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Advances in wound dressing technology

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Over the past 50 years or so, the emphasis in wound care research has been on developing a range of wound dressings with properties of absorption, hydration and more recently antibacterial activity[1]. The new developments have lead to a shift from simple dressings to more advanced devices and products that incorporate pharmaceutically active ingredients.

There is a need to improve the condition of wound bed tissue and provide products that repair and regenerate damaged tissue and optimise healing. This can be achieved either by the addition of essential healing components or by removing or neutralising elements that retard healing or lead to ongoing tissue damage.

An urgent requirement is to develop effective point-of-care diagnostic tests to identify and define the underlying cause of wound breakdown. A point-of-care test that can detect elevated protease levels is now available[2,3], but much could be done if we had a better understanding of the presence of inflammatory cytokines, wound pH, autoimmune antibodies and other markers of infection.

There are cost implications with these newer treatments and diagnostic tests, and it is important to not only look at the unit cost of a product but also to explore the cost-effectiveness of the intervention in relation to associated and long-term costs, as well as cost savings[4,5]. If newer methods of treatment prevent or reduce the length of hospital stay and speed healing, then in the long term it is possible to make an economic case for using them.

KERATIN-BASED WOUND MANAGEMENT

An interesting example of a new wound treatment is the development of keratin-based wound care products. The ability of keratinocytes to migrate is critical for wound re-epithelialisation[6,7]. Keratins are the major proteins in keratinocytes and are essential for many cellular functions (e.g. cell migration), and upregulation of keratin expression has been observed in response to wounding[8,9].

Keratin-based products have been approved for use in several regions of the world, including Australia, New Zealand and the USA. A robust keratin matrix (Keramatrix®; Keraplast Technologies LLC), designed for use on wounds with moderate exudate levels or for use as an interface with negative pressure wound therapy, has shown positive results[6,8]. As the wound heals, the keratin matrix

is absorbed into the wound and does not need to be removed at dressing change[6,8].

The matrix is also available as a hydrogel (Keragel™; Keraplast Technologies LLC), which is designed for use in chronic dry wounds, acute wounds and for the treatment of certain skin conditions, such as epidermolysis bullosa[10–12]. Keragel provides moisture to a dry wound as well as a keratin-rich environment to encourage cell growth, leading to excellent healing outcomes[13]. The author has used both forms of the keratin matrix with good results at the Wound Clinic, Austin Hospital, Heidelberg, Australia.

PHARMACOLOGICAL THERAPIES

The adjunctive use of pharmacology also has benefits in wound management, with some interesting agents being used including angiotensin-converting enzyme (ACE) inhibitors, monoclonal antibodies, topical immunosuppressants and xanthine oxidase inhibitors. An example was presented at the European Cardiology conference held in Munich, August 2013, by Ahimastos et al[14], whose randomised controlled trial demonstrated that ACE inhibition improved walking ability and quality of life in patients with peripheral arterial disease; an improvement that impacts on wound healing and is substantially beyond that reported with conventional medical therapies.

Biologics, including monoclonal antibodies and in particular tumour necrosis factor alpha-antagonists, are now being extensively evaluated in the setting of chronic wound healing. Preliminary studies and case reports provide evidence of the clinical potential of these compounds in treating *Pyoderma gangrenosum*[15,16].

The author's facility has used calcineurin inhibitors such as tacrolimus successfully for the induction or maintenance of remission in immune and inflammatory disorders, such as *Pyoderma gangrenosum*, necrobiotic xanthogranuloma and vasculitic wounds[17–19]; it is applied topically as a 0.1% ointment. Topical tacrolimus does not negatively impact acute cutaneous wound healing[20].

Tacrolimus promotes melanocyte and melanoblast growth and creates a favourable milieu for cell migration via keratinocytes, which are possible mechanisms of how tacrolimus ointment induces repigmentation in patients with vitiligo[21].

Tacrolimus forms complexes with cytoplasmic immunophilins, which block the action of calcineurin in activated T-cells. This prevents the production of interleukin-2 and other cytokines, which normally stimulate T-cell proliferation and differentiation. Tacrolimus is used for the prevention of solid organ transplant rejection and the prevention and treatment of graft-versus-host disease in stem cell transplants[22,23]. It is normally administered intravenously or orally.

INNOVATIVE DEVELOPMENTS

These are some examples of innovative developments for advanced wound management. These interventions offer promising additions and new possibilities, and suggest that the future is bright for improved wound healing as we uncover the mystery of tissue repair and develop new ways of restoring tissue balance. ■

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