

Emollients in the care of the diabetic foot

Ivan Bristow

Dry skin (anhidrosis, xerosis) commonly affects the feet of many patients. In a people with diabetes, dry skin has the potential to progress to cracking and fissuring creating a portal of entry for bacteria. The causes of the dry skin are varied and often multifactorial. Research evidence investigating the management of this condition using emollients is limited to a few small scale studies coupled with clinical experience. This paper will review how dry skin may develop, focussing on the diabetic foot, and suggest an approach to managing this common condition.

The skin has evolved as a highly developed organ acting as a barrier between the internal milieu of the body and the external environment. As a complex, self-renewing structure it plays a significant role in preventing excess water loss from the body, while preventing the ingress of noxious physical, chemical and biological agents such as bacteria. In order to fulfil this role, the skin undertakes a complex physiological process to maintain what has been termed the “skin barrier” (Elias, 1981).

The epidermis is organised into five layers. The main cell of the epidermis, the keratinocyte, arises from the stratum basale and then ascends the epidermis through the stratum spinosum, granulosum, and finally reaching the outermost layer, the stratum corneum. By the time cells have reached this layer, they have undergone a process of differentiation transforming into dead, anucleated flattened cells termed “corneocytes”. The outermost layer of the epidermis, the stratum corneum, is where the barrier function occurs. Cells of this layer are in close apposition, which is achieved by their high water content, keeping them turgid and in close physical contact with the adjacent cells, forming a tight but flexible seal.

Turgidity of the cell is maintained by a chemical known as a “natural moisturising factor” (NMF) an intracellular humectant (a substance that attracts water to itself; Cork, 1997). NMF is derived from a substance called filaggrin, which breaks down into a range of NMFs including urea, amino-

acids, pyrrolidonecarboxylic acid, and lactic acid. Additionally, this maintains a constant acidic pH of the epidermis. Locally, the barrier is enhanced by lipid layers that act like a waterproof mortar between the corneocytes. These lipids originate from the lamellar bodies in the stratum granulosum and are secreted into the epidermis at this level forming sheets rich in ceramides, fatty acids, and cholesterol.

Desquamation is maintained by the presence of epidermal proteases, which lyse corneodesmosomes and permit gradual shedding of the outermost layer of the epidermis. The action of proteases is limited by the low pH of the epidermis (around pH 5.5) and protease inhibitors are also present in the skin. Ultimately the thickness of the epidermis is maintained by this chemical balance and pH (Cork and Danby, 2009). Consequently, the skin barrier is able to retain sufficient moisture to remain flexible and pliable.

When the skin barrier fails it becomes dry (or “xerotic”; *Figure 1a*), scaly, loses elasticity, and patients may complain of itching or stinging. Generally, it is considered a disease that is associated with ageing but there are many causes (*Box 1*) and for most patients it may be a combination of factors.

Physiological dryness is common in both the young and old, particularly in women following the menopause. With ageing, skin turnover slows – along with the production of NMFs – resulting in varying levels of dryness as the skin’s ability to retain water declines (Tagami, 2008).

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Article points

1. Many surveys of dermatological conditions in patients with diabetes have been undertaken and xerosis is commonly reported.
2. Complex biochemical changes that result from hyperglycaemia may contribute to the development of xerosis.
3. Emollients are known to be effective in the management of dry skin and are recommended as part of the routine foot care regimen in people with diabetes.

Key words

- Dry skin
- Emollient
- Xerosis

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Box 1. Causes of dry skin (xerosis) (Bristow, 2013).**Physiological**

- Young or elderly
- Menopause
- Soaps, bubble baths and shower gels
- Soaking the skin
- Insufficient rinsing of skin cleaning products
- Vigorous drying with a towel
- Over-bathing
- Temperature & humidity – air conditioning and central heating
- Sun exposure

Pathological

- Many skin conditions e.g. eczema, psoriasis, ichthyosis
- Skin infection
- Peripheral vascular disease
- Iron deficiency anaemia
- Hypovitaminosis (A,B,C and E)
- Renal failure
- Diabetes
- Thyroid disease
- Anorexia nervosa
- Lymphoma and other internal malignancies
- Drugs including statins, cimetidine, retinoids

Normal bathing and washing can affect skin barrier function. Bubble bath, soaps (including moisturising brands), and shower gels can dry skin, particularly when applied vigorously or when they are not thoroughly rinsed from the skin during bathing. Moreover, such products are known to raise the skin's pH (Larson, 1999), promoting the activity of natural skin proteases, causing increased desquamation, and loss of skin barrier function. Product additives can also have a similar effect; sodium lauryl sulphate is a common ingredient and is known to be an irritant and increases water loss through the epidermis (Tsang and Guy, 2010). Practices avoiding the use of soaps can be hazardous to the skin barrier – soaking in pure water for long periods (>15–20 minutes) can have a significant drying effect (Bullus, 1998).

Pathological dry skin occurs due to the effect of diseases which may reduce NMF production or alter the keratinisation process itself. Skin diseases are a prime example of xerosis as many exhibit dryness as part of their symptoms.

Skin diseases are estimated to affect between 30% and 100% of people with diabetes (Bristow, 2008). Uncontrolled hyperglycaemia is thought to be responsible for an array of changes affecting the plantar tissues, including stiffening of connective tissues, abnormal load distribution, and increased susceptibility to infection and foot ulceration (Pavicic and Korting, 2006).

Many surveys of dermatological conditions in people with diabetes have been undertaken and xerosis is commonly reported in people with diabetes, frequently concurrent with the symptoms of pruritis, fissur and callus formation (*Figure 1b*). Estimates in diabetic populations have been found to be as high as 82% (Litzelman et al, 1997). However, research has not yet elucidate if the condition is more prevalent in people with diabetes than those without as, undoubtedly, the causes of xerosis in people with diabetes will share similar aetiologies to that of xerosis in those without the condition – particularly where common comorbidities associated with xerosis exist, such as psoriasis (Armesto et al, 2012), peripheral vascular disease (Faglia, 2011), renal failure (Bakris et al, 2000), and tinea pedis (Mayser et al, 2004).

However, complex biochemical changes that result from hyperglycaemia in diabetes may contribute to the development of xerosis through alternate

Figure 1. Examples of (a) xerosis of the foot, and (b) heel fissures.



pathways. Autonomic neuropathy causing vascular dysfunction reduces sweating on the foot, leading to epidermal dryness and fissuring (Vinik et al, 2003). In addition, skin elasticity is reduced in those with diabetes (Hashmi et al, 2006) with the deposition of advanced glycation end products (Aye and Masson, 2002). Coupled with increased plantar pressures in people with diabetic (Veves et al, 1992), the diabetic foot is at increased risk of trauma and skin damage. Ultimately, an impaired skin barrier can increase the chances of bacterial infection (Bristow and Spruce, 2009), a major risk factor for lower-limb amputation (Lavery et al, 2006).

Selection and benefits of emollient products

Literature on emollient selection and usage is limited and often not evidence-based (Hon et al, 2013). Much of it is based on common practice and

general consensus (Penzer, 2012), particularly in the management of dry skin conditions such as eczema and psoriasis, with even less focussed evidence available for dry skin on the diabetic foot.

Emollients are known to be effective in the management of dry skin (Proksch, 2008) and are recommended as part of the routine foot care regimen in people with diabetes (NICE, 2004). Research suggests that this may not only serve to improve skin quality but develop a preventative behaviour for detecting early diabetic foot lesions (Suico et al, 1998). As to which brand of emollient should be used, this should be a balance between patient preference and the available evidence for the specific condition being treated.

An emollient (often synonymously called a moisturiser) has a number of functions; it softens and raises the moisture content within the epidermis, increases the skin's resistance to irritation from outside agents, and improves pliability (Lodén, 2005). Emollient products contain a lipid base (fat, wax, or oil) with varying degrees of added water. Ointments tend to have the lowest water content through, with creams and gels having increased water content, while lotions have the lowest lipid content and, by their nature, feel lighter and less occlusive to the user (Bristow, 2013), although they have been shown to increase skin dryness through increased evaporation (Hon et al, 2013).

Not all emollients are the same and many have adjuvant ingredients to enhance efficacy. Despite a general lack of evidence in the effectiveness of emollients, much has been documented about the additives urea and alpha-hydroxy acids (AHA), such as ceramides, glycolic, and lactic acid (*Table 1*). Early work suggested the effectiveness of urea-based products (Van Scott and Yu, 1974), subsequently much investigation into its properties has been undertaken, with Locke et al (2012) undertaking a useful review of this literature.

As a naturally occurring substance within the skin, research has demonstrated urea's effectiveness at varying concentrations (5%–40%). Its ability to hold water within the epidermis (Cork and Danby, 2009), have a keratolytic effect (i.e. thinning of the epidermis without reducing water retention), and – as has been shown more recently – antimicrobial properties (Grether-Beck et al, 2012), have been documented. Recent work Lodén et al (2013)

demonstrated a 15% urea formulation rapidly improved dryness in the feet of people with diabetes, along with a measurable thinning of hyperkeratosis on the foot without detriment to the water retaining capacity of the epidermis.

Lactic acid, another naturally occurring lipid, has also been shown to be an effective emollient ingredient. Lactic acid has been shown to promote the synthesis of ceramide production in the skin, improving barrier function, and reduce susceptibility to infection and irritation (Rawlings et al, 1996).

Dosages and application

General guidance on emollients suggests that they should be applied frequently and can be used on other areas of unaffected skin safely (Penzer, 2012). The foot presents as a unique area, owing to its acral location, thick plantar epidermis and footwear being worn for significant periods of time. It has been recommended that heavier emollients containing urea may be more beneficial for the foot, and application of products just prior to bedtime may be more advantageous. Application of the emollient to the foot, covering the foot with a damp under sock and then a dry over sock may enhance the effectiveness of the moisturisation overnight and prevent soiling of bed clothes with emollient products (Bristow, 2013).

Emollients available in pump dispensers are considered to be more user-friendly, with a lower risk of contamination than traditional product tubs (Carr et al, 2008). Suggested dosages for a pair of feet are around 4–8 g per day of emollient (1 g being

Page points

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3. Not all emollients are the same and many have adjuvant ingredients to enhance efficacy, including urea and lactic acid.

Table 1. Examples of emollient products containing urea and their excipients (British Medical Association and Royal Pharmaceutical Society, 2011).

Brand Name	Constituents	Excipients
Aquadrate Cream	10% urea	None
Balneum Cream	5% urea, ceramide 1%	Benzyl alcohol, polysorbates
Calmurid	10% urea, 5% lactic acid	None
Dermatonics Heel Balm	25% urea	Beeswax, lanolin
E45 Itch Relief	5% urea	Benzyl alcohol, polysorbates
Eucerin Intensive Cream	10% urea	Benzyl alcohol, isopropyl palmitate, wool fat
Flexitol	25% urea	Benzyl alcohol, cetostearyl alcohol, fragrance, lanolin
Hydromol Intensive	10% urea	None
Nutraplus	10% urea	Hydroxybenzoates (parabens), propylene glycol

equal to roughly a single “pump” from an emollient dispenser; Bristow, 2013).

Adverse reactions to emollients are rare but can occasionally occur as irritancy or allergy. This is most frequently caused by excipients within common emollient formulations. *Table 1* highlights common additives to urea-based emollient preparations. Where a patient has a history of skin sensitivities, allergies or a history of eczema, a small area should be tested for a minimum of 48 hours before general use of any new emollient product (Penzer, 2012).

Conclusion

Dry skin (xerosis) on the foot is a common in people with diabetes, probably due to a combination of factors. The use of emollients can improve foot health through improving skin integrity and can also serve as a means of daily foot inspection for people with diabetes and at-risk feet. It is likely that any emollient applied regularly will have a positive impact on skin condition. Emollient choice should be primarily be based on patient choice, in consultation with their healthcare professional. Advice on how to use them should also be encouraged to ensure maximal effectiveness. Of the limited research into the most effective emollients for the diabetic foot to date has focussed on the benefits of using urea based products, which show positive benefits when compared to other emollients. ■

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