



## Diabetes and Heat Providers

Exposure to high temperatures can affect glycemic control and increase morbidity and mortality for patients with diabetes,<sup>1,2</sup> especially when blood sugar is poorly controlled.

### Heat Exposure Risks for People with Diabetes

Diabetes, including types 1 and 2, may contribute to increased risk of harm from heat exposure owing to effects of the disease on the body's ability to thermoregulate.

- Heat exposure promotes dehydration, which contributes to hyperglycemia and associated diuresis.
- Diabetics have an impaired ability to dissipate heat through sweating and vasodilation, especially with poor glycemic control.<sup>3</sup> HbA1c levels greater than 8.5% are strongly associated with reductions in skin blood flow.<sup>4,5</sup>
- Acute hyperglycemic episodes may also lead to irreversible vascular changes that may impair heat loss.<sup>6</sup>

#### Autonomic Neuropathy

Diabetics with autonomic neuropathy may be particularly at risk from extreme heat exposure. Neuropathy involvement of sudomotor function (i.e., autonomic nervous system control of sweat glands) can result in hyperthermia, while involvement of vasomotor control can lead to orthostatic hypotension and vasovagal syncope, especially when dehydrated.

#### Comorbidities

Nearly 4 in 5 individuals with type 2 diabetes have hypertension and are overweight or obese, and 1 in 5 have chronic kidney disease or cardiovascular disease.<sup>7</sup> These conditions increase risk of heat-related morbidity and mortality.

### Medication Considerations

#### Insulin

Manufacturers of insulin suggest storing unopened insulin in a refrigerator between 2° and 8°C (36° and 46°F), but not in the freezer. Opened insulin should be kept below 30°C (86°F).

Studies on insulin thermostability at high temperatures have found that insulin may retain efficacy even with relatively high and fluctuating temperatures. Temperature fluctuations from 25 to 37°C (77 to 98.6°F), as occurred in a Kenyan refugee camp, did not markedly reduce insulin bioactivity at the insulin receptor, nor Akt phosphorylation in hepatic cells, when compared with samples maintained at 2 to 8°C (36 to 46°F).<sup>8</sup>

#### Medications for Diabetic Comorbidities

Diabetic comorbidities, such as hypertension and heart disease, often require pharmacologic therapies that may further increase risk for heat-associated morbidity. In a study of Medicare beneficiaries, diuretics, beta-blockers, and ACE inhibitors were all found to increase risk of hospitalization during summer months. Diabetics were found to be particularly at risk when taking antipsychotics.<sup>9</sup> Rates of hospitalization did not increase significantly during heat waves.

Importantly, some medications may reduce risk of harm during heat exposure. A one-year trial of rosiglitazone was

associated with improved heat dissipation among diabetics to levels similar to healthy controls.<sup>10</sup> Statin users may also have lower odds of all-cause mortality with increasing ambient temperature from 29 to 34°C (84 to 93°F).<sup>11</sup>

## Temperatures of Concern

The temperatures that increase risk of harm for patients with diabetes may be far lower than those considered dangerous to many people. For most cities in the United States, the minimum mortality temperature (the temperature above which mortality rates increase) is often just below the 80th percentile of the annual temperature range.<sup>12</sup>

Temperatures tend to peak in mid to late afternoon. The time of day with the highest temperatures for your location can be found at [weatherspark.com](http://weatherspark.com).

The National Weather Service (NWS) issues heat advisories, excessive heat watches, and excessive heat warnings. To see if a heat alert has been issued for your location, check the weather app on your smart phone, or go to [weather.gov](http://weather.gov) and select your county or enter your zipcode. For more details on how to access NWS alerts for heat (and other weather extremes), as well as the differences between heat watches and warning, see the accompanying toolkit document titled “Accessing Weather Alerts”.

While most adverse effects of heat exposure occur on the day of heat exposure or a few days after, some studies find that diabetics may be at risk up to 10 days after heat exposure.<sup>1</sup>

## Built Environment

The forecast temperature available to patients may not accurately represent the temperature they are exposed to in their home or community. The upper levels of multi-story buildings, especially those without air conditioning, may be much warmer than lower levels.

Urban heat islands can result in temperatures more than 4°F higher than reported due to factors such as fewer trees and parks, more asphalt and concrete, and more traffic. Black American, Hispanic, and lower-wealth communities often live in neighborhoods with greater heat island effects.<sup>13</sup> Homeless individuals are at particularly high risk of heat exposure.

## Heat Action Plans for Patients with Diabetes

Appropriate guidance for people with diabetes should be based upon an assessment of the severity of their disease, comorbidities, occupation (especially if outdoors), access to air conditioning at home, and excess heat exposure from an urban heat island or the home environment.

Prior to a heat event, you can work with the patient to develop a plan. We recommend that you familiarize yourself with the “Heat Action Plan” provided in the toolkit and review it with diabetic patients. The action plan can be provided during care visits and can be the basis for a discussion around safety planning and care management in the event of extreme heat. Action plans should be completed in advance of heat season in your locale.

For additional guidance, see the accompanying toolkit document titled “Establishing a Heat Action Plan”.

## Anticipatory Guidance for Providers to Give Patients

Anticipatory guidance for hot days 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 excessive heat and reflect the “Heat Tip Sheet – Diabetes” available in the toolkit, which we encourage you to share with patients.

1. Before going outside, check the weather forecast on your phone, television, radio, or online (e.g., at [weather.gov](http://weather.gov) or [weather.com](http://weather.com)).
2. If a patient does not have a thermostat or thermometer that measures room temperature in their home, they can be bought for a few dollars at hardware stores or online. Consider having inexpensive thermometers available in your clinic to distribute.
  - a. Indoor temperatures in the patient’s home should ideally remain <80°F. If they cannot keep the temperature below 80°F, they should use a fan or consider moving to an air-conditioned space until the temperature cools.
3. When a heat advisory or heat alert has been announced by the NWS (see “Accessing Weather Alerts” for more information), advise patients to:
  - a. Follow their heat action plan (see “Establishing a Heat Action Plan” for guidance)
  - b. If a heat advisory is issued, patients with diabetes should preferably stay indoors in an air-conditioned space. If going outside is necessary, limit outdoor activities especially during the hottest part of the day (typically 11AM to 3 PM).
  - c. If an excessive heat warning is issued, patients with diabetes should remain in air-conditioned spaces until the warning expires.

## References

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