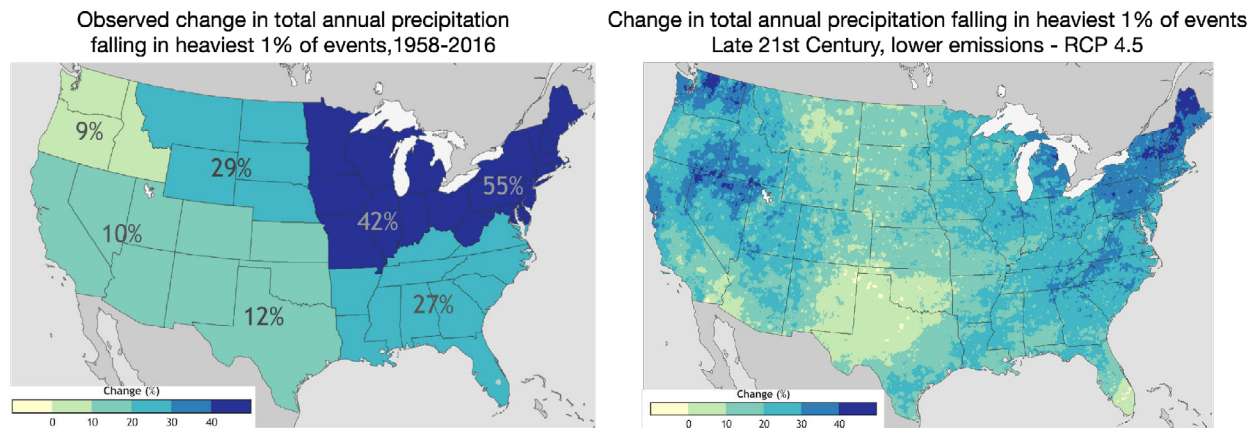




Floods and Health Providers

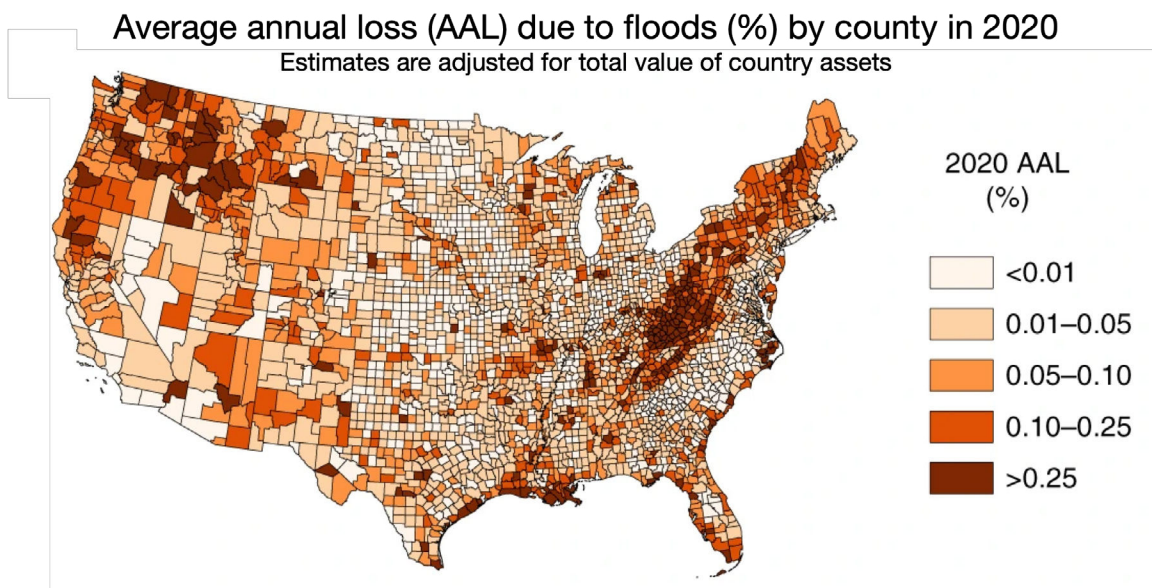
Floods and Climate Change

Flooding can result from prolonged or intense rainfall or snowmelt or from failures of infrastructure such as levees or dams. The built environment can also contribute to flooding, 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.



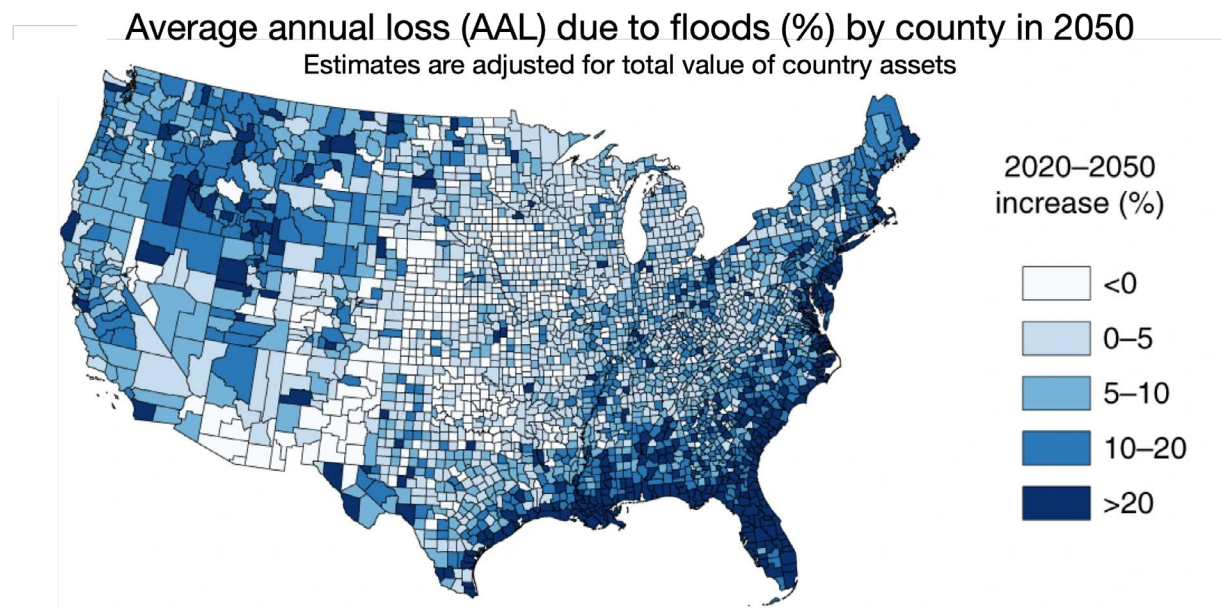
Source: Fourth National Climate Assessment - Figure 2.6

The map below shows where damages from flooding have been greatest, with darker red and brown counties suffering more losses (damages are adjusted for total assets in the county). It reveals that the Pacific North-west, Appalachia and the Gulf Coast are flood prone.



Wing, O.E.J., Lehman, W., Bates, P.D. *et al.* Inequitable patterns of US flood risk in the Anthropocene. *Nat. Clim. Chang.* 12, 156–162 (2022).
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This map shows that in the coming decades, damages from floods will grow most along the Gulf and Atlantic coasts.



Wing, O.E.J., Lehman, W., Bates, P.D. *et al.* Inequitable patterns of US flood risk in the Anthropocene. *Nat. Clim. Chang.* 12, 156–162 (2022).
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Health Impacts of Floods

Floods can contribute to a wide range of adverse health outcomes related to infectious disease outbreaks, mold infestations in buildings, mobilization of toxic substances, social upheaval, displacement, and physical and emotional trauma.

Immediate health risks from flooding

Common unintentional injuries due to floods 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.¹

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.² Individuals who obtain water from private wells may be at particularly high risk, but even public water systems can be contaminated during extreme storms.³

Standing water may create breeding grounds for disease-carrying mosquitos⁴ and fungal growth. Flooded homes are much more likely to have higher levels of molds, such as *Aspergillus*, *Penicillium*, and *Cladosporium*.^{5,6} Patients with allergic disorders may be more likely to develop symptoms from mold exposures.⁶ Fungal infections are less common, but immunocompromised individuals have developed respiratory fungal infections after flood induced mold exposures.⁶

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.⁶

Toxic exposures

Flooding can result in exposures to hazardous substances that are present in and around your community. They may be released from impoundments (e.g., coal fly ash; industrial chemicals in manufacturing facilities; animal wastes in ponds adjacent to livestock operations), landfills, or spread from soils (e.g., carcinogenic polychlorinated biphenyls or PCBs may have leached over time into soils and flood waters may push them into wells). 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.

As floods may result in power outages, 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.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, which can also lead to carbon monoxide poisoning.

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.⁸ Mental health symptoms may persist for years after flooding occurs.^{9,10}

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.^{11,12}

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 time¹³ and may have worse outcomes as a result.¹⁴

Populations at greater risk for harm after hurricanes

Population	Risk
Black and Hispanic	More likely to live: <ul style="list-style-type: none">• near industrial facilities that release toxic substances during and after a storm¹⁵• in areas with high flood risk¹⁶
Chronic Diseases	May be more likely to have disease flares due to: <ul style="list-style-type: none">• supply chain disruptions and medication shortages• difficulty accessing treatment or care• power outages affecting electric medical devices^{17,18}
Disabilities	Face barriers to: <ul style="list-style-type: none">• receiving emergency communications• evacuation due to inaccessible transportation options or lack of necessary mobility assistance• access to evacuation shelters¹⁹ May be more likely to live in public housing or in higher flood risk areas.
Low-income	More likely to live: <ul style="list-style-type: none">• closer to industrial facilities and toxic waste sites that may release pollution after a storm.¹⁹• in areas with high flood risk^{15,16}
Older Adults	More likely to have: <ul style="list-style-type: none">• medical comorbidities• limited capacity to evacuate or be resilient to a hurricane or flood, especially if they lose their homes^{20,21}
Rescue Workers and First Responders	More likely to sustain unintentional injuries during and after storms ¹⁷

Flood Action Plans for Patients

We recommend that you familiarize yourself with the “Flood Action Plan” 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 below may be helpful for you to provide to patients who are at risk from floods and reflect the “Flood Action Plan” available for patients in the toolkit.

Forecasts

Baseline and future flooding risk for many properties in the United States can be found at [riskfactor.com](https://www.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](#)ⁱ that show where flooding may be most likely given expected precipitation.

Reduce health risks from floods

We encourage you to provide patients with both patient handouts available in this toolkit (“Flood Tip Sheet” and “Flood Action Plan”). In addition, flood preparedness [guidance](#)ⁱⁱ and [infographics](#)ⁱⁱⁱ are available from CDC in multiple languages

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 smart phone).

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 enabling 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](#)^{iv} is available from FEMA.

i. <https://www.wpc.ncep.noaa.gov/qpf/ero.php?opt=curr&day=1>

ii. <https://www.cdc.gov/disasters/floods/readiness.html>

iii. <https://www.cdc.gov/orr/infographics/br-floods.htm>

iv. <https://www.ready.gov/evacuation>

[illegible]

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