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Nutrition and Cancer Treatment

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Etiology of Malnutrition in the Cancer Patient

Malnutrition is a frequent and serious problem in patients with cancer. Some types of cancers such as lung, prostate, head and neck, and gastric cancer are more frequently affected, but the overall incidence of malnutrition ranges between 30 and 87% of different populations studied.[1,2] The advanced starvation state resulting from decreased food intake and hormonal/metabolic abnormalities characteristic of the interaction between tumor and host has been called cancer cachexia.[3] A retrospective analysis of patient body weight at the beginning of cooperative chemotherapy trials determined that the presence of a 6% weight loss from usual body weight was a significant prognostic factor for survival.[4] The apparent effect of weight loss at the time of diagnosis on median survival for certain common cancers was greater than the impact of chemotherapy. Despite the development of advanced technology and delivery systems for total parenteral nutrition and continuous enteral nutrition, nutrition therapy alone has had little impact on this problem. While nutritional rehabilitation can be demonstrated in selected patients who respond to antineoplastic therapy, the application of parenteral and enteral nutrition as an adjunct to chemotherapy in cancer patients has not resulted in increased survival or predictable weight gain.[5,6] These observations suggest that decreased food intake alone cannot account for the progressive weight loss noted in cancer patients.

Metabolic Abnormalities in the Cancer Patient

Since predictable renutrition of the cancer patient has not been possible, a great deal of research has been conducted concerning specific hormonal and metabolic abnormalities which could interfere with renutrition. Over the last 15 years, research on the basic pathophysiology of cancer cachexia has resulted in the definition of several metabolic and hormonal abnormalities in malnourished cancer patients. These abnormalities are listed in Table 50.1.

Based on these abnormalities, a number of strategies using hormonal and metabolic agents have been tested. These are listed in Table 50.2. None of the above hormonal or metabolic strategies tested resulted in predictable weight gain.

TABLE 50.1

Metabolic Abnormalities in Cancer Patients

Hypogonadism in male cancer patients[7]
Increased glucose production[8,9]
Increased protein catabolism[10,11]
Increased lipolysis and fatty acid oxidation[12,13]
Insulin resistance[14,15]

TABLE 50.2

Research Strategies to Counter Metabolic Abnormalities

Hydrazine sulfate to inhibit gluconeogenesis[16]
Anabolic androgens to counteract metabolic effects of hypogonadism[17]
Insulin supplementation to counteract apparent insulin resistance[18]

Based on autopsy studies performed in the 1920s[19,20] and animal studies done in the 1950s[21] it was postulated that tumors acted to siphon off needed energy and protein from the host. In the 1970s and 1980s, specific abnormalities of intermediary metabolism were identified in cancer patients that could account for the common observation that such patients lost weight even in the face of apparently adequate nutrition. Studies conducted in a number of laboratories, including our own, have demonstrated that maladaptive metabolic abnormalities occur frequently in patients with cancer. In 1983, we demonstrated that adequate energy and protein administered to six patients with active localized head and neck cancer via forced continuous enteral alimentation under metabolic ward conditions for 29 days failed to lead to significant weight gain.[22] The mean nitrogen balance in these patients is shown in Figure 50.1. The observed failure of these patients to gain weight despite adequate caloric intake under metabolic ward conditions supports the concept that malnourished cancer patients are hypermetabolic.

If metabolic abnormalities promote the development of malnutrition or interfere with renutrition, then there should be some evidence of abnormally increased energy expenditure. A number of investigators have used indirect calorimetry and the abbreviated Weir formula to calculate energy expenditure at rest, and then compared this to the basal energy expenditure (BEE) determined using the Harris-Benedict formulas. Long et al.[23] demonstrated a mean difference of 2% when this comparison was performed in 20 normal controls. In 1980, Bozetti et al.[24] found that 60% of a group of patients with advanced cancer had basal metabolic rates increased 20% above predicted. In 1983, Dempsey et al.[25] studied energy expenditure in a group of 173 malnourished gastrointestinal (GI) cancer patients. Fifty-eight percent had abnormal resting energy expenditure (REE) by indirect calorimetry compared to BEE, but a greater percentage were hypometabolic rather than hypermetabolic (36 versus 22%). Knox et al.[26] studied 200 patients with a variety of cancers and found abnormal energy metabolism in 59%, but found more hypometabolic than hypermetabolic individuals (33 versus 26%). Figure 50.2 shows that while standard formulae accurately predict metabolic rate in normal individuals, the measured metabolic rates in patients with cancer have a much wider distribution.

Lean body mass rather than fat mass correlates with the individual variations observed in measured REE. The hypothesis that the malnourished cancer patient may be hypermetabolic relative to the amount of lean body mass remaining has been examined. Peacock et al.[27] studied resting energy expenditure in non-cachectic patients with sarcomas. These patients had no prior treatment, had large localized sarcomas, and had no weight loss or history of decreased food intake. REE corrected for body cell mass (BCM) determined by total body potassium counting or body surface area was significantly greater in male

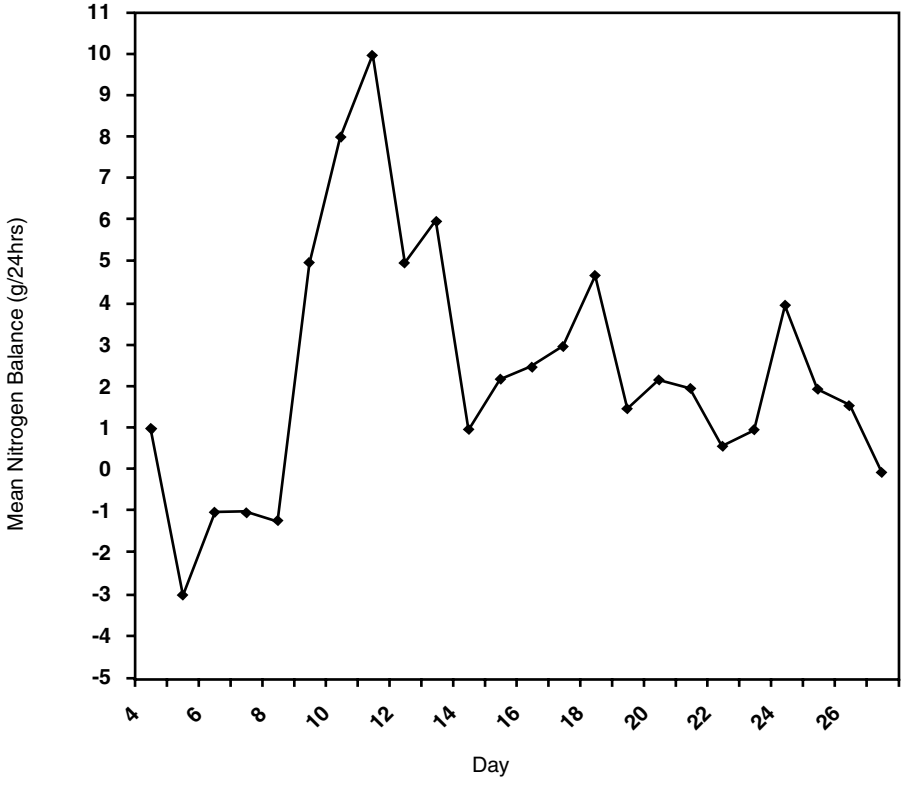

FIGURE 50.1
Mean nitrogen balance in grams per 24 hours in six patients with head and neck cancer receiving 1.25 × BEE kcal for 5 days and 2.25 × BEE for 19 days as a continuous enteral infusion. (From Geber, D., Byerley, L.O., Chi, J., et al. *Cancer* 58: 1867; 1986. With permission.)

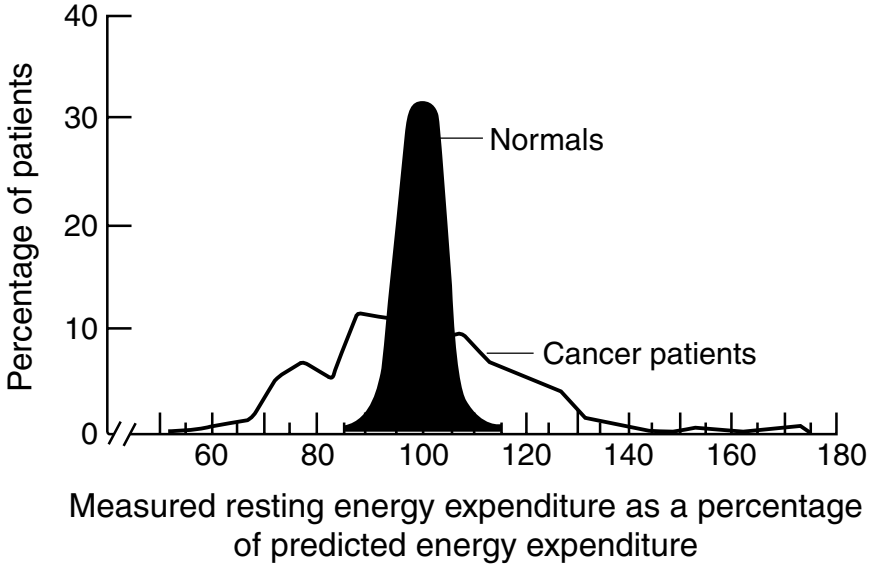

FIGURE 50.2
Measured resting energy expenditure as a percentage of predicted energy expenditure. (From Knox, L.S., Crosby, L.O., Feurer, I.D., et al. *Ann Surg* 197: 152; 1983.

sarcoma patients compared to controls. This difference was due to both a decrease in BCM and an increase in REE in these patients before the onset of weight loss. Tumors have been demonstrated to increase the rate of glucose utilization in a number of tissues.[28] Since there are only 1200 kcal stored in the body as liver and muscle glycogen, blood glucose levels would be expected to fall. This does not occur since there is also an increase in hepatic glucose production in cachectic and anorectic tumor-bearing animals and humans. The regulation of protein metabolism is tightly linked to carbohydrate metabolism, since these processes are critical to the normal adaptation to starvation or underfeeding. During starvation there is a decrease in glucose production, protein synthesis, and protein catabolism. The decrease in glucose production occurs as fat-derived fuels, primarily ketone bodies, are used for energy production. While there are 54,000 kcal of protein stored in the body cell mass, only about half of these are available for energy production. In fact, depletion below 50% of body protein stores is incompatible with life. Whole body protein breakdown is increased in lung cancer patients and has been shown to correlate with the degree of malnutrition such that more malnourished patients have greater elevations of their whole body protein breakdown rates expressed per kg of body weight (Figure 50.3).[11] The results of metabolic studies in lung cancer patients compared

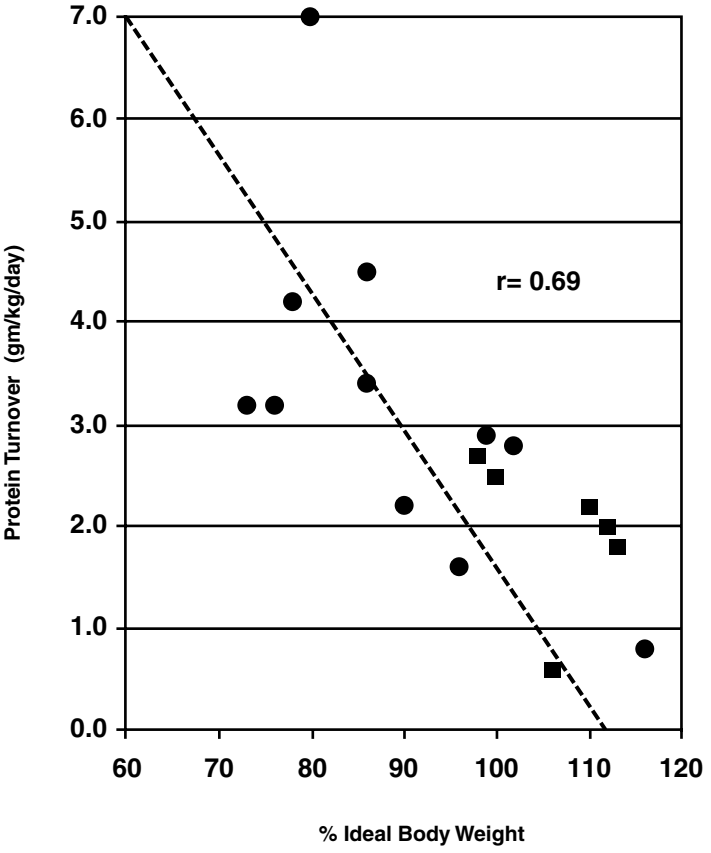

FIGURE 50.3
Whole-body protein turnover determined by [*U*-^{14}C] lysine infusion in the fasting state in g/kg/day versus percentage of ideal body weight for height in non-oat cell lung cancer patients (●) and age-matched healthy controls (■). The correlation coefficient of the linear regression drawn (- - - -) is shown as r ($p < 0.05$). (From Heber D, Chlebowski RT, Ishibashi DE, et al. *Cancer Res* 42: 4815, 1982. With permission.)

TABLE 50.3

Total Body Protein Turnover, Glucose Production, and 3-Methylhistidine Excretion in the Fasting State on Day 5 of Constant Nitrogen and Kcalorie Intake in Lung Cancer Patients Compared to Healthy Controls

Group	Protein Turnover (g/kg/day)	Glucose Production (mg/kg/min)	3-Methylhistidine Excretion (μmol/g creatinine/day)
Control	2.12 ± 0.38	2.18 ± 0.06	71 ± 8
Lung Cancer	3.15 ± 0.51[a,b]	2.84 ± 0.16[a]	106 ± 11[a]

[a] $p < 0.05$ versus control subjects.
[b] Mean ± S.D.

to healthy controls are shown in Table 50.3. Muscle catabolism, measured by 3-methylhistidine excretion, was increased in lung cancer patients compared to that of healthy controls. Methylhistidine excretion rates did not correlate with weight loss, percentage of ideal body weight, or age in the lung cancer patients studied. Glucose production rates were markedly increased in lung cancer patients compared with healthy controls, and changes in glucose production rates in the cancer patients studied did not correlate with weight loss, percent of ideal body weight, or age.

Hydrazine sulfate is a non-competitive inhibitor of gluconeogenesis. When this drug is administered to lung cancer patients not only does whole body glucose production decrease as expected, but there is also a decrease in whole body protein breakdown rates.[29] Increases in glucose production are directly and quantitatively linked to increased protein breakdown and changes in the circulating levels of individual glucogenic amino acids. Table 50.4 shows the influence of hydrazine sulfate on lysine flux. At one month, there

TABLE 50.4

Whole Body Lysine Flux in Lung Cancer Patients

	Lysine Flux (μmol/h)	
	Baseline	**1 mo**
Placebo Group		
1	2172	2812
2	1869	2959
3	2373	2674
4	2772	2269
5	2758	3195
6	3542	3585
Mean (SD)	2580 (580)	2920 (450)[a,b]
Hydrazine Treated		
7	2675	1146
8	2522	2119
9	2666	3129
10	1808	1217
11	2264	1438
12	3114	2006
Mean (SD)	2510 (440)	1840 (750)[b,c]

[a] $p = 0.08$; [b] $p < 0.05$, paired t-tests with baseline; [c] $p < 0.01$ by combined paired t-test both groups

was a significant reduction in the hydrazine group and a nonsignificant increase in the placebo group.

Both anorexia and abnormal metabolic adaptations to starvation play a role in the genesis of cancer cachexia. Anorexia has been given less attention than the metabolic abnormalities of increased glucose production, protein breakdown, and lipolysis. The tumor-bearing host does not adapt to decreased food intake normally, but studies of glucoregulatory and thyroid hormones fail to reveal systematic abnormalities other than insulin resistance which could impair renutrition. The immune response of the host to the tumor results in the local and perhaps systemic release of cytokines with potent metabolic effects. In fact, TNF-α has been shown to cause all of the metabolic abnormalities characteristic of cancer cachexia. It is possible that other cytokines may also participate in the pathogenesis of cancer cachexia. The study of the mechanisms of action of these cytokines and their interactions with cellular and soluble receptors may lead to improved strategies for the treatment of this perplexing clinical problem.

Assessment of the Cancer Patient's Nutritional Status

There are several nutritional assessment factors specific to the cancer patient, and these are listed in Table 50.5. Involuntary weight loss is a key indicator of undernutrition and is often a sign associated with a poorer prognosis and survival. The rate of weight loss is also important. It is accepted that an involuntary weight loss of 10% of the patient's usual body weight over a period of 6 months or less indicates undernutrition in patients with cancer.[30] One complicating factor in cancer patients is the development of edema or ascites; this should be kept in mind when interpreting weight data.

Ideal body weight is the weight associated with optimal survivorship in populations studied by life insurance companies. A commonly used reference is the 1983 Metropolitan Life Insurance Tables. With these tables, ideal weight range is calculated on the basis of height, body frame size, and sex, but no adjustments are made for age. Studies undertaken at the Gerontology Research Center (GRC), however, indicate that age significantly affects ideal body weight, while sex differences are not significant.[31] For a given height, older subjects have a higher ideal body weight range than younger individuals. Importantly, both tables are based on the same database, except that age is introduced as a variable only by the more recent GRC tables. Since cancer affects both the young and the aged, with the majority of patients in the older age groups,[32] it is more appropriate to utilize the age-adjusted tables to calculate ideal body weight range. Serious shortcomings still exist since there is no correction for disease-related changes in height, and no guidelines are provided in these tables for patients 70 years old or older.

Based on these ranges, we determine whether the patient is above, within, or below the ideal weight range. Thus, current weight compared to the expected or ideal body weight

TABLE 50.5

Nutritional Assessment Factors in the Cancer Patient

Involuntary weight loss
Comparison to usual, pre-illness, or ideal body weight
Anorexia and decreased food intake
Anthropometric measures
Biochemical and cellular biomarkers

range may help us determine the patient's nutritional status. An additional variable for consideration is usual or pre-illness weight. Therefore, both information on percent ideal weight and percent usual or pre-illness weight should be collected on all patients.There are healthy individuals who are below their projected weight for many years. From a clinical standpoint, stable weight and an adequate diet often equate with good nutrition even if the individual is below the ideal body weight range.

Anorexia and decreased food intake have long been recognized as key causes of undernutrition in patients with malignancies.[33,34] Anorexia is a treatable symptom of cancer which, if left untreated, leads to significant patient discomfort in addition to malnutrition.[35]

This information can be obtained by simply questioning the patient about a subjective loss of appetite and decrease in food intake. In order to further quantify these changes, we ask the patient to rate the appetite level from 0 to 7 (0 = no appetite; 1 = very poor; 2 = poor; 3 = fair; 4 = good; 5 = very good; 6 = excellent; 7 = always hungry). We also ask whether the amount eaten is enough to meet the patient's needs (0 = not at all; 1 = less than enough; 2 = enough; 3 = more than enough).

Detailed anthropometric measurements (such as mid-arm circumference and triceps skin fold) have long been utilized to determine skeletal muscle mass and nutritional status.[36] Although the value of these measurements can be limited if done in the hospital setting, serial measurements by the same professional in the outpatient clinic can help assess the patient's ongoing nutritional state. Problems with these measurements include interobserver variability and interference by edema or patient positioning. The decision to do these measurements should be individualized according to the acuteness of the underlying process, the availability of trained personnel, and intervention goals. It should be noted that muscle wasting and loss of adipose tissue reserves seen on physical examination are important but late signs of undernutrition. Ideally, early diagnosis and intervention should be directed at avoiding this advanced stage of undernutrition or cachexia.

The role of laboratory parameters, such as albumin or prealbumin level, transferrin, or total lymphocyte count, are less well defined in patients with cancer. These and other tests can be useful to assess protein depletion, but are difficult to interpret in patients with advanced cancer who often have metastases to visceral sites with organ dysfunction as well as metabolic and immunologic derangements due to cancer therapy.

Routine chemistry panels include albumin levels, which can be a useful indication of nutritional state. Albumin has a half-life in the circulation of about three weeks. Hypoalbuminemia can result from malnutrition but is also associated with liver disease, disseminated malignancies, protein-losing enteropathy, nephrotic syndrome, and conditions leading to expanded plasma volume such as congestive heart failure.

Prealbumin has a half-life of just under two days, and its level may increase with the use of steroid hormones and can be decreased by liver disease, disseminated malignancies, nephrotic syndrome, inflammatory bowel disease, the use of salicylates, or malnutrition.[37,38]

Transferrin can be measured by the transferrin antigen assay; the iron binding capacity provides with roughly equivalent results. Transferrin has a half-life of about one week, and it may increase with storage iron depletion or the use of hormonal agents and decrease with infection, malignancy, inflammation, liver disease, nephrotic syndrome, or malnutrition.[39]

Absolute lymphocyte counts can be reduced by malnutrition as well as a variety of other factors. More sophisticated tests (bioimpedance, total body K, basal metabolic rate [BMR] and others) are clinical research procedures.[40]

In many instances, a brief clinical nutritional assessment based on the degree of weight loss from usual or pre-illness weight, current weight as a percentage of usual and ideal body weight, and dietary history is sufficient to determine the clinical situation and consider potential interventions. We therefore reserve the use of anthropometric and

TABLE 50.6

Patient Characteristics in 644 Consecutive Cancer Patients*

Characteristic	Percent of Patients
Age — Median (range) in Years: 66 (22-91)	
Age <65	45
Age ≥65	55
Sex	
Women	53
Men	47
Type of Cancer	
Breast	16
Colon/rectum	14
Leukemia/lymphoma	13
Lung/non-small cell	14
Prostate	5
Stomach	4
Head/neck squamous	4
Ovary	3
Kidney/urinary bladder	3
Lung/small cell	2
All others	22
Stage of Cancer	
Metastatic	52
Non-metastatic	48

* Seen at Pacific Shores Medical Group and St. Mary Medical Center, Long Beach, California.

laboratory evaluations to specific individual situations. Interpretations of these evaluations should be based on an assessment of the clinical context.

A number of associated conditions are prevalent in older patients and can affect their food intake and nutrition. Mucositis as a side effect of chemotherapy or radiation therapy is common. Oral pain and dryness, poor dentition, periodontal disease, and ill-fitting dentures are also common. Other problems requiring consideration are dysphagia, alteration in taste, fatigue, nausea, vomiting, and diarrhea or constipation. Pain and other symptoms such as dyspnea can also interfere with nutrition. Depression is a well known cause of weight loss, and depression can worsen due to the stress of coping with cancer. Feelings of isolation and actual social isolation are not uncommon, especially in those patients who do not have strong family support. Socioeconomic and living conditions must be taken into account because they may impact food availability and preparation. These can all be very serious problems for patients with cancer, and require a multidisciplinary effort for proper management.

An understanding of the frequency and severity of malnutrition in cancer patients is necessary to better plan preventive, diagnostic, and therapeutic approaches, including the allocation of a variety of resources. To this end and as part of a more comprehensive effort, we studied nutrition-related clinical variables in 644 consecutive oncology patients regardless of type, status, or stage of cancer. The characteristics of these patients is shown in Table 50.6. The majority were seen as outpatients. We divided patients by age (<65 versus ≥65), and we analyzed the entire group as well as the subset of patients who had

TABLE 50.7

Nutritional Variables in 644 Consecutive Cancer Patients*

Variable	All Stages (n = 644)	Patients with Metastases (n = 377)
Decreased appetite	54%	59%
Decreased food intake	61%	67%
Underweight	49%	54%
Normal weight	37%	33%
Overweight	14%	13%
Weight loss		
Any	74%	76%
Up to 5%	15%	15%
>5 to <10%	22%	20%
10-20%	26%	27%
None	26%	24%

* Seen at Pacific Shores Medical Group and St. Mary Medical Center, Long Beach, California.

metastatic disease. Ideal body weight range was calculated using the GRC tables. The vast majority of patients sustained the weight loss shown within a period of six months from cancer diagnosis.

As shown in Table 50.7, the incidence of weight loss is very high in all patients, but particularly in those over the age of 65. Thus, 72% of all patients 65 or older with metastatic cancer had some degree of weight loss; 56% were underweight, 54% had decreased appetite, and 61% reported a decrease in food intake. Thirty-eight percent of patients 65 or older with metastatic disease had weight loss of 10% or more of their usual body weight. These data suggest that undernutrition at various stages is highly prevalent among oncology patients, particularly in the older population. Attention to the nutritional status of patients may afford the clinician opportunities for early diagnosis and intervention.

Nutritional and Adjunctive Pharmacotherapy of Anorexia and Cachexia

Counseling

The benefits of initial and follow-up evaluations and counseling by a registered dietitian, preferably in the context of a team approach, can be enormous, although difficult to quantify.[17] The main benefits relate to patient satisfaction, nutrition improvement or maintenance, compliance with team or institutional management protocols and guidelines, and a judicious use of risky and expensive treatments. The costs of nutritional counseling are modest when compared to other interventions. Table 50.8 shows the benefits, methodology and risks of common nutrition interventions. Nutritional evaluation and counseling, usually undertaken by a registered dietitian, is a first and important step. Ideally, a dietitian should be an integral part of the cancer care team.

In addition to assessing the clinical nutritional parameters previously outlined, it is our practice to first determine, through the dietary history, whether the patient is consuming a "balanced diet." The dietitian obtains a 24- to 72-hour recall diet history either verbally or, preferably, recorded at home. This diet record is then examined to assess the adequacy of kcalories and protein, utilizing food analysis tables compared to estimated energy and protein needs. Usually a weight-maintenance diet depends on the BEE, and is calculated

TABLE 50.8

Benefits, Methodology, and Risks of Nutrition Interventions

	Benefits	Methodology	Risks
1. Counseling	Patient satisfaction Nutrition maintenance Adherence to protocols	1 initial and 2 follow-up visits by dietitian	None
2. Food Supplements	Nutrition maintenance		Limited risks: diarrhea, nausea
a. Home-made	Avoid or delay need for more expensive therapy	a. Three 8-oz servings = 750 kcal/day	a. Diarrhea with lactose intolerance
b. Commercial		b. Three 8-oz servings = 750-1080 kcal/day	b. Patients may not like taste
3. Appetite Stimulants			
a. Megestrol acetate oral suspension	a. Improved appetite, weight, wellbeing, quality of life	a. 200 mg/d, 1 month supply 400 mg/d, 1 month supply 800 mg/d, 1 month supply	a. Impotence, vaginal bleeding, deep vein thrombosis
b. Dronabinol	b. Improved appetite, no significant weight change	b. 2.5 mg/d, 1 month supply 5 mg/d, 1 month supply	b. Euphoria, somnolence, dizziness, confusion
c. Prednisone	c. Short-term (4 weeks) appetite stimulation (see text)	c. 40 mg/d, 1 month supply	c. Hypokalemia, muscle weakness, cushingoid features, hyperglycemia, immune suppression
4. Enteral nutrition	Maintenance of nutrition via enteral route when oral route is not possible	Requires nasogastric, gastrostomy, or jejunostomy tube placement	Aspiration, diarrhea, nausea, bloating, infection, bleeding
5. Home parenteral nutrition	Maintenance of nutrition when no other alternative is appropriate; no evidence of improved survival in end-stage cancer	Central catheter surgically placed; parenteral infusion equipment and parenteral formulas: dextrose (20-25% w/w), crystalline amino acids (2-4% w/w), lipid emulsions (500 cc/d → 500 cc/wk)	Catheter-related pneumothorax, sepsis, thrombosis, bleeding; hepatic dysfunction, fluid and electrolyte imbalance

based on the Harris-Benedict formula[15] which, on an average, results in a daily requirement of 20 to 25 kcal per kg of body weight. The minimum recommended protein need is at least 0.8 grams per kg/per day.[16] These values need to be adjusted according to whether weight gain is desirable, and to match the metabolic needs of the patient.

One goal of nutrition education and counseling is to have the patient increase consumption of nutrient-dense foods to correct nutritional imbalances and deficiencies in order to achieve and maintain a desirable weight. Nutrient-dense foods are those with a high content in kcalories, protein, fat, and vitamins relative to their volume. Liquid supplements are the most common types of nutritional supplements, and are readily available for patient consumption. Patients may be anorectic due to illness, or be affected by disabling factors such as difficulty chewing, inability to prepare foods for themselves, visual difficulties, decreased energy level, or poor access to foods. Nutritional supplements may be homemade and are usually milk-based or commercially prepared and packaged. Although somewhat expensive, commercial supplements provide balanced, fortified (vitamin and mineral enriched) nutrition which require little or no preparation.

Not all cancer patients have the same requirements for nutrition. One major difference is whether patients are losing weight or have been treated successfully and are trying to prevent a recurrence through healthful nutrition. In the former case, calorically dense foods including those with low nutrient density can be used to increase the efficiency of kcalorie conversion to body fat stores. One limitation of this approach is that malnourished patients often are limited in their ability to absorb and digest fat due to the effects of malnutrition or enteritis caused by radiation or chemotherapy. Therefore, overprescription of high fat foods can in some cases lead to gastrointestinal distress. Foods containing refined sugar can also be used in these patients, as long as the patient has normal glucose tolerance. Since diabetes is a not uncommon comorbid condition in cancer patients, this is a practical consideration. Table 50.9 lists calorically dense foods and strategies for these types of patients. For patients who have been successfully treated, a preventive diet covered elsewhere in this text should be used.

Food Supplements

Liquid concentrated food supplements provide high kcalorie and protein, low volume nutrients, and are reviewed elsewhere.[17] Instant breakfast and milk provide an inexpensive and usually well-tolerated alternative. Commercial products may be more convenient and better tolerated in those patients with lactose intolerance. Dietitians will help patients select products on the basis of tolerance and palatability. These products are particularly helpful when patients can not maintain an adequate intake through a regular diet but are able to swallow and have a relatively intact GI tract.

Commercially prepared supplements are available in a variety of flavors (including unflavored) and in a variety of nutrient compositions. Most commercially prepared supplements are available in ready-to-drink eight-ounce cans or boxes and are usually lactose free, which for the patients is often more acceptable due to the increased incidence of perceived milk intolerance in this population. When patients have difficulty consuming adequate volumes of enteral supplement, a high-caloric supplement containing 2 kcal/ml (e.g., Isocal HCN [Mead Johnson] or Magnacal [Sherwood Medical]) can be used. Homemade supplements can also be made with commercially available products comprising a dry milk base to which whole milk and flavoring is added for a nutrient-dense

TABLE 50.9

Foods Recommended to Increase Kcalorie and Protein Intake of the Patient with Cancer

Food Group	Recommendations
Fruits and vegetables	Fruit juice added to canned fruit; pureed fruit added to milk, cereals, pudding, ice cream, gelatin; gelatin made with fruit juice to replace water; tender, cooked vegetables (mashed white or sweet potatoes, squash, spinach, carrots); vegetables added to soups and sauces; vegetables in cream or cheese sauces
Grains	Hot cereals prepared with milk instead of water; high protein noodles; noodles or rice in casseroles and soups; breaded and floured meats; bread or rice pudding; dense breads (i.e., bagels) and dense cereals (granolas, mueslis)
Beverages	Milk beverages; shakes made with fruit juices and sherbet when milk is not tolerated
Milk and calcium equivalents	Custards; milkshakes; ice cream; yogurt; cheeses; cheesecake; double-strength milk (1 quart fluid milk mixed with 1 cup nonfat dry milk powder); cottage cheese; flavored milk; pudding; commercial eggnog; cream soups; nonfat dry milk powder added to puddings, soups, sauces and gravies, casseroles and mixed dishes
Meat and protein equivalents	Diced or ground meat; casseroles; smooth peanut butter; cheese; egg and egg dishes; chopped, diced or puréed meats mixed with soups, sauces, and gravies; fish, poultry, and vegetable protein meat substitutes; tuna, meat, or cheese in cream sauces
Fats	Margarine or oil added to vegetables, hot cereals, and casseroles; cream used in place of milk or added to fruits and desserts; sour cream; salad dressings; mayonnaise mixed with tuna, egg, chicken salad
Sweets	Desserts made with dry milk powder, peanut butter, or eggs

beverage. Commercially prepared powdered breakfast drinks (e.g., Ultra Slim-Fast, Instant Breakfast), to which whole milk is added, is an inexpensive effective supplement when lactose intolerance is not an issue. These supplements have vitamin, mineral, kcalorie, fat, carbohydrate, and protein content similar to most commercially prepared supplements.

An eight-ounce supplement varies in nutrient density from 240 to 480 kcals, 7 to 20 grams of protein, 5 to 19 grams of fat and 12 to 25% of the U.S. Recommended Dietary Allowances (USRDA) for vitamins and minerals.

A nutritional supplement is advisable for patients whose GI tract is functional but who are unable to obtain adequate nutrition from a regular diet. The volume and choice of supplement is based on patients' individual nutrient needs and preferences, and GI tolerance. Supplements with fiber, generally soy or oat fiber, are available and may be beneficial to the patient who has diarrhea or constipation. Nutritional supplements are generally well accepted and may offer relief to a patient who has difficulties eating solid food. Tolerability can be enhanced by starting with small quantities and diluting the supplement with water or ice to decrease osmolality. A patient will usually accept one to three 8-ounce supplements per day, but there is great individual variability. Patients who have alterations in taste or nausea may better tolerate an unflavored supplement.

A common concern of patients and families is whether adding vitamins and other micronutrients to the patient's diet is beneficial. An analysis of the dietary record for the recommended number of servings from the Basic Four Food Groups (milk, meat and meat substitutes, vegetable and fruit, and grain) helps establish whether the minimum vitamin and mineral requirements are met. A computerized diet analysis program can help to quickly and accurately assess the nutrient content including vitamins and minerals. When intake is inadequate, we prescribe a daily multivitamin.

Patients should be provided with practical dietary advice about how to improve daily caloric intake, and the following are some simple tips to increase food intake:

- Avoid favorite foods after highly emetogenic chemotherapy to prevent the development of food aversions.
- Patients should be encouraged to consume any foods regardless of foods being labelled "non-nutritious," such as potato chips, nuts, or ice cream.
- Emphasize consumption of "nutrient-dense" foods as part of main meals or snacks, i.e., peanut butter, cheese, whole milk, and yogurt.
- Avoid the "Why don't you eat?" complaint. The patient should not be psychologically punished by the cancer care team and/or the family for not eating, but rather should be supported to overcome anorexia and other problems that lead to decreased food intake.
- Emphasize the pleasurable as well as social aspects of meals. Encourage patients to have their meals in a relaxed, friendly, and familiar atmosphere.
- Moderate alcohol intake is usually compatible with treatments and should be allowed before meals unless contraindicated.
- Avoid odors that can cause nausea. A short walk outside while meals are being prepared is advisable.
- Encourage food supplements and snacks between meals without being concerned that they may affect intake at meal time.

Patients are often deeply interested in the topic of nutrition as an unproven treatement. However, many will not bring up this topic unless encouraged and listened to in a nonjudgmental fashion. Open discussion and patient education may help prevent untoward effects of these diets and introduce nutrition-related issues into the mainstream of oncology care.

Nutrition Options and Alternative Therapies

A number of alternative therapies are being used by cancer patients in addition to standard medical oncology therapy,[41] as listed in Table 50.10. For this section, the nutrition alternatives will be outlined without reference to acupuncture or other non-nutritional therapies. Often patients fail to indicate that they are using these nutritional therapies. A number of potential side effects and concerns, listed in Table 50.11, may arise and need to be addressed.

Up until recently, most uses of vitamins and herbs were thought to be nontoxic. Recent animal studies suggest that antioxidants may affect tumor biology. The ATBC and CARET trials[42] in smokers demonstrated an increased incidence of lung cancer following admin-

TABLE 50.10

Alternative Nutritional Therapies Used by Cancer Patients

Multivitamins and single vitamin supplements
Low fat-, high fiber-, soy protein-supplemented diets
Specific macrobiotic diets
Vegetable and grass juicing
Herbal supplements (green tea extract, antioxidants)
Chinese herbal medicine (mushrooms, teas, roots)

TABLE 50.11

Potential Side Effects and Concerns

Vitamin toxicities (e.g. vitamin A >5000 IU per day)
Possible vitamin effects on tumor biology (apoptosis, proliferation)
Vitamin imbalances and conditioned deficiencies
Drug-nutrient interactions

istration of beta-carotene at a dose of 30 mg per day. There were no cancer-stimulatory effects noted with these doses of beta-carotene in non-smokers in a large heart disease prevention trial. However, there remains real uncertainty as to the safety of vitamin and mineral supplementation during chemotherapy or radiation therapy. For the large numbers of patients diagnosed today with early cancers of the breast and prostate, vitamin supplementation is as safe as in the general population once the treatment has been completed and nutritional intervention may prevent or delay cancer recurrence. However, the possibility of antioxidant effects on tumor biology or the effectiveness of antitumor drugs on radiation therapy requires much more research before general recommendations can be made. At this time, each patient and each oncologist must decide on the advisability of a given regimen for a given cancer patient based on clinical criteria without the benefit of a large scientific basis of controlled trials.

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