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Tube Feeding Techniques and Nutritional Supplements in Cancer Care: Review

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Abstract
There is a link between cancer and an increased risk of both morbidity and mortality. Cancer patients particularly those with complications such as Cricopharyngeal cancer, Breast cancer with diabetes, Stomach cancer with renal failure, Cervix cancer with asthma and Endometrium cancer with hypertension and hypothyroidism face specific challenges in maintaining adequate nutrition due to various factors such as lack of knowledge about the condition being faced, its dietary management, financial constraints on overall therapy, and access to quality supplements. Pre- and post-operative nutrition plays a crucial role in cancer care because it can delay recovery, exacerbate side effects from treatments, and weaken the immune system. Recently, breast cancer has become the leading type of cancer among women in India. Surprisingly, many educated women from urban areas are still unaware of its causes and signs. Dietary management mainly focuses on tailored diet meeting daily nutritional needs such as adequate calorie requirements, high quality protein, micronutrient needs, functional foods such as anti-inflammatory, anti-cancer foods. To speed up recovery and overcome therapy's side effects, tube feeding and nutritional supplements are essential. This review focuses on the need for future advancements in hospital diet and care provided to cancer patients, particularly those with complications. It also highlights the importance of advancements in tube feeding techniques, vegetarian-friendly diets, affordable homemade nutritional supplements for cancer patients in specific needs and overall provision of affordable cancer care across hospitals.

Keywords: Cricopharyngeal, Renal, Cancer, Nutritional management, Tube feeding, Malnutrition.

INTRODUCTION

The estimated number of cancer cases in India for 2022 was 14,61,427 (crude rate: 100.4 per 100,000). In India, one out of every nine people are likely to develop cancer during their lifetime (Sathishkumar *et al.,* 2022). The WHO defines cancer as large group of diseases that can start in almost any organ or tissue of the body when abnormal cells grow uncontrollably, go beyond their usual boundaries to invade adjoining parts of the body and/or spread to other organs. Malnutrition is a limiting factor in cancer care, particularly in advanced stages, because it can prolong recovery time, increase treatment side effects, and impair the immune system. Malnutrition is identified by screening tools as weight loss of more than 5-10% of last body weight or a low body mass index (BMI), which is associated with an increased risk of infection and survival. Many cancer patients have poor nutritional health, which has a significant impact on their treatment outcomes. Nutritional issues are frequently undiagnosed and untreated due to inadequate training among healthcare professionals. Nutrition is included as an essential component for

cancer management in the evidence-based recommendations for early nutritional screening, personalized interventions, and regular follow-ups to address malnutrition and its consequences, such as sarcopenia and cachexia. This will improve patient care and treatment efficacy (Liposits *et al.,* 2021).

In 2021, Karnataka reported 87304 new cases of cancer, including among all sexes, the breast, lip, oral cavity, and cervix were the most common (Saraswathy *et al*.,2024). The nutritional challenges for patients with specific cancer types, particularly those with complications, such as cricopharyngeal cancer, breast cancer complicated by diabetes, stomach cancer with renal failure, and cervix cancer with asthma and endometrium cancer with hypertension and hypothyroidism are multifaceted. In addition to increased metabolic requirements and organ dysfunction-related complications, these patients may have difficulty swallowing. Tube feeding is an effective way to ensure that these patients get enough nutrition, and dietary changes and specialized supplements can help them manage their conditions and recover faster.

Tube Feeding Techniques in Cancer Care

Tube feeding is used in cancer care when patients cannot consume enough nutrients orally due to swallowing issues, gastrointestinal obstructions, or other complications. The choice of feeding technique for head and neck cancer patients, particularly those with cricopharyngeal cancer, is determined by their diagnosis, expected treatment duration, and risk of complications (Coke *et al*., 2022)

Nasogastric (NG) Tube: is inserted through the stomach and nose and is typically used for short-term feeding. It is especially beneficial for patients experiencing temporary swallowing difficulties, such as those with cricopharyngeal cancer (Bin-Manie *et al,* 2023).

Percutaneous Endoscopic Gastrostomy (PEG) Tube: A PEG tube is inserted directly into the stomach through the abdominal wall for patients who need long-term nutritional support, such as those with advanced cancer or chronic complications (Fugazza *et al*., 2022).

Jejunostomy Tube (J-Tube): This method is used when the stomach is not working properly or there is a high risk of aspiration. Because of the high risk of aspiration, this is frequently used on patients who have complications like stomach cancer and renal failure (Debleds *et al*., 2024).

Criteria for Using a Tube to Feed:

1. Severe Dysphagia or Swallowing Dysfunction: Dysphagia is frequently experienced by patients with head and neck cancer, particularly those with cricopharyngeal cancer, as a result of tumor obstruction, radiation-induced mucositis, or post-operative changes. In order to guarantee proper nutrient intake, severe dysphagia may result in malnutrition and weight loss, requiring tube feeding (Li *et al*., 2024).
2. Malnutrition or Inadequate Oral Intake: In order to avoid malnutrition, tube feeding is advised for patients who consume less than 60% of their nutritional requirements for seven to ten days. Perfect for patients experiencing cancer cachexia or inadvertent weight loss of more than 5% in a month or more than 10% in six months (Cook *et al*., 2022).
3. Gastrointestinal Obstruction or Tumor Compression: Food and liquids cannot pass through obstructions brought on by tumors, especially in the esophagus, stomach, or intestines. In certain situations, the obstruction may be avoided by using a Percutaneous Endoscopic Gastrostomy (PEG) or tube feeding through a nasoenteric tube (Itou *et al*., 2023).
4. Severe Mucositis or Oral Ulceration Due to Chemoradiotherapy: Radiation and chemotherapy-treated cancer patients frequently experience excruciating mucositis, which makes it difficult for them to get

enough oral nutrition. In these situations, tube feeding helps avoid nutritional deficits (Wei *et al*., 2024).

5. High Risk of Aspiration Pneumonia: Cancer patients are more likely to aspirate when they have neuromuscular dysfunction, including neurological impairment brought on by treatment. Tube feeding reduces the danger of aspiration and guarantees safe nutrient delivery, particularly when done using PEG (Percutaneous Endoscopic Gastrostomy) (Hashida *et al*., 2023).
6. Prevention of Treatment Interruptions: In order to prevent therapy delays brought on by weight loss or malnutrition, tube feeding is frequently advised to maintain the nutritional condition of patients receiving severe treatments (Anderson *et al*., 2021).

Cricopharyngeal Cancer: This cancer affects the cricopharyngeal muscle, making it hard to swallow and increasing the risk of an obstruction in the airway. Tube feeding is often necessary for patients to maintain adequate nutrition (Maruo *et al*., 2023). The developed predictive model for reactive enteral feeding in head and neck cancer patients undergoing definitive chemoradiotherapy. This model, which is based on clinical and dosimetric factors, did a good job of identifying patients who might need to be fed through the nose for a long time. This approach allows for more personalized treatment planning and supports clinical decisions regarding the use of prophylactic versus reactive enteral feeding (Gaito *et al.,* 2021).

Enteral nutrition (EN) through a nasogastric tube (NGT) significantly improves nutritional status and physical condition in esophageal cancer patients undergoing chemoradiotherapy compared to oral nutritional supplements (ONS). NGT feeding may also decrease the risk of myelosuppression and esophagitis (Shui-an *et al.,* 2023).

Blenderized Tube Feeds (BTFs) are an efficient enteral feeding alternative to commercial formulas. Although BTFs produced slightly higher gastric residuals, the rate of delayed gastric emptying was comparable to that of formulas. Rather than the type of feed, larger feeding volumes were linked to higher residuals. This promotes the safe and effective use of BTFs in clinical practice, especially when tailored to specific patient needs (Hron *et al*., 2023).

Interpretation and Clinical Insight

Case study 1: A 44-year-old woman with cricopharyngeal cancer (squamous cell carcinoma)-She weighed 34 kg, was 148 cm tall, and had a Body Mass Index of 15.5 kg/m², indicating severe malnutrition. The patient, who is vegetarian and works as a farmer, was undergoing chemotherapy. She had a Ryles tube inserted due to dysphagia, which had been present for four months and made it difficult for her to consume solid, semisolid, and liquid foods. Meeting her daily calorie requirements through tube feeding and vegetarian-based supplements was both physically and financially demanding. In this case, calorie-dense home-based supplements and nasogastric tube feeding were critical in meeting her nutritional requirements. However, the main challenges associated with tube feeding were the need for an extra person to hold the tube during feeding, the lengthy feeding process, and the importance of maintaining hygienic practices. Furthermore, the cost of tube feeding was a significant burden for the patient. These challenges highlight the need for future development and widespread availability of cost-effective and simple tube feeding options.

Breast Cancer and Diabetes: The interaction of cancer treatments and diabetes makes it difficult for patients to manage both conditions concurrently. Tube feeding may be required if the patient is unable to maintain oral intake due to the side effects of chemotherapy or other treatments, and it can be difficult to maintain diabetic-friendly foods while tube feeding. Despite following the Joint British Diabetes Societies

(JBDS) guidelines, only 40% of patients met their target blood glucose level of 6-12 mmol/L. Although major hypoglycemic events were avoided, the study highlighted the difficulties in achieving optimal glycemic control, which are influenced by factors such as comorbidities, feed interruptions, and insulin administration. The findings emphasized the significance of proactive insulin dose adjustments and early involvement by diabetes inpatient specialist nurses (DISNs). The study also called for more research and a national audit tool to improve glycemic control during enteral tube feeding. (JBDS-IP. 2021). When aberrant breast cells proliferate uncontrollably and develop into tumors, it is known as breast cancer. The tumors have the potential to spread throughout the body and become lethal if untreated. The milk ducts and/or the breast's milk-producing lobules are where breast cancer cells start. The earliest type, known as in situ, is detectable in its early stages and poses no threat to life. Cancer cells have the ability to invade neighbouring breast tissue. Tumors resulting from this cause thickening or lumps. It is possible for invasive cancers to metastasize, or spread, to other organs or nearby lymph nodes. Metastasis can be deadly and life-threatening. The patient, the type of cancer, and its spread all influence the course of treatment. Radiation therapy, medication, and surgery are all part of the treatment. (WHO, 2024). Age, diet, and obesity are significant risk factors for both type 2 diabetes mellitus and breast cancer, which are complicated, chronic, diverse, and multifactorial diseases. Additionally, they exhibit mutually inclusive phenotypic traits such as hormonal imbalances, hypoxic situations, and metabolic dysregulations brought on by hyperglycemia. Both illnesses are the world's greatest causes of death, and if their causal relationship is not addressed, it might become a serious global health issue. Hyperglycemia, hyperinsulinemia, hormonal abnormalities, and chronic inflammation have all been presented by previous research. Therefore, in order to emerge from customized medicine, more effective therapeutic strategies are required (Durrani *et al*., 2021).

Diabetes: The chronic disease known as diabetes mellitus alters how proteins, fats, and carbs are metabolized. The main feature that sets all types of diabetes apart is hyperglycemia, which is defined by high blood sugar levels. The prevalence of diabetes has considerably increased as a result of modern lifestyle choices. Therefore, obtaining an early diagnosis of the ailment is crucial (Wang *et al*., 2021). Data pre-processing is an essential stage in building classification models. A crucial step in creating classification models is data pre-processing. The Pima Indian Diabetes dataset, which is available in the University of California Irvine (UCI) repository, is a challenging dataset with a higher percentage of missing values (48%) than other datasets of a similar kind (Salih *et al.,* 2024).

Clinical Perspective and Interpretation

Case study 2: This case of a 52-year-old woman with metastatic right breast cancer who had been undergoing chemotherapy for a year and was recently diagnosed with Type 2 *Diabetes Mellitus* (T2DM) highlights the difficulties of managing nutrition in cancer patients with complex commodities. Despite having a Body Mass Index of 26.6 kg/m², she struggles to maintain adequate nutrition due to severe breast infection, pain, and being bedridden since the third chemotherapy cycle. The primary goals of her care are to ensure adequate nutrient intake, support immune function, prevent blood glucose level progression, and reduce inflammation. Reducing chemotherapy side effects, providing free therapeutic meals that are high in nutrients and affordable supplements to address micronutrient deficiencies, and providing emotional support to geriatric cancer patients through monthly visit programs involving students, NGOs (Non-Governmental Organization), or even TV programs tailored for geriatric cancer patients, similar to those provided in paediatric units, are all potential future enhancements to cancer care. These initiatives

have the potential to raise awareness about cancer among students and the general public and significantly improve cancer patients' physical and psychological well-being. They will also promote holistic care and better treatment outcomes.

Stomach Cancer with Renal Failure: Patients with stomach cancer and renal failure experience complications such as nausea, vomiting, and difficulty absorbing nutrients, necessitating enteral nutrition through a tube to prevent malnutrition and support kidney function. Patients on dialysis who have been told they have stomach cancer face a lot of challenges (Dilber *et al*., 2024). While stomach cancer was detected earlier in dialysis patients, the prognosis remains significantly poorer than in non-dialysis patients, as evidenced by higher mortality rates. These findings suggest that factors such as the limitations and complications of cancer treatment in the context of dialysis, as well as the potential impact of uremic conditions on cancer progression, may play critical roles in determining outcomes. This emphasizes the importance of personalized therapeutic approaches, multidisciplinary care, and additional research to improve survival and quality of life for dialysis patients with stomach cancer (Kida *et al*., 2022). Stomach cancer is the third leading cause of cancer deaths worldwide. It was estimated that there were more than 1 million new cases and 7 million deaths due to stomach cancer in 2020, despite a decreasing trend in stomach cancer incidence. Stomach cancer is associated with multiple factors, including environmental and genetic factors. Smoking directly increases the risk of stomach cancer as it releases nitrosamines and other known carcinogens (Jia *et al*., 2024).

Renal failure: The pathological state of partial or complete loss of renal function brought on by the progression of chronic kidney disease (CKD) to a later stage is known as renal failure, or end-stage kidney disease (ESKD). Dialysis or kidney transplantation are the main options for patients with renal failure, who would soon have uremia or perhaps fatal consequences. A deadly condition that is causing concern worldwide is renal failure. Prior risk models for renal failure mostly depend on the identification of chronic kidney disease, which is largely undetected due to its lack of evident clinical signs, resulting in a notable exclusion of high-risk patients (Yang *et al*.,2021). The group with chronic kidney disease had lower albumin levels, greater comorbidity rates, and a larger percentage of older and male patients. In addition to increased rates of cardiovascular problems, anastomotic leakage, pneumonia, wound infections, pancreatic disorders, and short-term mortality, the group with chronic renal disease also experienced more severe postoperative sequelae overall. Additionally, compared to the nonchronic renal disease group, the chronic kidney disease group had a lower overall survival rate (Cheng *et al*., 2022).

Case study 3: A 35-year-old stomach cancer patient recently required renal replacement therapy (RRT) due to acute kidney failure. The patient was 172 cm tall, weighed 48 kg, and had a BMI (Body Mass Index) of 16.2 kg/m^2, indicating severe malnutrition. This demonstrates the intricate relationship between advanced cancer and renal failure, in which both the cancer and the complications of renal dysfunction worsen the patient's nutritional status and overall prognosis. The use of RRT in such cases emphasizes the importance of comprehensive care, which includes nutritional support and kidney management, to improve outcomes (Pistolesi *et al*., 2023). It also emphasizes the importance of a therapeutic diet in meeting both cancer and kidney requirements. The case emphasizes the significance of early identification and intervention.

Cervix cancer with asthma: Cervical cancer and asthma are significant health concerns globally, and their coexistence can present unique challenges in patient management. The connection between asthma and an increased risk of various cancers, including cervical cancer, has been the subject of recent research. Clinical Research Network found that patients with asthma were 1.36 times more likely to develop cancer

compared to those without asthma. Specifically, the risk for cervical cancer was elevated, with a hazard ratio of 1:46 among asthma patients not using inhaled steroids. This suggests that there may be a connection between asthma and an increased risk of cervical cancer, particularly if steroids are not taken inhalationally (Guo *et al*., 2023). As the fourth leading cause of cancer incidence and death in women globally, cervical cancer is a serious public health concern. Geographical disparities in cervical cancer are a result of disparities in access to appropriate screening and treatment, as well as variations in the prevalence of human papillomavirus (HPV) infection. A history of smoking, the use of oral contraceptives, the early age at which coitus begins, the number of sexual partners, a history of STDs, some autoimmune illnesses, and persistent immunosuppression are other epidemiologic risk factors linked to cervical cancer. About 80% of cervical malignancies are squamous cell carcinomas, with adenocarcinomas making up the remaining 20% (Cibula *et al*., 2023).

Asthma: The World Health Organization defines asthma as a chronic or long-term illness that occasionally causes inflammation and narrowing of the lungs' airways, resulting in coughing, wheezing, chest tightness, and shortness of breath. Over 300 million people worldwide suffer from asthma today, with 6% of children and 2% of adults living with the chronic illness in India alone. Even though asthma's share of non-communicable diseases' overall mortality burden is lower, the majority of its deaths are avoidable, making it a serious concern (Rashmi *et al*., 2021). Despite accounting for 13% of the global asthma prevalence, India has a thrice higher mortality rate and more than twofold higher DALYs than the rest of the world, showing a significant gap in asthma diagnosis and treatment. We must find solutions to close these gaps since asthma causes a great deal of pain, impairing people's quality of life and depleting the nation's resources. Building solid alliances between patients, the public, the government, the pharmaceutical sector, and non-governmental organizations is the most effective and economical way to combat asthma. The effects of asthma go beyond mere respiratory challenges, influencing individuals' self-image and their ability to engage socially. The stigma surrounding asthma can diminish self-esteem, causing individuals to hide their symptoms and postpone seeking help. When asthma is underdiagnosed, it can result in inadequate treatment and negative health outcomes, as patients may seem healthy and are less likely to be referred to specialists for a definitive diagnosis compared to rarer disorders. In India, low-income families, depend on government hospitals for affordable healthcare. Unfortunately, these facilities often lack the necessary equipment for proper asthma diagnosis and treatment even on therapeutically aspect. Many healthcare professionals, in both private and public sectors, do not possess the requisite knowledge and skills to effectively diagnose and manage asthma, frequently limiting their treatment to oral medications (Salvi *et al*., 2022).

Clinical Perspective and Interpretation

Case study 4: A 64-year-old female, diagnosed with stage IV A squamous cell carcinoma of the cervix, presented with a history of asthma, complicating her overall disease management. She weighed 43 kg with height 154 cm and Body Mass Index of 18.1 kg/m², indicating mild undernutrition, which further heightened concerns about her nutritional status during treatment. The patient was undergoing radiation therapy and was placed on Ryle's tube feeding due to treatment-induced dysphagia, making oral intake inadequate. Her enteral nutrition plan was tailored to meet her increased caloric and protein requirements, considering the need to preserve lean body mass and support immune function. A semi-elemental formula, rich in omega-3 fatty acids, antioxidants, and immunomodulating nutrients, was administered to reduce inflammation and prevent malnutrition. Considering asthma, special care was taken to monitor for potential aspiration and respiratory distress, ensuring that feeding was delivered in a semi-upright position

to minimize complications. The feeding regimen included intermittent bolus feeding to enhance tolerance and digestion while minimizing gastrointestinal discomfort. Close monitoring of her nutritional status, pulmonary function, and electrolyte balance was integral to her comprehensive care plan, aimed at improving her treatment outcomes and maintaining quality of life during the course of her therapy.

Endometrium cancer with hypertension and hypothyroidism: Endometrial cancer is one of the most common gynaecological cancers and is highly related to the endocrine system. Epidemiological studies reported that risk factors for endometrium cancer may relate to metabolic syndrome, obesity, diabetes, hypertension, younger age at menarche, late age at menopause, infertility, nulliparity, age at birth of first child, long-term use of unopposed oestrogens during hormone replacement therapy, tamoxifen use, polycystic ovary syndrome, and progression from atypical hyperplasia to cancer. The patients with endometrium cancer presented higher serum TSH levels 4,5,6,7,8. Hypothyroidism might influence the development of endometrium cancer by indirectly interfering with the risk factors or by directly acting on thyroid-related receptors and influencing the disease in other dependent mechanism (Leung *et al*., 2024). Hypertension is a well-established risk factor for endometrial cancer, contributing to tumor progression through mechanisms such as chronic inflammation, endothelial dysfunction, and abnormal angiogenesis. A meta-analysis of 26 observational studies involving 207,502 cases highlighted a 37% increased risk of endometrial cancer in hypertensive patients. Additionally, data from the Epidemiology of Endometrial Cancer Consortium (E2C2) confirmed that hypertension independently increased the risk of endometrial cancer by 14%, even after adjusting for confounding factors such as BMI, diabetes, and reproductive history. Effective blood pressure management is crucial in improving outcomes in patients with endometrial cancer and concurrent hypertension (Habeshian *et al*., 2024).

Hypothyroidism: A common endocrine disorder characterized by decreased thyroid hormone production, hypothyroidism affects a significant number of people, with rates of 0.6% to 12% among women. Numerous studies have examined the connection between hypothyroidism and endometrial cancer. Some studies have found that hypothyroidism is a common comorbidity among patients with endometrial cancer. Additionally, it has been observed that 15.3% of Endometrium Cancer patients had a prior diagnosis of hypothyroidism, and an additional 8.5% exhibited biochemical evidence of subclinical hypothyroidism based on baseline blood tests. Although epidemiological studies suggest a potential link between hypothyroidism and Endometrium Cancer, these observations are based on observational data, which are susceptible to confounding factors and bias. Gaining a comprehensive understanding of the causal association between hypothyroidism and endometrial cancer holds significant clinical implications for effective patient management (Wang *et al*., 2024).

Clinical Perspective and Interpretation

Case study 5: A 58-year-old female, weighing 40 kg with a height of 149 cm and Body Mass Index of 18kg/m^2, was diagnosed with carcinoma of the endometrium (Ca endometrium), complicated by hypertension and hypothyroidism. She was undergoing chemotherapy and was initiated on Ryle's tube (RT) feeding due to poor oral intake and increased risk of malnutrition. Her medical history included long-standing hypertension managed with antihypertensive medications and hypothyroidism controlled with levothyroxine. Given her low Body Mass Index and increased metabolic demands during chemotherapy, enteral nutrition through Ryle's tube was employed to provide adequate caloric and nutrient support. A semi-elemental formula was used to enhance nutrient absorption and minimize gastrointestinal discomfort, while essential micronutrient supplementation, including omega-3 fatty acids and antioxidants, was provided to mitigate inflammation and oxidative stress associated with cancer and

comorbid conditions. Careful monitoring of electrolyte balance, thyroid hormone levels, and blood pressure was conducted to prevent complications. Despite these challenges, nutritional intervention through Ryle's tube played a critical role in maintaining her nutritional status and enhancing treatment tolerance during chemotherapy.

Advancements in Tube Feeding Techniques:

1. India underutilizes tube feeding procedures, which are essential for cancer patients who are unable to take meals orally. High expenses, a shortage of skilled workers, anxiety about problems, and little awareness particularly in rural areas are the primary obstacles.
2. The lack of government-funded, individualized nursing care for critically sick patients in India, in contrast to other nations, results in poor management and elevated risks.
3. Economic constraints limit access to advanced tube feeding options for cancer patients. Family members or caregivers are often responsible for managing feeding, adding to the burden and risk of complications.
4. Cost-Effective Techniques for India: Simple, affordable methods like Percutaneous Endoscopic Gastrostomy (PEG) with gravity feeding, Low-Profile Balloon Gastrostomy (Mic-Key Button), and Naso jejunal Tube (NJT) can be useful for providing nutritional support.
   Patients who are incapable of eating orally can get long-term enteral nourishment through the use of Percutaneous Endoscopic Gastrostomy (PEG) with gravity feeding. This method uses endoscopic guidance to introduce a feeding tube straight through the abdominal wall into the stomach. With gravity feeding, the nutritious formula is given without the assistance of a pump; instead, gravity causes the formula to naturally flow into the stomach. This approach lowers equipment costs and streamlines the feeding process. the cost-effectiveness and safety of replacing gastrostomy feeding tubes (GFTs) at home, with no negative side effects documented results that imply for patients who need long-term enteral nutrition, GFT replacement is a safe and affordable substitute for PEG (Cominardi *et al*., 2021).
   The MIC-KEY Low-Profile Gastrostomy Feeding Tube is intended for long-term enteral feeding in patients who cannot tolerate oral intake. It can be inserted percutaneously using fluoroscopic, laparoscopic, or endoscopic guidance or used as a replacement through an established stoma tract (Makker *et al*., 2023). Despite its advantages, including improved comfort, reduced risk of accidental dislodgement, and easier replacement by the patient or caregiver without medical intervention, the MIC-KEY button has higher annual maintenance costs compared to traditional PEG tubes. More work is needed to improve its cost-effectiveness and availability.
5. Research is still being held on antimicrobial coatings for enteral feeding tubes to lower infection risk (Wang *et al*., 2022).
6. Research into biodegradable enteral feeding tubes should be encouraged, as they decompose naturally within the body, reducing the need for removal and minimizing patient discomfort and risks.
7. Need for Specialized Training and Certification: Currently, India does not offer specialized certification programs solely focused on tube feeding techniques. Existing nursing and clinical nutrition programs touch on tube feeding but do not offer in-depth, hands-on training specifically focused on feeding tube management.

Nutritional Supplements and Food Therapy

It is impossible to overstate the significance of nutritional supplements in meeting the nutritional requirements of cancer patients. Challenges in Implementing Nutritional Support in Cancer Care in India, while most multispecialty hospitals and tertiary care centers employ qualified dietitians and nutritionists, smaller hospitals, district health centers, and rural healthcare facilities often lack access to specialized nutrition services. This gap results in inadequate nutritional counselling and management, particularly for cancer patients in underserved areas. Strengthening dietetic services in these settings and ensuring the integration of medical nutrition therapy in cancer care protocols is essential to improve outcomes. Patients may benefit from specialized supplements and food therapy tailored to their condition, dietary preferences (such as vegetarianism), and nutritional requirements, in addition to tube feeding formulas. Post-surgical gastric cancer patients frequently experience malnutrition, which is frequently exacerbated by gastrointestinal issues and reduced food intake. A randomized clinical trial highlights the importance of combining post-discharge oral nutritional supplements (ONS) with dietary advice to address these issues. The study found that patients who received ONS lost significantly less weight, maintained their body mass index (BMI) and skeletal muscle index (SMI), and had a lower risk of sarcopenia than those who received dietary advice alone. Additionally, patients in the oral nutritional supplement (ONS) group showed improved tolerance to chemotherapy, with fewer instances of treatment delaying, reduction, or discontinuation.

Although the 90-day readmission rate was comparable between groups, patients who received ONS reported significant improvements in quality of life, such as decreased fatigue and appetite loss. These findings emphasize the importance of oral nutritional supplements (ONS) in postoperative nutritional management for cancer patients and the need for broader implementation, particularly in settings where such strategies are not yet widely used (Meng *et al*., 2021). Nutrition plays a significant role in the treatment of cancer, particularly in countries with low and middle incomes. It emphasizes the value of homemade liquid diets tailored to individual needs, which are significantly less expensive than commercial nutritional supplements while providing comparable caloric and protein content. Individual dietary preferences and medical conditions can be tailored to individual homemade recipes using locally available, low-cost ingredients, thereby increasing patient compliance (Elfadil *et al*., 2024) Furthermore, maintaining adequate nutrition is critical for improving treatment tolerance, lowering morbidity, and improving overall outcomes, particularly for cancer patients who are on liquid diets due to treatment complications. The significance of including dieticians on the cancer care team to guarantee that patients receive nutritional support that is cost-effective, palatable, and acceptable in addition to their medical treatments. In conclusion, the findings support cost-effective, patient-centered nutritional interventions (Kalbande *et al*., 2023)

Vegetarian-Friendly Nutritional Supplements: Vegetarian cancer patients, especially those with complications like cricopharyngeal cancer or breast cancer with diabetes, may have difficulty obtaining enough protein and other nutrients from plant-based sources. Therefore, it is critical to provide them with vegetarian-friendly tube feeding formulas and supplements.

High-Protein Plant-Based Formulas: These formulas are intended to meet the nutritional requirements of cancer patients while maintaining vegetarian dietary preferences.

They are typically made from soy protein, pea protein, or other plant-based protein sources. Examples include: Peptamen AF: A pea protein-rich, high-calorie formula that promotes tissue repair and immune

function. Ensure Plus Protein is a soy protein-based supplement that contains essential amino acids and promotes muscle maintenance.

Omega-3 Fatty Acids: Omega-3 fatty acids have anti-inflammatory properties and have been shown to improve muscle mass and reduce cachexia in cancer patients. Supplements such as Omega-3 enriched Enteral Formulas (e.g., Oxepa) are beneficial for cancer patients undergoing chemotherapy or radiation therapy.

Micronutrient-Rich Blends: Micronutrient deficiencies are common in cancer patients, especially those with malabsorption issues. Vitamin and mineral-rich formulas like Ensure Plus with Fiber can help meet these requirements. Nutritional Considerations for Specific Cancer Types:

Cricopharyngeal Cancer: Due to difficulty in swallowing, patients often require high-calorie, high-protein liquid supplements. Vegetarian foods that are dense in nutrients, soft, and simple to swallow, such as lentils, tofu, protein shakes made with soy, can be used. Breast Cancer with Diabetes: Managing blood sugar levels in breast cancer patients with diabetes is crucial. Low-glycemic, high-protein supplements, such as Ensure Diabetes Care, can help manage blood glucose levels while providing adequate nutrition. In addition, high-fiber supplements can support both blood sugar control and digestive health.

Stomach cancer and kidney failure necessitate low-sodium, low-potassium, and low-phosphorus enteral formulations for kidney function management. For these patients, plant-based protein sources like pea protein are ideal because they don't put too much stress on the kidneys. Protein consumption may be restricted to 0.6–0.8 g/kg/day, depending on the degree of kidney disease, unless the patient is receiving dialysis, in which case higher amounts may be required. Fluid balance and electrolytes: In order to control blood pressure and fluid retention, sodium consumption should be limited to less than 2,300 mg per day. Limiting consumption of foods high in potassium, such as sweet lime and ragi, can help avoid hyperkalaemia. To avoid mineral imbalances, phosphorus-rich foods like dairy and nuts should also be limited. Depending on dialysis status and kidney function, fluid consumption may need to be limited (Rovin et al.,2021).

Cervical Cancer with Asthma: Moong Dal (Yellow Lentil) Soup is high in protein, iron, and easy to digest. Rice and Dal Porridge (Khichdi), Balanced in carbohydrates and proteins, Ragi (Finger Millet) Porridge, Sweet Potato and Carrot Mash/Soup, Masoor Dal (Red Lentil) Soup- High in protein and iron, supporting tissue repair, Steamed and Mashed Bottle Gourd or Pumpkin- Low in allergens and high in fiber. Protein: To avoid muscle loss, people with stomach cancer frequently need to consume more protein (1.2–1.5 g/kg/day). On the other hand, too much protein can deteriorate kidney function in renal failure. Increase Intake of Fruits and Vegetables: dietary antioxidants, such as vitamins A, C, D, and E, play a crucial role in cervical cancer prevention (Hasanzadeh *et al*., 2023). Adhering to a Mediterranean diet, which is high in fruits, vegetables, whole grains, and healthy fats, can reduce the risk of cervical cancer by 60% (Meneses-Urrea *et al*., 2023).

Endometrium cancer with hypertension and hypothyroidism: Foxtail Millet (*Setaria italica*) and Moong Dal Porridge, rich in fiber, antioxidants, and iron. Barley (*Hordeum vulgare*) and Lentil Soup is high in soluble fiber, which helps manage blood pressure. Papaya and Coconut Milk Smoothie is loaded with beta-carotene, antioxidants, and healthy fats. Drumstick Leaves and Bottle Gourd Soup, Mashed Cauliflower and Sweet Potato Puree, Roasted Bengal Gram Flour Shake with Coconut Milk is high in protein, fiber, and essential minerals. It also provides sustained energy and prevents muscle loss. These Foods are ideal for recovery as they are high-protein and antioxidant-rich: Prevents muscle wasting and

supports tissue repair. low-glycemic and heart-healthy: manages hypertension and thyroid function. easily digestible, Suitable for smooth and lump-free tube feeds.

Also, homemade liquid drinks from Panivaragu (Proso millet) (*Panicum miliaceum*) a cereal, rich in complex carbohydrates, fiber, iron, and B vitamins, providing sustained energy and essential nutrients. With 12.5 g of protein per 100 g, Proso millet surpasses most other cereals, including Ragi and Jowar, making it ideal for boosting protein intake in cancer patients or individuals requiring high-protein diets. It releases glucose slowly, making it suitable for managing blood sugar, which is beneficial in cancer patients with diabetes or steroid-induced hyperglycemia. Safe for patients with gluten intolerance or celiac disease, and it's gentle on the digestive system, especially when blended for tube feeding. Herbal Decoction cost-effective herbal infusions using ingredients like ginger, turmeric, tulsi, and moringa can serve as potent antioxidant and anti-inflammatory supplements. These can help boost immunity and reduce treatment-related oxidative stress as they are functional foods.

Symptoms Management

Addressing treatment-related symptoms can improve nutritional intake:

a) Nausea and Vomiting: Can include low-fat, starchy foods like rice, white toast, and crackers, which may be less likely to induce nausea.
b) Dry Mouth: Maintaining adequate hydration is essential. Encourage sipping fluids throughout the day, but avoid large amounts before meals to prevent early satiety.

Monitoring and Follow-Up: Regular monitoring of weight, laboratory values, and swallowing function is necessary to adjust the dietary plan as needed. Collaboration with a multidisciplinary team, including speech therapists and oncologists, ensures comprehensive care. Implementing these dietary strategies can help manage the nutritional challenges associated with cancer, supporting overall health and treatment efficacy.

Benefits and Impact on Cancer Treatment

1. Tube feeding and nutritional supplementation are essential for improving treatment tolerance, preventing malnutrition, and enhancing recovery outcomes in cancer patients.
2. Improved Nutritional Status: Enteral nutrition ensures that patients receive adequate nutrients, preventing weight loss and muscle wasting, which are common in cancer patients.
3. Better Tolerance of Treatments: Patients with cancer who eat well are better able to handle treatments like chemotherapy, radiation, and surgery. It also supports immune function, improving the body's ability to fight infections and respond to cancer therapies.
4. Support for Organ Function: For patients with complications such as renal failure, nutrition plays a critical role in supporting organ function and managing complications. Tailored supplements help prevent electrolyte imbalances and support kidney health.

Challenges and Considerations

While tube feeding and nutritional supplements offer significant benefits, several challenges must be addressed:

1. Compliance and Acceptance: Some patients may resist tube feeding due to emotional or physical discomfort. Ensuring that the feeding process is as comfortable as possible is key to improving adherence.

2. Cost and Accessibility: Specialized formulas and supplements can be expensive, limiting accessibility for some patients. Improving access necessitates locating low-cost options that satisfy nutritional requirements.
3. Hospital menus in many institutions, both government and private, often lack sufficient energy and protein, with meals that suffer from poor consistency and overall nutritive value. This leads to low patient acceptance and significant food wastage. A dedicated registered dietician should be assigned to regularly evaluate and enhance meal quality, ensuring that the foods provided are both nutrient-dense and well-prepared, thereby supporting patient recovery and minimizing waste.
4. In addition, hospital canteens must eliminate junk and non-nutritious food options to prevent patients from choosing unhealthy alternatives. By mandating the provision of only wholesome, nutrient-rich meals, hospitals can improve patient outcomes and foster a healthier recovery environment while also reducing overall food wastage.

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