Addressing Environmental Health

Clinician Training and Practice of Environmental Medicine—ACOEM Guidance Statement

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In this guidance statement, the American College of Occupational and Environmental Medicine (ACOEM) Section on Environmental Health explores the role of occupational and environmental medicine (OEM) clinicians, comprising both physicians and advanced practice providers, such as nurse practitioners and physician assistants, in addressing environmental health concerns in both clinical practice and prevention policies. It also provides a discussion on emerging environmental occupations, clinical competencies in environmental medicine, and careers in environmental health.

That clinicians should be concerned with influences on health from the physical world around the patient is an ancient idea, familiar from pollution and infectious disease, but newly relevant and urgent in the context of climate change and its implications. As Hippocrates wrote in the introduction to *On Airs, Waters, and Places*, "Whoever wishes to investigate medicine properly, should… consider the seasons of the year… the winds, the hot and the cold… the qualities of the waters…."[1] It is now abundantly clear, more than 2000 years later, that our ambient environments (including that in our homes, communities, and our greater world) impact every aspect of our health. The World Health Organization estimated that, in 2016, 24% of global deaths and 28% of deaths in children under 5 years old were due to "modifiable environmental factors."[2] From the acute trauma of disasters to the long-standing health effects of toxic exposures in our air, water, soil, and food, down to the epigenetic and metabolic alterations that cumulative environmental exposures can create, the environments we inhabit have fundamental effects on our underlying physiological states, which can manifest into disease. Clinicians in every field should have a basic understanding of environmental health issues, from how a patient's aggregate environmental exposures can lead to health effects, to how to provide a patient with the resources and tools to treat, prevent, and mitigate these environmental exposures.[3] Clinicians specializing in OEM play an important role in providing consultation, evaluating patients with environmental health problems, educating both health professionals and the public, and advancing environmental health research and policies.

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DEFINING ENVIRONMENTAL HEALTH AND ENVIRONMENTAL MEDICINE

The American Public Health Association defines environmental health as "the branch of public health that focuses on the relationships between people and their environment, promotes human health and well-being, and fosters healthy and safe communities."[4] Environmental health includes local and global issues, prevention, sustainability, and environmental justice. Occupational health (OH) is frequently and accurately considered a subset of environmental health, focusing on the health and safety of workers.[5] OEM is the clinical practice of evaluating, diagnosing, and managing illnesses and injuries caused by both occupational and environmental exposures. Additionally, OEM clinicians provide consultations, education, and resources to health professionals and patients. Under the American Board of Preventive Medicine (ABPM), residency training is required for certification in the medical specialty of OEM. OEM certification is strongly recommended for physicians who wish to focus on environmental medicine. Given the small number of practicing physicians certified in OEM and the undersupply of OEM residency training programs, the specialty is not well known or understood by both the medical community and the general public.[6,7]

People are exposed to toxic substances in the air, water, soil, and food from sources as diverse as power plant and transportation emissions in the air, toxic waste dump and garbage landfill chemicals seeping into groundwater, and exposure to pesticides sprayed on nearby crops or in neighborhoods to control vector-borne diseases. Although some toxic environmental exposures are naturally occurring, such as radon or microbial toxins, most are anthropogenic, and for the most part resulting from the Industrial Revolution. Rachel Carson (*Silent Spring*)[8] and Lois Gibbs (*Love Canal*),[9] among others, made environmental pollution a national issue, leading first to the creation of the Environmental Protection Agency (EPA) in 1970 and subsequently to regulations to protect and mitigate the pollution of our environment.[10] The many ways that the environment influences human health go beyond the familiar "source-media-outcome" paradigm familiar in medicine and public health and require new ways of thinking about determinants of health effects and the science that describes them.[11] The term "exposome" has been proposed to describe an individual's unique environmental exposures throughout their life.[12] This paper will not cover all of the exposures and issues included in the broad field of environmental health but rather will use case examples to highlight the breadth of environmental health issues.

Case Example: Lead

The detection, management, and prevention of lead exposure in the workplace is a routine part of occupational medicine clinical practice. The devastating health effects of childhood environmental lead exposure was confirmed in the 20th century, with lead-based paint in homes and lead in the air resulting from leaded gas as the main culprits. Laws to ban lead in gasoline and most paints brought blood lead levels down for both children and adults.

The Centers for Disease Control and Prevention (CDC), in response to mounting scientific evidence of neurologic, reproductive, immunologic, and other effects, reduced the reference level blood lead in children from 10 to 5 μg/dL and now 3.5 μg/dL.[13,14] Testing blood lead levels in young children has become a routine part of pediatric clinical practice. However, just as lead exposure still continues in the workplace, lead exposure continues to be a threat for children, particularly in low-income and Black, Indigenous, and people of color (BIPOC) communities, with old housing and infrastructure.[15] Healthy People 2030 is working to reduce exposure to lead in the population in general and at the individual level to the 97.5 percentile of exposure.[16]

Case Example: Endocrine Disruptors

Environmental chemical exposures of particular concern are those that are persistent in our environment, biomagnified through the food chain, and have long half-lives in our bodies—a good example being endocrine-disrupting chemicals (EDCs). Research on EDCs has intensified over the last several decades, leading The Endocrine Society to state: "the expansion of data … removes any doubt that EDCs are contributing to increased chronic disease burdens related to obesity, diabetes mellitus, reproduction, thyroid, cancers, and neuroendocrine and neurodevelopmental functions."[17,18] Advances in understanding of epigenetic mechanisms have furthered our understanding of how toxic exposures can cause cancer and other health effects not only to those exposed but also to their progeny through heritable genetic mutations.[19]

Case Example: PFAS

Per- and polyfluoroalkyl substances (PFAS) illustrate the complexity of both research to uncover human health effects and clinical management of exposed individuals.[20] PFAS is composed of thousands of fluorinated chemicals, few of which have been studied or characterized for risk. PFAS are ubiquitous and persistent in our environment. The public, particularly those living near factories and toxic waste dumps with PFAS contamination, is reasonably and acutely concerned, all the more because of longstanding assurances that the chemicals were safe and even inert.[21] The National Academies of Sciences, Engineering, and Medicine (NASEM) recently reviewed PFAS studies and proposed clinical guidelines for people exposed.[22] Despite the lack of comprehensive studies, NASEM found significant or suggestive evidence for a wide range of health effects, including cancer, immune dysfunction, pregnancy-related hypertension, decreased infant birth weights, dyslipidemia, and thyroid dysfunction. NASEM goes on to recommend approaches to PFAS biomonitoring and clinical evaluation of potential PFAS-related conditions. However, in the face of uncertainty, NASEM notes "it is difficult to distill the necessary information for effective clinical practice with respect to PFAS exposure, its possible health effects, and options for shared decision-making once exposure has been confirmed." These clinical practice competencies in risk communication and risk management are employed by OEM clinicians routinely.

Case Example: The Built Environment

The human-built environment is composed of discrete structures including dwellings, factories, offices, schools, and places of worship, along with transportation and other infrastructure elements, such as roads, bridges, and sewers. The classic story of John Snow, the Broad Street water pump, and the 1854 cholera epidemic in London is one of the first "modern" examples linking the built environment with public health. During the latter half of the 20th century, concerns focused on indoor air, healthy housing, and ventilation-related exposures in indoor environments, including hospitals and offices. The COVID-19 pandemic has highlighted and advanced the field of indoor air.[23] The obesity epidemic and climate change have refocused concerns on the outdoor built environment and its contributions to morbidity and mortality through factors such as barriers to exercise, restricted access to high-quality foods, transportation availability and safety, social isolation, and pollution.[24–26] In addition, studies linking redlining with poorer health outcomes make clear the relationship between the built environment and environmental justice.[27]

An editorial in the *American Journal of Public Health*[25] asserted that "all infrastructure is health infrastructure" as it applauded the 2021 American Jobs Plan ("Build Back Better") that stressed health considerations be part of all infrastructure planning. Characteristics of the built environment, such as lack of effective indoor ventilation, crowding, air pollution, lack of access to healthcare, lack of green spaces, and inadequate transportation options, played a key role in the spread of COVID-19 during the early months of the pandemic.[28] The pandemic also highlighted the unique competencies of OEM clinicians and occupational and environmental health professionals to meet the challenges of this global disaster. These competencies include hazard identification, evaluation, and control; disaster preparedness and emergency response; medical surveillance; worker fitness and return-to-work evaluation; engineering/ventilation controls; personal protective equipment evaluation and use; vaccination programs; and OEM program management.[29,30]

Case Example: Climate Change and Planetary Health

The global impacts of human activity include climate change, ozone depletion, loss of biodiversity, and warming of the oceans, among others. These global impacts have resulted in hazards such as heat stress, hurricanes, floods, droughts, wildfires, food insecurity, air pollution, allergen exposures, vector and water-borne diseases, and exposure to solar ultraviolet radiation, that threaten not only ourselves but also the world's animals, ecosystems, and the "health" of our planet as a whole. These hazards affect every organ system, from ultraviolet effects like skin cancer and cataracts to air pollution-related respiratory diseases, to heat-related kidney dysfunction, to death, acute trauma, and mental health disorders from natural disasters.[31,32] These hazards impact everyone, with vulnerable populations, such as children, elderly, low income, and BIPOC most at risk.[33] ACOEM has published several guidance statements to inform OEM clinicians on best practices to keep workers healthy and provide evidence-based advice to employers,[34–36] and the fundamental principles have also been outlined elsewhere.[11]

In 2016, the US Global Change Research Program published a comprehensive report detailing the impacts of climate change on human health.[37] The authors assessed climate change–related health outcomes by considering exposure pathways, vulnerability, and sensitivity of different populations, such as children, elderly, workers, and adaptivity and resilience of people, communities, and institutions (see also Guidotti, 2015.[11]). Their analysis parallels OEM clinicians' approach to evaluating work-related hazards and health outcomes. In response to the climate crisis, Salas (2020)[38] states "there is a profound and urgent need to implement clinical practice improvements" both to take better care of our patients and to ensure the resilience of the healthcare system as a whole. This goal "will require multidisciplinary collaboration and sharing of best practices." OEM clinicians can both contribute to this collaboration and learn from other disciplines.

Case Example: War

War has a devastating effect on the environment. Armed conflict not only results in direct harm to military personnel and civilians but also disrupts the underlying infrastructure, which in turns causes population displacement. Such displacement affects the health and well-being of the most vulnerable populations, with the elderly, pregnant women, and children most at risk. Damaged infrastructure causes physical injuries and can lead to the spread of communicable disease (via waterborne, foodborne, and vector-borne routes), toxic exposures (heavy metals and chemicals released from weaponry and damaged building materials), as well as air pollutants emitted from the burning of fossil fuels and other contaminated energy sources.[39–43]

Military activities have historically left a legacy of environmental degradation, through the exploitation of natural resources and disruption of existing man-made resources, which are only compounded by human displacement and the breakdown of environmental governance in active conflict zones. The type of weaponry employed also has environmental consequences. There are chemical remnants released from the detonations of these devices (including mortar shells and cluster bombs, among others), further worsening the environmental situation on the ground.[44]

OEM TRAINING IN ENVIRONMENTAL HEALTH: EDUCATION AND CLINICAL COMPETENCIES

ACOEM has considered environmental medicine to be a part of OEM physicians' expertise for many years, as reflected in its name. Although in the past ABPM diplomates were officially boarded in occupational medicine (OM), in practice, the OM field has evolved to include environmental medicine. In 2022, the Accreditation Council for Graduate Medical Education and the ABPM officially agreed to change the name of the specialty from OM to OEM to reflect current OEM residency training, physician practices, and the breadth of the field.[45,46] OEM physicians are now boarded in OEM.

ACOEM developed and published OEM Core Competencies in 1998 and updated these competencies in 2008, 2014, and most recently in 2021.[47,48] The environmental health competencies have expanded with every update. The ACOEM 2021 environmental health competencies require that OEM physicians should be able to:

- Recognize potential chemical, physical, and biological environmental causes of health concern;
- Take an exposure history that includes environmental as well as occupational sources;
- Understand how to identify environmental hazards;
- Characterize environmental hazard risks;
- Understand applicable dose-response relationships;
- Compare environmental and biomonitoring data to published data;
- Be aware of common environmental agents and diseases in the geographic area where they practice;
- Recognize and manage common illnesses impacted by environmental exposures;
- Effectively communicate environmental health risks and ways to reduce risk; and
- Understand and advise on methods to control and mitigate environmental exposures.

These core competencies require that OEM physicians have the knowledge and skills to recognize possible biological, physical, and chemical causes of adverse health effects to communities or individuals. OEM physicians must be able to take an appropriate exposure history and perform a risk assessment to characterize and communicate risks due to environmental exposures and agents. Further, OEM physicians should be able to recognize and manage common illnesses that may be impacted by environmental exposures. Additionally, OEM physicians should understand basic principles of environmental mitigation and exposure control and be aware of resources that can perform mitigation and environmental monitoring. Clinicians practicing OEM should ensure that they are skilled in these environmental health competencies.

The OEM Content Outline was recently revised by ABPM and took effect for the initial certification examinations on January 1, 2024.[49] This new core content now includes separate environmental content, which constitutes 8% of the board examination. Environmental medicine tasks that OEM physicians may perform, which are listed in this ABPM OEM Content Outline, include:

1. Assess the environment for conditions and hazards (eg, silica, beryllium) using standard methodologies, standard metrics, and available resources from occupational medicine and other disciplines (eg, industrial hygiene) to control for potential harm.
2. Determine the impact of environmental factors, agents, and considerations on the workplace and workforce to develop policies and implement procedures that mitigate and manage health risks for individuals and populations.
3. Determine the risk of workplace products and byproducts, workplace events, and disasters (eg, leaks, spills into surface water, explosions, fires) to prevent or minimize adverse effects on the external environment.
4. Develop policies and protocols in conjunction with relevant stakeholders to contain, manage, and remediate the impact of an environmental event (eg, biological, toxicological, radiation).
5. Develop policies and protocols for internal and external communications in conjunction with relevant stakeholders (eg, CDC, practitioners, federal, state, local government agencies, industry, public relations) to respond to environmental threats.
6. Develop, advocate, and/or implement programs for wellness and lifestyle initiatives to address health issues arising from environmental conditions.

This new ABPM OEM Core Content also lists environmental medicine knowledge areas that are felt to be important for OEM practice. These knowledge areas include the following:

1. Laws and regulations related to environmental and workplace conditions (eg, EPA, Occupational Safety and Health Administration [OSHA], Resource Conservation and Recovery Act, Clean Water Act).
2. Exposure limits and relevant standards, including but not limited to OSHA Permissible Exposure Limits, American Industrial Hygiene Association, EPA, American Conference of Governmental Industrial Hygienists Threshold Limit Values, National Institute for Occupational Safety and Health Recommended Exposure Limits (NIOSH REL).
3. Environmental agents (eg, chemical, biological, radiological, nuclear, explosive).
4. Environmental factors related to community health (eg, air and water quality, sanitation, heat and cold stress, food safety, household and workplace injuries, noise).
5. Environmental considerations related to social determinants of health.
6. Health disparities arising from environmental conditions and/or exposures.
7. Research on intersection of environmental exposures and chronic medical conditions.
8. Health conditions related to environmental factors of natural and/or manmade disasters (eg, climate change, war, migration, resettlement).
9. Management of biproducts and waste.
10. Environmental remediation processes (eg, Superfund).
11. Environmental agents in the workplace potentially leading to health conditions (eg, sick building syndrome).
12. Diseases related to occupation or the environment such as asthma.
13. Principles of mitigation and management for various environmental exposures.

The American College of Preventive Medicine offers Military Environmental Exposures Certifications for clinicians caring for Veterans. Level 1 certification provides "foundational knowledge on how to assess military environmental exposures and how to address common health concerns related to these exposures," and Level 2 certification builds on Level 1 knowledge and provides more in-depth training on military environmental exposures.[50]

The landscape of OEM is expanding, with these additional competencies reflecting the evolving challenges and needs in the field. New areas of focus include health disparities, social determinants of health, the impacts of extreme temperatures and other climate change hazards, sanitation practices, the management of bioproducts and waste, and the handling of explosives, among others. These additional competencies underscore the importance of addressing a broad spectrum of factors that influence worker health and safety.[5]

A crucial aspect of advancing OEM involves enhancing communication and collaboration with interdisciplinary team members, including professionals trained in toxicology, industrial hygiene, and other related fields, who play a vital role in assessing and mitigating workplace hazards. This can be encouraged by:

- Promoting interdisciplinary collaboration from the outset of medical training,
- Implementing information and management systems that facilitate interaction among various specialists is recommended,
- Offering continuing medical education–sponsored lectures that include interdisciplinary fields can serve as valuable platforms for fostering mutual understanding and cooperation, and
- Teaching OEM physicians how to bridge gaps between different disciplines.

These measures cultivate a well-rounded approach to occupational and environmental health challenges, ensuring that clinicians are equipped to address the multifaceted nature of worker health and safety comprehensively.

INTEGRATING ENVIRONMENTAL HEALTH INTO OEM PRACTICE

These environmental health competencies highlight the need for OEM clinicians to integrate environmental medicine into their daily clinical practice. When evaluating a worker's illness or injury, OEM clinicians should consider environmental factors that may have contributed to the illness or injury, such as working in extreme temperatures.[51] When assessing a worker's ability to work in hot temperatures, OEM clinicians should consider whether or not a worker has home air-conditioning, among the many factors that may increase their risk of heat-related illness. When returning a worker to a job, OEM clinicians should consider whether an acclimatization schedule should be recommended.[36,52] OEM clinicians must be acutely aware of the environmental hazards in the regions where their patients live and work, including the day-to-day weather, natural disasters (ie, tornadoes, hurricanes, wildfires), and anthropogenic disasters and pollution (ie, train derailments, toxicants in the well water).

Clinicians in all specialties are ever more frequently confronting environmental health issues in their practices. As Becker and Saberi (2023)[53] note, "Many illnesses with environmental etiologies present with nonspecific symptoms and are overlooked. Alternatively, clinicians are often asked about environmental health issues but may not feel confident in addressing them." When assessing and diagnosing environmental conditions, clinicians encounter barriers, such as lack of training (or the time) to take an exposure history, what the appropriate diagnostic tools are, such as biomonitoring for some toxicants, how to interpret results, how to communicate risk to their patients, and how to counsel their patients on risk reduction. OEM clinicians have the expertise to provide consultation to these clinicians. OEM clinicians should make themselves available to their colleagues by both providing verbal consultations or seeing patients by referral for environmental health issues.

Many OEM clinicians provide consultation to employers and should be able to advise employers on environmental issues, including climate and disaster-related factors that affect workers and the company as a whole. Disaster planning and management is a well-established role for OEM, particularly in the operations of corporate OH departments.[48,54]

Disaster Planning and Emergency Management

OEM offers economies of scale and cost-effectiveness as an investment in emergency management because it provides value to the employer even if a threat fails to materialize. It is the essence of OEM. With the progression of time and the ongoing development of new chemicals, new toxicological concerns, and new-found distribution of potentially hazardous materials in the environment, the role of OEM clinicians has become even more important. The practice of OH and safety in the workplace parallels the general public health system in dealing with threats, hazards, and injuries unique to workplace organizations. Such potential disaster situations can be anthrax terrorist attacks as occurred in 2001, World Trade Center (WTC) collapse with all the associated conditions, East Palestine derailment, and many others.[48,55]

The scope of responsibility and requirements for expertise and instant response grew from addressing workplace-specific hazards and injuries to preparing for threats to the workplace infrastructure and weapons of mass destruction. OEM clinicians can take on the role of expert advisor on chemical, biological, and radiological threats as well as naturally occurring, emerging, and reemerging infectious diseases. The venue has expanded beyond the traditional plant and factory.

Environmental crisis (EC) is a concept that embraces disaster and emergency management, continuity of operations, and protection of human assets critical to resilience and recovery.[56] One may use EC as shorthand to mean the strategic response of communities and enterprises to public health threats and the security issues associated with environmental disruption. Specific issues include natural disasters, as well as weapons of mass destruction, the long-term consequences for the health of combatants, intentional ecological destruction, conflicts over resources with health implications (such as water), and restoration of environmental services following disruption.

OEM clinicians are uniquely suited to provide guidance on disaster planning, emergency response, and ongoing health surveillance activities. Emergency management and disaster planning have always been core functions of OEM departments, as evidenced most recently by their substantial involvement in the pandemic response. OEM clinicians' competencies and experience include industrial hygiene, epidemiology, risk communication, and, most importantly, clinical experience in evaluating and treating exposure-related hazards.[5,57,58] Such clinical skills include not only assessing and managing resultant illness but also risk evaluation for future development of harm following a latency period. The recent train derailment in East Palestine, Ohio, and the emergence of PFAS exposure in drinking water (and for select occupations such as firefighting) are salient examples of two ends of the environmental health exposure spectrum. Both are sentinels and evolving public health issues to which OEM clinicians are well trained to help with response, policy, and clinical approaches.

The 2001 WTC attack represents an acute event that evolved over the decades into emerging health issues in the early years and now includes chronic health issues, as well. OEM clinicians responded to these attacks from the very earliest days and continue to be at the forefront of clinical care and research in partnership with the CDC.[59] WTC serves as an enduring example of the multifaceted role OEM has in environmental exposures including partnering with public health agencies. Indeed, OEM clinicians can and should provide guidance on risk assessment considerations, exposure reduction strategies, and the development of clinical tools such as practice guidelines for assessing and treating impacted populations and individuals.

Careers in Environmental Medicine

The field of environmental medicine offers a variety of career paths specifically for clinicians with the interest and skillsets needed for success. This requires a fundamental understanding of environmental epidemiology, environmental toxicology, and how environmental changes in the air, water, and soil impact human health. As it is a multidisciplinary field, it focuses on understanding how environmental exposures can lead to disease and what strategies can be employed to manage health conditions that develop as a result of these cumulative exposures, as well as, developing a prevention framework to prevent disease. An aspiring OEM clinician can pursue a variety of environmental health careers, including:

- In government, as a public health officer, a regulatory expert, a policy maker, or a researcher,
- In an academic center, as an environmental health researcher and/or educator, with opportunities to teach medical and nursing students, residents, and students in other public health disciplines,
- In corporate medical departments, focusing on sustainability, environmental/climate risk, and environmental health management,
- In consulting, that is, offering medical-legal evaluations and/or subject matter expertise in toxicological tort cases, or
- As a dedicated OEM clinician with clinical toxicology expertise to manage patients with acute, chronic, and acute-on-chronic exposures.

ENVIRONMENTAL MEDICINE GOING FORWARD

The relationship between work and health is increasingly recognized as a complex interplay where work not only poses risks of illness and injury but also presents opportunities to enhance health and well-being. NIOSH's Total Worker Health® (TWH) initiative advocates for a holistic approach to worker well-being. It underscores the necessity of integrating protective measures against work-related hazards with proactive illness and injury prevention efforts. TWH calls for a comprehensive focus on the conditions within both the work and community environments, recognizing that factors such as healthy community design, access to safe and affordable housing, clean air and water, green spaces, and quality healthcare resources significantly impact worker health.[60]

The concept of One Health further broadens the scope of environmental health by acknowledging the interconnectedness of human, animal, plant health, and their shared environment. One Health advocates for a collaborative, multisectoral, and transdisciplinary strategy to achieve optimal health outcomes, underscoring the importance of a healthy ecosystem as the foundation of public health, community well-being, and by extension, OH.[57,61]

In light of this emerging evidence, it becomes imperative for organizations like ACOEM to recognize and advocate for the critical role of a healthy planet in supporting the health of communities and, consequently, the well-being of workers. This holistic perspective reinforces the notion that safeguarding environmental health is integral to fostering healthy work environments and promoting the health and safety of workers.

CONCLUSION

The specialty of OEM is essential in addressing the connection between environmental factors and human health. OEM clinicians are uniquely positioned to identify and mitigate the effects of environmental hazards on individual and public health. Their expertise not only contributes significantly to the development and implementation of effective prevention policies but also advocates for healthier environments. As the field continues to grow, so do the opportunities for OEM clinicians to lead, innovate, and improve health outcomes, underscoring the vital role they play in the broader medical landscape and planetary health.

OEM significantly enhances the interdisciplinary approach to environmental health issues, incorporating expertise from toxicologists, industrial hygienists, epidemiologists, nutritionists, emergency responders, and city planners, among many others. This collaboration is vital for tackling the health issues that arise as a result of cumulative environmental exposures. However, the effectiveness of this interdisciplinary cooperation often encounters obstacles due to the existing silos within the healthcare and public health sectors. These structural barriers can prevent the seamless integration of scientific knowledge with medical expertise, thus hindering the development of evidence-based strategies needed to address environmental health challenges. Breaking down these barriers is essential for fostering effective collaboration in light of the growing number of ECs facing our planet. OEM clinicians, by virtue of their training, can bridge these divides, formulating a unifying cohesive framework for knowledge-sharing and capacity-building to protect and improve public health in the face of environmental risks.

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REFERENCES

1. Hippocrates (Translated by Francis Adams). *On Airs, Waters, and Places*. Available at: classics.mit.edu/Hippocrates/airwatpl.mb.txt. Accessed April 18, 2024.
2. World Health Organization (WHO). *Preventing Disease Through Healthy Environments: A Global Assessment of the Burden of Disease from Environmental Risks*. September 13, 2018. Available at: https://www.who.int/publications/i/item/9789241565196. Accessed June 19, 2024.
3. Solomon G. Principles of Environmental Health. In: LaDou J, Harrison R, eds. *Current Diagnosis & Treatment - Occupational & Environmental Medicine, Sixth Edition*. New York, NY: McGraw Hill; 2021:755–763.
4. American Public Health Association. *Environmental Health*. Available at: https://www.apha.org/topics-and-issues/environmental-health. Accessed April 20, 2024.
5. Guidotti T. *The Handbook of Occupational and Environmental Medicine: Principles, Practice, Populations, and Problem-Solving*. 2nd ed. Santa Barbara, CA: Praeger, an imprint of ABC-CLIO, LLC; 2020.
6. Green-McKenzie J, Savanoor U, Duran H, et al. Outcomes of a survey-based approach to determine factors contributing to the shortage of occupational medicine physicians in the United States. *J Public Health Manag Pract* 2021;27:S200–S205.
7. National Research Council. *Addressing the Physician Shortage in Occupational and Environmental Medicine: Report of a Study*. Washington, DC: The National Academies Press; 1991.
8. Carson R. *Silent Spring*. Boston, MA: Houghton Mifflin Company; 1962.
9. Gibbs L. Love Canal: my story. 1982. *Am J Public Health* 2011;101:1556–1559.
10. Environmental Protection Agency. Laws & Regulations. November 2023. Available at: https://www.epa.gov/laws-regulations. Accessed December 10, 2023.
11. Guidotti T. *Health and Sustainability*. New York, NY: Oxford University Press; 2015.
12. Wild C. Complementing the genome with an "exposome": the outstanding challenge of environmental exposure measurement in molecular epidemiology. *Cancer Epidemiol Biomarkers Prev* 2005;14:1847–1850.
13. Centers for Disease Control and Prevention (CDC). Lead Poisoning Prevention. September 2022. Available at: https://www.cdc.gov/nceh/lead/prevention/default.htm. Accessed December 10, 2023.
14. Harsitha P, Bose K, Dsouza HS. Influence of lead-induced toxicity on the inflammatory cytokines. *Toxicology* 2024;503:153771.
15. Hauptman M, Rogers ML, Scarpaci M, Morin B, Vivier PM. Neighborhood disparities and the burden of lead poisoning. *Pediatr Res* 2023;94:826–836.
16. Office of Disease Prevention and Health Promotion, Office of the Assistant Secretary for Health, Office of the Secretary, U.S. Department of Health and Human Services. Healthy People 2030. Reduce Exposure to Lead - EH-08. Available at: https://health.gov/healthypeople/objectives-and-data/browse-objectives/environmental-health/reduce-exposure-lead-eh-08. Accessed April 17, 2024.
17. Gore AC, Chappell VA, Fenton SE, et al. Executive summary to EDC-2: the Endocrine Society's second scientific statement on endocrine-disrupting chemicals. *Endocr Rev* 2015;36:593–602.
18. Kahn LG, Philippat C, Nakayama SF, Slama R, Trasande L. Endocrine-disrupting chemicals: implications for human health. *Lancet Diabetes Endocrinol* 2020;8:703–718.

19. Patrizi B, Siciliani de Cumis M. TCDD toxicity mediated by epigenetic mechanisms. *Int J Mol Sci* 2018;19:4101.
20. Fenton SE, Ducatman A, Boobis A, et al. Per- and polyfluoroalkyl substance toxicity and human health review: current state of knowledge and strategies for informing future research. *Environ Toxicol Chem* 2021;40:606–630.
21. Sunderland EM, Hu XC, Dassuncao C, Tokranov AK, Wagner CC, Allen JG. A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects. *J Expo Sci Environ Epidemiol* 2019;29:131–147.
22. National Academies of Sciences Engineering and Medicine. *Guidance on PFAS Exposure, Testing, and Clinical Follow-up*. Washington, DC: The National Academies Press; 2022.
23. Allen JG, Ibrahim AM. Indoor air changes and potential implications for SARS-CoV-2 transmission. *JAMA* 2021;325:2112–2113.
24. Jackson R, Sinclair S. *Designing Healthy Communities*. San Francisco, CA: Wiley; 2012.
25. Jain B, Bajaj SS, Stanford FC. All infrastructure is health infrastructure. *Am J Public Health* 2022; 112:24–26.
26. Rollings KA, Dannenberg AL, Frumkin H, Jackson RJ. Built environment and public health: more than 20 years of progress. *Am J Public Health* 2024;114:27–33.
27. Swope CB, Hernandez D, Cushing LJ. The relationship of historical redlining with present-day neighborhood environmental and health outcomes: a scoping review and conceptual model. *J Urban Health* 2022;99:959–983.
28. Frumkin H. COVID-19, the built environment, and health. *Environ Health Perspect* 2021;129: 75001.
29. Green-McKenzie J, Khan A, Redlich CA, Margarin AR, McKinney ZJ. The future of occupational and environmental medicine. *J Occup Environ Med* 2022;64:e857–e863.
30. Guo AH, Diaz-Caturan MV, Reis C, et al. Practical strategies and tools for use by occupational and environmental medicine departments during COVID-19 pandemic surges. *J Occup Environ Med* 2022;64:10–18.
31. Tong S, Bambrick H, Beggs PJ, et al. Current and future threats to human health in the Anthropocene. *Environ Int* 2022;158:106892.
32. Scheelbeek PFD, Chowdhury MAH, Haines A, et al. Drinking water salinity and raised blood pressure: evidence from a cohort study in coastal Bangladesh. *Environ Health Perspect* 2017;125: 057007.
33. Ziegler C, Morelli V, Fawibe O. Climate change and underserved communities. *Prim Care* 2017; 44:171–184.
34. Nabeel I, Caraballo-Arias Y, Perkison WB, et al. Proposed mitigation and adaptation strategies related to climate change: guidance for OEM professionals. *J Occup Environ Med* 2021;63: e650–e656.
35. Perkison WB, Kearney GD, Saberi P, et al. Responsibilities of the occupational and environmental medicine provider in the treatment and prevention of climate change–related health problems. *J Occup Environ Med* 2018;60: e76–e81.
36. Tustin A, Sayeed Y, Berenji M, et al. Prevention of occupational heat-related illnesses. *J Occup Environ Med* 2021;63:e737–e744.
37. Crimmins A, Balbus J, Gamble J, et al. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. Washington, DC: U.S. Global Change Research Program; 2016. Available at: http://dx.doi.org/10.7930/J0R49NQX. Accessed May 1, 2024.
38. Salas RN. The climate crisis and clinical practice. *N Engl J Med* 2020;382:589–591.
39. Manduca P, Al Baraquni N, Al Baraquni L, et al. Hospital centered surveillance of births in Gaza, Palestine, 2011–2017 and heavy metal contamination of the mothers reveals long-term impact of wars. *Reprod Toxicol* 2019;86:23–32.
40. Hryhorczuk D, Levy BS, Prodanchuk M, et al. The environmental health impacts of Russia's war on Ukraine. *J Occup Med Toxicol* 2024;19:1.
41. Racioppi F, Rutter H, Nitzan D, et al. The impact of war on the environment and health: implications for readiness, response, and recovery in Ukraine. *Lancet* 2022;400:871–873.
42. Sidel VW, Levy BS. The health impact of war. *Int J Inj Contr Saf Promot* 2008;15:189–195.
43. Baraquoni NA, Qouta SR, Vanska M, Diab SY, Punamaki RL, Manduca P. It takes time to unravel the ecology of war in Gaza, Palestine: long-term changes in maternal, newborn and toddlers' heavy metal loads, and infant and toddler developmental milestones in the aftermath of the 2014 military attacks. *Int J Environ Res Public Health* 2020;17:6698.
44. Skalny AV, Aschner M, Bobrovnitsky IP, et al. Environmental and health hazards of military metal pollution. *Environ Res* 2021;201:111568.
45. Accreditation Council for Graduate Medical Education. Preventive Medicine Specialties. Available at: https://www.acgme.org/specialties/preventive-medicine/overview/. Accessed November 15, 2023.
46. American Board of Preventive Medicine. ABPM Updates Specialty Nomenclature. October 4, 2022. Available at: https://www.theabpm.org/2022/10/10/abpm-updates-specialty-nomenclature/. Accessed November 15, 2023.
47. Cloeren M, Gean C, Kesler D, et al. American College of Occupational and Environmental Medicine's occupational and environmental medicine competencies-2014: ACOEM OEM competencies task force. *J Occup Environ Med* 2014;56:e21–e40.
48. Hartenbaum NP, Baker BA, Levin JL, et al. ACOEM OEM Core competencies: 2021. *J Occup Environ Med* 2021;63:e445–e461.
49. American Board of Preventive Medicine. Occupational and Environmental Medicine Content Outline. Available at: https://www.theabpm.org/become-certified/exam-content/occupational-medicine-content-outline/. Accessed November 15, 2023.
50. American College of Preventive Medicine. *Level 1 and Level 2 Military Environmental Exposures Certifications*. Available at: https://www.acpm.org/education-events/military-environmental-exposures-certification/. Accessed June 19, 2024.
51. Spector JT, Bonauto DK, Sheppard L, et al. A case-crossover study of heat exposure and injury risk in outdoor agricultural workers. *PLoS One* 2016;11:e0164498.
52. National Institute for Occupational Safety and Health. *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments*. February 2016. Available at: https://www.cdc.gov/niosh/docs/2016-106/. Accessed May 4, 2024.
53. Becker J, Saberi P. Facing the health effects of increasing exposures from climate change and environmental hazards. *Philadelphia Medicine, The Official Magazine of the Philadelphia County Medical Society*. Spring 2023:24–25. Available at: https://issuu.com/nhgi/docs/philly_med_spring_2023i. Accessed October 24, 2024.
54. American College of Occupational and Environmental Medicine (ACOEM). ACOEM Consensus Opinion Statement - Disaster Preparedness and Emergency Management as a Core Competency in Occupational and Environmental Medicine. January 28, 2006. Available at: https://www.apaom.org/Resources/Documents/ACOEMDisasterPreparedness.pdf. Accessed May 15, 2024.
55. Reischl TM, Sarigiannis AN, Tilden J Jr. Assessing emergency response training needs of local environmental health professionals. *J Environ Health* 2008;71:14–19.
56. Tulchinsky T, Varavikova E. Environmental and occupational health. *The New Public Health* 2014.
57. McLellan R, Guidotti T. Occupational and environmental medicine: an asset in time of crisis. In: Ciotton G, ed. *Ciottone's Disaster Medicine, Third Edition*. Elsevier; 2023:198–205.
58. Rogers B, Lawhorn E. Disaster preparedness: occupational and environmental health professionals' response to hurricanes Katrina and Rita. *AAOHN J* 2007;55:197–207.
59. Moline J. World trade center disaster: reflections after twenty years. *Arch Environ Occup Health* 2021;76:361–362.
60. National Institute for Occupational Safety and Health. *Total Worker Health*. March 23, 2023. Available at: https://www.cdc.gov/NIOSH/twh/. Accessed May 4, 2024.
61. One Health High-Level Expert Panel (OHHLEP), Adisasmito WB, Almuhairi S, Behravesh CB, et al. One Health: a new definition for a sustainable and healthy future. *PLoS Pathog* 2022;18:e1010537.