HARVARD T.H. CHAN
SCHOOL OF PUBLIC HEALTH

C-CHANGE
CENTER FOR CLIMATE, HEALTH,
AND THE GLOBAL ENVIRONMENT

Climate Resilience for Frontline Clinics Toolkit

Module for
Hurricanes

in collaboration with

americares

Table of Contents

How To Use This Toolkit

The Climate Resilience for Frontline Clinics Toolkit includes a wide variety of resources for several different hazards. There is more material here than anyone has time to read in one sitting. The following suggestions may help you make the best use of these resources. These suggestions are based on feedback, focus groups, and interviews with frontline clinic staff that implemented earlier versions of these toolkit materials.

Designate a weather resilience lead

Designate one person at your facility as a weather resilience lead. This person can:

- Take the time to review these documents in detail.
- Identify which materials will be most useful to colleagues in different parts of the organization.
- Track imminent weather threats.
- Sign up for and receive alerts from various systems, if desired.

See the **Critical Roles and Responsibilities** document for more details.

Identify your clinical engagement strategy

Set up a meeting with members of your healthcare team to determine how you would like to use the clinical and patient facing resources at your facility. Frontline clinics that participated in the development of these resources use them in several different ways, including the following:

- Educating clinicians on the impacts of climate hazards and approaches they can use when counseling patients.
- Making sure printouts of patient facing materials are easily accessible alongside other counseling materials that are used in the clinic.
- Adding patient facing materials to electronic after-visit summary documents so that it is easy to distribute these materials along with other parts of the after-visit summary.
- Printing out patient-facing materials and leaving them in a prominent location in the waiting room.
- Conducting education sessions on the contents of this toolkit for staff, administrators, or patients.
- Assign a specific member of the healthcare team to ask patients about relevant hazards and provide educational materials. This could include roles such as nurses, doctors, social workers, pharmacists, community health workers, and others.

Tailor these resources to the needs of your institution

In some cases, it may be desirable to modify details in these toolkit resources to meet specific needs at your organization or to reflect your local situation. Examples of this could include:

- Adding more detailed information about how to reach local authorities.
- Providing information about specific city, county, or state level resources.

- Providing information about specific policies and practices at your institution.
- Providing information about resources in your community, such as how to find cooling centers available in your city or town.

The easiest way to do this is to modify the provided **Documentation Templates**, which you can import into after-visit summaries for your patients.

Alternatively, you may find it helpful to make a separate flyer with a list of local resources and phone numbers to accompany the materials from this toolkit.

Integrate resources into your electronic health record system

You may find it helpful to integrate resources into your electronic health record system.

- You are welcome to include the attached PDFs and content in after-visit summaries, or to link to them from internal institutional reference documents or databases.
- We have provided a set of documentation templates that you can easily import into your electronic health record system.
- If you need more advanced integration support, such as creating templates of these materials within your electronic health record system, we may be able to help provide the content in a compatible format. Please contact our team for more information.

Share your experience and ideas

Many of the clinics that helped develop these materials found it helpful to share ideas and learn from each other about how they used the toolkit resources. If you have insights or experiences to share, please contact our team. In some cases, your contributions may be shared with other clinics or healthcare workers, with credit to you and your institution if desired. Examples of what you might share include:

- A description of how you have been using a specific resource in the toolkit.
- An anecdote about a climate hazard that you have dealt with successfully.

Conduct periodic reassessments

It may be beneficial to periodically reassess your climate resilience activities. Consider doing this:

- Annually in late fall, after the risk of climate hazards has decreased.
- After specific climate-related events, such as a hurricane or heatwaves, to review and learn from the experience.

Notes:

Hurricane Action Plan and Tip Sheet

For Patients

Use this plan to stay safe in the event of a hurricane in your area. Share this plan with everyone in your home and with friends and family members. Review this information every year so that everyone is ready to act when a hurricane occurs.

Hurricanes are dangerous to your health

Hurricanes can cause drownings and injuries. After the storm, people may have problems getting medical care, or may suffer injuries during cleanup, carbon monoxide poisoning from using generators indoors, mental health impacts, and a variety of other health problems.

Before a hurricane

Know when a hurricane is expected to occur

The National Hurricane Center (https://www.nhc.noaa.gov/) provides detailed information about hurricanes, including forecast information.

You can also check for hurricane warnings on your phone weather app, on your computer (such as at weather.com), or your local news on the radio, television, or social media.

A hurricane watch means you should be prepared to take action. A hurricane warning means you should take action immediately.

HURRICANE **WATCH**	HURRICANE **WARNING**
A hurricane watch is issued when a hurricane may affect where you live within the next 2 days.	A hurricane warning is issued when a hurricane is expected where you live within the next day or day and a half.

To prepare for hurricanes I will check: _____

Sign up for emergency alerts which you can get to your cell phone or email

You can sign up for emergency alerts at NIXLE.

For general information on alerts: Emergency Alerts | Ready.gov

If you have a car or generator, make sure the fuel tank is full

Consider keeping your car out of the garage in case the door does not open when you need to evacuate.

Know your evacuation route and how you will evacuate (car, transit, etc.)

When evacuation orders are given, they will use your home's specific "evacuation zone" and have a route to follow.

You can find a link to your state's evacuation information at bit.ly/evac_zone. Click on your state in the list to find information about your evacuation zone.

Have an emergency "grab and go" kit and a "stay at home" kit ready.

This is a list of things to have ready in case of evacuating from a hurricane. Keep everything together, ideally in a single bag, so you can easily grab it to go. You should also prepare a "stay at home" kit if you need to shelter in place with supplies for a week. See **Building an Emergency Kit** for more information.

Keep copies of important documents ready and safe from flooding

This includes insurance policies, medication lists and birth certificates.

Plan for power outages

- Back up **medical equipment that needs electricity or batteries**.
- Have a backup cooler with ice for **medications that require refrigeration** and a thermometer to check the temperature inside the cooler.
- If you get water from a **well with an electric pump**, have a backup plan to have enough water to drink if the power goes out.
- If heat or air conditioning is not working, **consider going somewhere that heat or air conditioning is available.**
- **See more information on Plan for Power Outages**.

Prepare your home for flooding

You can install sump pumps and backflow valves on drains and toilets to prevent floodwaters from entering.

Look into your local community emergency response team (CERT) and think about signing up to volunteer to prepare yourself and your community for emergencies

Even if you do not sign up, there may be resources to help in disasters
https://community.fema.gov/PreparednessCommunity/s/welcome-to-cert?language=en_US

During a hurricane

Have a plan for evacuation and know who you can contact for help

Pay attention to local media outlets for evacuation orders. Know how to get out of your house - where the exits are and what windows can be opened.

Identify an emergency contact for everyone in your household to call.

My emergency contact person is: _____

Their phone number is: _____

Identify a preferred and backup evacuation location that has power if you need it. If possible, these two locations should be in different directions from where you live.

My evacuation locations are:

1. _____

2. _____

If I need to evacuate, the vehicle/transport I will use is: _____

If I need help evacuating, I can call:

Name	**Phone**
_____	_____
_____	_____

Prepare your home before you leave to make your return safer

- Turn off **electricity, gas, and water** supply.

Hurricanes can cause flooding and extreme wind speeds, take steps to stay safe during the hurricane

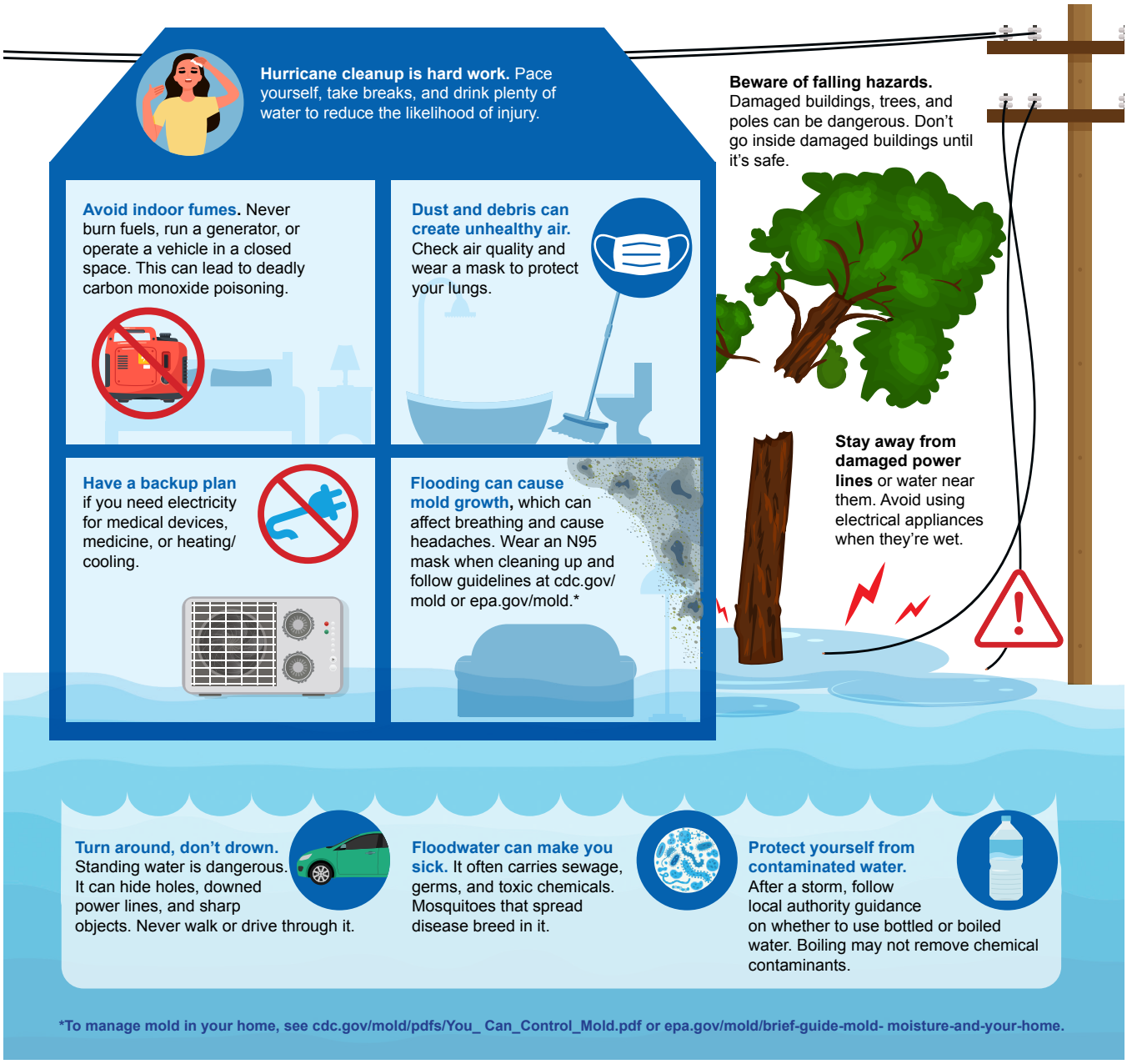
- Keep your **emergency supply "grab and go"** or **"home disaster kit"** in a place you can easily access.
- Listen to the radio, TV, or internet for **updates** on the hurricane.
- **Stay inside.** Even if it looks calm, do not go outside as it may worsen again. Wait until you hear an official message that the hurricane is over.

- Stay away from windows during hurricanes with strong winds. You could get hurt by pieces of broken glass or flying debris. Stay in a room with no windows or go inside a closet.
- Watch out for flying debris that can be lifted by winds from a hurricane and cause injuries. Think about wearing a mask if air quality is poor from dust.

• **Do not walk, swim, or drive through floodwaters** from hurricanes.

After a hurricane

Know the risks to your health following hurricanes and how to minimize them



Visit cdc.gov/disasters or FEMA “Returning Home After a Flood” to learn more about risks to your health from floods and hurricanes.

After a hurricane can be a stressful time for your health. Speak with your healthcare team about taking care of your long-term medical conditions and any mental health concerns after the hurricane.

Before re-entering your home, make sure it is not damaged, and call the authorities if it is before entering to stay safe.

Notes:

Helping Patients Establish a Hurricane Action Plan

For Providers

Hurricanes are becoming more intense with increased rainfall and coastal flooding which can exacerbate chronic health conditions and disrupt access to essential services such as power, water, and healthcare access.

Below is guidance to help you prepare for completion of the **Hurricane Action Plan and Tip Sheet** *included in this toolkit with your patients, which provides anticipatory guidance on what to do before, during and after a hurricane.*

Before a hurricane

Make sure your patients and their families know the risks of hurricanes

Ask: Do you know the risks to your health during and after a hurricane?

Discuss with your patient how hurricanes may affect their health. You can find information to discuss in the **Hurricanes and Health** overview document.

Assess if and how patients access weather reports and extreme weather warnings

Ask: Do you know how to learn if there is a risk of a hurricane near where you live?

If not, you can suggest the national hurricane center website, their phone weather app, weather.com, or their local news television station or riskfactor.com. For more detailed instructions, you can provide the **Hurricane Action Plan and Tip Sheet**.

Encourage patients to complete the Hurricane Action Plan and Tip Sheet well before a storm is imminent

Ask: Have you completed a hurricane action plan?

Establishing a plan before there is an imminent threat of a hurricane can be lifesaving, especially if a patient requires assistance to evacuate. We encourage patients to complete the evacuation section of the **Hurricane Action Plan and Tip Sheet**; doing so with a member of their healthcare team may be especially helpful.

During a hurricane

Determine patients' likelihood of following an evacuation order and help them develop an evacuation plan

Ask: If there was an evacuation order, would you evacuate?

For individuals with chronic medical conditions or who rely on electric medical devices, such as ventilators, reviewing the risks from hurricanes may help motivate them to evacuate when necessary.

Ask: If you need to evacuate, where will you go?

Ask: If you need to evacuate, how will you do so? Will you need help to evacuate? If so, who will you call?

If a high-risk patient will not have the needed assistance to evacuate, a provider can ask permission to share the patient's contact information with local emergency managers.

After a hurricane

Make sure their home is safe to enter and patients know health risks after hurricanes

Ask: Do you know the risks to your health after a hurricane or flood?

Help your patient identify their health risks after hurricanes and flooding. You can find information to discuss in the **Hurricanes and Health** and **Floods and Health** document.

Check in with your patients about control of long-term medical conditions and any mental health concerns after the hurricane

After a hurricane can be a particularly stressful time, with patients potentially experiencing exacerbations of chronic disease, as well as issues accessing clean food, water, and shelter. Consider proactively checking in with patients, particularly higher risk patients who have medical comorbidities or are living with limited mobility.

Ask: How is your health doing after the hurricane? Do you have access to all the things you need, like food, water, shelter?

There can also be significant mental health stresses after a hurricane, and it is important to bring it up and offer any local resources.

Ask: How is your mental health after the hurricane? Do you have all the resources you need?

Notes:

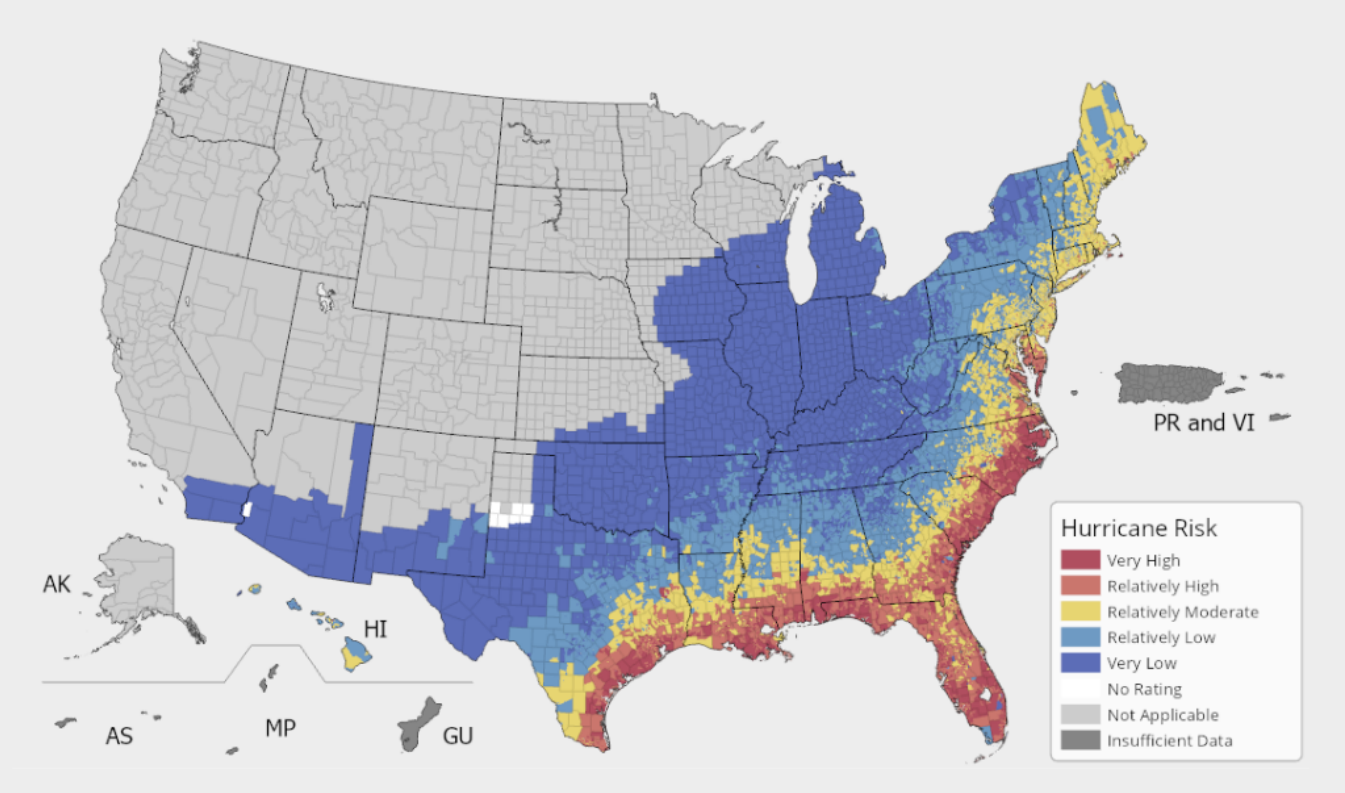
Hurricanes and Health

For Providers

This sheet is an overview on hurricanes providing background of how hurricanes impact health and how providers can help patients prepare.

Hurricanes and climate change

Hurricanes – intense low-pressure tropical storms producing destructive wind speeds and heavy rain – have far-reaching effects on health, especially for individuals with chronic medical conditions. The likelihood of hurricanes making landfall in the United States is illustrated in the map below.



Map of relative hurricane risk in the United States. Courtesy of FEMA, June 2024. You can determine your local National Risk Index here: https://hazards.fema.gov/nri/hurricane

Climate change warms the oceans, and hurricane strength comes from ocean heat. Climate models project more intense hurricanes and associated coastal flooding and wind damage in this century.[1] Hurricanes are also becoming wetter, with increased intensity, and less forewarning.[2] Trends show that hurricane peak intensity has been occurring closer to shore and their tracks have been moving north, putting more northern areas, which may be less familiar with or prepared for hurricanes, at greater risk from hurricane strikes.[3,4]

Health impacts of hurricanes

Hurricanes directly affect health through strong winds, heavy rains, freshwater flooding, and storm surge, all of which can cause injuries. Hurricane-related flooding is a major hazard. The primary direct health impact from flooding is drowning, accounting for up to 75% of mortality after floods.[5]

Patient Case

You see one of your regular patients in clinic for their annual visit and they mention that they have started stocking up for hurricane season, because with their aging knees, it has been increasingly hard for them to get out and about in the aftermath of the storms that frequently affect your region. You ask them where they live, and they report that they live in a beachfront house but are not particularly worried because they have always been fine in previous storms. They are on multiple medications that require refrigeration, including insulin and a new antibody treatment. They do not have any back up power supply currently.

What would you tell them about how hurricanes are changing as a result of climate change, and what steps would you suggest they take to stay safe during future storms? What should they do with their medications if the power goes out?

Hurricanes and associated high winds and flooding can disrupt essential services, including power, water, and healthcare access. Indirect health harm can result from harmful effects on infrastructure, housing, and healthcare, including limited or nonexistent access to prescription medications and regularly scheduled healthcare services. Hurricanes can increase immediate morbidity and mortality for individuals with a variety of medical conditions and can affect perinatal outcomes.

- **Respiratory disease** related mortality has been found to increase 8.3% one month after hurricanes.[6]
- **Cardiovascular disease** hospitalizations doubled in older patients up to 1 year after Hurricane Sandy. Myocardial infarctions and strokes were 22%7 and 7% higher, respectively, in areas more severely affected by the storm.8 Additionally, negative impacts on cardiovascular disease have been observed for years after hurricanes, including after Hurricanes Sandy and Katrina. [9,10]
- **Type II diabetes** related emergency room visits increased 84% during the week of Hurricane Sandy.[11] Increased diabetic morbidity after hurricanes may result from lack of access to medications and healthy foods.[12]
- **Infectious and parasitic diseases** increase after hurricanes, leading to increases in hospitalizations.[13]
- **Mental health and neuropsychiatric disorders** have both been shown to increase following hurricanes. In one study, hospitalizations for neuropsychiatric disorders transiently decreased, then subsequently increased starting a week after the hurricane.[13,14]
- **Chronic kidney disease** patients on dialysis have elevated mortality after hurricanes and may be more likely to need emergency department care, be hospitalized, and receive dialysis during hospitalization.[15,16] Risks to renal patients may result from lack of access to dialysis, concurrent heat wave exposure and associated health risks, infectious diseases, or direct trauma from the storm.[15]
- **Traumatic injuries**, both intentional and unintentional, are more likely after hurricanes.[11, 44]
- **Pregnant people** exposed to hurricanes were more likely to experience **preterm** birth, likely secondary to stress on the mother from the event.[13, 16]

Although there are many immediate health risks from hurricanes, there is growing evidence of long-term impacts from hurricanes, which may be related to interruptions in critical utilities and job and housing insecurity after these events.[20]

Populations at greater risk for harm after hurricanes

Studies have shown that hurricane related excess deaths can vary substantially by location, likely at least in part because of demographic factors and social inequities.[21]

Population	Risk
Chronic diseases	May be more likely: • to have biological exacerbations of their diseases[13] Have worsened health from: • supply chain disruptions and medication shortages • difficulty accessing treatment or care • power outages affecting electric medical devices[24]
Disabilities	Face barriers to: • receiving emergency communications • evacuation due to inaccessible transportation options or lack of necessary mobility assistance • access to evacuation shelters[25] May be more likely to live in public housing or in higher flood risk areas.[26]
Minoritized, low-income, and socioeconomically disadvantaged communities	More likely to live: • closer to industrial facilities and toxic waste sites that may release pollution after a storm[27] • in areas with high flood risk[22, 23]
Older adults	More likely to have: • medical comorbidities • limited capacity to evacuate or be resilient to a hurricane or flood, especially if they lose their homes[28, 29]
Children	More likely to: • experience post-traumatic stress and mental health problems[30] • be at risk for asthma exacerbations[31]
Rescue workers and first responders	More likely to: • sustain unintentional injuries during and after hurricane [24]
Pregnant persons and newborns	More likely to: • experience higher rates of preterm birth [18, 19]

Immediate health risks from hurricanes

Immediate impacts of hurricanes are often due to high wind speeds and flooding. Unintentional injuries are also common during and immediately following hurricanes, as well as during rebuilding efforts.

Common unintentional injuries due to hurricanes include:

- Drowning
- Electrocution
- Cuts, lacerations, and puncture wounds
- Falls
- Traumatic head injuries from falling debris
- Trauma from motor vehicle accidents[32]

Deaths from injuries after hurricanes have been found to peak about 1 month after a storm occurs.[6]

Infectious diseases associated with flooding

Hurricanes can cause widespread freshwater flooding and, in some cases, saltwater flooding due to storm surges. Flooding has been found to increase risks of infections, including vector, rodent and waterborne diseases, as well as illnesses associated with exposure to fungi. Infectious disease risk after hurricanes appears to peak 2 months after the event, but infections can be seen in the days after a storm occurs.[6]

Timing of post-flood infectious diseases in the United States

Early (<10 d after event)
Cellulitis, including from *Vibrios*
Pneumonias (may be aspiration related and polymicrobial)
Viral respiratory infections
Gastroenteritis (SSYCE, *Vibrios*, viruses)

Late (>10 d after event)
Mosquito-borne illnesses
Skin infection from atypical organisms (fungi, mycobacteria, mold)
Hepatitis A or E

Adapted from Paterson et al. Clin Inf Dis. doi:10.1093/cid/ciy227 and Ivers and Ryan. Curr Op Inf Dis. doi: 10.1097/01.qco.0000244044.85393.9e.

Floods have been commonly associated with outbreaks of waterborne diseases, including from bacterial and viral pathogens.[33] Individuals who obtain water from private wells may be at particularly high risk, but even public water systems can be contaminated during extreme storms.[34]

Standing water may create breeding grounds for disease-carrying mosquitoes[35] and fungal growth. Flooded homes are much more likely to have higher levels of molds, such as Aspergillus, Penicillium, and Cladosporium.[36] Patients with allergic disorders may be more likely to develop symptoms from mold exposures.[37] Fungal infections are less common, but immunocompromised individuals have developed respiratory fungal infections after flood induced mold exposures.[37]

Population displacement that occurs after hurricanes and floods can result in overcrowded homes and shelters, sometimes with inadequate sanitation. These conditions can result in the spread of many different infections, especially those transmitted by respiratory or fecal-oral routes.[3]

Toxic exposures

Hurricanes have caused large releases of toxic industrial, wastewater, and agricultural substances into the environment. Which toxins may be most prevalent in a community after a flood may reflect what is stored in local toxic substance impoundments. The EPA tracks sites in your community that may contain hazardous substances which can be mobilized by flooding here.

Hurricanes Katrina and Harvey damaged fossil fuel processing and storage facilities, which released hydrocarbons (known to cause respiratory irritation and arrhythmias), volatile organic compounds (which can be carcinogenic), and heavy metals, such as lead, into air, water, and soil. Hurricane Florence breached a coal ash pit in North Carolina.

Coal ash is a byproduct of coal combustion and coal ash pits are present across the country. Coal fly ash contains volatile organic compounds and heavy metals, including mercury, arsenic and/or chromium.

Infrastructure failures can cause additional unique and harmful exposures. Gasoline shortages after Hurricane Sandy led to increased gastrointestinal and pulmonary symptoms due to gasoline-siphoning related exposures.38 Acute intoxication from gasoline fumes can cause confusion, giddiness, nausea, headache, blurred vision, dizziness, and weakness. Severe exposure can result in respiratory depression, seizures, loss of consciousness, and coma.

Carbon monoxide poisonings often increase after disasters, most often from indoor or inadequately ventilated electrical generator use combined with absent or non-functional carbon monoxide monitors.[39] Patients may also attempt to cook or heat their homes by burning fuels, such as wood or propane, indoors, or to run their vehicle for air conditioning in an enclosed garage, which can also lead to carbon monoxide poisoning.

Mental health concerns associated with hurricanes

Increases in PTSD, depression, and anxiety symptoms have been documented after hurricanes.[24] Prevalence of diagnoses after hurricanes vary with the intensity of the storm. A meta-analysis of tropical cyclone survivors globally found ~18% had PTSD with more severe storms.[40] Need for psychiatric care can extend for prolonged periods after hurricanes make landfall. Reports of psychiatric concerns were elevated for years following Hurricanes Sandy and Katrina.[41-43]

Children, females, and older individuals may be most at risk of mental health symptoms after hurricanes.[44] Individuals in certain occupations, such as farm workers and first responders (e.g., emergency medical personnel, police officers, and fire fighters), may also be at higher risk. Mental health symptoms after exposure to a hurricane have also been found to be associated with lack of necessities, including medications and access to medical care as discussed above, personal physical exposure to hurricane forces (e.g., wind, rain, storm surge), evacuation, loss of a loved one or pet, repeat exposure to hurricanes, existing mental health disorders or recent personal adversity.[45-47]

Disruption of health-systems infrastructure and displacement

Hurricanes often impede healthcare delivery as they can damage healthcare facilities, cut off essential utilities, disrupt supply chains, and inundate roads. Patients who are displaced by storms may be unable to refill medications, and lack of access to medications after hurricanes and floods has been associated with increased morbidity.[32,48]

Patients with chronic conditions, including diabetes and cancer, may delay necessary healthcare services because of healthcare facility closure, difficulty with transportation, or competing demands on time,[28] and may have worse outcomes as a result.[31]

Hurricane action plans for patients

We recommend that you familiarize yourself with the **Hurricane Action Plan and Tip Sheet** provided in the toolkit and review it with any patient at risk of experiencing a hurricane. The action plan can be provided during care visits with adolescents and adults and can be the basis for a discussion around safety planning and care management in the event of a hurricane. Action plans should be completed before hurricane season in your locale.

Anticipatory guidance for providers to give to patients

Anticipatory guidance for hurricanes may contribute to improved health outcomes. The strategies and resources below may be helpful for you to provide to patients who are at risk from hurricanes and reflect the **Hurricane Action Plan and Tip Sheet** available in the toolkit.

At the start of hurricane season

Review this document to understand health risks and high-risk conditions associated with hurricanes and subsequent flooding. If you can, create lists of patients who are at higher risk during hurricanes, such as those with electricity dependent medical conditions or mobility impairment and other high-risk groups. Your whole healthcare team can help with this task and proactively reach out to higher risk patients to create Hurricane Action Plans. Also review local emergency service guidelines and resources to share with patients.

Before a hurricane

Forecasts

Baseline and future flooding risk for many properties in the United States can be found at riskfactor.com. Hurricane forecasts are available from several outlets including the National Hurricane Center.

A “hurricane watch” indicates that hurricane conditions (winds greater than 74 mph) are possible. A “hurricane warning” indicates that hurricane conditions are expected. Hurricane warnings are given 36 hours prior to the expected hurricane impact to give residents time to prepare or evacuate. Understand forecasts and share how to understand with patients.

Reduce health risks from hurricanes

We encourage you to provide patients with the patient handout available in this toolkit (**Hurricane Action Plan and Tip Sheet**). Pay particular attention to your higher risk patients.

In addition, hurricane and flood preparedness guidance is available from CDC and FEMA in multiple languages. CDC also has an infographic for hurricane preparedness and for keeping safe after hurricanes.

During a hurricane

Evacuation

Evacuation may be the best choice when hurricanes are expected near a patient's home. Patients can be encouraged to pay attention to local media outlets for evacuation orders (i.e., through newscasts, social media, or automated alerts on a smartphone).

Responsiveness to evacuation alerts has been found to vary by age, gender, and other factors. Men and full- time residents may be more likely to want to stay and protect their property, whereas homes with children, elderly individuals, pregnant women, individuals with health concerns, or part-time residents are more likely to evacuate early.[38]

Providers can ask whether a patient would be willing to evacuate when asked to do so. For those individuals who are unwilling to evacuate, especially for individuals with chronic medical conditions or who rely on electronic devices such as ventilators, reviewing the risks from hurricanes and floods may be helpful in motivating and enabling evacuation to safety when necessary. Be sure to talk about risks associated with flooding, and the importance of never walking or driving through floodwaters.

If a high-risk patient will not have the needed assistance to evacuate, a provider can ask permission to share the patient's contact information with local emergency managers.

Extensive, multilingual guidance on evacuation planning is available from FEMA.

After a hurricane

Short-term

If patients have evacuated, they should only return home when authorities say it is safe.

There can be substantial dangers associated with returning home, including exposure to floodwaters, which can lead to infectious diseases and toxic exposures as described above. In addition, there can be similar toxic exposures when cleaning up after a flood, particularly because of mold. Debris from hurricanes can also be dangerous and lead to traumatic injuries. Counsel patients on NOT using electrical equipment in water as it could lead to electrocution. Additionally, counsel on using generators only outdoors or in well-ventilated spaces to avoid carbon monoxide exposure.

Patients with respiratory conditions like asthma or other immunological conditions or immune suppression should be particularly careful with toxic, mold, and infectious exposures during cleanup.

Long-term resilience and recovery

Consider speaking with your patients about long term plans to improve their resilience to future hurricanes. This can include how and where to build their home and what types of building materials may be more able to withstand hurricane winds. It can also include ensuring backup power sources and creating plans for critical utility interruptions.

There may be available local resources to help with long-term resilience that can be shared, or there are federal resources such as FEMA's flooding risk map available here: https://www.fema.gov/flood-maps/tools-resources/risk-map that help make you aware of risks in the community to promote informed development or thee National Flood Insurance Program to reduce the long term impacts of floods.

Notes:

References

1. Knutson TR, Sirutis JJ, Bender MA, Tuleya RE, Schenkel BA. Dynamical downscaling projections of late twenty- first-century U.S. landfalling hurricane activity. *Climatic Change 2022 171:3*. 2022;171(3):1-23. doi:10.1007/ S10584-022-03346-7
2. Garner, A.J. Observed increases in North Atlantic tropical cyclone peak intensification rates. Sci Rep 13, 16299 (2023). https://doi.org/10.1038/s41598-023-42669-y
3. Baldini LM, Baldini JUL, McElwaine JN, et al. Persistent northward North Atlantic tropical cyclone track migration over the past five centuries. *Sci Rep*. 2016;6(1):37522. doi:10.1038/srep37522
4. Wang S, Toumi R. Recent migration of tropical cyclones toward coasts. *Science*. 2021;371(6528):514-517. doi:10.1126/SCIENCE.ABB9038
5. Cao W, Zhao S, Sun S. Mortality risks associated with flood events. BMJ. 2023 Oct 4;383:2101. doi: 10.1136/bmj.p2101. PMID: 37793692.
6. Parks RM, Benavides J, Anderson GB, et al. Association of Tropical Cyclones With County-Level Mortality in the US. *JAMA*. 2022;327(10):946-955. doi:10.1001/JAMA.2022.1682
7. Dresser C, Balsari S, Leaning J. Hurricanes and Health. *Oxford Research Encyclopedia of Natural Hazard Science*. Published online March 23, 2022.
8. Swerdel JN, Janevic TM, Cosgrove NM, Kostis JB. The effect of Hurricane Sandy on cardiovascular events in New Jersey. J *Am Heart Assoc*. 2014;3(6). doi:10.1161/JAHA.114.001354
9. Jiao, Z. et al. Effect of Hurricane Katrina on incidence of acute myocardial infarction in New Orleans three years after the storm. *Am. J. Cardiol.* 109, 502–505 (2012).
10. Lawrence WR, Lin Z, Lipton EA, Birkhead G, Primeau M, Dong GH, Lin S. After the Storm: Short-term and Long-term Health Effects Following Superstorm Sandy among the Elderly. Disaster Med Public Health Prep. 2019 Feb;13(1):28-32. doi: 10.1017/dmp.2018.152. PMID: 30841951.
11. Velez-Valle E, Shendell D, Health SE… of E, 2016 undefined. Type II diabetes emergency room visits associated with Hurricane Sandy in New Jersey: implications for preparedness. *JSTOR*. 2016;79(2):30-37. Accessed September 2, 2022. https://www.jstor.org/stable/26330515
12. Travia KR, Kahkoska AR, Igudesman D, Souris KJ, Beasley C, Mayer-Davis EJ. Impact of Hurricane Matthew on Diabetes Self-Management and Outcomes. N C Med J. 2021;82(2):100. doi:10.18043/ NCM.82.2.100
13. Parks RM, Anderson GB, Nethery RC, Navas-Acien A, Dominici F, Kioumourtzoglou MA. Tropical cyclone exposure is associated with increased hospitalization rates in older adults. Nat Commun. 2021 Mar 9;12(1):1545. doi: 10.1038/s41467-021-21777-1. PMID: 33750775; PMCID: PMC7943804.
14. Bourque, L. B., Siegel, J. M., Kano, M. & Wood, M. M. Weathering the storm: the impact of hurricanes on physical and mental health. *Ann. Am. Acad. Pol. Soc. Sci*. 604, 129–151 (2006).
15. Blum MF, Feng Y, Anderson GB, Segev DL, McAdams-DeMarco M, Grams ME. Hurricanes and Mortality among Patients Receiving Dialysis. *Journal of the American Society of Nephrology*. 2022;33(9):1757-1766. doi:10.1681/ ASN.2021111520
16. Kelman J, Finne K, Bogdanov A, et al. Dialysis Care and Death Following Hurricane Sandy. *American Journal of Kidney Diseases*. 2015;65(1):109-115. doi:10.1053/J.AJKD.2014.07.005
17. Karimaghaei C, Merkley K, Nazari H. Ophthalmology emergency room admission after Hurricane Harvey. *Am J Disaster Med*. 2021;16(4):255-261. doi:10.5055/AJDM.2021.0409
18. Sun S, Weinberger KR, Yan M, Brooke Anderson G, Wellenius GA. Tropical cyclones and risk of preterm birth: A retrospective analysis of 20 million births across 378 US counties. *Environ Int*. 2020;140:105825. doi:10.1016/J. ENVINT.2020.105825
19. Ng PC. The fetal and neonatal hypothalamic–pituitary–adrenal axis. Arch Dis Child Fetal Neonatal Ed. 2000;82(3):F250-F254. doi:10.1136/FN.82.3.F250

20. Kishore N, Marqués D, Mahmud A, Kiang MV, Rodriguez I, Fuller A, Ebner P, Sorensen C, Racy F, Lemery J, Maas L, Leaning J, Irizarry RA, Balsari S, Buckee CO. Mortality in Puerto Rico after Hurricane Maria. N Engl J Med. 2018 Jul 12;379(2):162-170. doi: 10.1056/NEJMsa1803972. Epub 2018 May 29. PMID: 29809109.
21. Parks RM, Kontis V, Anderson GB, Baldwin JW, Danaei G, Toumi R, Dominici F, Ezzati M, Kioumourtzoglou MA. Short-term excess mortality following tropical cyclones in the United States. Sci Adv. 2023 Aug 18;9(33):eadg6633. doi: 10.1126/sciadv.adg6633. Epub 2023 Aug 16. PMID: 37585525; PMCID: PMC10431701.
22. Perlin SA, Wong D, Sexton K. Residential proximity to industrial sources of air pollution: interrelationships among race, poverty, and age. *J Air Waste Manag Assoc*. 2001;51(3):406-421. doi:10.1080/10473289.2001.10464271
23. Bakkensen LA, Ma L, Blomquist G, et al. Sorting Over Flood Risk and Implications for Policy Reform. Published online July 2020. Accessed September 3, 2022. https://www.frbsf.org/economic-research/wp-content/uploads/ sites/4/Bakkensen_Ma_2020.pdf
24. Waddell SL, Jayaweera DT, Mirsaeidi M, Beier JC, Kumar N. Perspectives on the Health Effects of Hurricanes: A Review and Challenges. Published online 2021. doi:10.3390/ijerph18052756
25. Powell R, Gilbert S. *The Impact of Hurricanes Katrina and Rita on People with Disabilities: A Look Back and Remaining Challenges*.; 2006. Accessed September 3, 2022. https://ncd.gov/publications/2006/aug072006
26. Chakraborty J, McAfee AA, Collins TW, Grineski SE. Exposure to Hurricane Harvey flooding for subsidized housing residents of Harris County, Texas. *Natural Hazards*. 2021;106(3):2185-2205. doi:10.1007/S11069-021- 04536-9/TABLES/4
27. Friedrich MJ. Determining Health Effects of Hazardous Materials Released During Hurricane Harvey. *JAMA*. 2017;318(23):2283-2285. doi:10.1001/JAMA.2017.15558
28. Wang C, Bowers BJ. Bracing For Hurricanes: A Qualitative Analysis of the Extent and Level of Preparedness Among Older Adults. *Gerontologist*. 2018;58(1):57-67. doi:10.1093/GERONT/GNX187
29. Prohaska TR, Peters KE. Impact of Natural Disasters on Health Outcomes and Cancer Among Older Adults. *Gerontologist*. 2019;59(Supplement_1):S50-S56. doi:10.1093/GERONT/GNZ018
30. Dyregrov A, Yule W, Olff M. Children and natural disasters. Eur J Psychotraumatol. 2018 Aug 15;9(Suppl 2):1500823. doi: 10.1080/20008198.2018.1500823. PMID: 30128084; PMCID: PMC6095022.
31. Cowan KN, Pennington AF, Gregory T, Hsu J. Impact of Hurricanes on Children With Asthma: A Systematic Literature Review. Disaster Med Public Health Prep. 2022 Apr;16(2):777-782. doi: 10.1017/dmp.2020.424. Epub 2021 Feb 9. PMID: 33557998; PMCID: PMC8349925.
32. Lee S, Jayaweera DT, Mirsaeidi M, Beier JC, Kumar N. Perspectives on the Health Effects of Hurricanes: A Review and Challenges. *Int J Environ Res Public Health*. 2021;18(5):1-18. doi:10.3390/IJERPH18052756
33. Levy K, Woster AP, Goldstein RS, Carlton EJ. Untangling the Impacts of Climate Change on Waterborne Diseases: A Systematic Review of Relationships between Diarrheal Diseases and Temperature, Rainfall, Flooding, and Drought. *Environ Sci Technol*. 2016;50(10):4905-4922. doi:10.1021/ACS.EST.5B06186/ASSET/ IMAGES/LARGE/ES-2015-06186D_0005.JPEG
34. Mapili K, Rhoads WJ, Coughter M, Pieper KJ, Edwards MA, Pruden A. Occurrence of opportunistic pathogens in private wells after major flooding events: A four state molecular survey. *Science of The Total Environment*. 2022;826:153901. doi:10.1016/J.SCITOTENV.2022.153901
35. Centers for Disease Control and Prevention. Mosquitoes, Hurricanes, and Flooding. Accessed August 31, 2022. https://www.cdc.gov/mosquitoes/mosquito-control/community/mosquitoes-and-hurricanes.html
36. Barbeau DN, Grimsley LF, White LE, El-Dahr JM, Lichtveld M. Mold Exposure and Health Effects Following Hurricanes Katrina and Rita. *Annu Rev Public Health*. 2010;31:165-178. doi:10.1146/annurev.publhealth.012809.103643

37. Saulnier DD, Brolin Ribacke K, von Schreeb J. No calm after the storm: a systematic review of human health following flood and storm disasters. *Prehosp Disaster Med*. 2017;32(5):1-12. doi:10.1017/s1049023x17006574
38. Kim HK, Takematsu M, Biary R, Williams N, Hoffman RS, Smith SW. Epidemic gasoline exposures following Hurricane Sandy. Prehosp Disaster Med. 2013;28(6):586-591. doi:10.1017/S1049023X13009023
39. Centers for Disease Control and Prevention. Carbon Monoxide Poisoning: Natural Disasters and Severe Weather. Accessed September 1, 2022. https://www.cdc.gov/disasters/carbonmonoxide.html
40. Wang Z, Wu X, Dai W, et al. The Prevalence of Posttraumatic Stress Disorder Among Survivors After a Typhoon or Hurricane: A Systematic Review and Meta-Analysis. *Disaster Med Public Health Prep*. 2019;13(5-6):1065- 1073. doi:10.1017/DMP.2019.26
41. Schwartz RM, Gillezeau CN, Liu B, Lieberman-Cribbin W, Taioli E. Longitudinal Impact of Hurricane Sandy Exposure on Mental Health Symptoms. *International Journal of Environmental Research and Public Health 2017*, *Vol 14, Page 957*. 2017;14(9):957. doi:10.3390/IJERPH14090957
42. Olteanu A, Arnberger R, Grant R, Davis C, Abramson D, Asola J. Persistence of Mental Health Needs among Children Affected by Hurricane Katrina in New Orleans. *Prehosp Disaster Med*. 2011;26(1):3-6. doi:10.1017/ S1049023X10000099
43. Schwartz RM, Sison C, Kerath SM, et al. The impact of Hurricane Sandy on the mental health of New York area residents. *Am J Disaster Med*. 2015;10(4):339-346. doi:10.5055/AJDM.2015.0216
44. Lowe D, Ebi KL, Forsberg B. Factors increasing vulnerability to health effects before, during and after floods. *Int J Environ Res Public Healt*h. 2013;10(12):7015-7067. doi:10.3390/IJERPH10127015
45. Garfin DR, Thompson RR, Holman EA, Wong-Parodi G, Silver RC. Association Between Repeated Exposure to Hurricanes and Mental Health in a Representative Sample of Florida Residents. *JAMA Netw Open*. 2022;5(6):e2217251-e2217251. doi:10.1001/JAMANETWORKOPEN.2022.17251
46. Lowe SR, Rhodes JE, Zwiebach L, Chan CS. The Impact of Pet Loss on the Perceived Social Support and Psychological Distress of Hurricane Survivors. *J Trauma Stres*s. 2009;22(3):244. doi:10.1002/JTS.20403
47. Raker EJ, Lowe SR, Arcaya MC, Johnson ST, Rhodes J, Waters MC. Twelve years later: The long-term mental health consequences of Hurricane Katrina. *Soc Sci Med*. 2019;242:112610. doi:10.1016/J.SOCSCIMED.2019.112610
48. Ochi S, Hodgson S, Landeg O, Mayner L, Murray V. Disaster-Driven Evacuation and Medication Loss: a Systematic Literature Review. *PLoS Curr*. 2014;6. doi:10.1371/CURRENTS.DIS.FA417630B566A0C7DFDBF945910EDD96
49. Nogueira LM, Sahar L, Efstathiou JA, Jemal A, Yabroff KR. Association Between Declared Hurricane Disasters and Survival of Patients With Lung Cancer Undergoing Radiation Treatment. *JAMA - Journal of the American Medical Association*. 2019;322(3):269-271. doi:10.1001/jama.2019.7657

Hurricane Response Actions

For Administrators

Hurricanes pose a significant threat to the safety, well-being, and continuity of operations for healthcare facilities located in coastal areas. This Hurricane Response Actions document is divided into three sections, each addressing a specific phase of hurricane response: actions to take at the start of the hurricane season, when a hurricane watch or warning is issued, and during a hurricane event.

This document is intended to support clinic or health center administrators, managers, and/or the designated Weather Resilience Lead(s) to ensure their clinics are ready to protect the health and safety of their patients and staff during a hurricane.

Start of hurricane season

☐ Regularly monitor the National Hurricane Center (see **Weather Hazard Monitoring**).

☐ Review and verify your clinic's insurance policy to ensure adequate coverage for severe weather damage and repairs. There may be distinct policies or coverage based on the type and cause of damage. It is critical to understand the policy deductibles, coverage limits, and any exclusions in the policy.

☐ If your clinic or health center owns the property where it operates, pre-identify at least 2 companies that could conduct a professional assessment for flood and wind damage. If a single company cannot cover the full range of assessment services, identify multiple companies that together could do a complete safety assessment.

- Companies should be licensed, insured, and experienced in assessing damage at healthcare facilities.
- Sign an MoU where appropriate. The MoU should outline the scope of services, response times, and any associated fees.
- Put companies' contact information (and agreement, when applicable) in the partner contact information section of the clinic's emergency preparedness plan.

☐ If the clinic or health center owns the property, pre-identify a restoration team that can conduct necessary repairs. As above, multiple companies may be required to cover specialties such as structural safety, mold remediation, and HVAC systems. Ensure restoration companies are licensed, insured, and experienced with healthcare facilities.

☐ If your clinic or health center site is leased property, verify with the property manager who is responsible for hiring and paying assessment professionals and who is financially responsible for repair work. Discuss emergency preparedness plans and coordination with the property manager.

☐ Check the lease to understand whether the clinic will be required to pay rent during the restoration process.

☐ Ensure digital backup of patient records, if possible. Backups should be stored securely off-site or in the cloud to ensure accessibility in case of damage to the clinic systems. Patient records must meet HIPAA requirements.

☐ Considering stocking up on essential supplies, as hurricane impacts to transportation infrastructure can disrupt or delay supply delivery.

To mitigate damage to your facility, consider:

- Installing excess flow valves in the plumbing system (if not already in place). These will shut off water in the event of a burst pipe and will help mitigate water damage.
- Installing a sewer backflow valve (if not already in place) to prevent sewage from backing up through drainpipes into the facility during a flood.
- Placement of essential items for storage in safe locations. (For example, don't store generators in a basement that might flood).
- When upgrading the facility, consider building materials that provide greater damage resistance.
- Proactively removing any trees or tree limbs near the facility that may fall during high winds.

When a hurricane watch or warning is issued

Hurricanes forecasting models can often predict impact zones within 72 hours of projected landfall. Evacuation requirements may necessitate taking action even earlier. Consider the following actions when hurricanes are projected to impact your clinic or health center:

☐ Securing any outdoor equipment or furniture that may cause damage during high winds.

☐ Make sure gutters and drains are clear from debris.

☐ Reschedule patient visits and work with clinical staff to identify referral sources for patients in the event of an extended closure of the clinic/facility (this becomes more critical the more essential/timely the service is arranging for alternate dialysis locations and/or extra pre-storm dialysis sessions can be lifesaving).

☐ Consider transferring the main phone line to an on-call phone. This will allow clinicians to answer health-related questions or direct patients to available resources while the clinic is closed.

☐ Prepare to close the facility if told to evacuate.

☐ Ask clinical staff whether they may want to volunteer at local evacuation shelters. If so, connect them with the local Red Cross office or emergency management agency.

During a hurricane event

- Expect to close during a hurricane as transportation to and from your facility will be dangerous. Minimizing damage and preparing for the recovery process can help reduce the amount of time your facility is closed.
- Follow local emergency management guidance, alerts, and orders.
- After the hurricane, please refer to the **Guidance and Checklist for Facility Repair and Re-Entry After Storms and Flooding** document for guidance.

Notes:

Hurricane Communications Template

For Administrators

Effective communication is crucial for health centers and clinics to ensure the safety and well-being of their patients and staff during hurricanes. This document provides guidance and sample messages that can be used to disseminate important information and alerts before, during, and after hurricanes.

Before a hurricane

Recorded phone message or email – preparedness and staying informed

A hurricane is expected in [impacted region].

You can look up risk for flooding at your home's location at Riskfactor.com. This site will tell you the likelihood that flooding will occur at your address.

You can check for flood alerts and hurricanes/tropical storms on your phone, computer, or local news station. You can also get information on floods and hurricanes or tropical storms at weather.com.

In case you need to evacuate, keep a kit of emergency supplies ready so you can easily grab and go. [Clinic name] will remain [open / closed]. If open, specify hours and services provided

Know the difference between a flood warning and flood watch.

Flood warning is issued when flooding is happening or will happen soon. Some roads will be flooded.

Flood watch is issued when flooding is possible. Stay tuned to radio/TV/news media and be ready to seek higher ground.

Severe storms and hurricanes create conditions where injuries are more common. Know the risks to your health from hurricanes and floods and how to minimize them:

- Standing water – even as little as 6 inches of water can cause you to lose control of your vehicle.
- Power outages – if you use electric medical devices, you will need to have a back-up power plan in case you lose power.
- Infections – Standing water can contain bacteria and viruses that can cause disease. It can also serve as breeding ground for infection-transmitting mosquitos.
- Poor water quality – After severe storms, water may not be safe to drink, especially water from private wells. Listen for boil water advisories. Throw away any food and bottled water that may have contacted floodwater.

- Mold – Molds can grow after flooding, which can then cause coughs, congestion, and headaches as well as asthma flares.
- Electrocution – Strong winds can knock down or damage power lines. DO NOT touch any downed power lines or wade into standing water that power lines may have fallen into because this can electrocute you. Turn off the power to your appliances at the circuit breaker or fuse box if your home has flooded because wet appliances may also pose an electrocution risk.
- Falling trees, utility poles, and buildings – They can become unstable and fall on people and property.
- Carbon monoxide exposure – If you lose power, do not heat your home or cook by burning fuels such as wood or propane. These can lead to carbon monoxide poisoning.

Social media post or text messages – preparedness (1-5 days in advance)

A hurricane is expected in [impacted region].

You can look up risk for flooding at your home's location at Riskfactor.com. This site will tell you the likelihood that flooding will occur at your address.

You can check for flood alerts and hurricanes/tropical storms on your phone, computer, or local news station. You can also get information on floods and hurricanes or tropical storms at weather.com.

Potential for a hurricane exists in [impacted region]. Monitor weather forecasts for updates. Create an evacuation plan. You can find your evacuation zone and route here.

Get your emergency kit ready in case you need to evacuate.

Social media post or text messages (36 hours in advance)

A hurricane is approaching in [impacted region]. Monitor local media outlets for evacuation orders and prepare to evacuate. Know what evacuation zone your home is in and what the best evacuation routes are so that you can evacuate if needed. You can find your evacuation zone and route here.

During a hurricane

Social media post or text messages – prepare for evacuation

A hurricane is forecasted for [impacted region]. Pay attention to local media outlets for updates on the hurricane. Stay inside until you hear or see an official message that the hurricane is over. Stay away from windows because you can get hurt by pieces of broken glass or flying debris. Stay in a room with no windows or go inside a closet. Turn off gas and water supplies before you evacuate.

Keep your emergency supply kit ready to go. Remember to bring:

- All medications plus an extra stock for 7 days
- Medical paperwork, including a list of all conditions, medications, and dosages taken
- Charged essential medical equipment and back-up batteries
- All assistive devices including eyeglasses, dentures, hearing aids, and communication devices

[Clinic name] is open for [specify services] services from [opening time] to [closing time]. Due to damage at our normal location, we are currently providing services at [address / location].

Note: Only include the second sentence if your clinic has changed location

After a hurricane

Recorded phone message or email – clinic status

[Clinic's name] has / has not experienced significant damage as a result of the hurricane. We are working to get all services up and running as soon as possible.

To the degree possible, provide a brief overview of the damage and steps taken so far towards restoration.

Social media post or text messages – clinic status and safety

Like you, the clinic staff have just been allowed back into [impacted area] and we will begin inspecting the damage to our facility. Stay safe as you begin to assess the damage to your home. Remember:

Do not enter your home until it is safe to do so

Look for obvious structural damage, downed power lines and the smell of gas. Alert utilities companies as necessary.

Hurricanes can cause contamination of ground water. Check [local resource] to know what water quality safety measures are in place for your protection.

Notes: