3. Healing

3.1 How does the body heal?

There are three phases of wound healing:

- inflammatory (destructive)
- proliferative (regenerative)
- maturation (reparative)

During these phases there are a number of cells essential to the process of healing including platelets, neutrophils, macrophages and fibroblasts.

Some of the cells are present from the beginning of the wound healing process, through to the ultimate healing of the wound.

The phases of healing are a continuum. Each phase continues in a steady process merging with the next phase. In fact, one wound may be in more than one phase at one time.

3.2 Phases of healing

3.2.1 The inflammatory phase

When a wound is created (through surgical, traumatic or other means), an inflammatory response takes place. This phase is the shortest and involves:

- bleeding
- clot formation by platelets
- haemostasis from the clotting process
- production of wound exudate

Wound exudate has an important role in wound healing. It nourishes the tissues and flushes out foreign debris and necrotic tissue from the wound. It is also a support medium for antibodies and enzymes, which destroy non-viable tissue and cleanse the wound, and growth factors which are important to the healing cascade.

Notably, during this phase the wound can be red, hot, sore and swollen. This does not always indicate infection, and can represent the inflammatory process itself. It is not always necessary to apply topical antiseptics or antibiotics during this phase.

If the inflammatory phase is impaired or prolonged, it can prevent the onset of the proliferative and maturation phases. In turn, this may lead to fibrosed tissue. Factors that can slow the inflammatory phase are:

- presence of foreign material
- necrotic tissue
- clinical infection
- excessive antimicrobial use
- continued disruption of the wound
- skin dryness
- poor blood supply
- thermal shock

3.2.2 The proliferative phase

During the proliferative phase a new vascular bed is formed to provide oxygenated blood to the wound, and the wound fills with granular tissue. The proliferative phase consists of:

- Granulation

  Granulation tissue, which in part contains fibroblasts, forms in the wound. The fibroblasts lay down collagen, which is the essential framework for the connective tissue. Collagen is produced over a period of weeks, after which time no new collagen is produced.

- Contraction

  As the connective tissue fills the wound, contractile cells (myofibroblasts) pull the wound margins together.

- Epithelialisation

  Once the wound has filled with granulation tissue and contracted, epidermal cells grow and cover the surface of the wound. This process is most efficiently completed in a moist, clean environment.

3.2.3 The maturation phase

The maturation phase is the final stage of healing. During this stage the fibroblasts decrease in number and vascularisation decreases. The existing collagen then realigns itself by cross-linking, which importantly increases the tensile strength of the wound. At this stage the wound may have achieved surface closure; however, its tensile strength may take up to 12 months to develop. Wounds that are lacking in tensile strength, have an increased risk of breakdown.

3.2.4 Moist wound management

Traditionally, it has been thought that wounds should be kept clean and dry, through exposure to air and sunlight. Another theory was that wounds with a tissue cavity should be packed with dry gauze and covered with a dry dressing. However, the disadvantages of this method are:

- Scab formation

  Scabs create a physical barrier to healing because the epidermal cells cannot move through the formed scab.

- Air exposure

  Exposure to air reduces the surface temperature of the wound causing peripheral vasoconstriction, which reduces blood flow (carrying oxygen and nutrients) to the wound and delays healing.

- Wound packing with dry gauze

  This can impair healing as the dressing adheres to the surface of the wound causing it to dry out.

- Covering the wound with a dry dressing

  Wounds covered by dry dressings may traumatise the surface of the wound on removal.

The current practice is to allow wounds to heal under moist conditions. The advantages of moist wound healing are:

- Prevention of scab formation

  Wounds covered by an occlusive dressing do not form a scab, so epidermal cells are able to move rapidly over the surface of the dermis through the exudate which collects at the wound/dressing interface.

- Hydrating environment

  The application of a totally occlusive or semi-permeable dressing to the wound can also prevent secondary damage as a result of dehydration.

- Presence of exudate

  Exudate found in moist wounds has now been shown to assist with the autolytic debridement of wounds. It carries a number of growth factors essential to the healing of wounds, protects granulation and encourages epithelialisation of wounds.

3.3 Control factors affecting healing

Most wounds heal readily whereas others are slow or remain unhealed for a considerable length of time. There are a number of factors which affect the healing of a wound, and these factors are both intrinsic and extrinsic.

3.3.1 Intrinsic factors

Health status

Good circulation, both arterial and venous, is essential for good wound healing. Anaemia, regardless of type, reduces the capacity of the blood to provide oxygen to the tissues, since haemoglobin transports oxygen to the cells.

Immune function

Normal immune system function is required for the inflammatory phase of healing. A reduction in immune function slows the cleansing of the wound bed and reduces the ability of the body to fight invading pathogens. This is likely to be due to a reduction of the number and activity of the white blood cells.

Diabetes

Diabetes is one of the major problems for chronic wounds. Diabetic patients have a delayed capillary response to injury, reduced cellular function at the injury site, and defects in collagen synthesis and wound strength. Hyperglycaemia caused by reduced insulin availability and increased insulin resistance appears to be a major predisposing factor in delaying healing in diabetic patients.

Age factors

As we age our skin and tissues change. We lose the sensory cells, as well as the secretory cells which are so essential for the maintenance of skin moisture and flexibility. We lose vasculature within the skin, and hair follicles. The skin becomes thinner, dryer, and far more prone to destruction – whether by physical or by chemical means.

Body build

Because of the adipose tissue being poorly vascularised, an obese patient will have a great deal of trouble healing due to the inability to deliver oxygen and nutrients to the wound site. Underweight individuals may also experience difficulties in the healing process.

Nutritional status

Nutrition is one of the most important factors in the healing of wounds. Proteins, carbohydrates, fats, vitamins, trace elements and fluids all play a vital role in wound repair. Research has shown that amino acids (e.g. arginine), when given as a supplement, will improve the rate of wound healing.

Psychological Status

Psychosocial factors are now believed to be a significant component in wound healing. Depression reduces self-care behaviour and poor self-care has a detrimental effect on wound healing.

3.3.2 Extrinsic factors

Mechanical stress

When a patient is immobile and pressure is exerted locally, localised microvascular ischaemia will occur. This occurs particularly when pressure is exerted over a bony prominence for more than two hours, at a pressure exceeding 30 mm of mercury. This will ultimately lead to tissue destruction both at the surface and deeper into the wound, leading eventually to a pressure sore. Equally, shearing forces and friction occur when the tissue below the skin is forced to move while the skin itself is restrained by contact to a surface, such as the bed sheet. This is particularly evident in the patient's heels.

Debris

Debris –whether slough, eschar, scab, wound dressing residue, gauze fibres or sutures– will impede wound healing. Their presence will prolong the inflammatory phase, as well as predisposing the wound to infection. Debris should be removed, either surgically or by the use of hydrogels, proteolytic enzymes or hydrocolloids.

Temperature

The optimum temperature for the growth of human cells is 37 degrees centigrade. It is therefore essential to maintain the wound environment at body temperature. A drop in body temperature will lead to peripheral vasoconstriction- affecting the flow of blood through the wound- and will markedly reduce the activity of growth factors and proteases.

Desiccation

If a wound dries, healing is either delayed, or will cease. Exposed, dry wounds are more inflamed, painful, itchy, and have more scab material during the early stages of wound healing.

Maceration

Maceration may be due to incontinence, perspiration or excessive exudation. Maceration will cause the destruction of tissue and slow the healing process. It is essential to maintain the moist environment without excessive exudation.

Infection

All wounds will have some level of bacterial colonisation; however, this does not mean the wound is infected. The presence of erythema, discharge, fever, pain with elevated white blood cell count, and sometimes odour, is evidence that the wound is infected. If clinical signs of infection are present, the use of systemic antibiotics is mandatory. If there are no clinical signs of infection, there is little reason to use either systemic or topical antibiotics. An exception to this may be the use of very specific topical antibiotics in very specific cases to reduce the level of bacteria in wounds of compromised patients (e.g. the use of topical metronidazole in anaerobic colonised wounds). In general swabs will provide very little help in establishing if a wound is infected leading to overuse of antibiotics.

Chemical stress

Iodine, peroxide, chlorhexidine, alcohols, hypochlorites and acetic acid are commonly used antiseptics and cleansing agents. Use of these agents is often responsible for delayed healing, since they are non-selective in their activity and will kill healthy cells as well as bacteria. It is preferable to avoid the prolonged use of these products on a granulating wound. Their use in infected wounds is somewhat dubious. Research has shown that although they may reduce the surface load of bacteria in an infected wound, they do not penetrate below the surface. Therefore, they have no real effect on the infection in the tissue itself. They may be of use in dilute forms when applied to some chronic wounds and left in place for no more than five minutes before washing off.

Systemic medications

The effects of systemic medications on the healing wound vary greatly. We commonly see medicines prescribed for a condition which is unrelated to the wound, but may have side effects which could either inhibit or stimulate healing. Medications can therefore be divided into two groups: stimulatory drugs and inhibitory drugs. Stimulatory drugs affect the inflammatory response, epithelialisation, fibroblast activity, fibrinolysis, and cell stimulation; whereas inhibitory medications affect tensile strength, cell activity, capillary proliferation, and fibroplasia.

Lifestyle Factors

Alcohol

Excessive and/or chronic alcohol intake can lead to health problems affecting wound healing. Alcohol-induced digestive problems may lead to malnutrition and anaemia. Liver damage can result in chronic disturbances due to a reduction in platelet levels, and subsequent circulatory damage that may reduce the blood flow that is required for wound healing.

Smoking

The adverse effects of smoking and the potentiation of cancer in various parts of the body have been understood for many years. However, it is clear that the toxic constituents of smoking such as nicotine, carbon monoxide and cyanide have a dramatic and inhibiting effect on healing. Nicotine will diminish red blood cells, fibroblasts and macrophages, and increase platelet adhesiveness. This will produce cutaneous vasoconstriction. Carbon monoxide has an affinity for haemoglobin 200 times greater than that of oxygen. This will have a major effect on the oxygen-carrying capacity of the blood and may potentially lead to ischaemia. Hydrogen cyanide inhibits the enzyme-systems necessary for oxygen transport at the cellular level, as well as oxidative metabolism. Smoking can therefore be a major cause of the non-healing of wounds.