Diabetes and temperature

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Temperature has marked effects on blood glucose control and may adversely affect injectable glucose-lowering medications, and blood glucose measurement — as discussed in a previous article. Temperature is relevant in many other ways in diabetes.

Hot and cold weather

‘Sir Ranulph Fiennes … developed frostbite after taking off his outer gloves to fix a ski binding in temperatures of around minus 35°C (minus 27.4°F) … Sir Ranulph said diabetes may have made him more susceptible to frostbite. The 68-year-old was injured in a fall while skiing during training at a base camp in Antarctica … in temperatures of around minus 35°C (minus 27.4°F) …’ [H]e said: ‘I was trying to fix the ski binding in a total white-out. I tried fixing the bindings with my big overgloves on – couldn’t do a damn thing … Some people would say surely you shouldn’t take your mitts off. OK, so you sit there and go nowhere and die of cold … You’ve got to fix your bindings in order to go back … I had to take everything off to get a grip … It was no more than 20 minutes before I noticed one of my hands had gone completely white.’ The explorer said the surgeon who treated his fingers in Cape Town suggested that diabetes may be responsible for causing the frostbite.2

Peripheral vascular disease (PVD) in people with diabetes is often diffuse. Frostbite occurs even in the UK and usually affects the toes. Cold injury is more likely in patients with peripheral neuropathy.

One group X-rayed feet and hands of people with diabetes with and without severe neuropathy matched for age and diabetes duration, and without clinical evidence of PVD. ‘Medial arterial calcification was much more common and extensive in the patients with neuropathy, occurring in the feet in 15 and in the hands in eight compared with in four (p<0.001) and none (p<0.001) of the controls respectively.’3

Despite diabetes, cardiac and other problems, Sir Ranulph subsequently completed the Marathon des Sables in Saharan temperatures >50°C!4

Heat waves or cold snaps increase mortality. During the week of the 1995 Chicago heat wave, there were 17% excess deaths overall, with a 59% excess in Londoners aged ≥75 years.5

How vulnerable are people with diabetes? A UK study reported an increased risk of admission from hypothermia among people with diabetes, compared with the non-diabetic population, mainly among women.6 Hypoglycaemia when hypothermic may be fatal.1

During the week of the 1995 Chicago heat wave, there were 11% more hospital admissions than average for comparison weeks and 35% more than expected among patients aged ≥65 years. Of the excess, 59% of admissions were for dehydration and heat exhaustion. Acute renal failure increased. Excess admissions were seen for comorbid conditions: 23% excess for cardiovascular diseases, 30% for diabetes, 52% for renal diseases, and 20% for nervous system disorders, and for emphysema and epilepsy.7

A study in Chinese cities found significant associations between extreme hot and cold temperatures and diabetes mortality. The adverse effects of cold were delayed by three days in Harbin, lasting for six days (peak relative risk 1.223 at -23°C) and by seven days in Chongqing, lasting for four days (peak RR 1.201 at 4°C). The adverse effects of heat in Harbin were delayed by one day and lasted three days (peak RR 1.343 at 37°C); in Chongqing adverse effects were not delayed and lasted two days (peak RR 1.811 at 41°C).8

Why are people with diabetes vulnerable to heat? Possible reasons include dehydration due to hyperglycaemia, the use of diuretic therapy, and renal impairment. Autonomic neuropathy may reduce ability to cool by sweating. PVD, particularly when distal and diffuse, may reduce skin blood flow, impairing both warming and cooling.

Many people feel faint in very hot weather. Subjects in a tilt-test study at different temperatures dropped their blood pressure. Those with diabetes showed drops averaging 10mm Hg at 22°C and 21mm Hg at 42°C with inadequate cardiovascular compensation unlike the non-diabetic subjects.9

Sensory neuropathy

‘My feet are always cold, even my left foot which has reduced feeling in it post-stroke is cold … I do have a hot water bottle at night for which I have been told off severely about by the podiatrist I work with as I have burns marks on my left leg which happened before I realised that I couldn’t feel properly on that side …’

‘It was quite an eye-opener for me to … realise just how much sensation I have lost on my left side following my stroke which puts me at relatively high risk of damaging myself without knowing and I am now reasonably careful with my feet.’10

Two men with type 2 diabetes (T2DM) and neuropathy used microwavable bags instead of a hot water bottle. The 86-year-old found a heel ulcer after the first night’s use. The 53-year-old’s ulcers took 33 weeks to heal.11

Hot water is another hazard. Advise a bath thermometer or shower thermostat for neuropathic patients. Some people, especially in Asian countries, believe that numbness will improve on bathing feet in hot water.12 Patients may even pour boiling water over their feet.

A woman with asymptomatic diabetic neuropathy burnt her hand on a cup of tea.13

We diligently test feet for neuropathic sensory loss – we should also check hands, remembering that finger-prick glucose testing is an additional reason for blunted fine touch.

One man with T2DM burnt his neuropathic feet while walking on hot sand.14 Patients with neuropathy should wear properly-fitting beach shoes. ‘Scarlet socks’ are occasionally seen in returning diabetic holiday makers. Remind patients with lower limb neuropathy to reapply sunscreen after paddling.
Hot feet
Patients with treated diabetic foot disease – whether neuropathic or arteriopathic or both – are at considerable risk of recurrence.

People with diabetes with at-risk feet measured the temperature on the soles of their feet with a handheld infrared device, calling a nurse and walking less if a difference >4°F (2.2°C) between the left and right corresponding sites occurred. After six months, only 2% of this group had had foot complications compared with 20% of matched patients.15

A meta-analysis concluded that ‘an increase in skin temperature is predictive of foot ulceration when compared with the same site on the contralateral limb... the use of temperature-monitoring is an effective way to predict, and thus prevent, diabetic foot ulceration.’16

Temperature monitoring systems for this purpose include infrared thermometry and liquid crystal thermography.17

People with diabetic peripheral neuropathy may have impaired foot sweating. They often describe hot feet (as opposed to the cold feet of those whose main problem is PVD). Pedal temperatures in people with T2DM were compared in those with and without sudomotor dysfunction. Foottemperatures in the former group were significantly higher in those with sudomotor dysfunction, and correlated with its severity.18

The onset of type 1 diabetes

Autumn and winter see an increase in workload for paediatric diabetes services as diagnoses of type 1 diabetes (T1DM) peak then. Among Swedish children lower mean temperature and fewer hours of sunshine were independently related with a greater incidence of T1DM.19

A recent analysis of data from 50 000 children in 23 European centres during 1989–2008 confirmed the seasonality of T1DM onset with peaks in November to February in all but two small centres.20

Among many theories about the onset of T1DM21 is vitamin D deficiency. Polymorphism of CYP27B1 (important in the production of the active version of vitamin D in the body) was associated an increased risk of T1DM.22

Summary

People with diabetes are particularly vulnerable in hot and cold weather. Avoid dehydration and over-medication (diuretics/hypotensives) in heat. Stay safely warm in cold weather, protecting hands and feet.

Patients with diabetic neuropathy can suffer skin burns at home or when out and about. Test hands as well as feet for sensory loss. Warn neuropathic patients to avoid hot water bottles or microwavable equivalent; to use wrist protecting oven gloves; to use sunscreen, and reapply after paddling or swimming; not to walk barefoot, even on sand; and to use a bath thermometer or shower thermostat. Check for postural hypotension.

Consider using foot temperature monitoring in patients at high risk of recurrent foot problems.

Teach patients about the effects of temperature – both on their medication1 and their bodies.

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References