

# Sweating in diabetes

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It was hot in the Peruvian rainforest – over 40°C. We walked for hours looking for wildlife. That evening my clothes were wringing wet with sweat – and the macaws had eaten my soap.

Sweating cools our bodies. Adrenaline release causes sweating too. Most sweat is excreted from eccrine glands throughout the skin, especially on the palms, soles, and head. Sweat contains mainly water and sodium chloride, with potassium, bicarbonate, and trace components including glucose. Most of the sodium chloride is reabsorbed. Apocrine sweat glands, mainly in the axillae and anogenital area, excrete sweat containing lipids, proteins and steroids, mixed with sebum. Sweat is odourless but the action of skin bacteria makes it smell, particularly the oily apocrine sweat which may act as a pheromone.

## Cystic fibrosis

Cystic fibrosis affects over 10 000 people in the UK and is recessively inherited. Accumulated thick, sticky mucus impairs lung function and invites infection, causes malabsorption by impairing pancreatic digestive enzyme release, and leads to liver disease. About a third of people with cystic fibrosis develop diabetes. The median survival of 40 years in cystic fibrosis is reduced by having diabetes.<sup>1</sup> Cystic fibrosis increases chloride excretion in sweat – so diagnosis is by sweat testing.<sup>2</sup>

## Increased sweating in diabetes

### Hypoglycaemia

Sweating is a cardinal symptom of hypoglycaemia, due to adrenaline release as part of the counter-regulatory hormonal response to the low glucose. It is an autonomic symptom mediated by cholinergic sympathetic nerve fibres.<sup>3</sup> A meta-analysis found that 47–84% of people with diabetes experienced sweating when they were hypoglycaemic.<sup>4</sup> People with diabetes should learn their own early warning symptoms of hypoglycaemia.

### Gustatory sweating

'I am a 71-year-old man with diabetes... I've developed a very annoying problem. Every time I eat, I develop terrible sweating on my face and neck. It only lasts 10–15 minutes, but my shirt collar gets soaked and I'm too embarrassed to go out to dinner.'<sup>5</sup>

Gustatory sweating may be so severe as to prevent patients from eating enough. Within seconds of eating food, sweat appears on the forehead, then face and extends to throat and neck, sometimes shoulders and chest. Cheese appears to be the most common trigger, but spicy foods and indeed any food can also cause gustatory sweating. It is associated with autonomic neuropathy.<sup>6</sup> In one study, gustatory sweating was reported in 69% of those with diabetic nephropathy, 36% of those with diabetic neuropathy, and <5% of patients without these complications or non-diabetic controls. The worse the neuropathy, the more likely the person was to have gustatory sweating. Renal

transplantation improved or eliminated gustatory sweating.<sup>7</sup> Gustatory sweating has been treated successfully with topical glycopyrrolate cream.<sup>8</sup>

### Generalised sweating

'Hi, I was diagnosed 3 weeks ago... My problem is that I am sweating profusely nearly all day and through the night, it is so embarrassing. Is this normal?' (Pjd.)<sup>9</sup>

'hey all... i am a type 2 diabetic on diet only at the moment i suffer terribly from sweating too, day and night, its like my thermostat is broken??' (shez40.)<sup>9</sup>

'Me too. I have had excessive sweating for years now... The back of my shirt gets wet but especially my face and hair... Doctor did some tests including thyroid but the answer was "you have a sensitive thermostat".' (Django.)<sup>9</sup>

'I had this sweating problem for years when the neuropathy started getting severe... Now... I do not get it anymore. But I do not sweat on my feet and they get very dry. I think this is caused by the neuropathy complication too. I get normal sweating in the upper body now. Also that profuse sweating with hypos does not happen to me now either.' (Saber.)<sup>9</sup>

'i wish someone would give us a straight answer and a solution, even doctors have not got a clue, i am dreading summer.' (flashy158.)<sup>9</sup>

There are many such comments on the internet. The cause of excessive generalised sweating is not always clear. It may be associated with autonomic neuropathy, obesity, or menopause (you risk annoying a female patient if you do not clarify her menstrual status before suggesting this). Some medications can cause sweating, e.g. exenatide,<sup>10</sup> pioglitazone,<sup>11</sup> and antidepressants. Exclude hypoglycaemia, thyroid over-activity, and other endocrinopathies. Consider infection, e.g. tuberculosis, and neoplasia.

### Hyperthyroidism

A French study of symptoms of 1144 patients with hyperthyroidism found that 51.8% had heat intolerance or sweating which was more likely with a TSH <0.1mU/L and less likely in those >65 years.<sup>12</sup> Screening diabetic clinic patients found 2% with clinical hyperthyroidism, and 0.5% with subclinical hyperthyroidism. Thyroid over-activity was more common in women and in those with type 1 diabetes.<sup>13</sup>

### Acromegaly

Sweating is a prominent symptom of acromegaly that does not appear to correlate with clinical activity, nor with insulin-like growth factor (IGF) levels.<sup>14</sup> Among 2270 subjects with diabetes or glucose intolerance without known pituitary disease, six had persistently elevated IGF-1 and inadequate suppression of growth hormone (GH) during oral glucose tolerance testing – indicating abnormal GH production. Three of them had pituitary adenomas. The author estimated a prevalence for acromegaly of 480 per million adults in the general population, suggesting that many cases remain undiagnosed.<sup>15</sup>

### Phaeochromocytoma

These rare adrenal tumours (US prevalence <1/100 000)<sup>16</sup> secrete noradrenaline and adrenaline, so sweating is a common symptom. Consider phaeochromocytoma in someone with diabetes with paroxysmal or difficult to control hypertension, especially if prone to postural hypotension, headaches, tachycardia, and 'panic attacks'.

### Reduced sweating

Reduced or absent sweating (anhidrosis) is common in the feet or legs of people with diabetic neuropathy. In one study, biopsies demonstrated denervation of sweat glands in such patients – the extent of which correlated with HbA<sub>1c</sub>. Patients with sudomotor denervation also had evidence of cardiac autonomic neuropathy.<sup>17</sup> Skin samples in limbs amputated for diabetic foot disease showed shrunken eccrine sweat glands with thickening of the basement membrane.<sup>18</sup> Patients with absent sweating have dry feet and the skin is at risk of cracking and infection. Advise an appropriate moisturising cream and extra vigilance by the patient and the diabetes team. (Note that the study above used amputated limbs – a risk for these patients.)

### Hidradenitis suppurativa

'Hidradenitis suppurativa... is a chronic, inflammatory, recurrent, debilitating skin disease that usually presents after puberty with painful, deep-seated, inflamed lesions in the apocrine gland-bearing areas of the body, most commonly the axillary, inguinal and anogenital regions.' The lesions may spread outside these areas.<sup>19</sup>

It is a distressing and embarrassing condition. On examination, there are: rounded nodules (inflamed and non-inflamed); the holes of sinus tracts, perhaps draining pus; and abscesses. There may be extensive scarring and tethering of skin. Prevalence is estimated at 1% of the population. Risk factors include being female, smoking, obesity, having Crohn's disease, and perhaps diabetes, Cushing's syndrome and acromegaly.<sup>19</sup> The extent of the condition is often overlooked and the diagnosis missed. Lesions are often deep with extensive scarring. While bacterial culture may be negative, there may be secondary infection. Treatment options include topical clindamycin, oral tetracycline or other antibiotics; and surgery in severe cases. Immunotherapy and radiotherapy have been tried. The problem often recurs. The optimal treatment regimen remains unclear. Encourage weight loss and good glycaemic control. Protect lesions from rubbing by other body parts or clothes.<sup>20</sup> Treatment is difficult. Seek expert advice.

### Glucose testing through sweat

Finger-prick blood glucose testing is painful and messy so manufacturers are seeking non-invasive methodology. Electrochemical analysis of the glucose in sweat is possible but the technology must overcome wear and tear (rubbing or pulling skin) and problems with sweat collection, the effects of secreted lactic acid on glucose oxidase, and variations in ambient temperature. A system with a disposable multi-layer patch and miniature sensors has been developed which provides multi-modal glucose testing corrected real-time for pH, temperature and humidity. It is hoped to link this to a cutaneous drug delivery system.<sup>21</sup>

### Summary

- Sweating is more frequent among people with diabetes than is realised.
- Exclude hypoglycaemia.
- If sweating is generalised: check medication, e.g. pioglitazone or exenatide; exclude hyperthyroidism or other endocrinopathies; consider infection or neoplasia.
- Gustatory sweating usually affects the head and neck and is specifically related to eating. It is associated with autonomic neuropathy, especially with co-existing diabetic nephropathy. Avoid known triggers, e.g. cheese.
- Diabetic neuropathy may damage sweat glands and impair sweating in the feet and lower legs. This dry skin is vulnerable – protect it. Ensure regular foot checks by patient and professionals.
- Hidradenitis suppurativa is under-diagnosed. Features include recurrent rounded nodules, scars, holes, and abscesses in the axillae and anogenital region. It is notoriously difficult to treat – seek expert help.
- Non-invasive blood glucose monitoring through glucose in sweat is feasible – we await clinical trials, and reports on practicality.

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