unused medical supplies within local networks of institutions in order to reduce waste and financial spending. • Institutionalize educational programs for clinical staff on types of plastic waste and recycling and sorting procedures to maximize accordance with guidelines.	• Promote Extended Producer Responsibility policies whereby manufacturers and importers are made accountable for the environmental impacts of the products and packaging they produce and sell.[20] • Develop national guidelines for sustainable practices in institutions, including enforcing commitments to both sustainability and global health equity as a primary operational goal. • Require the public reporting of waste production by all health care institutions. • Mandate that hospitals comply with facility-level emission standards.	• Coordinate efforts with the medical device and plastics industries to make recycling and reusing medical plastics as economically viable as possible. • Increase funding for medical plastic design that is benign and recyclable. • Study the cost-effective production of bioplastics and other single-use plastic replacements. • Invest in local infrastructures to reprocess medical products and increase the production of value-added products while avoiding system-wide shortages.[20]

Aside from making waste reduction efforts, the health care system is also obligated to reduce harmful pollution that undermines population health. A robust health care system would consider population health as well as health care quality to further incentivize emissions reduction.[20]

Finally, since ineffective recycling and disposal procedures can deter upstream efforts to reduce waste, student and clinician education on waste and regulation is integral. Findings from a 2019 Massachusetts General Hospital study found that 85% of waste disposed of in regulated medical waste (RMW) containers was not RMW, for example. Most clinicians are likely unaware that poor disposal practice generates expensive hauler fees for processing RMW (10 times more than landfill fees and 30 times more than recycling fees) and generates organizational costs and fines that could exceed $100 000 annually.[27,28]

Waste Reduction Cost Savings

Waste reduction and proper disposal are not only ethical, but also cost efficient. Hospitals submitting data to the 2019 Environmental Excellence Awards saved an estimated $68 million on sustainability initiatives in 2018 "while reducing more than 309 million kBTUs of energy, diverting 146,750 tons of waste from the landfill, and avoiding 182 370 metric tons of carbon emissions through mitigation projects."[29] As another case example, most PPE used in the United States is designed for single use and is made from polypropylene nonwoven fabrics that have poor biodegradability and can result in harmful degradation byproducts upon incineration.[30] Not only can reusable gowns reduce environmental impacts by more than 60%,[31,32] but they also are cost efficient, as one hospital system's implementation of reusable gowns resulted in savings of more than $3.5 million over 4 years.[33] Despite concerns about inferior performance of cloth gowns, advances in textile engineering have allowed the production of high-quality cloth materials that meet stringent health care standards while reducing health waste.[34]

Extended product responsibility (EPR) policies that hold manufacturers and importers accountable by internalizing environmental costs associated with waste streams have also demonstrated promising cost-saving opportunities.[20] In British Columbia, Canada, EPR policies could save $14 to $17 million Canadian dollars due to incentives to recover waste and maintain inputs at highest-value application for as long as possible.[20,35]

Conclusion

Clinicians' obligations to not harm extend beyond the patient-physician interaction to health sector operations. Health care organizations and critical stakeholders, such as policymakers and supply industries, have ample opportunities to recover costs and reduce waste and emissions by embedding institutional sustainability goals in operational strategies to improve waste production and management in health care. Reducing health care waste generation will not only preserve environmental resources and improve global health in LMIC countries, but also enhance resilience against inevitable sociopolitical changes and supply chain shortages. Significant cost savings could also be realized by transitioning away from single-use items.

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Navami Jain is an undergraduate at Stanford University in Stanford, California, studying biology and mathematical and computational science.

Desiree LaBeaud, MD is a physician-scientist, epidemiologist, and a professor in the Division of Pediatric Infectious Diseases at the Stanford University School of Medicine in Stanford, California, where she studies the epidemiology and ecology of domestic and international arboviruses and emerging infections.

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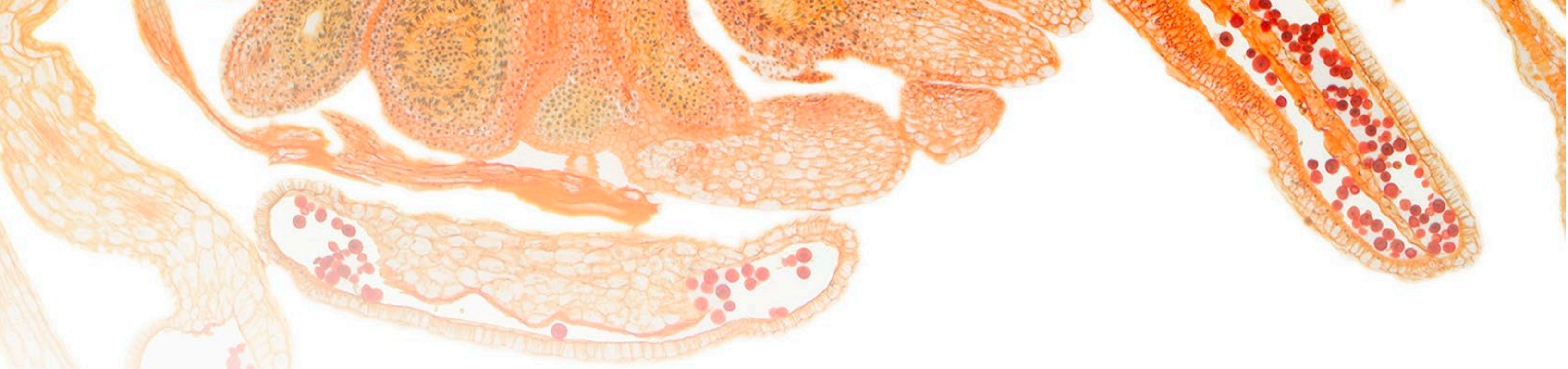

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POLICY FORUM: PEER-REVIEWED ARTICLE

Strategies to Help Health Care Organizations Execute Their Food System Leadership Responsibilities

Susan Veldheer, DEd, RD and Daniel R. George, PhD, MSc

Abstract

Food systems influence environmental sustainability and health. The fact that our current food production and distribution practices neither support nor promote planetary or human health raises ethical concerns. Since health organizations offer food to patients, community members, and employees, they are situated at key intersections among food systems, agricultural policies and practices, and public health. This article considers the nature and scope of health care organizations' local food system leadership responsibilities and describes how health care organizations' food practices can help improve health outcomes and motivate equity.

Food Production Emissions

Modern agricultural food systems exert a major impact on both the environment and human health. Food production accounts for an estimated 19% to 29% of greenhouse gas (GHG) emissions and an estimated 70% of global freshwater withdrawals.[1,2] The production of animal-based protein (eg, beef, pork, and chicken) makes the largest contribution to GHG and imposes the greatest burden on water and land resources.[3,4] In contrast, plants (eg, fruits, vegetables, legumes, and grains) have the lowest environmental impact.[3,4] At the same time, there is compelling evidence demonstrating that plant-based diets high in fruits and vegetables can be used for primary prevention or treatment of many of the most prevalent chronic diseases in the United States, including cardiovascular disease, type-2 diabetes, obesity, and some cancers.[5,6,7,8,9] Thus, the imbalance of our current food production practices not only degrades environmental health, but also has implications for human health.

However, at a time of historic wealth and income inequality, when life expectancy in the United States has reversed for the first time in a century and 6 of 10 Americans are living with at least one diet-related chronic disease (eg, heart disease, obesity, diabetes),[10,11] fostering healthier diets remains a persistent challenge.[12] Food production and consumption patterns that are misaligned with healthy dietary patterns are in part driving these troubling public health trends. For instance, population-level red meat intake is higher than recommended in North America and in most regions of the world, while intake of fruits and vegetables, legumes, whole grains, and nuts is well below recommended levels in most regions.[4,13] Dietary patterns that perpetuate poor health are influenced by a complex, interrelated, global and domestic network of stakeholders, policies, laws and regulations, supply and food distribution chains, sociocultural norms, and individual behaviors that reproduce current practices and associated outcomes. The diffuse nature of this system makes it challenging to address population health so that disparities can be ameliorated, not perpetuated. Equitable and ethical solutions will require substantial changes in food systems, production, and consumption at the local, national, and global levels, including within the institutions and structures that are degrading human and planetary health.[14]

As actionable strategies are developed, the use of established frameworks can ensure that multiple perspectives are considered. The United Nations (UN) Sustainable Development Goals (SDG), designed to "promote prosperity while protecting the environment and tackling climate change,"[15] is one such framework that can be used to assess whether food systems are ethical and sustainable. Of the 17 SDG, at least 9 are relevant to food systems, including no poverty (SDG 1), zero hunger (SDG 2), good health and well-being (SDG 3), reduced inequalities (SDG 10), sustainable cities and communities (SDG 11), responsible consumption and production (SDG 12), climate action (SDG 13), life below water (SDG 14), and life on land (SDG 15).[15] With the UN SDGs in mind, health care systems, including hospitals and outpatient clinical care, can play a critical role in ethical and sustainable health promotion.

Because health and food are so intimately connected, health care organizations are poised to provide more local and regional leadership at the intersection of food systems, agriculture, and human health. However, they have historically been on the periphery of food systems discussions.[16] Moreover, in the United States, fee-for-service health care models have historically disincentivized organizations from making strategic investments in preventive and community health (a dynamic some have termed "sick care" rather than health care).[17] Political-economic and cultural forces are, however, beginning to shift incentives, which necessitates that health care systems make a meaningful impact both on population-level health outside the clinic and on patient-level health inside the clinic.[18]

Here, we focus on 2 separate but potentially complementary pathways by which health care organizations can integrate sustainable food systems policies that improve human and planetary health into existing operational activities: (1) population-level community health needs assessments (CHNAs) and (2) patient-level clinical screening for social determinants of health (SDoH).

Community Health Needs

It is well established that community-level interventions make a greater impact on aggregate health than individual-level interventions, such as patient care delivered within a health care setting.[19,20] Thus, in 2010, the Patient Protection and Affordable Care Act (ACA) focused on improving community-level factors by requiring nonprofit hospitals to conduct CHNAs and develop plans to address identified priorities.[21] The ACA encouraged alignment of these efforts with population-level community benefit rather than patient-level benefit because a narrow patient focus excludes community members who might not interface with the system (eg, the underinsured or uninsured). It also created an incentive structure for hospital systems to follow through with CHNAs by penalizing failure to do so with a possible loss of tax-exempt status and a $50 000 excise tax.[22] In this way, the ACA sought to nudge health care institutions to assume greater responsibility for their communities and patients by incentivizing them to develop innovative, population-level intervention strategies.

Identifying pressing population-level needs and devising realistic strategies to address them requires hospital leaders to embrace the role of community health steward.[23] An initial step in fulfilling this role includes creating CHNA committees to solicit stakeholder input. CHNA committee members often include various individuals from inside health care organizations (eg, health care workers and administrators) and from the community (eg, representatives from local health departments, leaders from food banks, mental health agencies, and youth service groups). Often, these individuals have broad interests in addressing public health generally and the health of medically underserved, low-income, and minority populations more specifically. As a result of bringing these diverse stakeholders together, health care organizations have the potential to coordinate and amplify the voices of vulnerable and marginalized communities while creating opportunities to respond to local root causes of diet-related health disparities. Despite the directive for CHNAs to be community focused, however, existing data reveal that the majority of "community" programs have often focused on individual, patient-level clinical interventions.[24] Given the substantial community-level stakeholder collaboration involved in conducting CHNAs, a focus on patient-level interventions is a missed opportunity to develop ethical, sustainable, community-level food system changes that would have broader population and ecological health impacts.[16]

In contrast, as elaborated below, some health systems are demonstrating that there is value in promoting nutrition and food systems-based programs as part of a population-level approach to the CHNA process.[24] Since CHNA committees are already engaged in coordinating community stakeholders, they should not underestimate their potential to serve in a dual role as stewards in promoting UN SDGs and as leaders in organizing impactful, sustainable, nutrition-related initiatives to prevent or delay the onset of major chronic diseases at the population level.[25,26]

Screening for Social Determinants

Another US policy-level initiative gaining momentum in clinical settings is identifying and addressing patient-level SDoH, ie, factors that impact the "environments where people are born, live, learn, work, play, worship and age."[27] While the United States ranks first internationally in health care expenditures, it stands at the bottom of the Organisation for Economic Co-operation and Development countries for important health outcomes, including average life expectancy and infant mortality.[28] One reason for these poor outcomes is that, while up to 80% of preventable morbidity and mortality is attributable to SDoH and behavioral factors,[29] the United States directs the majority of its health care resources toward biomedical treatment rather than the provision of services to ameliorate detrimental social conditions.[30,31,32]

In 2017, the National Academy of Medicine published a report recommending that health care organizations screen for patient-level SDoH during clinical encounters to better understand and address the root causes of health disparities at the clinical point-of-contact.[33,34] Many health care organizations have begun developing screening tools and systematically identifying relevant patient needs, such as food security, access to transportation, or housing stability.[35] However, clinical processes and workflows to address the identified patient-level needs are still being developed and operationalized in many organizations.[35,36,37,38]

Health care organizations possess several advantages in addressing SDoH. We argue that, as health care organizations develop clinical processes specifically to address food access and food insecurity, they can act with greater intentionality as leaders, stewards, and partners within local and regional food systems to simultaneously promote the 3 aims of human, environmental, and planetary health. Furthermore, there is significant opportunity and economic incentive for health care organizations to align their efforts with UN SDGs by integrating access to sustainable, local options for healthy food into community programs that will improve both patient- and population-level health. Below, we outline some existing patient- and population-level strategies being employed in various settings that can serve as models for future initiatives.

Strategies

Promoting nutrition and food systems-based programs can be accomplished at both the population level and the patient level through already existing pathways, including CHNAs and clinical SDoH screening. These institutional tools can work in a complementary fashion to (1) identify both population- and individual-level health needs linked to poor diets and (2) leverage regional resources in addressing those needs, especially for at-risk and disadvantaged community members.

Patient-level strategies. A number of similar, patient-level clinical interventions are being piloted across the country at the clinic-community interface that could be employed when food access is identified as an SDoH challenge in clinical settings. These include providing patients with community-supported agriculture boxes,[39] providing patients with fruit and vegetable vouchers to reduce costs (eg, prescription produce programs),[40,41] and hosting hospital-based farmers' markets[42,43] or community gardens where patients can access high-quality, low-cost produce.[44,45] Some of these programs not only provide local fruits and vegetables to patients at clinical points-of-care, but also multiply community benefit by lending economic support and visibility to local food growers. This support increases reach for community actors who are producing and distributing products that, in turn, improve human health, lower the overall GHG footprint, and strengthen regional economies. Moreover, such programming and coordination between food and health systems can build a greater sense of social cohesion, especially for marginalized groups. For instance, Penn State Hershey Medical Center has used a partnership with an urban farmers' market not only to provide food security for recently resettled refugees (by helping them purchase local fruits and vegetables on a weekly basis), but also to help integrate these families into the cultural fabric of their new communities (eg, hosting English as a second language classes at the market and having families practice their English with vendors).[46] By bringing individuals and organizations together in synergistic ways, hospitals that forge such partnerships arguably improve individual health outcomes while adding social value to and supporting the economic viability of their communities.

Population-level strategy. Another type of community program that could be explored through the CHNA process is farm-to-hospital initiatives that can support population health, enhance rural economies, reinforce the environment and sustainable food systems, and improve food access and nutrition.[47,48] The first National Agricultural Statistics Service local food marketing practices survey, published in 2016, found that, among 167 000 US farms that produced and sold food through direct marketing to consumers, the majority of food sold was within 100 miles of the farm.[47] Furthermore, the survey reported that farmers who sold to institutions such as schools, universities, and hospitals brought in the most revenue. These findings support the notion that health care institutions can be stewards of their local economies and promote sustainable food systems by leveraging their buying power and sourcing food products from local farms in their service areas. Such investments may be less cost-efficient than buying from multinational food suppliers, but they create branding and marketing opportunities for institutions that can enhance their regional profile.

Patient- and population-level strategy. Another up-and-coming partnership that can provide food access at the patient- and population-level is hospital-supported organic farms, where food is grown on campus and used to fulfill organizational missions such as teaching, research, patient care, and service to community (see Table).[49] Specific to human and environmental health, such infrastructure allows institutions to substantially reduce the environmental costs of food production and distribution while creating point-of-service opportunities for patients and community members to integrate healthy organic produce into their diets. Such sites can operate synergistically at the patient- and population-level by providing opportunities for community education (eg, cooking and gardening demonstrations), outreach to vulnerable groups (eg, community-supported agriculture shares that can be given to food-insecure patients), and opportunities to educate frontline health professionals and trainees who work with at-risk patients about diet and sustainability. At present, our research team at the Penn State College of Medicine has identified approximately 25 hospital-based organic farms located at US hospitals and is in the process of documenting the innovative outreach work being done in these spaces. With the commitment of scarce land and resources, organizations investing in hospital-based farms send a meaningful, tangible message to their constituents that they are committed to community health and well-being in addition to environmental sustainability.

Table. How Hospital-Based Farms Can Fulfill Health Care Organizational Missions

Health care mission area	Strategy
Clinical	
	Use space for experiential learning about chronic disease prevention and management via nutrition education, including cooking demonstrations, gardening, and sustainable, plant-based diets.
	Source produce locally for fruit and vegetable prescription programs or community-supported agriculture boxes.
Education	
	Educate cross-disciplinary students in medicine, nutrition, nursing, public health, agriculture, and other allied health professions.
	Partner with local schools and community groups to teach nutrition, gardening, agriculture, and sustainability in alignment with the WHO SDGs.
Community outreach	
	Provide community gathering space for health-focused events and groups.
	Provide free or reduced-cost produce to employees, community members, and local organizations as a retail operation.
	Donate farm produce to food assistance programs and food banks.
Research	Use farm as a lab space to explore the impact of farming on community health.
	Explore multiple initiatives in addition to community-level interventions related to food access, nutrition education, and many other programs, including those described above.

Conclusion

The 21st century has been defined by rising inequality, falling life expectancy, declining health outcomes, persistent health disparities, and rising global temperatures. For too long, health care in the United States has been an extractive industry drawing revenue from a fee-for-service model that neither effectively serves patient-level preventive health nor population-level community health. While the ground is slowly shifting under the CHNA policy of the ACA and efforts to conduct clinical SDoH screening, health care institutions may be both slow to change and reluctant to truly extend their missions beyond the walls of the clinic.

We assert that hospital systems have a responsibility to use their position within their communities to serve as environmental stewards and community leaders. By leveraging already existing CHNA pathways and patient-level SDoH screening, they can use their existing resources and serve as central hubs for regional networks, effectively connecting at-risk individuals with food producers and other local organizations (ie, farmers' markets and gardens) involved in food production and distribution. Given the increasing responsibility that health care institutions have for population health, the intimate relationship between chronic disease and diet, and the embeddedness of hospitals within food service and retail markets, we believe health care organizations must serve as leaders in local food systems. In effect, not taking on this leadership role constitutes a wasted opportunity to serve as a unifying force for local stakeholders to collaboratively develop impactful programs at the intersection of food systems, agriculture, and human health.

Through the equity lens of the UN SDGs, such leadership can use the existing population-level CHNA framework and patient-level SDoH screening to improve health outcomes while also supporting local producers and reducing the environmental footprint of their current supply chains. In an era in which we collectively face critical ecological and public health challenges, leadership is not only necessary but ethically warranted.

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Susan Veldheer, DEd, RD is an assistant professor in the Department of Family and Community Medicine and the Department of Public Health Sciences at the Penn State College of Medicine in Hershey, Pennsylvania. Her research aims to develop and test food-as-medicine interventions that reduce the burden of diet-related chronic disease. Her most recent work reaches outside of the traditional clinical settings to test fruit and vegetable prescription programs in adults with type 2 diabetes and to teach gardening skills to adults with risk factors for cardiovascular disease.

Daniel R. George, PhD, MSc is an associate professor of medical humanities and public health sciences at the Penn State College of Medicine in Hershey, Pennsylvania, who studies dementia and Alzheimer's disease. He coauthored *The Myth of Alzheimer's: What You Aren't Told About Today's Most Dreaded Diagnosis* (St Martin's Press, 2008) and *American Dementia: Brain Health in an Unhealthy Society* (Johns Hopkins University Press, 2021).

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How Should We Respond to Health Care Generating Environmental Harm?

Amy Collins, MD and Shanda Demorest, DNP, RN, PHN

Abstract
Clinicians and organizations in the health sector have healing missions, and physicians, specifically, take oaths to "do no harm." Yet, paradoxically, health care operations contribute to pollution and exacerbate environmental disease burden. This article offers a view of how health sector actions exacerbate climate warming and iatrogenically harm global public health and argues that clinicians and organizations have ethical responsibilities to respond.

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Lessons From the Syringe Tide

Medical waste management ethics came into focus in the late 1980s, when HIV-contaminated syringes, needles, and other medical trash washed up on East Coast beaches.[1] Known as the Syringe Tide,[1] this environmental disaster led to awareness of improper disposal of sharps and infectious waste as exacerbating pollution and increasing pathogen exposure and needlestick injuries and prompted passage of the Medical Waste Tracking Act of 1988.[2] A movement to properly segregate and dispose of medical waste to protect human and planetary health had begun.

As this example illustrates, the health sector's waste management practices can have health impacts. Despite the age-old, ethical code of medicine to "do no harm," the health sector, through its direct and indirect emissions and waste management practices, contributes to many conditions that clinicians that aim to treat. Professionals and organizations have responsibilities to reconcile such ethical inconsistency and to better align their commitment to nonmaleficence with the consequences of their actions. In what follows, we discuss how health sector actions exacerbate climate warming and iatrogenically harm global public health and argue that clinicians and health organizations have ethical responsibilities to respond to the health sector's contribution to the climate crisis.

Organizational Nonmaleficence

In the 1990s, the US Environmental Protection Agency (EPA) identified medical waste incineration as a major source of emissions of carcinogenic dioxins[3] and mercury,[4] a potent neurotoxin. In response, 28 organizations came together to form Health Care Without Harm (HCWH), founded on the health sector's responsibility to reduce its environmental impact on health.[5] In 1998, the American Hospital Association, HCWH, and the EPA signed a memorandum of understanding agreeing to virtually eliminate mercury from waste streams by 2005.[6] Leveraging the do-no-harm message, HCWH led campaigns to eliminate mercury-containing thermometers and devices from hospitals and pharmacies and to close thousands of medical waste incinerators while promoting non-incineration technologies (eg, autoclaves, microwaves) to decontaminate infectious waste.[5] The campaigns led to near-elimination of the market for mercury-based measuring devices in the United States and eventually culminated in the Minamata Convention on Mercury, a global agreement to phase out mercury.[7] The coalition also identified ways to reduce waste and pollution,[5] and a sustainable health care movement was born.

Global Irony Management

Just as incineration of mercury-containing medical waste ironically poses a risk to public health, so does the industrialization of health service delivery, which contributes to the climate crisis and indirectly harms human health. US hospitals produce over 5 million tons of waste per year.[8] Fossil fuels are required to move regulated waste to facilities (eg, for incineration, chemical mitigation, or other energy-intensive treatment) before being landfilled, and the magnitude of such fossil fuel-dependent transportation and treatment contributes to health care's climate footprint. The World Health Organization has identified climate change as the "single biggest health threat facing humanity."[9] The global health community is united in its concern about the climate health crisis, delivering an unprecedented and powerful message calling for urgent climate action to protect health in an editorial simultaneously published in more than 200 journals[10] and in an open letter signed by more than 600 organizations representing 46 million health workers that urged world leaders at the Conference of the Parties (COP26) to commit to aggressive climate goals to avert the impending health catastrophe.[11] Health care leaders, in addition to policymakers, would be wise to heed such stark warnings from the world's doctors and nurses. Despite COVID-19 and the numerous challenges currently facing health care, the sector does not get a pass on climate action. Instead, it must urgently leverage its moral, political, and economic influence to lead climate solutions.

Resultant indirect public health harms of US health care emissions, which constitute 27% of the global health care footprint[12] and 8.5% of US greenhouse gas (GHG) and other toxic pollutant emissions,[13] are on the same order of magnitude as medical errors,[14] directly undermining the sector's aim to avoid harm. One must question why the sector has not addressed harms caused by its operations with the same urgency with which it has responded to some iatrogenic harms, such as medical errors.[15] To appreciate the myriad ways that health care activities generate emissions, it is important to understand the sources of GHG emissions, which are classified into 3 scopes. Scope 1 refers to emissions generated directly from a facility (eg, from on-site energy generation or fleet vehicles or from operating rooms' generation of waste anesthetic gases, such as desflurane and nitrous oxide[16,17]). Scope 2 refers to indirect emissions generated from energy purchased from a utility provider, such as electricity or steam.[18] The greatest source of emissions (62% in the National Health Service[16] and

82% in the United States[13]) are indirect Scope 3 emissions generated by activities such as product transport, employee commutes, business travel, waste generation, food and pharmaceuticals, and investments.[18] Every health care activity—from nonclinicial services, such as cooking, cleaning, and maintaining facilities, to performing surgeries—consumes energy, requires materials, and generates waste, all of which add to health care's climate impact.

Clinical Care and Emissions

Clinical care is the single largest contributor to health care emissions.[14] Clinicians order tests and treatments, perform procedures and surgeries, and prescribe pharmaceuticals daily. However, such interventions can be overused and may not always add value, with a low-value test or procedure delivered to an older adult every 80 seconds in a US hospital.[19] Factors that promote low-value care include fear of litigation, payment systems, pharmaceutical and device production, and a culture of intention to do everything possible for a patient.[20] While previous calls for reducing low-value care have focused on cost reduction and patient safety, reducing overdiagnosis, overprescribing, and overtreatment can also help reduce emissions. Clinicians have an ethical responsibility to evaluate clinical care choices through a climate lens and to minimize unnecessary surgeries, tests, interventions, and medications to help reduce health care's environmental impact without compromising patient safety and quality.

Clinicians also have an ethical responsibility to reduce the demand for health care services and keep people out of the hospital. Our current health care system functions as a "sick care" system,[21,22] with a reimbursement model designed to incentivize resource-intensive health care utilization, not prevention. The result is an unsustainable cycle: acute and chronic illness lead to health care utilization, which leads to emissions and pollution, which in turn leads to increased burden of disease. For health care to become more sustainable, there must be a focus on preventive care, which would reduce the demand for health care utilization, lessen emissions, and help realign health care with its mission.

Slow Response

Given the toll that climate is having on human health and that extreme weather events can impair health care access and delivery, one would think that health care would be at the forefront of climate solutions. Ironically, that isn't the case, and while some health systems are making significant progress, US health care emissions overall rose between 2010 and 2018.[13] Thus, the medical community has been slow to recognize connections among climate, health, and health care. Perhaps the health harms from climate change feel distant and abstract compared to the immediacy of patient care. Quite possibly, health professionals believe they are already doing enough "good" and don't need to do more. The majority of health professionals haven't received education on health care emissions or training on how to implement sustainable solutions,[23] and there has not been enough research conducted to understand the magnitude of the problem or enough data disseminated to allow health professionals to make evidence-based interventions. Finally, there is often a lack of awareness of the strong business case for sustainable health care and a misperception that "greening" is costly.[24]

There are currently no comprehensive regulatory or sector-wide mandates for sustainable health care or sustainability reporting, and health care organizations lag behind other sectors in sustainability reporting, a common practice among large businesses.[25] Moreover, there is a stark contrast between traditional and sustainability hospital committees. Hospital committees related to quality, value analysis, and ethics are often required by regulators or hospital administration. Such committees play a critical role in management and decision making and are bolstered by oversight, staffing, and resources. In contrast, hospital sustainability committees or “green teams” are often initiated by employees, led by volunteers, and without oversight or accountability. While a few health systems have staffed sustainability programs, most do not have a full-time employee dedicated to the role, and some sustainability leaders have been charged with embedding an entire facility’s sustainability work within another role, such as facilities director or executive chef (Janet Howard, personal communication, November 2021).

Oversight and Transformation

Historically, the nation’s guiding bodies that provide oversight of the health sector have neglected to meaningfully account for environmental performance and emissions in metrics or reporting requirements. However, in November 2021, the Biden administration committed to decarbonizing US health care through the COP26 Health Programme,[26] with Assistant Secretary for Health for the US Department of Health and Human Services (HHS), Admiral Rachel Levine, announcing that the United States would start by decarbonizing federal health care facilities.[27] This announcement was followed by President Biden signing an executive order in December 2021 requiring all federal facilities to decarbonize in alignment with the national GHG reduction commitment by achieving a 50% reduction in federal building emissions by 2032 and net-zero federal buildings by 2045, including Veterans Health Administration and Defense Health Agency facilities.[28] Moreover, in 2021, the National Academy of Medicine formed the Action Collaborative on Decarbonizing the US Health Sector, a partnership of health sector leaders—including leaders from the Joint Commission, HHS, and the Centers for Medicare and Medicaid Services[29]—committed to reducing the sector’s climate impact while strengthening its resilience.[30] Finally, on Earth Day 2022, HHS and the White House issued a call to action to the health care sector to commit to tackling the climate crisis by reducing its GHG emissions and increasing its climate resilience.[31] They asked health organization stakeholders to sign a pledge committing to reducing their organization’s emissions by 50% by 2030 and to net zero by 2050, completing an inventory of Scope 3 emissions, developing climate resilience plans, and designating an executive lead for this work.[31,32]

Creating a low carbon, climate-smart health care sector will require transformational change. A climate lens must be applied to every aspect of health care decision making: facility operations, food services, supply chain, employee commutes, waste management, clinical care, and financial investments (see Table for suggestions). Moreover, we must move toward preventive health care and efficient, value-driven care. To avert the most devastating health effects of climate change, the health sector must join other sectors in halving emissions by 2030 and achieving net-zero emissions by 2050. If the sector continues on a business-as-usual path, health care emissions are predicted to triple by 2050.[33] Health care has 2 choices: urgent mitigation or further contribution to suffering. Only one choice is moral. The only ethical future is one in which health care does not cause harm to patients and the planet.

Table. Operationalizing Sustainable Health Care With an Ethical Focus on Climate

Issue	Ethical Tension	Climate-Centered Ethical Choice
COVID-19 accelerated rapid expansion of telehealth services.	Barriers to telehealth (eg, lack of internet access or digital literacy, regulatory and reimbursement requirements) can prevent realization of benefits (eg, reduced exposure, utilization of PPE and other resources, and emissions reduction).[34,35]	• Explore opportunities to further expand and improve telehealth services as part of an overall strategy to reduce health care's transportation footprint.
Sustainability directors and committees set goals, prioritize initiatives, and make program decisions.	Tensions can exist between environmental stewardship and infection control, cost, return on investment, and other health care priorities.	• Encourage hospital ethicists or members of the ethics committee to join the sustainability committee and participate in ethical decision making with a climate change lens.
Health care institutions hold investments in fossil fuel companies.	Health care institutions' investments, including in fossil fuels, contribute to Scope 3 emissions, and emissions from fossil fuels contribute to air pollution, disease burden, and the climate crisis.	• Divest or freeze portfolio fossil fuel holdings and invest in clean technologies. • Consider offering fossil fuel-free retirement funds. • Use guidance from the *BMJ*'s divestment campaign.[36]
Health care uses large amounts of single-use medical devices and disposable supplies, often plastic.	Single-use supplies' convenience and perceived infection control benefits can weigh against reusable devices and supplies' safety, efficacy, and reduction in medical waste, emissions, and costs.	• Educate clinicians about environmental benefits of reusables, along with their safety, efficacy, and potential cost savings. • Transition to reusable devices whenever possible, using guidance from relevant life cycle assessments.[37] • Consider single-use device reprocessing.
Hospitals serve large quantities of meat and animal products.	Patients', staff members', and visitors' perceived preference for meat and animal-based products may weigh against their contribution to global GHG emissions, which is twice that of plant-based foods.[38]	• Reduce the amount of meat served in facilities and emphasize plant-based patient and retail menus. • Educate patients and staff about the health and climate benefits of plant-based diets.
Anesthesiology providers select anesthetic agents during surgeries and procedures.	Anesthesiologists' preference for anesthetic agents based on induction and recovery times, adequate amnesia and anesthesia, patient condition, and surgery type can contribute significantly to an OR's climate footprint.[17]	• Consider total intravenous anesthesia when possible. • Transition from desflurane and nitrous oxide and consider less environmentally damaging anesthetics (eg, isoflurane and sevoflurane). • Optimize fresh flow rates. • Review nitrous oxide equipment for leaks. • Use guidance from the American Society of Anesthesiologists.[39]
Ambulances often idle outside emergency departments during handoffs.	Ambulances' need to idle to maintain communication systems, refrigeration for medication, life support equipment, and climate control can weigh against fuel waste and generation of air pollutants that can cause cardiorespiratory problems.[40]	• Encourage ambulance companies and EMS units to consider auxiliary power units to avoid idling.[41] • Provide education about the link between idling, climate change, air pollution, and adverse health effects and about how limiting idling can reduce fuel costs.

Abbreviations: EMS, emergency medical services; GHG, greenhouse gases; OR, operating room; PPE, personal protective equipment.

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Amy Collins, MD is an emergency physician and sustainable health care professional who serves as the medical director for physician engagement and education at Health Care Without Harm, where she leads its Physician Network and supports physicians and medical students who are interested in promoting climate-smart health care and other climate solutions. She also founded the sustainability committee at MetroWest Medical Center in 2007 and led its sustainability efforts for 7 years. Previously, she worked as a sustainable health care consultant for Vanguard Health Systems and implemented sustainability programs at Vanguard's 26 hospitals nationwide. She speaks internationally about the intersections between climate change, health, and health care and the role of the health care sector in leading climate solutions.

Shanda Demorest, DNP, RN, PHN is the associate director for climate engagement and education at Health Care Without Harm and leads the Nurses Climate Challenge in partnership with the Alliance of Nurses for Healthy Environments. With expertise in the intersection of environmental sustainability in health care and human health impacts of climate change, she has provided direct care cardiovascular nursing and served as an assistant clinical professor at the University of Minnesota School of Nursing.

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MEDICINE AND SOCIETY: PEER-REVIEWED ARTICLE

How Health Care Organizations Can Be Stewardship Leaders

Lloyd Duplechan

Abstract
Mismanagement of hospital waste can release harmful, deleterious contaminants into soil, water, and air. Irresponsible or noncompliant handling of health care waste can have far-reaching environmental and public relations consequences. This article describes legal, safe, sustainable health care waste stream management as a challenge to health care leaders that can be met by implementing good stewardship practices.

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Challenges of Solid Waste Management

According to Practice Greenhealth, a membership organization seeking to provide sustainability initiatives for global environmental improvement, hospitals generate over 29 pounds of waste per bed per day, producing over 5 million tons of waste each year.[1] Moreover, the health care industry generates wastes that are considered among the most harmful, including sharps, human body parts, blood, chemical waste, pharmaceutical waste, radioactive waste, and medical devices.[2] When developing federal solid and hazardous waste disposal legislation in 1976, Congress found that "disposal of solid waste and hazardous waste in or on the land without careful planning and management can present a danger to human health and the environment."[2]

The ripple effects of hospital waste mismanagement can not only be environmentally far-reaching, but also give rise to assiduous civil enforcement activity and, in some cases, subject corporate officers to criminal liability. The Environmental Protection Agency (EPA) Criminal Enforcement Program focuses on significant and egregious violations of environmental laws that pose significant threats to human health and the environment.[3] This program is arguably appropriate and necessary, given the potential harm associated with negligent waste handling. The COVID-19 pandemic, however, underscored the challenge of waste management, as it fomented palpable instability in health care waste handling and recycling due to the sheer volume and contagious nature of the waste generated.[4]

A challenge faced by health care leadership, particularly environmental services (EVS) and environmental health and safety (EHS) professionals, is to develop programs to manage waste material in a manner that is prescribed by law; is safe for workers, the public, and the environment; is economically sustainable; and demonstrates ecological stewardship. In the final analysis, EVS and EHS professionals and the rest of the multidisciplinary team, including workers in infection prevention and control and waste handling vendors —indeed, the entire health care organization—must take a pragmatic, integrated approach to keep a steady hand on the tiller, as they navigate the whirlwind of regulatory and statutory requirements. In what follows, I highlight and trace the interconnections among waste management, the environment, and federal governance.

Solid Waste Streams

The first page of the playbook is identifying kinds of waste. Federal regulations define solid waste as any discarded material (that is not excluded under law) that is abandoned, recycled, or considered "inherently waste-like."[5] Waste streams are differentiated by type of facility and by the nature of the services, processes, and material or product used. The different types of health care wastes include the following:

- Infectious waste/medical waste: articles contaminated with blood and other bodily fluids and sharps waste
- Pathology waste: human tissues, organs or fluids, and body parts
- Chemicals: spent solvents and reagents, disinfectants that could meet criteria for regulation under the Resource Conservation and Recovery Act (RCRA)[6] or wastewater discharge prohibitions under the Clean Water Act[7]
- Pharmaceuticals: expired, unused, and contaminated drugs and vaccines; cytotoxic drugs used in cancer treatment, some of which could trigger special waste handing requirements under relatively new RCRA subsections
- Radioactive waste: articles contaminated by radionuclides, including radioactive diagnostic or radiotherapeutic materials
- Universal wastes, such as waste electronics, light tubes, and batteries
- Nonhazardous or general waste (ie, solid municipal wastes)
- Food wastes
- Recyclable materials, the responsible management of which is the cornerstone of waste minimization and environmental stewardship

Practice Greenhealth recently estimated that solid waste is the largest waste stream for health care organizations, constituting two-thirds of all hospital waste, the management and disposal of which can consume more than 30% of the hospital's waste budget.[8] Hospital solid waste typically comprises paper (especially corrugated cardboard and shipping containers), food waste, and disposable linens, along with rubber, nitrile and plastic from gloves, catheter bags, and other supplies.[8]

Waste Management Laws

Irresponsible or noncompliant management of health care waste can release harmful and deleterious contaminants into the soil, water, and air. Various laws pertaining to the management of wastes were penned by different lawmakers at different times to help address different issues, such as public safety, environmental protection, worker safety, and sanitation.[9,10,11,12,13,14] This section briefly highlights some important principles of waste management as they align with specific legal provisions of related public policy and underscores the ecological consequences of noncompliance and the importance of demonstrating organizational ethos and commitment to environmental stewardship.

RCRA. The Solid Waste Disposal Act (SWDA) was signed into law in 1965 to address public concern about inappropriate burning and open-air dumping of trash.[15] This act reconciled the notion of sanitary management of waste with applied epidemiological science of the time. As an amendment to the SWDA, RCRA was intended by Congress to be the nexus of all environmental regulations.[6] RCRA's original objectives were conserving energy and natural resources, reducing the amount of waste generated, and ensuring that wastes are managed in an environmentally sound manner. By the end of the 1970s, however, heightened public awareness of and congressional attention to hazardous waste led to RCRA amendments for hazardous waste management under Subtitle C.[16] As amended, RCRA was designed to fully regulate hazardous waste management from the "cradle to the grave," as opposed to at the "end of the pipe," as was previously specified. This reorientation shifted accountability for hazardous waste from the waste destination storage and disposal facilities upstream to the waste generator (the health care facility) and throughout the entire waste management continuum, including shipping, transport, and disposal. The statute gave rise to stringent regulations addressing waste identification, collection, accumulation and storage, transport, and treatment disposal, all tracked through the use of a uniform manifesting procedure.

The ensuing EPA regulations advanced the congressional agenda and intent by providing prescriptive, legally enforceable requirements for waste management.[17] According to the EPA, the discovery of pharmaceuticals in drinking water around the country raised concerns about potentially adverse environmental consequences and detrimental effects on human health.[18] It is imperative that drugs are included in the health care organization's waste minimization, handling, and disposal programs in accordance with RCRA.[19]

Comprehensive Environmental Response, Compensation, and Liability Act. The Comprehensive Environmental Response, Compensation, and Liability Act—commonly known as "Superfund"—addresses the safe and environmentally responsible management of abandoned waste sites, cleanup of releases of hazardous substances into the environment, and the financial responsibility for abatement.[20]

The importance of cradle to grave accountability was painfully underscored for some California hospitals that, in good faith, offered to transport their waste lead containers and aprons (from diagnostic imaging) to a local metals smelter company for disposal. In July 1992, the *Los Angeles Times* wrote: "The US Environmental Protection Agency had declared the property in ... Bell Gardens a threat to public health. Cleanup crews leveled the smelter building last week and began digging up hundreds of cubic yards of contaminated soil."[21] These hospitals found themselves in the throes of civil action, as the federal government directed the disposal facility and alleged contributory parties to remove and remediate the waste.

Regulations pertaining to radioactive waste. Radioactive waste is a byproduct of various nuclear technologies used in health care facilities, including nuclear medicine, radiotherapy, and reagents for research. This waste contains radioactive substances, eg, unused liquids from radiotherapy or laboratory research. Radioactive contaminated glassware, packages or absorbent paper, and urine and excreta from patients treated or tested with unsealed radionuclides also constitute radioactive waste.[22] Centers for Medicare and Medicaid Services regulations pertaining to radiology address precautions to safeguard against radiation hazards and harmful exposures, including "appropriate storage, use and disposal of radioactive materials."[23] Similarly, Joint Commission standard EC.02.02.01 EP 6 specifies that hospitals must minimize risks associated with selecting, handling, storing, transporting, using, and disposing of radioactive materials.[24] The US Nuclear Regulatory Commission regulates low-level waste disposal through a combination of regulatory requirements, licensing, and safety oversight.[25]

Clean Air Act. The SWDA was the first federal law that required environmentally sound methods for disposal of household, municipal, commercial, and industrial waste. Due to the various treatment methods used to render waste nonhazardous and suitable for landfill disposal, these provisions gave rise to new air quality challenges.[26] In 1970, shortly following the first Earth Day, Congress enacted amendments to the Clean Air Act to improve upon its prior legislative efforts to control air pollution. The EPA published Clean Air Act Guidelines and Standards for Waste Management that identified stationary sources of air pollution for waste management industries and their corresponding air pollution regulations and guidelines. Applicable regulations include National Emission Standards for Hazardous Air Pollutants,[27] New Source Performance Standards,[28] and waste incineration rules.[29]

Waste management and climate change. According to the EPA, landfill gas (LFG) is a natural byproduct of the decomposition of organic material in solid waste landfills that is composed primarily of methane (the primary component of natural gas) and carbon dioxide (CO_2).[30] The 2014 Intergovernmental Panel on Climate Change assessment report states that methane is a potent greenhouse gas (GHG) that is 28 to 36 times more effective than CO_2 at trapping atmospheric heat over a 100-year period.[31] Poorly managed food waste, for example, can contribute significantly to GHG emissions. According to the EPA, every year in the United States, approximately 31% (133 billion pounds) of the overall food supply is wasted, which contributes to the 18% of total US methane emissions from landfills.[30] In light of this finding, in 2015, the US Department of Agriculture joined the EPA in setting a goal to cut our nation's food waste by 50% by the year 2030.[32] Proper management of food waste through composting and other waste minimization programs can demonstrate an organization's concern for long-term ecological issues and a commitment to making adjustments in the spirit of environmental stewardship.

Clean Water Act. A revision and reorganization of the Federal Water Pollution Control Act of 1948, the Clean Water Act regulates wastewater discharges and quality standards and establishes federal funding schemes for pollution control programs,[33] all of which were necessitated by improper solid waste disposal. When waste chemicals are not properly manifested and shipped to licensed treatment and disposal facilities and are instead shipped to municipal waste landfills, chemicals can leach into the groundwater and eventually surface water by means of percolation, precipitation, and runoff. While new landfills are required to have clay or synthetic liners and collection systems to protect ground water, older landfills, however, do not have these safeguards. These landfills were often sited over aquifers or close to surface waters and in permeable soils with shallow water tables, enhancing the potential for leachate to contaminate ground water.[34]

Occupational Safety and Health Administration. Following a well-publicized incident in the late 1980s involving medical waste washing up on several East Coast shores,[35] Congress passed the (temporary) Medical Waste Tracking Act (MWTA), which required the EPA to examine various treatment technologies and various chemical and mechanical systems for their ability to render waste noninfectious.[36] Two years after the enactment of the MWTA, the EPA concluded that the disease-causing potential of medical waste is greatest at the point of generation and that the occupationally exposed individual is more at risk than the environment.[37] In light of this risk profile, provisions of the Occupational Safety and Health Administration Bloodborne Pathogen (BBP) standard protect workers who can reasonably be anticipated to come into contact with blood or other potentially infectious materials as a result of performing their job duties, such as handling potentially contaminated waste.[38] In addition to its requirements concerning engineering and work practice controls, personal protective equipment, and vaccinations, the BBP standard provides for the proper collection, containment, and management of regulated waste, including placement of waste in properly labeled containers that are closable, rigid, and constructed to contain all contents and to prevent leakage of fluids during handling, storage, transport, or shipping.

Health Insurance Portability and Accountability Act. In 1996, the Health Insurance Portability and Accountability Act was promulgated as an amendment to the Consolidated Omnibus Budget Reconciliation Act in an effort to make health care delivery more efficient and to "improve the portability and accountability of health insurance coverage" for employees between jobs.[39] Included is a general mandate that a health care facility must reasonably safeguard protected health information (PHI)—identifying information, as well as information about a patient's medical condition or method of payment—from negligent use or disclosure. These safeguards include measures for managing wastes that contain PHI, such as after- visit summaries, medication labels, invoices, and information on intravenous bags. In consequence, hospital waste management systems must include unfettered access to designated confidential waste bins at the point of waste generation, a robust chain of custody, and verifiable destruction.[40]

Waste Reduction

The denouement of this story should come as no surprise: the best way to manage waste is not to generate it in the first place. Ecological considerations notwithstanding, from a business perspective—irrespective of the type or volume of waste a hospital generates—it is all the same in one respect: it costs money! In fact, hospitals pay twice—once when the material is purchased and the second time when it's thrown away. By consuming and discarding less, health care organizations can reduce the need to handle, treat, and dispose of waste. The EPA encourages practices that reduce the amount of waste needing to be disposed of, such as source reduction, waste prevention, and recycling.[41] The federal government, however, has mainly depended on local and state governments to enact their own waste management and recycling laws.[42]

In recognition of the fact that much of the commercial sector waste sent to landfills is readily recyclable, states like Illinois and California have championed targeted recycling initiatives and laws. The state of California, for example, requires all businesses, apartment complexes, and government entities to recycle as one of the first actions under the state's Air Resources Scoping Plan, which lays out California's strategy for meeting GHG reduction goals.[43] In the state of Illinois, the 3 main pieces of legislation that address waste reduction and recycling are the Illinois Solid Waste Management

Act, the Illinois Solid Waste Planning and Recycling Act, and the Illinois Environmental Protection Act.[44]

Action Steps for Organizations

Other waste reduction and minimization ideas include the following:

- Employ permitted or legally approved onsite treatment, neutralization, and detoxification of chemical wastes to render them suitable for safe sewer disposal. For example, the California Health and Safety Code contains regulations and incentives that ensure that the generators of hazardous waste employ technology and management practices for the safe handling, treatment, and recycling of their hazardous wastes prior to disposal.[45]
- Develop internal programs that promote the substitution of less hazardous chemical products and laboratory chemistry whenever clinically and operationally feasible, such as nontoxic or less toxic xylene replacements for the pathology laboratory that are compatible with tissue processors and mounting media.
- Work with procurement and supply and suppliers to avoid products with excessive packaging whenever possible and to purchase items in bulk, in concentrate, or in refillable packages.
- Donate used (but still operating) electronics for reuse. Doing so extends the life of devices and keeps them out of the waste stream for a longer period of time.

As a matter of law, hazardous waste generators (including hospitals) must certify that they have waste reduction programs in place. Along with federal hazardous waste regulations is a little-known waste minimization certification tucked away within Item 15 of the Uniform Hazardous Waste Manifest that must accompany off-site shipments.[46]

A large-quantity hazardous waste generator, for example, must certify to a statement that the generator has "a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable."[46] That means every signature of every hazardous waste manifest memorializes an organization's commitment to regulatory compliance, as well as its covenant to the community, and should strengthen the organization's resolve to help protect the environment through strong waste reduction policies and practices.

Conclusion

The true *raison d'etre* of health care is to improve public health, as highlighted in the mission statement of the American Medical Association. Pursuant to that goal, this article has shown how the management of medical waste can be aligned with environmental sustainability, resource stewardship, and regulatory compliance.

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Lloyd Duplechan is the principal and chief executive officer of Duplechan and Associates Healthcare Consultants and a former hospital chief operating officer with 40 years of health care experience. He is a recognized author and speaker on health care regulatory compliance, quality and care experiences, environmental services, and leadership.

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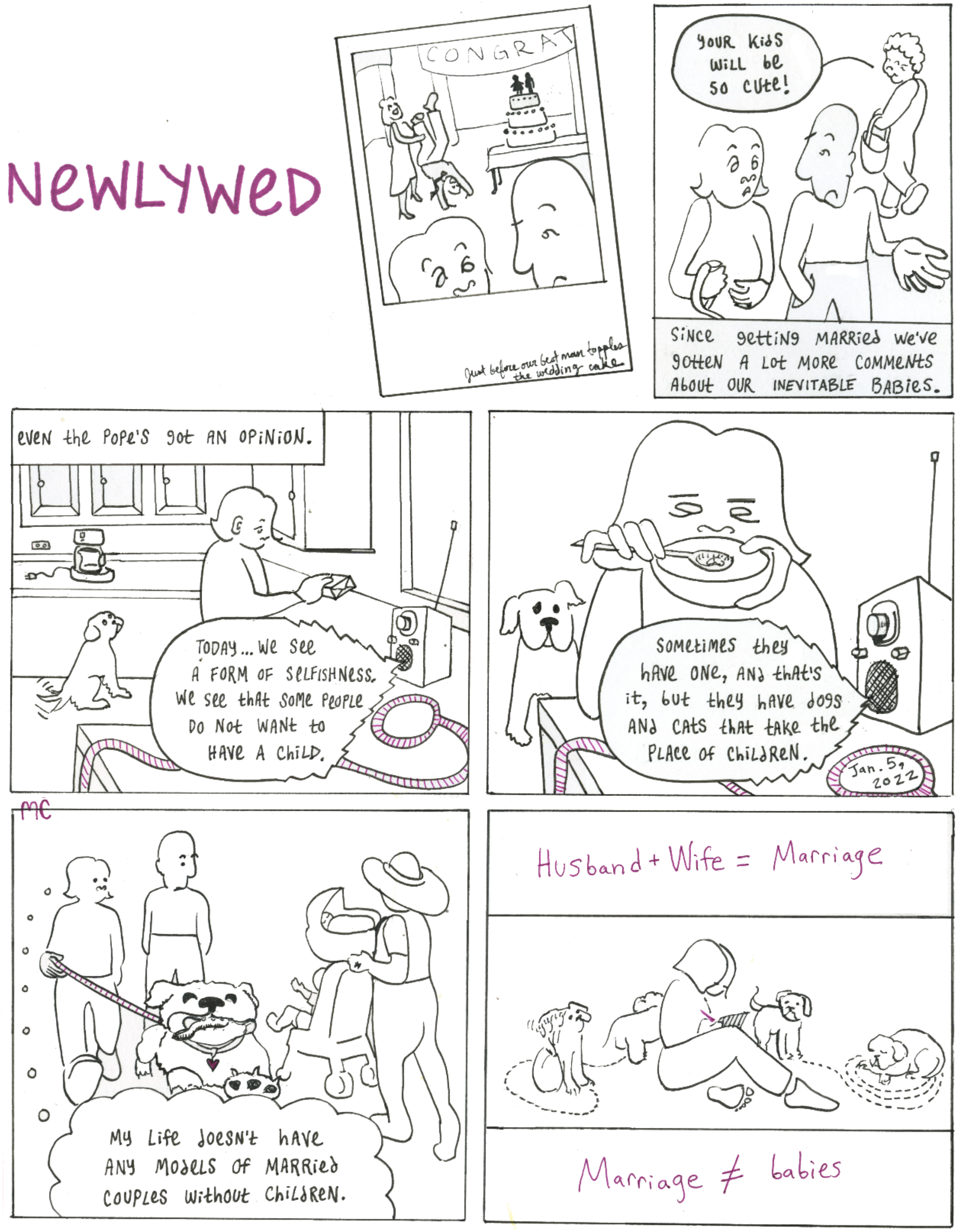
ART OF MEDICINE

Questioning Marriage and Family Norms

Michaela Chan

Abstract
In *Newlywed*, a woman is stressed by unsolicited opinions and frequent insinuations that marriage inevitably leads to babies. She laments, "Even the pope's got an opinion!," in response to his suggestion that selfishness motivates couples who choose not to have children.

Figure. *Newlywed*



Media

Ink on paper, 9" x 11".

In January 2022, Pope Francis suggested that selfishness motivates couples who choose not to have children.[1] From this point of view, a couple who does not have children supposedly gives up opportunities to instill good values in the next generation.

Calling childless persons' motivations "selfish" perhaps can be charitably interpreted as recognition of the hard work that parenting demands. But reasons to remain childless should likely also be recognized as dependent upon many legitimate possible priorities. A sense of selflessness, for example, not *selfishness*, can motivate decisions of childless couples who wish to reduce their carbon footprint and apply their energies to existing lives. Furthermore, why must a decision not to have children be tied to any moral imperative at all?

This comic originally had a different ending. To celebrate childless couples, I wanted the woman in the comic to have a thought bubble filled with intentionally childless, historically significant married couples. This didn't work out. Neither research nor polling helped turn up more than a few examples, all of whom happen to have been artists: Frida Kahlo and Diego Rivera; Georgia O'Keefe and Alfred Stieglitz; and Virginia and Leonard Woolf. These disruptors of norms, however, did not uniformly *choose* to be childless: Kahlo was injured,[2] O'Keefe and Stieglitz seemed to disagree,[3] and Woolf, rightly or wrongly, deemed his wife too unstable to have children.[4] The scrapping of this ending due to there being few historical models of significant childless marriages might suggest that, when diverse pairs of persons feel pressure to bear and raise children, this pressure itself and its sources warrant critical appraisal of the norms they protect. Questioning a norm's legitimacy is key to personal and public inclusion.

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Michaela Chan is a graduate student at the School of the Art Institute of Chicago in Illinois, and her comics start as questions, songs, and conversations.

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ART OF MEDICINE

A Future We Create

Christa J. Prentiss

Abstract
This drawing considers roles of health care waste in environmental stewardship and individuals' and communities' health outcomes.

Figure. *Inheritance*

Media
Watercolor, acrylic, and graphite on cold press paper, 11" x 5.5".

Caption
Single-use, disposable health care supplies promote safety but generate abundant waste. Even when produced cheaply, these items travel, used or unused, from packaging to landfills, and their biohazardous influence is not isolated to institutional locations where they are discarded. In this watercolor, an anonymous, white-clad health worker navigates a growing pile of waste. Scattered used blue masks stray from collections contained in yellow and red bags, becoming part of an environmental inheritance of the children at play.

Christa J. Prentiss is a fourth-year medical student at Oregon Health & Science University in Portland, Oregon, whose interests include health care access, intersections of art and science, and rock climbing.

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