The multifactorial nature of leg ulcers and the necessity to address all aetiologies to ensure successful healing: a case study

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Abstract

The aetiology of leg ulcers is multifactorial in nature and all of the factors need to be addressed so that appropriate management can be implemented. This article describes a case study of a female with diabetes that presented to the wound management service (WMS) with a chronic leg ulcer. This ulcer was complicated by infection, venous disease and impaired microcirculation. The management of this ulcer by the multidisciplinary team is outlined and the costs involved in the treatment are also discussed. Only when all of the aetiologies were addressed did healing rate increase, confirming the importance of correct diagnosis in managing leg ulcers.

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Introduction

Leg ulcers can be painful, take a long time to heal and place a considerable burden on the health budget. It is well known that the longer the ulcer is present, the more difficult it is to heal [1]. Moreover, patients with diabetes have reduced sensory nerve function, contributing to impaired healing [2] and an increased risk of infection [3]. The overall outcome in this group of patients is ulcers that balloon in cost due to the increased time it takes to heal.

These situations need to be avoided. Timely referral to appropriate services would ensure adequate care was provided. This would then reduce the length of time that the ulcer is present and reduce the risk of infection, which would normally further delay healing, particularly in those high risk patients with diabetes. Further, in patients with diabetes, a reduction in sensory nerve function and the consequent reduction in microvascular blood flow and transcutaneous oxygen tension need to be considered as factors that could contribute to delayed healing.

The Wound Foundation of Australia runs a wound management service (WMS) clinic at the Heidelberg Repatriation Hospital, a campus of Austin Health, Melbourne, Australia. This is a private clinic that sees patients with chronic wounds, referred from the community by general

practitioners or specialists. This multidisciplinary service aims to use current, evidence based practice to appropriately manage wounds, with an emphasis on research. Aged care specialists, nurses, podiatrists, pharmacists and researchers contribute to the management of patients to provide best care.

This case study will outline the treatment of a chronic 'venous' leg ulcer in a patient at the clinic with diabetes, including the costs involved.

Case study

Medical history

Ms C is a 41 year old woman diagnosed with diabetes for 11 years. She is obese, suffers from dermatitis and has osteoarthritis in her right knee. She is currently taking a variety of medications: Advantan ointment (0.1%) and elocon ointment (0.1%) for her dermatitis, Amaryl (2mg), celebrex (100mg), Levlen ed 150mcg/30/mcg), Lipex (10mg), Losec (20mg), Mitard injection 30/70 novolet 3ml, nilstat oral (500,000iu), ventolin (100mcg) and panamax as required. At time of referral to the WMS, she was taking IV Cephtriaxon antibiotics (1gm). Ms C is allergic to honey, cashews, indocid and plastic tape.

Upon presentation to the WMS

Ms C first presented to the WMS at the Heidelberg Repatriation Hospital on 16 January 2003. The ulcer was situated on the left medial gaiter region, 32x30mm in size, with depth level III, with visual estimates of 80% tenacious yellow slough and 20% necrotic tissue as evidenced by blackened areas visible in the wound (Figure 1).

There was surrounding atrophe blanche, erythema/inflammation and oedema. There was moderate, serous exudate coming from the wound and surrounding venous eczema.

Figure 1. Ms C's leg ulcer at initial presentation to the WMS.

The general practitioner had taken a swab of the wound, which showed profuse growth of methicillin resistant *Staphylococcus aureus* (MRSA) and *Enterococci faecalis.* Ms C complained of pain present at the wound site.

There was a second ulcer present on the lateral aspect of her right foot. This was smaller, 2x3mm in size, with depth II and showing 100% granulation tissue. Her ankle brachial indices were found to be 1.0 in both legs. The ulcer had been present since August 2002.

She was referred to our wound clinic in December 2002. There was a history of previous ulceration, having formed in January 2002, which had healed prior to the new ulcers forming. Previous treatment for these ulcers included mild compression in the form of shaped tubular compression (listed compression of 19mmHg) and almost the full range of dressings: Hydrogel, paraffin impregnated tulle, non-stick secondary dressings and a hydrocolloid. The last dressing used was a cadexomer iodine which the patient could not tolerate because of discomfort and had to be changed back to a hydrocolloid paste.

The initial assessment by the WMS found normal ankle brachial indices, evidence of varicosities, haemosiderin deposits and oedema in the lower limb. Following the first two categories of the CEAP classification of chronic venous disease of the lower extremities [4], the WMS determined the aetiology of the ulcers to be predominantly venous ulcers with a component of bacterial infection and prescribed custom made 30mmHg compression stockings. The leg ulcer was dressed with hydrocolloid paste and foam attached with stretch hypoallergenic cloth tape. This was to be changed three times weekly. The foot ulcer was dressed with a hydrocolloid thin sheet over a smear of hydrocolloid paste, and to be changed twice a week. Further, antibiotics (ciprofloxacin) were prescribed to try to reduce the bacterial load of the wound(s).

Review appointments

Upon review at the WMS 3 weeks later, there was no change to the size of either of the ulcers; however, in the left medial gaiter ulcer, the necrotic tissue had resolved due to the action of the hydrocolloid paste and treatment of the infection reducing some of the devitalised tissue build up. Both wounds had a tissue base consisting totally of tenacious slough. Both the erythema and oedema had reduced, as had the amount of exudate. Another course of antibiotics was prescribed to ensure further reduction in infective bacteria. In

both wounds, a topical dressing of hydrocolloid paste was continued, with a non-adherent secondary dressing applied. Both wound dressings were to be changed twice weekly.

The second review 3 weeks later showed no change in size of the left medial gaiter ulcer. The right foot ulcer had decreased in size and Ms C felt reduced pain in this region. Both ulcers still had 100% slough in the bases. At this point the antibiotics were discontinued. Both ulcers continued to be dressed with a hydrocolloid paste and non-adherent secondary dressing.

At the next review, 4 weeks later, the ulcer size and amount of slough still had not altered. At this time the Sonoca ultrasonic wound debrider machine [Söring, Germany] was made available to WMS which was then used to remove the tenacious slough on the left medial gaiter ulcer. Lignocaine cream (25mg/g lignocaine and 25mg/g prilocaine) was applied to the wound, covered with plastic wrap and left in place for half an hour. After this time, the area was sufficiently numb to allow the ultrasound debridement to occur with minimal pain. The Sonoca ultrasound debrider was able to remove the majority (90%) of the slough.

Further, as Ms C had diabetes, it was postulated that a possible reduction in sensory nerve function resulting in a concomitant reduction in microvascular blood flow and oxygen tension could be contributing factors to delayed healing, even though arterial supply was normal[5]. To test this theory, we undertook oxygen tension measuring using the transcutaneous monitor TCM 400 [Radiometer, Denmark] (see Ogrin *et al.*[6] for the clinical use of the TCM 400).

Fixation rings [Radiometer, Denmark] were attached to superior and inferior sites of the ulcer, the same sites on the opposite leg, and a reference site on the chest, near the collarbone were measured concurrently. The sensors were heated to 44^{0}C and calibrated to room air. A couple of drops of contact fluid [Radiometer, Denmark] were applied in the fixation rings followed by the attachment of the sensors. The partial pressure of oxygen at the skin was then assessed when readings stabilised (approx. 15 minutes post application).

Ms C was found to have TcpO_2 reading at the left medial gaiter ulcer of 10mmHg inferior to this ulcer, and 20mmHg superiorly. The other leg also had lower readings of inferior control site 22mmHg and superior control site of 30mmHg when compared to the chest level of 63mmHg. The literature has shown that TcpO_2 reading of below 20mmHg[7] to 25mmHg [8] indicates reduced healing due to poor tissue oxygenation. Due to the low readings of TcpO_2, we referred Ms C to a hyperbaric oxygen therapy clinic to be assessed for hyperbaric oxygen treatment. Hyperbaric oxygen therapy has been shown to improve microvascular blood flow[9] and we believed that it may be effective where our other treatments were unsuccessful.

Hyperbaric therapy

Ms C was assessed and accepted for hyperbaric oxygen treatment. She underwent 2 hours of hyperbaric oxygen for 5 days a week over 8 weeks. At the end of this treatment when she returned to the WMS, her ulcer had reduced in size to 24x20mm, depth II, with visual approximation of 95% granulation tissue and 5% slough (Figure 2). The right foot ulcer was healed. Her dressing was changed to zinc and foam to be changed three times a week and she was advised to continue wearing her compression stockings. Continued improvement of Ms C's wound is expected.

Cost of treatment

Table 1 shows the overall cost of treatment of Ms C's ulcers. The hyperbaric treatment involved ambulance transport to and from the centre from the patient's home, which considerably increased the cost of this treatment. Her wound dressings during hyperbaric treatment continued to include hydrocolloid paste, foam, tape and compression, changed twice a week with application of a zinc barrier cream to the surrounding skin. The hyperbaric team also applied cortisone-containing cream to the area surrounding the ulcer for the last few weeks as there was irritation from the zinc barrier cream used. Ms C continued to see her general practitioner during the hyperbaric treatment twice weekly.

Discussion

Ms C was referred to our clinic 6 months after the ulcer formed. The ulcer at initial presentation appeared to be infected, and was very deep, with slough fully covering the

Figure 2. Ms C's leg ulcer post 40 hyberbaric oxygen treatments.

base. People with diabetes are at higher risk of infection due to a variety of reasons such as defects in the phagocytotic mechanism [3] and decreased fluidity of the polymorphonuclear cells [10]. Moreover, there is impaired sensory nerve activity in the skin of people with diabetes, hence a reduction in the release of neuropeptides and growth factors [11], further contributing to the reduction in healing rates [12, 13].

The venous disease also contributes to disturbed microcirculation as the capillaries become blocked by white blood cell margination [14]. The leukocytes release free radicals, proteolytic enzymes, cytokines and other components [14], also causing tissue damage. Reduced healing rates and higher risk of infection predispose patients with diabetes to suffer long-standing ulceration, in this case further exacerbated by the venous disease microcirculatory disruption. This combination makes it imperative that any lower extremity ulceration is assessed quickly and aetiology ascertained so that appropriate management can commence as soon as possible.

Table 1. The cost of treatment for Ms C's ulcer.

Treatment	No./ units	Cost per unit ($)	Total cost ($)
Dressings			
• Hydrogel	2	3.50	7.00
• Non adherent dressing	10	0.90	9.00
• Paraffin impregnated tulle	5	3.35	16.75
• Hydrocolloid sheet	5	4.10	20.50
• Hydrocolloid paste	8	9.80	78.40
• Cadexomer iodine	1	43.78	43.78
• Zinc paste bandage	1	9.90	9.90
• Foam	45	4.10	184.50
• Cloth tape	1	12.69	12.69
• Zinc barrier cream	1	6.25	6.25
• Cortisone cream	1	8.06	8.06
• Tubular shaped stocking	2	14.50	29.00
Compression stockings	2 pair	75	150.00
General practitioner visits	90	25.05	2,254.50
WMS consults: initial with doppler	1	137.65	137.65
WMS consults: review	4	52.10	208.40
Hyperbaric treatment	40	209.80	8,392.00
Ambulance transport	80	128	10,240.00
Total			$21,808.38

As shown by Figure 3, the ulcer started as small breaks in the skin. They were superficial, although quite sloughy. At this point the full aetiology was not known, and treatment involved antibiotics, mild compression and a topical dressing of hydrocolloid past and foam. The ulcers steadily increased in size, shown at 2 months post initial outbreak (Figure 4) and 7 months after initial wound started (Figure 1), indicating that the treatment did not address all of the factors affecting healing.

For the first few months after referral to the WMS, the infection was resolved and the ulcer became no worse. Treatment involved higher compression, which has been shown to improve capillary flow [15] and arterial pulsatile flow [16], antibiotics to address infection and a continuation of the hydrocolloid paste and foam to try to remove slough and encourage granulation. Healing did not progress as the full underlying cause of the problem was not understood.

After considering factors affected by diabetes, the aetiology was localised to a possible reduction in sensory nerve activity

Figure 3. Ms C's leg ulcer when first presented to GP.

Figure 4. Ms C's leg ulcer 2 months after intial minor breakdown.

with a consequent reduction in microvascular blood flow and transcutaneous oxygen tension. Research has shown that inhaling oxygen can improve the capillary density and growth, hence improving some of the microvascular deficits [9].

A randomised controlled trial of hyperbaric oxygen has been shown to improve wound healing in people with diabetes [17]. Ms C was referred for hyperbaric therapy. Ms C received 40 treatments over 8 weeks, after which her ulcer improved markedly, and she was well on her way to healing. As venous disease was a component further impeding healing, Ms C continued to wear compression stockings during and after the hyperbaric treatment.

The costs of the treatment were, for the most part, subsidised by the government, although dressings and compression stockings were not. The stockings are an essential component in treating venous leg ulcers and the cost burden falls to the patient. This cost is considerable and ongoing, as patients from the WMS are advised to change the stockings at least every 12 months to ensure adequate compression is maintained. The stockings are to be worn continuously even after the ulcer has healed as compression has been shown to prevent ulcer recurrence [18, 19].

Conclusion

In conclusion, this study highlights the multifactorial nature of leg ulcers and the need for all factors to be addressed so that appropriate management can be implemented. In this case, the referral to a multidisciplinary WMS was integral to the correct aetiology being found. Once aetiology was addressed, healing rates increased and this in turn reduced the risk of another infection, which would have further delayed healing, increasing costs even more. Up to this point, the cost of treating this ulcer was over AU$20,000 with the cost of the dressings and compression falling to the patient.

People with diabetes are particularly at risk of infection and need speedy intervention to prevent, at best, the ulcer(s) from becoming chronic, at worst, lower extremity amputation. Finally, we have presented only one case in which sensory nerve activity and microvasculature were significant hindrances to healing. Further research assessing a number of patients with this wound aetiology is necessary to provide rigorous, statistically relevant information upon which practitioners could base treatment management regimes.

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