

Climate Resilience for Health Care: All / Multiple Hazards



Impact of Climate-Related Hazards on Healthcare Organizations

Direct impacts to healthcare delivery from climate-related disasters and extreme weather events can include power disruptions from increased demand on energy systems as well as infrastructure damage that causes interruptions in critical utilities. Indirect impacts can include patient surges from hazard-specific and all-cause morbidity as well as disruptions to supply chains and local transportation infrastructure (that result in barriers to access the facility for both staff and patients).

When extreme weather events and climate-related disasters occur, healthcare organizations often confront multiple crises at once or in quick succession. For example, in the aftermath of Hurricane Beryl in 2024, millions of Texas residents experienced power outages – some for 10 days – while, at the same time, the region experienced an extreme heat wave. Immediately following Beryl's landfall, hospitals were unable to safely discharge patients because of widespread power outages. The number of patients with heat-related illnesses tripled compared to the previous week, and carbon monoxide poisoning cases spiked from improper use of emergency generators. In the weeks following the event, the local public health department reported an outbreak of West Nile Virus that they suspected was linked to the flooding and heat following the storm (DeGuzman, 2024 a.; DeGuzman, 2024 b.; Gill & MacDonald, 2024; Johnson, 2024; Martinez & Foxhall, 2024). Twenty-nine hospitals in the region surrounding Houston, Texas, faced patient surges for weeks after the event.

An all-hazards approach to resilience planning fosters multidisciplinary collaboration and leads to resilience strategies that can work synergistically and confer multiple benefits. Following Superstorm Sandy in 2012, surveys of affected hospitals in New York and New Jersey identified recommended best practices that can confer resilience to multiple stressors and disruptions, such as:

- Implementing redundant communication systems
- Sharing disaster plans and developing a clear, specific chain of representation for planning and operations with the inclusion of Emergency Medical Services, hospitals, emergency management, public utilities, and ancillary health services
- Planning for staff's potential need to shelter in place, making provisions for loved ones affected by damaged community infrastructure, and caring for their mental health (American College of Emergency Physicians, 2015)

Applying an all-hazards preparedness lens to campus design and construction can be more efficient and more effective than focusing on one hazard at a time. For example, increasing water and energy efficiency can reduce operating costs, which increases financial resilience as well as resilience to utility disruptions. Solar installations can also reduce operating costs, serve as a backup power source, provide shade for staff and visitors, and permit a healthcare facility to serve as a community resilience hub during periods of grid disruption. In New Orleans, CrescentCare Community Health Center's solar microgrid with a backup battery system will reduce utility expenses, help ensure the continuous provision of essential health services during and after disasters, and allow CrescentCare to serve as a Lighthouse of the Community Lighthouse Project, created by the nonprofit, Together Louisiana. A Lighthouse is a place of refuge for community residents to access essential resources, such as cooling and charging stations, food, and water (Dempsey, 2023).

Elements of a Climate-Resilient Healthcare Organization: All/Multiple Hazards

Climate resilience complements core emergency management activities. It expands vulnerability assessments to consider the implications of the changing climate – not only on a healthcare organization's physical infrastructure but also on its staff, clinical care, relationship with the community, and evolving role as a key member of the multidisciplinary emergency response network that operates during disasters to keep the community safe.

This section of the Toolkit underscores the foundational importance of an all-hazards approach to improving climate resilience and complements the Toolkit's hazard-specific sections. It includes crosscutting resilience actions that healthcare organizations can implement to build resilience to all climate change-related hazards in their region. Tools and resources that can inform the implementation of these resilience actions can be found in the Appendix.

1. Prospective Risk Assessment

Climate change is leading to changes in the incidence and severity of extreme weather events and disasters, such as heat waves, wildfires, and storms. Because historical patterns may not accurately reflect future risk, using forward-facing climate projections can help to mitigate the impacts of future climate-related events on community health and healthcare delivery.

2. Health Equity and Community Engagement

Climate change impacts vary within and among communities and regions and across the United States. As a result of racial inequality and other societal and political factors, certain groups experience more environmental exposures than others. Therefore, healthcare organizations' action plans should focus on health equity and community engagement to help providers build resilience among their most medically-fragile populations and reduce the risk of all-cause patient surges during and after climate change-related disasters.

3. Assessment and Remediation of Vulnerabilities in Infrastructure and Operations

Healthcare organizations are on the front lines when a climate-related disaster or extreme weather event takes place. Regardless of the specific climate hazard, healthcare organizations are called to staff their facilities and deliver quality medical care – for both disaster-related complaints and all-cause clinical visits.

4. Collaboration Between Healthcare Organizations

Disruption in care delivery in an outpatient facility may result in a patient surge in an acute care setting, and evacuation and transfers between facilities during and after disasters may be required. Therefore, sharing information and resources across the full range of regional healthcare providers is important for increasing resilience both at the facility level and across the regional healthcare delivery ecosystem. Collaboration between healthcare facilities to increase climate resilience can include communication and information sharing, resource coordination, plans for potential evacuation and transfers, medical staff deployment, data sharing, joint public health outreach efforts, and joint disaster preparedness drills.

5. Interdisciplinary Planning, Oversight, and Evaluation

Planning for climate resilience requires an interdisciplinary team and coordination across a range of critical functions, including administration, emergency management, clinical leadership, information technology, construction and real estate, facility operations (e.g., power, water, waste disposal, food service, custodial services, etc.), communications, transportation, and purchasing. Aligning facility operations, procurement, and capital expenditures to balance climate change mitigation goals (i.e., reducing greenhouse gas emissions) and resilience goals can help the organization chart a climate-positive and cost-neutral path toward resilience.

6. Communications and All-Hazards Approach

Climate-related disasters and extreme weather events often occur simultaneously or in quick succession, which increases the risk of multisystem failures at the community scale (such as disruptions to water and power utilities) that can cause compounding threats to healthcare infrastructure and operations and surges in healthcare demand. The effects of simultaneous or sequential climate-related hazards can be particularly prolonged and cascading for populations at disproportionate risk of health harms.

Resilience Strategies: All / Multiple Hazards



Element 1. Prospective Risk Assessment



Climate change is leading to changes in the incidence and severity of extreme weather events and disasters, such as heat waves, wildfires, and storms. The annual average number of (Consumer Price Index-adjusted) billion-dollar extreme weather events and disasters in the United States increased from 8.5 in the period of 1980–2023 to 20.4 in the period of 2019–2023. The geographic distribution of events is also changing. For example, historically-temperate regions, such as the Pacific Northwest, are increasingly experiencing extreme summer heat (Heeter et al., 2023). Because historical patterns may not accurately reflect future risk, using forward-facing climate projections can help mitigate the impacts of future

climate-related events on community health and healthcare delivery; for example, a health impact assessment of regional climate action plan strategies in Western Massachusetts combined historical baseline data with projected changes in extreme heat exposure to evaluate the potential health impacts of two interventions: (1) providing cooling centers and other protective outreach to at-risk populations, and (2) improving energy efficiency in municipal buildings (Massachusetts Department of Public Health, 2016).



Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 1: Prospective Risk Assessment](#)

Planning

ACTION: Consider both historical trends and climate projections to identify regional climate change-related hazards.

SUMMARY: As a result of the climate changing, historical trend lines are not necessarily an accurate predictor of the future. Incorporating both historical trends and climate projections when developing emergency management strategies around climate change-related hazards can thus help organizations future-proof the planning, response, and recovery process.

ACTION: Consider both historical trends and climate projections to inform an emergency preparedness plan.

SUMMARY: Integrating regional climate projections into a healthcare organization's emergency preparedness plan can help enrich understanding of how its facilities' current risk profiles are likely to change in the coming decades as a result of climate change.

ACTION: Add a prospective risk assessment and impact forecasting to the local hazard mitigation plan.

SUMMARY: It can be helpful to work with public health and local emergency management partners to add a prospective risk assessment and impact forecasting to the local hazard mitigation plan (Hess et al., 2017).

Resilience Strategies: All / Multiple Hazards



Element 2. Health Equity and Community Engagement



Climate change impacts vary within and among communities and regions and across the United States. As a result of racial inequality and other societal and political factors, certain groups experience more harmful environmental exposures than others. Blending empirical data with community members' lived experience and sense of place is crucial to ensuring that climate action is designed to reduce historic inequities in both exposure and health outcomes (Marino et al., 2023). Therefore, healthcare organizations' action plans should focus on health equity and community engagement to support at-risk populations and reduce the risk of all-cause patient surges during and after climate change-related disasters. Healthcare

organizations should also include patient and community voices as an integral part of their climate change resilience planning process so that they can tap into shared perceptions of local assets, vulnerabilities, and healthcare needs; feelings of empathy and a shared sense of care for at-risk community members; and the local knowledge, sense of place, and belief systems that are foundational to fostering a culture of resilience in the community (Imperiale & Vanclay, 2021).

The following sub-elements describe specific ways in which a healthcare organization can integrate health equity and community engagement into its hazard planning.

- 2.1. Community Input:** Frameworks, like social determinants of health (U.S. HHS, n.d.) and vulnerability assessments, can help healthcare organizations map the location of patients and community members who are at higher risk of harm from one or more climate-related hazards. It can be helpful to include community input in the vulnerability mapping exercise. Furthermore, community-based organizations are often in the best position to connect patients with local resources, such as emergency power, food distribution, housing and utility assistance.
- 2.2. Community Infrastructure:** Climate-related disasters and extreme weather events can damage buildings, transportation routes, and utility infrastructure. Healthcare organizations can enhance community resilience by supporting programs that increase redundancy in local utilities, increase adaptive capacity in home environments, and provide emergency distribution of essential goods and services.
- 2.3. Community Services:** Healthcare organizations can collaborate with community partners to (1) mitigate risk factors (such as housing or utility insecurity) for climate-related health harms, (2) coordinate emergency outreach efforts to at-risk populations, and (3) provide essential community-based services (such as emergency power and food distribution) during and after disasters.
- 2.4. Coordination with Local Office of Emergency Management:** It has become increasingly important for healthcare organizations to develop, implement, and revise their emergency preparedness plans in coordination with peer organizations, the local health department, the local office of emergency management, and the local utility to ensure that the entire emergency response network activates as a single, cohesive team when a climate change-related event occurs. The coordination process can also reveal gaps and redundancies across organizations before the event takes place, helping to prevent unintended negative outcomes. Coordination also fosters personal relationships across disciplines, which can benefit the speed and effectiveness of the emergency response.

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Element 2.1 Community Input



Frameworks, like social determinants of health (U.S. HHS, n.d.) and vulnerability assessments, can help healthcare organizations map the location of patients and community members who are at higher risk of harm from one or more climate-related hazards. It can be helpful to include community input in the vulnerability mapping exercise. Furthermore, community-based organizations are often in the best position to connect patients with local resources, such as emergency power, food distribution, housing and utility assistance.



For example, in the aftermath of Superstorm Sandy (2012), healthcare institutions partnered with the New York City Department of Health and Mental Hygiene, community-based organizations, and others to integrate empirical data with judgments informed by lived experience to develop a consensus weighting of the probability, severity, and manageability of nine hazards. The ranking survey collected 1,834 responses, including 160 responses from hospitals, 185 from nursing homes, and 72 from other types of healthcare facilities. Participating organizations have used the resulting rankings to prioritize emergency management activities and enhance regional preparedness across multiple hazards. Results from this participatory decision-making process highlighted that different stakeholder groups had different hazard management priorities. The final list synthesized high ranking strategies into a single set of priorities that represent the overall region (Ray et al., 2024).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 2.1: Community Input](#)

Planning

ACTION: Map patient populations who are sensitive to high-priority climate change-related hazards.

SUMMARY: Collaborating with community partners to map patient populations who are at high risk of negative health outcomes after short-term and/or long-term exposure to climate change-related hazards can increase organizational and community resilience by helping to ensure that protocols supporting healthcare access during and after climate change-related emergencies are tailored to those populations' needs (Patel et al., 2022).

ACTION: Use the JEDI framework to structure community input.

SUMMARY: Consider following the Justice, Equity, Diversity, and Inclusion (JEDI) framework to integrate community input into the development and operation of the healthcare

organization's climate resilience plan (American Public Health Association & CDC, 2021).

People and Operations

ACTION: Integrate community input into conversations about the implications of regional climate projections on a healthcare organization's emergency planning process, future clinical needs, and opportunities to support community resilience.

SUMMARY: Creating opportunities for community members to share their needs in the face of new and more frequent and/or extreme environmental hazards can help healthcare providers target investment in areas that will bring the greatest co-benefits to the communities they serve (American Meteorological Society, 2014).

Climate Resilience Actions, continued

ACTION: Regularly engage with community organizations in climate resilience education, communication, and integration sessions.

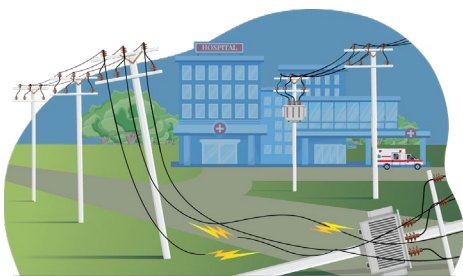
SUMMARY: Creating and maintaining regular opportunities for community organizations to facilitate a two-way

conversation between the healthcare organization and community members around climate resilience can increase the effectiveness of the organization's emergency preparedness plan when it is implemented (Day et al., n.d.).

Resilience Strategies: All / Multiple Hazards



Element 2.2 Community Infrastructure



Climate-related disasters and extreme weather events can damage buildings, transportation routes, and utility infrastructure. For example, the 2021 summer heat wave in the Pacific Northwest caused roads to buckle and public transportation infrastructure, such as streetcar cables, to be compromised (Thompson et al., 2022). Following Hurricane Ian in 2022, approximately 25% of Florida's residential customers lost power and over 90% of homes on Florida's southwest coast remained without power a week after the storm (Entress & Stevens, 2023). Healthcare organizations can enhance community resilience by supporting programs that increase redundancy in local utilities, increase adaptive capacity in home environments, and provide emergency distribution of essential goods and services.



Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 2.2: Community Infrastructure](#)

People and Operations

ACTION: Integrate regional climate projections into multiagency disaster protocols related to utilities, communications, and transportation.

SUMMARY: Collaborating with public agencies responsible for utilities, communications, and transportation is essential to ensure that healthcare services remain accessible and functional during crises (American College of Healthcare Executives, 2020; Marinucci et al., 2014).

ACTION: Support and direct patients to local programs that increase adaptive capacity in the home environment.

SUMMARY: Support and direct patients to local programs that increase the adaptive capacity of low-income residents and other high-risk groups (such as adults over 65 years of age). Examples are weatherization programs, air conditioning rebates and donations, community solar subscriptions, and utility assistance programs (e.g., Low Income Home Energy Assistance Program) (Patel, 2022).

Physical Infrastructure

ACTION: Catalyze the development of resilient infrastructure at the neighborhood and community level.

SUMMARY: As anchor institutions, healthcare campuses and public health institutions can catalyze neighborhood and community-scale efforts to increase resilience against anticipated climate change-related environmental hazards (Pastor & Morello-Frosch, 2014; Hacke & Deane, 2017).

ACTION: Enhance community resilience by remediating contaminated sites for healthcare installations.

SUMMARY: Strategically locating healthcare facilities on sites in need of environmental remediation (such as brownfields) can accelerate the clean-up process, thereby reducing the risk of community exposure to toxin-laden dust and flood waters during extreme weather events (Ballogg, 2015; ATSDR, 2021).

ACTION: Support protective measures that mitigate hazard exposure at the community level.

SUMMARY: Support protective measures that mitigate extreme hazard exposure at the community level, such as increasing trees and greenspace, expanding and improving cooling centers, and using building materials

Climate Resilience Actions, continued

that increase insulation and are more reflective of solar radiation (Casanueva, 2019).

ACTION: Work with local and regional partners to lower barriers to travel for patients and staff during climate change-related emergencies.

SUMMARY: Transportation infrastructure failures can prevent staff from reporting to work and patients from

traveling to healthcare facilities to receive needed care during natural and human-caused disasters. Healthcare organizations can support regional climate change resilience by working with local and regional partners to lower barriers to travel (WHO, 2020). For example, limited public transit service and priority access to gas stations could be offered for essential workers (U.S. HHS, 2014).

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Element 2.3 Community Services



Healthcare organizations can collaborate with community partners to (1) mitigate risk factors (such as housing or utility insecurity) for climate-related health harms, (2) coordinate emergency outreach efforts to at-risk populations, and (3) provide essential community-based services (such as emergency power and food distribution) during and after disasters.

For example, Oregon Medicaid provides air conditioners, space heaters, air purifiers, mini-fridges for medication, and battery packs for electricity-dependent durable medical equipment, such as ventilators to low-income residents who have been diagnosed with health conditions that would worsen

during an extreme heat event, air pollution event (such as wildfire), or power outage. The goal of the program is to protect 200,000 of the most at-risk residents in the state as a response to the 2021 heat dome that resulted in 102 deaths (primarily adults 65+ and low-income individuals); 60% of patients who visited the emergency department (ED) during the heat dome with a heat-related complaint reported a household income of less than \$50,000 per year. The program is similar to an effort spearheaded by integrated health system, Kaiser Permanente, during the 2021 Pacific Northwest heat wave. Kaiser Permanente estimated that it saved \$42,000 in avoided ED visits and \$400,000 in avoided hospital admissions by distributing air conditioners to 81 patients in Oregon and Washington State (Young, 2024).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 2.3: Community Infrastructure](#)

Planning

ACTION: Consider preemptive planning for patients who use electricity-dependent DME.

SUMMARY: Proactively help patients who rely on electricity-dependent durable medical equipment (DME) to ensure that they have a backup power source or another contingency plan in the event of power shutoffs during extreme weather events (Pacific ADA Center, 2017).

People and Operations

ACTION: Coordinate with community partners to create a multi-sector protocol for the delivery of mental health services during and after climate change-related emergencies.

SUMMARY: The mental health impact of climate change-related emergencies can be severe. Healthcare

organizations can help increase community resilience by supporting crisis response planning among community partners in the public and private sectors who provide mental health care for survivors of natural disasters (WHO, 2020).

ACTION: Fill gaps in local services to increase resilience, such as acting as a place of refuge during extreme weather events.

SUMMARY: Healthcare facilities equipped to continue operations during power outages can enhance local resilience by offering their facilities as refuges for community members during extreme weather events (Johns & Rosenthal, 2024; Toner et al., 2017). It is important to formalize this role with the Office of Emergency Management ahead of the event so that the facility receives extra fuel, supplies, and staff to manage non-medical emergency services (U.S. HHS, 2014).

Climate Resilience Actions, continued

ACTION: Integrate community resilience needs into healthcare organization emergency management plans.

SUMMARY: Include provisions in the healthcare organization’s emergency plan to accommodate community members who may seek to use the facility as a refuge and patients who require access to electrical power to charge their medical devices and/or refrigeration for their medications. Consider creating a registry of

patients needing this kind of assistance and setting up a two-way communications protocol (such as a Reverse 911 or wireless emergency alert system [National Academies of Sciences, 2018]) to contact them in the event of a power disruption or outage (Patel et al., 2022).

Resilience Strategies: All / Multiple Hazards



Element 2.4 Coordination with Local Office of Emergency Management



Population health emergencies linked to climate change are increasingly experienced as a rapid succession of related disasters or compound events (Ebi et al., 2021). In response, it has become increasingly important for healthcare organizations to develop, implement, and revise their emergency preparedness plans in coordination with peer organizations, the local health department, the local office of emergency management, and the local utility to ensure that the entire emergency response network activates as a single, cohesive team when a climate change-related event occurs. The coordination process can also reveal gaps and redundancies across organizations before the event takes place, helping to prevent unintended

negative outcomes. Coordination also fosters personal relationships across disciplines, which can benefit the speed and effectiveness of the emergency response.

For example, an analysis of the effectiveness of interagency coordination during the 2014 Ebola virus outbreak in the Dallas-Fort Worth, Texas, metroplex found that effective coordination across healthcare organizations, the local public health department, and the local office of emergency management required three parallel components: (1) formal mechanisms, such as the official community emergency management plan, (2) informal mechanisms, such as back-channel conversations based on previous relationships, and (3) a strong information and communications network that consistently broadcast high-quality information to partners and the general public (Soujaa et al., 2021).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 2.4: Coordination with Local Office of Emergency](#)

Planning

ACTION: Add local and regional climate change vulnerability assessments to the healthcare organization's emergency preparedness plan.

SUMMARY: Consider adding local and regional climate change vulnerability assessments to the healthcare organization's emergency preparedness plan to integrate projections of how the region's exposure to climate change-related hazards may change in coming decades compared with historical trends (Marinucci et al., 2014).

ACTION: Formalize cooperation agreements with utility providers (both power and water) to ensure that the healthcare organization's facilities are integrated into local emergency management and climate resilience planning efforts.

SUMMARY: Critical facilities, hospitals, and other healthcare building types should be fully integrated into local utilities' emergency management and climate resilience planning efforts. It is particularly important to include facility power and water needs in emergency preparedness and climate resilience planning efforts to ensure that they can continue to provide care during and after climate change-related disasters (McCabe et al., 2023; Van der Heijden, 2022).

Climate Resilience Actions, continued

ACTION: Integrate legal preparedness into the healthcare organization's emergency management and climate action plans.

SUMMARY: Uncertainty about who has the legal authority to authorize difficult decisions during disasters can slow a healthcare organization's ability to pivot from normal operations to respond to a disaster. Healthcare organizations can enhance the resilience of their emergency management and climate action plans by including parameters that clarify the conditions in which a facility may share information outside of the healthcare organization, administrators may order facility evacuations, and clinical staff from outside organizations are authorized to practice in the healthcare facility. These plans may also include a decision framework for deciding how to allocate scarce resources during utility outages (Toner et al., 2017; VanDevanter et al., 2014).

ACTION: Collaborate with local partners to coordinate climate-related disaster messaging.

SUMMARY: It can be helpful to collaborate with local public health department partners to coordinate climate-related hazard messaging with clinicians and patients, such as through prompts in the healthcare organization's electronic health record, e-newsletter, and patient texting system. This approach can increase community awareness of both the short- and long-term health risks associated with exposure to climate-related disasters (WHO, 2020)

People and Operations

ACTION: Build relationships with the local public health department, other health systems, and the wider community to facilitate coordination around climate resilience and emergency response.

SUMMARY: Setting up an institutional framework that fosters personal relationships across key agencies,

organizations, and community groups is often the first step in establishing effective communication and a shared goal around priority hazards – both related to investing in climate resilience before disaster strikes and during the emergency itself (Chi et al., 2015; Gooding et al., 2022; Nuzzo et al., 2019).

ACTION: Coordinate climate hazard-related syndromic surveillance with the local office of emergency management and the local weather station.

SUMMARY: It can be helpful to add climate hazard-related illness to your organization's syndromic surveillance reports during and immediately following designated emergencies. Aligning the organization's protocol for collecting relevant diagnostic data with the local office of emergency management and weather station's protocol for declaring a climate-related emergency will help ensure that your organizational climate resilience action plan deploys in coordination with local alerts (Hess et al., 2023).

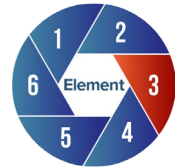
ACTION: Leverage healthcare facilities as intervention sites for local hazard action plans.

SUMMARY: Healthcare organizations often offer their locations as community intervention sites for the local hazard action plan. For example, allowing the Office of Emergency Management to use strategically located hospitals, medical office buildings, and clinics as distribution sites for water bottles, food, etc., can increase community access to health-promoting supplies. Officially designating publicly available spaces in healthcare facilities – such as the cafeteria – as resilience hubs or temporary shelters during climate-related events can help support patients and family members as well as raise awareness in the community that climate-related events are public health emergencies (Hess et al., 2023; IOM, 2012).

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Element 3. Assessment and Remediation of Vulnerabilities in Infrastructure and Operations



Healthcare organizations are on the front lines when a climate-related disaster or extreme weather event takes place. Regardless of the specific climate hazard, healthcare organizations are called to staff their facilities and deliver quality medical care – for both disaster-related complaints and all-cause clinical visits. As a result, many of the actions that healthcare organizations can take to enhance their climate change resilience improve the efficiency, flexibility, and redundancy of their facility infrastructure and operations (Ebi et al., 2021).

Taking an all-hazards approach to climate-resilient facilities often involves selecting the set of design and operations strategies that bring the greatest co-benefits to both climate change mitigation (i.e., reducing greenhouse gas emissions through efficiencies and generating on-site renewable power) and resilience. Many strategies serve both purposes. For example, a healthcare facility that is at risk of extreme heat, flooding, and hurricanes can enhance resilience to all three hazards by minimizing its use of electricity from the central grid (through efficiencies and renewable energy), reducing flood and heat exposure (by maximizing vegetation at the ground and roof level), and placing critical building and medical equipment in locations that are protected from heat, water, and wind. Many of these strategies would also reduce the facility's greenhouse gas emissions. Recognizing the strong synergies linking climate change mitigation and resilience building design strategies, several federal programs encourage capital investments that both reduce a healthcare facility's carbon footprint and also increase its resilience to power outages. For example, CMS has issued a categorical waiver allowing healthcare facilities to supply emergency power from a clean-energy-powered microgrid rather than a fossil fuel-powered generator (CMS, 2023).

Similarly, research shows that staffing, clinical, and supply chain protocols aimed at increasing the healthcare organization's resilience to climate change benefit from taking an all-hazards approach because the fundamental approach remains constant even when the details change from one hazard to the next. For example, the major outline of protocols that govern which staff will work during a disaster, staff accommodations at the facility, staff's family members and pet accommodations, and plans for emergency communications and transport remain the same regardless of whether the disaster is a hurricane, flood, winter weather event, or inland storm (Nuzzo et al., 2019).

The following sub-elements describe specific ways in which a healthcare organization can enhance its facility infrastructure and operations' climate resilience.

3.1. Staff Support: Healthcare organizations depend on dedicated clinicians, administrators, and facilities and operations staff to deliver care. Staff and their families are often impacted by the same climate change-related hazards as the facilities in which they work. Integrating staff protections and accommodations into healthcare emergency planning can mitigate logistical challenges (such as disruption of transportation routes) that can make it difficult for staff to get to work. These measures can also reduce mental strain caused by worrying about loved ones at home, allowing staff to focus on providing essential patient care.

3.2. Clinical Considerations: Climate change health impacts can be grouped into short-term and long-term effects. Short-term effects include acute impacts of extreme weather events and disasters, whereas long-term effects can result from air pollution, changing patterns of infectious diseases, altered food systems, and harms to mental and behavioral health. Climate resilience planning in health care includes both (1) anticipating potential patient surges

during and after acute events, and (2) implementing preventative clinical and community health interventions that can mitigate risk factors for climate change-related health harms prior to the event.

3.3. Building and Campus – Design & Construction: While building codes require structural redundancies that harden buildings against potential environmental hazards, future-proofing healthcare facilities in the setting of evolving and cascading climate-related hazards requires incorporation of forward-facing risk assessment in campus design, construction, and renovation. Climate-resilient healthcare facilities maximize energy efficiency, use diverse energy sources and on-site energy storage, protect critical operating systems, and incorporate landscaping and indoor environmental quality measures that mitigate risk from climate-related events, such as extreme temperature and precipitation.

3.4. Building and Campus – Facility Operations: Facility operations are essential to building a healthcare organization's resilience to any and all climate change-related hazards. Many clinical procedures depend on ready and consistent access to electricity, water, temperature control, and oxygen – as do many infection control protocols. Building equipment, like air conditioning and heating systems, and medical equipment, like X-rays and sterilizers, use large quantities of energy and water to function.

Given healthcare facilities' dependence on active systems to provide clinical care, operational resilience is at the center of all climate change resilience conversations.

3.5. Supply Chain: Climate-related disasters and extreme weather events can affect the production of critical supplies and can damage transportation infrastructure, resulting in disruptions to commercial shipping routes. Furthermore, equipment failure can jeopardize the safety of many items in a healthcare organization's supply chain – both clinical and non-clinical – that require refrigeration. Healthcare organizations can enhance their resilience by assessing supply chain vulnerabilities, for contingencies that can be implemented in the event of regional transportation or production disruptions.

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Element 3.1 Staff Support



Healthcare organizations depend on dedicated clinicians, administrators, and facilities and operations staff to deliver care. Staff and their families are often impacted by the same climate change-related hazards as the facilities in which they work. Integrating staff protections and accommodations into healthcare emergency planning can mitigate logistical challenges (such as disruption of transportation routes) that can make it difficult for staff to get to work. These measures can also reduce mental strain caused by worrying about loved ones at home, allowing staff to focus on providing essential patient care.



A survey after Hurricane Katrina in 2005 found that 80% of public hospitals set up sleeping areas for staff during disasters, 73% include childcare and food provisions for staff's children, 37% include provisions for elderly relatives under staff's care, and 23% include pet care. The same survey reflected strong interest (over 90%) in reducing the pressure on regular medical staff during disasters by credentialing "volunteer health professionals" as a supplemental workforce during disaster events; 85% of respondents plan to credential outside physicians, 78% plan to credential nurses, and 68% plan to credential pharmacists to work in their facilities during emergencies (National Association of Public Hospitals and Health Systems, 2007).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 3.1: Staff Support](#)

Planning

ACTION: Set staff expectations for their role during climate-related extreme weather events.

SUMMARY: Clearly define expectations with healthcare facility staff related to working during extreme weather events – particularly under circumstances that lead to power disruptions or outages, and those that may require staff to remain at work for extended periods. Share with staff a list of personal items they should bring with them to an anticipated multi-day response effort, such as food, water, personal medication, hand sanitizer, extra clothes, and sleeping gear. Co-create policies and programs with staff establishing a flexible and supportive approach to staffing, accommodations, and transportation during and after disasters. For example, it may be necessary to shorten staff shifts during emergency operations to give staff the ability to rest mentally and physically. Include daycare, shelter, and other accommodations for staff family members, as needed (Danna et al., 2010; Toner et al., 2017; WHO, 2020).

ACTION: Train staff in all types of healthcare facilities (including community-based outpatient clinics) in disaster management.

SUMMARY: Training clinical healthcare staff in emergency preparedness can increase their ability to work with in-house emergency preparedness teams and external partners to effectively respond to climate change-related disasters. Relevant training topics may include education about how to prepare the facility to continue operations during a disaster; clinical skills specific to high-risk climate change-related events; training in relevant medical equipment, building equipment, and telecommunications equipment that may be needed during a utility outage; standard operating procedures for different disasters; clear roles and responsibilities; and training in how to work as a group during disaster scenarios (Hilton et al., 2015).

Climate Resilience Actions

ACTION: Train clinical staff in alternative procedures for delivering care during disasters.

SUMMARY: Healthcare organizations can support staff in preparing for disaster response by offering training in alternative procedures for intake and triage if inpatients are transferred from other facilities without their medical records, as well as training in alternative procedures for delivering care in situations with limited access to electricity and water, such as manually counting intravenous pump drips, manually suctioning intubated patients, and manually taking blood pressure readings (U.S. HHS, 2014).

People and Operations

ACTION: Integrate regular emergency preparedness employee training into the healthcare organization's continuing education program.

SUMMARY: Implementing a regular emergency preparedness employee training program can increase awareness of climate change-related risks to the healthcare organization, as well as protocols and procedures designed to enhance resilience in the face of increasingly frequent and severe climate change-related events (Hilton, 2015; WHO, 2020). Include training on how key staff roles will be assigned during emergencies, and consider developing checklists for each department that break down key tasks according to when they should occur – pre-event, during response, and post-event (U.S. HHS, 2014).

ACTION: Provide alternative transportation and housing for healthcare staff during extreme weather events and disasters.

SUMMARY: Consider establishing agreements with nearby transportation providers and temporary housing facilities (such as hotels) to support employees and their immediate families (including pets) in the event that transportation pathways and/or utilities are disrupted during an extreme climate change-related disaster. This may also involve preparing for staff to stay at healthcare facilities before the extreme weather event begins to mitigate potential transportation interruptions (Morris et al., 2016; WHO, 2020).

ACTION: During transportation disruptions, coordinate across the healthcare system to redistribute staff to facilities they can access – even if they are not at their “home” facility.

SUMMARY: It may be necessary immediately following climate change-related events that damage infrastructure – such as hurricanes, severe inland storms, and floods – to temporarily redistribute the healthcare system's staff to facilities they can access (Morris et al., 2016). Establish a tracking system so that staff can report to supervisors who are physically located in different facilities (Wyte-Lake et al., 2018). Cross-training staff so that they can fulfill multiple roles can benefit the overall healthcare system by ensuring essential clinical services are offered by a mixture of permanent and temporary staff (Hilton et al., 2015).

ACTION: Ensure that staff who are supporting a disaster effort have access to clothing, a place to sleep, routine medications, and wellness services.

SUMMARY: Given the often-rapid evolution of many climate change-related disasters and their impacts on community infrastructure, staff may be required to stay at their place of work for more than 24 hours without access to basic necessities, such as a change of clothes and daily medications. Healthcare organizations can increase the resilience of their clinical services by ensuring that staff have access to clothing, a place to sleep, routine medications, and wellness services while they support patients in the midst of a disaster (Evans, 2017; Hilton et al., 2015; Morris et al., 2016; Toner et al., 2017).

ACTION: Establish a culture that acknowledges the personal challenges staff are facing during a disaster.

SUMMARY: Acknowledging the personal challenges faced by staff during a climate change-related disaster can increase a healthcare facility's resilience by increasing the willingness of staff who are able to report to work. It also creates space for staff to request tangible assistance (such as a hotel room or childcare) that would make it possible for them to support the disaster response (Morris et al., 2016; Toner et al., 2017).

ACTION: Provide staff support post-disaster.

SUMMARY: Creating a post-disaster employee assistance program for staff and their families in the aftermath of a climate change-related event – including mental health services – can help them build the long-term physical, mental, and social resilience that will be needed to respond to the next disaster (Dana et al.,

Climate Resilience Actions, continued

2010; WHO, 2020). Immediate support for staff who have experienced a major loss (such as their home) can also increase their ability and willingness to return to work after the event (Morris et al., 2016).

Physical Infrastructure

ACTION: Establish alternative communications channels for contacting staff during utility outages.

SUMMARY: Staffing during and immediately following climate change-related disasters that cause utility outages

can be complicated by disruptions to telecommunications infrastructure. Establishing alternative communications channels (such as multiple cell phone providers, satellite phones, walkie-talkies, and installing a generator-powered cell tower on the roof of the facility) can increase a healthcare organization’s resilience to these events by making it possible to share important information with staff – such as facility closures and requests that staff report to the facility closest to their home (U.S. HHS, 2014; Morris et al., 2016; Wyte-Lake et al., 2018).

Resilience Strategies: All / Multiple Hazards



Element 3.2 Clinical Considerations



Climate change health impacts can be grouped into short-term and long-term effects. Short-term effects include acute impacts of extreme weather events and disasters, whereas long-term effects include air pollution, changing patterns of infectious diseases, altered food systems, and mental and behavioral health. Climate resilience planning in health care includes both anticipating potential patient surges during and after acute events and implementing preventative clinical and community health interventions that can mitigate risk factors for climate change-related health harms prior to the event.



Examples of clinical improvements that can help healthcare organizations prepare for compound and cascading climate change-related events include programming the electronic health records system to flag heat-sensitive medications during heat events and power outages, stocking up on respiratory medications in preparation for poor air quality events, and making mental health services available to both patients and staff during and after disasters (Sorensen et al., 2020). Social work and social determinants of health programs are well-positioned to connect at-risk patients to related behavioral interventions, such as community air conditioning distribution programs, home environmental health programs, and education about ways to reduce their risk of exposure to environmental hazards and infectious disease pathogens (Sorensen et al., 2020). Participating in the development of a crisis standard of care can further guide clinical decisions during patient surges, shortages in supplies, and/or disrupted access to utilities during and following disasters.

From 2012–2014, the State of Maryland used a deliberative democracy approach (e.g., engaging with healthcare providers and the general public) to develop a consensus crisis standard of care for the state that reflected local values. The framework was revised and expanded during the COVID-19 pandemic to reduce the cognitive burden on triage clinicians in determining where to allocate scarce resources in the face of an extended patient surge (Biddison et al., 2019; Ehrmann et al., 2021).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 3.2: Clinical Considerations](#)

Planning

ACTION: Integrate epidemiological and meteorological data into climate-related hazard preparedness.

SUMMARY: Consider combining local epidemiological and meteorological data with downscaled climate models for your region to estimate the increase in patient volume (and corollary staff and medical supplies) that might be expected for different levels and durations of extreme heat events (Patel et al., 2022).

ACTION: Enhance syndromic surveillance during climate-related hazard events.

SUMMARY: Consider enhancing the healthcare system's syndromic surveillance during climate-related hazard events by submitting hazard-related illness data to the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (Burkom et al., 2021). Work with local public health partners to interpret and act on real-time hazard-related illness and all-cause morbidity and mortality data during and immediately following extreme weather events.

Climate Resilience Actions, continued

ACTION: Develop a continuity of care plan listing essential clinical services that will be provided at different tiers of utility disruption.

SUMMARY: Many healthcare facilities are designed to function at full or partial capacity under a variety of environmental stressors. Organizations can increase resilience to climate change-related events by creating and training staff to implement a continuity of care plan outlining essential clinical services that will be provided at different tiers of utility disruption (Toner et al., 2017).

People and Operations

ACTION: Adjust normal procedures and standards of care ahead of forecasted climate change-related events to extend the amount of time existing patients can go without routine treatment.

SUMMARY: Consider establishing protocols triggering an adjustment to the healthcare organization's clinical procedures (e.g., in pharmacy, drug treatment, dialysis, etc.) ahead of forecasted climate change-related events to extend the amount of time existing patients can go without routine treatment. When possible, expedite inpatient discharge to free up bed space ahead of expected patient surges during and immediately following the event (Scott, 2017; Toner et al., 2017).

ACTION: Develop a plan for patient surges and train staff in its implementation, including scenarios for accommodating cascading and simultaneous climate change-related disasters.

SUMMARY: Many climate change-related events occur simultaneously or in quick succession. For example, hurricanes often occur during heat waves. Wildfires, drought, flooding, and landslides often trigger or exacerbate each other. It is, therefore, increasingly important to develop a plan for patient surges and train staff in its implementation. Include procedures for bringing in temporary staff, adapting clinician services to

fast-changing conditions, and altering the schedule for routine operating procedures to free up space and staff to provide emergency care (Toner et al., 2017).

ACTION: Co-locate critically ill and fragile patients on the same floor of the facility as the emergency command center to maximize staff communication and patient safety.

SUMMARY: Identify the safest floors of the healthcare facility when exposed to different types of climate change-related events. Consider co-locating the most critically ill and fragile patients on those floors alongside the emergency command center to expedite communication between leadership and staff to maximize patient safety (U.S. HHS, 2014).

ACTION: If it is necessary to evacuate patients during a disaster, consider sending nurses, nursing assistants, and leadership staff with them to ensure continuity of care.

SUMMARY: Hospitals that evacuated patients alongside care staff and their leadership team during Superstorm Sandy (2012) reported lower rates of anxiety about the evacuation among patients and their families (U.S. HHS, 2014).

Physical Infrastructure

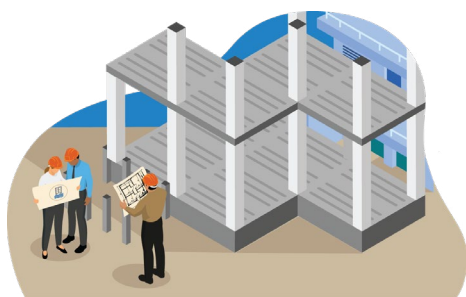
ACTION: Deploy mobile health units to take medical care to high-risk patients in the community during transportation disruptions.

SUMMARY: Consider including in the healthcare organization's list of emergency response assets mobile units that are used to deliver routine care to community members. Use the organization's map of high-risk patients – such as patients who need dialysis or those with a substance use disorder, diabetes, or heart disease – to prioritize the provision of medical care during transportation disruptions caused by a climate change-related event (Toner et al., 2017).

Resilience Strategies: All / Multiple Hazards



Element 3.3 Building and Campus: Design & Construction



While building codes require structural redundancies that harden buildings against potential environmental hazards, future-proofing healthcare facilities in the setting of evolving and cascading climate-related hazards requires incorporation of forward-facing risk assessment in campus design, construction, and renovation. Climate-resilient healthcare facilities maximize energy efficiency, use diverse energy sources and on-site energy storage, protect critical operating systems, and incorporate landscaping and indoor environmental quality measures that mitigate risk from climate-related events, such as extreme temperature and precipitation.



A survey of public hospitals after Hurricane Katrina in 2005 found that 73% plan to convert non-clinical areas of the hospital into patient areas during disaster-related patient surges; 66% have also put in place plans to expand their footprint into the community during disasters by delivering care at alternative care sites, such as at schools and religious institutions. Over 60% of respondents have established a staffing plan and supply cache for alternative care sites – often in coordination with local partners (National Association of Public Hospitals and Health Systems, 2007).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:
[Element 3.3: Building and Campus: Design & Construction](#)

Planning

ACTION: Use regional climate models to future-proof the efficiency and redundancy of building systems in the face of projected increases in the frequency and severity of climate change-related hazards.

SUMMARY: Building codes and engineering best practice guides use historical weather trends to set guidelines for the overall capacity of building systems, the maximum temperature at which they will function, and expectations for “average” temperature and rainfall. Climate models indicate that using historical trends to set the outer limits of building system functionality will likely fall short of operational needs within a few decades. It is therefore advisable for healthcare facilities (many of which are designed to function for 50 or more years) to maximize energy efficiency and identify opportunities for diversifying their energy supply (such as installing renewable power microgrids for backup power) in order to extend the functional life of the building as long as possible within the context of a rapidly changing climate (Casanueva et al., 2019).

People and Operations

ACTION: Work with consultants who are familiar with climate-resilient design and construction techniques.

SUMMARY: Working with architects, engineers, owner’s representatives, and general contractors who are knowledgeable about the different design strategies, building technologies, and materials required to build and operate a climate-resilient healthcare facility is often key to integrating climate resilience planning into a new building, renovation project, or facility upgrade (Darko & Chan, 2017).

Physical Infrastructure

Structure and Landscaping

ACTION: Design new buildings and reinforce existing structures to withstand future climate change-related exposures as described in the healthcare organization’s prospective risk assessment (Element 1).

SUMMARY: Many building codes rely on historical data

Climate Resilience Actions, continued

to set structural requirements for withstanding climate change-related hazards like wind, flooding, fire, heat, and landslides. Healthcare organizations can reduce the risk of a major disaster causing sufficient physical damage that shuts down operations by designing and renovating facilities to withstand future climate change-related exposures as described in their prospective risk assessment (Element 1) (U.S. HHS, 2014).

ACTION: Design facilities to promote both environmental sustainability and resilience.

SUMMARY: Many green and healthy design strategies bring multiple co-benefits to healthcare facilities, such as reducing utility costs, reducing their contribution to climate-warming fossil fuel emissions, enhancing their resilience to climate change-related events, demonstrating the organization's commitment to environmental stewardship, and promoting the health and well-being of patients and staff (WHO, 2020).

ACTION: Provide and maintain safe, shaded pathways between the property line or patient drop-off point and the facility entrance for multiple modes of transportation.

SUMMARY: Providing shaded pathways linking the facility's main entrance with transit stops, parking, and other access points can increase the safety and effectiveness of multimodal evacuation plans when they are deployed during a climate change-related event (Basu et al., 2022).

Energy Efficiency and Renewable Energy

ACTION: Establish a net-zero requirement for all new buildings and major renovations in the healthcare system.

SUMMARY: Net-zero facilities are designed with enough energy efficiency measures (e.g., enhanced building and wall insulation, efficient building and mechanical equipment, and efficient lighting systems) to reduce their energy demand to a level where they can generate sufficient electricity using on-site renewable power (e.g., solar, wind, geothermal). These facilities can continue to provide clinical care during to climate change-related events that disrupt regional power grids.

ACTION: Use building design strategies, like insulation and shading devices, to maintain safe temperatures inside the healthcare facility during extreme heat and cold events.

SUMMARY: Design strategies to improve the efficiency of the building envelope can reduce the risks of extreme temperature, decrease heating and cooling demand, and

extend the length of time the facility can function on backup power systems. For example, buildings in warm climates in the Northern Hemisphere should install white or garden roofs and minimize unprotected windows on the south and west side of the building to reduce the amount of solar radiation entering the building. Overhangs on the south and vertical screens (including plants) on the east and west side of the building can reduce exposure to both heat and glare. Installing high performance windows (e.g., with two or three sheets of glass and solar film) and highly insulated wall and roof construction (e.g., R-30 or higher in many climates) also reduces the transfer of heat or cold into the building. Installing windows that open in low acuity areas of the facility can help maintain safe temperatures during power outages (Sun et al., 2020).

ACTION: Install energy efficient building equipment to extend the length of time the facility can function on backup power systems.

SUMMARY: Installing energy efficient building equipment (such as air conditioning, heating, ventilation, and lighting systems) can reduce demand for air conditioning and heating and extend the length of time during which the facility can function on backup power systems (Carvallo et al., 2022).

ACTION: Incorporate renewable power generation infrastructure in the design of new facilities and major renovations.

SUMMARY: Many healthcare facilities are designed to operate for 50 or more years. It is, therefore, particularly important to build today's facilities to accommodate future retrofits, such as solar arrays, all-electric building systems, battery storage, geothermal heat pumps, and parking garages dominated by electric vehicles. All of these strategies serve dual purposes. They both reduce greenhouse gas emissions and increase the facility's resilience to climate change-related disasters and extreme weather events (Lazo et al., 2023).

ACTION: Increase resilience to power outages by installing cogeneration facilities on-site or in the medical district.

SUMMARY: Investing in an on-site or district-wide cogeneration plant connected to secure power sources, such as geothermal, and to on-site power storage capacity can reduce a healthcare facility's reliance on external power sources needed to maintain continuity of care (Isa et al., 2018).

Climate Resilience Actions, continued

Water Efficiency and Flood Resilience

ACTION: Maximize water efficiency to reduce demand during low water pressure and boil water notice events.

SUMMARY: Water is critical to the functioning of healthcare facilities – both clinical and building systems. To maximize the availability of potable water for clinical uses, consider minimizing once-through use in process equipment – such as the heating, ventilation, and air conditioning (HVAC) system, sterilizers, and medical equipment. Further, consider installing low-flow toilets, urinals, handwash stations, and showers – except where volume is needed for occupational uses (such as water filling stations and decontamination showers) (Van der Heijden, 2022; WHO, 2015).

ACTION: Separate potable and process water systems from each other and source an emergency water supply to maintain water pressure during water outages.

SUMMARY: Water pressure can drop in a community during extreme weather events (e.g., extreme heat, extreme cold, and drought) or as a result of infrastructure failures caused by hazards like hurricanes and tornadoes. Healthcare facilities should be designed to operate using on-site water supplies for at least 72 hours. Facilities located in high-risk areas can increase resilience by identifying supplementary water sources (such as connections to allow temporary water supply from trucks or other sources, permanent storage tanks/cisterns, and wells) that can be used to maintain water pressure during low pressure events. Facilities with the ability to separate process water systems from potable water systems are particularly resilient to water outages (Healthcare Environmental Resource Center, 2015; Van der Heijden, 2022; WHO, 2015).

ACTION: Protect the permanent and emergency water supply from extreme weather and contamination from flood waters.

SUMMARY: Weatherize water supply pipes, cisterns, and tanks to prevent breakages in extreme cold weather. Place emergency water storage (such as tanks and cisterns) outside of areas at risk of flooding or landslides. Install float valves and overflow outlets that drain away from the facility to avoid flooding interior spaces after a cistern or tank fills up. Install one or more supplementary water pumps (depending on need) and connect them to the emergency power supply to keep water pressure at safe levels when the power goes out (Van der Heijden, 2022; WHO, 2015).

ACTION: Install backflow prevention valves to prevent sanitary sewage from backing up into the hospital during flood events.

SUMMARY: Healthcare facilities located in communities with combined sanitary and storm sewers may experience sewage backup during extreme flood events. Facilities can enhance resilience by installing backflow prevention valves and capping drains on lower floors during flooding events (Van der Heijden, 2022; WHO, 2015).

Thermal Comfort and Indoor Air Quality

ACTION: Install operable windows with screens in non-clinical spaces to increase the healthcare facility's resilience during power outages.

SUMMARY: Installing operable windows with screens can extend the period of time a healthcare facility can function during a power outage by reducing reliance on the air conditioning system for cooling and ventilation (Sun et al., 2020).

ACTION: Install high-efficiency air filtration systems to reduce the concentration of pollutants in indoor air.

SUMMARY: Installing highly efficient air filtration systems (e.g., MERV 13) coupled with increasing the volume of outdoor air introduced to the building can reduce the concentration of a range of airborne contaminants, including airborne pathogens; particulate matter; cleaning and disinfection chemicals; and toxins emitted from furniture, architectural finishes, and composite wood products, like plywood (Mousavi et al., 2020).

Resilient Critical Operating Systems

ACTION: Install redundant communication systems for use during power and communications outages.

SUMMARY: Extreme weather events can disrupt electricity supply, cell towers, radio transformers, and other community communications networks. Healthcare organizations can reduce the risk of disruption in communications to other facilities in their network, regional healthcare organizations, and local emergency management agencies by installing and maintaining redundant communication systems, such as analog phones, fax machines, handheld two-way radios, ham radios, and solar-powered devices (Hedges et al., 2018).

Resilience Strategies: All / Multiple Hazards



Element 3.4 Building and Campus: Facility Operations



Facility operations are essential to building a healthcare organization's resilience to any and all climate change-related hazards. Many clinical procedures depend on ready and consistent access to electricity, water, temperature control, and oxygen – as do many infection control protocols. Building equipment, like air conditioning and heating systems, and medical equipment, like X-rays and sterilizers, use large quantities of energy and water to function. The healthcare sector is the second most energy-intensive commercial building type in the United States (EIA, 2022).

Given healthcare facilities' dependence on active systems to provide clinical care, operational resilience is at the center of all climate change resilience conversations. Many resilience strategies can be deployed across multiple climate change-related hazards. For example, facility operations strategies that increase resilience to power outages are protective in the face of climate-change related hazards that result in power outages, such as extreme heat, hurricanes, flooding events, landslides, inland storms, and wildfires. A post-disaster assessment of a nursing home in Florida where 12 residents succumbed to heat-related illness after a power outage caused by Hurricane Irma in 2017 found that a combination of nonmechanical facility operations strategies (such as opening windows and doors to enhance natural ventilation) and mechanical interventions (such as installing and maintaining on-site power generators and thermal storage) would have reduced the risk of loss of life during the combined hurricane and extreme heat event (Fritz, 2017; Sun et al., 2020).

An all-hazards approach to climate-resilient facility operations begins by considering how the building design (Element 3.3) can be enhanced to reduce energy and water demand. Building design enhancement involves strategies such as increasing wall and roof insulation, installing white or garden roofs, and shading the building (particularly windows) from the outside by either using shade structures or vegetation. The organization's prospective risk assessment (Element 1) can then be used as a guide for prioritizing operational strategies with the greatest number of co-benefits in the face of projected climate change-related hazards.

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 3.4: Building and Campus: Facility Operations](#)

Planning

ACTION: Integrate pre-event resilience measures into healthcare facility operations preventive maintenance and emergency management plans.

SUMMARY: Pre-event resilience measures in healthcare facilities include maintaining building systems to maximize energy efficiency and enhance ventilation, diversifying the energy supply (such as installing renewable power and battery storage for backup power), increasing insulation and solar reflection for the facility

walls and roof, installing shading devices to minimize heat exposure inside the building, and performing routine maintenance to seal cracks and fix plumbing leaks (Casanueva et al., 2019).

ACTION: Categorize electricity loads by their contribution to critical operations.

SUMMARY: Healthcare facilities can increase resilience to power outages by creating a load-shedding protocol that powers down building systems based on their level of importance to clinical care. Consider cross-referencing the protocol with stages of evacuation preparation so that

Climate Resilience Actions, continued

patient transfers to partner facilities take place before conditions (such as extreme temperatures, exposure to flood waters, etc.) reach dangerous levels (FEMA & ASPR, 2019).

ACTION: Perform a baseline analysis of water usage and categorize usage types into tiers of critical need.

SUMMARY: Water is a critical component of clinical care, including sanitizing medical equipment. Performing a baseline analysis of the healthcare facility's water usage and categorizing usage types into tiers of critical need can help facility managers direct potable water supply to the most important clinical needs during low water pressure and boil water notices while also reducing overall facility water usage (WHO, 2015; Van der Heijden, 2022).

ACTION: For climate change-related hazards that could result in widespread damage to utilities and community infrastructure, include security considerations in the healthcare facility's emergency preparedness plan.

SUMMARY: Extreme weather events that cause widespread damage to utilities and community infrastructure can result in a temporary need for increased security at a healthcare facility, particularly if it experiences a patient surge and/or acts as a place of respite for community members (Danna et al., 2010).

People and Operations

ACTION: Implement a preventive maintenance program to ensure that energy efficient building systems function as designed.

SUMMARY: All building systems require regular maintenance. Preventive maintenance, an approach to regularly inspecting and tuning equipment, is particularly important for facilities that are designed to continue operations during utility outages. These programs ensure that the energy and water demands remain at levels that can be met by on-site sources, such as renewable power and recycled process water (Kolokotsa et al., 2012).

ACTION: Conduct regular tests of emergency generators, water supplies, and transportation plans to ensure that they are ready to deploy in the event of an emergency.

SUMMARY: It can be difficult to source fuel, water trucks, and emergency transportation contractors in the immediate run-up to a climate change-related event. Healthcare organizations can check the status of their resilience to the first 72 hours of anticipated climate change-related events by performing regular tests and maintenance on emergency generators and on-site

sources of emergency water. It can also be helpful to perform regular drills with outside contractors who will be responsible for supplying more fuel, trucked-in water, emergency transportation for staff and patients, and other activities included in the facility's emergency operations plan (U.S. HHS, 2014).

ACTION: Conduct regular stress tests of the healthcare facility's ability to continue providing clinical care during extreme weather events.

SUMMARY: Consider performing regular stress tests of the healthcare facility's ability to continue providing clinical care during extreme weather events. Incorporate scenarios that involve power outages, low water pressure, a surge of patients experiencing hazard-related illness, a surge of all-cause complaints, and a surge of community members seeking to use the facility as a resilience hub and safe place to charge electrical devices (including medical equipment). Stress tests can help identify critical systems (such as vacuum suction systems and electricity-dependent medication delivery systems) whose failure would result in cascading effects across the facility and impact delivery of critical care (Ebi et al., 2018).

Physical Infrastructure

ACTION: Operate net-zero healthcare facilities to increase resilience to temperature extremes and power outages.

SUMMARY: Net-zero facilities are able to continue operating during brownouts and blackouts because they are both highly efficient and produce renewable energy on-site. As a result, they are more resilient than conventional buildings to climate change-related hazards that cause utility disruptions (Lakatos et al., 2023).

ACTION: Conduct regular walk-throughs of the healthcare facility to confirm compliance with fire safety and evacuation signage requirements.

SUMMARY: Facility evacuation can be impeded if exits are obstructed, signage is missing or confusing, or life safety equipment, like sprinklers and fire extinguishers, is missing or broken. Conducting regular walk-throughs of the healthcare facility to confirm that these essential emergency preparedness components are in place and in working order could be seen as a first level of resilience to any climate change-related hazard that might damage the building structure or result in an eventual evacuation (U.S. HHS, 2014).

Climate Resilience Actions, continued

ACTION: Generate renewable energy on the healthcare campus.

SUMMARY: Producing electricity on-site using renewable energy sources, such as solar and geothermal, coupled with storage capacity (e.g., batteries) can reduce reliance on external sources for electricity needed to maintain continuity of care (Lazo et al., 2023).

ACTION: Prior to an anticipated disaster, walk through the facility to identify locations that might require repair during and immediately following the event and stage the necessary materials and equipment (including pumps) nearby.

SUMMARY: Certain locations in and around the healthcare facility – such as the roof, windows, and

lower floors – are more vulnerable to damage from wind, flooding, heat, fire, and external soil and water pressure. Healthcare organizations can reduce the risk of disruption to clinical operations by identifying likely repair needs prior to the event and staging the relevant construction materials and equipment within easy reach to minimize the impact of minor leaks, broken windows, and other building damage on regular facility operations (ASPR TRACIE, 2023 b.).

Resilience Strategies: All / Multiple Hazards



Element 3.5 Supply Chain



Climate-related disasters and extreme weather events can affect the production of critical supplies and can damage transportation infrastructure, resulting in disruptions to commercial shipping routes. Furthermore, equipment failure can jeopardize the safety of many items in a healthcare organization's supply chain – both clinical and non-clinical – that require refrigeration. Healthcare organizations can enhance their resilience by assessing supply chain vulnerabilities for contingencies that can be implemented in the event of regional transportation or production disruptions. In addition, they should develop and implement a plan for managing their refrigerated supply chain and on-site storage during power outages (Ruble et al., 2021).



For example, during the COVID-19 pandemic, the public healthcare system in New York City, NYC Health + Hospitals, met the need for three times the normal demand for ventilators by both sourcing the equipment itself and building out temporary infrastructure to accommodate a dramatic increase in piped oxygen. The organization installed sprinklers in its facilities to thaw oxygen tank valves, which can freeze when supplying large quantities of oxygen. Hospital staff monitored the tanks 24/7, and the system coordinated with fire and emergency management authorities due to the combustion risk. Disposable components of ventilator equipment, which reached critically low levels, were redistributed throughout the network on an as-needed basis. Bedside staff also communicated frequently with supply chain leadership to ensure placement of orders for personal protective equipment and common hospital supplies, like intravenous (IV) tubing, blood sample supplies, infusion pumps, and wound dressings, before supplies reached stock levels that would trigger a new order under normal conditions (Uppal et al., 2020).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 3.5: Supply Chain](#)

Planning

ACTION: Integrate regional climate change projections into the healthcare organization's supply chain emergency planning process.

SUMMARY: Identifying potential vulnerabilities within a healthcare organization's supply chain related to the full range of regional, projected climate change-related hazards can inform contingency planning and emergency preparedness planning, including establishing redundancy among providers for critical supplies (Lakatos et al., 2023; Sherman et al., 2023).

ACTION: Integrate medical supply storage into resilience planning.

SUMMARY: Consider how your organization's prospective risk assessment of climate-related hazards (Element 1) might lead to supply chain disruptions and/or changing needs. Maintain an adequate supply of medical supplies to treat patients with hazard-related illnesses, particularly for products that are most vulnerable to weather-related disruptions in transportation routes (Hedges et al., 2018). Consider separating emergency supplies into two categories: high-volume medical supplies (such as IV bags, sharps, and oxygen) and equipment/supplies that would only be needed during a disaster. Establish a timeline for activating the supply chain plan ahead of the anticipated climate change-related event. Include in the

Climate Resilience Actions, continued

timeline when a comprehensive check of both types of inventory should take place and when normal deliveries should be suspended (for example, 120 hours and 12 hours ahead of an anticipated hurricane, respectively) (Maslanka & Hurwitz, 2022).

People and Operations

ACTION: Add net-zero requirements to purchasing contracts.

SUMMARY: A healthcare organization's supply chain may represent more than half of its total carbon footprint. At the same time, the purchasing office has limited control over reducing the carbon intensity of the products it buys. Signaling demand for low-carbon products by adding net-zero requirements to purchasing contracts can be effective for encouraging suppliers to reformulate products – particularly when healthcare organizations coordinate contracting language with other leaders in the field.

ACTION: Require suppliers of essential goods and services to provide a continuity of operations plan for climate change-related disasters.

SUMMARY: Healthcare organizations are dependent on a large network of vendors to supply goods and services that are essential to facility operations and continuity of care. Requiring suppliers of essential goods and services to provide a continuity of operations plan is an important first step in building the healthcare organization's resilience to disasters that disrupt transportation infrastructure (Toner et al., 2017).

ACTION: Stockpile potable water.

SUMMARY: Maintaining a stockpile of potable water, either inside the healthcare organization's storage facilities or through a contract with external vendors, can bridge the gap for both medical procedures and community services (i.e., sharing bottled water with community members) during water shortages.

Physical Infrastructure

ACTION: Boost the resilience of refrigerated storage areas.

SUMMARY: Consider increasing wall insulation and access to auxiliary power in refrigerated storage areas to extend the shelf life of temperature-sensitive products, like pharmaceuticals and food supplies, during brownouts and blackouts (Lazo et al., 2023).

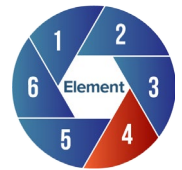
ACTION: Store essential medical supplies, food, and fuel lasting 5–7 days on or near the healthcare campus to facilitate rapid deployment ahead of extreme weather events that could disrupt supply chains and/or utility and transportation infrastructure.

SUMMARY: One of the hallmarks of climate change is the increased length of utility outages and damage to transportation infrastructure, leading to supply chain disruptions of a week or more. Healthcare organizations can increase their resilience to this changing landscape by stockpiling 5–7 days' worth of medical supplies, food, and fuel on or close to healthcare facility campuses (Danna et al., 2010).

Resilience Strategies: All / Multiple Hazards



Element 4. Collaborations Between Healthcare Organizations



Disruption in care delivery in an outpatient facility may result in a patient surge in an acute care setting, and evacuation and transfers between facilities during and after disasters may be required. Therefore, sharing information and resources across the full range of regional healthcare providers is important for increasing resilience both at the facility level and across the regional healthcare delivery ecosystem. Collaboration between healthcare facilities to increase climate resilience can include communication and information sharing, resource coordination, plans for potential evacuation and transfers, medical staff deployment, data sharing, joint public health outreach efforts, and joint disaster preparedness drills.

For example, because of the VA's experience in providing trauma-informed behavioral health care to its veterans, the VA is often well-positioned to serve as a key partner in local communities' disaster behavioral health response. Partnerships between the VA and local communities are facilitated by establishing and maintaining emergency management and clinical relationships, as illustrated by the VA Pacific Island Healthcare System's (VAPIHC) provision of disaster behavioral health care in the Mariana Islands following Typhoon Yutu in 2018. VAPIHC, based in Honolulu, Hawai'i, had previously established telemental health in a non-VA healthcare clinic on the island of Tinian. After Typhoon Yutu devastated the island, causing many essential healthcare staff to lose their homes, the clinic was able to serve as a temporary housing site for its employees, and VAPIHC was able to provide telemental health services to healthcare staff (Wyte-Lake et al., 2021).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 4: Collaboration Between Healthcare Organizations](#)

Planning

ACTION: Create plans to increase the resilience of critical outpatient care during climate change-related emergencies.

SUMMARY: Create contingency plans in coordination with regional healthcare partners to ensure that individuals with chronic physical and/or mental health conditions – who are at high risk due to potential interruptions in medication administration or outpatient care – have access to alternative arrangements if their usual care becomes unavailable or inaccessible due to a climate change-related event (Toner et al., 2017; WHO, 2020).

ACTION: Enhance healthcare organization preparedness for climate-related hazards through mutual aid MOU.

SUMMARY: A mutual aid memorandum of understanding (MOU) with other healthcare providers in the region that includes the results of a prospective risk assessment (Element 1) can help prepare for circumstances that require patient transfers or referrals – such as utility outages, patient surges, etc. Pay particular attention to current gaps in preparedness for climate-related events that are projected to increase in frequency and/or severity in the region. It is important to address legal and reimbursement challenges that can limit a facility's ability to quickly and efficiently transfer patients and/or supplies to other facilities in the region. Consider working with CMS and other healthcare organizations in the region to fill in those gaps over time using an all-hazards approach (U.S. HHS, 2014; Patel et al., 2022).

Climate Resilience Actions, continued

ACTION: Exchange epidemiological data and health assessments related to climate hazards with other healthcare organizations and the local health department.

SUMMARY: Exchanging epidemiological data and health assessments related to climate hazards with other healthcare organizations and the local health department can support regional climate resilience planning efforts. Use these conversations to jointly develop protocols for identifying emerging climate-related health threats in the region, collecting and disseminating data, and coordinating emergency response across the range of facility types in the regional health system – including acute care hospitals, community clinics, and long-term care facilities (Patel, 2022).

ACTION: Integrate an analysis of cross-institutional collaboration in regional after-action reviews of climate change-related events.

SUMMARY: As part of an all-hazards emergency management plan, include an after-action analysis of interdisciplinary coordination within the organization, as well as with other regional healthcare organizations and the local office of emergency management to assess how well the emergency response system functioned as a whole. Consider including prospective climate metrics (Element 1) as one indicator of the system's resilience to future events (Davies et al., 2019; Parker, 2020).

ACTION: Perform joint disaster preparedness exercises and drills with other local healthcare organizations, the local health department, and the local office of emergency management.

SUMMARY: Joint disaster preparedness exercises and drills can help healthcare organizations test their readiness for climate-related disasters and extreme weather events (including simultaneous and cascading events), identify areas for improvement in their emergency response plans, and build working relationships with other first responders. Including representation from multiple institutions and professions in the exercise can also help identify emerging at-risk populations who are projected in climate models to require more protection and/or resources as certain climate-related events occur more frequently and/or with greater severity (WHO, 2020; ASPR, 2024).

ACTION: Work with other regional healthcare organizations to develop integrated patient evacuation plans.

SUMMARY: Healthcare organizations can increase their own and regional resilience by working together to develop integrated emergency evacuation plans. Consider

including contingency plans to address damage to a facility's structure, exposure to contaminated air and/or water damage, power and water outages, destruction of electronic medical records, infrastructure failures, and a limited number of ambulances. Contingency plans may involve transferring patients to alternate facilities or establishing temporary medical sites in safer areas (Patel, 2022).

People and Operations

ACTION: Share resources and coordinate personnel during climate-related events.

SUMMARY: Collaboration between response organizations may involve sharing critical resources and coordinating the deployment of personnel to support impacted communities in areas of greatest need (Patel, 2022). Consider integrating the results of the organization's prospective risk assessment (Element 1) into planning conversations to funnel resources to new and emerging at-risk populations related to the changing climate.

ACTION: Collaborate with regional healthcare organizations on public health education and outreach programs.

SUMMARY: Healthcare institutions can collaboratively develop and disseminate public health education and outreach programs so that the community receives a consistent and coordinated message about climate-related hazards, protective behaviors, and access to resources such as healthcare services (California Department of Public Health, 2022).

ACTION: Consider proactively credentialing neighboring healthcare facility staff to help execute the healthcare organization's emergency preparedness protocol.

SUMMARY: Proactively credentialing staff at neighboring healthcare facilities to prepare for emergencies can contribute to backup care if one facility is unable to provide care due to hazard-related and extreme weather utility interruptions (WHO, 2020).

ACTION: Establish effective communication channels to share real-time information across healthcare organizations during climate-related events.

SUMMARY: Consider working with other healthcare organizations and entities in the region to establish effective real-time communication channels with one another and the public during climate-related events. Examples of critical information that can be shared this

Climate Resilience Actions, continued

way include information about the progression of the hazard, who should evacuate, where evacuees should go, which healthcare facilities are open to receive new patients and/or community members seeking refuge, real-time information about the number of beds available in the region and consistent definitions for each bed type, and levels of critical medical supplies needed and available for each facility in the cooperation network (CDC, 2003; California Department of Public Health, 2022; U.S. HHS, 2014).

ACTION: Share knowledge and lessons learned with other regional healthcare organizations.

SUMMARY: Sharing knowledge and lessons learned across healthcare organizations can help the entire region coordinate their climate resilience plans, investments in resilient facilities and operations, and protocols for information and resource sharing during events (ASPR, 2024).

Physical Infrastructure

ACTION: Build out alternative communications channels to help regional healthcare organizations share real-time information with each other during disasters.

SUMMARY: Interorganizational cooperative agreements for sharing resources and transferring patients during climate change-related disasters depend on real-time communication among facilities in the network. Building out alternative communications channels connecting healthcare organizations with each other (such as multiple cell phone providers, satellite phones, walkie-talkies, and generator-powered cell towers on the roof of key facilities) can increase the effectiveness of the entire network's emergency response (U.S. HHS, 2014).

Resilience Strategies: All / Multiple Hazards



Element 5. Interdisciplinary Planning, Oversight, and Evaluation



Planning for climate resilience requires an interdisciplinary team and coordination across a range of critical functions, including administration, emergency management, clinical leadership, information technology, construction and real estate, facility operations (e.g., power, water, waste disposal, food service, custodial services, etc.), communications, transportation, and purchasing. Aligning facility operations, procurement, and capital expenditures to balance climate change mitigation goals (i.e., reducing greenhouse gas emissions) and resilience goals can help the organization chart a climate-positive and cost-neutral path toward resilience.



For example, the Massachusetts General Brigham healthcare system in New England conducted climate change vulnerability analyses of over 30 buildings, including hospitals, outpatient facilities, administrative buildings, research labs, and rehabilitation centers. The analysis team included clinical leaders, architects, engineers, climate change consultants, facilities managers, research leads, and emergency preparedness leaders from across the system. The team emphasized the importance of engaging local leaders from a variety of disciplines in each facility in the process. The range of viewpoints resulted in a robust and holistic vulnerability assessment that mapped the relationships between vulnerabilities related to physical infrastructure, patient needs, and clinical services. The assessment identified vulnerabilities and recommended solutions related to heat waves, flooding, and high winds. The system immediately addressed several high priority vulnerabilities – such as connecting air conditioning systems to emergency power sources – and is including long-term vulnerabilities in future renovation and new construction plans. Sustained engagement with local member facility leaders increased these facilities' buy-in to the recommended actions coming out of the process (Baugh et al., 2021).

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:
[Element 5: Interdisciplinary Planning, Oversight, and Evaluation](#)

Planning

ACTION: Incorporate interdisciplinary approaches into hazard planning.

SUMMARY: Consider incorporating interdisciplinary approaches into the healthcare organization's hazard planning process since natural disasters and hazard events can impact a range of dependencies – such as infrastructure, clinical care, energy systems, and waste management (Rogers et al., 2020).

ACTION: Incorporate long-term goals and climate projections into healthcare extreme weather planning and response plans.

SUMMARY: It can be helpful to integrate long-term, interdisciplinary strategic goals into the healthcare organization's extreme weather emergency preparedness and response plans – including community input as outlined in the Justice, Equity, Diversity, and Inclusion (JEDI) framework (American Public Health Association & CDC, 2021).

Climate Resilience Actions, continued

ACTION: Implement surveillance and interdisciplinary after-action reviews in organizational hazard action plans.

SUMMARY: Incorporate building surveillance and interdisciplinary after-action reviews into the healthcare organization's hazard action plan. These measures will help identify and evaluate the elements of the plan that worked during a recent event; assess whether changing climatic conditions might have influenced aspects of the event (such as its severity); and change the parts of the plan that did not meet expectations. The after-action review should be tailored to the specific disaster type experienced (Hess et al., 2023; Parker, 2020).

ACTION: Maintain a hard copy of the most current emergency management plan and contact information for key emergency management personnel.

SUMMARY: Power, internet, and cell phone outages can slow emergency response efforts, particularly early on in the disaster. Healthcare organizations can streamline deployment of emergency response plans by maintaining a hard copy of the most current emergency management plan and protocols for each individual hazard, as well as emergency roles, addresses, and phone numbers for all staff with key roles in an emergency response (Becker's Healthcare, 2018).

People and Operations

ACTION: Develop a system-wide plan for coordinating care across all facility types under different disaster scenarios.

SUMMARY: Establishing a protocol for coordinating care and opportunities to shelter in place during extreme weather events across all facility types in a healthcare system (from acute care to neighborhood clinic) can help direct at-risk populations to appropriate services (ASPR, 2024).

ACTION: Integrate viewpoints from all segments of the healthcare organization, as well as from outside partners, into climate resilience and emergency planning.

SUMMARY: The impacts of climate change touch every department in a healthcare organization as well as every partner in government and the community. Therefore, climate vulnerability assessments, resilience plans, and emergency planning efforts are most valuable and impactful when they combine insights from a wide range of disciplines drawn from both inside and outside the organization (ASPR, 2024; Parker, 2020).

ACTION: Use the hazard vulnerability assessment process as an opportunity to build a culture of resilience within the healthcare organization.

SUMMARY: Conducting a multidisciplinary hazard vulnerability assessment that integrates stakeholder feedback can help build a culture of resilience both within the healthcare organization and between the organization and community partners so that protocols and procedures safeguarding the continuity of clinical care are in place ahead of hazardous events (ASPR TRACIE, n.d.b.; Parker, 2020).

ACTION: Develop a digital operations center for the healthcare system to monitor potential emergencies that could impact critical services and to coordinate resilience strategies and emergency response.

SUMMARY: Digital platforms that facilitate communication across campuses within a healthcare organization and externally with other healthcare organizations and emergency management partners can help build a learning organization culture by supporting evidence-based decision-making during emergencies as well as after-event evaluations (Al Knawy et al., 2022; Reifels et al., 2022).

Resilience Strategies: All / Multiple Hazards



Element 6. Communications and All-Hazards Approach



Climate-related disasters and extreme weather events often occur simultaneously or in quick succession, which increases the risk of multisystem failures at the community scale (such as disruptions to water and power utilities) that can cause compounding threats to healthcare infrastructure and operations and surges in healthcare demand. The effects of simultaneous or sequential climate-related hazards can cause prolonged and cascading health harms for populations at disproportionate risk. In fact, climate change is projected to exacerbate existing racial disparities across a range of health outcomes (Berberian et al., 2022).



Proactive planning and coordination of disaster-related education and messaging for clinicians, staff, patients, community partners, and the public increase healthcare organizations' and communities' resilience to multiple hazards. This is an essential feature of an all-hazards approach to climate resilience planning. For example, in a series of focus groups with San Diego residents representing populations at risk for heat-related illness, participants consistently identified diversification of communication channels as an important strategy to increase the reach and effectiveness of heat risk education and warning messaging (VanderMolen et al., 2022). In particular, participants recommended leveraging existing networks that have high levels of social capital, cultural competence, and extensive local reach (such as community centers, schools, and faith-based organizations). Establishing and maintaining relationships with these trusted messengers can help healthcare organizations effectively disseminate and target disaster-related risk communication across multiple hazards.

Climate Resilience Actions

Tools and resources relevant to these actions can be found in the appendix:

[Element 6: Communications and All-Hazards Approach](#)

Planning

ACTION: Collaborate with local partners to coordinate climate-related disaster messaging.

SUMMARY: It can be helpful to collaborate with local public health department partners to coordinate climate-related hazard messaging with clinicians and patients, such as through prompts in the healthcare organization's electronic health record, e-newsletter, and patient texting system. This approach can increase community awareness of both the short- and long-term health risks associated with exposure to climate-related disasters (WHO, 2020).

ACTION: Use simultaneous disasters as an opportunity for education about the co-benefits of taking an all-hazards approach to resilience.

SUMMARY: Simultaneous and cascading disasters can be opportunities to educate the community, staff,

and emergency management partners about the value associated with using a co-benefit approach to risk assessment, emergency planning, emergency response, and rebuilding efforts (National Academies of Sciences, 2022).

People and Operations

ACTION: Broadcast climate-related hazard alerts using culturally appropriate language and communication pathways.

SUMMARY: Broadcasting alerts about climate-related hazard vulnerability and protective behaviors to patients, staff, and community partners using culturally appropriate language and communication pathways can help amplify the local public health department and office of emergency management's communication efforts (Hasan et al., 2021; O'Neill et al., 2009).

Climate Resilience Actions, continued

ACTION: Establish two-way communication systems with patient populations who are sensitive to high priority climate change-related hazards.

SUMMARY: Implementing two-way communication systems, like Reverse 911 and wireless emergency alerts (National Academies of Sciences, 2018), can aid in connecting sensitive populations with protective measures before an event occurs and direct them to

community services during the event. With the assistance of community groups and local health departments, designated community leaders can deliver culturally sensitive messages. These messages would inform residents about safeguarding themselves and their neighbors against climate change-driven hazards and provide guidance on actions to take if they experience illness during such events (Steinberg & Sprigg, 2016).

Climate Resilience for Health Care: Drought



Impact of Drought on Healthcare Organizations

Drought-related effects on water and air quality, along with economic strain, can trigger or exacerbate respiratory and cardiovascular diseases and lead to increased cases of waterborne and vector-borne diseases and mental health concerns. These effects can lead to patient surges in healthcare settings, especially in agriculturally reliant rural areas (U.S. HHS, 2021). Moreover, thermal plants may suffer from reduced power generation during droughts due to high water temperatures that reduce cooling capacity. Reduction in water quantity and quality, especially across an entire community or region, can increase water utility rates (U.S. HHS, 2021). Hospitals are major consumers of potable water and energy (U.S. HHS, 2014) and face operational risk from reduced power generation and increased water utility rates. A significant portion of commercial water supply is used by hospitals for heating and cooling systems, restrooms, and medical equipment (Fink, 2022 a.). Furthermore, loss of soil moisture and groundwater levels during droughts can lead to subsidence, damaging roads and foundations (Ohenhen et al., 2024), while insufficient river levels disrupt water-bound transportation. These multifaceted challenges can collectively impact health care by affecting its infrastructure, facility operations, medical supply chains, and patient care. Further, drought often occurs in conjunction with other climate change-related hazards, such as heat waves, wildfires, flooding, and disease-carrying vectors, which can increase the complexity of the required response.



Important Considerations

Health Effects of Drought: Impaired access to drinking water leading to dehydration; impaired sanitation and hygiene leading to skin infections; decreased air quality; increased waterborne, vector-borne, respiratory, and cardiovascular diseases; food shortages and malnutrition; mental health effects



Populations at Risk: People with chronic conditions, immune-compromised populations, outdoor workers, older adults, young children, pregnant women, populations reliant on well water, populations living near contaminated soil



Risks to Facility Operations: Supply chain disruption, patient surge, insufficient potable water, disruption of supporting infrastructure



Infrastructure Risk: Disruption of industrial processes, utilities, and transportation, subsidence damage to building foundations

Elements of a Climate-Resilient Healthcare Organization: Drought

Integrating the following climate resilience elements into the healthcare system's emergency management plan can enhance its ability to respond to increasingly frequent and severe drought events.

The following six elements characterize a drought-resilient healthcare organization. Review each element section to explore more detail.

1. Prospective Risk Assessment

Emergency preparedness plans that include drought risk assessments should incorporate forward-facing climate projections to adequately address the possibility of more frequent, severe, and prolonged droughts. The impacts of a drought may be compounded by extreme heat, wildfire, and heavy rainfall (e.g., flooding from heavy rainfall can be more likely in a drought-affected landscape), affecting healthcare facilities' – and their patients' and communities' – access to safe and clean water. In addition, droughts may not prompt the urgency required for a timely response because they often develop more gradually than other disasters and extreme weather events, although so-called "flash droughts," droughts that develop over the course of a few weeks, are becoming more common in the era of climate change. And, urban areas may not realize that droughts affect the entire region – not just agricultural communities. Proactive and early response can help mitigate the impacts of drought on healthcare organizations and the communities they serve.

2. Health Equity and Community Engagement

Droughts can negatively impact populations for prolonged and variable lengths of time, requiring proactive and collaborative approaches to mitigate inequitable health harms. Community partners can help healthcare organizations identify populations at risk from drought-related health harms, design and implement targeted strategies to mitigate community-level and individual risk factors, and effectively prioritize protective interventions.

3. Assessment and Remediation of Vulnerabilities in Infrastructure and Operations

The effects of drought have been described as creeping up on communities because it takes time for a shortage or absence of water to be felt. When a drought's effects finally become evident, they are often most extreme for infrastructure. Climate change is already causing more frequent, severe, and long-lasting droughts in many regions of the world. As those changes increase over time, healthcare organizations located in drought-prone regions will need to plan for (1) alternative water sources to supplement local water supply when water pressure drops, (2) alternative electricity sources in regions dependent on hydropower, and (3) more flexible utility infrastructure in regions at risk of subsidence. These facilities are also at risk of direct structural damage as well as the indirect effects of impaired roads, bridges, water lines, and other community infrastructure serving the facility.

4. Collaboration Between Healthcare Organizations

During drought events, surges in clinical and nonclinical demands as well as evolving water supply challenges can stress healthcare facilities. Given the importance of minimizing the time that sensitive patients are exposed to the repercussions of drought, collaborations among healthcare organizations can help direct patients to the closest facility with the capacity to meet patients' needs.

5. Interdisciplinary Planning, Oversight, and Evaluation

Droughts can affect various critical dependencies within healthcare organizations, such as administration, information technology, electricity, natural gas, water, wastewater and waste disposal, communications, transportation, and critical products. An interdisciplinary approach to planning, oversight, and evaluation is essential for comprehensive drought preparedness. For example, engaging staff and community members

early in developing the drought resilience plan can raise awareness about the interconnected impacts of droughts on clinical care, facility operations, and community infrastructure.

6. Communications and All-Hazards Approach

Droughts often occur together or in succession with extreme heat and/or wildfires and can often end with a heavy rainfall that results in flooding. Multi-hazard events increase the risk of multiple system failures at the community scale (such as disruptions to the water and power utilities), and they can result in both direct and indirect harm to population health. Repeated patient surges and cascading infrastructure failures, both in the community and within healthcare facilities, can temporarily disrupt the entire healthcare system in a region. Fortunately, many policy, infrastructure, and communications interventions can increase organizational resilience to more than one climate-related hazard.