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Original Communications

Long-Term Enteral Nutrition Facilitates Optimization of Body Weight

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ABSTRACT. *Background:* Optimization of body mass index (BMI) among cancer survivors is a priority. Long-term enteral nutrition is required by many head and neck cancer survivors and may be utilized to affect changes in BMI. *Methods:* We used a retrospective review of head and neck cancer survivors dependent on enteral nutrition. Patients were grouped according to their BMI at initiation of enteral feeding. Patients with normal, low, or elevated BMI were assigned a goal of weight maintenance, weight gain, or weight reduction, respectively. Changes in BMI over time were recorded. *Results:* We identified 39 head and neck cancer survivors requiring enteral nutrition. Median time on enteral nutrition was 32 ± 39.6 months. At the initiation of enteral feeding, 51% of patients had a normal BMI and were assigned to the weight maintenance group, 84% successfully maintained a normal BMI (mean 22.4 ± 1.7 kg/m^2), and 18% had a low BMI and were assigned to the weight gain group. In all, 85% achieved or trended toward a normal BMI (from 16.5 ± 1.9 to 19.2 ± 1.6 kg/m^2; $p = .02$). When enteral feedings began, 31% of patients had an elevated BMI and were assigned a goal of weight reduction; all were able to reduce their BMI (from 30.2 ± 5 to 27.3 ± 6 kg/m^2; $p < .001$). *Conclusions:* Long-term enteral feeding facilitates body weight optimization among ambulatory head and neck cancer survivors. These findings may potentially be generalized to all ambulatory patients who are dependent on enteral nutrition. (*Journal of Parenteral and Enteral Nutrition* **29:**198–203, 2005)

Body mass index (BMI; weight in kilograms divided by height in meters squared) is one of the best general measures of nutrition status. A normal BMI falls between 19.0 and 24.9 kg/m^2.[1] A BMI outside of the normal range is associated with increased morbidity and mortality.[2,3] An elevated BMI is a risk factor for diabetes mellitus, hypertension, cardiovascular disease, stroke, hypercholesterolemia, liver disease, arthritis, and several cancers.[4,5] A low BMI is associated with increased mortality when associated with cancer or infection.[6–8] Normalization of body weight is an effective way to reduce this mortality.[9,10] This is especially true for cancer survivors. In fact, recent reports from the National Cancer Institute and the American Cancer Society suggest that achieving a healthy body weight should be a priority for long-term cancer survivors.[11,12]

Traditionally, nutrition support for cancer patients has focused on helping them gain weight. However, an increasing number of cancer patients and cancer survivors are overweight or obese and would not benefit from additional weight gain. Instead, for these patients the goal of nutrition support should be to optimize BMI. Therefore, at Memorial Sloan-Kettering, we have developed a systematic approach to providing nutrition support in a way that optimizes the body weight of each individual cancer patient and survivor.

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Cancer of the head and neck with an annual incidence of over 41,000 cases in the United States is the most common underlying malignancy in patients on home enteral feedings.[13,14] The most common nutrition-related problem resulting from head and neck cancer and its therapy is dysphagia.[15] In some patients, dysphagia may persist long after eradication of the underlying cancer. Permanent enteral nutrition is then required to provide adequate nutrition and hydration. It is estimated that 10% of long-term head and neck cancer survivors require permanent enteral nutrition.[16]

These patients, who have been cured of their underlying cancer but are left with chronic dysphagia and dependence on enteral nutrition, are an ideal population to study. They are long-term survivors, are generally stable, have an otherwise normal gastrointestinal tract, and remain active. Therefore, they can serve as a model for the effect of long-term home enteral nutrition in ambulatory patients.

Enteral nutrition is a safe and effective method for providing nutrition.[17–19] However, the effect of prolonged enteral nutrition on BMI has not been well studied. This report describes the ability of long-term enteral nutrition to facilitate body weight optimization among head and neck cancer survivors.

MATERIALS AND METHODS

All patients on enteral nutrition at Memorial-Sloan Kettering Cancer Center are followed by a specialized multidisciplinary nutrition support team. Patients who have been cured of their head and neck cancer but

remained dependent on enteral nutrition for more than 1 year due to persistent dysphagia were identified.

Patients who met the following inclusion criteria were included in this study: over 18 years of age; history of head or neck cancer without evidence of disease; and dependence on enteral nutrition support for at least 1 year.

Complete medical records were searched for the following data: dates of all enteral tube placements; types of enteral tubes placed; total number of tubes; duration of enteral feeding; total enteral calories infused; total oral calories; complications related to enteral feeding or enteral access; body weight at initiation of enteral feeding; most recent body weight; height; age; sex; type of primary cancer; date of primary diagnosis; and comorbidities.

Nutrition goals were defined for each patient at the beginning of enteral feeding based on nutrition status and BMI. Patients were categorized under 1 of the following 3 goals: *weight maintenance* for patients who presented with a normal BMI (19.0–24.9kg/m^2); *weight gain* for patients who presented with a BMI classified as underweight (<19.0kg/m^2); and *gradual weight reduction* for patients who had a BMI classified as overweight or obese (>25.0kg/m^2). For each group, mean BMI at initiation of tube feeding was compared with current BMI. Comparisons were made using a paired-samples *t* test.

This study was conducted in compliance with the policies of the Institutional Review Board of Memorial-Sloan Kettering Cancer Center.

RESULTS

Data from 39 patients were included in this study. Table I describes patient characteristics and BMI at the initiation of enteral feeding. The mean BMI for all patients when enteral feeding began was 23.4 kg/m^2; their mean current BMI is 22.7 kg/m^2.

Of the 39 total patients, 33 patients (85%) maintained, achieved, or trended toward a normal BMI while on enteral feeding. These patients used enteral feeding for a median time of 36 ± 41 months. In all, 37 patients had percutaneous endoscopic gastrostomy tubes and 2 had direct percutaneous endoscopic jejunostomy tubes. On average, these patients infused 1892 calories through their feeding tube with a range of 750–3250 calories per day. They also took an average of 339 calories by mouth with a range of 0–1000 calories. The average total caloric intake was 2231 calories per day.

Patients with Weight Maintenance Goal

In this group, 20 patients were in the normal BMI range (19.0–24.9 kg/m^2) when enteral feeding began, and had a weight maintenance goal. Before enteral feeding began, the median weight loss from their usual adult weight was 6.5 ± 4 kg. Of these patients, 17 (84%) maintained their weight within the normal BMI range while on enteral feeds (Fig. 1). At initiation of enteral feeding, their mean BMI was 22.3 ± 1.6 kg/m^2; their current BMI is 22.4 ± 1.7 kg/m^2. The difference in BMI at tube feed initiation, when compared with the current BMI, is not statistically significant ($p = .46$). Their median time on enteral nutrition was 38 ± 42 months. These patients took an average of 2312 ± 564 calories, with 1989 ± 641 from enteral feeding and 323 ± 340 by mouth. The average daily caloric intake for this group was 35 ± 6 kcal/kg (Table II).

Three patients (16%) in the weight maintenance group became underweight while on enteral feeding.

TABLE I
Subject characteristics

	Total	BMI at TF initiation		
		Normal	Underweight	Overweight/obese
n	39	20	7	12
Sex				
Male	22	14	3	5
Female	17	6	4	7
Age (years)	65 (44–79)	65 (49–79)	65 (52–74)	66 (44–75)
Years since cancer diagnosis	6.9 (1.2–25)	6.6 (1.2–11.5)	12.8 (2.8–25)	4.1 (1.2–13)
Median months on enteral feeding (SD)	32 (40)	36 (41)	45 (34)	27 (44)
Subjects with PEG	37	19	6	12
Subjects with PEJ	2	1	1	0
Number of feeding tubes	2.8 (1–13)	2.5 (1–13)	3.4 (1–6)	3.1 (1–10)
Tube feed duration (months)	47.5 (13–146)	46.8 (13–146)	52.1 (16–95)	45.8 (13–138)
Total calories	2231 (1250–3500)	2382 (1250–3500)	2235 (1750–3000)	1976 (1500–2400)
TF calories	1892 (750–3250)	2082 (750–3250)	1700 (1250–2500)	1684 (900–2000)
Calories by mouth	339 (0–1000)	300 (0–1000)	535 (0–1000)	292 (0–1000)
Pre-illness body weight (kg)	72.5 (41–137)	70.1 (50–86.4)	57 (41–74)	85.5 (62–137)
Height (cm)	168 (152–188)	171 (156–185)	168 (152–188)	163 (154–177)
Weight at start of TF (kg)	66.2 (39–137)	64.5 (50–81.5)	46.6 (39–61.2)	80.4 (60–137)
BMI at TF start (kg/M^2)	23.4 (12.7–43.7)	22.1 (19.2–24.9)	16.4 (12.7–18.3)	29.8 (25.1–43.7)
Current BMI	22.7 (15.4–43.4)	21.8 (18.1–24.9)	18.7 (15.4–21.6)	26.4 (16.3–43.4)
KPS at TF start	76 (60–90)	81 (70–90)	77 (60–80)	74 (60–90)
Current KPS	86 (70–100)	86 (70–100)	94 (80–100)	81 (70–90)

BMI, body mass index; KPS, Karnofsky performance scale; PEG, percutaneous endoscopic gastronomy tube; PEJ, percutaneous jejunostomy tube; TF, tube feeding.
Data are presented as mean (range) except where noted.

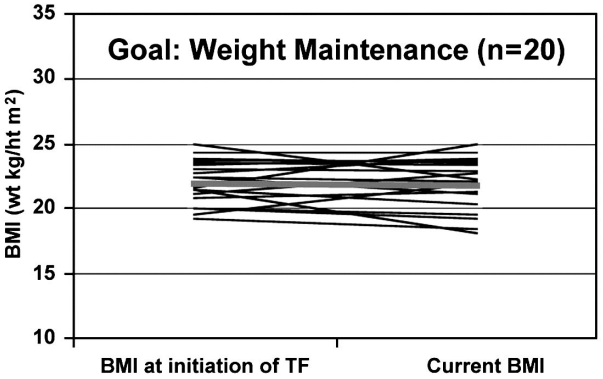

FIG. 1. Changes in BMI over time among patients with a nutrition goal of weight maintenance. Thick line, mean change for the group. TF, tube feeding.

Their BMIs at the initiation of feeding were 21.6, 21.4, and 19.2 kg/m^2; they dropped to current BMIs of 18.7, 18.1, and 18.4 kg/m^2, respectively. Their time on enteral nutrition was 25, 15, and 15 months, respectively. These patients were prescribed an average of 2613 ± 537 calories from enteral feedings. Two patients were also taking minimal calories orally (Table II).

The patient with a current BMI of 18.7 kg/m^2 began enteral feeding at 57 kg. This patient lost weight after chemoradiation treatment due to a premature attempt to transition from enteral to oral nutrition. During this trial of oral intake, the patient lost weight and reached a low weight of 48.7 kg. Resumption of enteral feedings led to prompt regain of weight. The patient with a BMI of 18.1 kg/m^2 lost 10 kg in the first month after feeding tube placement because of reluctance to use the feeding tube and noncompliance. The patient with a BMI of 18.4 kg/m^2 has likely become underweight due to a course complicated by severe chronic obstructive pulmonary disease and multiple hospital admissions for respiratory distress.

Patients with Weight Gain Goal

Seven patients were underweight (BMI <19.0kg/m^2) at the initiation of enteral feeding and had a weight gain goal. At initiation of enteral feedings, they had already lost an average of 10.4 kg. Six of these patients (85%) trended toward or achieved a normal BMI while on enteral feeds (Fig. 2). Their median time on enteral nutrition was 59 ± 35 months. The average weight gain for this group was 8.4 kg (range, 3.3–15.1 kg). Of these 7 patients, 4 gained enough weight to reach a normal BMI while on enteral feeding. Two patients gained some weight but still remained underweight.

At the initiation of enteral feeding, the mean BMI for patients who needed to gain weight and did so successfully was 16.5 ± 1.9 kg/m^2; their current mean BMI is 19.2 ± 1.6 kg/m^2. The difference in BMI at tube feed initiation compared with the current BMI is statistically significant ($p < .02$). On average, these patients took in 2317 ± 443 calories, with 1775 ± 473 from enteral feedings and 542 ± 292 by mouth. The average caloric intake for this group was 44 ± 4 kcal/kg (Table II).

The patient who continued to lose weight was noncompliant and did not infuse the complete prescribed formula.

Patients with Gradual Weight Loss Goal

Twelve patients had a weight loss goal and were classified as overweight or obese (BMI >25.0kg/m^2) when enteral feeding began; all of them were able to reduce their BMI during enteral feedings. Most patients trended toward a normal BMI but remained overweight or obese (Fig. 3). The average weight loss for this group was 9.0 kg (range, 0.3–21.4 kg) over a median of 27 ± 44 months.

Of the 12 patients in this group, eight were classified as overweight (BMI, 25.0–29.9 kg/m^2) and 4 were obese (BMI >30.0 kg/m^2). For the purposes of this study, all patients with a BMI >25.0 kg/m^2 were categorized together. Three patients (25%) with a weight loss goal gradually lost enough weight to achieve a normal BMI. Eight patients (67%) had some weight reduction but still remained overweight, and 1 patient lost too much weight and became underweight.

At initiation of enteral feeding, the mean BMI for patients who needed to lose weight and did so successfully was 30.2 ± 5.2 kg/m^2; their mean current BMI is 27.3 ± 6.1 kg/m^2. The difference in BMI at tube feed initiation compared with the current BMI is statistically significant ($p < .001$). On average, patients who successfully reduced their weight took in 1996 ± 349 total calories, with 1746 ± 335 calories from enteral feeds and 250 ± 371 calories by mouth. The average

TABLE 2
Mean BMI and caloric intakes based on nutrition goals and outcome

	n	Mean BMI at TF Start	Mean current BMI	Mean kcals/kg^2	Mean total kcals	Mean TF kcals	Mean PO calories	Median TF Duration
Weight maintenance								
Maintained normal BMI	17	22.3	22.4	35	2312	1989	323	38
Became underweight	3	20.7	18.4	54	2780	2613	167	20
Weight gain								
Trended toward normal BMI	6	16.45	19.2	41	2317	1775	542	59
Became underweight	1	16.4	15.4	46	1750	1250	500	26
Weight loss								
Trended toward normal BMI	11	30.22	27.3	28	1996	1746	250	27
Became underweight	1	25.3	16.3	45	1750	1000	750	32

BMI, body mass index; TF, tube feeding.
Mean kcals/kg calculated from current kcal intake and current body weight. Median tube feed duration in months through March 2004.

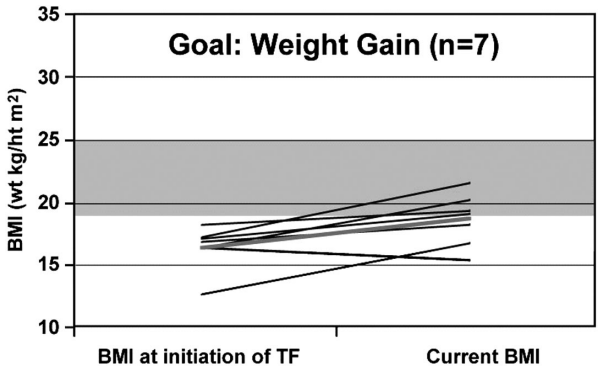

FIG. 2. Changes in BMI over time among patients with a nutrition goal of weight gain. Thick line, mean change for the group.

caloric intake for this group was 28 ± 7 kcal/kg (Table II).

The patient who began enteral feeding overweight, but became underweight, went from a BMI of 25.3 kg/m^2 to 16.3 kg/m^2 while prescribed an average of 1750 total calories (1000 from enteral feeding and 750 by mouth; Table II). This patient maintained a BMI of 18.1 kg/m^2 for at least a year, but recently lost 5 kg and dropped to a BMI of 16.3 kg/m^2. The patient was trying to transition from a predominantly enteral diet to a predominantly oral diet. Her preference is oral nutrition rather than enteral; however, her oral intake has been continuously hindered by dysphagia and thick mucosal secretions.

Complications

Enteral nutrition was generally well tolerated by all patients in the study. On average, each patient required 3 feeding tubes (range, 1–13). Tubes were replaced approximately every 17 months. The majority of feeding tubes were changed because of the patient's desire to convert to low-profile devices (n = 26) or because of tube deterioration. In all, 20% of patients experienced mild leakage at the tube site, 20% had infections near the tube site that required antibiotics, and 5% had embedded bumpers that required tube changes. It is interesting to note that the 2 patients with embedded bumpers both gained weight (56 kg to 59.5 kg and 61 kg to 76.3 kg). This weight gain may have contributed to the embedded bumper if the external bolster was not loosened sufficiently. Fifteen percent of patients experienced constipation or diarrhea, likely related to enteral feeding. There were also limited reports of mild, clinically insignificant metabolic complications, such as hypo- or hyperglycemia and hypo- or hypernatremia; it is difficult to determine how many of these episodes were caused by enteral nutrition. All complications were of minor significance and none resulted in a clinical complication or required hospitalization.

DISCUSSION

This study demonstrates that by setting appropriate goals, long-term enteral feedings can be used to optimize body weight and therefore possibly reduce the morbidity associated with being underweight, overweight, or obese. Underweight patients who began enteral feeding gained weight, patients of normal weight maintained their weight, and overweight patients gradually lost weight. In all, 85% of patients achieved the nutrition goal of either maintaining a normal BMI, trending toward a normal BMI, or achieving a normal BMI. For the subgroup of patients with a gradual weight reduction goal, 100% achieved or trended toward a normal BMI.

We found that most patients needed approximately 2000 calories per day to maintain their body weight. This is consistent with the Estimated Energy Requirements recommended by the Institute of Medicine.[20] Even patients with a weight loss goal received a median of 1875 ± 340 calories. The amounts of standard enteral formula needed to provide this caloric intake also contained adequate protein, vitamins, minerals, and trace elements. Enteral feeding was well tolerated and complications related to enteral nutrition or enteral access were minimal.

Dysphagia caused by cancer or anticancer therapies may persist long after the eradication of underlying malignancy. In this setting, enteral nutrition can be lifesaving and is often required for extended periods of time. The exact number of patients currently receiving home enteral nutrition is difficult to determine, but the most recent survey demonstrates that Medicare pays home enteral nutrition for more than 73,000 patients at a cost exceeding $137 million annually.[21] Cancer is the most common indication for home enteral nutrition, accounting for more than 40% of patients.[22] Outcome in these patients is dependent on the underlying cancer; however, a significant percentage do well. This is particularly true if the underlying cancer can be eradicated or controlled. A review of the North American Registry showed 36% of all cancer patients on home enteral nutrition were alive after 1 year.[21]

Among cancer survivors, chronic dysphagia is most frequently encountered in patients who have completed therapy for cancer of the head or neck.[14] In a series from the M.D. Anderson Cancer Center, dysphagia was reported in 63% of a cohort of head and neck cancer survivors.[15] Ten percent of long-term head and neck cancer survivors require permanent enteral nutrition.[16]

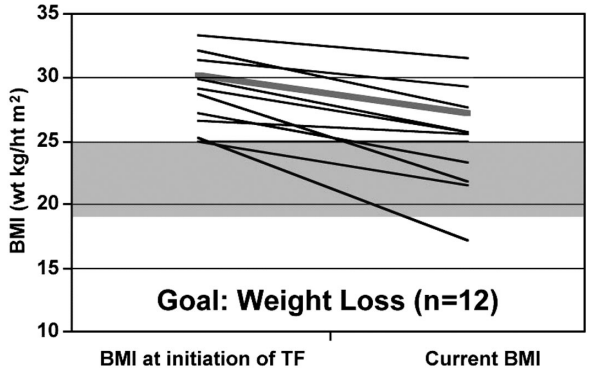

FIG. 3. Changes in BMI over time among patients with a nutrition goal of weight loss. Thick line, mean change for the group.

Maintaining general health after cancer eradication is critical. There are approximately 9.5 million cancer survivors in the United States, making this an area of extreme importance.[23] An increasing number of studies suggest that health maintenance needs for cancer survivors may be different than those of the general population.[24] According to a report from the National Cancer Institute, many cancer survivors are at risk for developing late and long-term effects of cancer and cancer treatments, which could lead to premature morbidity and mortality.[11] Similarly, a report from the American Cancer Society highlights the importance of lifestyle factors, including optimizing body weight, in order to reduce this risk of adverse cancer sequelae.[12] In fact, this report emphasizes that achieving a healthy body weight should be a priority for long-term cancer survivors.

Optimal BMI for adults is defined as 19.0–25.0 kg/m^2.[1] BMIs outside of the optimal range are associated with increased mortality. In a 1979 landmark report, the observed relationship between BMI and mortality was described as a J-shaped curve.[2] Other studies have confirmed this relationship and have shown that the lowest all-cause mortality rate was found for BMIs of 23.5–24.9 kg/m^2 in men and 22.0–23.4 kg/m^2 in women.[25–27] Being underweight poses an increased risk of morbidity and mortality from infections and cancer,[28–31] whereas being overweight or obese significantly increases the risk for cardiovascular disease, cancer, and diabetes.[32–34]

Even though obesity trends in long-term cancer survivors are still unclear, it is reasonable to speculate that they parallel trends of the general population. In 2000, 64% of American adults were overweight or obese with a BMI >25 kg/m^2; 30% of these adults were obese with a BMI >30 kg/m^2.[4] This is especially concerning for cancer survivors, because a prospective study of 900,000 men and women found that being overweight or obese was clearly associated with the risk of death for all cancers, and for cancers at many specific sites.[5] Studies on lymphoma, breast, and testicular cancer survivors have found individuals who are overweight or gain weight after treatment have a greater risk for cancer recurrence, secondary cancers, and death than individuals who maintain or achieve a healthy weight.[35–39] The American Cancer Society report supports this association and states there are convincing data linking obesity to many types of cancer recurrence.[12]

This is the first study of its kind to report on the ability of enteral nutrition to optimize body weight. It offers a unique opportunity to examine the effect of long-term calorie control on BMI. Because most patients had minimal (if any) oral intake, we were able to evaluate the effects of changes in caloric intake on BMI.

The primary study limitation is its retrospective analysis. Introduction of error could have occurred at various points. For example, much of the analysis was based on prescribed calories and not actual intake. We do, however, believe there was a high correlation between prescribed and actual calories even though objective measures were not available. Similarly, body weights were obtained at clinical visits, but because follow up was dictated by clinical care we did not have weights at set intervals for all patients. However, all patients were closely followed in a nutrition clinic specifically designed to optimize their nutrition management.

In conclusion, these results offer a preliminary view of the ability for long-term enteral nutrition to successfully optimize body weight in a group of cancer survivors. The results of this study warrant further investigation. Future studies should include prospective analyses of patients on long-term enteral nutrition related to the adequacy of nutrition status, including evaluation of trace elements, vitamins, and minerals; bone mineral density; and quality of life. Further studies on body weight optimization should also evaluate changes in the comorbidities associated with obesity, including diabetes, hypertension, and secondary cancers.

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