The Changing Climate: Managing Health Impacts

Cindy L. Parker, MD, MPH, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland
Caroline E. Wellbery, MD, PhD, Georgetown University School of Medicine, Washington, District of Columbia
Matthew Mueller, DO, MPH, Henry Ford Wyandotte Hospital, Wyandotte, Michigan

Concentrations of greenhouse gases continue to accumulate in the atmosphere at increasing rates, heating the Earth's surface and destabilizing climate. Health impacts from climate change may include increased morbidity and mortality from worsening cardiopulmonary health, worsening allergies, and greater risk of infectious disease and mental illness, including anxiety, depression, and posttraumatic stress disorder from extreme weather events. Family physicians should advise patients to minimize exposure to air pollution, which is potentiated by rising temperatures. Use of self-monitoring devices, tracking local weather information, and awareness of events such as wildfires can alert patients to poor ambient air quality. Vulnerable individuals should avoid intense outdoor exercise and stay indoors or wear protective N95 masks when air quality is in the harmful range. Physicians can teach patients to recognize early symptoms of heat illness and advise adequate hydration and cooling on hot days. Physicians should become aware of the signs and symptoms of vectorborne illnesses to ensure early treatment and limit spread. Physicians should be aware of the climate and health benefits of active transport and plant-based diets when counseling their patients. Physicians can have a positive impact on climate change awareness and policy by incorporating counseling, public health precepts, and advocacy into their practice. (*Am Fam Physician*. 2019;00(0):618-626.
Copyright © 2019 American Academy of Family Physicians.)

Concentrations of greenhouse gases continue to accumulate in the atmosphere at increasing rates, pushing Earth's climate further from the stability that has persisted since humans developed civilizations.[1] The health consequences of a rapidly changing, less predictable climate are expected to be substantial.

Our understanding of climate science and projections of how the climate is changing continue to improve: 97% of active climatologists agree that the climate is changing, that human activity and the burning of fossil fuels are primarily responsible, and that the effects will be mostly negative.[2] Moreover, the climate is changing faster than anticipated. For example, the five-year average melting in west Antarctica from 2012 to 2017 was three times faster than from 1992 to 1997, putting coastal cities at increasing risk of flooding, enduring inundation, and saltwater contamination of freshwater sources.[3] The most worrisome effects for Americans include more frequent and severe extreme weather events such as hurricanes, floods, droughts with resulting wildfires, and heat waves *(Table 1*[1,4]*)*; worsening air pollution affecting cardiopulmonary health; and changing seasonal characteristics that increase the risk of infectious disease spread, allergies, and asthma.[4]

Just as adapting the household environment is an essential component of asthma management, so is the need to

See related editorials on page 602 and at http:///www.aafp.org/afp/2019/1115/od3.html, and related Curbside Consultation at https://www.aafp.org/afp/2019/0101/p44.html.

CME **This clinical content** conforms to AAFP criteria for continuing medical education (CME). See CME Quiz on page 607.

Author disclosure: No relevant financial affiliations.

WHAT'S NEW ON THIS TOPIC

Climate Change

Eighteen of the past 19 years have been the warmest on record.

The five-year average melting in west Antarctica from 2012 to 2017 was three times faster than from 1992 to 1997, putting coastal cities at increasing risk of flooding, enduring inundation, and saltwater contamination of freshwater sources.

As temperate and colder regions experience shorter, warmer winters, insect vectors can expand into new regions. The Centers for Disease Control and Prevention reported a doubling of vectorborne diseases reported from 2004 to 2016.

Air pollution is associated with increased risks of coronary heart disease, myocardial infarction, and stroke, and is associated with increased emergency department visits, chronic obstructive pulmonary disease and asthma exacerbations, and development of respiratory disease.

Downloaded from the American Family Physician website at www.aafp.org/afp. Copyright © 2019 American Academy of Family Physicians. For the private, noncommercial use of one individual user of the website. All other rights reserved. Contact copyrights@aafp.org for copyright questions and/or permission requests.

develop climate-resilient communities and regions to provide appropriate care for patients in the setting of climate change. Family physicians have an important and timely role to counsel patients about how climate change will affect their health and what they can do about it.

Health Impacts

Climate change will have many different effects on health, specifically cardiopulmonary health, heat injuries, allergies, infectious diseases, and mental health *(Table 2)*.[1,4-17] This article reviews steps clinicians can take to lessen impacts for patients and reduce greenhouse gas emissions.

CARDIOPULMONARY HEALTH

Climate change affects cardiopulmonary health in complex ways, mediated in large part by air pollution, which is a major cause of morbidity and mortality worldwide.[18] Air pollution potentiates the effects of climate change, increasing ground-level ozone levels in hot weather, particularly in already polluted urban areas.[19,20] Air pollution also drives climate change, especially through pollutants such as black carbon and methane.[19,20] Climate change, in turn, affects meteorologic conditions that increasingly hamper natural clearance of pollutants through rain and wind, and expansion and severity of wildfires intensify exposure to smoke.[19,20]

A recent study shows an association between particle and ozone air pollution and mortality, with no lower threshold considered safe.[5] Specifically, air pollution has been associated with an increased risk of coronary heart disease,[21] myocardial infarction,[22] and stroke,[23] and is associated with increased emergency department visits, chronic obstructive pulmonary disease and asthma exacerbations, and development of respiratory disease.[24] Children, older adults, people with chronic diseases, and those living in poverty are among the most vulnerable.[25,26]

Reducing air pollution is a recognized policy challenge.[27,28] However, little is known about the effectiveness of clinical management strategies, which are typically tied to reductions in exposure. Use of self-monitoring devices, local weather information sources, and awareness of events such as wildfires can alert patients to current air quality conditions.[29] People at high risk, including children, pregnant women, older adults, and those with preexisting cardiopulmonary conditions, should avoid intense outdoor exercise and stay indoors with windows closed when air quality is poor.[29] N95 masks—but not ordinary surgical masks—reduce particulate inhalation and may be useful in the setting of wildfires.[29,30] The AIR (ask, inform, react) mnemonic has been suggested as a potentially useful counseling tool *(Table 3)*.[7]

HEAT INJURY

Increasing greenhouse gas emissions are the primary reason that 18 of the 19 warmest years on record have occurred this century.[31] Heat waves, which are longer than usual periods of hot days, are predicted to increase in the coming decades[1] and have been associated with emergency department visits and increases in morbidity and mortality worldwide.[32] Hot weather and heat waves are associated with increases in myocardial infarction,[33] stroke,[34] acute and chronic kidney injuries,[34]

TABLE 1

Impacts of Extreme Weather Events on Health Risks and Social Determinants of Health

Extreme weather event	Direct health risks	Impacts on social determinants of health
Droughts	Insufficient water supplies to meet daily needs for hydration, hygiene, and food production	Loss of income from crop losses can cause mental health effects and homelessness
Floods	Drowning, injuries, infections from contaminated water, respiratory and neurologic effects from mold*, infections from crowding in shelters, PTSD, anxiety, depression	Loss of employment, income, and home; displacement; inability to procure medications for chronic illnesses
Heat waves	Heat-related morbidity and mortality	Health and functional effects on outdoor workers
Hurricanes	Injuries and death during and after storm, PTSD, anxiety, depression	Loss of employment, income, and health insurance; inability to procure medications for chronic illnesses
Wildfires	Injuries and death, cardiovascular and respiratory illnesses, PTSD, anxiety, depression	Loss of home and employment, displacement

PTSD = posttraumatic stress disorder.

*—Physicians should direct patients affected by floods to the Centers for Disease Control and Prevention's website on mold prevention and clean-up (https://www.cdc.gov/mold/default.htm).

Information from references 1 and 4.

TABLE 2

Mechanisms of Climate Change–Related Health Effects and Proposed Clinical Interventions

Health effect	Mechanism	Clinical interventions
Cardiopulmonary effects (e.g., increased risk of asthma and chronic obstructive pulmonary disease exacerbations, myocardial infarction, stroke)	Worsening air pollution, higher ozone concentrations, extended pollen season[4-6]	Self-monitoring devices, N95 protective masks, staying indoors in response to air quality alerts, avoiding high-traffic areas[7]
Heat injury (e.g., muscle cramps, sweating, nausea, vomiting, ataxia, altered mental status, seizures, death)	Warmer temperatures, urban heat islands, more frequent and severe heat waves[1,4]	Counsel patients about prevention, including moving to public cooling centers during heat waves, recognizing early symptoms, and taking appropriate actions[8] Outdoor workers should avoid peak heat, take breaks, and hydrate adequately*
Infectious disease (e.g., West Nile virus, Zika virus, Lyme disease, dengue virus, malaria)	Warmer temperatures and longer summers allow more effective reproduction of insect vectors Warmer, shorter winters allow insect vectors to expand range poleward (Lyme disease, dengue virus) and into higher altitudes (malaria); unexposed populations have less behavioral and/or physiologic resistance, and changes in environmental conditions (e.g., drought) change behavior of wildlife, which facilitates transmission (West Nile virus)[1,4] Warmer surface water temperatures are directly correlated with increasing *Vibrio* counts, and warmer ambient temperatures are associated with higher incidence of diarrheal illness; groundwater and drinking water contaminated with sewage increases risk of enteric disease[9]	Early detection and appropriate treatment; notify public health authorities; counsel patients about signs and symptoms to watch for and ways to reduce exposure[4]
Allergies (e.g., allergic rhinitis, asthma)	Extended hay fever season[10] and more severe allergic responses; higher ozone levels combine with the urban heat island effect to cause higher pollen counts, especially from ragweed[11-13]	Pharmacologic treatment; counsel patients to monitor pollen counts and adjust medications using parameters provided by physician[14]
Mental health effects (e.g., anxiety, depression, posttraumatic stress disorder)	Exposure to natural disasters, loss of resources, loss of social support systems,[15,16] worry[17]	Screening during office visits (especially after disasters) and appropriate referral[15,16]

*—A smartphone app on heat safety is available from the Occupational Safety and Health Administration at https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html.

Information from references 1 and 4-17.

cognitive function deficits,[35] and suicide.[36] Heat-related illnesses were discussed in a previous issue of *American Family Physician* (https://www.aafp.org/afp/2019/0415/p482.html).

Use of certain medications can increase the risk of heat injury.[37] Vulnerable populations include infants, outdoor workers, older adults, people with medical and psychiatric comorbidities, people living in poverty, and those without access to cooling.[37] A meta-analysis found that poor physical or cognitive function and lack of social support increase the risk of heat injury, possibly because these conditions inhibit protective behaviors, such as proper hydration and relocation to cooler environments.[8] However, except for air conditioning and moving to a cool place, no intervention could be clearly identified as protective against heat-related deaths, and some might have unintended adverse effects, such as hyponatremia in the case of excess hydration and falls in people seeking relief with frequent showers or baths.[8]

There have been few studies on individual measures to reduce vulnerability to heat.[38] Suggested public

TABLE 3

AIR Mnemonic for Patients with Pulmonary Disease

Ask patients what they know about the effects of air pollution on their lung health

Inform patients about symptoms that may be related to air pollution (e.g., phlegm, shortness of breath, chest tightness)

React: counsel patients to monitor air quality, carry a rescue inhaler on high-risk days, limit time outdoors, and avoid intense or prolonged exertion outdoors

Information from reference 7.

health interventions include early heat warning systems and alerts, public cooling centers, and climate-smart projects to improve the environment and counteract the heat-trapping effects of urban heat islands.[39]

ALLERGIES

Increasing global temperatures and longer frost-free seasons allow for longer growing seasons, which lead to longer allergy seasons.[10] Higher levels of carbon dioxide and associated air pollutants increase the production and allergenicity of pollen from certain highly allergenic plants, such as ragweed.[11-13] Several studies have shown that when pollen counts are high, there is an increase in emergency department visits and hospitalizations for severe respiratory problems over the following two to five days, as well as an increase in outpatient visits for allergic rhinitis.[14,39,40] Counseling patients to track their local pollen counts (using online monitoring sites such as https://weather.com/maps/health/allergies/treepollen and https://www.pollen.com) and providing instructions for medication changes to prevent flare-ups when pollen counts are high could potentially decrease visits and hospitalizations.[14]

Precipitation, humidity, and flooding, which are expected to worsen with climate change, enhance the growth of indoor mold.[41] Compromised indoor air quality exposes vulnerable populations to allergens. Family physicians should counsel patients about the health benefits of preventing, identifying, and removing mold from inside their homes.[41] The Centers for Disease Control and Prevention has an online resource on mold prevention and clean-up at https://www.cdc.gov/mold/default.htm.

INFECTIOUS DISEASES

Climate change can affect the spread of some infectious diseases. As temperate and colder regions experience shorter, warmer winters, insect vectors can expand into new regions, resulting in an increased incidence of illnesses such as malaria, Lyme disease, West Nile virus, Zika virus, dengue virus, and chikungunya virus.[1,4] For example, *Ixodes*, the tick that transmits Lyme disease, expanded its range in the U.S. Northeast and Upper Midwest between 2001 and 2015.[4] The Centers for Disease Control and Prevention reported a doubling of vectorborne diseases from 2004 to 2016.[42] Vectorborne illnesses were discussed in a previous issue of *American Family Physician* (https://www.aafp.org/afp/2016/1001/p551.html).

Waterborne diarrheal diseases are also occurring more frequently, especially outside the United States, and typically involve enteric viruses, parasites, and bacteria, most notably *Vibrio*.[4] Physicians should be familiar with the signs and symptoms of diseases involving these organisms to ensure early treatment and prevent transmission, and should stay up to date on new and emerging infectious diseases in their communities and other locales where their patients may travel.[4]

Prevention of insect- and waterborne diseases includes counseling patients about appropriate clothing and use of insect repellent, ensuring that household windows have screens, checking for ticks after spending time outside, and use of insect netting.[43,44]

MENTAL HEALTH

The mental health effects of climate change depend on the degree of exposure and perceived threat. Weather-related disasters can produce anxiety, depression, and posttraumatic stress disorder.[15,16] These effects may be transient, or they can persist in people who experience significant losses as a result of the disaster and in at-risk groups, including children, people living in poverty, and first responders.[15,16] Physicians should be prepared to connect patients with appropriate community resources and mental health professionals. Extrapolating from the trauma literature, psychological therapies may be particularly helpful in reducing the likelihood of posttraumatic stress disorder in children and adolescents exposed to weather-related disasters.[45]

Although much research has focused on the mental health effects of catastrophic events such as storms or floods, less is known about the effects from "slow" events such as droughts or rising sea levels. These events affect land use, agricultural yield, and infrastructure and can lead to interpersonal or economic stress, displacement, or other existential conditions with concomitant mental health impacts.[46] However, anxiety and worry about potential impacts of climate change can be constructive and adaptive, and may support pro-environmental attitudes and actions.[17] Positive engagement behaviors may serve as effective mental health interventions. A Cochrane review of studies on outdoor environmental enhancement and conservation activities found qualitative evidence for improved well-being among participants.[47] Although further study is needed, the idea of local environmental interventions to enhance well-being (e.g., via social connections) suggests that engagement in community-based pro-environmental behaviors may have benefits for both health and the environment.

The Role of Physicians

The consequences of failing to stabilize the climate at a global average surface temperature below 2.5°F (1.5°C) above preindustrial levels[48] are so detrimental for human health and well-being that a compelling argument can be made that physicians have a moral obligation to educate their patients and support policies to reduce greenhouse gas emissions.[49]

One approach is for physicians to counsel patients on the personal and environmental benefits of transitioning to active transport (e.g., walking, jogging, bicycling) and a plant-based diet. In healthy individuals and in safe settings, active transport confers cardiopulmonary benefits, may reduce stress, and reduces ambient air pollution.[50] Although recent reviews have found few health risks associated with consumption of red meat,[51] diets that emphasize the intake of fruits, vegetables, nuts, and legumes (e.g., the Mediterranean diet) are associated with a multitude of health benefits while also reducing agricultural carbon dioxide emissions and waste.[52,53] Although no studies have shown that emphasizing these environmental cobenefits in the clinical setting results in more significant behavioral change compared with counseling about the personal health benefits of diet and exercise alone, one ongoing study is researching the effects of incorporating behavioral counseling, mindfulness, and climate change education.[54] Such studies are important for gauging patient receptivity to counseling that explicitly addresses climate change as a health concern.

The U.S. health care sector is responsible for 10% of all greenhouse gas emissions, 10% of smog formation, 12% of air pollution emissions, and smaller but significant amounts of ozone-depleting substances and other air toxicants.[55] The health effects of these emissions and resource use in 2013 were equivalent to the loss of 470,000 years of healthy life (in disability-adjusted life years).[55] The use of climate-smart practices in the health care sector has the potential to save lives by reducing energy and resource use, thereby safeguarding the environment, demonstrating leadership in the community, and saving money.[56] Physicians can work with hospitals, the most resource-intensive institutions in the health care sector, to reduce energy use. Efforts to reduce hospital emissions, increase employees' active transportation, and educate physicians about the health impacts of air pollution were successful in one

TABLE 4

Climate Change Actions and Resources for Health Care Professionals

Actions	Resources
Encourage the facilities where you work to lead by example by adopting measures to reduce their carbon footprint	Health Care Without Harm (https://noharm-uscanada.org/content/us-canada/join-our-physician-network)
	My Green Doctor (https://www.mygreendoctor.org)
Encourage professional associations to explore and address the issue of climate change and the role the health care sector has in mitigation	American Academy of Family Physicians position statement on environmental health and climate change (https://www.aafp.org/about/policies/all/climate-pollution.html)
	American Academy of Pediatrics policy statement on global climate change and children's health (http://pediatrics.aappublications.org/content/136/5/992)
	The American College of Emergency Physicians policy statement on climate change and public health (http://bit.ly/2JoqJoi)
	Additional associations with policy statements: American Academy of Dermatology (http://bit.ly/2J5J5uS) American College of Physicians (http://bit.ly/2HaCLyK) American College of Preventive Medicine (http://bit.ly/31z8hik) American Congress of Obstetricians and Gynecologists (http://bit.ly/2ZZDsnb) American Medical Association (http://bit.ly/2WtLUJt) American Psychiatric Association (http://bit.ly/35Wg11i) American Thoracic Society (http://bit.ly/33Q26I7) National Medical Association (http://bit.ly/2YfGXUZ)
Work with professional associations and teaching institutions to make climate literacy a mandatory requirement for all clinical education programs	Global Consortium on Climate and Health Education (http://bit.ly/2DUF9sK)
	Medical Society Consortium on Climate and Health (https://medsocietiesforclimatehealth.org)
Become an informed advocate for climate mitigation and adaptation efforts	Many professional and evidence-based advocacy organizations are providing useful information, such as the American Academy of Family Physicians, American Public Health Association, and Physicians for Social Responsibility
Set an example: do your part to understand and minimize your own carbon footprint	Carbon footprint calculators are available at: http://bit.ly/2Wsi9Zb https://www3.epa.gov/carbon-footprint-calculator https://www.conservation.org/act/carboncalculator/calculate-your-carbon-footprint.aspx#

TABLE 5

Public Health Resources for Natural Disasters

Preparedness

CDC natural disasters and severe weather resource:
https://www.cdc.gov/disasters/index.html

CDC disaster preparedness educational materials for people with chronic diseases:
https://www.cdc.gov/disasters/hurricanes/educationalmaterials.html

EPA:
https://www.epa.gov/natural-disasters

Federal Emergency Management Agency climate change resource:
https://www.fema.gov/climate-change

National Center for Disaster Preparedness:
https://ncdp.columbia.edu

U.S. Department of Homeland Security disaster preparedness resource:
https://www.ready.gov

WHO resource on preventing heat-related illness:
http://www.euro.who.int/__data/assets/pdf_file/0007/147265/Heat_information_sheet.pdf

Building resiliency

APA resource for flood victims:
http://www.apa.org/helpcenter/flood-distress.aspx

APA resource for hurricane victims:
https://www.apa.org/helpcenter/hurricane-stress.aspx

EPA Climate Change Adaptation Resource Center:
https://www.epa.gov/arc-x

EPA resource on climate change and heat islands:
https://www.epa.gov/heat-islands/climate-change-and-heat-islands

EPA resource on indoor air quality:
https://www.epa.gov/indoor-air-quality-iaq/adapting-buildings-indoor-air-quality-changing-climate

Indiana University Environmental Resilience Institute:
https://eri.iu.edu/erit/implications/public-health.html

Substance Abuse and Mental Health Services Administration disaster behavioral health resources:
https://www.samhsa.gov/dtac/disaster-behavioral-health-resources

U.S. Climate Resilience Toolkit:
https://toolkit.climate.gov

Emergency responders

National Institute for Occupational Safety and Health emergency response resources:
https://www.cdc.gov/niosh/topics/emres/natural.html

OSHA hurricane preparedness and response resource:
https://www.osha.gov/dts/weather/hurricane/index.html

OSHA indoor air quality resource:
https://www.osha.gov/SLTC/indoorairquality/index.html

OSHA occupational heat exposure resource:
https://www.osha.gov/SLTC/heatstress

OSHA wildfire resource:
https://www.osha.gov/dts/wildfires/index.html

Public health organizations

American Public Health Association:
https://www.apha.org/topics-and-issues/climate-change

CDC:
https://www.cdc.gov/climateandhealth

Center for Climate Change and Health:
http://climatehealthconnect.org

National Institute of Environmental Health Sciences:
https://www.niehs.nih.gov/research/programs/geh/climatechange/index.cfm

U.S. Global Change Research Program:
https://www.globalchange.gov

WHO:
http://www.who.int/health-topics/climate-change

Health care resources

CDC mold prevention and clean-up resource:
https://www.cdc.gov/mold/default.htm

Climate for Health:
http://climateforhealth.org

Health Care Without Harm:
https://noharm.org

National Association of County and City Health Officials climate change resource:
https://www.naccho.org/programs/environmental-health/hazards/climate-change

Practice Greenhealth:
https://practicegreenhealth.org

APA = American Psychological Association; CDC = Centers for Disease Control and Prevention; EPA = U.S. Environmental Protection Agency; OSHA = Occupational Safety and Health Administration; WHO = World Health Organization.

health care system.[57] Multiple resources exist to assist clinicians and hospitals in providing climate-smart health care *(Table 4)*.

Physicians also have an important role as advocates. The American Academy of Family Physicians recognizes "serious adverse health consequences resulting from pollution, greenhouse gas emissions from human activities, climate change and ozone layer depletion," and recommends "strong action on the part of all public and private institutions to reduce pollution of our land, atmosphere, and water."[58] Physicians can strengthen and support public health and community initiatives (e.g., heat wave warning systems)

SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	Evidence rating	Comments
Physicians should counsel patients about prevention of heat injuries, including moving to public cooling centers during heat waves, recognizing early symptoms, and taking appropriate actions.[8]	C	Recommendation based on a meta-analysis of case-control or cohort studies
Physicians should encourage the use of self-monitoring devices and N95 protective masks, and should counsel patients to stay indoors and avoid intense outdoor exercise in response to air quality alerts.[7]	C	Recommendation based on expert opinion
Physicians should encourage walking, jogging, and cycling where safe as means of transportation to improve cardiopulmonary health and reduce stress while reducing air pollution.[50]	C	Recommendation based on public health epidemiologic data
Physicians should encourage a plant-based diet to improve health while reducing agricultural pollution and waste.[52]	C	Recommendation based on multiple methods of assessment, including prospective trials, epidemiologic research, and modeling studies
Providing climate-smart health care has the potential to save lives by reducing energy, resource use, and associated emissions.[55-57]	C	Recommendation based on multiple methods of assessment, including prospective trials, epidemiologic research, and modeling studies

A = consistent, good-quality patient-oriented evidence; **B** = inconsistent or limited-quality patient-oriented evidence; **C** = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to https://www.aafp.org/afpsort.

TABLE 6

Disaster Planning and Preparedness for Patients with Chronic Disease

Patient education	Patient preparedness	Collaborate and coordinate with local and state public health departments
Discuss potential barriers to preparedness and find solutions	Help patient create an emergency kit containing medications, information about chronic disease (from education activities), protective clothing, cell phone, and important contact information	Develop a plan for alternative storage of refrigerated medications in case of power outages
Ensure patient knows disease names	Help patient create evacuation plan for likely disasters and consider early evacuation	Develop evacuation plans for people with chronic disease, disability, or lack of transportation
Provide paper or access to digital summary of current medications and dosages	Help patient locate alternative sources of critical medical supplies (potentially outside of likely disaster zone)	Develop local and regional plans for continuity of care for patients with chronic diseases
Provide paper or access to digital summary of medical history	Help patient procure emergency supplies of critical medications	Develop resources for procuring emergency medications and medical supplies for patients unable or unwilling to evacuate
Provide paper or access to digital summary of treatment goals and plan		Train shelter personnel and volunteers to ask about chronic disease and connect patients with community resources or personnel who can provide assistance
Remind patient to take medications if evacuated		
Chronic disease may make patient more susceptible to illness or infection; discuss appropriate precautions for likely risks		

Information from references 59-63.

by increasing public awareness and helping patients locate community-based resources *(Table 5)*. Clear disaster preparedness guidelines are emerging for patients with chronic diseases. Physicians can assist patients with planning and preparedness activities for likely disasters, such as possible early evacuation, procurement of supplies of critical medication and equipment, and arrangements to receive critical treatments outside of the disaster area[59,60] *(Table 6*[59-63]*)*.

Advocacy tools that are broadly applicable to other physician concerns are also useful for taking action to combat the health impacts of climate change.[64]

This article updates a previous article on this topic by Parker.[65]

Data Sources: A PubMed search was completed in Clinical Queries using the key terms climate change AND asthma, allergies, vector-borne disease, air pollution, mental health, psychological impacts, disaster psychology, and psychological adaptation. The search included meta-analyses, clinical trials, original research on mechanisms, and reviews. Also searched were UpToDate, OVID, and the Cochrane database. Search dates: June 17, 2018, and March 11, 2019.

Editor's Note: Dr. Wellbery is associate deputy editor of *American Family Physician*.

The Authors

CINDY L. PARKER, MD, MPH, is codirector of the Program on Global Sustainability and Health at John Hopkins Bloomberg School of Public Health, Baltimore, Md.

CAROLINE E. WELLBERY, MD, PhD, is a professor in the Department of Family Medicine at Georgetown University School of Medicine, Washington, D.C.

MATTHEW MUELLER, DO, MPH, is an emergency medicine resident at Henry Ford Wyandotte (Mich.) Hospital.

Address correspondence to Cindy L. Parker, MD, MPH, at cindyparker@jhu.edu. Reprints are not available from the authors.

References

1. Pachauri RK, Meyer LA; Groupe d'Experts Intergouvernemental sur l'Evolution du Climat. Climate change 2014: synthesis report: contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change; 2015.
2. Anderegg WR, Prall JW, Harold J, et al. Expert credibility in climate change. *Proc Natl Acad Sci U S A*. 2010;107(27):12107-12109.
3. IMBIE team. Mass balance of the Antarctic Ice Sheet from 1992 to 2017. *Nature*. 2018;558(7709):219-222.
4. Reidmiller DR, Avery CW, Easterling DR, et al., eds.; U.S. Global Change Research Program. Impacts, risks, and adaptation in the United States: fourth national climate assessment. November 2018. Accessed May 7, 2019. https://nca2018.globalchange.gov
5. Di Q, Dai L, Wang Y, et al. Association of short-term exposure to air pollution with mortality in older adults. *JAMA*. 2017;318(24):2446-2456.
6. Brook RD, Rajagopalan S, Pope CA III, et al.; American Heart Association Council on Epidemiology and Prevention, Council on the Kidney in Cardiovascular Disease, and Council on Nutrition, Physical Activity and Metabolism. Particulate matter air pollution and cardiovascular disease: an update to the scientific statement from the American Heart Association. *Circulation*. 2010;121(21):2331-2378.
7. Huang YC. Outdoor air pollution: a global perspective. *J Occup Environ Med*. 2014;56(suppl 10):S3-S7.
8. Bouchama A, Dehbi M, Mohamed G, et al. Prognostic factors in heat wave related deaths: a meta-analysis. *Arch Intern Med*. 2007;167(20):2170-2176.
9. Smith KR, Woodward A, Campbell-Lendrum D, et al.; Intergovernmental Panel on Climate Change. Human health: impacts, adaptation, and co-benefits. In: Climate change 2014: impacts, adaptation, and vulnerability. Cambridge University Press; 2014:709-754.
10. Walsh J, Wuebbles D, Hayhoe K, et al. Appendix 3: climate science supplement. In: Melillo JM, Richmond TC, Yohe GW, eds. Climate change impacts in the United States: the Third National Climate Assessment. U.S. Global Change Research Program; 2014:735-789.
11. Ghiani A, Aina R, Asero R, et al. Ragweed pollen collected along high-traffic roads shows a higher allergenicity than pollen sampled in vegetated areas. *Allergy*. 2012;67(7):887-894.
12. El Kelish A, Zhao F, Heller W, et al. Ragweed (*Ambrosia artemisiifolia*) pollen allergenicity: SuperSAGE transcriptomic analysis upon elevated CO2 and drought stress. *BMC Plant Biol*. 2014;14:176.
13. Rogers CA, Wayne PM, Macklin EA, et al. Interaction of the onset of spring and elevated atmospheric CO2 on ragweed (*Ambrosia artemisiifolia L.*) pollen production. *Environ Health Perspect*. 2006;114(6):865-869.
14. Darrow LA, Hess J, Rogers CA, et al. Ambient pollen concentrations and emergency department visits for asthma and wheeze. *J Allergy Clin Immunol*. 2012;130(3):630-638.e4.
15. American Psychological Association; Climate for Health; ecoAmerica. *Mental Health and Our Changing Climate: Impacts, Implications, and Guidance*. ecoAmerica; 2017.
16. Schwartz RM, Gillezeau CN, Liu B, et al. Longitudinal impact of Hurricane Sandy exposure on mental health symptoms. *Int J Environ Res Public Health*. 2017;14(9):957-969.
17. Verplanken B, Roy D. "My worries are rational, climate change is not": habitual ecological worrying is an adaptive response. *PLoS One*. 2013;8(9):e74708.
18. Kelly FJ, Fussell JC. Air pollution and public health: emerging hazards and improved understanding of risk. *Environ Geochem Health*. 2015;37(4):631-649.
19. Strosnider H, Kennedy C, Monti M, et al. Rural and urban differences in air quality, 2008-2012, and community drinking water quality, 2010-2015 – United States. *MMWR Surveill Summ*. 2017;66(13):1-10.
20. Stocker TF, Qin D, Plattner GK, et al.; Intergovernmental Panel on Climate Change. Climate change 2013: the physical science basis. Accessed February 17, 2019. https://www.ipcc.ch/report/ar5/wg1
21. Kaufman JD, Adar SD, Barr RG, et al. Association between air pollution and coronary artery calcification within six metropolitan areas in the USA (the Multi-Ethnic Study of Atherosclerosis and Air Pollution): a longitudinal cohort study [published correction appears in *Lancet*. 2016;388(10045):660]. *Lancet*. 2016;388(10045):696-704.
22. Mustafić H, Jabre P, Caussin C, et al. Main air pollutants and myocardial infarction. *JAMA*. 2012;307(7):713-721.
23. Lee KK, Miller MR, Shah AS. Air pollution and stroke. *J Stroke*. 2018;20(1):2-11.
24. Bayram H, Bauer AK, Abdalati W, et al. Environment, global climate change, and cardiopulmonary health. *Am J Respir Crit Care Med*. 2017;195(6):718-724.
25. Hutchinson JA, Vargo J, Milet M, et al. The San Diego 2007 wildfires and Medi-Cal emergency department presentations, inpatient hospitalizations, and outpatient visits: an observational study of smoke exposure periods and a bidirectional case-crossover analysis. *PLoS Med*. 2018;15(7):e1002601.
26. Perera FP. Multiple threats to child health from fossil fuel combustion: impacts of air pollution and climate change. *Environ Health Perspect*. 2017;125(2):141-148.
27. Medical Society Consortium on Climate and Health. Mission and consensus statement. Accessed October 26, 2018. https://

medsocietiesforclimatehealth.org/about/mission-and-consensus-statement

28. Centers for Disease Control and Prevention. Climate and health: CDC policy. Accessed October 20, 2018. https://www.cdc.gov/climateandhealth/policy.htm
29. Centers for Disease Control and Prevention. Protect yourself from wildfire smoke. Accessed October 20, 2018. https://www.cdc.gov/features/wildfires/index.html
30. Environmental Protection Agency. Wildfire smoke factsheet: protect your lungs from wildfire smoke or ash. Accessed October 20, 2018. https://www3.epa.gov/airnow/smoke_fires/respiratory-protection-508.pdf
31. NASA Global Climate Change. Vital signs of the planet: global temperature. Accessed March 11, 2019. https://climate.nasa.gov/vital-signs/global-temperature
32. Knowlton K, Rotkin-Ellman M, King G, et al. The 2006 California heat wave: impacts on hospitalizations and emergency department visits. *Environ Health Perspect*. 2009;117(1):61-67.
33. Lam HC, Chan JC, Luk AO, et al. Short-term association between ambient temperature and acute myocardial infarction hospitalizations for diabetes mellitus patients: a time series study. *PLoS Med*. 2018;15(7):e1002612.
34. Flynn A, McGreevy C, Mulkerrin EC. Why do older patients die in a heatwave? *QJM*. 2005;98(3):227-229.
35. Cedeño Laurent JG, Williams A, Oulhote Y, et al. Reduced cognitive function during a heat wave among residents of non-air-conditioned buildings: an observational study of young adults in the summer of 2016. *PLoS Med*. 2018;15(7):e1002605.
36. Thompson R, Hornigold R, Page L, et al. Associations between high ambient temperatures and heat waves with mental health outcomes: a systematic review. *Public Health*. 2018;161:171-191.
37. World Health Organization. Public health advice on preventing health effects of heat: new and updated information for different audiences. Accessed October 31, 2018. http://www.euro.who.int/__data/assets/pdf_file/0007/147265/Heat_information_sheet.pdf
38. Gupta S, Carmichael C, Simpson C, et al. Electric fans for reducing adverse health impacts in heatwaves. *Cochrane Database Syst Rev*. 2012;(7):CD009888.
39. Osborne NJ, Alcock I, Wheeler BW, et al. Pollen exposure and hospitalization due to asthma exacerbations: daily time series in a European city. *Int J Biometeorol*. 2017;61(10):1837-1848.
40. Zhang F, Krafft T, Zhang D, et al. The association between daily outpatient visits for allergic rhinitis and pollen levels in Beijing. *Sci Total Environ*. 2012;417-418:39-44.
41. Spengler JD, Adgate JL, Busalacchi AJ Jr, et al. Dampness, moisture, and flooding. In: *Climate Change, the Indoor Environment, and Health*. National Academies Press; 2011:133-154.
42. Rosenberg R, Lindsey NP, Fischer M, et al. Vital signs: trends in reported vectorborne disease cases — United States and territories, 2004-2016. *MMWR Morb Mortal Wkly Rep*. 2018;67(17):496-501.
43. Centers for Disease Control and Prevention. Ticks: on people. Accessed October 25, 2018. https://www.cdc.gov/ticks/avoid/on_people.html
44. Centers for Disease Control and Prevention. Prevent mosquito bites. Accessed October 25, 2018. https://www.cdc.gov/features/stopmosquitoes/index.html
45. Gillies D, Maiocchi L, Bhandari AP, et al. Psychological therapies for children and adolescents exposed to trauma. *Cochrane Database Syst Rev*. 2016;(10):CD012371.
46. Hayes K, Blashki G, Wiseman J, et al. Climate change and mental health: risks, impacts and priority actions. *Int J Ment Health Syst*. 2018;12:28.
47. Husk K, Lovell R, Cooper C, et al. Participation in environmental enhancement and conservation activities for health and well-being in adults: a review of quantitative and qualitative evidence. *Cochrane Database Syst Rev*. 2016;(5):CD010351.
48. Allen M, Babiker M, Chen Y, et al.; Intergovernmental Panel on Climate Change. Special report: global warming of 1.5°C: summary for policymakers. Accessed October 20, 2018. https://www.ipcc.ch/sr15/chapter/spm
49. Barrett B, Charles JW, Temte JL. Climate change, human health, and epidemiological transition. *Prev Med*. 2015;70:69-75.
50. Maizlish N, Woodcock J, Co S, et al. Health cobenefits and transportation-related reductions in greenhouse gas emissions in the San Francisco Bay area. *Am J Public Health*. 2013;103(4):703-709.
51. Zeraatkar D, Han MA, Guyatt GH, et al. Red and processed meat consumption and risk for all-cause mortality and cardiometabolic outcomes: a systematic review and meta-analysis of cohort studies [published online October 1, 2019]. *Ann Intern Med*. Accessed October 18, 2019. https://annals.org/aim/fullarticle/2752320/red-processed-meat-consumption-risk-all-cause-mortality-cardiometabolic-outcomes
52. Estruch R, Ros E, Salas-Salvadó J, et al.; PREDIMED Study Investigators. Primary prevention of cardiovascular disease with a Mediterranean diet supplemented with extra-virgin olive oil or nuts. *N Engl J Med*. 2018;378(25):e34.
53. Springmann M, Godfray HC, Rayner M, et al. Analysis and valuation of the health and climate change cobenefits of dietary change. *Proc Natl Acad Sci U S A*. 2016;113(15):4146-4151.
54. Barrett B, Grabow M, Middlecamp C, et al. Mindful climate action: health and environmental co-benefits from mindfulness-based behavioral training. *Sustainability*. 2016;8(10):1040.
55. Eckelman MJ, Sherman J. Environmental impacts of the U.S. health care system and effects on public health. *PLoS One*. 2016;11(6):e0157014.
56. Frumkin H, Coussens C; Institute of Medicine. *Green Healthcare Institutions: Health, Environment, and Economics*. National Academies Press; 2007.
57. Joy EA, Horne BD, Bergstrom S. Addressing air quality and health as a strategy to combat climate change. *Ann Intern Med*. 2016;164(9):626-627.
58. American Academy of Family Physicians. Environmental health and climate change. Accessed October 22, 2019. https://www.aafp.org/about/policies/all/climate-pollution.html
59. Carameli KA, Eisenman DP, Blevins J, et a;. Planning for chronic disease medications in disaster: perspectives from patients, physicians, pharmacists, and insurers. *Disaster Med Public Health Prep*. 2013;7(3):257-265.
60. Centers for Disease Control and Prevention. Natural disasters and severe weather: chronic conditions. Accessed October 31, 2018. https://www.cdc.gov/disasters/hurricanes/educationalmaterials.html
61. Tomio J, Sato H. Emergency and disaster preparedness for chronically ill patients: a review of recommendations. *Open Access Emerg Med*. 2014;6:69-79.
62. Ryan B, Franklin RC, Burkle FM Jr, et al. Identifying and describing the impact of cyclone, storm and flood related disasters on treatment management, care and exacerbations of non-communicable diseases and the implications for public health. *PLoS Curr*. 2015;7.
63. Arrieta MI, Foreman RD, Crook ED, et al. Providing continuity of care for chronic diseases in the aftermath of Katrina: from field experience to policy recommendations. *Disaster Med Public Health Prep*. 2009;3(3):174-182.
64. Haq C, Stiles M, Rothenberg D, et al. Effective advocacy for patients and communities. *Am Fam Physician*. 2019;99(1):44-46. Accessed September 12, 2019. https://www.aafp.org/afp/2019/0101/p44.html
65. Parker CL. Slowing global warming: benefits for patients and the planet. *Am Fam Physician*. 2011;84(3):271-278. Accessed September 12, 2019. https://www.aafp.org/afp/2011/0801/p271.html