Nutritional support for the patient with wounds: food intake and supplementation

Introduction

The daily intake of food is an activity that is associated with life and the maintenance thereof. Unfortunately, there is more to food than meets the eye and what is eaten is not necessarily exactly what the body needs. When confronted with skin breakdown and wounds, evidence is mounting to support the notion that intake of food and additional nutritional supplementation in these individuals are paramount in facilitating the wound healing process. It is a well known fact that wounds heal the quickest in well-nourished patients.

Supplementation can play a vital role as discussed later in this article, but it is important that basic nutrition should be in place.

General Nutritional Guidelines and the South African food based dietary guidelines:

- Use fresh foods as much as possible to elevate the intake of vitamins/minerals, and decrease the use of additives/preservatives.
- Increase the intake of fish and white meats, nuts, beans and pulses since they are lower in saturated fat.
- Decrease the intake of red meat (2–3/week) to reduce saturated fat intake.
- Increase the intake of oily fish such as sardines, mackerel, trout, salmon, herring (2–3/week) to increase omega-3 polyunsaturated fats and natural intake of vitamin D.
- Use other poly- and mono-unsaturated fats/oils in moderation (sunflower oil, olive oil) rather than butter and hard fats.

The Food Based Dietary Guidelines for healthy eating for South Africans older than seven years states that it is important to:

- Enjoy a variety of foods.
- Be active.
- Make starchy foods the basis of most meals.
- Eat dry beans, split peas, lentils and soya regularly.
- Chicken, fish, milk, meat or eggs can be eaten daily.
- Drink lots of clean, safe water.
- Eat plenty of vegetables and fruits every day.
- Eat fats sparingly.
- Use salt sparingly.
- Use food and drinks containing sugar sparingly and not between meals.
- If you drink alcohol, drink sensibly.

Nutrients that play a role in skin repair

Macronutrients

Energy, Protein, Carbohydrates and Fat

Energy (E)

Total energy intake is most probably the most important aspect in the prevention of malnutrition and tissue breakdown. The basic energy requirements are normally: 25–35 kCal/kg (105–147 kJ/kg). Energy intake can be negatively influenced by a number of aspects such as difficulty to eat, taste and or texture preferences, social aspects, dysphagia, gastro-intestinal (GI) disorders and depression. Wounds and trauma or surgery can increase the basic need of energy.

The first step to prevent malnutrition is to monitor if the patient consumes enough food by weighing the patient regularly. In this way unwanted or unmonitored weight loss can be identified quickly. Easy questions to ask a patient during a basic assessment should include the following:

- Have you been eating less than usual?
- Have you experienced vomiting or diarrhoea recently?
- What is your normal weight?
- Have you lost weight recently?
- How tall are you?
- Have you noticed any change in appetite recently?

Energy intake in the patient at risk for malnutrition can easily be increased to 35–40 kCal/kg (147–168 kJ/kg) to prevent weight loss or for those who are underweight to start out with.

Energy intake is very dependent on maintenance of a balance as over-nutrition also has its own negative effects especially on immunity and possible re-feeding syndrome.

Protein

Protein is required for the synthesis of new tissue. Deficiency adversely affects wound healing by blunting the fibroblastic response, new blood vessel formation, collagen synthesis, and wound remodelling processes. A minimum protein goal is normally in the range of 1.0–1.5 gram/kg/day (12–20% of total E intake). Calculations should be based on actual body weight, which should be adjusted in the presence of oedema, chronic renal impairment (lower protein for conservative renal impairment treatment) and especially in the older patient, since too high protein intake can result in dehydration.
Specific amino-acids may influence the healing process e.g. arginine appears to influence wound healing favourably by affecting microvascular and perfusion changes, enhancing collagen production via proline synthesis.1,2,7

Glutamine serves as a fuel source for cells with rapid turnover, such as enterocytes, epithelial cells, fibroblasts, macrophages and lymphocytes. In patients with burns, glutamine supplementation has resulted in faster wound healing rates.10,13,14 No studies have been conducted on glutamine and wound healing for pressure ulcers. Neither the NPUAP (National Pressure Ulcer Advisory Panel) nor the EPUAP (European Pressure Ulcer Advisory Panel) recommends routine glutamine supplementation for pressure ulcers.2

**Carbohydrates**

Carbohydrate in the form of glucose is the major fuel source for collagen synthesis which is the building block of tissue.8 It should however be stated that it is not necessary to take in pure glucose since it can affect the blood glucose levels negatively. When carbohydrates are taken in, the body will break them down to glucose, therefore low glycaemic index (low GI) carbohydrates are recommended since they can be beneficial in controlling blood glucose levels and release glucose over a longer period of time to the body. Intake of a variety of carbohydrates is very important and emphasis should be placed on including whole grains in the diet since they contain all three layers of the grain (bran, germ, and endosperm).15 Examples of whole grains include brown rice, wheat (“koring”), barley (“gort”), oats, and whole mealies (corn on the cob/ green mealies). The general guideline is that carbohydrate intake should consist of 50–60% of the total daily energy intake.

**Fats**

Except for normal fat intake for energy, omega-3 fatty acids play an important role in the immune functions and have been shown to be beneficial pre- and postoperatively in facilitating quicker recuperation of these patients.7 Trans-fats and hydrogenated oils should be avoided due to their negative health effects. Intake of olive oil may also play a role in decreasing inflammation and improving endothelial function.16 Fat is also responsible for the normal functioning of all tissue and helps transport nutrients across the cell membrane.4

Total fat intake 30–35% of total energy intake. Saturated fat < 10% of total energy intake. Poly-unsaturated fat 4–10% of total energy intake. Mono-unsaturated fat should make up for the balance of the fat intake.21

**Micronutrients**

Vitamin A, C, D, E, Zinc, Copper, Iron

### Vitamin A

Vitamin A stimulates various aspects of wound repair by a number of mechanisms. It affects fibroplasia, collagen synthesis, epithelialisation, angiogenesis, and is involved in the inflammatory processes with specific stimulatory effects on macrophages, which play a dominant role in wound healing. Vitamin A is essentially beneficial in stimulating wound healing that has been retarded by the use of corticosteroids. It has also been demonstrated that it can reverse impaired wound healing caused by serious injuries, tumours, and radiation.12

- **Food sources – Vitamin A**
  - Liver, kidney, milk fat (cream), fortified margarine, egg yolk, yellow and dark green leafy vegetables, apricots, cantaloupe (“spanspek”/ orange-fleshed melon), peaches, fish liver oil.5,13

### Vitamin C

Vitamin C plays a critical role in wound healing and collagen formation and a deficiency can have a crucial effect on wound healing. During vitamin C deficiency, fibroblasts produce unstable collagen which provides a weak structural framework for tissue repair. Vitamin C is also important for proline and lysine hydroxylation, collagen synthesis and cross-linkage. High dosages of vitamin C may however cause diarrhoea which may increase the risk factor for the development of decubitus ulcers (pressure sores).4,7,10,16

- **Food sources – Vitamin C**
  - Citrus fruit, tomato, melon (orange/green), peppers, broccoli, brussel sprouts, raw cabbage (e.g. cole slaw), guava, strawberries, pineapple, potato, kow.1,13

### Table I: Vitamin A guidelines2,14

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age in years</th>
<th>EAR mg/day</th>
<th>RDA mg/day</th>
<th>UL mg/day</th>
<th>LOAEL mg/day</th>
<th>Recommended serum levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>31–50</td>
<td>75</td>
<td>90</td>
<td>2,000</td>
<td>3,000</td>
<td>Serum ascorbic acid</td>
</tr>
<tr>
<td>Female</td>
<td>31–50</td>
<td>60</td>
<td>75</td>
<td>2,000</td>
<td>3,000</td>
<td>0.4-2.0 mg/dL</td>
</tr>
</tbody>
</table>

v NOAEL 2,000 mg/day

* Please note that this is the values used in reference 2 and that local laboratory values may differ

### Vitamin D

Calcitriol, a metabolite of vitamin D has been shown to have an important regulatory function of cellular differentiation and proliferation.15 Many hospitalised and institutionalised patients might have a vitamin D deficiency due to low sun exposure.

- **Food sources – Vitamin D**
  - Milk fat (cream), liver, egg yolk, salmon, tuna fish, sardines, and sunlight converts 7-dehydrocholesterol to cholecalciferol.5,13

### Table III: Vitamin D guidelines2,14

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age in years</th>
<th>UL µg/day</th>
<th>LOAEL µg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>31–50</td>
<td>50</td>
<td>95</td>
</tr>
<tr>
<td>Female</td>
<td>31–50</td>
<td>50</td>
<td>95</td>
</tr>
</tbody>
</table>

5 µg = 200 IU

NOAEL 10 µg/day for both males and females of this age group

* a NOAEL was established at 14,000 µg/day/4667 IU, which excludes women of childbearing age. **b No observed adverse effect level (NOAEL) was established at 4500 µg/15000 IU

*** Please note that this is the values used in reference 2 and that local laboratory values may differ
Vitamin E

Vitamin E through its anti-inflammatory properties may enhance wound healing. Additional research is however needed and routine supplementation in the patient with pressure ulcers is not recommended unless a clinical deficiency is present. Vitamin E comprises eight naturally occurring forms (tocopherols and tocotrienols) of a fat soluble antioxidant that is present in plasma, membranes, and tissues. Their functions as chain-breaking antioxidants come from their ability to rapidly scavenge lipid-peroxyl radicals before they can react with other lipids, thereby ending the propagation of lipid peroxidation in membranes. Excessive amounts of vitamin E may be detrimental to wound healing, as it increases the risk for fibroses and spontaneous hemorrhage.

Vitamin E should not be taken for at least a week before surgery due to its anti-platelet effect. Patients taking anti-platelet medication should as a rule be careful when taking vitamin E as added supplementation. Vitamin E deficiency is rare but can occur with fat malabsorption as seen with short bowel syndrome, chronic diarrhoea, cystic fibrosis, coeliac disease and patients who have had gastrectomy surgery.

- **Food sources – Vitamin E**

  Wheat germ, vegetable oils, green leafy vegetables, milk fat (cream), egg yolks, nuts, vegetable oils.5,13

**Table IV: Vitamin E guidelines**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age in years</th>
<th>EAR mg/day</th>
<th>RDA mg/day</th>
<th>UL mg/day</th>
<th>Recommended serum levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>31–50</td>
<td>12</td>
<td>15</td>
<td>1,000</td>
<td>Serum α-tocopherol 5.5–18 mg/L*</td>
</tr>
<tr>
<td>Female</td>
<td>31–50</td>
<td>12</td>
<td>15</td>
<td>1,000</td>
<td></td>
</tr>
</tbody>
</table>

* Please note that this is the values used in reference 2 and that local laboratory values may differ.

Zinc

Zinc is most probably the nutrient where the importance of maintaining a balance is demonstrated the best since excess and deficiency give almost the same symptoms. Zinc plays a role in over 200 enzymes that are important for immune function and with catalytic and structural roles. It is also involved in protein synthesis, DNA/RNA replications and cell division. Zinc deficiency results in poor wound healing, reducing the work capacity of respiratory muscles, DNA/RNA replications and cell division. Zinc deficiency is rare but can occur with fat malabsorption as seen with short bowel syndrome, chronic diarrhoea, cystic fibrosis, coeliac disease and patients who have had gastrectomy surgery.

- **Food sources – Zinc**

  Oysters, animal flesh – particularly red meat, beef liver and poultry, fish, toasted wheat germ, pecan nuts, wild rice, milk, walnuts, egg, dry beans, and whole grains.5,13

**Table V: Zinc guidelines**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age in years</th>
<th>EAR mg/day</th>
<th>RDA mg/day</th>
<th>UL* mg/day</th>
<th>LOAEL mg/day</th>
<th>Recommended serum levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>31–50</td>
<td>9.4</td>
<td>11</td>
<td>40</td>
<td>Serum zinc 60–120 µg/dL*</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>31–50</td>
<td>6.8</td>
<td>8</td>
<td>40</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

* UL was based on the adverse effect of excess zinc on copper metabolism; it applies to total zinc intake from food, water and supplements (including fortified food). The UL is not meant to apply to individuals who are being treated with zinc under close medical supervision. * Please note that this is the values used in reference 2 and that local laboratory values may differ.

Iron

As iron is an important component to ensure adequate haemoglobin levels and oxygen-carrying capacity in the body, it should be monitored and assessed in the patient with severe malnutrition and those with a non-healing wound history. It is important to keep a close observation on haemoglobin levels (Hb) as that may serve as a point of reference regarding iron status in patients with infection or major wounds, since iron biochemical markers may be low during infection.

Blood products are rarely given unless the Hb falls below 8 g/dL.7

- **Food sources – Iron**

  Liver, red meats, baked beans, blackstrap molasses, oysters, baked potato with skin, toasted wheat germ, spaghetti with tomato sauce, apricots, spinach, cocoa powder, wholewheat bread, and dried fruits.5,13

Hydration

The adequate intake of water is directly related to the effectiveness

**Table VII: Iron guidelines**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age in years</th>
<th>EAR mg/day</th>
<th>RDA mg/day</th>
<th>UL</th>
<th>LOAEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>31–50</td>
<td>6.0</td>
<td>8.0</td>
<td>45</td>
<td>70 mg/day x</td>
</tr>
<tr>
<td>Female</td>
<td>31–50</td>
<td>8.1</td>
<td>11</td>
<td>45</td>
<td>70 mg/day x</td>
</tr>
</tbody>
</table>

* LOAEL of 70 mg/day was established from data in studies on adult men and women.
of blood perfusion in a body. The role of perfusion in studies of nutritional support in persons with wounds needs increased attention. Oxygen to tissue is vital in wound healing and is dependent on blood perfusion. Impaired oxygen tension to tissues can result from haemorrhage, haemodilutional and dehydration. Patients at risk for perfusion problems also include those with renal failure, congestive heart failure and the elderly. Hospitalised patients are at risk of being inadequately hydrated and under-perfused. However administrations of extra fluid must be done carefully, as elderly patients may suffer from impaired homeostasis mechanisms and may not be able to regulate fluid balance as effectively as younger persons.

Monitoring of hydration status is therefore vital for proper wound healing. Signs and symptoms of dehydration include rapid changes in weight, skin turgor, urine output and elevated serum sodium. Make sure to provide extra fluids for individuals consuming high levels of protein, those with an elevated temperature, uncontrolled vomiting, profuse sweating, diarrhoea or heavily draining wounds.

Other factors
Factors not discussed in detail in this article but which can adversely affect and subsequently delay timeous healing of wounds are discussed below.

1. Wound management should be in place and should include proper wound cleansing, debridement of callus or necrotic tissue, of loading of pressure and appropriate antibiotic therapy for infection.

2. Diabetes and metabolic syndrome
Hyperglycaemia increases the risk of wound infection and may seriously delay wound healing rates.

The role of HbA1c in monitoring glucose control is becoming more important and it might be beneficial to test this during the initial baseline assessment not only in diabetics, but also in obese patients and patients suffering from the metabolic syndrome. Merely relying on fasting glucose or random glucose levels is no longer sufficient in measuring glycaemic control. New guidelines, however, suggest that HbA1c should not be too low in elderly patients; for the rest of the diabetic population an HbA1c level < 7 is the current cut off point.

3. Obesity

4. Smoking

5. Acid Base balance (pH)

6. Cardiovascular risk including cholesterol and hypertension

7. HIV/Aids

Nutritional status and wound healing: current best evidence

- Nutritional screening, support and regular monitoring should be commenced as early as possible to optimise outcome.
- Adequate energy should be provided to maximise nitrogen retention and wound healing, including a source of omega-3 fatty acids.
- Adequate protein should be provided based on age- and disease-related needs, arginine/proline-enriched feeds may be considered in the management of large surface area wounds.
- Suspected or confirmed micronutrient deficiency should be treated at an early stage by providing a minimum 100% RDA of micro nutrients.
- In the absence of deficiency, supplemental intakes of micro-nutrients such as vitamin C or zinc provide no clinical benefit.
- Attention should be paid to controlling physiological aspects detrimental to wound healing, such as dehydration, anaemia, hyperglycaemia and mobility.
- Involuntary weight loss and poor oral intakes significantly increase pressure ulcer risk.

Conclusion
Practical implications for the wound practitioner are that any patient with a non-healing or a slow-to-heal wound should be screened properly for possible malnutrition. By adding a dietitian to the interdisciplinary team, the wound outcome for a patient can be positively influenced with a few dietary adaptations or maybe supplementation.

Acknowledgements
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Conflict of interest
The author of this article is an independent GNLD distributor and thus believes in the benefits of possible nutritional supplementation.

References: