Wound Care and Tissue Repair
Modality Therapies

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PROVIDING CARE for chronic wounds is rapidly becoming a defined specialty as well as representing one of the fastest growing areas of medicine in the United States. In number of professionals entering the field, products being introduced in the market, amount of monies spent providing care, and other parameters, this area of medicine has shown tremendous growth. The US healthcare system treats approximately 5-7 million patients with chronic wounds each year utilizing 2.5% of all annual healthcare expenditures (figure 1). Research in the practice of wound care has eclipsed the question of what dressing to put on the wound and advanced to explore how tissue heals and repairs itself at microscopic and genomic levels. Treatment options now include tissue substitutes grown in laboratories, artificial dermal replacements, and isolated growth factors. Therapeutic modalities include ultrasound energy, electrical stimulation, and negative pressure among others.

Responding to this growth, a number of wound care specific journals are in circulation and professional societies have formed in many countries as well as government supported panels focusing on specific issues such as pressure ulcers. This year's World Union of Wound Health Societies was held in Toronto on June 4-8, 2008, and a one year fellowship for wound care physicians is available at Universities in both Chicago and Boston. For those wanting a comprehensive introduction to the specialty of wound care and discussion of surgical and therapeutic treatments, access to video streams of lectures from the recent "Wound Care: Specialization, Science, Technology" conference held in Chicago, IL will be available online at www.woundcaresst.com.

While it is easy to go right into a discussion of technical advancements, it cannot be over emphasized that the key to success in healing a difficult wound is to have the correct diagnosis and to ensure that the required building blocks of new tissue are maximized for the patient. Often, thousands of dollars in care are provided to a patient in attempts to heal wounds with growth factors, enzymes, and various modalities while the patient's peripheral vascular disease, vasculitis, skin cancer, or other confounding disease process has been left unrecognized or untreated. The ability of the provider to discern chronic wound specific conditions from more common conditions is paramount. Practitioners must be competent in recognizing such conditions as the cutaneous caustic dermatitis of lymphorrhea from an acute cellulitis as well as identifying conditions such as Charcot flair, calciphylaxis, skin cancer, pyoderma gangrenosum, and other conditions associated with wound care but not often seen in the typical medical or surgical practice.

Those issues aside, the wound care practitioner of today has a wealth of tools at their disposal to achieve closure of resistant and problematic wounds. The primary goal of using therapeutic modalities is to prepare the wound bed for closure or facilitate closure via secondary intention.

COMMON WOUND CARE MODALITIES

Pulse Lavage

A historically common treatment used by physicians to clean a wound has been whirlpool therapy. This approach has, for the most part, fallen out of favor in exchange for the more controlled and sanitary option of mechanical pulse lavage. The primary purpose of this treatment is for removal of exudates, and debris in the wound bed. Through the pulsatile action at 8-12 pounds per square inch, bacteria are removed and the tissue is effectively

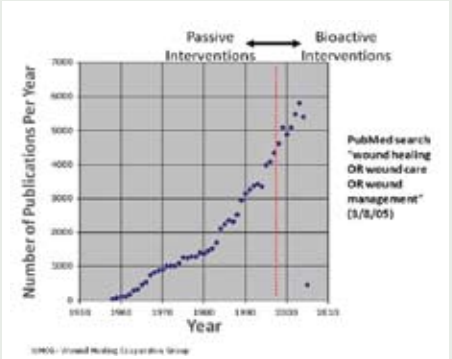

Figure 1: The increase in publications of literature related to wound care

cleaned. Compared to the traditional whirlpool approach, the pulse lavage is site specific which avoids periwound maceration and cross contamination. Treatments can be done at bedside and clean up is much easier. The tools are disposable and it is recommended that the therapist wear a mask and protective equipment to avoid sprays or aerosolized particles. Pulse lavage can be done daily or as needed depending on the condition of the wound. Pulse lavage is often used in conjunction with other modalities such as negative pressure with beneficial results. Care must be taken when using pulse lavage near vessels, within tunnels, near cavity linings, and where hemostasis is a concern.

Ultraviolet Radiation

Ultraviolet C-band (UVC) radiation, commonly referred to as ultraviolet light is another useful tool to facilitate cleaning of a wound bed. UVC radiation is non thermal, bactericidal, virucidal, and ionizing through photo-chemical reactions that occur in the tissue. While UVC is usually absorbed in the epidermal layer, direct application to open wounds facilitates control of bacterial levels and prevents build up of colonization that can hinder healing. Care must be observed with UVC therapy in patients taking medications that increase photosensitivity, on radiation therapy, and to certainly avoid direct eye exposure by the patient or therapist. Contraindications to UVC therapy include carcinoma in the wound or periwound tissue, acute psoriasis, herpes simplex or eczema, fever, and lupus. Certain disease states such as severe diabetes, hyperthyroidism, pulmonary tuberculosis and other major organ system diseases or medications such as doxycycline may cause a patient to be photosensitive and should be taken into consideration.

Ultrasound

The usefulness of ultrasound therapy with 1MgHz or 3MgHz frequencies has been used in physical therapy, physiatry, and sports medicine for years but the effects on wound healing are still being discovered with papers showing variable results. The traditional ultrasound treatment is limited to the periwound tissue and requires direct patient contact. The process produces cavitation and microstreaming that increases cell wall permeability and induces growth factor release. Studies have discussed protein synthesis by fibroblasts and growth factor release from mast cells and macrophages as possible pathways to the observed acceleration of wound contraction and increase in granular tissue growth. This hypothesis, the frequency resonance theory, is being studied to better determine the signal-transduction pathways and energy induced protein molecules conformational changes that have direct implications for wound healing. A recent study published in Ostomy Wound Management (2005;51(8):24-39) presents a randomized, double blind, controlled, multicenter study with sham control that utilized a lower frequency ultrasound setting of 40Khz designed to achieve vascular vasodilation and bone healing. This approach also incorporated a non-contact delivery model using a dense mist to transmit the ultrasonic energy rather than the traditional gel that requires contact. This new approach allows the energy to be delivered directly to the wound bed without contact. The study was found to significantly increase the healing rate of recalcitrant wounds compared to control.

Although the MIST low frequency application demonstrates a new approach, traditional ultrasound is more widely available and still useful. The most effective time to use megahertz ultrasound is in the inflammatory phase. Use in this phase has shown acceleration to the proliferative phase, resolution of ecchymosis and induration. During the proliferation phase, ultrasound treatments accelerate contraction through effect on fibroblasts and stimulate endothelial cell activity increasing vascularization of granulation tissue. Precautions should be taken when used over bony prominences, major nerves and organs, the scalp and epiphyseal plates in immature adults. Contradictions include use over the pregnant uterus, malignancies, pacemakers, central nervous tissue, phlebitis, and joint cement.

Electrical Stimulation

Electrical stimulation is another therapeutic treatment with papers with variable results. A meta-analysis published in Wound Repair and Regeneration in 1999 (Vol 7:495-503) examined 15 studies and found that electrical stimulation use demonstrated an increase healing rate of 144% over the control rate with no overlap of the 95% confidence interval between the study and control groups. While there are several types of electrical stimulation devices, only high voltage pulsed current (HVPC) will be discussed. The approach of electrical stimulation revolves around the current of injury and disruption of electrical current in the skin when a wound is present. Application of external energy attempts to modulate this environment for the purpose of facilitating healing. Macrophages are attracted to the positive signal while neutrophils are variable in their response. With inflammation, neutrophils are attracted to the positive signal while in the absence of inflammation, netrophilic activity is reversed. Epidermal cells are attracted to the positive signal while fibroblasts, important for proliferation, and myofibroblasts, important for remodeling, are attracted to the negative. Taking advantage of the galvanotaxic properties of cells, inflammatory duration and be decreased and key cellular components can be drawn toward or away from the site of injury.

Electrical stimulation typically is provided 3x to 5x per week depending on the severity and phase of healing. As the treatment can cause vasodilation and increase of sustained microcirculatory flow from cytokinin release, caution must be observed in patient with distant malignancies. Skin irritation can also occur under the electrodes and residue from creams and ointments should be removed if they contain metal ions (silver, zinc, etc) or petroleum based products. Contraindications include local malignancy, active osteomyelitis, and presence of a pacemaker. Electrodes should not be placed over the carotid sinus, laryngeal muscles, phrenic nerve or tangential to the heart.

Negative Pressure

Negative pressure has been a highly publicized therapy since 1995 and most widely promoted by the US based company KCI. Recently, competitor models and designs have appeared on the market but the approach centers around a porous dressing applied to the wound bed that is covered in an air-tight seal which is connected to a pump that creates a sub-atmospheric pressure under the dressing. By this process, wound fluid and drainage is removed, the wound edges are drawn together, and conformational changes take place at the dressing / tissue interface that promote healing and tissue growth. The exact cell signaling and pathways have yet to be determined as have the optimal pressure settings for various wounds. Recent literature must be carefully read as the authors are often financially supported by manufacturers however; the points are well stated that clinical experience has led to practices using varying pressures in different clinical situations. Clinical examinations at dressing changes are important to ensure clinical goals are being reached with the current settings and that tissue hemorrhage, necrosis, or other complications have not developed. If these issues arise or the tissue no longer is responding, stopping the negative pressure therapy should be considered and other modalities may be a better choice. Combining additional modalities such as those mentioned above have shown benefit in facilitating negative pressure. Care must be taken over structures such as bone and tendon, exposed vessels, and near lumens where the negative pressure can collapse luminal spaces or induce an inflammatory response that can lead to fistula formation. The contraindications have changed over the past 10 years as new techniques have been tried and complications addressed.

Therapeutic modalities provide the wound care clinician with powerful tools that have been show to greatly alter the microenvironment in chronic wounds and can be used in combination with the advanced dressings available on the market today to achieve clinical goals. It is often easy to decide to start therapeutic modalities based on the indications but it takes a significant amount of training and experience to learn when to stop or when alternative therapies or modalities would provide better outcomes. It is important to keep in mind that the approach to a patient with a chronic wound requires a comprehensive assessment and plan of care of which the preparation of the wound bed is a significant but not isolated part. ■