A study to assess a cosmetic product in the treatment of cracked heels among diabetics

Kate Carter, Alistair McInnes, Judith Anders, Martin Grant, Elizabeth Cheek

ABSTRACT

**Background** An evaluation of the effectiveness and safety of two readily available over-the-counter cosmetic products used in the treatment of cracked heels on people with diabetes mellitus. **Method** An aqueous cream and 25% urea cream were randomly allocated to the right and left foot of each participant. Products were applied twice-daily for 2 weeks. The effectiveness of each product was assessed using corneometry, the Xerosis Assessment Scale (XAS), and a self-perception questionnaire. **Results** 25 people with type 2 diabetes and moderate foot xerosis were included. The mean corneometer values revealed no significant differences in skin hydration between the products (p>0.05). A clinical improvement in skin hydration was shown by the XAS scores and mean self-perception questionnaire scores. **Conclusions** The results support the daily use of emollients for improving xerosis in the diabetic foot. Further research is indicated to assess the effectiveness and safety of urea-based emollients for the treatment of xerosis.

Declaration of interest This study was funded by Scholl, owned by Reckitt Benckiser, who supplied the test product. Funding was paid directly to the University of Brighton and the right to publish was reserved.

Key words

Diabetes
Urea
Emollient
Xerosis
Dry skin
Cracked heels

Introduction

Xerosis is one of the most common abnormalities with prevalence higher than 40% observed in the diabetic foot (Romano et al, 1998), promoting ulceration through the development of fissures and hyperkeratosis (Garrigue et al, 2011). In patients who have diabetes, fissures can provide portals of entry for fungal or bacterial infection. Fissures are considered the main complication of anhydrosis and are implicated in the causal pathways to foot ulceration in patients with diabetes and autonomic neuropathy (Locke et al, 2012). At present, it is unclear how many diabetic foot ulcers are preceded by anhydrotic fissures. However, fissures affecting the foot appear to be common in patients with diabetes (Locke et al, 2012). The treatment of xerosis is therefore paramount and must be implemented early on (Garrigue et al, 2011).

Current prevention of foot ulceration and amputation focuses on identifying at-risk patients and regular provision of podiatric care by the Foot Protection Team (NHS Diabetes and Diabetes UK, 2011). Foot health education and advice is widely recommended for all people with diabetes. The National Institute for Clinical Excellence states that foot care education that includes the benefits and necessity of moisturising skin is a key preventative measure (NICE, 2004). Studies have demonstrated the efficacy of moisturisers in repairing the epidermal barrier function and in treating xerosis (Gerrits et al, 2008). Although moisturiser use as part of preventative...
care is widely accepted, there are few data available regarding the effectiveness of the products available for this purpose in people with diabetes (Baker, Rayman, 2008). Therefore, the identification of an emollient that is optimally effective at reducing the relevant risk factors for diabetic foot ulceration is important.

Emollients containing urea have been shown to significantly increase the hydration of the skin measured by skin capacitance, and therefore directly increase skin elasticity and smoothness (Rawlings et al, 2004). Several studies have focused on the efficacy of urea-based moisturisers in a variety of dry skin conditions (Jennings et al, 1998), but only seven have assessed their impact on the feet of diabetic patients (Garrigue et al, 2011; Baker, Rayman, 2008; Pham et al, 2002; Baird et al, 2003; Scholemann et al, 2007a; Papanas et al, 2011; Grossman et al, 2011). The properties of urea are concentration-dependent, with moisturising effects at 5%, desquamation action at 20% and keratolytic action at 40% (Raab, 1997). The studies including people with diabetes test urea creams containing percentages ranging from 5% (Garrigue et al, 2011), 10% (Baker, Rayman, 2008; Pham et al, 2002; Scholemann et al, 2007a; Papanas et al, 2011), 25% (Baird et al, 2003), to 33% (Grossman et al, 2011). Baird et al (2003) concluded that the 25% urea cream was both clinically and statistically more effective than the preparations with 10% urea cream. Locke et al (2012) also stated there is promising evidence that a 25% urea cream may be more effective in the short term for the hydration of the skin on the plantar aspect of the foot for patients with diabetes.

There are many cosmetic products available for sale over-the-counter that are marketed for use on dry skin and cracked heels, but that have not undergone the rigorous evaluation of a clinical trial. This lack of evidence base is of particular concern in regard to foot care for people with diabetes. The aim of this study was to assess the effectiveness and safety of Scholl Cracked Heel Repair Cream K+, a moisturiser containing 25% urea, specifically designed for the treatment of cracked and fissured heels.

Methods
This comparative controlled study was conducted at The University of Brighton, Leaf Hospital Eastbourne. Each participant served as his/her own control. The test and control product were randomly assigned to either the right or left foot of each participant. Treatment order was randomly predetermined using a computer software programme and allocated to participant codes (Jennings et al, 2008), providing a distribution of each product between right and left foot.

Ethical opinion was sought and approved by the West London Research Ethics Committee and The University of Brighton Faculty Research Ethics and Governance Committee. The investigation was undertaken in accordance with the governing principles of the Helsinki Declaration and the relevant local regulations.

Participants
Participants were recruited from East Sussex Podiatry Services [East Sussex Healthcare NHS Trust] and The University of Brighton, Department of Podiatry, Leaf Hospital Eastbourne. The participants eligible for inclusion were men and women aged over 18 years with type 1 or type 2 diabetes mellitus with moderate to severe xerosis on both feet (assessed using a validated Xerosis Assessment Scale (XAS) scoring ≥3 to ≤7, and score differences of ≥1 between feet). Participants with and without peripheral neuropathy were included, tested with a 10g monofilament and 128-Hz tuning fork. The loss of protective sensation at more than one site, plus loss of vibration sensation, established the presence of peripheral neuropathy. Participants also included were those who were able to treat their own feet and did not require podiatry treatment of the test area prior to or during the study.

Exclusion criteria were current foot ulcers or any history of foot ulcers, current skin allergies or skin diseases, a previously unfavourable reaction to any foot care products and bleeding fissures on the feet. The presence of critical ischaemia diagnosed by an ankle-brachial index of <0.4 was excluded due to the potential of skin damage caused by the urea content of the test product. Other exclusion criteria included females who were pregnant, lactating or taking inadequate precaution to prevent pregnancy; patients taking concurrent medication likely to affect the response to the control and test products or confuse the results of the study, and those with a significant current or past medical history that would compromise the safety of the participant or affect the outcomes of the study.

Individual participant assessments, involving a medical questionnaire and foot examination, were undertaken to establish suitability for involvement in the study. Written informed consent was obtained from each participant enrolled in the study prior to involvement.

Study design
Xerosis was clinically assessed with the XAS (Garrigue et al, 2011; Pham et al, 2002), a nine-point scale (0-8) that assesses the amount and size of skin flakes, scales and fissures (Table 1). The scale was used to assess the skin on both heels at day 0, day 7 and day 14 by the same investigator podiatrist.

Table 1.
The Xerosis Assessment Scale.

<table>
<thead>
<tr>
<th>Assessment of Xerosis</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal skin</td>
<td>0</td>
</tr>
<tr>
<td>Few minute flakes</td>
<td>1</td>
</tr>
<tr>
<td>Many places many undifferentiated flakes</td>
<td>2</td>
</tr>
<tr>
<td>Some polygonal scales</td>
<td>3</td>
</tr>
<tr>
<td>Moderate number of polygonal scales</td>
<td>4</td>
</tr>
<tr>
<td>Large number of polygonal scales</td>
<td>5</td>
</tr>
<tr>
<td>Fissuring between scales</td>
<td>6</td>
</tr>
<tr>
<td>Moderate deep fissuring between scales</td>
<td>7</td>
</tr>
<tr>
<td>Deep fissuring</td>
<td>8</td>
</tr>
<tr>
<td>Xerosis assessment scale</td>
<td>/8</td>
</tr>
</tbody>
</table>

Xerosis was also assessed using the quantitative biometric method of corneometry, which measures moisture content of the epidermis via skin capacitometry.
Each application. The use of any other washing hands thoroughly between other hand to apply the other cream, one hand to apply one cream and the amount of each product and to use they were asked to apply a pea-sized the left foot twice-daily for two weeks. and the alternate cream to the heel of one cream to the heel of the right foot 25% urea. Heel Repair Cream K+ was the test product with the active ingredient of purified water to 100%). The Cracked paraffin, phenoxyethanol 1% w/w and sulphate, liquid paraffin and white soft cetostearyl alcohol, sodium lauryl 30% w/w (ingredients include: dry skin. It is an emulsifying ointment as it is commonly recommended by BP was selected as the control product for feet treated with the test product. Aqueous cream BP and Scholl Cracked heel products applied to the feet was prohibited 48 hours prior to the study’s commencement and during the study.

Statistical analysis
The Wilcoxon signed-rank test was used to compare the two products on each of the three days. The products were also compared using the change in score from day 0 at days 7 and 14. Cronbach’s alpha was used to assess the internal consistency of responses to the self-perception questionnaire.

Results
25 people were recruited to the study, 17 male and 8 female, aged between 42 and 87, all with type 2 diabetes mellitus (Table 2). One participant dropped out after day 7. Recruitment ceased on reaching a total of 25 participants. There were 17 participants with no neuropathy and 8 with neuropathic.

Table 2. Study group demographics.

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants (n)</td>
<td>17</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>71.24</td>
<td>63.50</td>
<td>68.76 (range 42.87)</td>
</tr>
</tbody>
</table>

Following completion of the study it was revealed that the pot labelled ‘cream A’ contained the aqueous cream BP and the pot labelled ‘cream B’ contained the 25% urea-based cream.

Xerosis Assessment Scale
Clinical assessment of the feet revealed no significant difference in XAS scores between the feet at the beginning of the study (p=0.128), with both groups showing moderate xerosis at baseline. The higher the XAS scores, the more severe the xerosis. Figure 2 shows improvement in xerosis was noted to both feet of each participant during the study; but there was no significant difference between the test and control products.

A significantly greater improvement from day 0 to day 14 was found for the test product B compared with the control product A. Therefore, the test product showed significantly greater (p<0.05) improvement in xerosis scores compared to feet treated with the control product between day 0 and day 14 (Table 3).

Corneometer measurements
The corneometry results at day 0 were consistent with the clinical XAS scores showing there was no significant difference in xerosis between the feet at the beginning of the study (p=0.417), with both groups showing moderate xerosis at baseline. The greater the degree of skin hydration, the higher the corneometry value recorded (Girard et al, 2000). The mean corneometry values in Figure 3 show an increase in skin hydration for feet treated with the test product and for feet treated with the control product between day 0 to day 14, but no significant differences were found between the products (Table 4).
A marked improvement was noted between day 0 and day 7 with similar values found on day 7 and day 14. The questions asked participants to rate the skin and cracks on the heels, which included how severe, soft, nourished, smooth, thick, dry and supple the skin was on the heel area, the level of discomfort caused by cracked heels, and rating the condition and appearance of the skin on the heels. There was a high level of internal consistency within the questionnaire at each time point (minimum Cronbach’s alpha = 0.897). Therefore, mean values over the 10 questions were compared. The mean values are based on an ascending Likert scale of 0 to 5 whereby the most negative perception of skin condition received the highest score. The average self-perception score was significantly higher for the test product than the control product at day 0 (Table 5).

Therefore, the test product was randomly assigned to the foot perceived to have significantly more severe xerosis by the participants. There was no significant difference at days 7 or 14. However, there was a significantly greater improvement from day 0 to day 7 for the test product compared with the control product (p<0.05), depicted in Figure 4.

### Product acceptability questionnaire

On day 14 study participants were asked to rate their satisfaction with cream A and cream B using a product acceptability questionnaire, again based on a 0 to 5 Likert scale with the most negative attributes receiving the highest score. No significant difference was found between the products in any of the attributes.
Furthermore, Figure 5 shows the mean scores for all attributes were less than 3, suggesting that both products were well evaluated with no particular problems. Texture was the only attribute scored less favourably for test product B than the control product, with ease of use and odour rated equally, and all others were rated better for the test product, including improvement in skin condition, overall product satisfaction and use of the product again.

**Participant adherence**
18 out of 25 participants completed the diary, producing 72% patient adherence to the twice-daily applications of creams. Therefore, 28% of participants failed to apply the cream twice daily.

**Evaluation of safety**
There were no reported skin reactions or other adverse effects for the duration of the study.

**Discussion**
Although podiatrists routinely advise patients with diabetes on the importance of regular emollient application, a cornerstone of good foot health education, this medical advice is based on anecdotal experience and common sense knowledge rather than being evidence-based. The rationale is to keep the skin of the foot soft and pliable, helping to prevent complications that may lead to limb-threatening infection or ulceration (Baker and Rayman, 2008). However, there are few data available regarding the effectiveness of the products available for this purpose in people with diabetes (Locke et al, 2012; Baker, Rayman, 2008). The study aim was to evaluate the effectiveness and the safety of the test product containing 25% urea in the treatment of foot xerosis in patients with diabetes.

### XAS
The XAS scores showed moderate xerosis in both groups at day 0. The baseline xerosis levels were similar to the study by Garrigue et al (2011) and Pham et al (2002) both having used the XAS. In this study, continual improvement was noted in the XAS scores for both products, with the test product at each point receiving lower scores than the control product; this trend is also consistent with other studies (Garrigue et al, 2011; Pham et al, 2002). However, this study showed no significant difference between the two products, unlike the results of Garrigue et al (2011) and Pham et al (2002).

### Corneometry
A marked improvement in mean corneometer values and thus skin hydration was observed at day 7, but this did not continue to day 14. This is consistent with the results shown by Garrigue et al (2011) with a greater percentage increase reported between day 0 and 14 than between day 14 and day 28. Although Papanas et al (2011) noted a significant improvement in skin capacitance after 1 and 2 weeks of treatment with a 10% urea cream, this was compared to an untreated foot and not relative to another emollient. The lack of statistical significance in using the XAS may be due to a shorter study period and a smaller sample size. Of the few papers published on urea cream use on diabetic xerosis, studies by Garrigue et al (2011) and Pham et al (2002) have one of the longest trial periods and larger sample sizes of 54 and 40 respectively. The current study of 2 weeks duration was similar to other published methodologies such as Baker and Rayman (2008), Papanas et al (2011), and Grossman (2011). The study sample size also aligned with other published research using similar methodologies; sample sizes ranging from 10 to 30 (Baker; Rayman, 2008; Baird et al 2003; Papanas et al, 2011; Grossman, 2011). However, other studies that included a clinical assessment of xerosis used non-validated scales (Baker; Rayman 2008; Grossman et al, 2011). The effectiveness and safety profile of urea creams should be established using longer trial periods, greater sample sizes permitting adequate statistical power, and using validated scales such as the XAS.

### Table 6
The p-values from Cronbach’s alpha to assess the internal consistency of responses to the acceptability questionnaire.

<table>
<thead>
<tr>
<th>Comparison between product A and B</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>0.999</td>
</tr>
<tr>
<td>Odour</td>
<td>0.999</td>
</tr>
<tr>
<td>Texture</td>
<td>0.403</td>
</tr>
<tr>
<td>Absorption</td>
<td>0.997</td>
</tr>
<tr>
<td>Feel of skin</td>
<td>0.467</td>
</tr>
<tr>
<td>Improvement</td>
<td>0.499</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.173</td>
</tr>
<tr>
<td>Use again</td>
<td>0.473</td>
</tr>
</tbody>
</table>

Figure 5. Scores from the product acceptability questionnaire completed by participants on day 14.

![Figure 5](image_url)
and reproducibility of measures was not performed prior to the commencement of data collection, which may have identified inter-day and intra-day variations. This could have influenced the results and may be the reason for no statistically significant difference being found in skin capacitance measures compared with other studies (Garrigue et al, 2011; Baird et al, 2003; Scholemann et al, 2007a; Papanas et al, 2011).

Participant questionnaires

The results of the self-perception questionnaires revealed participants were unable to detect a significant difference in the condition of the skin on either foot during the study. This is in agreement with the results found by Pham et al (2002) who included a diary sheet for participants to record any comments regarding the study creams. All 40 participants completed the diary sheets but 19 did not make any additional comments, 5 stated both their feet felt better, and 5 stated the foot to which the test product was applied felt and looked better (Pham et al, 2002). Although this study concluded the 10% urea cream provided significantly greater improvement in xerosis of the studied population, only 12.5% of the participants reported having noticed a difference to their feet.

A general trend was observed of mean values decreasing at each point during the study for both products, representing more positive perceptions of skin condition. However, subjective impartiality — whereby the participant attempts to pre-empt a favourable response — cannot be eliminated from consideration, despite minimal interaction with the investigator during completion of the questionnaires and blinding to the products and previous scores.

The day 14 product acceptability questionnaire showed that the mean scores for all attributes relating to usability, formulation and satisfaction were less than 3, suggesting that both products were well evaluated and tolerated. The test and control products were not matched in colour, odour or texture therefore it was possible for participants to identify a difference between the products. However, participants were not made aware to the name or content of either product so this will not have fully un-blinded the study. No statistically significant differences between the products in any of the attributes were found, suggesting participants were unable to distinguish between the products.

Though texture scored less favourably for the test product than the control product, participants rated the cream containing 25% urea better for improvement of skin condition, overall product satisfaction and use of the product again. This is in general agreement with a study by Baker and Rayman (2008) who used a satisfaction questionnaire to show the 10% urea cream was rated ‘high’ by 83% of participants for overall satisfaction, and when asked which cream they wished to continue using 96% of participants selected the urea cream. However, data for satisfaction of the control moisturiser (the participant’s regular moisturiser) was not reported clearly and thus direct comparison is difficult.

Baker and Rayman (2008) report that adherence to moisturising feet appears to be short-lived among people with diabetes and its practice should be perceived to have worthwhile and noticeable benefits, especially if that task is to become a part of everyday life. Therefore, assessing this subjective element for observed improvements should be considered important for changing health behaviour, but few studies have included this as part of their evaluation (Baker; Rayman 2008; Pham et al, 2002). It has been proposed that a multipronged bio-metropolitan approach helps to better identify the changes in the stratum corneum of diabetic xerosis (Piérard, 2012). Only this current study and the research by Garrigue et al (2011) have used a mixed quantitative and qualitative methods approach while also using validated clinical assessment tools.

Study limitations

Other studies in this field of research concluded the urea-based creams were more effective than the control products. The lack of statistical significance in this study may be a result of other limitations identified in this section leading to potential error.

The corneometry readings provided sufficient evidence to demonstrate an increase in skin capacitance and improved skin hydration. However, this study did not investigate skin elasticity (Yoon et al, 2002) or skin autofluorescence (Gerrits et al, 2008) that would indicate changes to the mechanical properties of skin as a result of improved hydration. To explore the causal pathophysiological pathway towards diabetic foot ulceration, it would be useful for further studies to include the measure of skin elasticity and skin autofluorescence, to link the development of microvascular complications in patients with type 2 diabetes leading to skin changes and the mechanical improvements following increased skin hydration from emollient application.

This comparative study was purposefully designed to reflect true-to-life patient health behaviour. Therefore, footwear, socks, exact amount and technique of product application, activities following application, frequency of bathing, use of different soaps, for example, were not controlled and thus their effect cannot be excluded. However, with the participants acting as their own control this allowed for fair comparison between feet. The methodology design reflects the complex nature of providing diabetic foot health education. Confounding factors such as concordance and contamination were accounted for but could not be controlled. In clinical practice, patients are advised to adopt a self-care foot regime and the same degree of variability to the accuracy of its undertaking will apply.

Patient non-adherence and difficulties following an effective emollient application regimen are well documented in the dermatology literature (Baker; Rayman, 2008). A study by Somroo et al (2011) showed an excess of 70% of patients with diabetes possibly non-adherent to a daily moisturising routine. Many patients feel that multiple daily applications of an emollient contribute to the already significant burden experienced as a result of their disease (Loden et al, 2005; Locke et al, 2012).
propose reducing the burden of repeated daily applications by the identification of an emollient that is effective at reducing relevant risk factors for diabetes foot ulceration with a once-daily application, and thus improving patient adherence.

**Conclusion**

Both creams, the Aqueous cream BP and 25% urea-based cream (Scholl Cracked Heel Repair Cream K+), clinically improved skin hydration as assessed by a podiatrist and by the participants. There were no reported skin reactions or other adverse effects during the study and both creams were well evaluated and tolerated by all participants. Although, this study was not able to establish any statistically discernible differences in the level of skin hydration between the two products, the results support the daily use of emollient for improving xerosis in the diabetic foot.

There are many cosmetic products available for sale over-the-counter that are marketed for use on dry skin and cracked heels, but have not undergone the rigorous evaluation of a clinical trial on patients with diabetes. Further research is indicated to assess the effectiveness of urea-based emollients for increasing skin hydration and elasticity and, in turn, the prevention of diabetic foot ulceration.

**References**


