Responsibilities of the Occupational and Environmental Medicine Provider in the Treatment and Prevention of Climate Change-Related Health Problems

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Workers are uniquely susceptible to the health hazards imposed by environmental changes. Occupational and environmental medicine (OEM) providers are at the forefront of emerging health issues pertaining to working populations including climate change, and must be prepared to recognize, respond to, and mitigate climate change-related health effects in workers. This guidance document from the American College of Occupational and Environmental Medicine focuses on North American workers health effects that may occur as a result of climate change and describes the responsibilities of the OEM provider in responding to these health challenges.

Over the last century, global climate changes have resulted in increased frequency and intensity of adverse weather events including heat waves, droughts, wildfires, and flooding.[1] This change has impacted all regions of the United States, resulting in loss of life and economic costs in the billions of dollars. Further costs include the loss of worker productivity and expenditures associated with relocation.[2]

Currently, the impact of climate on the health and productivity of workers in the United States has not been an area of high concern. This paper primarily focuses on North American workers health effects that may occur as a result of climate change. Rising temperatures, reduced air quality, and extreme weather patterns impact the health of workers directly and indirectly (Table 1).[3–5] Occupational health care providers and the American College of Occupational and Environmental Medicine (ACOEM) are uniquely suited to promote protection of the health of US working populations facing these challenges.

Many working groups are susceptible to both direct and indirect health impacts of climate because of their job type (eg, outdoor workers, laborers, athletes, wildland firefighters) or their existing, underlying health risks (eg, respiratory illness, heart disease, pregnancy). Direct health effects due to climate include heat-related illness, respiratory disease due to reduced air quality, and increased allergy induction; indirect effects include illness secondary to exposures encountered during a disaster response, stress and mental illness secondary to the experience of traumatic natural event, and increased susceptibility to vector-borne disease.[3]

It is important to characterize climate-related health hazards so that effective mitigation and adaptation strategies can be developed to protect workers' health and safety by minimizing their vulnerability. Therefore, this paper identifies direct and indirect climate-related health challenges among workers and describes the responsibilities of the occupational and environmental medicine (OEM) provider in responding to these health challenges. The issues discussed in this paper are an essential part of ACOEM's core competencies,[6] and therefore OEM providers should possess the core skills that make them specifically qualified to address and mitigate the impacts of climate change on worker health and productivity.[1]

DIRECT IMPACTS OF CLIMATE CHANGE ON WORKER HEALTH

Direct health effects likely to impact workers due to rising temperatures and changing weather patterns include heat, respiratory effects from reduced air quality, and allergen sensitization. Closely related atmospheric changes affecting stratospheric ozone concentration also result in increased exposure to ultraviolet (UV) effects and heat and emissions that accompany carbon dioxide cause more severe ground-level or ambient air pollution.

Heat and Ultraviolet Effects

Rising temperatures and increased air pollution directly impact worker health. Increased ambient temperatures can exacerbate the risks of injury, illness, and death for those working in hot environments.[7] In 2013, the US Bureau of Labor Statistics reported that thousands of occupational heat-related illnesses occur each year and more than 350 civilian worker deaths happened in the past decade due to environmental heat exposure.[8] This is may be a considerable under-estimate of the total, as many cases are not recognized as such because heat interacts with other working conditions to which the cause of death is more likely to be apportioned, and because heat increases the risk of death from common conditions such as cardiovascular disease and chronic lung disease.

Heat-related illnesses result as a malfunction of the central nervous system and the body's adaptation mechanisms during intense heat.[9] The most severe form is heat stroke, in which the body is unable to cool down, resulting in confusion and possible coma, seizures, or death. Other heat-related illnesses include heat exhaustion, heat syncope, heat cramps, and rhabdomyolysis.[4] Workers exposed to extreme heat are more prone to accidents and injuries and have lower productivity due to sweaty palms, fogged safety goggles, discomfort, agitation, and fatigue.[4] Temperatures above 95 °F have been shown to decrease productivity and increase work injuries and mistakes.[10] Even weather events that are not extreme on a world scale can result in lethal heat-related fatalities in places where the climate provides little opportunity for acclimatization,[11] and when the worker is susceptible due to age, pre-existing condition, medications, obesity, or lifestyle.

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TABLE 1. Impacts of Climate Change on Worker Health

Climate Event	Exposure Pathway/ Mechanism	Health Effect	Potential High-Risk Occupational Groups	ACOEM Core Competencies
Heat waves	Increased temperatures, hotter than usual summers and milder winters	Heat stress related morbidity and mortality	Outdoor trades workers, athletes, firefighters, military, migrant farm workers. Older, isolated or poorer workers more at risk for heat stress-related illness; workers without access to air conditioning.	Environmental health, hazard recognition, evaluation, and control, OEM-related law and regulations, work fitness and disability management, OEM population management, health and productivity, OEM-related management and administration, clinical OEM
Solar ultraviolet radiation (concomitant risk affecting many of same populations)	Increased solar UV radiation from ozone-depleting gases in the atmosphere (overlap with greenhouse gases)	Cataracts, cutaneous malignant melanoma, immune system and sunburn	Outdoor workers, construction trades, agricultural workers, military, displaced workers, courier and delivery service workers	Environmental health, hazard recognition, evaluation, and control, public health, surveillance, and disease prevention, OEM-related management and administration, clinical OEM
Ambient air pollution	Increases in carbon emissions, particulate matter, airborne aeroallergens and other respiratory exposures from wildfires and ground-level ozone	Respiratory disease exacerbation including asthma, COPD, allergic rhinitis, bronchitis; premature death, acute and chronic cardiovascular	Older workers and/or those with pre-existing respiratory illness	Environmental health, hazard recognition, evaluation, and control, toxicology, public health, surveillance, and disease prevention, health and productivity
Flooding	Increased variation, geographic and seasonal distribution of vectors	Drownings, injuries, skin infections, mosquito, tick and other vector borne diseases	Outdoor workers, first responders	Environmental health, public health, surveillance, and disease prevention, disaster preparedness and emergency management, OEM-related management and administration, hazard recognition, evaluation, and control, clinical OEM
Vector- and waterborne disease	Extreme weather events; changing temperatures affect vector, pathogen, and host habitats; increased variation in geographic and seasonal distribution of vectors	Mosquito, tick, and other vector-borne diseases, waterborne disease	Sanitation workers, food-animal production workers, military-deployed populations, farmers, foresters, landscapers, laborers, construction and forestry workers, international aid workers, pregnant women, or those of childbearing age, emergency responders	Hazard recognition, evaluation, and control, clinical OEM, environmental health
Mental health and well-being	Increased exposure to traumatic events such as natural disasters	Mental, behavioral health and stress disorders	Displaced workers, first responders, those with a history of depression or anxiety	Environmental health, OEM-related law/regulations, disaster preparedness and emergency management, health and productivity, OEM-related management and administration

COPD, chronic obstructive pulmonary disease; OEM, occupational and environmental medicine; SES, socioeconomic status; UV, ultra violet.
Adapted and modified from Patz et al.[5]

It is generally assumed that heat stress is more of a threat in the general population than in working populations because the general population has a higher frequency of individuals with susceptibilities and some lack access to cool environments. However, workers often have less control over their work environment and activities than the general community. In construction work, courier delivery, firefighting, and prolonged outdoor work, for example, environmental heat exposure in workers may be more hazardous than in other situations due to the inhibition of the normal behavioral response to heat stress.[8] Vulnerable populations such as aging, pregnant, and migrant workers and workers with chronic illnesses may be at more risk.[12]

Atmospheric changes causing climate change and stratospheric ozone depletion share many of the same chemical drivers and present coupled risks. However, UV radiation protection remains an important occupational health measure for many of the same workers at highest risk for heat stress. Outdoor workers are also at increased risk for a variety of eye diseases from UV radiation exposure, such as cataracts and macular degeneration.[13]

OEM providers are uniquely positioned to monitor workers for climate-related health hazards, educate employers and workers on heat stress and UV radiation

exposure prevention, and evaluate and treat heat-related injury and illness. In most states, at-risk workers rely on the Occupational Safety and Health Administration (OSHA) General Duty Clause to provide regulatory protection from extreme heat as required by the Occupational Safety and Health Act of 1970. With increasing ambient temperatures and heat waves, the OEM provider should be prepared to recommend heat stress medical surveillance programs and prevention/adaptation strategies for occupational heat stress, and to evaluate and treat heat-related illnesses.[6] The National Institute for Occupational Safety and Health (NIOSH) Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments is an important resource for OEM clinicians wanting more information on managing at risk workers.[14]

Air Quality

Climate change, UV radiation exposure due to ozone depletion, ambient air pollution, and transport of air toxins are all related by complex atmospheric physical and chemical phenomena. Although usually considered separately, each has complicated interactions, interdependencies, and common origins in the drivers of atmospheric change.[4] Air quality for working populations is degraded by many drivers of atmospheric change: heat waves, increased global temperatures, potential recurring increases in UV radiation, and extreme weather.[15] In cities where there are large concentrations of workers, the combination of the urban heat island effect with urban air pollution, compounds the effects of climate change.[16]

The main categories of air pollutants that have occupational implications are ground-level ozone, polycyclic aromatic hydrocarbons, pesticides, and allergens. Ozone is temperature dependent—ambient levels rise with increasing heat.[17] Ground-level ozone as well as particulate matter have well established correlations with increased incidence of cardiovascular and respiratory disease, and premature death.[18,19] Workers in proximity to combustion sources are at higher risk for exposure to polycyclic aromatic hydrocarbons (PAHs).[20] While the most significant health end-point of PAHs is cancer, there may also be non-cancerous effects on the respiratory, gastrointestinal, renal, and dermatological systems.[21] Outdoor air pollution is a Group I carcinogen for lung and other types of cancer according to the International Agency for Research on Cancer.[22] Workers subjected to pesticides and other dermal pollutants may experience increased exposure because of amplified dermal uptake during hyperthermic conditions due to sweating and increased blood flow.[20]

OEM providers must be able to implement medical surveillance programs that address the needs of specific job classes and job vulnerabilities for those that may be affected by changes in air quality. The spectrum of organ systems impacted by degraded air quality ranges from cardiovascular to reproductive. The OEM provider is well prepared to attend to this range of potential health impacts when designing or implementing a surveillance system in order to include at risk workers. The OEM provider also must be able to identify, diagnose, and treat occupational or environmental diseases that result from air pollution and manage work restrictions and accommodations. In addition, the OEM provider must be able to identify and manage health effects associated with air quality and understand when it is appropriate to obtain environmental monitoring to measure airborne toxins associated with climate change.[6]

Allergic Sensitization

Incidence and severity of occupational respiratory and allergic disorders are projected to increase secondary to climate change.[23] A survey of members of the American Thoracic Society indicates a strong majority opinion that increased morbidity from respiratory and allergic disease is already evident clinically.[24]

Intensification of seasonal variations and extreme weather patterns contribute to allergen exposure. Contributing factors include increased temperature, carbon dioxide, and ozone. For example, ragweed season length, production, and amount of major ragweed allergens have increased in response to elevated ambient levels of carbon dioxide.[25,26] Furthermore, thunderstorms and floods are associated with increased pollen dispersion. Several aspects of the pollen season are influenced by climate: earlier and longer flowering seasons, increased pollen production, and increased potency of pollen. Increased exposure to air pollutants damages natural airway protective mechanisms. As a result, the immune cells are more exposed to inhaled allergens and irritants, and so individuals are at higher risk of sensitization.[27]

Flooding as a result of hurricanes, storms, and other extreme precipitation events encourages allergen growth. This can result in new onset or worsening of respiratory disorders such as allergic disorders and asthma.[28] Ambient ozone levels also play an important role in triggering asthmatic events.

The OEM provider can identify those who have compromised health and/or work performance due to allergy sensitization. Some contaminated air settings, such as indoor air, may be a result of precipitation or water-related events.[28,29] OEM providers must possess the core knowledge to identify environmental conditions that lead to nasopharyngeal and respiratory conditions such as allergy sensitization.[6]

INDIRECT IMPACTS OF CLIMATE ON WORKER HEALTH

Indirect health impacts of climate are those experienced due to natural disasters, floods, and displacement. These effects include disaster zone exposures, stress and mental health impacts, and waterborne and vector-borne diseases.

Disaster Zone Exposures

Disaster can be defined as the disruption of a system in which the demand to respond exceeds the system's resources. In 2005, the United States experienced its second largest and most expensive natural disaster, Hurricane Katrina. This disaster and Hurricanes Sandy and Irene that followed, provided responding local leadership with the experience to give recommendations for improved disaster management and emergency preparedness.[30] Experienced professionals recommend five categories on which to concentrate resources for responding to future natural disasters: (1) planning and evaluation; (2) education and training; (3) building relationships; (4) disaster and behavior health; and (5) financial preparedness.[31] OEM core competency training parallels these recommendations for improved disaster management and are listed in Table 1 by event.[6] The trained and experienced OEM physician is qualified to help prepare employers and workers for disaster-zone exposures related to extreme weather changes, flooding, heat waves, and wildfires by developing protocols for mitigation of a disaster incident at the worksite or in the community in general. Also, the OEM provider can be consulted to establish emergency procedures and protocols for the clinical management of individuals involved in disaster incidents and disaster zone exposures.[15] Additional training in disaster management and emergency preparedness competencies can be found on the Federal Emergency Management Agency web site.[32] This training can be adapted to all disasters and emergencies from the worksite to the national level.

Stress and Mental Health Related Impacts

Studies have shown that the mental health of workers in susceptible occupations can be significantly affected by increasing weather fluctuations associated

with changes in climate. A positive association has been found between suicide rates among farmers and the severity of drought conditions.[33,34] First responders are also susceptible to the effects of natural disasters. In August 2005, Hurricane Katrina devastated the New Orleans area resulting in hundreds of deaths and the evacuation of entire communities. A significant number of first responders who worked in the aftermath of this storm reported new onset of depression and posttraumatic stress disorder.[16,35,36] The number of first responders reporting mental health disorders was even more significant among those who developed respiratory symptoms, had their own family members affected by the storm, or were working in isolated duty stations.[16,36]

It will be important to guide employers to have additional mental health resources available for their workforce during increasingly frequent severe weather events, and that the OEM provider will be able to rapidly deploy these services for the employees. The ACOEM core competencies in the section on Psychiatry, provide a comprehensive description of the fundamental skill set that will enable the OEM provider to effectively deal with these challenges.[6]

Waterborne and Vector-Borne Diseases

Climate associated shifts in seasonal and geographic patterns are expected to increase the frequency of certain tick-, mosquito-, and flea-borne diseases. Climate change influences the abundance and distribution of vectors and animal reservoirs, the percentage of infected vectors, presence of vector habitats, and human behaviors that increase frequency of contact.[37] Outdoor workers are particularly vulnerable to these climate-related health effects.[16,38] Contact with contaminated soil, water, animals, and infrastructure also makes certain working populations more susceptible to pathogenic bacteria exposure, including those in fisheries, agriculture, sanitation, and animal husbandry.[20] Vector-borne and non-vector-borne diseases create an unhealthy and less physically capable workforce, contribute to decreased local work productivity with associated economic consequences, and have the potential for lingering health effects after resolution of acute illness.[39]

OEM providers should, where applicable, anticipate and recognize how shifting patterns of vector and waterborne disease might affect worker populations, and are familiar with prevention, evaluation, treatment, and referral for such conditions, including notification of appropriate public health agencies. Core competencies specific to the recognition and management of vector-borne and waterborne disease are listed in Table 1.

In the face of extreme weather events, the OEM provider must anticipate and address the health impacts of vector-borne and waterborne pathogens on affected workers. Given the potential for climate-related changes in exposure risk to workers, providers must regularly access current resources for up-to-date vector and disease information.[14,40–46] When the risk cannot be completely eliminated, OEM providers need to recommend worksite precautions which may include the use of personal protection equipment, application of mosquito or tick repellant, and/or altering work hours to minimize exposure. These actions are also relevant in a disaster setting.

OEM providers are clinically trained to take thorough occupational and environmental histories, allowing them to screen and characterize risk for climate related health exposures. In a setting of increased exposure risk, the OEM provider is prepared to identify, manage, treat, or appropriately refer for treatment those with exposures resulting in disease. Travel medicine OEM providers follow shifting patterns of vector-borne disease when making decisions about required workforce prophylaxis.

Beyond the individual clinical interaction OEM providers are additionally skilled at interpreting and communicating risk on a population level, which is critical for certain weather related health events. Local public health OEM professionals are also trained to develop and implement vector-borne disease surveillance, prevention, and control programs.[47,48] These activities may entail collaboration with other clinical specialties and public health professionals.

OPERATIONAL SUPPORT-RELATED RESPONSIBILITIES OF AN OEM PROVIDER

OEM providers must understand the direct and indirect impacts of climate change on working individuals and act within an organization to mitigate health risks as well as respond to health crises.[20] The OEM provider's skills encompass clinical case management, comprehensive knowledge of the workplace setting, and providing effective guidance to employers in matters involving environmental health-related issues.[6,15,49] The following list summarizes the responsibility of the OEM provider in climate-related organizational worker health issues:

1. Provide guidance to the employers on how to protect working populations in the outdoors or in the field who are potentially exposed to the extreme temperatures.[37,50]
2. Quickly identify employees with acute and chronic cardiovascular and respiratory illnesses within the organization who will be significantly affected by increasing temperature and worsening air quality, an increase in ozone, particulate matter, and high pollen count.[16,37,51]
3. Help in devising a plan of action with the employer to mitigate potential adverse effects before, during and after flooding events and disruption of essential infrastructure.[37,52]
4. Provide effective guidance to employers about seasonal activity and address the increasing risk of vector-borne disease among the working population.[37,53]
5. Expedite clinical management and isolation of employees affected by food-borne illnesses and work with the employer in protecting the population served by these individuals.[37,54]
6. Deliver support to the employees at risk for mental illness due to disasters, loss, and migration by providing more comprehensive programs through their employment.[37,55]
7. Help with communication strategies during climate change related scenarios. Exposure pathways included extreme heat, poor air quality, reduce food and water quantity, concomitant UV exposure, changes in infectious agents and population displacement.[37]

SUMMARY AND CONCLUSIONS

Workers are uniquely susceptible to the health hazards imposed by environmental changes. Direct hazards include heat waves, reduced air quality, and allergen sensitization. Indirect health hazards include disaster zone exposures, stress and mental health impacts, and waterborne and vector-borne disease. The OEM provider possesses the core competencies needed to recognize risks and mitigate hazards, as well as recognize and respond to health effects in the occupational environment. OEM providers are called to be on the forefront of emerging health issues pertaining to working populations including climate change. The competent OEM provider should address individual and organizational factors that impact the health and productivity of workers as well as create policies that ensure a healthy workforce.[6] Therefore, OEM providers must be prepared to recognize, respond to, and mitigate climate change-related health effects in workers.

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