The importance of nutrition in wound healing

Nursing Standard's recent Focus on Nutrition campaign raised some uncomfortable issues about nurses’ knowledge of wound healing. We continue the theme here, with a review of the importance of good nutrition for effective wound healing.

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A person’s nutritional requirements increase following trauma or surgery, and in the presence of a chronic wound. If the increased demand for nutrients is not met, this can have a significant impact on wound healing, but it is nevertheless a factor that is often overlooked by health professionals in their patient assessments. Metabolic demand rises in the presence of a wound because the cell activity in the region is greatly increased. The process of wound healing requires cell division and migration of macrophages, fibroblasts and endothelial cells bringing in new blood vessels and epithelial cells from the surrounding tissues.

Cellular processes during wound healing During wound healing, the cells, particularly fibroblasts, synthesise and secrete proteins to form scar tissue, while macrophages secrete the growth factors which direct the activity of surrounding cells and, thus, the sequence of wound healing. All of these activities place extra nutritional demands on the patient, and wounds, fistulae and burns also cause an increased loss of protein from the body through exudate. At times, especially when burns are extensive, this loss can be severe and even life-threatening. This article reviews the criteria for nutritional assessment of patients with wounds, explains the specific nutritional requirements for the healing wound and examines particular conditions where nutritional risk may be increased.

NUTRITIONAL REQUIREMENTS DURING WOUND HEALING

Malnutrition of specific nutrients can cause wounds. In the 18th century, leg ulcers were most commonly found in young males with vitamin C deficiency or scurvy, a problem that has been well documented through the records of Royal Naval surgeons (Loudon 1981). Malnutrition can increase the risk of developing pressure ulcers (Fig. 1) and virtually all pressure sore risk assessment scales incorporate some measure of nutritional status.

Carbohydrate Wound healing leads to an increase in the nutritional requirements of a patient. Obviously, the increase in metabolic demand causes an increase in demand for carbohydrate – one of the major nutrients. Carbohydrates are used to manufacture glucose which cells then use to produce adenosine triphosphate (ATP), the fuel source for all cellular activity. If carbohydrate intake is insufficient, the body utilises fat and protein stores for gluconeogenesis (the making of new glucose) instead. This is particularly so following major trauma or burns, when the stress hormones, adrenaline and corticosteroids, are released, triggering the breakdown of fat and protein stores (White and Baxter 1994).

Metabolic or energy demands rise significantly following surgery, trauma or in the presence of a chronic wound. It has been estimated that the basal metabolic rate rises 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 (White and Baxter 1994). Continuing demand for carbohydrate that is not met in the diet can ultimately lead to loss of the body’s structural proteins. The skeletal muscle tissue is broken down to provide amino acids for the formation of glucose molecules.

**Protein** Protein is another major requirement for wound healing. Not only does the demand for protein increase in the presence of wounds, but loss of proteins occurs in any exuding wound. Proteins in the diet and structural body proteins, if necessary, are broken down into amino acids, which are then used for cell division and to manufacture the proteins required for scar tissue formation. The main protein synthesised in the healing wound is collagen.

**The importance of collagen** Collagen is the major extracellular protein of the body. It is a large protein which makes up over 25 per cent of human dry body weight (Alberts et al 1989) and is found everywhere from bones and tendons, to blood and skin. There are more than ten types of collagen, but the main fibre in skin and scar tissue is Type I collagen.

This is a particularly strong fibre and is usually found arranged in a wickerwork pattern in intact skin so that mechanical stress can be withstood.

In the healing wound, Type III collagen (normally found mainly in fetal tissue) initially provides a structural framework for healing to take place. During the granulation phase of healing, Type I collagen gradually replaces Type III, but in a disorganised manner (Hunt 1988). Although this disorganised layout is remodelled during the maturation stage of healing, it never attains the structured order of normal skin. For this reason, a scar will only attain about 70 to 80 per cent of the strength of normal tissue. It can take more than 12 months for a scar to reach its maximum strength following wound healing.

During this time, collagen fibres in the scar are reorganised and replaced. Activity in the wound site is ongoing, even after the healing has apparently been completed. Consequently, the need for some nutritional support, particularly in the form of micro-nutrients where diet is poor, may be ongoing. Synthesis of collagen and the other proteins needed for cell division, migration and scar tissue formation, requires an increase in enzyme activity within the cells. Many enzymes utilise micro-nutrients as co-enzymes or essential components of their structure. Absence of these from the diet reduces the number of enzymes available for protein synthesis.

**Vitamins** The most commonly discussed micro-nutrients for wound healing are vitamin C and zinc. Vitamin C is particularly important for collagen synthesis because of the unique structure of this group of proteins. Vitamin C is required to form bonds between the strands in the collagen fibre, and provides extra stability and strength to the collagen. If these bonds do not form within a collagen fibre, once the collagen is secreted from the cell, it will be rapidly broken down by collagenases found in the extracellular fluid.

This occurs in scurvy, where newly forming fibres in tissue with a relatively high turnover of collagen – for example blood vessels, gums, skin and scar tissue – are broken down. This leads to loss of total collagen and the symptoms of scurvy – easy bruising and bleeding, loss of teeth, ulcer formation and breakdown of old scars. A less severe vitamin C deficiency will cause similar problems whereby rapid collagen synthesis and protein synthesis, therefore demand for zinc will be high wherever rapid cell division and protein secretion occur. The healing wound also needs vitamins of the A and B complex, and the minerals copper, manganese and magnesium (McLaren 1992).

Evaluating actual levels of these vitamins and minerals in the plasma is difficult and costly, and

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### Table 1. Nutritional requirements for wound healing

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>ROLE</th>
<th>SOURCES</th>
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</thead>
<tbody>
<tr>
<td><strong>Proteins</strong></td>
<td>Cell mitosis and migration; immune system responses; synthesis and secretion of intracellular and extracellular proteins, especially collagen; synthesis and secretion of growth factors</td>
<td>All meats, fish, dairy products, beans and pulses, cereals, bread, soya products</td>
</tr>
<tr>
<td><strong>Carbohydrates</strong></td>
<td>Provision of ATP for all cellular activity</td>
<td>Most food sources; body stores of fat and protein</td>
</tr>
<tr>
<td><strong>Vitamin C</strong></td>
<td>Collagen synthesis; cell mitosis and migration; immune system function</td>
<td>Citrus fruit, green vegetables, fruit juices, tomatoes</td>
</tr>
<tr>
<td><strong>Zinc</strong></td>
<td>Cell mitosis; protein synthesis; strengthening and maturation of collagen</td>
<td>Red meat, offal, nuts, some fortified breakfast cereals*</td>
</tr>
<tr>
<td><strong>Vitamins A and B</strong></td>
<td>Strengthening and maturation of collagen</td>
<td>A: yellow and green vegetables, liver, egg yolks, butter, milk B: yeast, liver, green vegetables, fortified breakfast cereals</td>
</tr>
<tr>
<td><strong>Iron</strong></td>
<td>Oxygen delivery to wound bed</td>
<td>Red meat, leafy green vegetables, fortified breakfast cereals</td>
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*Absorption of zinc from the gut may be reduced if the person is taking iron supplements at the same time.
plasma levels may not necessarily reflect intracellular concentrations. It is probably more cost effective to perform a nutritional assessment on the patient and use nutritional supplements if they appear to be necessary. Giving vitamin and mineral supplements to a well nourished patient will not increase wound healing rates, but may have a significant impact on someone who is malnourished. A summary of nutrients and their roles in healing is to be found in Table 1.

Iron
One nutrient not included in many assessments is iron. This is because lack of iron causes anaemia and impaired oxygen-carrying capacity in the blood. Many practitioners do not regard this deficiency as having any direct impact on wound healing. It is important to correct this assumption.

A patient who is anaemic will have impaired healing for two reasons. First, oxygen delivery to the wound site is directly proportional to the concentration of oxygen circulating in the blood; any reduction will be reflected at the wound site. Second, if the anaemia is severe, peripheral circulation is likely to be reduced to preserve oxygenated blood for vital organs. In such circumstances, wounds will be further deprived of oxygen and the metabolic activity of the cells in the wound bed will be decreased.

**Assessment of Nutritional Status**

Nursing assessment of the nutritional status of a patient should be regarded as a preliminary step to a proper assessment by a qualified dietician. Once a patient is regarded as being at risk nutritionally, a dietician is able to provide a skilled assessment, appropriate nutritional supplementation, and to offer ongoing evaluation. Initially, however, the nurse must be able to identify those patients who should be referred for dietetic assessment. Over recent years, there has been a recognition that healthcare professionals are failing to identify patients with poor nutritional status, or those who are at risk of developing malnutrition (Baughen 1988, McWhirter 1994, Wood 1998).

Full nutrition relies on five factors (Cataldo et al 1991) (Fig. 2):

- **Unrestricted access to food** In the community setting, the client must be able to afford to buy food, to transport it home and cook it. Thus, a nutritional assessment should consider the client’s mobility, socio-economic status, usual diet and knowledge about nutrition.

- **In hospital,** the patient must be able to express likes and dislikes, be able to obtain food and feed him- or herself. Numerous studies have shown that hospitalised patients are at risk of starvation (Baughen 1988, McWhirter 1994, Wood 1998).

- **Poverty**

- **Poor mobility**

- **Inability to express likes or dislikes**

- **Debilitating disease**

- **Depression**

- **Some medications**

- **Inability to express likes or dislikes**

- **Neuromuscular disorders**

- **Stroke**

- **Pancreatitis**

- **Gall bladder disorder**

- **Paralytic ileus**

- **Diarrhoea**

- **Vomiting**

- **Bowel or gastric resection**

- **Physical activity**

- **Trauma, surgery, fever, sepsis**

- **Access to food**

- **Appetite**

- **Swallowing**

- **Absorption**

- **Energy intake < metabolic demand**

- **Deprivation of nutrients**

- **Total (starvation)**

- **Selective (malnutrition)**

- **Delayed wound healing**

**Fig. 2. Factors affecting nutritional status in wound healing**
Changes in hospital practices over the years, whereby meals are delivered to the ward already served, have been used as an excuse for the withdrawal of nurses from the assessment of patients’ nutritional status and involvement in their dietary intake. It is difficult to see this as the sole reason for nutritional problems in the hospitalised patient. Registered nurses claim to have closer relationships with patients than ever before and to the needs of individual patients should be easier to integrate into nursing practice.

**Appetite** Disease states, medication (such as some opiates, metformin and chemotherapeutic drugs), smoking and psychological factors can all affect appetite. Poorly fitting dentures or oral infection may also reduce appetite.

**The swallowing reflex** Any patient with a neurological or neumoromuscular condition should be assessed and, if necessary, receive a modified diet.

**Absorption of nutrients** This can be affected by conditions such as pancreatic or biliary dysfunction, or any alteration in the secretion of digestive enzymes which diminishes the breakdown of food in the gastrointestinal tract. Nutritional assessment should also take into account any condition or event which alters gut mobility, either stasis or diarrhoea, or decreases the area for absorption, such as gastric or small bowel resections.

**Energy intake and metabolic demand** Metabolic demand is determined by the amount of physical activity undertaken, growth needs including wound healing, and the basal metabolic rate (BMR). BMR is determined by age, thyroid hormones, sex and lean body mass. It is increased following trauma or surgery, in fever and sepsis.

**SPECIFIC APPROACHES**

**Nutrition and obesity** It should be noted that obesity, where energy intake may exceed metabolic demand, does not necessarily mean over-nutrition. An obese person is likely to be suffering from selective nutrient deficiency, since the bulk of his or her diet may be composed of carbohydrate or fat at the expense of proteins and essential vitamins and minerals.

**Diabetes and wound healing** The patient with diabetes poses a different problem in the balance between metabolic demand and energy intake. Diabetes affects the utilisation of carbohydrates for energy needs within the cell. The person with diabetes is not able to take glucose into the cell to manufacture ATP. This poses an additional nutritional risk, apart from the other effects of diabetes on wound healing rates and development of chronic wounds (related to neurological and microvascular changes associated with diabetes). While a person with diabetes may have none of the nutritional risk factors given above, where 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 be very well controlled and closely monitored in the presence of a wound.

**A MULTIDISCIPLINARY APPROACH**

These factors can be incorporated into simple nutritional risk assessment tools (such as, Charalambous et al 1993, Robshaw 1995). Most dieticians would be happy to share and discuss nutritional risk assessment with interested nursing staff. Use of a simple scale to assess nutrition of patients, particularly those with chronic wounds, may lead to a more rapid recognition of the role nutrition plays in the individual’s healing process. Nutritional risk should be incorporated in the holistic assessment of every patient with a problem wound.

Apart from the use of a risk assessment tool, nurses can assess nutritional status by simply weighing patients over a period of time. The practice of daily weighing is used to assess fluid balance, and is not relevant in nutritional assessment. In long-term care, however, weekly or even monthly weighing can be very useful. Other assessments, such as anthropomorphic measures (skin folds), serum protein levels and nitrogen balance, are more complex and require skilled input. It is unlikely that these would be considered cost-effective, particularly in the case of a patient with a chronic wound.

Like wound healing itself, nutrition is a multidisciplinary field. While nurses are at the forefront of assessment and identification of at-risk patients, the contributions of medical staff and dieticians are invaluable. Occupational therapists have a significant role to play when access to food and difficulty with feeding cause concern. In the community, social services can be used when financial or mobility problems are an issue.

**CONCLUSION**

Nutritional requirements change in the presence of a wound, whether it is surgical, traumatic or chronic in nature. Most wounds heal given time, but the rate of healing can be improved by identifying those patients at risk of malnutrition early on in the healing process, ensuring that diet reflects the increased demands of wound healing. Knowing the impact that trauma, surgery, burns and exudating wounds have on the balance of nutrients, particularly carbohydrates and proteins, enables us to ensure that nutritional support is in place before these conditions can damage the healing process.