Floods and Health

For Providers

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

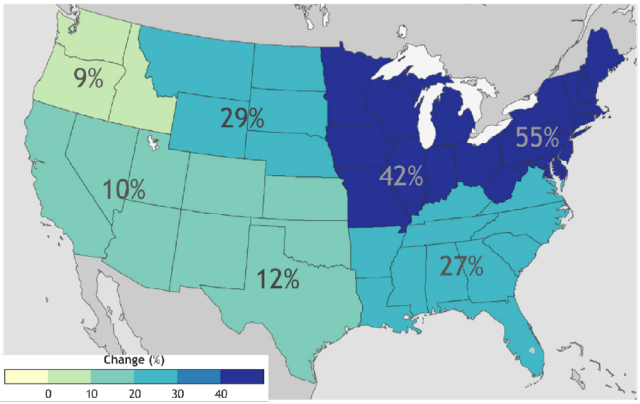
Floods and climate change

Flooding can result from:

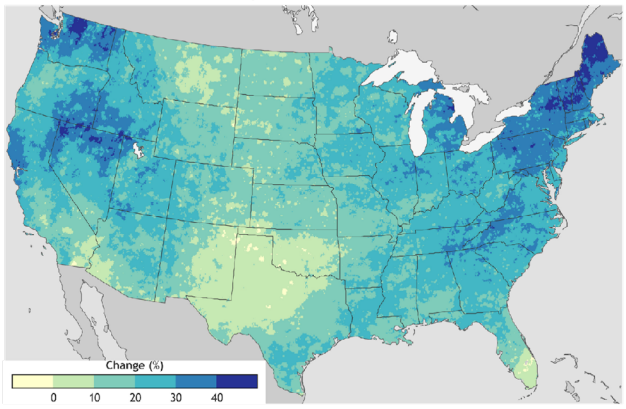
- prolonged or intense rainfall or snowmelt
- failures of infrastructure such as levees or dams
- the built environment, particularly in cities where lesser vegetation and more paved surfaces may increase flood potential.

Precipitation events have already become more severe in recent decades in many parts of the United States and, with climate change, are expected to become even more intense.

Observed change in total annual precipitation falling in heaviest 1% of events,1958-2016



Change in total annual precipitation falling in heaviest 1% of events Late 21st Century, lower emissions - RCP 4.5



Source: Fourth National Climate Assessment - Figure 2.6

Health impacts of floods

Floods can contribute to a wide range of adverse health outcomes related to drowning, infectious disease outbreaks, mold infestations in buildings, mobilization of toxic substances, social upheaval, displacement, food and water contamination and physical and emotional trauma. Most direct flood related mortality is from drowning, accounting for up to 75% of immediate mortality.[1]

Patient case

A 37-year-old woman presents to your clinic with concerns about allergies. She says she has had a runny nose and been sneezing a lot and has felt very fatigued since moving back into her home after a recent flood, which inundated their home to a depth of 4 feet and led to them throwing out most of their furniture. She has also noticed that her children have similar symptoms.

What might be causing the symptoms, and what steps can this patient take to protect herself and her family? What other actions would you suggest they take at the same time given the situation?

Immediate health risks from flooding

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

Infectious diseases associated with flooding

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.[2]

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, such as those described in the table below.[3] Individuals who obtain water from private wells may be at particularly high risk, but even public water systems can be contaminated during extreme storms.[4]

Precipitation and flooding		
Cryptosporidium, *G. lamblia*	Increased discharge from water treatment plants, industry, and animal-feeding operations due to flooding and infrastructure damage	Increased because of higher pathogen burden in water sources
V. cholerae, hepatitis A virus, other fecal pathogens	Compromised WASH infrastructure (e.g., wells and potable water sources) due to damage from flooding and extreme events	Increased because of higher pathogen burden in water sources

Precipitation and flooding		
Leptospira, staphylococcus, hepatitis A virus, rotavirus	Increased pathogen mobilization and transport due to stormwater runoff and sewage overflow	Increased because of more frequent exposure to contaminated surface water (e.g., floodwater) and soil (e.g., mud)
Escherichia coli O157:H7 and other fecal pathogens from animal and human sources	Increased runoff from non-point sources (e.g., livestock manure, wildlife, or septic system); groundwater contamination with fecal pathogens during heavy precipitation in regions with insufficient water treatment; overwhelmed water treatment, resulting in contamination of water sources and river and lake sediments	Increased because of higher pathogen concentrations in surface water

Standing water may create breeding grounds for disease-carrying mosquitos[5] and fungal growth. Flooded homes are much more likely to have higher levels of molds, such as Aspergillus, Penicillium, and Cladosporium.[6,7] Patients with allergic disorders may be more likely to develop symptoms from mold exposures.[7] Fungal infections are less common, but immunocompromised individuals have developed respiratory fungal infections after flood induced mold exposures.[7]

Population displacement that occurs after 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.[7]

Toxic exposures

Flooding can result in exposure to hazardous substances that are present in and around your community. Hazardous exposures can come from:

- impoundments (e.g., coal fly ash; industrial chemicals in manufacturing facilities; animal wastes in ponds adjacent to livestock operations)
- landfills (flooding causing leaching of materials from landfills)
- soils (e.g., carcinogenic polychlorinated biphenyls or PCBs may have leached over time into soils and flood waters may push them into wells)
- carbon monoxide with power outages (indoor or inadequately ventilated electrical generator use combined with absent or non-functional carbon monoxide monitors.[7] 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)

Health risks depend on which toxins are released and the extent of exposure to them. After flooding, monitoring may be done to assess air and water quality but may not be adequate to address all relevant hazardous exposures.

Floods and mental health

Mental health may decline after flooding, with greater reports of depression, anxiety and post-traumatic stress often reported. Individuals displaced by floods, especially when they were unaware of imminent flood risk, as well as those who have been cut off from close friends and family, may be at elevated risk.[9] Mental health symptoms may persist for years after flooding occurs.[10, 11]

Disruption of health-systems infrastructure and displacement

Floods 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 floods has been associated with increased morbidity.[12, 13]

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[14] and may have worse outcomes as a result.[15]

Populations at greater risk for harm after flooding

Population	Risk
Children	May be more likely to be outdoors and play in flood waters leading to health harms such as drowning or infectious diseases. They are also developing physically and mentally and may be more at risk for mental health harms and poor air quality from mold after floods.[16]
Pregnant and postpartum women	Flooding can lead to increased risks of pregnancy complications such as preterm birth and eclampsia.[16] More likely to: • experience waterborne illness • mental health exacerbations such as PTSD[16]
Rescue workers, first responders and occupational risks	More likely to sustain unintentional injuries during and after storms.[17]
People living with chronic diseases	May be more likely to have disease flares due to: • supply chain disruptions and medication shortages • difficulty accessing treatment or care • power outages affecting electric medical devices[17,18]
People living with disabilities	Face barriers to: • receiving emergency communications • evacuation due to inaccessible transportation options or lack of necessary mobility assistance • access to evacuation shelters[19] May be more likely to live in public housing or in higher flood risk areas.

Population	Risk
Older adults	More likely to have: • medical comorbidities • limited capacity to evacuate or be resilient to a flood, especially if they lose their homes[20, 16]
Minoritized, low-income, and socioeconomically disadvantaged communities	More likely to live: • near industrial facilities that release toxic substances during and after a storm[21] • in areas with high flood risk[20, 22]

Flood action plans and tip sheet for patients

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

Anticipatory guidance for patients

Anticipatory guidance for floods may contribute to improved health outcomes. The strategies and resources from the **Flood Action Plan and Tip Sheet** and the **Helping Patients Establish a Flood Action Plan** can be used to help patients prepare for floods.

Before a flood

Forecasts

Baseline and future flooding risk for many properties in the United States can be found at riskfactor.com.

Flood risk depends on many factors aside from absolute rainfall, including geography, volume of prior recent rainfall, the built environment, and proximity to rivers (and their levels). The National Weather Service does provide flash flood forecast maps that show where flooding may be most likely given expected precipitation.

Weather alert information available at weather.com or other weather websites can provide real time information on phones or other devices. A flood watch means you should be prepared to take action. A flood warning means you should take action to keep yourself safe.

Reduce risks from floods

We encourage you to provide patients with both patient handouts available in this toolkit (**Flood Action Plan and Tip Sheet**).

In addition, flood preparedness guidance and infographics are available from CDC in multiple languages.

Make sure patients are aware of the Turn Around Don't Drown Guidance from weather.gov on the risks of driving or walking through flood water, as this contributes to over half of flood related drownings.

During a flood

Evacuation

Evacuation may be the best choice when flooding is 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).

Advise patients against walking, swimming, or driving through flood waters as that can lead to drowning.

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.[11]

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 floods may be helpful to encourage evacuation to safety when necessary.

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 flood

Short-term

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

There can be substantial dangers associated with return, 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 to mold. Debris 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 immunosuppressive conditions should be particularly careful with toxic, mold, and infectious exposures during cleanup.

https://www.ready.gov/floods#after provides additional information that can be used by patients before, during and after floods.

Long-term resilience and recovery

Discuss long term plans with your patients 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 the National Flood Insurance Program to reduce the long term impacts of floods.

Notes:

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