COMMENTARY

Health Care, Cities, and Climate Change: Challenges and Opportunities

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ABSTRACT: By 2050, 70% of the human population will reside in cities. The climate crisis increasingly threatens city healthcare systems, infrastructure, and residents. Climate change directly and indirectly impacts the functioning of health care systems—which also contribute to environmental and climate hazards through medical waste, pollution, and greenhouse gas emissions. Both health care systems and city planners have critical roles in addressing climate impacts. In addition to providing medical care and counselling for climate-related issues, health care systems can expand into roles as anchor institutions and resilience hubs to support climate readiness efforts. Cities can champion such efforts while also employing policy and infrastructure approaches to create climate-ready cities that support residents' health and urban healthcare institutions. While health care systems and cities can make independent progress toward climate adaptation, mitigation, and resilience, their interdependencies call for increased exploration of collaborative approaches. In this article, the authors outline the impacts of climate change on health care systems and cities and provide a strategic overview of what health care systems and city leaders can do to address climate change. They provide examples of practical solutions, underscore the importance of data and their role in protecting urban populations, highlight potential challenges, and suggest a path forward for cities and their health care systems.

KEYWORDS: city infrastructure; climate and health; climate change; collaboration; extreme weather; health; health care facilities; health care systems; urban planning

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SUMMARY FOR POLICYMAKERS

- Climate change affects human health, health care systems, and health care delivery through direct and indirect pathways, including health care utilization and disruption of health care delivery.
- Health care systems can support cities and their residents through direct patient care, counseling, advocacy, education, and as anchor institutions.
- Climate-smart investments in urban infrastructure can reduce health risks and support health care system functioning. Essential utilities; water, sanitation, and hygiene (WASH) infrastructure; stormwater management; transportation; housing; and other municipal services are important determinants of health.
- Health care systems and cities are interdependent. Strategies to achieve climate readiness should be developed collaboratively. Approaches ranging from investments in urban infrastructure to proactive, data-driven engagement with medically complex patients in at-risk neighbourhoods are possible.
- Data sharing is an increasingly important bidirectional opportunity. City public health departments rely on health care data to understand their communities' health status; hospitals need information on anticipated hazards and resources for their patients.
- Aligning health care systems and cities to tackle climate change is an important challenge.
- Climate adaptation, mitigation, and resilience efforts can be strengthened through collaborative communication, stakeholder engagement, needs assessments, prioritization, and iterative improvements

Introduction

By 2050, 70% of the human population is expected to live in cities (United Nations Department of Economic and Social Affairs, 2017). City residents face increasing impacts from climate-responsive hazards including extreme heat, severe weather, flooding, wildfires, air pollution, and tropical cyclones (Intergovernmental Panel on Climate Change [IPCC], 2022; Romanello et al., 2023; Willige, 2024). While an increasing number of cities are taking action to address climate change through mitigation, adaptation, and resilience, the human impacts of climate change continue to mount (IPCC, 2022). The health impacts of climate change are numerous and well studied (Arcaya & Figueroa, 2017; Balbus et al., 2022; Charlson et al., 2021; IPCC, 2022; Morello-Frosch & Obasogie, 2023; G. Smith et al., 2022; White et al., 2023). These range from increased mortality during heat waves to mental health effects from natural disasters. Climate change also has long-term implications for communicable and non-communicable

diseases, security, distress migration, mental health, and community cohesion (IPCC, 2022; Romanello et al., 2023).

Health care institutions play a critical role in providing preventative and acute care services and serve at the front lines of climate and health surveillance, preparedness, and response. Urban policymakers and planners also have an essential role in creating climate-ready communities, infrastructure, and policies. Interdependencies between health care systems and cities are becoming increasingly important to understand as the impacts of climate change intensify (Ebi et al., 2021); city planners can support the transformation of health care systems beyond their traditional role as providers of patient care, and welcome them as anchor institutions, resilience hubs, and educational nodes that can support societal climate readiness.

The current situation calls for cross-sectoral approaches that support healthcare access, the functioning of health care systems, and health protection for city residents worldwide (Salas, Friend, et al., 2020). Here, we describe the impacts of climate change on health care systems; elucidate intersections between climate change, the built environment, population health, and a city's health care infrastructure; and provide a framework for understanding the interdependence of healthcare systems and cities in our changing climate, highlighting interdependencies and opportunities for collaborative solutions (Figure 1).

Impacts of climate change on health care systems

Climate change affects health care systems through direct impacts such as storm damage and indirect impacts on supply chains, workforce availability, road

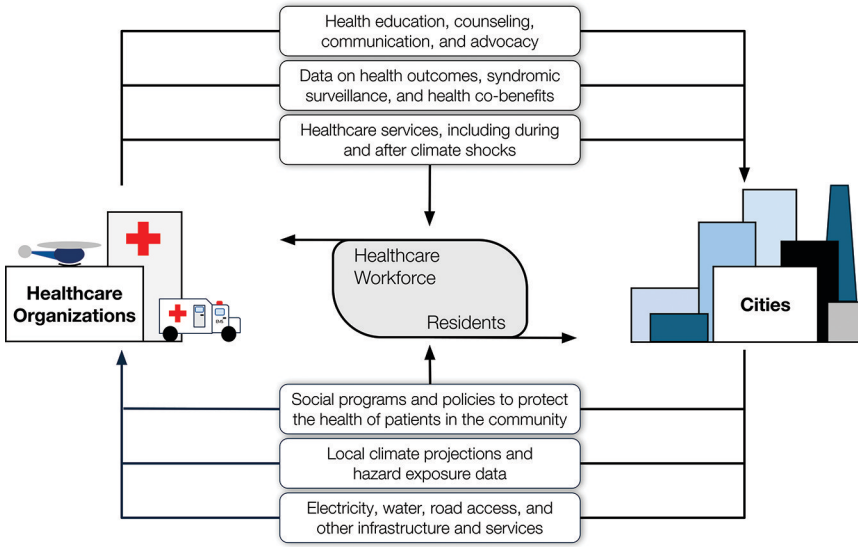

Figure 1: Interdependencies between health care systems, cities, and their residents

access, and essential utilities. Even when facilities remain operational, utilization surges driven by population-level climate impacts may exceed local capacity, affecting both people harmed by climate hazards and those with unrelated medical needs. (Figure 2).

Direct impacts of climate hazards on health care infrastructure

Climate hazards can compromise the integrity and functioning of health care facilities. Exposure to extreme rainfall and tropical cyclones can lead to damage from flood waters or the inability to maintain hygienic spaces, for example for childbirth (Rattanakanlaya et al., 2022; Shahid et al., 2023). Wildfires have damaged facilities and triggered large-scale evacuations; many facilities in fire-prone regions are at risk (Bedi et al., 2023; Hospital Council, n.d.; Scott & Martin, 2020). Extreme temperatures can lead to burst pipes or temperature variations between hospital floors associated with adverse outcomes (Kakkad et al., 2014; NBC Boston, 2023). Outpatient clinics, dialysis centers, nursing homes, and other non-acute facilities, which may have limited disaster preparedness capabilities, have also been damaged or destroyed (Codjoe et al., 2020; Dobalian et al., 2010; Dosa et al., 2020; Kaiser et al., 2021; Klein & Nagel, 2007; R. Smith et al., 2020).

Indirect impacts of climate hazards on health care systems

Climate-related impacts on urban infrastructure, the health care workforce, and supply chains can incapacitate health care delivery. Disruptions can be acute (e.g., power loss during storms), sub-acute (e.g., prolonged droughts that disrupt water supplies), or permanent (e.g., rising seas inundating roads serving a hospital).

Health care delivery relies on electricity and clean water. In high-income settings, hospitals obtain power from the surrounding region, with limited-duration backup systems for use when municipal infrastructure fails (Klinger et al., 2014). In low- and middle-income settings, facilities may use grid electricity or power produced on-site. Water is often obtained from municipal sources; some facilities have on-site purification and storage systems (van der Heijden et al., 2022). Risks to operations and patient safety are substantial when critical utilities fail (Chandra et al., 2021; Hiete et al., 2011; World Health Organization [WHO], 2020).

Transportation infrastructure is crucial for health care system access and functioning. Patients, staff, and medical supplies must be able to reach health care facilities. Crises can disrupt public transportation on which patients and staff rely, increase burdens on remaining transportation infrastructure, and reduce accessibility (Bíl et al., 2015; Litman, 2006; Murata & Matsuda, 2013; Rickless et al., 2023; Siff, 2024). Sea level rise may gradually impede access in coastal cities (Tarabochia-Gast et al., 2022).

Health care workers can also be impacted; they may have to attend to family, friends, pets, livestock, or other responsibilities. Staff shortages following disasters can be prolonged (Cone & Cummings, 2020; Ochi et al., 2016). Administrative barriers can limit health care worker availability as well—staff credentialing is often specific to facilities. Proactively addressing health care workers' needs to

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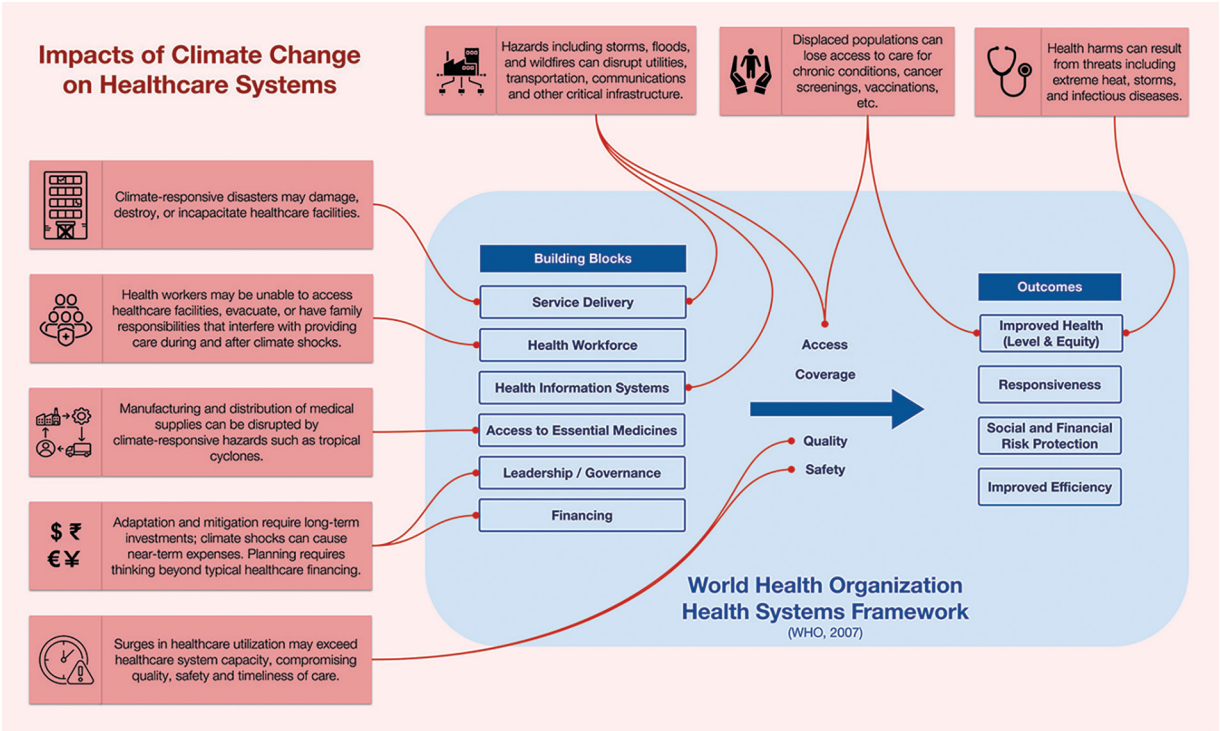

Figure 2: The impacts of climate change on health care systems, in the context of the World Health Organization Health Systems Framework (World Health Organization, 2007). Icons in the figure are courtesy of The Noun Project: Alhaliza Risma Elvariani, Berkah Icon, bsd studio, Hanbai, Llisole, syafii5758, CC BY 3.0

enhance resilience includes considering childcare, safe transportation, and cross-credentialing into nearby health care systems.

Medical supply chains are vulnerable to climate change. Disruption rapidly impacts clinical practice and may force maximization or rationing of limited resources (Durugbo & Al-Balushi, 2022; Ranney et al., 2020). Pharmaceutical and medical supply manufacturing and distribution systems may have bottlenecks related to specific factories or importers. Following manufacturing facility destruction in Puerto Rico during Hurricane Maria, saline infusion bags became scarce; this led to IV fluid rationing in American hospitals, highlighting production vulnerabilities and the need for supply chain preparedness (Sacks et al., 2018).

Health care utilization

Climate hazards can affect health care utilization through surges (as affected people seek care), spatial displacement (as populations seek care for existing conditions in new locations), temporal displacement (e.g., elective surgery rescheduling), and decreases in utilization due to inaccessibility of care or decisions to forgo care due to other, critical disaster-associated priorities.

Surges are of particular concern to chronically overburdened acute care hospitals and emergency medical services (EMS) with limited surge capacity (Savioli et al., 2022). Extreme heat can trigger substantial increases in utilization, as seen in the Pacific Northwest heat dome of 2021 (Wettstein et al., 2024). Extreme heat correlates with increased EMS response times; even those with conditions unrelated to heat may experience longer wait times for EMS (Thornes et al., 2014). Solutions to address health care overcrowding and reduce population hazard exposure are urgently needed.

The displacement of health care utilization, a lack of access, and decisions to forgo care during crises demand thoughtful approaches that address root causes, provide interim solutions, and confront health inequities. Solutions may lie within the health care system, for example, through proactive re-engagement with individuals whose care was delayed; in other situations, such as land inundation due to sea level rise, policy and governance must anticipate and address the needs of impacted populations.

Implications of health care system disruption

A cascade of impacts occurs when health care institutions are damaged, disrupted, or overburdened. Patients may need to be evacuated (Hua et al., 2024); increased morbidity and mortality can occur (Bell et al., 2023). Patients may lose access to care or travel further for care (Arrieta et al., 2008). Disasters may shutter primary care clinics, dialysis centers, and pharmacies (R. Smith et al., 2020). This can affect continuity of care, chronic disease management, and infection control programmes, turning manageable chronic conditions into life-threatening emergencies (Kelman et al., 2015; Lew et al., 2015). Additionally, climate-responsive disasters affect the distribution of vaccines, disproportionately affecting lower income nations with great vaccination needs (Jadeja et al., 2023). Disruption of cancer screenings and scheduled surgeries may mean patients progress to

advanced conditions that require greater health care resources (El Saghir et al., 2018). Post-disaster studies have demonstrated that cancer outcomes are affected by screening disruptions and treatment delays (Aldrich & Benson, 2008; De Guzman & Malik, 2019; Man et al., 2018). Strategies to maintain access to care can prevent these impacts.

Impacts of health care on the urban environment

Health care contributes to global climate change and affects local air quality, waste, and pollution (Campbell-Lendrum et al., 2023; Eckelman et al., 2020; Frumkin, 2021; Karliner et al., 2019; Speer et al., 2020). The global health care sector contributes approximately 4.5% of global greenhouse gas emissions annually. Health care sectors in industrialized nations have higher relative contributions; the U.S. health care system accounts for approximately 8.5% of U.S. emissions (Eckelman & Sherman, 2016; Rodríguez-Jiménez et al., 2023).

Health care–related emissions include direct Scope 1 emissions from organizational assets (for example operating hospital vehicles), indirect Scope 2 emissions from facility operations (e.g., from purchasing electricity), and indirect Scope 3 emissions from other activities such as employee and patient transportation, waste disposal, emissions during manufacturing and delivery of pharmaceuticals and medical supplies, and other sources (Ganatra et al., 2022; Health Care Without Harm, 2019, 2021; Janik-Karpinska et al., 2023). Initiatives to reduce health care–associated greenhouse gas emissions include efficiency upgrades, reuse programmes, plant-forward menus, the elimination of certain anesthetic gasses, and ambulance electrification (Huang et al., 2024; Kaiser Permanente, n.d.; NHS Improvement, 2017; Salas, Maibach, et al., 2020; Wanegård & Fagerberg, 2019). Such initiatives can improve the urban environment. Exhaust from idling ambulances contributes to urban air pollution, an issue that can be addressed through vehicular electrification (Brown et al., 2012). Mitigating emissions from patient travel in private vehicles can sometimes be achieved through enhanced telemedicine access, which may also alleviate traffic congestion near major hospitals (Thiel et al., 2023).

Road maps and resources for health care decarbonization are widely available (Health Care Without Harm, 2021). Health care institutions in wealthy countries have greater environmental impacts and more resources for decarbonization than those in low- and middle-income countries. Nations with limited health care resources may prioritize essential medical services over climate-ready health care investments, or conduct both simultaneously (Pan American Health Organization, n.d.). The WHO's (n.d.-a) ATACH programme provides a forum where national governments can assess these issues and learn from one another.

Health care's role in a climate-ready city

Health care organizations can support many aspects of city climate readiness (Balbus, 2022; Dresser et al., 2024; Hess et al., 2009; Howard et al., 2023; Loosemore et al., 2011; Sorensen et al., 2023). Facilities can become resources, rather

than liabilities, during climate-related disasters, and can proactively initiate programmes to prevent hazard-related illnesses and maintain access to care. As anchor institutions, health care systems can support community organizations, intentionally invest in the local economy, and enhance community resilience; their clinicians can help patients and stakeholders navigate an increasingly hazardous world.

Climate-ready health care

Numerous opportunities exist to enhance health care system climate readiness, including actions to reduce further climate change and efforts to adapt to and prepare for climate impacts (Centers for Disease Control and Prevention, 2024; Hess et al., 2009; Patel et al., 2022; WHO, 2023).

Facilities are often vulnerable to climate hazards; this does not have to be the case. Preventative measures range from placing generators above potential flood waters to investments in on-site electricity generation, water storage and purification, and hardening against storms and fires (Nickel, 2016). Health care facilities can be transformed into resilient assets, becoming resources rather than recipients during climate-related crises (Paterson et al., 2014; Seltenrich, 2018; Sherman et al., 2023). Health care facilities can build on this approach by serving as "resilience hubs" or "resilience centres"; they can offer a safe location during disasters and provide preparedness training, risk-reduction activities, distribute resources, and connect vulnerable individuals, including medically vulnerable patients, with relevant services (California Strategic Growth Council, 2023; Li et al., 2021; U.S. Climate Resilience Toolkit, n.d.).

The Pan American Health Organization (PAHO) Smart Hospitals programme demonstrates the promise of this approach. Hospitals that invested in weatherproofing, critical systems, and on-site renewable energy have weathered major hurricanes, continued providing care, and offered additional services to their surrounding communities (Pan American Health Organization, n.d.). In the British Virgin Islands, Peebles Hospital temporarily hosted government meetings as it was one of the only remaining functional structures in a storm's immediate aftermath; in St. Vincent and the Grenadines, St. George's Hospital provided access to potable water for the surrounding community following a hurricane (Pan American Health Organization, n.d.).

Proactive health protection

Proactive health protection can serve individual patients. These efforts extend the concept of preventative medicine and may involve thinking outside typical institutional boundaries (Patel et al., 2022). For example, major storms have been referred to as "kidney failure disasters," in which fragile dialysis-dependent patients are unable to access care (Lempert & Kopp, 2013). However, scheduling patients for pre-storm dialysis can reduce harm; in a study following Hurricane Sandy, patients who received extra dialysis immediately before hurricane landfall had fewer emergency department visits and hospitalizations (Lurie et al., 2015).

Climate-related risks can also be addressed proactively at the scale of health care systems. Proactive cross-credentialing of health care workers can simplify mutual aid if staffing shortages occur or allow inpatient teams to accompany their patients during hospital evacuations (Iserson, 2020). Pre-planning temporary outpatient services at alternate sites can address time-sensitive health care access needs ranging from radiation therapy to prescription refills for displaced patients (Gay et al., 2019).

Health care workforce

Health professionals work with people at high risk of climate-related health harms, hold a unique position of trust, and can communicate actions to address the health impacts of climate change (Bernstein et al., 2022; Gallup, n.d.; Lemery et al., 2020). Health care workers can advise policymakers, support strategic planning, provide testimony to lawmakers, and co-develop health-informed policy solutions; inclusion of climate-informed health professionals in advisory or programmatic capacities has become increasingly common (Medical Societies Consortium on Climate and Health, n.d.). Health care workforce members may increasingly receive professional training in sustainability and climate hazard preparedness (Dresser et al., 2024) and can share this knowledge with family, classmates, and community members.

Formal education, resources for practicing clinicians, and the use of data to guide targeted risk reduction strategies can improve the ability of clinicians to inform patients, policymakers, and the public (Katzman et al., 2023; Lemery et al., 2020; Salas, 2020). Existing resources include profession-specific programmes (Demorest et al., 2019), badges to facilitate clinical engagement (Climate Rx, n.d.), and patient action plans (Americares, n.d.).

Anchor institutions

Health care systems can support urban climate readiness as anchor institutions (Franz et al., 2019); these are "nonprofit or public place-based entities, such as universities, hospitals, county governments, and municipalities rooted in the local community by their mission. They are often among the largest employers and property holders in the communities they serve" (Health Care Without Harm, 2023, p. 3).

Health care institutions have numerous opportunities to enhance climate readiness as anchor institutions (Health Care Without Harm, 2023, n.d.; Sergeant & Hategan, 2023). Health care systems can leverage purchasing decisions to support local suppliers with climate-friendly business practices (Practice Greenhealth, n.d.), or use existing resources to support community members. Following Hurricane Sandy and the North American Blackout, people came to health care facilities to refrigerate medications or charge medical devices (Greenwald et al., 2004; D. Lee et al., 2016).

Longer term partnerships between health care and community organizations can connect vulnerable patients with counselling, equipment such as air conditioning units, or subsidized power to run them (Pennar, 2023; WBUR, 2023).

Frontline clinics are testing this approach. Opportunities also exist to support climate-smart practices in the private sector, such as providing education on protection from heat for outdoor workers (Americares, n.d.; Martinez et al., 2022).

Urban form and function can support health and health care

City implementation of climate-smart policies can support residents' health and health care facility functionality. Population health status and outcomes can vary substantially between neighbourhoods, with differing characteristics of their built environment (Heaviside et al., 2017; Jackson, 2003; Mueller et al., 2020; Rędzińska & Piotrkowska, 2020; Wolf et al., 2020). Health care institutions depend on cities for electricity, water, communications, transportation, and workforce. The form and function of urban environments impact health care use and usability during climate shocks and long-term population health (Frank & Kavage, 2008; Sharifi et al., 2021).

Health adaptation through form: Urban infrastructure and design

Urban infrastructure is a determinant of individual health and institutional functionality. Health care facilities rely on continuous supplies of electricity, clean water, and communications connectivity for electronic health records, telemedicine, and other essential functions. Patients are similarly dependent, relying on electricity to refrigerate medications, power medical devices, and power communications technology to connect with clinicians (Bedi et al., 2025). Reliable utilities are essential; investments in climate-smart infrastructure can support health care function and prevent health harm (Figure 3).

Globally, electrical grids need upgrades to increase capacity, accommodate renewable energy, and improve climate-hazard resilience (Gonçalves et al., 2024). Cities can prioritize improving electrical, water, and communications infrastructure based on exposure and criticality. Planners may consider the locations of hospitals, clinics, and vulnerable patients; in the United States, resources such as the Social Vulnerability Index, emPOWER, and Environmental Justice databases can prioritize neighbourhoods (U.S. Department of Health and Human Services, n.d.).

Preventing infectious disease is a long-standing urban challenge and a growing concern with climate change. Changing temperature and rainfall can increase the suitability of urban areas for disease vectors such as mosquitoes (Ligsay et al., 2021). Increasingly frequent and severe flooding introduces pathogens to drinking water (Dupke et al., 2023). Cities that invest in WASH infrastructure (UNICEF, n.d.), removing standing water (WHO, 2023c), and effective stormwater management systems will be better prepared for an increasingly warm, wet, and crowded world.

Transportation infrastructure is also of importance. Health care facilities rely on regular medical supply deliveries and must remain accessible. Investing in road systems, railways, and other transportation infrastructure capable of surviving increasingly severe climate events is essential to ensure functional health care

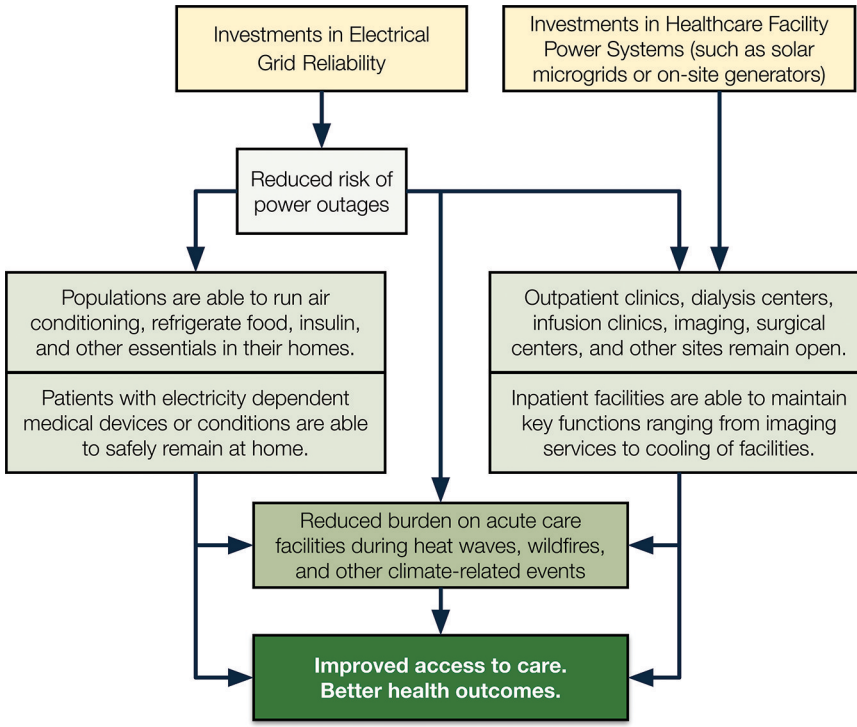

Figure 3: Implications of electrical infrastructure investments for health care systems, facilities, and patients

institutions. Urban transportation must also remain safe for patients; unshaded bus stops in hot cities and underground subway lines without protection from extreme rainfall represent health hazards to residents and liabilities to their cities. Functional transportation that keeps riders safe is essential.

Climate-related health hazards can be ameliorated through architecture and urban design (Gómez-Palacio, 2024). Storm-resistant housing, urban greenspace, and cool roofs reduce hazard exposure (Bunker et al., 2024; Lee & Maheswaram, 2011; Rojas-Rueda et al., 2019). Other approaches include "Cool Blocks" to reduce the urban heat island effect or a "Sponge City" approach to manage stormwater (Bebinger, 2022; Ruwitch, 2023).

Housing deserves special consideration; housing policy is a health intervention. Many people spend more than half of their time at home; city emergency response teams cannot feasibly reach and remove all vulnerable residents from their homes for transport to cooling centers or storm shelters (Ortiz-Ospina et al., 2020). Long-term climate adaptation—and long-term health protection—require safe housing (Burlotos et al., 2023).

Zoning and permitting offer a practical means to achieve this. In addition to energy efficiency and emissions standards, planners can ensure design standards for new homes are inherently protective (U.S. Department of Housing

and Urban Development, 2023; van Bijleveld, 2023). Whether taking a climate mitigation and health co-benefits approach (e.g., disallowing new particulate-emitting buildings in residential areas; National Caucus of Environmental Legislators, n.d.), an adaptation approach (e.g., mandating essential equipment be elevated above possible floodwaters; Climate Safe Housing, n.d.), or a blended approach (e.g., requiring on-site renewable energy with battery backup), there are opportunities for city authorities to support climate mitigation, adaptation, and resilience.

Rental market law presents another opportunity to protect health, for example, by mandating cooling or air filtration systems for rentable units. However, such interventions must consider possible unintended consequences, such as increases in housing costs or decreased housing access.

Health adaptation through function: Services and programmes

In addition to physical infrastructure, services and programmes present a climate adaptation opportunity. Inequities in how cities are designed, structured, and operated create disparities in climate-related health risks. Targeted interventions are essential to address environmental injustices and advance health equity (Morello-Frosch & Obasogie, 2023). Cities can improve behavioural adaptation by influencing activities in public spaces. Rescheduling outdoor sports activities to early morning or late evening during hot weather or offering the use of publicly owned air-conditioned spaces such as libraries can reduce the risk of extreme heat (Maese, 2019). Transit schedules can be altered or extended to support work or travel schedules during cooler periods of the day or night.

Municipal services that reach those at risk are particularly important. Educating municipal workers to recognize climate risks and refer to relevant services presents one possible approach; for example, housing authorities may connect tenants or landlords with city programmes that support building retrofits focused on efficiency, weatherization, storm and flood resistance, or cooling (U.S. Environmental Protection Agency, 2024).

Dedicated programmes can also coordinate action around a specific intervention. In New York, the Be a Buddy programme pairs at-risk older adults with a person who checks on them during heat waves (City of New York, n.d.). Another example is using public libraries as resilience hubs, which offer safety during heat waves or storms paired with education and resources during good weather (Massachusetts Library System, 2020).

Urban policies can also support community organizations that work with vulnerable individuals. These can include mutual aid groups, religious organizations, or other non-profit organizations. In one successful example, Meals on Wheels added wellness checks to their food delivery programme during a heat wave (Renwick, 2023). The business community can also be engaged in climate-related health issues ranging from safety for outdoor workers in extreme heat to initiatives related to preparedness, response, or cleanup from hydrometeorological disasters (WHO, 2023a, 2023b).

Urban health care data

Cities and their health care systems share an interest in climate and health data. Health care systems collect data that can detect emerging health problems, identify vulnerable populations, and measure health outcomes. City governments invest in data on hazards, infrastructure, housing, industry, and social and economic patterns within their population that could inform health facility resilience planning and patient care. A core mission of both entities is the well-being of their community; investing in data accessibility and integration can enhance climate readiness and advance their missions (Figure 4).

However, shared interest does not necessarily translate into data sharing. The legal and administrative approvals required to establish data-sharing relationships, the financial costs associated with extraction, transfer, and analysis, and the ethical and privacy concerns surrounding human data are non-trivial. Health care organizations may be unable to devote resources toward data-related activities perceived as outside their core activities or may be unable to easily access patient data if it is managed by a third party such as an electronic health records company. Despite these challenges, well-designed data-sharing mechanisms complemented by protocols for analysis can enhance individual care, improve institutional readiness and disease surveillance, inform public health action, guide investments for adaptation, and be optimized to intervene and save lives during disasters (Balsari et al., 2021).

Health care and city data sets have the potential to improve support for at-risk individuals if applied collaboratively. Dangerous heat provides an illustrative example. Air-conditioning units and subsidized power can prevent health harms and health care overburdening, but funding and logistical challenges limit

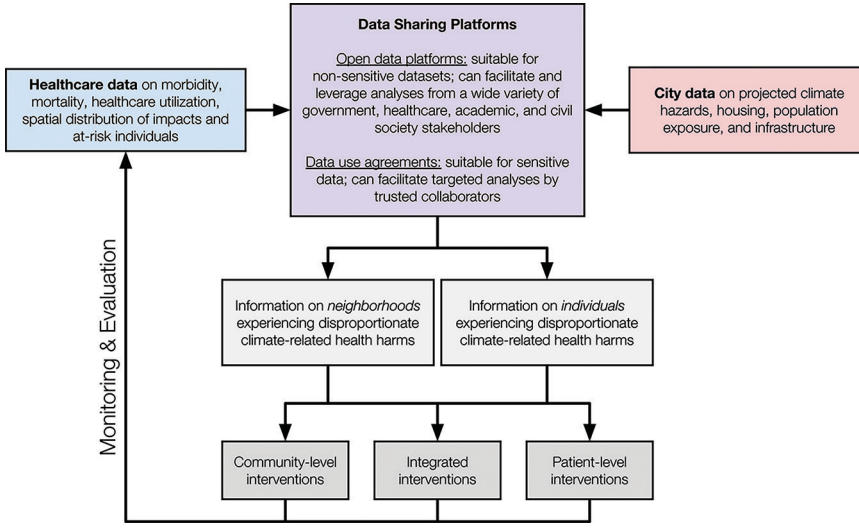

Figure 4: Framework for leveraging health care system and city data to improve patient health and health care system readiness

deployment. Targeted delivery and installation for the most vulnerable would enhance programme effectiveness (Lane et al., 2014; O'Neill et al., 2005). Large-scale epidemiological analyses have identified risk factors including advanced age, lack of air conditioning, and medical comorbidities (Sun et al., 2021) but typically do not provide hyperlocal information on social, economic, and environmental factors. An individual's personal finances, living situation, block-level heat exposure, in-home air temperature, community characteristics, and transportation options can affect overall heat exposure and their ability to manage heat risks. This information is often fragmented between medical records, urban planning data, and organizations and agencies working directly with impacted communities. Data sets integrating information on local hazards and resources with individual health data could be used to prioritize limited resources for individuals facing intersecting risks. Health care institutions are an ideal setting to review personal health data, verbally screen for risk factors, and provide referrals to a heat preparedness programme; funding and operating such services and managing hazard and neighbourhood-level data are roles better suited to city government.

Data provide one example of the bidirectional dependencies and opportunities that will become increasingly important as climate change impacts escalate.

Challenges in collaboration and prioritization

The interdependence of health, health care, and cities facing climate hazards is clear (Cerise, 2010; Hasegawa et al., 2016; Hierink et al., 2020; McGinty et al., 2017; Yamada et al., 2006). Climate readiness efforts that unite key institutions and health care systems around collaborative or complementary strategies have great potential (Dresser et al., 2024), but challenges are to be expected.

An immediate concern is establishing effective communication between organizations. This requires navigating differing priorities, responsibilities, organizational structures, timelines, and incentives. Overcoming this barrier requires patience from all parties, clear identification of roles, and identification of shared objectives aligned with the missions of both organizations (United Nations Economic Commission for Europe, n.d.).

To work together, city and health institutions must value climate readiness, approve collaborations and relevant data sharing between their organizations, and be prepared to adjust plans as consensus develops regarding which climate readiness initiatives to prioritize and implement. These actions require support from institutional leadership.

The motivations of health care systems, urban institutions including city governments, and their decision-makers regarding climate readiness can be complex (Dresser et al., 2024). Cities and health care systems face competing threats, constraints, responsibilities, operational time frames, and short-term needs. When stressors such as financing become salient, institutions and their leadership may focus on perceived core responsibilities and financial solvency. While such approaches may be necessary to safeguard the existence of key institutions, they

can reduce the leadership support, political capital, and funding available for climate-readiness activities that are essential in the medium to long term.

Some resilience interventions are visibly effective—the success of elevated cyclone shelters in Bangladesh provides one example (Haque et al., 2012)—but their utility can also be invisible (e.g., a backup power system that functions flawlessly during a power outage), or delayed, as in the case of hazards that may have lengthy return times (Ali, 2022). A lack of visibility can dampen momentum for investment, but the inverse—public outcry when insufficient investment exposes populations and institutions to climate-related hazards—must also be considered within the policymaking calculus.

Urban health care and climate change: A path forward

Cities and their health care systems must find a path toward climate readiness that addresses and leverages their interdependencies, despite the challenges. Many approaches are possible, ranging from investments in urban infrastructure to proactive, data-driven engagement with medically complex patients in at-risk neighbourhoods. While specific projects will be determined by local needs and capabilities, successful approaches will build on shared values and involve stakeholder engagement, assessment of risks and possible solutions, collaborative implementation, and iterative improvement.

Stakeholder engagement is essential. Depending on the project, clinicians, urban planners, community organizers, local leaders, policymakers, and patient or community representatives may be included. The goal is to assemble expertise, influential leaders, and ensure that communities are meaningfully invested in a project's design and success (Medical Societies Consortium on Climate and Health, 2023). In addition to broad inclusion, this process must establish working relationships between teams to conduct the work and ensure that proposed solutions do not worsen inequities.

Collaborative action toward climate adaptation and resilience requires assessing climate hazards, vulnerabilities, and opportunities for adaptation; mitigation-focused projects require an understanding of current emissions and strategies to reduce them. Cities and health care systems may need to assess current climate threats, future hazards, and the potential for cascading impacts. Multiple climate hazards may have to be addressed, and numerous potential interventions may exist, each with varying cost, utility, visibility, and longevity. Interventions may involve short-term or long-term approaches and low- or high-cost investment requirements. (Figure 5)

Long-term climate-informed adaptation can reduce exposure and vulnerability to hazards and increase the capacity to deal with impacts when they occur and is a more cost-effective strategy for recurrent and intensifying hazards (Pugacheva & Mrkaic, 2018). Resources including vulnerability and adaptation assessments (WHO, n.d.-b) and Climate Impact Checkups (Healthcare Climate Action, 2024) may be applied. Stakeholders should analyze potential interventions within appropriate frameworks and prioritize accordingly.

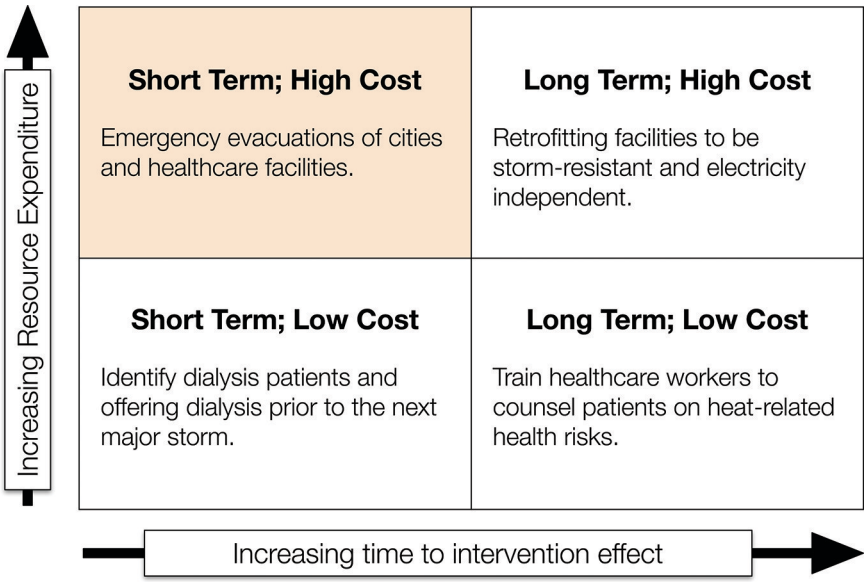

Figure 5: Framework for assessing climate adaptation, mitigation, and resilience interventions with respect to the time to intervention effect and necessary resource expenditures; the upper-left quadrant, shaded for emphasis, illustrates interventions that are costly and reactive—the scenario that effective adaptation planning seeks to prevent

Several strategies can be considered when developing possible climate-readiness programmes, policies, or interventions. Regulatory approaches provide relatively direct means to change organizational behaviour but could also harm financially fragile health care institutions without guidance, technical capacity, and financing to support compliance. Accreditation and licensure provide related incentive mechanisms; the issuance of voluntary climate-related standards by the United States' Joint Commission (2023) and the inclusion of climate content in medical licensing examinations suggest increasing roles in future years (Medical Council of Canada, 2022).

In some situations, stakeholders may find a health co-benefits framing advantageous. Policies or actions that provide long-term climate change mitigation and short-term health benefits are identified and cost savings from reduced resource consumption or averted health impacts are included in assessments of project value. For example, ambulance electrification can provide long-term climate change benefits and short-term health and financial benefits from reduced air pollution (NHS England, 2021). Health co-benefits assessments can address political or financial roadblocks and help identify projects likely to receive broad support.

Leaders can reframe organizational practices to align with their overall climate-readiness goals and values. This may include broadening the assessment of success to a triple bottom line that includes social or environmental metrics or

synthetic metrics such as averted financial or physical harm. Some approaches require thinking beyond traditional care patterns and may not be financially incentivized by existing health care reimbursement mechanisms; city governments may have a role in brokering and supporting such initiatives (Salas, 2020). Health care system hardening, local renewable power generation, micro-grids, and health care–based resilience hubs are public goods that can advance overall urban resilience and may be worthy of public investment.

Cities and their health care systems should seek to implement programmes in an inclusive manner and engage in iterative improvement processes. Ensuring that unintended consequences are thoughtfully and inclusively addressed, intervention impacts are maximized, new interventions are designed when necessary, and ineffective approaches are modified or phased out is important. The Building Resilience Against Climate Effects framework from the U.S. Centers for Disease Control (2024) can help guide such efforts, as can the experience of other cities or organizations that have faced similar challenges. International forums such as the WHO (n.d.-a) ATACH programme and the C40 Cities (2024) initiative provide opportunities for peer-to-peer learning within a global community of practice.

Finally, highlighting successes that have long been invisible is important. Maintaining social and political support for climate-readiness efforts requires a sense of urgency and agency. Celebrating averted harms such as a hurricane that passes without impacting an at-risk hospital can help patients, policymakers, and the public understand the value of sustained investment in adaptation.

Conclusion

Climate change is an escalating threat to cities and their health care systems. Health care systems and city governments share goals related to the well-being of urban populations. Preparedness for climate impacts and risk reduction at individual, institutional, and city-wide scales requires collaboration between health care systems, health professionals, city governments, urban planners, community organizations, and other stakeholders. While aligning health care and city systems to tackle climate change is not simple, it presents an important opportunity to reduce harm and support effective climate adaptation, mitigation, and resilience. These efforts lay the groundwork to build communities where all people can truly be well.

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