Climate Change as a Driver of Health Outcomes

Selected Recommendations for Healthcare Stakeholders

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Executive Summary

As climate change continues to alter patterns of everyday life, advocacy groups and citizens alike are urging policymakers and industries to take action. According to a nationally representative, survey on climate change sponsored by Yale University, 74% of Americans want to hear more about climate change and 78% want to hear more about the impact of climate change on their local community.[1]

Healthcare stakeholders can adopt actionable plans to 1) prevent and mitigate negative environmental contributions and 2) address the impacts of climate change on health outcomes, healthcare costs, and health equity. Healthcare stakeholders are beginning to make pledges to reduce their environmental impacts, but despite a growing body of evidence relating climate change to human health, large corporations and governmental bodies have more progress to make in taking clear climate action. This paper summarizes the impacts of climate change on human health and provides recommendations for healthcare stakeholders seeking to optimize their response and demonstrate their dedication to climate and sustainability. Key takeaways for providers, health plans, and manufacturers are as follows:

- **Providers**: US healthcare facilities are highly energy-intensive, accounting for 10.3% of total energy consumption in the commercial sector despite occupying less than 5% of the total land area.[2] Further, they are increasingly impacted by extreme weather events and natural disasters, impairing their ability to deliver care effectively and equitably. Patients may face issues accessing facilities and proper care as a result of energy or infrastructure disruption (e.g., staff departures or sickness, water shortage, supply chain disruption or shortages). The impact of climate change on human health can exacerbate adverse health outcomes and high healthcare utilization, thereby burdening health systems and providers. Providers can establish and implement mitigation and adaptation strategies to alleviate pressure on the overall healthcare system.
- **Health Plans:** Health plans are likely to see increased healthcare utilization and cost of care associated with climate change impacting member health as severe storms, droughts, wildfires, rising sea levels, and other environmental changes increase risk of comorbidities and worse outcomes. Plans can develop adaptive efforts to reduce harm to their members, particularly considering how vulnerable members may be disproportionately impacted.
- **Manufacturers:** In addition to the need for efforts toward environmental sustainability (i.e., reducing waste, lowering energy consumption, and offsetting carbon emissions, optimizing supply chain) manufacturers can learn to understand and respond to a rapidly changing

[1] Anthony Leiserowitz et al., "Climate Change in the American Mind, September 2021." Yale Program on Climate Change Communication. Yale University and George Mason University, (2021), https://climatecommunication.yale.edu/wp-content/uploads/2021/11/climate-change-american-mind-september-2021.pdf.

[2] Khaled Bawaneh et al., "Energy Consumption Analysis and Characterization of Healthcare Facilities in the United States." *Energies* 12, no. 19 (2019): 3775, https://doi.org/10.3390/en12193775.

environmental landscape as a result of climate change and its uncertainties, as well as address inequities among patients seeking care and treatment.

Though the severity and extent of the impacts on these stakeholders varies by geography, population demographics, and degree of preparedness, the US healthcare system may consider enacting and mobilizing robust climate action strategies.

Climate Change, Environmental Health, and Health Outcomes

Introduction

Natural fluctuation and human-induced elevation of greenhouse gas (GHG) emissions continue to contribute to rapid climate change. Atmospheric carbon dioxide (CO_2) is currently 50% higher than pre-industrial levels[3], facilitating record-breaking temperatures, significant increases in heat vulnerability, altered weather patterns, ocean acidization, and more negative effects.[4] Vulnerable populations continue to experience more harm due to a lack of preparedness (e.g., cooling mechanisms, emergency planning, urban green space) for extreme weather events such as fires, floods, storms, and other natural disasters and their aggravation of food and water insecurity. Environmental changes to air and water quality also create ripe conditions for infectious disease transmission and rising sea levels may increase the risk of water-borne pathogens, both of which are most concerning for dense populations. Degraded ecosystems and loss of biodiversity further contributes to warming by impairing the natural ability of certain ecosystems to trap carbon. The combination of extreme weather events; infectious disease transmission; and food, water, and financial insecurity threaten all of humankind and are most acutely and rapidly impacting the most vulnerable populations and ecosystems least able to cope or adapt.

The recently released sixth Intergovernmental Panel on Climate Change (IPCC) report confirmed the above adverse effects of climate change on health, all of which will worsen with each incremental rise in levels of global warming. Authors urge a 2-pronged approach involving mitigation (e.g., cutting GHG emissions) *and* adaptation (i.e., reacting to current changes and impacts), noting that adaptation efforts will be increasingly difficult to operationalize with any additional level of warming.[5]

Despite the overwhelming evidence for unprecedented, adverse environmental events in the recent decades, global forces have failed to act in a timely, effective manner to cut carbon emissions and curb global warming. Responsible for roughly 8.5% of US greenhouse gas

[3] Marina Romanello et al., "The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future." *The Lancet* 398, no. 10311 (2021): 1619-1662, https://doi.org/10.1016/S0140-6736(21)01787-6.
[4] Ibid.
[5] IPCC. "Climate change: a threat to human wellbeing and health of the planet." (2022). https://www.ipcc.ch/report/ar6/wg2/resources/press/press-release/.

emissions and the world's 7th largest producer of carbon dioxide,[6] the healthcare industry is a major contributor to environmental changes like air pollution.[7] In a recent survey comprising clinicians, clinician leaders, and executives, only 8% of respondents reported that their organizations have pledged net zero emissions.[8] Pharmaceutical companies face an even more drastic need for change; the sector emits 13% more carbon than the automotive industry despite its considerably smaller market.[9] Emission intensity continues to increase for 7 of the top 15 manufacturers that will now need to reduce carbon emissions by up to 60% to meet the 2025 US greenhouse gas reduction target announced at the 2015 Paris Agreement.[10]

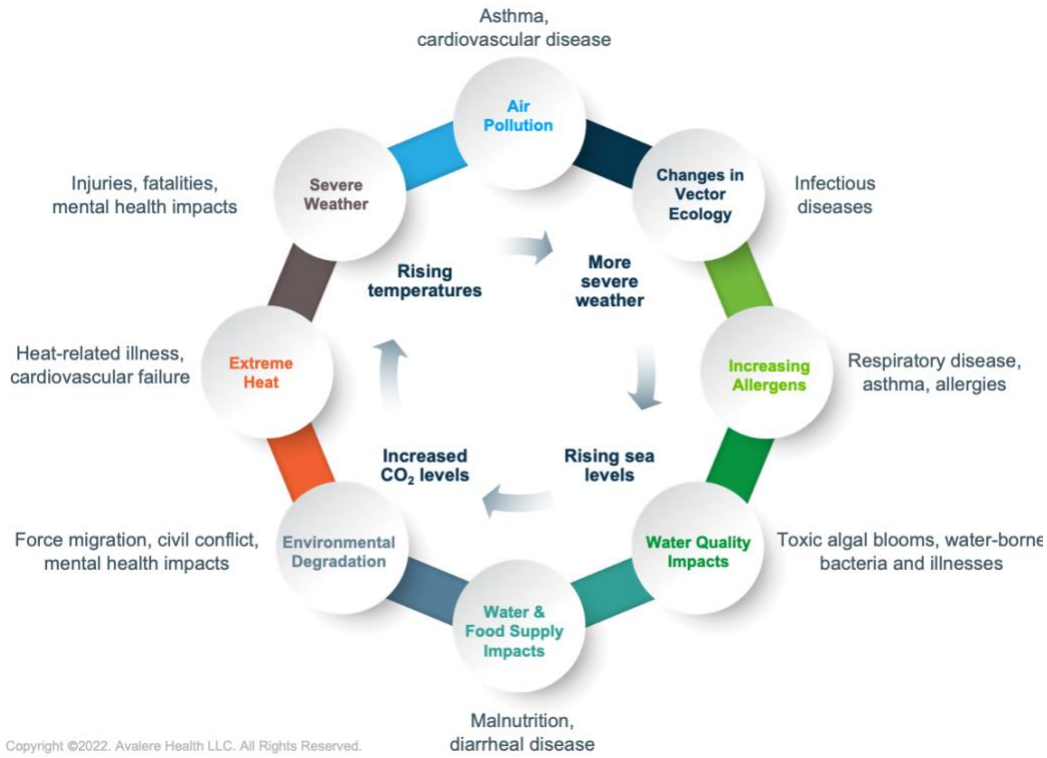
Globally, climate-related investment needs to increase to $4 trillion annually to prevent devastating effects of planetary warming.[11] Current climate financing amounts to less than $700 billion, creating significant gaps to reaching a more carbon-neutral society.[12] The public sector is responsible for almost half of this funding, while corporations and other private institutions lag behind at only $124 billion (or 17%).[13] With a myriad of opportunities to increase climate mitigation efforts (such as investing in cleaner, renewable energy or launching a carbon offsetting strategy), the value in establishing a climate strategy is clear.

Impacts of Climate Change on Human Health

Rising temperatures, more extreme weather, rising sea levels, and increased CO_2 levels harm environmental health and, in turn, impair human health and stakeholder operations throughout the healthcare system (see Figure 1). The various impacts of climate change on environmental health (e.g., water scarcity, food shortages, extreme heat) may cause human well-being to suffer, including through increased rates of both physical and mental illness.

[6] "CO2 Emissions | Global Carbon Atlas." Global Carbon Atlas. Global Carbon Project (2021), http://www.globalcarbonatlas.org/en/CO2-emissions.
[7] Matthew J. Eckelman et al., "Health Care Pollution And Public Health Damage In The United States: An Update." *Health Affairs* 39, no. 12 (2020): 2071-2079, https://doi.org/10.1377/hlthaff.2020.01247.
[8] Renee N. Salas, "The Growing Link Between Climate Change and Health." *NEJM Catalyst Innovations in Care Delivery*, 3 (2022), https://doi.org/10.1056/CAT.22.0052.
[9] Alf Goebel, "How Can the Pharmaceutical Sector Reduce Its Carbon Footprint?" iSpeak Blog. International Society for Pharmaceutical Engineering, (2021), https://ispe.org/pharmaceutical-engineering/ispeak/how-can-pharmaceutical-sector-reduce-its-carbon-footprint.
[10] Lotfi Belkhir and Ahmed Elmeligi, "Carbon footprint of the global pharmaceutical industry and relative impact of its major players." *Journal of Cleaner Production* 214 (2019): 185-194, https://doi.org/10.1016/j.jclepro.2018.11.204.
[11] "Global Landscape of Climate Finance 2021." Global Policy Initiative (2021), https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2021/.
[12] Ibid.
[13] Ibid.

Figure 1. Impact of Climate Change on Human Health



Adapted from CDC National Center for Environmental Health (March 2021)

Certain groups—especially those that are most marginalized and underserved—are more vulnerable to effects of climate change. The Environmental Protection Agency (EPA) categorizes individuals at increased risk based on their exposure (i.e., socioeconomic status, communities of color, high-risk occupations, geographic variations), sensitivity (i.e., pregnant women, children, people with pre-existing conditions), and adaptability (i.e., older adults, people with limited ability, indigenous populations).[14] According to a 2021 EPA report, people of color are the most likely among the socially vulnerable groups examined (i.e., low-income, people of color, no high school diploma, 65 and older) to live in areas projected to have the highest rates of climate-related impacts (e.g., increases in mortality, increases in childhood asthma diagnoses).[15] Another study found that people of color live in census tracts with higher heat intensity temperatures than do White individuals in almost all 175 of the most urbanized cities.[16]

A 2020 study assessing the link between redlining and extreme heat exposure found that 94% of the urban cities studied showed patterns of elevated temperatures up to 7°C in formerly

[14] "Understanding the Connections Between Climate Change and Human Health." U.S. Environmental Protection Agency, (n.d.), https://www.epa.gov/climate-indicators/understanding-connections-between-climate-change-and-human-health.
[15] "Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts." U.S. Environmental Protection Agency, EPA 430-R-21-003 (2021), http://www.epa.gov/cira/social-vulnerability-report.
[16] Angel Hsu et al., "Disproportionate exposure to urban heat island intensity across major US cities." *Nature Communications* 12, no. 2721 (2021), https://doi.org/10.1038/s41467-021-22799-5.

redlined districts compared to non-redlined districts.[17] Findings are similar for low-income individuals, demonstrating how climate change disproportionately impacts certain groups and can contribute to a widening of health inequities. Dense populations in urban cities face inadequate housing and transportation, poor sanitation and waste management, food insecurity, limited green space, concentrated heat pockets. Urban reliance on fossil fuels further drives climate change, with cities accounting for 60% of global GHG emissions.[18] Furthermore, cities with high rates of poverty, unemployment, and poor planning or disaster preparation are at highest risk for climate incidents.[19]

Climate change further affects the social determinants of health (SDOH)—including access to clean air, safe drinking water, nutritious food, healthcare services, and secure shelter—and is therefore expected to widen existing health disparities.[20] According to the EPA, one-third of Americans live in counties with air quality that does not meet national standards, the impacts of which can cost up to $6.4 billion.[21] Changes like increased frequency and severity of wildfires and droughts, prolonged pollen seasons, and more extreme hot and cold weather all increase air pollutants that can directly trigger or aggravate respiratory conditions like asthma and cardiopulmonary disease.[22] Another study found that US households using gas stoves release potent greenhouse gases (i.e., methane) that have an annual climate impact similar to that of the carbon emission from 500,000 cars. Pollutants from stoves also include nitrogen oxides, which further contribute to respiratory disease.[23] Additionally, relying on cooling systems to combat extremely high temperatures may not be feasible; despite 92% of US households having air conditioning, 20,500 heat-related deaths occurred in 2019 and contributed even further to increased energy consumption and thus carbon emissions.[24]

Nearly two-thirds of healthcare services in the US are at risk to be affected by natural disasters.[25] Therefore, such disasters may exacerbate existing disparities in accessing quality healthcare services. For instance, extreme weather threatens electrical services and causes many health facilities to rely on generators that may not be prepared to handle heatwaves or snowstorms (especially in regions unfamiliar with these new or more extreme weather patterns).[26] In February 2021, Texas faced a snowstorm that left 10 million people without power at its peak.[27] The state's electric grid was not prepared to withstand severe winter conditions, creating internal disasters in dozens of hospitals facing blackouts and water outages.[28] Healthcare facilities largely relied on generators to continue operations, emphasizing the importance of disaster preparation for human health. Other extreme events can disrupt the

[17] Jeremy S. Hoffman et al., "The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas." *Climate* 8, no. 1 (2020): 12, https://doi.org/10.3390/cli8010012.
[18] World Health Organization. "Urban health." (2022). https://www.who.int/health-topics/urban-health#tab=tab_1.
[19] IPCC, (2022).
[20] "Climate change and health." World Health Organization, (2021), https://www.who.int/en/news-room/fact-sheets/detail/climate-change-and-health.
[21] "Air Quality – National Summary." U.S. Environmental Protection Agency, (n.d.), https://www.epa.gov/air-trends/air-quality-national-summary.
[22] Gennaro D'Amato et al., "Climate change and respiratory diseases." *European Respiratory Review* 23, (2014): 161-169, https://doi.org/10.1183/09059180.00001714.
[23] Eric D. Lebel et al., "Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes." *Environ. Sci. Technol.* 56, (2022): 2529-2539, https://doi.org/10.1021/acs.est.1c04707.
[24] Romanello et al., (2021).
[25] Ibid.
[26] "Extreme Heat-NIHHIS." U.S. Climate Resilience Toolkit, (2021). https://toolkit.climate.gov/topics/human-health/extreme-heat
[27] Joshua W. Busby et al., "Cascading risks: Understanding the 2021 winter blackout in Texas." *Energy Research & Social Science* 77 (2021), https://doi.org/10.1016/j.erss.2021.102106.
[28] Ibid.

supply chain, as evidenced during Hurricane Harvey. Some hospitals reported running out of intravenous fluid in 2017 as a result of the hurricane.[29]

The cost of extreme weather events is substantial: estimates from a 10-year period (2004–2013) exceed $500 billion and between 200 and 1,200 total fatalities (depending on the event).[30] The potential costs and impacts on human health as a result of climate change shows the need to mobilize funds and efforts for not only mitigation (e.g., lowering CO_2 emissions), but also for adaptation efforts (e.g., disaster planning).

Downstream Impacts on the Healthcare Sector

Regional Variations

Impacts of climate change often differ across regions of the US, posing unique challenges to national and regional health plans and health systems.

- **Northeast:** Temperatures are likely to increase by several degrees in the Northeast and this region may experience the highest rate of ocean warming in the nation, which may increase water-borne illness in humans and animals.[31]
- **Southeast:** Night and day temperatures may increase and contribute to $47 billion in annual productivity losses. Rising sea levels are also likely to harm coastal communities (i.e., more frequent floods, land loss, damages to freshwater ecosystems, loss of infrastructure).[32]
- **Midwest:** Extreme heat may compromise crop yields and lead to potentially more temperature-related deaths than in other regions. Poor air quality partially driven by nutrient pollution in the region is also leading to harmful algal blooms that threaten freshwater in the Great Lakes.[33] Freshwater sustains daily human life in many ways (i.e., food production, manufacturing, sanitation).[34]
- **Northern Great Plains:** Arid regions may experience water scarcity as winters shorten and precipitation declines by as much as 40% in the mountains,[35] creating conditions for some insects to threaten acres of forests. Natural tree cover provides shade and carbon trapping, essential for air purification and cooling. As this region contributes greatly to our agricultural sector and is a residence for many national tribes, these climate-induced changes impact the whole nation.
- **Southern Great Plains:** In addition to an existing high frequency of extreme weather events that are likely to worsen with global warming, drought threatens the region's aquifers, and the

[29] Jonathan Bees, "How Health Care Leaders Respond to Climate Change." *NEJM Catalyst Innovations in Care Delivery* 3, (2022). doi: 10.1056/CAT.22.0062.
[30] "Extreme Events." U.S. Climate Resilience Toolkit, (2021), https://toolkit.climate.gov/topics/human-health/severe-storms-and-flooding.
[31] Richard T. Conant et al., "Northern Great Plans." *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (2018): 941-986, https://doi.org/10.7930/NCA4.2018.CH22.
[32] Ibid.
[33] Ibid.
[34] "Freshwater." Teaching Resources. National Geographic Society, (n.d.), http://www.nationalgeographic.org/education/freshwater/.
[35] Ibid.

Gulf Coast may see rising sea levels and therefore more coastal disasters and spread of infectious diseases.[36]

- **Northwest:** Increasing winter rains can create more dry conditions during the summers resulting from reduced snowmelt (because precipitation that falls as snow in the winter corresponds to the amount of snow that melts in spring and summer),[37] provoking even more forest fires and harming agricultural yields (as well as farmworker health). Extreme heat and drought further harms agricultural livelihood.
    - In June 2021, this region experienced record-high temperatures of 40°C for 13 days.[38] From June 25–30, 2021, the mean daily number of heat-related illness emergency department (ED) visits was 69 times higher than during the same time period in June 2019 and adults 75 and older were most affected (1,094 per 100,000 ED visits).[39]
- **Southwest:** More heat waves, rising sea levels, ocean acidity, severe drought, and wildfires all contribute to water scarcity and food insecurity, particularly for the indigenous populations in this region.[40]

Implications for Stakeholders

The downstream impacts of climate change on health outcomes poses a significant threat to all healthcare stakeholders. Prioritizing climate policy according to carbon reduction models can prevent over 74 million deaths in the next millennium and save $258 million in climate damages.[41] Increased negative health outcomes and poor management of health conditions as a result of worsening environmental health increases the burden on the healthcare system, increases health plan costs, and threatens to undermine the progress of life sciences interventions as a result of medication displacement and overwhelming drug demand. Disproportionate access to medications and treatment can worsen due to climate change and impact both uptake and adherence. Although some large health plans) have sustainability programs, most are focused on corporate responsibility rather than member health outcomes.

In a November 2021 survey of global healthcare professionals, 69% felt strongly that their organizations move to adopt policies and processes to lessen their impacts on climate change. Close to 70% of clinicians and roughly half of executives reported having high or moderate recognition of climate change health impacts, while half said their patients have little to no awareness. Globally, respondents also identified the top 3 impacts related to climate change as air pollution-related illness, exacerbation of existing illness, and supply chain disruption. Overall, non-US respondents reported higher use of corporate policies to mitigate climate impact than US-respondents.[42]

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[36] Conant et al., (2018).
[37] "Snow Drought." National Integrated Drought Information System, (n.d.). https://www.drought.gov/what-is-drought/snow-drought.
[38] Romanello et al., (2021); Ed Townsend and Cole Evans, "Historic Heat Wave – Early Summer 2021." *Inland Northwest Informer* 29 (2021), https://www.weather.gov/media/pdt/Vol29-2021Fall.pdf.
[39] Paul J. Schramm et al., "Heat-Related Emergency Department Visits During the Northwestern Heat Wave – United States, June 2021." *MMWR Morb Mortal Wkly Rep* 70, no. 29 (2021): 1020-1021, http://dx.doi.org/10.15585/mmwr.mm7029e1.
[40] Conant et al., (2018).
[41] R. Daniel Bressler, "The mortality cost of carbon." *Nature Communications* 12, no. 4467 (2021), https://doi.org/10.1038/s41467-021-24487-w.
[42] Salas, (2022).

According to a recent *NEJM Catalyst* report, clinicians do not typically engage patients in discussion around climate change.[43] This lack of communication impedes the richness of claims data and prevents patients from understanding the relationship between climate change and their personal health. While policymakers have a large role in addressing climate change, healthcare professionals also have an opportunity to drive action at the executive level and influence individual-level change by sharing with patients the impact on health outcomes.

The healthcare sector can use its platform and resources to align with its mission of sustaining health and serving patients. The *NEJM* report offered the healthcare sector's COVID-19 response as an example for entities in the healthcare system to take advantage of partnerships, multisector coalitions, and innovation (e.g., virtual care, renewable energy sources, supply chain redesign) to respond to a worldwide crisis such as climate change.[44] The need for real-world evidence and more widely disseminated research linking climate change and poor health outcomes is needed to drive a similarly rapid and drastic response.[45] As significant contributors to greenhouse gases that drive climate change, health systems, health plans, and manufacturers can leverage different mechanisms to mitigate harmful health impacts as well as avoid carbon taxes and fines and showcase a growing dedication to environmental justice to an increasingly concerned consumer base.[46]

Recommendations for Healthcare Stakeholders:

All healthcare stakeholders can implement pledges or develop a corporate sustainability plan to reach internal or US-set milestone targets by promoting cleaner operations and reducing environmental impacts. Many health plans, health systems, and manufacturers have already developed programs or initiatives toward climate resiliency.

A corporate sustainability plan may include the following:

- Outline actions that can improve waste reduction and reduce energy consumption (i.e., renewable energy, carbon neutrality)
- Develop sustainable supply partners
- Provide avenues for employees to adopt corporate policies at home
- Establish community partnerships to design interventions that address impacts on health and care delivery and reach those with limited healthcare access due to climate change
- Work with municipal leaders to adopt mitigation and adaptation efforts
- Share basic information and education with patients and/or providers

As described in a previous Avalere Insight on health equity, prioritizing climate action among senior leadership and developing an action plan can attract attention from other stakeholders and consumers to foster partnerships, demonstrate dedication to environmental sustainability, and establish prominence in the conversation around climate change conversation.

[43] Bees, (2022).
[44] Bees, (2022).
[45] Salas, (2022).
[46] Goebel, (2021).

Avalere has extensive experience providing technical assistance to a wide range of healthcare stakeholders and can partner with foundations and advocacy groups, providers, health plans, and manufacturers to develop and implement actionable strategies that address climate change. A list of selected opportunities is presented below:

Strategies for Foundations & Advocacy

- Host a multi-stakeholder dialogue or roundtable to brainstorm solutions that could be developed into national initiatives (e.g., Malnutrition Quality Improvement Initiative)
- Demonstrate thought leadership around the intersection between environmental issues and public health to become a trustworthy voice in the broader discussion (e.g., Robert Wood Johnson Foundation's Call For Proposals for Global Ideas for US Solutions)
- Define the problem at a community level and target adaptation plans to high-risk populations
- Conduct population-level research on the impact of climate change on health among its target population (e.g., respiratory diseases, allergens, water and food supply, housing displacement, etc.)
- Conduct a landscape assessment to identify relevant social needs (e.g., housing or food insecurity) that can be prioritized to prevent climate-related health inequities

Strategies for Providers, Hospital Systems, & Health Plans

- Collect qualitative research to compile a set of best practices and establish a learning collaborative to discuss natural disaster preparedness and potential strategies
- Conduct population-level research on the impact of climate change on health among its patient/beneficiary population (e.g., respiratory diseases, allergens, water and food supply, housing displacement, etc.)
- Design supplemental benefits that can help mitigate health impacts from climate change and related sources of pollution (e.g., home cooling devices, filtration systems, etc.)
- Collect and stratify data related to climate and related health outcomes to identify high-risk patients for these changes and develop evidence-based adaptations that target vulnerable individuals (e.g., case management, home-based care, care coordination)
- Conduct a landscape assessment to identify relevant social needs (e.g., housing or food security) that can be prioritized to prevent climate-related health inequities

Strategies for Manufacturers

- Generate stratified real-world evidence on the effects of climate change to inform a market access strategy. Data can provide insight into patient access, safety and efficacy of medications, disease management, medication adherence, healthcare utilization and costs, and factors contributing to disproportionate risk and negative health outcomes
- Map patient populations to identify those at high risk of suffering from climate-related environmental changes and understand variations in treatment patterns and health outcomes to inform effective responses that may include partnerships with public health departments or community nonprofits

- Enhance patient engagement programs to account for the disproportionate impacts of climate change on vulnerable populations (i.e., connect patients to social services)
- Review voluntary Carbon Disclosure Project (CDP) Climate Change Questionnaires and create a dashboard of sustainability actions being taken by pharmaceutical companies to manage internal environmental risks and opportunities
- Outline impact on pharmaceutical or health intervention uptake and access resulting from climate-related health inequities and develop a market strategy to address those impacts (e.g., partner with public health departments or health plans, discuss proper disposal of prescription drugs to reduce chemical pollution that may drive climate change)

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A healthcare consulting firm for more than 20 years, Avalere Health partners with leading life sciences companies, health plans, providers, and investors to bring innovative, data-driven solutions to today's most complex healthcare challenges. For more information, please contact info@avalere.com. You can also visit us at **avalere**.com.

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