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Top 5 Things Health Professions Students Should Know About Ecology and Waste Management

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Abstract

The environments in which we live affect individual and community risk for disease transmission and illness severity. Communities' and neighborhoods' waste stream management designs and health care organizations' spatial and structural architecture also influence individuals' and communities' pathogenic vulnerabilities and how well health sector industrial hygiene practices support them. This article describes a One Health approach to planetary environmental health and suggests strategies for implementing a One Health or Planetary Health approach in the context of climate change.

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Introduction

The health care industry is a major contributor to environmental degradation through the generation of waste and greenhouse gas emissions.[1,2,3] Health care professionals have a responsibility not only to manage the health consequences of our current environmental crisis (eg, food-, water-, and vector-borne diseases), but also to minimize ongoing contributions of the health care industry to that crisis. To lean into this challenge, health care professionals should understand the sources and health impacts of plastic waste and wastewater and factors that exacerbate or alleviate environmental health threats, such as climate change and the built environment. Climate change, in particular, is intensifying these threats and the health inequities rooted in poverty and insanitary living conditions.[4] Systems-based approaches, such as those offered by One Health or Planetary Health, can be applied to local disease ecology worldwide to improve both local and global public health. This article describes a One Health approach to planetary environmental health and suggests strategies for implementing such an approach in the context of climate change.

Plastic Waste

A significant global issue is the pollution crisis, especially plastic waste, which harms both the environment and human health. The problem of plastic waste is particularly acute in low-income countries with inadequate waste management systems and policy regulation. Non-biodegradable plastic waste leads to blockage of drainage systems and accumulation in landfills, oceans, and other natural habitats, contributing to ecosystem degradation and biodiversity loss.[5,6] Plastics also enter the food chain in the form of microplastics and ultimately end up in our bodies; the accumulation of microplastics in the digestive tract may be linked to negative health effects, including alteration of the gut microbiome and increased risk of colon cancer.[7,8] The breakdown of plastics and other household waste, either in landfills or by burning, also releases toxic chemicals that contaminate soil, ground and surface water, and air. These toxic chemicals also cause harm to the central nervous system and the respiratory and cardiac systems and interfere with hormone function, causing developmental and reproductive problems in both humans and wildlife.[9,10] Furthermore, burning plastic waste not only contributes to air pollution but also results in greenhouse gas emissions that contribute to climate change, causing both direct and indirect harm to human health.[11]

Local management of plastic pollution is only part of the solution to planetary environmental health. Addressing plastic pollution at large is vital to protecting both the environment and public health, and reducing the further generation of plastic waste is a global responsibility. A sizeable proportion of US health care waste is unrecycled plastic,[12] and, as such all health care professionals should contribute to shifting the medical system to more sustainable practices.

Wastewater

Wastewater infrastructure plays 2 major roles: removal of feces and buffering of rainwater. The impacts of inadequate water infrastructure are far-reaching. It is a major risk factor for diarrheal disease,[13] one of the leading causes of pediatric death worldwide.[14] While people often think about access to clean drinking water as key to preventing diarrheal disease, the removal of wastewater is just as important to preventing environmental contamination with diarrheal pathogens and intestinal helminths.[15] Fecal contamination of soil perpetuates the cycles of ascariasis, strongyloidiasis, and hookworm infections. Inadequate wastewater infrastructure leads to contamination of surface water and groundwater; this contaminated water can leach into wells and piped water systems or end up in agricultural irrigation water.[16,17,18] Often less considered are the myriad nondiarrheal diseases that can be spread by inadequate water infrastructure. For example, inadequate storm drainage and consequent flooding can increase the risk of not only diarrheal diseases but also mosquito-borne infections, leptospirosis, snake bites, and injuries.[19]

Health care facilities generate some of the most high-risk wastewater. Hospital wastewater from sewage sources is a risk not only for pathogens broadly but also for highly antibiotic resistant microorganisms, pharmaceutically active compounds, detergents, and other chemical and organic toxins.[20] Indeed, the biodegradability index of hospital wastewater is lower than that of municipal wastewater.[21,22,23] Additionally, hospital wastewater composition and treatment varies by place, and many treatments do not completely eliminate antibiotic-resistant microorganisms, viruses, or other organic and chemical pollutants.[24] In addition to following facility-wide wastewater management protocols, each medical department can contribute to identifying less toxic replacement products wherever possible.

Architecture and Built Environments

Architecture plays a key role when it comes to environmental and human health and has the potential to promote well-being or increase disease risk. The built environment has broad impacts on health that range from infectious disease risk to poor mental health, air pollution, and heat exposure. For instance, the risk of vector-borne diseases, such as chagas disease (spread by triatomine bugs), dengue fever (spread by *Aedes aegypti* mosquitoes), and malaria (spread by *Anopheles* mosquitoes) are mediated by house construction and landscaping features. Better house construction materials have been associated with decreased infestation with triatomine bugs,[25] just as air conditioning and building materials that promote ventilation and window screens that create barriers for mosquito entry can decrease risk of dengue fever and malaria.[26,27,28] Landscape features outside the house also play an important role in mosquito abundance. The presence of containers that hold rainwater or gutters on houses create ideal breeding sites for *Aedes Aegypti* mosquitoes,[29] which also increase in places with shade, such as house eaves or cover from trees in the yard.[30,31] Similarly, stagnant pools of water provide breeding sites for *Anopheles* mosquitoes.[32]

In addition to influencing the spread of vector-borne infectious diseases, the built environment plays a critical role in exposure to animals—and thereby zoonotic diseases—as well as diarrheal diseases, as discussed above, and other health conditions.[33,34] Urban design and housing construction have been linked to cardiorespiratory and metabolic diseases.[33,34] The built environment also affects mental health and overall well-being.[35] Hazardous construction materials and residential proximity to industries generating toxic pollutants can have a multitude of negative health effects, such as hematologic and respiratory impacts of benzene exposure.[36,37,38]

Health care professionals have the opportunity to collaborate with ecologists, architects, urban planners, and policy makers to design and advocate for construction of a healthy built environment. By understanding how the built environment affects disease risk, health care professionals can engage with public policy makers, urban planners, and engineers to build healthier communities. Furthermore, the built environment in and around the hospital is critical to promoting well-being for the most sick and vulnerable people in the community. The importance of a resilient hospital built environment has never been as important as it is today, with increasing extreme weather events placing even greater strain on health care systems. Preventive medicine thus goes beyond diet, exercise, and health screenings: it entails building resiliency and an all-hazards approach to disaster planning into health care systems.

Climate as an Ecological Health Determinant

Climate change poses the most significant threat to public health[39] and compounds the waste problem in many ways. For instance, the problem of marine food insecurity from pollution is exacerbated by the effects of climate change on oceans, including ocean acidification and deoxygenation, which is resulting in unprecedented loss of marine biodiversity and abundance.[40] *Aedes aegypti* mosquitoes, which breed in discarded plastic waste, are highly adapted to hot temperatures and therefore their suitable habitat range is rapidly expanding and is projected to include 91% of the US population by 2100.[41] Increasing extreme weather events have also been associated with amplification of vector-borne, zoonotic, and diarrheal diseases. For example, drought increases water insecurity, resulting in increased use of water storage containers that provide breeding grounds for *Aedes aegypti* mosquitoes.[42] Drought also amplifies interspecies contact and thereby transmission between animals, vectors, and humans, as recently proposed as a trigger for an unusual yellow fever virus outbreak in Brazil.[43] At the opposite extreme, flooding can increase contact with water contaminated by rat or dog urine in places with poor trash and water management, increasing the spread of leptospirosis; flooding also overwhelms wastewater systems and exposes people to feces-contaminated water.[44,45] Extreme weather events, including flooding and heat waves, are also associated with mood disorders and cardiovascular events.[46,47]

Again, health care providers have an important role not only in the management of these impacts, but also in urgently decreasing emissions that are driving climate change. The US health care system alone is responsible for approximately 4.5% of global greenhouse gas emissions, and despite the importance of mitigating climate change to improve health, it has lagged behind other industries in reducing emissions.[48] Health care providers and professionals have a responsibility and opportunity to mitigate climate change by advocating for and making choices to get to net zero—by improving preventive care, investing in clean energy, and selecting environmentally conscious supplies.[49]

A Planetary Ecological Approach

One Health is a long-standing approach to public health in which the health of the collective communities of humans, animals, and the environment is assessed simultaneously in recognition of their interdependence. Historically, One Health has focused on zoonotic infectious diseases, with physicians, veterinarians, and ecologists working closely together.[50] A classic example is leptospirosis, a bacterial infection that can cause severe, life-threatening disease in humans. Leptospirosis is transmitted to humans by physical contact with water that has been contaminated by the urine or feces of an infected animal, often rats or stray dogs.[51,52] Trash in or around a community increases the abundance of these animals, thereby increasing the risk of leptospirosis, particularly in communities that are also prone to flooding. In addition to flooding, which is increasing with climate change, trash accumulation and the rise of informal urban settlements promote the spread of this disease.[53]

The One Health approach has expanded beyond zoonotic disease in recent years, given the increasing recognition of the plethora of connections between human health and the environment. The evolution and expansion of the One Health approach is now often termed Planetary Health and incorporates research on climate change and social determinants of health.[54] Planetary Health also incorporates environmental health, including waste, and its relation to human health. Microplastics invade the food chain and are increasingly recognized as a problem for both animals and humans.[55,56] Pollution on land and in the oceans negatively impacts our food supply and increases food insecurity.[55,56,57,58] Research shows that increased mental health stress is associated with residential areas having an abundance of trash and, conversely, that well-being is associated with local green space.[59,60] Taking a One Health or Planetary Health approach to health problems can improve health care professionals' early recognition of environmental health risk factors and promote health at the community and individual levels.

Conclusion

Waste management, the built environment, and climate change are intricately connected and shape environmental risk for many health issues. These risks are often compounded and disproportionately affect the most vulnerable populations. Understanding the interaction between health and ecology provides an opportunity to improve public health both locally and globally. For health professionals, this opportunity extends beyond identifying individual patient risk factors; individual efforts related to waste management, the built environment, and climate change can help minimize the widening inequities in population health. In particular, health professionals' responsibility to advocate for patients' health includes raising the specter of climate change, plastic pollution, and waste management as a critical health threat that demands radical mitigation. By taking a planetary health approach and collaborating with specialists from other disciplines—for instance, with veterinarians, ecologists, policy makers, urban planners, and local community advocates—health professionals can help to build a world that reduces the impact of the climate crisis on humans and our environment. Much of this work needs to look inwards—at the environmental, and therefore health consequences, of the waste and greenhouse emissions generated within the health care industry.

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