Chapter 8

# NUTRITION

Poor nutrition can negate all the benefits of proper wound care or advanced medical interventions. Studies have shown that malnourished patients often require longer hospitalizations, have more postoperative complications, and have delayed wound and fracture healing compared with well-nourished patients.

Usually, patients who do not ingest adequate amounts of calories and protein are also not meeting vitamin and mineral requirements. Malnutrition essentially depletes physiologic reserves and leads to many problems, including impaired wound healing and impaired immune function.

Elective surgery is often contraindicated and therefore not performed in malnourished patients. This illustrates the importance of understanding the basics of nutrition as they affect wound healing.

## Types of Malnutrition

### *Marasmus*

Malnutrition due to inadequate caloric intake is called marasmus. The patient has severe physical wasting due to the loss of fat and somatic (skeletal) muscle. This condition is seen not only in the developing world and in times of famine but also in patients with cancer or anorexia. Although the patient is not taking in sufficient calories, he or she is getting sufficient protein. As a result, measured serum protein stores (see below) are adequate.

### *Kwashiorkor*

Patients with kwashiorkor take in sufficient calories but do not meet their protein needs. The typical patient has thin arms and legs with a large protruding belly and peripheral edema (swelling in the soft tissues).

### *Marasmic Kwashiorkor*

Marasmic kwashiorkor is a combination of protein and calorie malnutrition. It is the most common form of malnutrition in the developing world and occurs when a chronically starved patient (e.g., a patient with cancer) suffers an additional stress (e.g., injury, infection).

## Assessment of Nutritional Status

Evaluation of protein stores provides a good estimate of nutritional status.

### *How to Evaluate Protein Stores*

The liver produces various proteins, including albumin, prealbumin, and transferrin, that can be measured in the serum. These proteins have been found to correlate well with general nutritional status. Albumin does not correlate with nutritional status as well as prealbumin and transferrin. However, measurement of albumin is useful if the more expensive tests for prealbumin and transferrin are unavailable.

**Table 1. Serum Protein Measurements as a Guide to Nutritional Status**

| Protein | Normal Value | Moderate Malnutrition | Severe Malnutrition |
|---|---|---|---|
| Albumin (gm/dl) | 3.5–5.0 | 2.1–2.7 | < 2.1 |
| Prealbumin (mg/dl) | 15–40 | 5–10 | < 5 |
| Transferrin (mg/dl) | 200–400 | 100–150 | < 100 |

### *How to Estimate Caloric Needs*

A patient's daily caloric requirements are affected by a number of factors. Most calories are used to provide the energy for the basic body functions in a resting state, also called the basal metabolic requirements (BMR). These body functions include breathing, maintaining an upright posture, maintaining stable blood pressure, and digestion. The need for additional calories depends on various stresses. Examples of stresses that increase caloric requirement include burns, blunt trauma, fever, infection, surgery, and exercise.

#### *Harris-Benedict Equation*

The Harris-Benedict equation is commonly used to estimate the BMR in healthy people. Height (in cm), weight (in kg), and age (in years) are factored into the equation:

$$\text{BMR for men} = 66.47 + [13.75 \times \text{weight}] + [5.0 \times \text{height}] - [6.76 \times \text{age}]$$

$$\text{BMR for women} = 655.1 + [9.56 \times \text{weight}] + [1.85 \times \text{height}] - [4.68 \times \text{age}]$$

To determine *total* energy needs, the BMR must be multiplied by factors for activity and stress levels. Activity factors are 1.2 for patients at bedrest and 1.3 for ambulatory patients. Stress factors range from 1.2 for minor surgery or a fracture, to 1.8–2.0 for severe sepsis or severe burns.

### *Example*

A 35-year-old women weighs 60 kg and is 5 feet tall. While working she fell and broke her arm. What are her caloric needs? Because height must by in cm, 5 feet must be converted to 152.4 cm:

$$\text{BMR} = 655.1 + [9.56 \times 60] + [1.85 \times 152.4] - [4.68 \times 35]$$

$$\text{BMR} = 655.1 + 573.6 + 281.94 - 163.8 = 1346.84 \text{ kcal/day}$$

*Total needs* = 1346.84 × 1.3 (she is ambulatory) × 1.2 (minor fracture)

*Total needs* = 2101.07 kcal/day

### *A Simpler Formula to Estimate Caloric Needs*

To get a general estimate of daily caloric requirements, multiply the patient's weight in kg by 25–40, depending on stress level (25 = low stress, 40 = high stress, as in patients with burns or sepsis). For the patient above:

*Total needs* = 60 × 30 (the fracture adds a little to the stress level) = 1800 kcal/day

## Protein

Protein is probably the most important nutrient. It is broken down into individual amino acids, which are important building blocks for bone, muscle, and skin. Thus, adequate protein intake is vital for normal wound healing. Protein is found in food derived from animals and plants. Not all sources of protein contain all of the necessary amino acids required to maintain adequate protein stores; in other words, they are not considered to be "complete" protein sources.

In general, animal sources (e.g., eggs, meat, milk) contain all of the required amino acids. Dried beans, peanuts, and soy-derived foods are the best nonanimal sources of protein. Although protein is present in cereals and grains, they are not complete sources of protein. Corn may be a good source, but often much protein is lost during processing. Fruits and vegetables contain little protein.

Patients who have limited access to animal protein must combine vegetable protein sources carefully to provide complete proteins each day. Sources of vegetable protein include rice and beans, cereal with milk, and noodles with cheese.

### *How to Estimate Protein Needs*

The adult U.S. recommended dietary allowance (RDA) for protein is 0.75 gm/kg of body weight/day, which for an average-sized adult is 45–60 gm/day. Children and infants have higher protein requirements (1–2 gm/kg/day).

Stress, such as infection, burns, or traumatic injury, increases protein breakdown and thus protein requirements. Even under these circumstances, the requirements usually do not increase by more than 50% of the RDA.

During times of stress, precise measurements of nitrogen loss can be determined by collecting the urine produced over a 24-hour period and measuring its urea nitrogen content. Multiply this number by 1.25 to estimate total nitrogen lost. Determine how much nitrogen the patient took in based on diet. If the patient is losing more nitrogen than he or she is taking in, more nitrogen must be ingested to prevent depletion of protein stores.

## Important Vitamins and Minerals

The following vitamins and minerals are important for proper wound healing. Because vitamins and minerals cannot be made by the body, they must be ingested. They serve as cofactors in many enzymatic reactions that are necessary for normal physiologic functioning. Although supplements are indicated in patients with deficiencies, little evidence indicates that higher supplemental doses have beneficial effects in patients with adequate vitamin/mineral stores.

**Note:** These nutrients have other important physiologic effects, but only their effect on wound healing is discussed below. All of the listed minerals (calcium, copper, iron, magnesium, manganese, and zinc) are important in collagen synthesis.

### *Vitamin A*

Because vitamin A is fat-soluble, it can be stored by the body. It is needed for the formation and maintenance of healthy skin and hair. It is a cofactor for collagen synthesis and is also important for normal immune function. Studies have shown that in patients taking chronic, high-dose steroids, Vitamin A is particularly important for proper wound healing. In this specific population, higher daily doses than the RDA may be beneficial for a short period (few weeks). In patients who are not taking steroids and who ingest a healthy diet, extra doses of vitamin A can be harmful.

**RDA:** 5,000 IU/day.

**In patients taking steroids with an open wound:** 25,000 IU/day orally; 200,000 IU/8 hr topically.

**Sources:** liver, egg yolks, fortified milk and cheese, dark green leafy vegetables, deep orange fruits/vegetables, fortified cereals.

### *Vitamin C (Ascorbic Acid)*

Because vitamin C is water-soluble, it is not stored in significant amounts in the body. Patients must take in enough vitamin C on a daily basis to prevent deficiency. It is an important cofactor for collagen synthesis.

**RDA:** 60 mg/day.

**Sources:** citrus fruits, potatoes, tomatoes, broccoli, green peppers.

### *Vitamin E*

Vitamin E is needed to maintain proper immune function and proper cell health. In patients with wounds exposed to radiation, vitamin E can counteract the negative effects of radiation on wound healing.

**RDA:** 30 IU/day.

**Sources:** vegetable oils, wheat germ, whole grain cereals, dried beans, nuts, green leafy vegetables, eggs, seeds.

### *Calcium*

Calcium is found primarily in bones and teeth. Every day 700 mg of calcium is turned over between plasma and bone.

**RDA:** 400–1200 mg/day.

**Sources:** dairy products, green leafy vegetables, dried beans, nuts, whole grains.

### *Copper*

**RDA:** none at present, but the estimated safe and adequate daily dietary intake (ESADDI) is 1.3–3 mg/day.

**Sources:** shellfish, dried beans, nuts, organ meats, whole grains, potatoes.

### *Iron*

**RDA:** men, 10 mg/day; women, 15 mg/day.

**Sources:** liver, shellfish, meat, poultry, and fish; dried beans and whole grains.

### *Magnesium*

**RDA:** 250–350 mg/day.

**Sources:** found widely in vegetables and nuts.

### *Manganese*

**ESADDI:** 2–5 mg/day.

**Sources:** whole grains, nuts, dried beans, vegetables, fruits, tea, instant coffee.

### *Zinc*

Zinc is important for wound epithelialization and increases wound strength.

**RDA:** men, 15 mg/day; women, 12 mg/day.

**Sources:** meat, fish, poultry, milk products, beans, whole grains, nuts.

## Bibliography

1. Mora RJF: Malnutrition: Organic and functional consequences. World J Surg 23: 530–535, 1999.
2. Ruberg RL: Role of nutrition in wound healing. Surg Clin North Am 64:705–714, 1984.
3. Van Way CW: Nutrition Secrets. Philadeplhia, Hanley & Belfus, 1999.