WOUND MANAGEMENT

Using electroceutical treatment to reduce symptoms and improve healing in chronic wounds

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Abstract

Chronic inflammation in a wound is often associated with infection and biofilm, which are linked to raised matrix metalloproteinases (elevated protease activity) and reduced cell production along with growth hormones in the wound bed. This causes persistent challenges to healthcare professionals and increases the costs of wound management; the related symptoms also affect the quality of life (QoL) of patients living with wounds that are hard to heal.

Electrical energy known as the 'current of injury' is required to assist in tissue repair. It allows different cell types, such as white blood cells, growth factors, enzymes and fibroblasts, into the wound to allow for stimulation of cell proliferation and collagen synthesis. In chronic wounds, the current of injury becomes disrupted due to biofilms, infection and unhealthy tissue in the wound bed. This prevents the wound from going through normal physiological healing.

Use of electrical stimulation and electroceutical treatment effectively restores the current of injury, expediting normal healing and reducing chronic inflammation, biofilms, infection and associated symptoms, such as pain and high exudate. Clinical outcomes and QoL are improved and there are also economic benefits.

Keywords

biofilm, chronic wound, chronic inflammation, electrical stimulation therapy, electroceutical treatment, tissue viability

Introduction

Wound healing is complex and involves various biological processes. To heal, a wound will pass through several stages – two or more of which can occur simultaneously – including inflammation, proliferation, epithelialisation and maturation. Chronic wounds are those that do not pass through a normal and timely sequence of repair as the result of some untoward event (Cutting et al 2015). Wound healing can be disrupted and delayed by many factors including:

- Patient-related factors such as co-morbidities, age, non–concordance, and psychological and social factors.
- Factors in the wound bed, such as infection, biofilm, chronic inflammation and maceration caused by exudate.
- Extrinsic factors such as medication, radiotherapy, unrelieved pressure, malnutrition and dehydration.
- Poor diagnosis of wound aetiology (Guest et al 2015a).
- Lack of evidence-based treatment applications (O'Brien et al 2002, Vowden and Vowden 2009) because of issues concerning staff competency and/or time constraints.

This article will focus on some of the factors in the wound bed that affect healing, and the use of electrical stimulation therapy and electroceutical treatment to assist wound-bed preparation (WBP), improve clinical outcomes for patients and demonstrate economic benefits.

Inflammation and acute wounds

Inflammation is the initial phase in the healing of acute wounds following haemostasis. Matrix metalloproteinases (MMPs) are part of the larger family of metalloproteinase enzymes, which play an important part in acute wound healing throughout the inflammatory, proliferation and remodelling phases of healing (Lazaro et al 2016). The various stages of healing require specific types and levels of these MMPs, which are delicately balanced throughout. Successful healing is achieved when this inflammatory response 'switches off' and moves into a 'resolution' phase (Cutting et al 2015). Initial high levels of MMPs have been linked to delayed healing in a variety of chronic wounds and these levels change as the wound starts to heal.

Chronic inflammation

Chronic wounds are held in a persistent and abnormal inflammatory phase, similar to other chronic infections such as chronic inflammatory bowel disease, cystic fibrosis and periodontal disease. Wolcott et al (2008) suggested that the presence of biofilm causes the increased inflammatory response. The longer the wound remains unhealed, the more susceptible it is to becoming contaminated, colonised by bacteria, critically colonised and ultimately presenting as infected (Percival and Suleman 2015). The bacteria live in the wound as free-floating planktonic bacteria (unattached) and sessile bacteria, which have adhered to a suitable surface, forming a biofilm community (Wolcott et al 2008). A biofilm is composed of microorganisms which encase themselves in an extracellular polymeric substance that promotes protection of the biofilm community; this frequently makes them resistant to topical antiseptics, systemic antibiotics and normal host responses (Wolcott et al 2008).

Delayed healing in wounds including diabetic foot ulcers (DFUs), venous leg ulcers (VLUs), pressure ulcers (PUs) and dehisced surgical wounds has also been correlated to initial high levels of MMPs (Lazaro et al 2016), which should reduce as normal healing occurs.

Wounds with delayed healing therefore generally share similar biochemical characteristics, including biofilm/infection, elevated inflammatory markers, high levels of MMPs, elevated protease activity, diminished growth factor and reduced cell numbers in the wound compared to in acute wounds (Nunan et al 2014, Lazaro et al 2016).

Quality of life for patients with chronic wounds

A persistent inflammatory response is the major cause of the symptoms experienced, such as pain, odour, and high levels of exudate, maceration and peri-wound excoriation. Herber et al (2007)'s systematic review of the effects of leg ulceration on patients' quality of life (QoL) looked at qualitative and quantitative studies. This determined that patients found pain to be the worst thing about having a leg ulcer as it restricted activities such as walking and sleeping, resulting in negative well-being. The capacity to perform work and housework were impaired, as was personal hygiene, which was linked to increased loneliness and social isolation. Patients felt they were 'controlled' by their ulcer, experienced altered body image, and found the treatments and bandages uncomfortable.

Addressing some of the symptoms of chronic inflammation can therefore not only assist in and expedite the healing of wounds, but also improve patients' QoL.

Economic burden of chronic wounds

Guest et al (2015a) estimated there were 2.2 million patients (4.5%) of the adult population with a wound in the UK. The cost of managing wounds and associated co-morbidities in the UK in 2012-13 was £5.3 billion; the cost of managing just the wounds was between £4.5 billion and £5.1 billion. These figures are comparable to managing obesity, which costs £5 billion per annum and represents 4% of the total NHS budget. More than 65% of the costs were incurred in the community, with most money spent on healthcare professionals, and dressings alone accounting for 14% of the total cost. However, this is likely to be an underestimate, since it did not account for care provided in community clinics, podiatry clinics, patients' homes or care homes (Guest et al 2015a).

The cost of lower limb wounds alone was £2.3 million, with a mean difference of £3,726 between a healed and an unhealed leg ulcer; the cost of any unhealed wound was a mean 135% greater than that of a healed wound (Guest et al 2015a, 2016).

Patients with wounds for more than six months are also at greater risk of hospital admission and extended hospital stay (Ousey et al 2013), further increasing the economic burden. Lack of assessment and multidisciplinary team (MDT) working reduces healing rates for all wounds, resulting in poor clinical outcomes for patients and increased costs to the NHS (Guest et al 2015a, 2016).

Improving clinical outcomes for patients and reducing the number of wounds being managed should therefore also reduce costs for the NHS.

Wound management

Wound management requires a holistic approach to ongoing assessment which follows national and local guidelines and protocols to determine aetiology and any factors that might delay healing. A care plan should be outlined, involving the MDT as required. Training for generalist clinicians in the fundamentals of wound management

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is required to ensure competency to assess and to provide appropriate treatments (Guest et al 2016). This could be achieved through formal courses, conferences, in-house training and experiential learning. Determining the underlying cause of the wound and management of patient co-morbidities will contribute to improvement in the wound, together with good WBP using moist wound healing.

There are many topical treatments available to reduce the effects of chronic inflammation and assist in the management of biofilms. These include: anti microbials, highly absorbent dressings, protease-modulating dressings, skin protectants and compression therapy for VLUs. Additional options to be considered are advanced wound care therapies such as larvae, negative pressure wound therapy, hyperbaric oxygen, bio-healing, electrical stimulation therapy and electroceutical treatment – these might be more effective at an earlier stage in the patient pathway, to improve healing rates, QoL and reduce the economic burden. However, not all advanced therapies are readily available and/or well tolerated by the patient. Treatments should be specific to patients and adapted to their needs (Wounds International 2012). Clinicians should therefore be able to demonstrate to commissioners the clinical effectiveness and economic impact of the various treatments, to ensure the best possible outcomes are achieved in a reasonable time frame.

Electrical energy in the body and skin

Electrical impulses regulate many physiological functions. In the skin, the difference in voltage between the surface of the epidermis and the deeper layers creates a ‘skin battery’ that permits low amperage currents to stream along the skin (Martin-Granados and McCaig 2014, Kambouris et al 2014). During wounding, the streams of this ‘skin current’ discontinue at the wound site and the current flows outwards, creating a ‘current of injury’ (Kambouris et al 2014). This helps to orchestrate the repair of tissue by attracting different cell types, such as white blood cells, growth factors, enzymes and fibroblasts to stimulate cell proliferation and collagen synthesis. The current of injury ceases at epithelialisation. If the healing is halted for any reason – the presence of biofilm or infection, necrotic tissue, foreign body or chronic inflammation – the current of injury is disrupted; electrical activity has been found to be absent in some chronic wounds (Kloth and McCulloch 1996).

Electrical therapy/energy in medicine

Electrical therapy/energy has been used for centuries in medicine, to manage pain and repair fractures. In the 20th century, it was superseded by chemical compounds and its use declined; however, in the 1990s, it re-emerged in the management of pain and for athletic enhancement (Kambouris et al 2014). It is also increasingly being used as a facial therapy to reduce the effects of ageing (American Academy of Dermatology 2011). Although it has been used to manage wounds for several years, its application in practice has been difficult – the treatments are available in large units that often require several applications a day, which is not always practical in the community.

Thakral et al (2013) examined 21 randomised controlled trials (RCTs) using several different types of application of electrical stimulation to accelerate wound healing in a variety of different wound types, including VLUs, mixed aetiology leg ulcers, arterial ulcers and diabetic foot wounds. It concluded that electrical stimulation decreased bacterial infection, increased local perfusion and accelerated wound healing in recalcitrant wounds; it could also be a positive adjunctive therapy for complicated post-surgical wounds. There were several limitations to the review, such as the use of different types of electrical stimulation with varying doses and duration of therapy and the fact many of the studies were small. Therefore, further evidence is needed to establish the appropriate dosage, timing and types of electrical stimulation that are the most beneficial.

It is believed that electrical stimulation and electroceutical treatment ‘kick-starts’ or accelerates wound healing by imitating the current of injury, which has been reduced in chronic wounds (Thakral et al 2013). A reduction in inflammation, extra-cellular matrix production, cell proliferation and collagen deposition subsequently occurs, helping to restore tissues (Kambouris et al 2014, Kloth 2014). Several studies and case series have demonstrated a reduction in pain, exudate and wound size (Jünger et al 2008, Herberger et al 2012, Griffin 2013, Thakral 2013, Greaves 2014, Kambouris et al 2014, Ovens 2014, 2015, Guest et al 2015b).

Treatment modalities using electrical stimulation

Herberger et al (2012) reported a multi-centre study undertaken in Germany using an electro-stimulation impulse generator called WoundEL. This was applied twice daily to a range of refractory acute and chronic wounds that had failed to improve through standard care with modern wound dressings, the intensity of the impulses being adjusted according to patients' sensitivity. The outcome measures included wound size and change of status of tissue type in the wound bed. Results demonstrated increased granulation and epithelialisation as observed in wound photos, improved peri-wound margins, and reduction in wound odour and pain. However, WoundEL is unavailable in the UK.

An alternative to WoundEL is BRH-A2 – a class II type BF device (has double insulation or reinforced insulation against electric shock for treatments that have a medium- or long-term contact with the patient) weighing 10kg. This combines ultrasound and electro-stimulation, modulating them individually and in combination during the treatment to create a 'micro-circulation' using a massage-like process in the blood vessels and tissues to increase the blood supply.

A retrospective study (Avrahami et al 2015) undertaken in Israel used BRH-A2 for 25 minutes, twice weekly, with patients who had either VLUs or DFUs. Results demonstrated 50% wound closure in 59.3% of the DFU group and 71.1% of the VLU group within four weeks of treatment. The authors recommended further evaluation and an RCT to demonstrate the benefits of the combined therapy.

BRH-A2 is available to rent or buy in the UK and any disposable items available for purchase and are for single use only. The treatment is applied by the healthcare professional (HCP) in the clinic or hospital, and can be used alongside the patient's standard therapy.

Electroceutical treatment

Electroceutical therapy for wound management uses a small, targeted, electrical current to create a physiological change that amends the impaired biological functions in the wound, kick-starting the healing process in the wound but not healing it itself. The treatment, Accel-Heal, is a small disposable class IIa (any active therapeutic device intended to administer or exchange energy) portable medical device. Two electrodes are applied to healthy skin either side of the wound edge. The small unit is attached to the electrode pads by the HCP, patient or carer, where it applies a small, programmed, painless electrical current. The treatment is left in-situ for 12 days, during which standard wound therapy including compression bandages are continued and applied by the HCP as appropriate. It is a one-off treatment and is available on prescription in the UK.

In Guest et al (2015b)'s study, when applied to VLUs with a mean age of one year, Accel-Heal enabled full wound closure within 2.5 months; when applied to VLUs with a mean age of 6.1 years, it was linked to a 42% reduction in wound size. All patients experienced improved clinical outcomes including a reduction in pain and exudate levels. The study demonstrated that the treatment should be applied early in the patient's treatment plan, alongside compression therapy, to reduce the effects of chronic inflammation and improve healing rates.

Case study

A 50-year-old woman presented with recurrent ulceration to her right medial malleolus, which had reoccurred spontaneously three weeks previously. Her relevant past medical history included: carcinoma of the right breast, which had cleared several years ago; and a previously fractured right ankle. During assessment, her analogue pain score was 10/10 and she was crying with discomfort, particularly during dressing change. The patient was taking co-codamol 30/500 tablets every four to six hours (maximum eight in 24 hours) as prescribed and pregabalin 300mg twice daily.

She was reluctant to have her medication increased in accordance with the World Health Organization (WHO) analgesic ladder (WHO 1996). She could not tolerate a full Doppler assessment to determine an ankle brachial pressure index. However, pulses were all palpable, audible and mainly bi-phasic and tri-phasic; limb assessment suggested signs of venous hypertension.

Based on clinical examination and presentation, the leg ulcer was deemed to be of venous aetiology, although a Doppler assessment was pending to eliminate arterial disease. The patient had been taking broad-spectrum antibiotics for a wound infection for several weeks. The wound measured approximately 7.5cm x 7.5cm with 10% slough and 90% granulation and was 0.75cm deep in one area. Her dressing regime included anti microbial cleansers, topical honey and a highly absorbent dressing. She could only tolerate support bandages. Photos and tracings were taken to determine progress/deterioration (see Figures 1 and 2).

Following discussion and obtaining informed consent, it was agreed with the patient to commence the electroceutical treatment (Accel-Heal) with the aim of reducing the inflammation and the pain. Once the pain was controlled, it was planned that a full Doppler assessment and compression therapy would be commenced. The electrode pads were applied as instructed (see Figure 3) and treatment continued as before. Demonstrations were given about how to change the small electroceutical unit every 48 hours. The electrode pads would remain in-situ until the next dressing change in clinic.

The patient returned to clinic for the dressing change as scheduled. Her pain score was 3/10 and she reported sleeping better. She also tolerated dressing changes. The wound was noted to be 100% granulation.

The pain continued to reduce and the wound significantly improved (see Figures 4 and 5), with a reduction in size and exudate. The treatment was completed two weeks later.

A Doppler assessment determined an ankle brachial pressure index of 1.25 bilaterally and a short-stretch bandage was commenced on the right leg. The pain was now minimal and only small dry scabs remained. The plan was to continue short-stretch bandaging until good tensile strength was obtained in the wound and then to measure for compression hosiery. The patient was surprised by the speed of recovery and – more importantly – by the significant reduction in pain after just a few days of treatment.

It is hoped that due to the electroceutical treatment, there is deposition of good type-one collagen. Collagen provides integrity, firmness and elasticity to the skin, and when strong collagen is formed during healing, the tensile strength of the healed tissue will be stronger, reducing the risk of recurrence. The patient will be continually monitored.

Figure 1. Photos and tracings were taken to determine the progress of the wound

Figure 2. Taking wound measurements

Figure 3. Applying electrode pads

Figure 4. Monitoring wound progress

Figure 5. End of the two-week treatment

Contraindications

Recognised contraindications of electrical stimulation and electroceutical treatment include pregnancy, active cancer, and use proximal to the head for patients with epilepsy and proximal to the chest for patients with pacemakers (Thakral et al 2013, Kambouris et al 2014). As with all electrical devices, the units should not be in contact with water and should be removed during other electrical investigations such as a magnetic resonance imaging scan, electrocardiography or electroencephalogram. A review of the clinical evidence observing electrical stimulation in wound care found no device-related complications or adverse effects, and supported the safety and ease of use of the treatment (Ud-Din and Bayat 2014). However, individual product literature should be read and taken into consideration before using any treatment.

Economic benefits and implications for nursing practice

Several studies have demonstrated the cost-effectiveness of using electric stimulation for the management of chronic wounds (Clegg and Guest 2007, Taylor et al 2011, Guest et al 2015b). Guest et al (2015b) demonstrated that using an electroceutical treatment for the management of VLUs was a dominant treatment – that is, it resulted in improved outcomes for less cost. In the 12 months after the electroceutical treatment, compared with the same period before the treatment, there was a 12% improvement in health of 0.09 quality-adjusted life years ($p<0.01$), a 34% reduction in required nurse visits per patient from a mean of 50.7 to 33.3, and a 26% reduction in the number of dressings. This resulted in an 11% reduction in the cost to the NHS of VLU management from £1,981 to £1,754 per patient. The mean cost of managing a wound that healed in the study period was reduced by 35% from £1,196 to £779. As the wounds healed, there was no ongoing cost over and beyond the 12 months.

Guest et al (2015b) also demonstrated a correlation between the age of a wound and how quickly it heals following an electroceutical treatment. This suggests that the treatment should be applied early in the patient pathway, rather than waiting for the wound longevity to increase.

NHS England (2015) supports the use of new, innovative technologies for transforming and improving patient outcomes and allows for the adoption of cost-effective technologies to reduce costs to the healthcare system. It is important for clinicians to ensure they are aware of new technologies and advanced modalities available for their patients. With the current financial pressures on the NHS and the boundaries often imposed by wound-dressing formularies, the use of new technologies can be challenging. However, focusing on value-based care – the cost of the total treatment in relation to the possible outcomes – as opposed to the unit cost of the product or treatment, clinicians can highlight the benefits to commissioners (Dowsett 2015). HCPs' time, patients' time, transport, treatment, therapies and hospital admission also need to be included when considering costs.

Conclusion

There are sizeable challenges for patients who have chronic wounds and for the clinicians managing them. Holistic assessment and management should be undertaken to address all the wider factors that can contribute to delayed healing. Chronic inflammation is linked to elevated protease activity and reduced growth hormones and cell numbers, which prevent the wound healing normally. Advanced dressings and treatment modalities can aid WBP and reduce chronic inflammation.

Electrical stimulation is a relatively new concept in advanced wound therapy and can reduce chronic inflammation, bio-burden, biofilms, pain and exudate, and assist in cell proliferation and collagen synthesis. Electrical stimulation may also reduce costs to the NHS in the long-term. Financial constraints can cause difficulties in obtaining new treatments for clinicians. However, the recommendation (NHS England 2015) to support cost-effective new technologies will enable clinicians to push for better opportunities to improve outcomes and QoL for patients.

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