CLINICAL SCIENCE OF NUTRITION
Clin Sci Nutr. 2025;Early View:1-10
Review Article
DOI: 10.62210/ClinSciNutr.2025.109

Individualized nutritional management for cancer patients: a key component of treatment

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Cite this article as: Hopancı Bıçaklı D. Individualized nutritional management for cancer patients: a key component of treatment. *Clin Sci Nutr*. 2025;Early View: 1-10.

ABSTRACT

The type of cancer, size and location of the tumor, stage of the disease, and treatments provided may lead to different degrees of malnutrition in patients. Symptoms that develop due to the tumor itself or the treatment process may cause a decrease in oral food intake. Therefore, for patients undergoing cancer treatment, personalized nutrition therapy is of great importance. Patients should be regularly screened and evaluated for early detection of malnutrition. All oncology patients should be provided with nutritional counseling, and individuals in the high-risk group should be closely monitored. The nutrition plan should be created based on the type of the disease, treatment process, symptoms, individual needs and living conditions. The primary preference in nutritional treatment is to ensure that the patient is naturally fed orally. However, in cases of inadequate nutritional intake, oral nutritional suplements (ONS), enteral nutrition (EN) or parenteral nutrition (PN) methods can be utilized. EN and PN can be used as complementary to each other when necessary and can increase the effectiveness of nutritional therapy. Regular follow-ups during this process are critical for the maintenance of the patient's nutritional status and prevention of possible complications. The nutritional education process should be reinforced with supportive educational materials whose language is understandable and plain in an environment suitable for the patient's needs.

Keywords: cancer, malnutrition, nutritional support

Introduction

Cancer is not only a disease of abnormal cell growth, but also a condition that profoundly affects the body's metabolic processes and nutritional balance. Throughout the course of the disease, from diagnosis to treatment and beyond, patients often face challenges that compromise their ability to maintain adequate nutritional intake. Addressing these challenges is essential for improving treatment outcomes, quality of life, and overall prognosis.

Malnutrition in patients with cancer

The type of cancer, size and location of the tumor, stage of the disease, and treatments provided may lead to varying degrees of malnutrition in patients with cancer. Gastrointestinal dysfunction and anorexia that develop due to the disease or the treatment process may cause malnutrition. Malnutrition, a common problem in patients with cancer, is detected in 15-40% of the cases at the time of diagnosis. This rate increases during the treatment process and reaches a high rate of 40-80% in patients with advanced-stage cancer. Therefore, nutritional status should be evaluated early, and patient-specific nutritional therapy should be planned.[1]

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Received: April 11, 2025 **Accepted:** July 10, 2025
Published: August 15, 2025

Symptoms that may affect the patient's nutrition may occur during radiotherapy (RT), chemotherapy (CT), and surgical procedures. Symptoms that vary according to the application dose and the area where RT is performed prevent the patient from taking in nutrients. For instance, RT performed on the head and neck region may cause changes or loss in taste, mucositis, dry mouth, fatigue, nausea, trismus, and tooth and gum problems. If the patient undergoes RT together with CT, these symptoms may be accompanied by loss of appetite, nausea, lack of hunger, feeling full quickly, and fatigue. RT performed on the abdominal region may cause diarrhea, abdominal pain, or cramps. If RT is performed on the thoracic region, it may cause stenosis or strictures in the esophagus, esophagitis, and difficulty swallowing.[2] The location, complexity, and extent of resection of surgical procedures performed on the patient may have a direct impact on the patient's nutritional status.[3] Surgeries targeting the digestive system increase the risk of malnutrition and thus may affect absorption of nutrients and gastrointestinal functions. In addition, combinations of CT performed before or after surgery, and long-term treatment protocols may lead to numerous negative effects on nutrition. Side effects such as nausea, vomiting, mucositis, loss of appetite, and changes in taste due to treatment make it difficult for the patient to have adequate and balanced nutrition, and thus increase the risk of malnutrition further.[4]

Main Points

- Malnutrition is common in cancer patients and requires early assessment.
- The patient's nutritional status should be evaluated early, and an individualized nutritional treatment plan should be developed and continuously monitored.
- Symptoms affecting food intake due to treatment should be kept under control.
- Nutritional therapy should primarily focus on natural oral feeding; however, when necessary, oral nutritional supplements (ONS), enteral nutrition (EN), or parenteral nutrition (PN) may be used. EN and PN can also be combined when needed.
- Nutrition education should be simple and understandable, supported by clear educational materials in appropriate setting.

Consequences of malnutrition on treatment outcomes

Malnutrition is a common problem at every stage of cancer, regardless of the stage, and has intense effects on patients' general health status. In patients receiving curative, adjuvant, or palliative treatment, nutritional deficiencies can bring about serious consequences such as muscle loss, decreased functional capacity, increased risk of infection, and poor response to treatment. Malnutrition is also known to increase surgical complications and is an independent risk factor that negatively affects survival.[5,6] Malnutrition that occurs during cancer treatment increases the risk of toxicity, worsens the quality of life, and reduces patients' functionality. It is also closely related to sarcopenia, since it worsens muscle function and causes a decrease in lean body mass and muscle performance.[7] Low skeletal muscle mass and weight loss are independent prognostic factors that negatively affect survival in cancer patients. These factors are also key features of cancer cachexia, a progressive and often irreversible syndrome commonly observed in advanced-stage disease.[7,8] Sarcopenia is not only caused by cancer or old age, but can also be triggered by CT. Iatrogenic sarcopenia is characterized by poor muscle quality, which leads to changes in the volume of distribution of medications, pharmacokinetics, and consequently increases CT toxicity. Sarcopenia is associated not only with reduced CT response but also with worse outcomes in a vicious cycle. Muscle loss deteriorates the patient's general health status further and thus can adversely affect the response to treatment.[9] Negative effects of sarcopenia on outcome also occur in surgical patients, since it is a risk factor for perioperative and postoperative complications.[10] Although more than 50% of hospitalized patients with cancer and up to 30% of outpatients develop sarcopenia, unfortunately, in clinical practice, nutritional assessment is performed in only 30–60% of malnourished patients.[11,12] Muscle mass and adipose tissue are among the important factors affecting oncological outcomes. Therefore, adequate nutrition is the most important strategy to optimize body composition, since it is an essential part of successful cancer treatment. The main goal in performing nutritional intervention is to affect body composition positively in order to improve outcomes of the cancer treatment and prognosis, and to reduce morbidity.[1]

Guidelines and evidence-based nutritional interventions

In international guidelines, it is recommended that intensive nutritional counseling should be given and oral nutritional supplements (ONS) should be provided to increase nutritional intake, reduce treatment-related weight loss, and prevent treatment interruptions in patients undergoing cancer treatment.[13-15] Oral nutritional intervention is a critical step in the prevention and treatment of malnutrition by closing the gap between recommended and actual nutritional intake during treatment to meet the patient's needs.[15] It has been demonstrated that nutritional counseling provided by oncology dietitians provide significant benefits in improving nutritional status, body weight, and quality of life.[3,16]

The key factor in successful cancer treatment is appropriate nutrition. The type of nutritional therapy varies according to the patient's history, the type and stage of the tumor, and the patient's response to treatment. The type of the cancer or the location of the tumor requires personalized nutritional models. Since nutrition affects the development of the disease, natural symptoms of the tumor, response to anti-neoplastic therapies and recovery, and thus has a strong effect on the quality of life and prognosis of the disease, it is a central factor in oncology.[1] The idea that patients should take adequate nutrients to maintain daily activity, functional capacity, and to have more successful treatments is accepted by both patients and their families and caregivers.[17]

In 2021, the European Society for Clinical Nutrition and Metabolism (ESPEN) recommended the following:

1. Malnutrition risk should be screened regardless of body mass index (BMI) or history of weight loss,
2. Nutrient intake, body composition, inflammation, energy expenditure, and physical function should be assessed,
3. Individualized multimodal therapy should be provided to improve oral nutrient intake, reduce inflammation and metabolic stress, and increase physical activity.[18]

On the other hand, in 2020, the American Society of Clinical Oncology (ASCO) recommended that only dietary counseling should be given and corticosteroids and progesterone analogs should be appropriately administered.[19] Both ESPEN and ASCO emphasize that enteral and parenteral nutrition should only be administered to patients with inadequate oral intake or impaired intestinal function. In 2021, the European Society for Medical Oncology (ESMO) recommended that screening should be performed for malnutrition, and that the patient's clinical, psychological and social status, nutrition, social support and exercise needs, requirements for corticosteroids, olanzapine, and progestin to improve his or her appetite should be comprehensively assessed.[20]

Nutritional screening and assessment

The patient's nutritional status should be assessed periodically at different stages of the cancer journey, because nutritional status is not steady; it varies. The type and stage of the tumor, the treatment method and comorbidities affect the patient's nutritional needs. The patient's inflammatory and metabolic processes should be continuously assessed. Nutritional interventions can be adapted according to the current risk.[7] Patients' nutritional problems should be assessed continuously from the initial signs and symptoms of anorexia to pre-cachexia, cachexia and advanced cachexia. If this is compared to a pyramid, while advanced cachexia represents the peak of the pyramid, pre-cachexia caused by initial malnutrition is the broad base of the pyramid.[21] The effectiveness of any nutritional intervention depends on the timing of support. The best results from nutritional intervention are achieved when it is performed early, adequately and continuously.[18] Proactive assessment of nutritional status is essential for the selection of the intervention needed, which makes it possible to identify and follow up patients who would benefit from nutritional intervention. Although there are many screening and assessment tools, none of them is complete and flawless. In adult oncology patients, screening and assessment tools proved as valid and reliable can be used to determine the malnutrition risk. One of these tools is the Patient-Generated Subjective Global Assessment (PG-SGA), which was developed specifically for patients with cancer, is administered to rate the symptoms.[22] The PG-SGA is considered as a valid and reliable tool that can be used to assess nutritional needs of adult oncology patients receiving outpatient and inpatient treatment comprehensively, and to determine nutritional triage.[23-26] In addition to the PG-SGA, the NRS 2002[26,27], a nutritional risk screening tool recommended by ESPEN for inpatients, and the Subjective Global Assessment (SGA)[28], which is mandatory to be recorded in the reimbursement system in Turkey, are also used. The Global Leadership Initiative on Malnutrition (GLIM) proposed a definition of malnutrition that takes into account both phenotypic (unintentional weight loss, low body mass index [BMI], and reduced

muscle mass) and etiological criteria (reduced nutrient intake or absorption, inflammation, or disease burden) for the diagnosis of malnutrition to guide nutritional intervention and expected prognosis.[29] The primary goal of all these nutritional screening tools is to assess the nutritional status of patients and, accordingly, to predict the risk of improved or worsened clinical outcomes.[30]

The nutritional treatment process should be evaluated in five stages:

1. Nutritional Screening and Assessment: determining the risk of malnutrition.
2. Medical and Nutritional History: Acute and chronic diseases and nutritional habits.
3. Anthropometric Measurements: BMI, calf circumference, mid-upper arm circumference, hand dynamometer.
4. Biochemical Data: Albumin, prealbumin, transferrin, micronutrients, CRP, etc.
5. Physical Examination Findings: Muscle loss, adipose tissue changes, ascites, edema, functional capacity.[31]

To ensure the effectiveness of individualized nutrition therapy, in addition to nutritional and clinical parameters, patients' oral food consumption, daily eating habits, food choices, psychological status, autonomy in eating and cooperation should be examined in detail. In addition, whether patients need help or support in the nutrition process should be determined and a personalized approach should be developed. When the patient's nutritional history is taken, not only his or her energy and protein intake but also changes in solid and liquid food intake (type, texture, temperature), the suitability and adequacy of ONS, EN or PN application if previously recommended, the actual daily macro and micronutrient intake level from artificial nutrition and other nutritional sources, ONS use, food avoidance and intolerances, medications used, herbal products and complementary or alternative products, ability to shop, prepare food, people who the patient lives with, and economic factors affecting his or her access to food should also be questioned and recorded.[31] After the use of herbal and supplementary products in patients receiving CT is questioned, the patient should be informed about potential drug-non-drug interactions regarding nutritional support. Before a nutritional plan is made for adult oncology patients, some laboratory findings such as fasting blood sugar, neutrophil and platelet levels, nutritional anemia profile (hemoglobin, hematocrit, folate, vitamin B12 and iron); electrolyte and kidney (urea creatinine) and liver functions; albumin and prealbumin values to be evaluated together with C-reactive protein value, and the results of gastrointestinal function tests (swallowing tests, abdominal films, gastric emptying and transit time, etc. tests).should also be taken into account.[31]

The patient's intellectual level should be taken into consideration when nutritional counseling and education is provided to him or her. Factors such as the presence of fatigue or depression, the severity and location of pain if present, whether or not the patient lives alone, whether or not the patient receives social support, and whether or not the patient has a chronic disease that requires him or her to go on a diet may affect both the nutritional plan and the way the patient implements these. In addition, especially in patients over the age of 65, loss of muscle mass, loss of subcutaneous fat, presence of pressure ulcers or wounds, appetite, structure and health of the mouth and teeth, and presence of edema or ascites should also be taken into account.[31]

To assess muscle loss, which is a defining characteristic of sarcopenia and cachexia of sarcopenia and cachexia, a bioelectrical impedance analyzer can be used or, more practically, calf circumference is measured. Other anthropometric measurements such as weight, height, BMI, weight loss, mid-arm circumference, and skinfold thickness are also indispensable criteria for follow-up and evaluation. The process of muscle loss in a cancer patient is similar to a forest fire and subsequent afforestation. Just as fire destroys a forest rapidly, muscle loss also occurs in a short time. However, like reforestation, recovery of muscle mass can also be possible over time, with proper nutrition and appropriate support. Early intervention is important because preserving existing muscle is easier than rebuilding it.[32]

Nutrition education and counseling in oncology

From a nutritional perspective, interventions include oral nutrition and diet education, ONS, or EN or PN as appropriate, and combinations of these.[32] In the clinical practice of individualized nutrition counseling, oral nutrition always ranks in priority. Oral nutrition is the preferred way of feeding, as it is an important part of the patient's daily routine and contributes to the patient's autonomy significantly. The patient should be encouraged to sit at the dinner table with the family and friends, and to avoid isolating himself or herself. Diet is the only factor that the patient can control during all treatments

and interventions. Accepting that the prescribed diet is suitable and adapted to individual needs is also a very effective approach in terms of supporting the patient's psychology, as it gives the patient a sense of control. Individualized diet counseling should be performed and monitored by a dietician who is an expert in this field. Adequate nutritional intake is also accepted by both the patient, and the family and caregivers to maintain activities of daily living, energy, functional capacity, and to have more successful treatments.[1] Patients' spouses and relatives are more concerned about patients' weight loss than are the patients. Patients feel more pressurized when they are forced to eat, which affects their relationships negatively.[33] Individualized nutritional counseling is the most effective nutritional intervention, and ensuring consistent and adequate nutrition is one of the most important factors that can overcome predictable post-treatment deterioration.[24,34,35]

In multidisciplinary teams providing cancer treatment, an oncology dietitian should always be included. Patients receiving active treatment should be evaluated by an oncology dietitian and provided with medical nutrition therapy if necessary.[31] The main goal of nutrition therapy is to protect oral nutrition while food-related discomfort is minimized with strategies such as individualized diet counseling, food fortification and ONS.[36] Dietary recommendations should be provided considering factors such as food quality, portion size, meal timing and consistency compliance to optimize energy and protein intake. The dietitian can provide personalized recommendations based on the patient's energy expenditure, disease status and food preferences. In nutritional counseling, symptoms such as anorexia, nausea, dysphagia, abdominal bloating, diarrhea and constipation should be addressed, and compliance should be encouraged by explaining the reasons and goals of the nutritional recommendations to the patient.[37]

After all assessments are performed, a dietitian should inform the patient about the personalized nutrition plan in a relaxed and calm environment, where the patient's relatives are present if possible and allow them to ask questions. A significant obstacle to behavioral change is that patients generally do not consider nutrition as therapy. Animated videos, easily understandable illustrated educational materials, brochures, and other patient-focused resources can be effective in educating patients about nutrition-based treatments.[11,32]

It is recommended that dietetic counseling should be held face to face within the first 4 days after treatment is started, once a week during the first half of treatment, and then once every 2 weeks for the remaining period. Between the nutritional counseling sessions held face to face, additional counseling can be given on the telephone if necessary.

Use of supplements and complementary practices

The prevalence of complementary and alternative medicine use among adult patients with cancer in the United States is approximately 36%.[38] Interactions between medicinal plants and foods and oral antineoplastic agents are an issue that should be taken into consideration, because the complementary medicine combinations used may interact with cancer medication taken by patients and lead to negative results. Although there are a limited number of studies conducted on the pharmacokinetic interactions of dietary supplements and cancer drugs, there is evidence of several possible interactions and adverse reactions. Certain components of foods and dietary supplements (e.g., St. John's wort, grapefruit juice, and epigallocatechin gallate obtained from green tea") may alter the pharmacokinetics of certain types of drugs.[39]

Inappropriate or excessive use of dietary supplements during and after treatment may also lead to serious problems. In a study in which the use of antioxidant dietary supplements (selenium, multivitamins, zinc, and vitamins A, C, and E) before and after diagnosis in postmenopausal breast cancer survivors was investigated, it was demonstrated that the risk of total death increased and recurrence-free survival worsened with the use of antioxidant dietary supplements during CT or RT.[40]

Oral nutrition support and dietary strategies

A nutrition education program including nutritional change lists, quick, easy and nutritious snack ideas appropriate for the patient's needs, nutritional measures that can be taken against symptoms should be arranged, and plans for personalized meals and recipes should be made.[11] In the literature, studies in which dietary counseling has been demonstrated to help prevent discontinuation of treatment in patients receiving adjuvant RT or CT, to increase oral protein and energy intake, body weight and quality of life, and to reduce the frequency and severity of toxicity are available.[14,34,41,42] In several studies, it has been reported that regular dietary counseling is superior

to interventions that provide ONS alone in maintaining quality of life, and the positive effect continues even three months after RT in the outcomes of patients in the group receiving counseling.[34,41,43] It has been reported that providing additional ONS results in better weight gain, increases protein-calorie intake, improves quality of life, and is associated with better anticancer treatment tolerance.[44] Dietary counselling and use of ONS should be the first step towards increasing oral energy and protein intake to improve clinical outcomes.[45,46] In the Oncology Evidence-Based Nutrition Practice Guidelines, it is indicated that early and intensive nutritional intervention improves weight management and treatment outcomes in a variety of cancers (e.g. breast, ovarian, lung, leukemia, head and neck, colorectal, upper gastrointestinal).

Nutritional intervention increases lean tissue mass, perceived health, patient satisfaction, appetite and treatment tolerance, and shortens length of hospital stay and admissions.[31]

Because of the strong association between nutritional status and quality of life, it has been emphasized that all adult oncology patients should be provided with a nutritional plan after diagnosis.[47] In their systematic review and meta-analysis, Baldwin et al. investigated the effect of dietary intervention in 1414 patients with cancer who were malnourished or at risk of malnutrition, and who received both CT and RT as adjuvant, neoadjuvant, or primary treatment. Oral nutritional intervention by a dietitian improved global quality of life, emotional functioning, dyspnea, and anorexia, but did not affect mortality.[48]

In a randomized controlled trial conducted to compare nutritional outcomes of patients undergoing RT applied to the gastrointestinal or head and neck region according to the radiation oncology medical nutrition protocol of the American Dietetic Association and patients undergoing standard practice, less deterioration was reported in body weight, nutritional status, and quality of life in the protocol group at the end of 12 weeks.

In addition, there were clinically significant differences between the protocol group and standard practice group in terms of lean mass, which suggested that nutritional intervention performed according to the protocols would be more beneficial in patients undergoing RT.[49]

When the patient's diet is planned, it should be taken into consideration that tumors and treatments may affect nutritional status and nutrient absorption. Malnutrition is common in patients with head, neck, and gastrointestinal system cancers, while symptoms such as mucositis, taste changes, dysphagia, nausea, and diarrhea may be observed in patients receiving RT.[14] Fiber and lactose intake has been analyzed in the treatment of diarrhea in patients receiving RT applied to the abdominal and pelvic region.[50-52] In a study, reduced lactose and fiber intake were determined to have no effect on GI toxicity after 12-24 months.[34] In another study, a diet rich in soluble fiber significantly improved GI toxicity.[53]

It is reported that high-fiber and low-fat diets, together with probiotics, have a protective effect against GI toxicity in patients receiving RT.[54] Improvement in RT-related diarrhea results from non-starch polysaccharides. During this period, fluid intake should be increased, and fatty and gas-producing foods should be avoided. In addition, foods rich in potassium and sodium should be recommended.

In case xerostomia and mucositis occurs after RT applied to the head and neck region, patients should be given stews and soft foods, oral nutrition products should be used, and a nutrition plan with sufficient content in terms of vitamin C, beta carotene and vitamin E should be prepared.[55] During this period, oral care should be performed very well, and hard and dry foods, acidic drinks and salty foods should be avoided.

One of the frequently asked questions is the use of antioxidants during RT. Although antioxidant use reduces RT toxicity in patients with head and neck cancer, it may increase overall recurrence and mortality, especially in those who smoke during RT. In studies on the antioxidant use, conflicting effects on treatment toxicity have been revealed.[56] In the ESPEN oncology guideline, it is stated that vitamin and mineral intake should be provided according to recommended dietary allowance and that high-dose micronutrient use should not be recommended unless there are significant deficiencies.[13]

A working group including the members of the Italian Association of Medical Oncology (AIOM), the Italian Society for Clinical Nutrition and Metabolism (SINPE) and the Federation of Voluntary-Based Cancer Organizations (FAVO) published a consensus document in the joint project called "Integration of Nutritional Therapy in Oncology" (INTO)[57] in which appropriate nutritional support for patients with cancer was given in detail.[46] According to this document, the main practical recommendations can be summarized as follows:

a. Nutritional screening should be performed at diagnosis and at regular intervals in patients at risk of malnutrition by using validated tools.

b. Patients at risk of malnutrition should be referred to an oncology dietitian to make a comprehensive nutritional assessment.

c. Nutritional support should include ONS and/or EN, total or supplemental PN, depending on spontaneous food intake, tolerance to and efficacy of food intake, and especially dietary counselling.

d. Alternative hypocaloric anticancer diets (e.g. macrobiotic, ketogenic or vegan diets) are not recommended.

e. Nutritional support can be integrated into palliative care programs based on individual assessments, quality of life impacts, life expectancy and patient awareness.

f. Home artificial feeding should be prescribed and regularly monitored using protocols defined by oncologists and oncology dietitians.

Enteral and Parenteral Nutrition in Oncology

If the patient is able to eat and has a functional gastrointestinal system, nutritional counseling with or without ONS should be the intervention of choice to address changing nutritional demands due to treatment or disease. If oral feeding is inadequate, artificial feeding should be considered. Criteria for increased nutritional measures include the following:

1. if there is inadequate nutritional intake for more than 10 days due to surgery, CT or RT and if it is expected to be less than 50% of requirements
2. if nutrient intake is less than 50% of requirements for more than 1-2 weeks
3. if it is thought that malnourished patients will not be able to take in and/or absorb sufficient amounts of nutrients for a long period of time due to antineoplastic treatments
4. if the tumor mass itself obstructs oral intake and nutrient progression through the upper GI tract, artificial feeding should be considered

The decision whether EN or PN is performed should be made by considering the location and extent of the tumor, complications, treatment plan and purpose, prognosis, general physical condition of the patients, and duration of nutritional support.[45,58] EN should be preferred in artificial nutrition to preserve the function and integrity of intestines and to reduce bacterial translocation and infectious complications. A standard polymeric nutritional formula may be preferred. EN is recommended during CT/RT in malnourished or at-risk patients, if malnutrition or inadequate nutritional intake is present or expected. Routine systematic artificial nutrition is not recommended during RT. PEG or nasogastric tube is recommended in case radiation-induced mucositis is severe or the tumors of the head, neck, or thorax are obstructive.[27] EN is contraindicated in cases of intestinal obstruction or ileus, severe shock, intestinal ischemia, high-output fistula, severe intestinal bleeding, intestinal failure due to radiation enteritis, short bowel syndrome, peritoneal carcinomatosis, and chylothorax.[31]

In these cases, or when EN is inadequate, a combination of EN and PN, or PN alone should be considered.[45] Whatever the nutritional intervention chosen is, monitoring of the patient's compliance is essential.

Micronutrients, macronutrients and muscle preservation

Understanding the nutritional needs of patients and creating targeted plans to prevent or increase low muscle mass in cancer is of great importance. Although evidence varies by the type of the method, in studies on cancer, generally, the following is recommended: energy requirements (25-30 kcal/kg/day), protein (1.0-1.5 g/kg/day), branched-chain amino acids (leucine: 2-4 g/day), glutamine (0.3 g/kg/day), carnitine (4-6 g/day), creatine (5 g/day), fish oil/eicosapentaenoic acid (EPA) (2.0-2.2 g/day eicosapentaenoic acid and 1.5 g/day docosahexaenoic acid), vitamins/minerals (e.g., vitamin D: 600-800 IU/day), and multimodal approaches (nutrition, exercise, pharmaceuticals) aimed at preventing muscle loss. The overall goal is to minimize muscle loss during cancer treatment and to maximize muscle anabolism during recovery. This approach is anticipated to help improve overall health and prognosis by improving treatment tolerance and survival.[59]

Although many patients with cancer are advised to take >1 g/kg/day of protein, this may not be possible all the time. Limited protein intake primarily results from diet-related symptoms that affect dietary intake.[1] In recent guidelines, a higher range of protein intake (1.2–1.5 g/kg/day) is recommended due to the positive effects of higher protein intake on balancing protein and preserving muscle mass. In individuals with sarcopenia and insulin resistance, it is recommended that more energy should be obtained

not from carbohydrates but from fat to reduce glycemic load.[18] The recommended daily carbohydrate intake is <5 g/kg. Physical activity reduces muscle loss by improving insulin sensitivity, suppressing inflammatory mediators, and promoting protein synthesis.[11] Eicosapentaenoic acid (EPA) has been identified as a promising nutrient due to its clinical benefits. Several mechanisms have been proposed to explain the potential benefits of EPA on body composition. Some of them are as follows: inhibition of catabolic stimuli by modulating the production of proinflammatory cytokines, increase in insulin sensitivity which induces protein synthesis, and positive effects on appetite. In several interventional studies, it has been demonstrated that EPA may prevent deterioration of nutritional status and help improve calorie and protein intake. In some other studies, it is stated that n-3 fatty acids may inhibit the proliferation of cancer cells, prevent muscle loss, and reduce CT toxicity.[1,60]

It has been reported that vitamin D deficiency may be related to cancer, and that there is a relationship between low vitamin D levels and muscle loss. Vitamin D may be necessary to optimize the effectiveness of protein supplements. If patients with cancer have vitamin D deficiency, it should be replaced. Then, 600-800 IU of vitamin D supplementation for maintenance purposes is thought to be beneficial in preventing muscle loss. This approach can contribute to the treatment process by supporting patients' general health.[1]

Toward a proactive nutrition care model in oncology

In conclusion, due to the high risk of malnutrition in patients with cancer who undergo treatment, nutritional status should be assessed and monitored at regular intervals and nutritional interventions should be performed when necessary. Oral nutrition and diet education are the basis of nutritional therapy. Depending on the type and location of the disease, individual needs and the level of malnutrition, nutritional and diet counseling should be provided by an oncology dietitian and should be continuously monitored by a multidisciplinary team. In cases of indication, Oral Nutrition Support (ONS), Enteral Nutrition (EN) or Parenteral Nutrition (PN) treatments should be an integral part of the treatment process. The risk of malnutrition should not be ignored in all cancer patients, nutritional therapy should be carried out with proactive interventions on an individual basis, and treatment results should be closely monitored.

Author contribution

The author declare contribution to the paper as follows: Study conception and design: DHB; data collection: DHB; analysis and interpretation of results: DHB; draft manuscript preparation: DHB. The author reviewed the results and approved the final version of the article.

Source of funding

The authors declare the study received no funding.

Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Ravasco P. Nutrition in cancer patients. *J Clin Med*. 2019;8:1211. **[Crossref]**
2. Bossola M. Nutritional interventions in head and neck cancer patients undergoing chemoradiotherapy: a narrative review. *Nutrients*. 2015;7:265-276. **[Crossref]**
3. de van der Schueren MAE, Laviano A, Blanchard H, Jourdan M, Arends J, Baracos VE. Systematic review and meta-analysis of the evidence for oral nutritional intervention on nutritional and clinical outcomes during chemo(radio)therapy: current evidence and guidance for design of future trials. *Ann Oncol*. 2018;29:1141-1153. **[Crossref]**
4. Baji DB, Patel JP, Konanur Srinivasa NK, Gande A, Anusha M, Dar H. Nutrition care in cancer surgery patients: a narrative review of nutritional screening and assessment methods and nutritional considerations. *Cureus*. 2022;14:e33094. **[Crossref]**
5. Fearon K, Strasser F, Anker SD, et al. Definition and classification of cancer cachexia: an international consensus. *Lancet Oncol*. 2011;12:489-495. **[Crossref]**
6. Martin L, Senesse P, Gioulbasanis I, et al. Diagnostic criteria for the classification of cancer-associated weight loss. *J Clin Oncol*. 2015;33:90-99. **[Crossref]**
7. Bossi P, Delrio P, Mascheroni A, Zanetti M. The spectrum of malnutrition/cachexia/sarcopenia in oncology according to different cancer types and settings: a narrative review. *Nutrients*. 2021;13:1980. **[Crossref]**
8. Gannavarapu BS, Lau SKM, Carter K, et al. Prevalence and survival impact of pretreatment cancer-associated weight loss: a tool for guiding early palliative care. *J Oncol Pract*. 2018;14:e238-e250. **[Crossref]**
9. Bozzetti F. Chemotherapy-induced sarcopenia. *Curr Treat Options Oncol*. 2020;21:7. **[Crossref]**

10. Ma BW, Chen XY, Fan SD, et al. Impact of sarcopenia on clinical outcomes after radical gastrectomy for patients without nutritional risk. *Nutrition*. 2019;61:61-66. [Crossref]
11. Aprile G, Basile D, Giaretta R, et al. The clinical value of nutritional care before and during active cancer treatment. *Nutrients*. 2021;13:1196. [Crossref]
12. Planas M, Álvarez-Hernández J, León-Sanz M, et al. Prevalence of hospital malnutrition in cancer patients: a sub-analysis of the PREDyCES® study. *Support Care Cancer*. 2016;24:429-435. [Crossref]
13. Arends J, Bodoky G, Bozzetti F, et al. ESPEN guidelines on enteral nutrition: non-surgical oncology. *Clin Nutr*. 2006;25:245-259. [Crossref]
14. Isenring EA, Bauer JD, Capra S. Nutrition support using the American Dietetic Association medical nutrition therapy protocol for radiation oncology patients improves dietary intake compared with standard practice. *J Am Diet Assoc*. 2007;107:404-412. [Crossref]
15. Bauer DJ, Ash S, Davidson LW, et al. Evidence based practice guidelines for the nutritional management of patients receiving radiation therapy of the Dietitians Association of Australia. *Nutr Diet*. 2008;65(Special Issue):1-20. [Crossref]
16. Leis C, Arthur AE, Chen X, Greene MW, Frugé AD. Systematic review of nutrition interventions to improve short term outcomes in head and neck cancer patients. *Cancers (Basel)*. 2023;15:822. [Crossref]
17. Loeliger J, Dewar S, Kiss N, et al. Co-design of a cancer nutrition care pathway by patients, carers, and health professionals: the CanEAT pathway. *Support Care Cancer*. 2023;31:99. [Crossref]
18. Muscaritoli M, Arends J, Bachmann P, et al. ESPEN practical guideline: clinical nutrition in cancer. *Clin Nutr*. 2021;40:2898-2913. [Crossref]
19. Roeland EJ, Bohlke K, Baracos VE, et al. Management of cancer cachexia: ASCO guideline. *J Clin Oncol*. 2020;38:2438-2453. [Crossref]
20. Arends J, Strasser F, Gonella S, et al. Cancer cachexia in adult patients: ESMO clinical practice guidelines. *ESMO Open*. 2021;6:100092. [Crossref]
21. Muscaritoli M, Arends J, Aapro M. From guidelines to clinical practice: a roadmap for oncologists for nutrition therapy for cancer patients. *Ther Adv Med Oncol*. 2019;11:1758835919880084. [Crossref]
22. Ottery FD. Definition of standardized nutritional assessment and interventional pathways in oncology. *Nutrition*. 1996;12:S15-S19. [Crossref]
23. Bauer J, Capra S, Ferguson M. Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. *Eur J Clin Nutr*. 2002;56:779-785. [Crossref]
24. Isenring E, Bauer J, Capra S. The scored Patient-generated Subjective Global Assessment (PG-SGA) and its association with quality of life in ambulatory patients receiving radiotherapy. *Eur J Clin Nutr*. 2003;57:305-309. [Crossref]
25. Kwang AY, Kandiah M. Objective and subjective nutritional assessment of patients with cancer in palliative care. *Am J Hosp Palliat Care*. 2010;27:117-126. [Crossref]
26. Laky B, Janda M, Cleghorn G, Obermair A. Comparison of different nutritional assessments and body-composition measurements in detecting malnutrition among gynecologic cancer patients. *Am J Clin Nutr*. 2008;87:1678-1685. [Crossref]
27. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z; Ad Hoc ESPEN Working Group. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr*. 2003;22:321-336. [Crossref]
28. Detsky AS, McLaughlin JR, Baker JP, et al. What is subjective global assessment of nutritional status? *JPEN J Parenter Enteral Nutr*. 1987;11:8-13. [Crossref]
29. Cederholm T, Jensen GL, Correia MITD, et al. GLIM criteria for the diagnosis of malnutrition - a consensus report from the global clinical nutrition community. *Clin Nutr*. 2019;38:1-9. [Crossref]
30. Ruan X, Nakyeyune R, Shao Y, et al. Nutritional screening tools for adult cancer patients: a hierarchical Bayesian latent-class meta-analysis. *Clin Nutr*. 2021;40:1733-1743. [Crossref]
31. Thompson KL, Elliott L, Fuchs-Tarlovsky V, Levin RM, Voss AC, Piemonte T. Oncology evidence-based nutrition practice guideline for adults. *J Acad Nutr Diet*. 2017;117:297-310.e47. [Crossref]
32. Prado CM, Anker SD, Coats AJS, Laviano A, von Haehling S. Nutrition in the spotlight in cachexia, sarcopenia and muscle: avoiding the wildfire. *J Cachexia Sarcopenia Muscle*. 2021;12:3-8. [Crossref]
33. Strasser F, Binswanger J, Cerny T, Kesselring A. Fighting a losing battle: eating-related distress of men with advanced cancer and their female partners. A mixed-methods study. *Palliat Med*. 2007;21:129-137. [Crossref]
34. Ravasco P, Monteiro-Grillo I, Vidal PM, Camilo ME. Dietary counseling improves patient outcomes: a prospective, randomized, controlled trial in colorectal cancer patients undergoing radiotherapy. *J Clin Oncol*. 2005;23:1431-1438. [Crossref]
35. Orell H, Schwab U, Saarilahti K, Österlund P, Ravasco P, Mäkitie A. Nutritional counseling for head and neck cancer patients undergoing (chemo) radiotherapy-a prospective randomized trial. *Front Nutr*. 2019;6:22. [Crossref]
36. Blackwood HA, Hall CC, Balstad TR, et al. A systematic review examining nutrition support interventions in patients with incurable cancer. *Support Care Cancer*. 2020;28:1877-1889. [Crossref]

37. Arends J, Baracos V, Bertz H, et al. ESPEN expert group recommendations for action against cancer-related malnutrition. *Clin Nutr*. 2017;36:1187-1196. [Crossref]

38. Collado-Borrell R, Escudero-Vilaplana V, Romero-Jiménez R, Iglesias-Peinado I, Herranz-Alonso A, Sanjurjo-Sáez M. Oral antineoplastic agent interactions with medicinal plants and food: an issue to take into account. *J Cancer Res Clin Oncol*. 2016;142:2319-2330. [Crossref]

39. PDQ Integrative, Alternative, and Complementary Therapies Editorial Board. Cancer Therapy Interactions With Foods and Dietary Supplements (PDQ®): Health Professional Version. In: PDQ Cancer Information Summaries. Bethesda, MD: National Cancer Institute (US); 2002. Available at: https://www.ncbi.nlm.nih.gov/books/NBK563071/

40. Jung AY, Cai X, Thoene K, et al. Antioxidant supplementation and breast cancer prognosis in postmenopausal women undergoing chemotherapy and radiation therapy. *Am J Clin Nutr*. 2019;109:69-78. [Crossref]

41. Ravasco P, Monteiro-Grillo I, Marques Vidal P, Camilo ME. Impact of nutrition on outcome: a prospective randomized controlled trial in patients with head and neck cancer undergoing radiotherapy. *Head Neck*. 2005;27:659-668. [Crossref]

42. van den Berg MG, Rasmussen-Conrad EL, Wei KH, Lintz-Luidens H, Kaanders JH, Merkx MA. Comparison of the effect of individual dietary counselling and of standard nutritional care on weight loss in patients with head and neck cancer undergoing radiotherapy. *Br J Nutr*. 2010;104:872-877. [Crossref]

43. Ravasco P, Monteiro-Grillo I, Camilo M. Individualized nutrition intervention is of major benefit to colorectal cancer patients: long-term follow-up of a randomized controlled trial of nutritional therapy. *Am J Clin Nutr*. 2012;96:1346-1353. [Crossref]

44. Cereda E, Cappello S, Colombo S, et al. Nutritional counseling with or without systematic use of oral nutritional supplements in head and neck cancer patients undergoing radiotherapy. *Radiother Oncol*. 2018;126:81-88. [Crossref]

45. Arends J, Bachmann P, Baracos V, et al. ESPEN guidelines on nutrition in cancer patients. *Clin Nutr*. 2017;36:11-48. [Crossref]

46. Caccialanza R, Pedrazzoli P, Cereda E, et al. Nutritional support in cancer patients: a position paper from the Italian Society of Medical Oncology (AIOM) and the Italian Society of Artificial Nutrition and Metabolism (SINPE). *J Cancer*. 2016;7:131-135. [Crossref]

47. Polański J, Jankowska-Polańska B, Mazur G. Relationship between nutritional status and quality of life in patients with lung cancer. *Cancer Manag Res*. 2021;13:1407-1416. [Crossref]

48. Baldwin C, Spiro A, Ahern R, Emery PW. Oral nutritional interventions in malnourished patients with cancer: a systematic review and meta-analysis. *J Natl Cancer Inst*. 2012;104:371-385. [Crossref]

49. Isenring EA, Capra S, Bauer JD. Nutrition intervention is beneficial in oncology outpatients receiving radiotherapy to the gastrointestinal or head and neck area. *Br J Cancer*. 2004;91:447-452. [Crossref]

50. Garcia-Peris P, Velasco C, Hernandez M, et al. Effect of inulin and fructo-oligosaccharide on the prevention of acute radiation enteritis in patients with gynecological cancer and impact on quality-of-life: a randomized, double-blind, placebo-controlled trial. *Eur J Clin Nutr*. 2016;70:170-174. [Crossref]

51. Wedlake L, Shaw C, McNair H, et al. Randomized controlled trial of dietary fiber for the prevention of radiation-induced gastrointestinal toxicity during pelvic radiotherapy. *Am J Clin Nutr*. 2017;106:849-857. [Crossref]

52. Pettersson A, Nygren P, Persson C, Berglund A, Turesson I, Johansson B. Effects of a dietary intervention on gastrointestinal symptoms after prostate cancer radiotherapy: long-term results from a randomized controlled trial. *Radiother Oncol*. 2014;113:240-247. [Crossref]

53. Wedlake LJ, McGough C, Shaw C, et al. Clinical trial: efficacy of a low or modified fat diet for the prevention of gastrointestinal toxicity in patients receiving radiotherapy treatment for pelvic malignancies. *J Hum Nutr Diet*. 2012;25:247-259. [Crossref]

54. Allenby TH, Crenshaw ML, Mathis K, et al. A systematic review of home-based dietary interventions during radiation therapy for cancer. *Tech Innov Patient Support Radiat Oncol*. 2020;16:10-16. [Crossref]

55. Chung MK, Kim DH, Ahn YC, Choi JY, Kim EH, Son YI. Randomized trial of vitamin c/e complex for prevention of radiation-induced xerostomia in patients with head and neck cancer. *Otolaryngol Head Neck Surg*. 2016;155:423-430. [Crossref]

56. Harvie M. Nutritional supplements and cancer: potential benefits and proven harms. *Am Soc Clin Oncol Educ Book*. 2014;undefined:e478-e486. [Crossref]

57. Caccialanza R, De Lorenzo F, Pedrazzoli P. The integrating nutritional therapy in oncology (INTO) project: rationale, structure and preliminary results. *ESMO Open*. 2017;2:e000221. [Crossref]

58. Cotogni P, Pedrazzoli P, De Waele E, et al. Nutritional therapy in cancer patients receiving chemoradiotherapy: should we need stronger recommendations to act for improving outcomes? *J Cancer*. 2019;10:4318-4325. [Crossref]

59. Prado CM, Purcell SA, Laviano A. Nutrition interventions to treat low muscle mass in cancer. *J Cachexia Sarcopenia Muscle*. 2020;11:366-380. [Crossref]

60. Murphy RA, Mourtzakis M, Mazurak VC. n-3 polyunsaturated fatty acids: the potential role for supplementation in cancer. *Curr Opin Clin Nutr Metab Care*. 2012;15:246-251. [Crossref]