Nutrition & Wound Care

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Introduction

The 'term' wound can represent a wide range of injury from a minute laparoscopic incision to a large surgical scar, from an small venous ulcer to an chronic exudative pressure sore, an extensive full-thickness burn or an open abdominal wound.[1] Chronic and complex wounds require the most skill, time and resources to heal. Venous leg ulcers, pressure ulcers and diabetic foot ulcers are the most common types, accounting for more than 90 per cent of chronic wounds, and although healing often follows a predictable course, some may remain unhealed for many years.[2] The cost of treating a pressure ulcer varies from £1,064 (Grade 1) to £10,551 (Grade 4). The cost increases with ulcer grade because the time to heal is longer due to higher complications. The total cost of treatment in the UK is £1.4 to £2.1 billion annually, four per cent of the total NHS expenditure.[3] Specific nutrients are required for particular stages of the wound healing process. Identifying specific nutrients may potentially accelerate wound healing.

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Malnutrition

Over 50 years ago, it was recognised that patients losing 20 per cent of their body weight during a hospital stay had a substantially higher risk of developing complications, including impaired tissue repair.[4] Malnutrition has been implicated as an important cause in the development of pressure ulcers.[5] On admission to hospital 25 per cent to 45 per cent of all patients are estimated to be malnourished. In patient groups at risk for developing pressure ulcers, malnutrition rates are even higher, for example, it has been shown that 64 per cent of elderly patients with an acute hip fracture and 59 per cent of nursing home patients are malnourished.[5]

Weight loss and muscle wasting reduces the natural padding between skin and bone and will further increase the vulnerability of pressure sores.[4] Recognising poor nutrition by nutrition screening and assessment will help to reduce the risk of developing wounds and assist the healing of wounds. Wound healing is a three-step sequence which is outlined in **Table One**.

Patients at risk

Individuals who present with a chronic wound or trauma, and those who have undergone surgery, will have increased nutritional requirements and may be at greater risk of wound development or impaired wound healing. Those who have an inability to swallow will also be at risk if they are not assessed adequately. A patient who is anaemic will have impaired healing due to a lack of oxygen delivery to the wound site.[6]

Diabetes affects utilisation of carbohydrate for energy needs. If the amount of circulating insulin is reduced or where cells are unable to respond to insulin, the energy needs of individual cells may be unmet. Thus, it is important that diabetes is well controlled and closely monitored in the presence of a wound.[6]

Obese patients may also demonstrate reduced movement and be more difficult to mobilise, thus reducing capacity for pressure relief.[4] Excess of body weight may mask nutritional deficiencies such that morbidly obese individuals may still be malnourished. Patients who are underweight, where bones become prominent and skin resistance is decreased, are at an increased risk of wound development.[8]

Patients with underlying gut disorders, where potentially there may be an element of malabsorption or nutritional losses, will be at risk. In a recent survey, 43 per cent of patients with gastrointestinal disorders, who underwent nutritional screening (using the 'MUST' – **www.bapen.org.uk/must_tool.html**), were found to be at risk of malnutrition.[9] An infected pressure ulcer also increases tissue damage causing further strain, a deeper ulcer and an increase in nutritional demands.[10]

Protein energy malnutrition in the presence of a wound leads to loss of lean body mass which is likely to impede the healing process.[11] Patients with a loss of more than 15 per cent of total lean body mass will also be at risk of impaired wound healing, the greater the loss the larger the healing deficit. A loss of 30 per cent or more leads to the development of spontaneous wounds such as pressure ulcers, and death is likely to occur with a 40 per cent lean body mass loss.[11]

Macronutrients

Metabolic or energy demands rise in the presence of a wound due to increased cell activity. It has been established that basal metabolic rate increases by up to 10 per cent following even minor surgery, and can rise by 100 per cent or more in the presence of severe burns.[6] Poor energy intake is likely to lead to decreases in fat stores and loss of protective cushioning which increases the likelihood of pressure injuries.[8] In addition, a low energy intake is usually associated with a lower intake of micronutrients and the resultant deficiencies may impact wound healing.[8] An individual may require a minimum of 30-35 kcals per kg body weight/day with 1 to 1.5g/kg/day protein and 1 ml per kcal per day of fluid intake.[7]

Fats are broken down into free fatty acids. Polyunsaturated fatty acids (PUFAs) are used for cell membranes whilst saturated fatty acids are used for fuel.[11] The benefit of PUFAs has been

Table One: Stages of Wound Healing[1]

Inflammatory phase 4 to 6 days	**Proliferative phase** 5 days to 3 weeks	**Remodelling phase** 2 weeks to 2 years
• Coagulation cascade initiated – platelets relsease growth factors and cytokines locally • Fibrin clot formation • Vasodilation to improve perfusion • Polymorphonucleocyte (PMN) activation • Macrophages and neutrophils attracted to the wound to engulf bacteria, remove debris and secrete growth factors, proteases and cytokines	• Epithelial cells provide protective covering over lesion • Fibroblasts produce collagen for granulation tissue • Collagen cross-linkage • Myofibroblasts induce wound contraction • Angiogenesis	• Collagen maturation and stabilisation • Fibrous scar tissue matures and retracts

demonstrated by the application of 20 mls of n-6 rich PUFA to high risk skin areas three times a day, which resulted in a significant reduction in pressure sore development and increased skin hydration and elasticity.[12] Fatty acids are an essential component of cell membranes and deficiency will impair wound healing. However, an omega-3 (n-3) fatty acid rich diet inhibits platelet aggregation and may reduce wound healing strength by affecting the fibroblastic and maturation phases of the healing response.[13] Conversely, there is also evidence that n-3 fatty acids can have a benefit when administered as immune feeds pre and post-operatively.[14]

Carbohydrates are a key component of glucoproteins, a key element in healing wound, used for their structure and communicative properties. Carbohydrates have also been found to be a key factor in the activity of enzymes used for wound repair reactions.[4] A continuing demand for carbohydrate that is not met by diet can ultimately lead to loss of the body's structured proteins. Protein losses also occur in any exudating wound.[6]

The immune system is mainly composed of protein and an inadequate intake adversely affects this process, including the formation of collagen[8] and by inhibiting wound re-modelling.[15] Specific amino acids, e.g. arginine, have been shown to enhance collagen deposition at the wound site, enhance cellular immune activities, especially T cell function, and reduce urinary losses and protein catabolism after injury.[5] A study of 30 elderly patients, aged >65 years with a sustained experimental surgical injury, receiving a supplement of arginine (17g/day) demonstrated increased indicators of collagen deposition at the wound site compared to controls.[15]

Glutamine is the most abundant amino acid in the body and is considered conditionally essential during injury. Glutamine supplementation has not been shown to dramatically impact the wound. However, it does appear to have some positive impact to reduce wound infection and healing in experimental studies.[11] Studies utilising glutamine pre and post-surgery and in burns patients have shown mixed results. Oral feeding of glutamine in surgery did not affect plasma glutamine or nitrogen turnover. In contrast, IV glutamine in surgery patients showed better post-operative results by significantly reducing length of hospital stay.[15] It is noteworthy that excess glutamine can increase the risk of ammonia formation, especially in the elderly.[11]

Although macronutrient intake will vary, general guidance can be offered.

Micronutrients

Providing additional calories is insufficient.[1] Micronutrients are required for co-factors in energy production and collagen synthesis and deposition. Vitamins A, B1, B2 and B6 are vital to this process.[4]

Vitamin C is necessary for collagen formation and as a tissue antioxidant.[16] It also contributes to the process of cross linking as well as formation of new blood vessels. Some research has shown that vitamin C supplementation helps promote pressure ulcer healing with a dose of 60-200mg/day in the deficient patient. Doses over 200mg are not necessary as tissue saturation occurs at this point. Iron provides oxygen to the site of the wound. Vitamin C will increase absorption.[16] Studies on hospitalised elderly women indicated an average intake of 21mg/day of vitamin C, with 85 per cent consuming less than two-thirds of the EC RDA of 60mg/day![17] Evidence suggests that benefits are only obtained in vitamin C deficient individuals.[5]

Vitamin A increases the inflammatory response of wounds, stimulating collagen synthesis. It has been suggested that vitamin A can restore wound healing, which has been impaired as a result of long-term steroid therapy or by diabetes.[16] Surgical patients with sepsis and those with fractures, tendon damage or vitamin A deficiency may benefit from peri-operative vitamin A supplementation. Short-term supplementation of 25,000 IU appears safe for most non-pregnant adults.[10] Supplementation requires caution as there is a risk of toxicity.[5]

There is inconclusive evidence with regard to vitamin E supplementation and surgical wounds.[18] Some research shows reduced injury to the wound by controlling excessive free radicals, whereas some evidence suggests supplementation over 400mg/day has an increased health risk.[16] Anecdotal reports claim topical vitamin E enables speedy wound healing. In two clinical trials with surgically induced wounds where vitamin E was applied topically, most subjects experienced no effect, cosmetic appearance of scars worsened, or they developed contact dermatitis.[15]

Adequate nutrition in severe burns patients has a huge impact on the healing process. Copper, zinc and selenium have a role in the immune system and wound healing, and are lost in significant amounts. Patients with total body surface area burns of 30 per cent or greater are recommended IV supplementation for the first eight days from admission, and serum levels monitored on a weekly basis. Research on vitamin requirements in burns remains limited. If patients are on fortified feeds and supplementary drinks, additional vitamins are not recommended.[18]

Zinc plays a role in protein and collagen synthesis and in tissue growth in healing.[6] Zinc deficiency has been associated with delayed wound healing. However, supplementation in people who are not deficient appears to have no benefit. It has been recommended that supplementation for non-healing pressure ulcers is 15mg/day and with larger non-healing wounds 20-25mg/day but that it is limited to 14 days.[16]

Hydration

Dehydration will reduce the delivery of nutrients to the wound site. Fluid and electrolyte disturbance is most common amongst the elderly.[4] Patients on

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air fluidised beds require additional fluid intake of approximately 10-15mls/kg body weight, to prevent dehydration that can occur from the drying effects of the speciality beds.[8] Dehydration is also a major risk factor for the development of pressure sores as the skin becomes inelastic, fragile and more susceptible to breakdown.[1]

Nutritional supplements

The overall goal is to ensure that the patient is in an optimum nutritional state, allowing wounds the best chance to heal. This can be achieved by providing the individual with adequate energy and nutrients, and preventing protein energy malnutrition. Foods high in protein and carbohydrates include milk, cheese, meat, eggs and bread, cereals, potatoes, rice and pasta. Adding fats to meals such as butter and cream, along with choosing full fat varieties will increase the energy content further. It is important that these are presented in a suitable way, for example, patients with swallowing difficulties may require a modified consistency.

If patients are unable to meet their nutritional requirements, oral nutritional supplements (ONS) should be considered. Often the cost of poor wound healing seen in undernourished patients will outweigh the cost of ONS, making them a cost viable option.[5] Reduction in the risk of pressure sore development has been shown in those given oral nutritional supplements, particularly if tailored to the disease process or via enteral feeding.[21]

Particular examples of typical nutrient dense ONS include: Ensure® TwoCal (Abbott); Fortisip® Extra and Fortimel (Nutricia); Fresubin® 2kcal and Fresubin® Protein Extra (Fresenuis Kabi); and Resource® 2.0 Fibre and Resource® Protein (Nestlé). These are high calorie, high protein ONS supplements that are readily available. Additionally, there is large choice of protein or calorie modular supplements, and more recently we have seen the launch of products such as Pro-Cal Shot™ (Vitaflo) which contains 2g protein & 100kcal in 30ml, and ProSource® Liquid which contains 10g protein and 100kcal in just 30ml, making it ideal to add to a tube feed or meals/drinks taken orally or those on a restricted diet, such as a fluid restriction.

Alternative therapies

Centella asiatica (gotu kola) and aloe vera have been used for decades as folk remedies for burns, wounds or scars. Improved wound healing has been reported from topical or internal application. Centella asiatica has been documented to aid wound healing in several studies, particularly by the stimulation of T-1 collagen production. However, further clinical trials are needed to determine the safety and benefits of peri-operative administration.[15]

The systematic review of four studies to determine the efficacy of topical aloe vera for the treatment of burn wounds, found that the healing time of the aloe vera group was 8.79 days shorter than the control group and, therefore, could be an effective intervention for use in burn wound healing for first and second degree burns.[19]

Bromelain is a crude extract from the pineapple that contains, amongst other components, various closely related proteinases. A wide range of therapeutic benefits have been claimed, including accelerating in wound healing.[20] Studies show mixed results. Two studies administering 400mg bromelain daily and 40mg four times daily respectively showed no significant effects relating to oedema and inflammation. On the other hand, studies have also shown that bromelain reduced swelling, bruising pain and healing time in patients following dental surgery. It is suggested that these positive effects of bromelain could be related to its anti-inflammatory action rather than a direct analgesic action.[15]

Conclusion

The primary goal of nutrition intervention is generally to correct protein energy malnutrition and micronutrient deficiencies, ideally via oral feeding. Considering fluid intake is equally important. Where enhanced normal feeding is not possible, protein, energy rich oral supplements may be considered. The success of nutrition intervention should be reviewed within an ongoing nutrition assessment which may be indicated by outcomes, such as a reduced incidence of new pressure ulcers and the healing of established pressure ulcers. The EPUAP recommendation is that a minimal assessment of nutritional status should include regular weighing of patients, skin assessment and documentation of food and fluid intake.[7]

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