

Harnessing Occupational and Environmental Medicine Expertise to Transform Medical Care: A Catalyst for Mitigating the Human Health Impacts of Climate Change

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The escalating global health crisis precipitated by climate change demands urgent attention in health care education and practice. This paper explores the pivotal role of occupational and environmental medicine (OEM) clinicians as a resource for climate change education and practice across the health professions. Drawing on their unique interdisciplinary expertise, OEM clinicians can help bridge the knowledge gap between climate science and clinical practice. The authors present a comprehensive framework for leveraging OEM expertise to enhance climate literacy and practice among health care professionals, ultimately fostering a more resilient and adaptive health care system in the face of mounting environmental challenges. The ethical guidance of this effort rests on the four pillars of medical care: autonomy,

beneficence, nonmaleficence, and justice. However, the paper reaches beyond an anthropocentric focus to include the broader, emerging ethical principles associated with planetary health that recognize humans as an integral part rather than masters of the ecosystem.

IMPACT OF CLIMATE CHANGE ON HUMAN HEALTH

Debate about the urgency of mitigating climate change has often centered on the economic costs of energy transition compared to the cost of business as usual. Indeed, evidence is mounting that the cost of business as usual will be far more catastrophic than anticipated.^{1,2} Leading health organizations throughout the globe have identified climate change as the most significant health threat facing humanity in our time.^{3–5} There are present and future far-reaching implications for morbidity, mortality, health care systems, quality of life, and environmental health, as well as economic productivity.⁶ In the summer of 2019, more than 150 medical organizations from around the United States deemed the unprecedented pace of climate change as a “health emergency,” calling numerous stakeholders, including government and industry leaders, to prioritize the Climate, Health, and Equity: A Policy Action Agenda.⁷ The World Health Organization (WHO) has proclaimed that “Health professionals are well placed to play a unique role in helping their communities to understand climate change, protect themselves, and realize the health benefits of climate solutions.”⁸ Lancet’s Countdown on health and climate change also declared an “imperative for a health-centered response in a world facing irreversible harms.”⁹

A combination of natural and anthropogenic forcing factors creates changes in temperature, precipitation, and weather patterns that drive climate change. However, the unprecedented changes since the emergence of the industrial era have been primarily due to human activities, particularly fossil fuel usage, which emit greenhouse gases (GHGs), such as carbon dioxide, methane,

nitrous oxide, and halogenated compounds.¹⁰ Although the international community has made impressive progress in reducing GHGs since the 2015 Paris Agreement, restricting global warming to 1.5°C or less is no longer achievable with existing national pledges. The hottest year on record was 2024, with the global average temperature increase reaching an average 1.55°C.¹¹ According to the latest United Nations Intergovernmental Panel on Climate Change (IPCC) report, the continued increase in global GHG emissions makes the time window for achieving the Agreement’s aspirational goal or even the more modest goal of 2°C as little as a few years. Dramatic and rapid changes in the atmosphere, oceans, cryosphere, and biosphere have already occurred, damaging nature, the built environment, and human health.¹²

Many resources detail the impacts of climate change on health and health care in the United States and globally^{4,13–15} (see SDC 1 for additional resources, <http://links.lww.com/JOM/C105>). In brief, rising temperatures, precipitation extremes, extreme weather events, and rising sea levels expose humans to extreme heat, poor air quality, increasing allergens, reduced food and water quality, changes in infectious disease vector ecology, and population displacement. In turn, these exposures create environmental hazards that affect many organ systems and can lead to multiple adverse health outcomes, including temperature-related illnesses; food, water, and vector-borne diseases; air pollution-related conditions; mental health problems; injuries; malnutrition; and interpersonal violence. Individual and population susceptibility is associated with exposure dose and mediated by social, behavioral, occupational, environmental, and institutional contexts.¹⁶ This paper focuses on the impact of climate change on the broad environment that sustains human health and all life. When important to emphasize the occupational exposures linked to the general environment, the term occupational and environmental (OE) will be used. See Figure 1.

In addition to adverse health effects directly related to global climate change, other aspects of global environmental change

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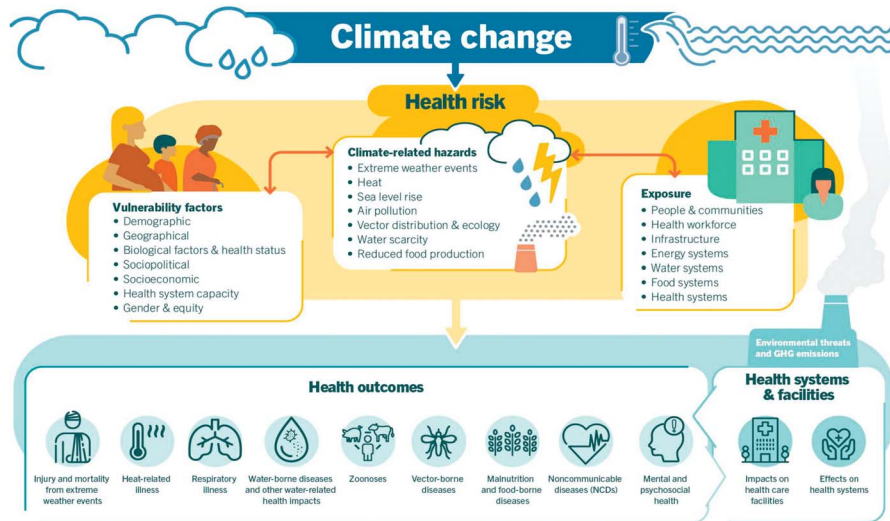


FIGURE 1. Overview of climate-sensitive health risks, their exposure pathways and vulnerability factors. World Health Organization.⁴

directly impact human morbidity and mortality. Extreme weather events can severely damage or potentially destroy the critical infrastructure on which society and public health depend, such as transportation, energy, health care, wastewater systems, electric power grid, and telecommunication.¹⁷

Other aspects of environmental degradation include loss of biodiversity, chemical pollution, air pollution, food insecurity, the emergence of zoonotic diseases, and solastalgia (the emotional distress caused by environmental change).¹⁸ Two interrelated concepts have arisen to address these broader environmental issues and their connection with climate change. The One Health concept stresses the interrelationships of the health of humans, other species, and the environments that they share. It has been driven partly by the need to confront the complex changes in food production systems and agricultural intensification, habitat and biodiversity loss, and the consequent rise in emerging zoonotic and vector-borne diseases. These changes have emphasized the interdependence of the health of humans, animals, and their shared environments.¹⁹ The One Health approach also calls for interdisciplinary collaboration between human health, animal health, and environmental professionals. COVID-19, Ebola, and the avian influenza are examples of the need for this close collaboration. The Quadripartite agreements of the WHO, the UN Food and Agriculture Organization (FAO), the World Organization for Animal Health (WOAH), and the UN Environmental Program (UNEP), as well as policies of national agencies such as Centers for Disease Control and Prevention (CDC) and United States Department of Agriculture (USDA), support One Health collaboration.¹⁹ Planetary Health, a closely related concept gaining

traction, points to not only threats to ecosystems necessary for human health, including climate change but also the exceeding of “planetary boundaries” including water and soil degradation, biodiversity loss, and atmospheric pollution.²⁰ Although climate change and other causes of ecosystem degradation affect all people, as illustrated in Figure 1, they disproportionately affect vulnerable populations that already shoulder an increased burden of health risks and health inequities. These groups include many workers, older adults, pregnant women, individuals with underlying medical conditions or disabilities, low-income communities, communities of color, and children. The fact that often these populations have contributed the least to GHGs compounds this inequity.¹⁴ Examples of these inequities include heat waves that can challenge individuals without access to air conditioning or transportation to cooling centers. Outdoor and some indoor workers may be at increased risk of exposure to heat stress and be less likely to have access to occupational health services. Children are at increased risk of adverse effects of climate change especially given their ongoing physiologic and psychological development.^{21,22} Furthermore, low-income countries and small island developing states are experiencing a more significant climate change burden. In these vulnerable areas, deaths from floods, droughts, and storms were 15 times higher from 2010 to 2020.¹² Climate effects on food security because of crop failures and sea-level rise flooding seacoast communities are driving both civil conflict and forced migration, producing large and vulnerable populations of climate refugees.²³

Climate change poses significant risks to health care facilities, with every increment in global temperature dramatically

compounding environmental hazards to patients and health care workers. Over the past several years, multiple hospitals and other health care facilities have required evacuation due to severe weather and flooding. The urgency for increasing the resilience to withstand future disasters is growing.^{24,25}

A recent study revealed that 25 of 78 metropolitan statistical areas on the US Atlantic and Gulf Coasts have half or more of their hospitals at risk of flooding from relatively weak hurricanes.²⁶ The impacts on health care facilities are both immediate and pervasive, requiring urgent attention to both adaptation and mitigation strategies. Health care facilities themselves are contributors to greenhouse gas emissions. The US health care ecosystem contributes approximately 8.5% of US GHGs. As a result, the National Academy of Medicine (NAM) has issued a call for action to decarbonize the US Health Sector and provided resources to facilitate the process.²⁷ Similarly, the WHO has created a reference to support building climate-resilient health systems.²⁵

In brief, climate change is upon us. Its effects on human health and health care are profound and present. The deaths of millions of people have already been attributed to climate change.²⁷ As protectors of health and safety, health care providers and systems have a responsibility to act now.²⁷ The American Medical Association's (AMA) *Journal of Ethics* devoted an entire issue to Health Care Ethics and Professionalism in the Era of Climate Change. Articles in this issue outline the medical community's ethical responsibility in mitigating climate change's impact on human health, including the importance of climate advocacy and leading efforts for environmental sustainability in health care organizations.^{28–30}

CURRENT STATE OF CLIMATE AND HEALTH EDUCATION IN HEALTH CARE

Leading medical societies and global health organizations such as the WHO, the American College of Physicians (ACP), the American Academy of Pediatrics (AAP), and the AMA have acknowledged the profound health impacts of climate change. They have also urged clinicians to incorporate climate-related counseling into routine patient care. Their position statements highlight that clinicians can serve as trusted messengers, offering patients personalized guidance on minimizing climate-related exposures and encouraging behaviors that promote environmental sustainability and health resilience.^{8,31–33} See SDC 1 for an annotated list of resources and tool kits (<http://links.lww.com/JOM/C105>).

According to an Association of American Medical College (AAMC) survey of medical school curricula, 71 of 125 medical school respondents now include a course that contains a term related to climate change in its title.³⁴ However, despite growing recognition of climate change's health impacts, formal education on this topic remains inadequate in most health care curricula.³⁵ This educational deficit extends beyond medical schools, permeating continuing medical education programs for practicing clinicians across various specialties.³⁶

A 2019 resolution by the AMA called for medical education to include climate change.³⁷ Medical schools and residencies have been slow to adapt their curricula to the urgent need to prepare future clinicians and other health personnel for the impact of climate on health. An international project, the Planetary Health Report Card (PHRC), is a student-driven metric-based tool that aims to evaluate health professional schools on discrete metrics in five main category areas: (1) curriculum, (2) interdisciplinary research in health and environment, (3) community outreach and advocacy, (4) support for student-led initiatives, and (5) campus sustainability.³⁵ As recently as 2024, only 2 of 53 US medical schools achieved an A on this report card; 32 only managed a C or worse.³⁵ Of 17 other countries participating in this effort, few did any better. Notably, Rwanda's University of Global Health Equity represents one of the few schools that received an A. The American College of Occupational and Environmental Medicine (ACCOEM) has published core competencies for OEM specialists, which established a need for training on environmental and climate-related health effects.³⁸ The AAP policy statement on climate change and children's health recommends that medical schools, residencies, and continuing education courses incorporate climate, health, and equity into their curricula.³¹ Despite medical

societies urging residency programs to incorporate instruction in the health effects of climate change, graduate medical education has been slow to adopt this addition.³⁹ Encouragingly, several residencies have published successful efforts to “climatize” their programs. See SDC 1 for examples (<http://links.lww.com/JOM/C105>).

Clinicians recognize climate health risks but lack sufficient knowledge to address them with their patients. In 2021, Harvard Chan C-Change, in collaboration with AmeriCares, conducted a national survey of frontline health care workers in 43 states.⁴⁰ More than a third of these workers reported discussing climate-related risks with their patients. However, almost half (46.3%) of providers and case managers stated that they lacked confidence in developing disease management plans to protect their patients from the impact of climate change.⁴¹ Informing patients about the threats of climate change to their health must be combined with instruction in adaptation solutions and access to the resources needed.

The Association of Schools and Programs of Public Health (ASPPH) has also published a framework of actions for academic public health for responding to the climate change and health crisis.⁴² The framework calls for its members to advance work in four areas: education and training, practice, research, and policy and advocacy.

In sum, multiple health professional organizations have identified climate change as a significant factor affecting human health. They have called for incorporating climate and health instruction and training into all levels of medical and public health education.

THE UNTAPPED POTENTIAL OF OEM CONTRIBUTION TO CLIMATE AND HEALTH EDUCATION AND PRACTICE

As the evidence for the adverse human health effects of climate and other environmental factors grows, it becomes increasingly urgent for the medical community to address these factors in clinical practice and health policy.⁴³ Although educational resources and practical toolkits are becoming more available, there is a clear need for greater support of practicing and student health personnel.⁴⁴ A significant knowledge gap persists among health care professionals regarding the complex relationships between climate change and health outcomes.^{41,45}

OEM clinicians occupy a unique position at the intersection of climate science, public health, and clinical medicine. Their competence in assessing and managing the impact of the occupational and general environment on human health provides a vital resource for climate and health education. This

paper posits that OEM clinicians can play a critical role in educating their colleagues across various health professions about the health implications of climate change.⁴⁴ By doing so, they can catalyze the development of a climate-aware health care workforce capable of addressing the complex health challenges of the 21st century.

OEM clinicians possess a distinctive skill set that combines clinical acumen with a profound understanding of OE health risks. Their core competencies include clinical OEM; OEM-related law and regulations; environmental health; work fitness and disability management; toxicology; hazard recognition, evaluation, and control; disaster preparedness and emergency management; health and productivity; public health, surveillance, and disease prevention; and OEM management and administration.³⁸ They routinely work in multidisciplinary teams with disciplines vital to identifying and controlling OE hazards. This background equips them to act outside as well as inside the exam room to advance primary and secondary, as well as tertiary prevention. Their skill sets enable the following broad actions:

- a) Elucidate complex interactions between OE exposures and human health outcomes.
- b) Develop and implement evidence-based strategies to mitigate OE health risks.
- c) Translate scientific data on climate change into actionable clinical guidelines and public health interventions.
- d) Bridge the gap between environmental policy and health care practice.

This combination of skills positions OEM clinicians as ideal educators and change agents in climate and health education.

A sample of areas of OEM practice related to climate change that can inform their collaboration with other health professionals include:

- heat stress, including psychosocial effects and acute and chronic organ function injuries, such as respiratory, neurological, psychiatric, and kidney function;
- emergency and disaster preparation and management;
- health effects of indoor and outdoor air pollution;
- chemical exposures in hot environments;
- vector-borne and water-borne disease exposures;
- health effects of water pollution;
- traumatic injury;
- neurological effects due to air pollution and natural disasters;
- work-site violence;
- exposures threatening reproductive health;
- fitness for duty;
- hierarchy of controls to minimize hazard exposure, ranging from personal protective

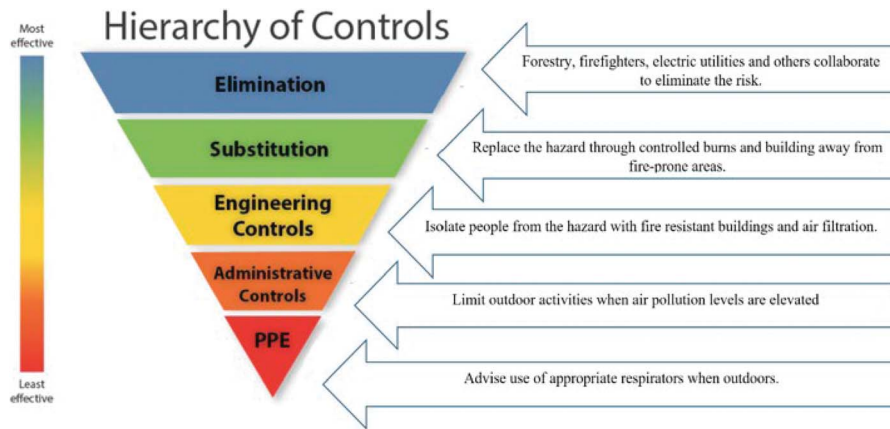


FIGURE 2. Example—using the hierarchy of controls to mitigate health risks of wildfires. Adapted from Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. *About Hierarchy of Controls*. April 10, 2024. Available at: <https://www.cdc.gov/niosh/hierarchy-of-controls/about/index.html>.⁵⁵ Accessed May 23, 2025 and Khan A, Berenji M, Cloeren M, Solomon G, Goldman R. Climate change and health: occupational and environmental medicine at the frontlines. *J Grad Med Educ*. 2024;16(6s):49–52.⁴⁴

equipment to administrative controls, engineering, and substitution (see Fig. 2); and

- predictive analysis of climate change-related events and their short- and long-term effects on individual and population health outcomes.

As examples of the OEM approach to the medical aspects of climate change, ACOEM has published guidance statements on addressing the needs of workers related to climate change.^{46,47} The College also published guidance on clinician training and practice of environmental medicine.⁴⁸

On an organizational level, ACOEM is an official member organization of the House of Delegates of the AMA, with the AMA being an official constituent member of the World Medical Association. As a result, the structural platform is already in place, so collaborative efforts with other medical specialties nationally and internationally can be pursued and cultivated. The Planetary Health learning objectives listed in Table 1, as recommended by the Consortium of Universities

for Global Health, highlight the necessary breadth of knowledge and planetary perspective to prepare society for the evolving impacts of climate change on health and the ecosystem.⁴⁹ Given its unique skill set, OEM is well suited to collaborate with other medical specialties, nursing, community health workers, and primary preventionists (including safety, industrial hygiene, public health practitioners) as change agents to create a climate-literate health workforce.

RECOMMENDATIONS FOR ACOEM AND OEM PROFESSIONALS TO ADVANCE CLIMATE AND HEALTH KNOWLEDGE AND PRACTICE

The following recommendations represent ten ways that ACOEM and OEM could use their expertise to advance the mitigation of the impacts of climate change on health. OEM clinicians' practice settings and skill sets will influence which of these recommendations they can apply in their work.

1. Develop Proficiency in Identifying and Managing Climate-Related Health Risks for Patients, Workforces, and Community Populations

This recommendation aligns with ACOEM's OEM core competencies.³⁸ OEM residencies should address climate change and, more broadly, environmental health. The AMA and other authorities have called for this curricular expansion.^{37,50} ACOEM can contribute to achieving this goal by helping create standardized residency didactic curricula and other educational opportunities.⁴⁴ Climate and health knowledge should be assessed by residency competency evaluations, board examinations, and survey research. As detailed in the supplemental content (see SDC 1, <http://links.lww.com/JOM/C105>), several resources are available to OEM residency directors and practitioners to meet this recommendation. In addition, ACOEM has published relevant guidance papers and

TABLE 1. Consortium of Universities for Global Health Recommended Planetary Health Learning Objectives, 2024 Version

1. **Earth system changes:** identify the natural and human-generated causes of altered biogeochemical flows, climate change, biodiversity loss, environmental pollutants, land-system change, freshwater change, ocean acidification, atmospheric aerosol loading, stratospheric ozone depletion, and other global environmental changes.
2. **Ecological systems:** describe how the ecosystems formed by human, domestic animal, wildlife, plant, and other biotic populations are affected by human actions across trophic levels, geographies, and time.
3. **Human health outcomes:** explain how extreme temperature and precipitation events, reduced air and water quality, population displacement, and other global changes increase incidence, prevalence, and mortality from infectious diseases; malnutrition; respiratory, cardiovascular, and other non-communicable diseases; sexual and reproductive health issues; psychosocial health disorders; and injuries.
4. **Risk assessment:** analyze how economic, social, cultural, political, environmental, technological, and health systems affect ecosystem and human vulnerability and resilience to environmental change.
5. **Governance:** evaluate how local, national, and international laws and policies have contributed to environmental problems and solutions.
6. **Actions:** compare the roles and responsibilities of governments, the commercial sector, civil society organizations, communities, and individuals in promoting conservation, restoration, mitigation, and adaptation related to environmental change.
7. **Ethics:** articulate the principles of intragenerational, interspecies, and intergenerational environmental justice.
8. **Communication:** demonstrate environmental and health literacy by accessing, evaluating, and communicating reliable scientific information about global environmental change.

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delivers educational content in webinars and in-person conferences.^{46–48,51}

2. Offer Clinical Consultation Related to Climate And Health

Because few clinicians have climate change or even OE health education in school and residency training, OEM clinicians are well positioned to serve as consultants to other medical specialties encountering climate-impacted patients.⁵⁰ OEM clinicians bring the skill set that facilitates risk assessment (hazard identification, exposure evaluation, and risk characterization). This approach informs a collaboration for preventing, diagnosing, and mitigating climate-related health conditions. This consultation service would benefit other specialties, given that time scarcity hinders many clinicians having climate-related conversations with patients.^{52–54} OEM clinicians also are used to working with a team of professionals helpful in addressing OE problems, such as safety, industrial hygiene, and heating, and ventilation engineers.

3. Utilize Diverse Methods for Disseminating Knowledge Throughout the Health Care Ecosystem and Across the Medical Education Continuum

In addition to providing consultations to individual patients, OEM clinicians can collaborate with other specialists to teach the importance and methods of evaluating OE exposure risks and diagnosing (and reporting cases of) OE-related illness.⁴⁸ OEM clinicians are well equipped to contribute their knowledge of assessing and managing risk to other disciplines. The risk assessment paradigm of hazard identification, exposure assessment, dose response, and risk characterization can be tailored to the published climate risks specific to a region. The hierarchy of controls promoted by the National Institute of Occupational Safety and Health (NIOSH) can be added to this paradigm to be relevant to climate risks⁵⁵ (see Fig. 2). With reference to this OEM approach, clinicians can teach how to optimize medical treatment and social support to improve individual, workforce, population, and community resilience. Audiences for this knowledge include the entire medical education spectrum and health ecosystem, involving employers, home health care providers, social services, community leaders, and others who can address stressors and support in a patient's environment. This section offers approaches to disseminating OEM knowledge that goes beyond traditional didactic lectures and professional publications, including case-based learning, interdisciplinary collaboration, technology-enhanced learning, and community engagement.

Case 1.

Referred by his primary care provider, a 55-year-old construction worker (independent contractor) presented with symptoms during a heat wave while working in Phoenix. During the heat wave, he repeatedly experienced fatigue, nausea, headache, dizziness, mild confusion, muscle cramps, and an elevated sense of his own blood pressure. He also developed a heat rash after long work hours in intense heat over several days. Although his physician recognized he was suffering from heat stress, he was unsure how to manage his work exposure. The history revealed he had elevated blood pressure, obesity, chronic back pain, and type 2 diabetes mellitus. His medications include Lipitor 20 mg/d, metoprolol 25 mg bid, semaglutide 0.25 mg weekly, and amitriptyline 25 mg (for chronic neuropathic pain). His social history reveals he has been a ½ pack per day smoker for 30+ years, drinks alcohol (two beers per day on average), and denies the use of cannabis or illicit substances. Further interview identified that the patient operates heavy machinery with full personal protective equipment (PPE). The clinician noted that limited shade and water resources are available at the worksite and that the patient lives alone in a one-bedroom apartment on the third-floor without air conditioning.

The patient was advised that he was suffering from conditions related to heat stress, including heat rash, cramps, and exhaustion. He was informed that his amitriptyline made him more vulnerable to heat stress and that he should discuss an alternative approach to managing his peripheral neuropathy with his primary physician. He was provided a fact sheet with guidance that included taking frequent breaks and hydrating to keep his urine light yellow. He was provided a community resource which provided him a portable air conditioner at no cost.

On follow-up, he reported that his physician had substituted gabapentin for amitriptyline and that he felt better with more frequent breaks to cool off and hydrate. With the patient's permission, if this patient were working at a site with a construction manager, the OEM provider could contact the manager about heat safety and offer worksite heat education and mitigation consultation. This case exemplifies the complex interplay between underlying comorbid conditions with the environmental, occupational, and social factors in heat-related illnesses. The combination of a record-breaking heat wave, a medication that increases vulnerability to heat stress, physically demanding work in full PPE, and inadequate cooling options at work and at home created this situation, leading to heat exhaustion.

The case highlights how occupational and environmental interventions can effectively detect and mitigate the adverse effects of changing environmental conditions on personal health. It also points out how OEM providers' competence in addressing working conditions can support both workers and their employers.

Case-Based Learning

The Medicine for a Changing Planet's set of case studies exemplifies an effort to provide materials for training clinicians on clinical skills relevant to medical conditions caused by climate and other environmental changes.⁵⁶ The cases add an environmental exposure history as part of the social history. Students learn to integrate this history with physical and laboratory data to make a diagnosis and form a treatment plan. They also learn how to initiate preventive measures using a host-environment paradigm: increasing host resilience and reducing environmental exposures. Case studies include toxic exposures, vector-borne diseases, pandemic preparedness, climate distress and ecoanxiety, food security, waterborne disasters, extreme heat, air pollution, emerging zoonoses, animals as sentinels, and refugee health.

Interdisciplinary Collaboration

Clinical consultation supports sharing specialized OEM knowledge with other clinicians. OEM professionals can teach clinicians how to help workers and employers adapt to climate change. Similarly, involvement as faculty in medical undergraduate, graduate, and continuing education courses provides opportunities to collaborate with other medical specialties to bring the OEM perspective to the spectrum of medical topics. In addition, participation in organizational and community-based disaster preparedness and management committees provides ideal opportunities for OEM professionals to disseminate their relevant occupational and environmental knowledge to a broad team of disciplines.

Technology-Enhanced Learning

Technology has created several new strategies to reach audiences with information

Case 2.

A 49-year-old electrician with underlying coronary artery disease, who has an implantable pacemaker/defibrillator, was tasked with rewiring the electrical circuits in a building basement damaged by floodwaters following a hurricane. When he visited his primary care provider, he reported feeling weak and lethargic but could not pinpoint the issue. During their conversation, he mentioned working on fixing the electrical circuit when an unexpected event occurred: an electrical wire fell into standing water from the hurricane, resulting in him being electrocuted. Although he felt a sudden jolt, he did not consider it serious and continued working.

Three weeks later, upon pacemaker interrogation, the device recorded nonsustained polymorphic ventricular tachycardia, occurring hours after the electrical injury. This case underscores how environmental challenges can significantly impact personal health. It raises the importance of identifying preventive measures for an event that could recur due to climate-driven increases in flooding.⁵⁷

that helps mitigate and adapt to climate change. Webinars, podcasts, and online courses offer asynchronous opportunities to disseminate climate and health knowledge. OEM professionals can also use social media, blogs, online news, professional forums, and print mass media to share their climate-related knowledge. One example is an article in MedPage that reached a broad audience with information about how OEM is a critical resource in preparing for and managing disasters such as wildfires.⁵⁸ Several academic medical centers (AMC) have used the web-based Project ECHO platform as a “teach all, learn all” strategy that engages climate experts with members of the health ecosystem including health care personnel, environmentalists, social service workers, librarians, and more.⁵⁹ Interactive educational websites for clinicians and other health professionals abound and are widely available. See SDC 1 for a curated list of some of these resources (<http://links.lww.com/JOM/C105>).

Community Education

Community trust in clinicians makes them uniquely positioned to cultivate awareness of the health impacts of climate change and how to optimize adaptation and mitigation. Clinicians can use community-oriented events to disseminate their knowledge, such as “Walk with a Doc,”⁶⁰ testifying in public hearings, and other events that bring clinicians in contact with local citizens, leaders of community-based organizations, and legislators. Close to home, clinicians can engage with their homeowners' associations to advocate for clean technologies to reduce GHG emissions through devices such as smart thermostats, solar panels, and heat pumps. On a larger scale, OEM professionals can engage with regional organizations such as the Midwest Climate Collaborative and the Regional Greenhouse Gas Initiatives. ACOEM's Council on Government Affairs and committees of ACOEM's

regional components provide venues to influence national policy-making.

4. Use Effective Communication Strategies to Discuss Climate and Health With Patients, Working Populations, Communities, and Leaders.

Communication researchers have identified effective strategies to communicate with different audiences about the impact of climate on health.^{61–63} Two key takeaways: (1) tailor communication to the audience and (2) most audiences relate to discussing how climate will impact their families' and community's health, safety, and well-being.

Case histories personalize the impact of climate on health and can help engage patients and communities. Stories, rather than statistics, make important information more likely to resonate personally with clinicians and patients alike.^{56,64} Kathleen Hayhoe, a renowned climate communicator, emphasizes the importance of identifying a person's interests as a hook to explain the impact of climate on their health.⁶⁵ For example, an avid outdoor sports person with asthma may resonate with how increasing wildfire smoke impairs their ability to enjoy their hobbies without suffering an asthma attack. With this connection comes the opportunity to inform the patient about Airnow.gov, a website that provides current local air pollution and wildfire information.

When clinicians see patients for wellness visits, the social history, as a “Social-E,” can incorporate environmental stressors such as living situation, occupation, and community environmental hazards.⁶⁶ Clinicians can help patients adapt to climate change by making them aware of public websites that track key metrics of their environment, such as heat and air quality.

5. OEM Clinicians Can Partner With Other Medical Specialties to Integrate Climate Risk Screening, Counseling, and Adaptation Strategies Into Clinical Workflows Increase Knowledge of Climate-Specific Health Risks Focused on Practice Locations and Populations Served

The public health threats of climate change vary based on geographic locations, the built environment, housing, and host characteristics. Several tools can be used to predict climate risks for a specific location^{67–69} (see SDC 1, <http://links.lww.com/JOM/C105>). Some aspects of the built environment can affect these risks. For example, urban settings are often hotter than rural settings due to the heat island effect driven by the lack of green spaces, shade, and presence of large areas of roads and concrete buildings. Communities built on landslide-prone hills or in mountain valleys will be more prone to flooding in regions plagued by extreme precipitation events. Housing characteristics such as heating, ventilation, air-conditioning, and air purification can be designed to mitigate predictable environmental insults such as extreme heat and air pollution due to wildfires. Aside from the comorbidities of a specific patient, certain populations are more susceptible to climate risks to health: children, outdoor workers and athletes, elderly, pregnant people, and socially disadvantaged populations.¹⁴

Implement Climate Risk Screening

Incorporate climate-related factors into existing health screenings to identify patients who may be vulnerable to the impacts of climate change (eg, heat stress, waterborne illnesses).⁷⁰ Many primary care and specialty practices use previsit screening questionnaires to identify information important to the patient's reason for a visit and that will help diagnose and treat the patient's problem. Screeners specific to health maintenance examinations frequently include questions about social determinants of health (SDoH). The Social-E adds some environmental questions to this routine part of a patient history.⁶⁶ Table 2 illustrates questions added to one AMC's children's wellness screening questionnaire. Among other questions important for anticipatory guidance, the screener asks the parent about social determinants of health. It also asks whether the respondent would like to discuss health concerns related to climate change. When checked, the climate questions populate the on-screen agenda in the electronic health record (EHR) for the well-child visit with the high-priority concerns for the pediatrician to address. See Table 2.

Case 3.

A 21-year-old male with asthma, who is an avid outdoor athlete, visited the clinic with wheezing. Typically, his asthma is well controlled, but this past week has been unusually challenging. He was surprised by how significantly he was impacted, barely able to sleep due to his dyspnea. His favorite pastime of running outdoors was severely disrupted. He pondered several questions: Did I miss a dose of my bronchodilators? Has my asthma worsened? Is there anything else I'm missing in terms of controlling my symptoms?

Upon reviewing the timeline, it became clear that his symptoms coincided with an increase in nearby wildfires. The clinician explained how changing environmental conditions, such as wildfire smoke, could exacerbate asthma by increasing airway inflammation and irritation.

The patient was highly motivated to learn how the worsening of his asthma was provoked by air pollution due to climate change. He eagerly accepted tools and guidance on minimizing exposure to wildfire smoke and particulate matter, such as staying indoors during high outdoor air pollution events and using a portable air filter in his apartment. By taking these steps, he managed his symptoms more effectively and avoided returning to his outdoor activities until the air pollution alert passed.

Implementation science frameworks can guide efforts to identify barriers and necessary support to facilitate practice change. This tool can also help identify and manage the socioeconomic factors that increase patients' vulnerability. Furthermore, the method can help scale and spread successful OE medicine-driven interventions across health care systems. This involves considering factors such as costs and resource needs for broader implementation, policy changes needed to support adoption, and strategies for building organizational buy-in and leadership support. Finally, implementation science demands the evaluation and continuous improvement of interventions. By systematically addressing these factors, health care organizations can more effectively disseminate climate-informed practices to primary and specialty care services.

By applying implementation science principles, health care organizations can systematically incorporate climate-related health concerns into clinical practice, improving patient care and community resilience in the face of these environmental challenges. The Consolidated Framework for Implementation Research (CFIR) is a particularly suitable framework for implementing climate health-specific practice. Developed in 2009, CFIR offers a pragmatic approach to managing the complex, interacting, and multilevel factors that influence implementation processes.⁷⁵ This framework provides a comprehensive strategy for integrating climate health-specific practices into medical settings, encompassing five domains: intervention characteristics, outer setting (external factors such as local regulation and resources), inner setting (internal organizational factors such as culture and leadership support), characteristics of individuals involved, and the implementation process. It addresses the complexity of implementing environmental health screening tools and treatment protocols, considering factors such as local climate risks, health care settings, and clinical workflows. CFIR emphasizes the importance of understanding organizational context, clinician knowledge and attitudes, and patient needs, which are essential factors in successfully incorporating climate health considerations into routine patient

Offer Climate-Related Health Counseling

Provide patients with information and support to cope with or mitigate the effects of climate-related health conditions, such as anxiety, depression, or respiratory issues exacerbated by air pollution, flooding, and wildfires.⁷¹ The aforementioned screener can automatically trigger inclusion of educational resources relevant to the climate concern in the after-visit patient education material generated by the EHR. Responses to the EHR screening questions can also generate decision-making support that facilitates referral for OEM consultation when appropriate.⁷²

Overwhelming evidence documents increased hospital and emergency room admissions for renal, cardiovascular, respiratory, and mental health conditions during hot weather and air pollution events.^{9,14,15} These events should trigger counseling of susceptible patients with chronic conditions. Practices can use EHRs to identify at-risk patients for notification of weather and air pollution alerts and how best to prepare. Medication lists should be reviewed for products that can decrease adaptation to heat stress.⁷¹ Leveraging EHR data, clinicians should identify those patients burdened by chronic medical conditions and social determinants for tailored counseling to help them adapt to climate-driven events specific to their living environment.^{14,67-69}

Enhance and Curate Existing Toolkits and Resources Incorporating an OEM Perspective

Drawing on their occupational and environmental expertise, OEM professionals can help improve existing clinical practice toolkits and other resources with the OEM perspective. The number of climate and health resources available to health care

personnel has exploded and can easily overwhelm the busy clinician. OEM can work with other medical disciplines and their organizations to curate resources useful for different specialties and tailored to the climate risks in a region. See SDC 1 (<http://links.lww.com/JOM/C105>).

6. Use Implementation Science to Accelerate the Adoption of Climate Counseling Tailored to Geographic Location, Patients, and Clinic Operations

Access to resources, toolkits, and education about climate and health will not be enough to change medical practice. Research has demonstrated that it takes up to 17 years for mainstream medical practice to adopt the best evidence.⁷³ Health care quality improvement processes are increasingly using implementation science to accelerate the adoption of new science into routine practice.

Implementation science is “the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of the health services and care.”⁷⁴

TABLE 2. Climate Questions on Well-Child Screener

“Many families are concerned about how changes in weather and environment can affect their child's health. This includes heat waves, local flooding, severe storms, air quality, and even the risk of tick and insect-borne illnesses. Would you like more information about climate change and kids?”

Check all that apply:

- Planning for power outages or natural disasters
- Monitoring air quality
- Preparing for play in extreme weather (hot/cold)
- Preventing tick and insect bites.

Source: Anderson et al.⁵⁴

Activity & Purpose	Timing	Participants
Semi-Structured Interviews Identify potential implementation barriers, facilitators, provider beliefs & experiences with climate-informed care to refine Toolkit & guide implementation plans, timing & training	Pre-pilot (Aug-Sept 2023)	N=16 provider & staff champions (13 interviews) representing 7 PPC clinics
Training Feedback Survey Satisfaction with and effectiveness of CIPC trainings delivered to each clinic between Jan-March 2024	1-2 weeks post training	N = 44 representing 6 of 7 clinics: providers, nurses, MAs, schedulers
Provider Survey Administered to all providers & staff champions in each clinic to gather baseline & post-pilot attitudes about and confidence with practicing CIPC, patient & family needs, provider training needs, and barriers to CIPC implementation	Pre-pilot (Oct. 2023) and Post-pilot (Oct. 2024)	Pre: N=50 (62% of 81) providers from 7 PPC clinics Post: N=38 (44% of 86) including 9 of 14 Champions (64%) See Appendix for details
Champion Meetings & Focus Group Monthly champion meetings during early implementation to discuss and collect feedback on implementation of CIPC Toolkit, distribution of materials to patients & caregivers, Smartphrase use; identify successful strategies and/or solutions to overcome challenges	During pilot (Jan – April 2024)	Attendance 5-6 clinic champions / month. N=5 in April Focus Group.

FIGURE 3. Implementation of climate-informed pediatric care.

care. See SDC for relevant resources (<http://links.lww.com/JOM/C105>).

The Climate-Informed Pediatric Care Project exemplifies the use of implementation science with a structured, multidisciplinary framework for integrating climate awareness into pediatric practice.⁵⁴ The project promotes climate-informed care as a new standard of practice. It equips pediatric clinics with eye-catching, climate-related posters and brochures featuring QR codes directing families to reliable resources. Short role-playing videos and sample scripts guide clinicians in effectively and culturally sensitively communicating the impacts of climate change on child health. By following this approach, pediatricians can more effectively recognize and mitigate climate-related health issues, from advising families on reducing indoor pollutants to addressing the mental health implications of climate anxiety. Ultimately, this intervention aims to establish climate-informed care as a foundational component of pediatric practice and can be used as an example to implement in adult practices. See Figures 3 and 4 for a summary of implementation steps.

Feasibility: Identify Barriers and Supports to Incorporating Climate Counseling into Routine Clinical Practice

No matter how scientifically compelling, incorporating new evidence and protocols into existing clinical operations challenges most health care systems and their clinicians. One important method for successfully including new evidence into clinical practice relies on co-production. This approach involves all stakeholders, including clinicians, support staff, administrators, and patient advisors. Stakeholder input helps identify barriers and success factors to facilitate practice change. An extensive literature has documented some common issues that slow change. Time scarcity creates roadblocks to adding new issues to a clinical visit.⁷⁶ Compensation at the system and individual clinician levels is closely related to time constraints. Providers who lack the knowledge and confidence to address climate-related health issues will be unlikely to respond to efforts urging them to discuss the impact of climate on their patients' health. Multiple resources can mitigate this concern (see SDC 1

for additional resources, <http://links.lww.com/JOM/C105>). Another concern voiced by clinicians is that climate discussion in the exam room may not be welcome by their patients.^{61,77} Following are some approaches to addressing these problems.

Co-Production—Tailoring Approaches to Different Audiences, Individual Clinics, and Regions

Successful design and implementation of climate-informed care require tailoring the intervention to the needs, resources, and climate threats specific to a clinical practice and its populations. OEM clinicians can work with health systems, personnel, and patient populations to tailor interventions and education for particular audiences and regions. Adaptive strategies to mitigate patients' climate risks should be designed with a focus on the local climate threats with tools such as social determinants of health screeners, national databases such as the Climate Vulnerability Index, and knowledge of the generally climate-sensitive groups, including older adults, children, pregnant persons, and underserved populations.^{14,67} Interventions should

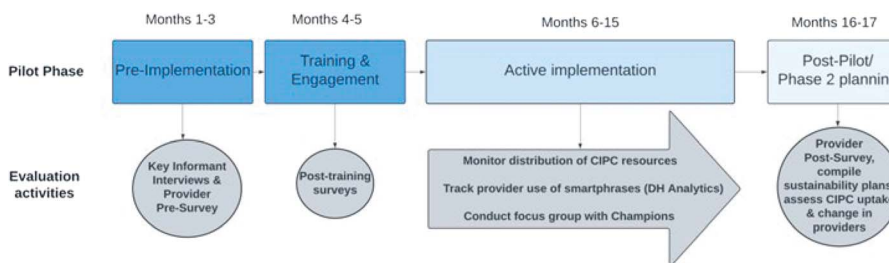


FIGURE 4. Climate-informed pediatric care pilot implementation and evaluation timeline.

incorporate climate justice, which addresses how the climate crisis aligns with long-standing and interconnected patterns of social injustice.⁷⁸ Focus groups and surveys of stakeholders should inform issues that may impede implementation and potential solutions to address barriers.⁴⁶

Address Time Scarcity and Alert Patients to the Clinic's Interest in Addressing Climate-Related Health Concerns

Several approaches help alleviate the problem of adding more information for a busy clinician to discuss with their patient. Many clinicians may already address issues such as the increase of vector-borne disease, heat stress, or preparation for extreme weather. A few additional words in conversation and facilitating access to curated, relevant resources will often be sufficient. Scripts have been published that offer general information about the health threats of climate change during a well-care visit that take less than a minute to deliver.⁷⁹ Clinicians can provide patient-oriented factsheets on common climate threats.⁴⁰

Educational materials, such as brochures, fact sheets, and posters, can be placed in waiting and exam rooms to inform patients that their climate and health-related concerns are topic areas that the clinicians in that practice can address.⁵⁴ These materials can include QR codes and URL links to authoritative online resources that provide greater detail and practical advice. These materials can cover topics ranging from recognizing symptoms of climate change effects—such as heat stress, heat strain, and worsening air quality—to understanding vector-borne diseases and the appropriate times to seek medical attention. Digital platforms like clinic websites, patient portals, and social media can offer up-to-date information and reliable resources. Visual aids, such as informative displays or educational videos in common areas, can reinforce these messages, ensuring patients receive consistent and accessible guidance on climate change health issues.

Leverage EHRs to Identify and Target Interventions for High-Risk Patients

To efficiently and reliably implement best practices to optimize climate and health outcomes, health care organizations can leverage existing capabilities within EHR systems. Strategies might include incorporating practical tools within the EHR, such as patient education materials, clinical decision support tools (including guides and reminders), and order sets that include climate-friendly prescription and treatment choices.

By adding personalized educational content into after-visit summaries, patients

receive immediate, relevant information on climate-related exposures and preventive strategies tailored to their circumstances. By using screeners that include questions about climate concerns and incorporating the social determinants of health, after-visit summaries can be auto-populated with educational materials customized to the individual patient's needs. See Table 2. The screeners can be linked to order sets that can trigger referrals to social services to address socioeconomic or other OE factors that increase risks to a patient.

Setting up the EHR to incorporate screening questionnaires that include climate questions helps create visit agendas that prompt the clinician to address climate health risks during patient visits tailored to the patient's concerns. Integrating reputable resources and educational materials within the EHR provides clinicians easy access to reliable information, ultimately supporting more informed decision-making and better patient outcomes. See Table 3, which lists educational materials that can be incorporated into the EHR as well as other materials that facilitate patient education.

Spread Responsibility to the Whole Health Care Team

Engage the entire health care team to identify and manage patients at risk for climate-related health conditions. By implementing previsit screening tools during appointment scheduling or check-in processes, health team support personnel can ensure that patient concerns and high-risk individuals are flagged early based on their climate exposure histories. Nurses, medical assistants, social workers, and administrative support personnel can all participate in climate communication efforts. Working together, health team members can share information on identified risks and develop coordinated care plans. Including all team members in education and training sessions equips everyone with role-specific knowledge and skills to recognize and respond appropriately to climate-related health issues.

Compensation for Climate Counseling

Although some businesses may object to their health personnel discussing climate and health, salaried corporate clinicians can include this counseling without financial barriers. However, in fee-for-service practices, compensation depends on how visits are documented and billed. In these settings, some options exist to receive reimbursement for climate counseling. Clinicians can use standard evaluation and management (E/M) codes to bill for time spent on climate counseling, provided they document the climate-related health factors and guidance given.^{77,80} Some health care organizations are exploring performance-based incentives for climate-related care within existing care delivery models or value-based care system models.⁸¹ The reimbursement landscape is evolving with advancements in climate-specific coding systems, enabling clinicians to integrate climate counseling into their workflow and track climate-related health metrics and outcomes. See Case 4, which illustrates the coding appropriate for the clinical scenario presented in Case 1.

Address Clinician Concerns about Climate Hesitancy in the Exam Room

A recent nationally representative survey of American adults showed that a majority (66%) of responders are at least “somewhat worried,” which includes 30% who are very worried about global warming and a majority (61%) understand that it is primarily anthropogenic.⁸² According to a 2023 Associated Press NORC poll of the general public, the vast majority (79%) of US adults reported being personally affected by at least one severe weather event in the last 5 years. Of those, 69% believe climate change was partially responsible. In this survey, this belief varied with political affiliation. A majority (91%) of Democrats, compared to 62% of Independents and 42% of Republicans, ascribed the severe weather to climate change.⁸³

TABLE 3. Sample Resources in a Pediatric Toolkit to Support Climate and Health Counseling

Child-friendly posters for waiting and exam room walls depicting climate threats to health specific to the clinic location
QR codes on the posters that link to relevant, vetted educational resources
Patient and family brochure with guidance actions for the most common climate-related health risks in the clinic's location
Educational activity book for school-age children
Template and web-based resources for a clinic policy about climate and health and sustainable practice within the health care organization
Written scripts for simple, brief conversations about various aspects of climate and health
Short patient-provider role-playing videos of problem-focused typical conversations about climate and health
Climate and social determinants of health questions to add to electronic health record pre-visit questionnaires
Patient education texts, fact sheets, and action steps for after-visit summaries
Curated list of climate and health educational and advocacy resources for clinicians

Although attitudes about climate change continue to be highly partisan, most relevant to climate clinical counseling is a study in a general pediatric practice that showed that large majorities of liberal, moderate, and conservative parents and caregivers respond positively to climate guidance by their physician.⁷⁹ As discussed previously, previsit screening questions can help select those patients most interested in these conversations. Connecting with a patient's specific health concerns or avocational interests may provide an approach to introducing climate-relevant counseling without entering climate politics.⁶⁵ Motivational interviewing is another effective technique that may gently nudge patients to adopt a variety of healthier behaviors to adapt to climate change who otherwise are hesitant to acknowledge its impact on their health.⁸⁴

Identify and Support Clinic Climate Champions

The role of practice champions is understated.⁸⁵ With a clear mandate, dedicated time, and proper training, health care personnel serving as practice champions can significantly contribute professional and personal competencies to facilitate technology adoption. Champions have been identified as a key factor in successful technology implementation by health personnel.⁸⁶ A similar use of champions can help promote climate change and health discussions in the clinical practice arena. To succeed, practice climate champions need organizational support, which could include recognition, dedicated time, or additional monetary compensation. In addition, the following elements further the power of the champion model.

- Provide up-to-date training: Organize workshops or seminars on the latest climate change research and its impacts. Invite experts to speak on specific topics related to climate change.
- Develop a resource library: Create a curated collection of articles, videos that include role-playing of clinician climate conversations with patients, and infographics on climate change. Ensure these resources are easily accessible to all practice champions and their colleagues. Incorporate selected materials into the EHR framework. See SDC 1 (<http://links.lww.com/JOM/C105>).
- Encourage personal research: Assign specific climate change topics to each champion to investigate and present to the group. This tactic promotes a deeper understanding and ownership of the subject.
- Link climate change to their specific field: Help champions understand how climate change relates to their area of

expertise. Encourage them to identify and share relevant examples from their work, such as the impact of inhalable particulate matter (PM_{2.5}) on cardiovascular health. Focus on translating this unique information into practice.

- Improve communication among the peer group: Establish regular meetings for practice champions to share insights and discuss challenges.⁸⁷
- Implement a mentorship program: Pair more experienced champions with newer ones to foster knowledge sharing. Rotate pairs periodically to diversify perspectives.
- Encourage cross-disciplinary collaboration: Create projects that require champions from different backgrounds to work together to promote a more holistic understanding of climate change issues.⁸⁸
- Facilitate feedback sessions: Regularly gather feedback on communication effectiveness within the group. Use this feedback to continually improve communication strategies.

Evaluate the Impact and Conduct Continuous Improvement of Climate Counseling

Continuous quality improvement (CQI) is a key principle of implementation science that should be applied to climate medicine practices. CQI involves tracking key metrics such as screening rates, interventions prescribed, and patient outcomes; gathering feedback from clinicians and patients to refine implementation strategies; and staying abreast of the latest scientific research on climate change and health to ensure that clinical practices remain current and evidence-based. The CDC has produced a program evaluation framework that can be used as a stepwise approach toward evaluating the quality of a program or process and continually improve its delivery.⁸⁹ Four outcomes can be measured in a clinic setting: patient-reported, observer-reported, provider-reported, and performance-reported outcomes.^{90,91} Specific approaches to collecting this information include the following:

Quantitative Assessment

- Preintervention and postintervention surveys to measure changes in knowledge, attitudes, and practices related to climate and health.
- Analysis of clinical performance metrics related to managing climate-sensitive health conditions. Potential metrics include (i) adoption (ie, are clinicians applying the new OE health practices systematically?), (ii) consistency (ie, are the clinical decision-making protocols being followed as intended?), and (iii) sustainability (ie, are changes maintained over time?). These measures can help identify implementa-

tion challenges and successes, guiding ongoing refinement of climate medicine practices. Billing and ICD codes can help track reimbursement, performance, and health outcomes.⁹² Tracking these factors can help assess the value of climate counseling.

- Longitudinal studies tracking the integration of climate impacts on health into clinical practice.
- With large EHR data sets, ICD coding can facilitate epidemiologic investigations of climate-related health problems and the impact of their management and assist health care systems with identifying their patients' need for social support services. See Case 4 for an example of how the clinical scenario presented in Case 1 should be coded.

Qualitative Evaluation

- In-depth interviews with health care professionals to gather insights on climate-health education's perceived value and applicability.
- Focus groups to identify barriers and facilitators to implementing climate-aware health care practices.
- Case studies documenting institutional changes resulting from climate-health education initiatives.

Patient-Centered Outcomes

- Assessment of patient satisfaction and health outcomes in relation to clinicians' participation in climate change education programs.
- Evaluation of changes in patient behaviors and health-seeking patterns following climate-informed counseling.

Continuous Improvement Cycle

Implement an iterative process of curriculum refinement based on evaluation findings, emerging scientific evidence, and evolving health care needs. Using a structured approach to practice change and quality improvement, many programs have successfully incorporated health interventions directly related to reducing patient risk to climate-related health effects.^{94,95}

7. Collaborate With Other Medical Specialties and Organizations to Advocate for the Mitigation of Health Care Sector Greenhouse Gas Emissions and to Promote Resilience to Climate Change

ACOEM currently participates in The Medical Society Consortium on Climate & Health, which aims to mobilize health voices for climate action. Individuals can also join

this organization.⁹⁶ The NAM has created an Action Collaborative to Accelerate Health care Decarbonization replete with online resources.³ The WHO has also created an operational framework for building climate-resilient health systems.²⁵ Supplemental content (see SDC 1, <http://links.lww.com/JOEM/C105>) contains a curated list of additional resources that focus on the decarbonization and resilience of health care to accomplish these aims at the organizational and individual clinic level.

8. Provide Expertise for Informing Policies That Restore and Protect Planetary Health From Climate Change

Human health relies on a healthy planet. ACOEM and OEM professionals can work with medical associations and other organizations to create positions on climate change and mitigating its impact on human and planetary health. They can also contribute their expertise to interdisciplinary guidance to government at all levels to support climate-friendly policies in the context of one health.

9. Collaborate With Multidisciplinary Research Teams Investigating and Mitigating the Effects of Climate Change on Health

The unique OEM perspective can help identify the questions confronting climate

science, public health, and occupational and environmental health. OEM professionals practicing in all settings have opportunities to contribute to advancing planetary and human health, whether in academic, community, government, or advocacy organization settings. See Table 4.

10. Support High-Level System Strategies

OEM professionals are encouraged to support strategies that influence the health ecosystem by enhancing the climate competencies of board-certified OEM physicians and other OEM clinicians, addressing social determinants of health by connecting health systems with community resources, leveraging artificial intelligence (AI), and joining the multiple disciplines committed to One Health.

An ACOEM guidance paper outlines the rationale and approach for enhancing OEM clinicians' competence in environmental medicine.⁴⁸ It recognizes that the standards for this competence have expanded with every revision of OEM Core Competencies. The next revision could further advance the need for specific expertise in addressing the impact of climate on health as a core competence.^{44,51} In collaboration with the American Board of Preventive Medicine, ACOEM could develop a quality improvement module addressing climate and health for Maintenance of Certification, similar to what the AAP published.³¹

As climate change increasingly threatens our global ecosystem, it becomes imperative that we find remedies for the SDoH that underlie many populations' vulnerability.¹⁰⁵ Implementation science provides health care systems with a stepwise approach to identify and assist patients with the SDoH related to climate change. However, the evaluation of its effectiveness has lagged.¹⁰⁶⁻¹⁰⁸

Although many EHRs have integrated personal determinants of health such as family history, nutrition intake, tobacco, and alcohol intake, health care systems often do not adequately address the underlying social causes of these lifestyle factors¹⁰⁹ (see Fig. 5). Health care systems have not systematically collected and acted on SDoH for many reasons. Ethical issues and potential health risks arise when identifying SDoH for which no solution is planned. Some patients questioned about their SDoH may feel stigmatized by the clinic. If no solutions are offered to identify risks, frustration and abandonment of the health care system may result.¹⁰⁷

Even large health care systems are not designed to address the social causes of some populations' vulnerability to climate change-related health risks. This type of systemic change requires a collaborative focused effort that brings together community stakeholders, including businesses, faith organizations, social services, government, and nongovernmental organizations.^{110,111} OEM professionals should strive to connect

TABLE 4. Examples of OEM Contribution to Climate and Health Literature

Topic/Condition	Brief Description	OEM Contribution
Acute kidney injury in agricultural workers exposed to extreme heat ^{97,98}	Rising temperatures and intense physical labor increase the risk of heat stress and dehydration, which can lead to acute kidney injury (AKI) and chronic kidney disease in farmworkers, particularly in sugarcane and other agricultural settings.	<ol style="list-style-type: none"> 1. Conducting rigorous workplace heat-stress assessments and monitoring hydration and renal function among workers 2. Developing and implementing evidence-based interventions, such as structured water-rest-shade protocols and heat acclimatization programs 3. Advocating for workplace policy changes and engineering controls to reduce heat exposure and mitigate the risk of AKI in high-risk agricultural settings
Heat-related injury risks in construction workers ^{99,100}	Excessive heat not only precipitates physical health risks but can also heighten accident and injury rates on worksites.	<ol style="list-style-type: none"> 1. Conducting comprehensive evaluations of construction sites to identify periods and areas of extreme heat exposure 2. Designing interventions such as optimized work-rest cycles, hydration strategies, and the use of cooling technologies to alleviate both physical and mental strain
Vector-borne diseases in forestry and agricultural workers ^{101,102}	Shifts in temperature and precipitation have expanded the habitats of ticks and mosquitoes, increasing workers' exposure to Lyme disease, West Nile virus, dengue, and other infections.	<ol style="list-style-type: none"> 1. Providing training for forestry and agricultural workers on preventive measures (eg, use of insect repellents, wearing protective clothing) and early symptom recognition to reduce disease incidence 2. Advising on integrated pest management strategies and environmental modifications that lower vector populations in high-risk areas
Air pollution and cardiopulmonary exacerbations in transport workers ^{103,104}	Increased heat worsens ground-level ozone and particulate matter, aggravating asthma, COPD, and cardiovascular disease. These risks are pronounced for drivers and outdoor transport personnel.	<ol style="list-style-type: none"> 1. Developing strategies to limit exposure in transport workers during peak pollution periods 2. Establishing routine spirometry and cardiopulmonary evaluations aids in the early detection of pollutant-related health impairments in transport workers 3. Educating employers and workers about protective behaviors such as utilizing in-cabin air filtration systems and proper use of personal protective equipment to help mitigate adverse health outcomes

Case 4. Coding a Clinical Encounter to Include Climate-Driven Environmental Exposures

Case 1 described a common clinical scenario related to heat stress and the OEM interventions to manage the condition. Accurate coding of the encounter is crucial for proper documentation, occupational safety, potential worker's compensation claims, and epidemiological tracking. The following *ICD-10* codes⁹³ capture the full clinical assessment:

- T67.5XXA: Heat exhaustion, unspecified, initial encounter
- Z57.6: Occupational exposure to extreme temperature
- Z59.1: Inadequate housing (no air conditioning)
- Z56.6: Physical and mental strain related to work
- W92.XXXA: Exposure to excessive heat of man-made origin

Intervention Codes

1. 99214: Office visit (moderate complexity)
 - Appropriate for the level of medical decision-making required
2. 99401: Preventive medicine counseling (15 min)
 - Allows for patient education on heat illness prevention and management

This level of clinical documentation:

- **Establishes medical necessity:** The comprehensive documentation of symptoms, vital signs, and contributing factors establishes the medical necessity for treatment and follow-up care.
- **Supports worker's compensation claim:** Detailed documentation of work conditions and their relation to heat exhaustion provides a mechanism of exposure and details causation.
- **Climate-related illness identification:** Appropriate coding contributes to accurately capturing climate-related hazards, supporting further research.
- **Occupational health outcomes:** Documentation of work conditions and their impact on health supports evaluating and improving occupational safety measures.
- **Social determinants of health tracking:** Inclusion of social factors (in this case: living on the third floor of a walk-up building, lack of air conditioning) aids in understanding and addressing health disparities.

addressing digital literacy concerns, and establishing ethical review boards with patient representatives to oversee AI deployment in SDoH initiatives. OEM clinicians interested in AI applications in their work should consider joining ACOEM's Health Informatics Section, which explores the utility, limitations, and challenges associated with AI in OEM practice.

OEM clinicians should consider joining other disciplines in furthering the One Health field, which is gaining traction in the United States and worldwide as an essential strategy to protect human, animal, and environmental health.¹¹² Human health depends on a healthy ecosystem. Our planet's ecosystem provides services such as water purification, clean air, crop pollination, food, waste decomposition, and recreation, to name a few. Climate change and other aspects of environmental degradation threaten these services and the wildlife that also depends on them.¹¹³ Zoonotic outbreaks such as COVID-19 and avian influenza are two of the most recent examples of how human interaction with animals at work and in our communities threatens public health. As the medical specialty that already addresses the occupational risks associated with animal and agricultural work, many OEM clinicians have already collaborated with veterinarians and the farming professions. Leveraging this experience, OEM professionals can help introduce One Health to health students at all education levels and to their clinical colleagues. OEM can play a critical role in One Health teams to protect ecosystems and the life that depends on them. By joining this multisectoral,

their clinical practices with community health workers and social workers who can be instrumental in addressing these risk factors. Even more powerfully, OEM practices can join other community stakeholders to create collaborative interventions to address SDoH. See Table 5 for some examples of how SDoH interact with climate threats and mitigation strategies.

AI has opened promising avenues for research and addressing SDoH in clinical practice. Advanced natural language processing algorithms can extract SDoH information from unstructured clinical notes, significantly improving the identification of patients who may have OE factors influencing their health outcomes. AI-powered predictive models enable more sophisticated risk stratification by combining claims data with SDOH information, facilitating tailored interventions for high-risk populations. Moreover, AI-driven platforms can personalize health education materials and interventions based on individual SDoH factors, enhancing patient engagement and understanding. Ensuring equitable implementation requires patient engagement,

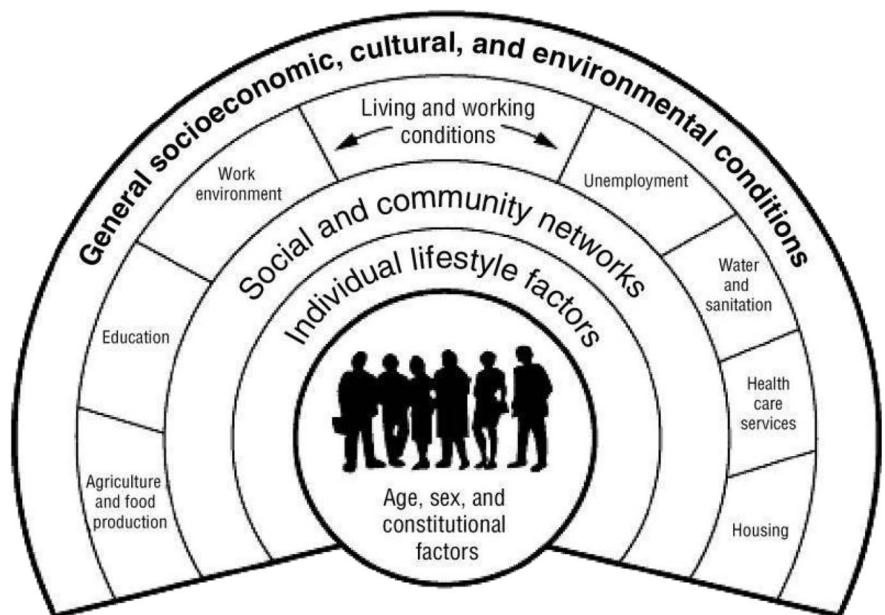


FIGURE 5. The main determinants of health. This figure is reprinted with permission from the Institute for Future Studies¹⁰⁹ (<http://www.iffs.se/media/1326/20080109110739filmZ8UVQv2wQFShMRF6cuT.pdf>).

TABLE 5. Examples of Interaction of Social Determinants of Health and Climate Threats

Climate Threat	Population	SDoH Factors	Health Implications	Mitigation Strategies
Heat stress	Food delivery worker in New York City using e-bike	Low income, lack of air conditioning at home, no nearby cooling center accessible by public transit, limited work flexibility, limited health care access	Heat exhaustion, dehydration, cardiovascular strain, reduced productivity, potential for heat stroke	Employer-provided cooling breaks, municipal cooling stations along delivery routes, subsidized home cooling, heat-health early warning systems
Flooding	Rural agricultural worker	Substandard housing in flood plain, limited evacuation routes, economic dependence on weather-vulnerable crops, limited insurance coverage	Drowning risk, waterborne illness exposure, property damage, income loss, mental health impacts	Improved flood mapping, subsidized housing relocation, crop insurance programs, infrastructure improvements, community evacuation planning
Air quality	Elderly resident in industrial community	Fixed income, preexisting respiratory conditions, energy-inefficient home, limited mobility, social isolation	Exacerbation of COPD/asthma, cardiovascular complications, reduced outdoor activity, increased health care costs	Indoor air purifiers, community alert systems, home weatherization programs, telehealth access, community outreach programs
Drought	Indigenous community with traditional water sources	Water insecurity, limited infrastructure investment, dependence on local ecosystems, historical disinvestment	Water-related illness, nutritional deficiencies, cultural disruption, mental health impacts	Water rights protection, infrastructure investment, cultural preservation programs, diversified water sourcing strategies
Extreme weather	Single-parent household in coastal area	Job insecurity, rental housing, lack of property insurance, limited savings, transportation challenges	Displacement, disrupted education for children, loss of belongings, employment disruption, health care discontinuity	Emergency savings programs, tenant protection policies, community resilience planning, childcare contingency networks, job security provisions
Vector-borne disease	Construction worker in expanding suburban area	Outdoor work environment, limited protective equipment, inadequate workplace health policies, housing near ecological transition zones	Increased exposure to ticks/mosquitoes, occupational illness, lost wages during illness, treatment barriers	Workplace vector protection protocols, expanded health coverage for vector-borne diseases, habitat modification, education and surveillance programs
Food insecurity	Urban family in food desert	Limited access to fresh food, transportation barriers, neighborhood disinvestment, economic constraints	Nutritional deficiencies, diet-related conditions, developmental impacts on children, mental health strain	Urban agriculture initiatives, mobile markets, SNAP benefit expansion during climate events, community food storage programs
Mental health impacts	Disaster survivor with limited resources	Disrupted social networks, inadequate mental health services, housing instability, job precarity	Post-Traumatic Stress Disorder, depression, anxiety, substance use disorders, social isolation	Trauma-informed community services, peer support networks, integrated mental health in disaster response, housing stability programs

COPD, chronic obstructive pulmonary disease; SDoH, social determinants of health; SNAP, Supplemental Nutrition Assistance Program.

transdisciplinary effort, OEM can contribute to public health preparedness.¹¹⁴ See SDC 1 for One Health resources (<http://links.lww.com/JOM/C105>).

CONCLUSION

OEM clinicians have unique skills and knowledge, making them valuable resources for advancing climate change education among health care professionals and mitigating the health impacts of climate change. By leveraging their expertise through a multifaceted approach to knowledge dissemination, OEM clinicians can play a pivotal role in building a health care workforce better prepared to address the complex health challenges posed by climate change. This paper summarizes ten recommendations for fostering a climate-literate health care workforce, enhancing health system resilience, and improving society's capacity to protect and promote public health in the face of unprecedented environmental challenges.

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