Introduction

Over the last several years, considerable progress has been made in the field of wound healing. Clear examples are the cloning and testing of growth factors, the evolution of better techniques for growing primary human cells in vitro, and the development of sophisticated skin substitutes. The process of fibrosis, too, has received great attention, and we now have a better understanding of the mechanisms that might be involved in the downregulation of scarring. Undoubtedly, progress in our understanding of the normal wound healing process has been facilitated by increasingly complex ways of evaluating the effect of single genes in vivo, as with the use of transgenic and knockout animal models.

Yet, in spite of these advances in the scientific basis for tissue repair and in the development of new and advanced therapeutic products, the improvement in our care of chronic wounds has not been as dramatic as was initially predicted. There are many reasons for this, but the most important may be our inability to properly correct the fundamental pathophysiological abnormalities present in such chronic wounds as venous, diabetic, and pressure ulcers. Recently, a new paradigm for “preparing” chronic wounds to accelerate their healing and to improve the efficacy of advanced therapeutic products has emerged. This paradigm, termed “wound bed preparation,” is becoming widely accepted as a way to manage difficult-to-heal wounds. Here we will discuss the fundamental aspects of wound bed preparation in the context of pressure ulcers.

Pressure Ulcers: Basic Principles

The subject of pressure ulcers has been reviewed from the clinical standpoint in detail elsewhere. Here we will focus on the main points as they apply to our discussion about wound bed preparation. Pressure ulcers, also called decubitus ulcers, represent the most common type of chronic wound in the western world. Figures vary as to the frequency of pressure ulcers, but they have been said to occur in up to 10% of patients in the acute care setting. The prevalence of pressure ulcers increases dramatically when patients have major predisposing factors, such as cardiovascular disease, neurological dysfunction, and orthopedic injury. The true prevalence of pressure ulcers in chronic care facilities is unknown, but a figure of approximately 20% is likely.
An important feature of pressure ulcers, one with great clinical implications, is that their apparent surface area does not correlate well with the full extent and severity of the problem. The ulcer area can appear to be quite small, but there may be extensively undermined edges and tunneling to deep structures. The classical explanation proposed for this phenomenon has been that the skin may be more resistant to pressure than subcutaneous tissue and muscle. As a result of this, the shape of the wound in pressure ulcers resembles a conical defect, with the base of the cone away from the skin. Undermining of the pressure ulcer’s edges is important, because this space may provide a protected environment for bacterial overgrowth. The location of the direct pressure is also critical. For example, the amount of pressure registered over bony prominences can be as high as 2000 mmHg.

Ultimately, the actual development of ulceration is due to ischemia from pressure applied to the blood vessels. However, a number of cofactors play a fundamental role in the development, persistence, and recurrence of pressure ulcers. Malnutrition and inability to move, shearing forces, the local environment created by urinary and fecal incontinence are all important in the pathogenesis.

Full understanding of pressure ulcers has to take into account various other factors besides the direct forces of pressure alone. A number of predictors for the development of such ulcers have been proposed. Hypoalbuminemia, bone fractures, and incontinence are stated to be important, but few studies have been done to confirm these as independent predictors.

**Impaired Healing and Wound Bed Preparation**

It may be preferable to talk about “impaired healing” when addressing chronic wounds, although the tendency has been to use the term “failure to heal.” The reality is that, with ulcers due to pressure, healing should occur almost unimpeded once the pressure is removed. We will now discuss some of the pathophysiological components that lead to impaired healing, and then place them in the context of wound bed preparation. Some factors are common to all chronic wounds, while others may be more specific for pressure ulcers. Later, we will describe some of the advanced solutions for healing pressure ulcers and other types of chronic wounds. These advanced therapies rely very heavily on appropriate wound bed preparation.

**Bacterial Burden and Biofilms**

Colonization with bacterial and, less commonly, fungal organisms is a feature of chronic wounds. Pathophysiological factors leading to sustained bacterial colonization include absent epithelium and thus lack of barrier function, exudate conducive to bacterial growth, and poor blood flow and hypoxia. The term “bacterial burden” has become widely used when describing the level of bacterial colonization. Because of the lack of well-defined human experimental data, questions remain as to what constitutes an unacceptable bacterial burden that interferes with wound closure. There is evidence that, regardless of the type of bacteria present, a level greater than or equal to $10^6$ organisms per gram of tissue is associated with serious healing impairment. For pressure ulcers, governmental guidelines in the United States indicate that quantitative bacteriology,