The value of nutritional assessment in major abdominal surgery
Haverkort, E.B.

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Chapter 7

Suboptimal intake of nutrients after esophagectomy with gastric tube reconstruction

E.B. Haverkort
J.M. Binnekade
R.J. de Haan
O.R.C. Busch
M.I. van Berge Henegouwen
D.J. Gouma

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Abstract

Esophagectomy with gastric tube reconstruction results in a variety of postoperative nutrition-related complaints that may impair nutritional intake and nutritional status. The aim of this study was to determine to what extent patients reached the recommended intake of various nutrients at six and twelve months after esophagectomy. It was also analyzed whether a suboptimal intake could be explained by the most clinically significant nutrition related complaints after esophagectomy. In a prospective cohort study (2002-2006), the nutrient intake of 96 patients, recorded in preprinted nutritional diaries, was compared with the recommended energy intake in The Netherlands and Recommended Daily Allowance of protein and micronutrients. Energy and protein intake remained below recommendations in 24% and 7% of the patients, respectively. Less than 10% of the patients had a sufficient intake of all micronutrients. Folic acid, vitamin D, copper, calcium and vitamin B-1 were the micronutrients most often reported to have a suboptimal intake. Multivariate logistic regression, corrected for preoperative epigastrical pain and energy intake, showed that the number of nutrition-related complaints was not an independent risk factor for the presence of a suboptimal intake of nutrients (adjusted odds ratio = 1.11; 95% CI 0.94 to 1.31; \( P = 0.22 \)). This study shows that the intake of micronutrients remains below recommendations in the majority of patients twelve months after esophagectomy. This problem requires special attention and care by dietitians.

Key words
Nutrition; Esophagectomy; Nutrients; Vitamins; Minerals.
Introduction

In patients who undergo a resection of the esophagus or cardia (esophagectomy), the preferred reconstruction is a gastric tube. This procedure results in severe changes in the gastrointestinal anatomy (eg, the cardia is resected and the remaining part of the esophagus is reconnected to the stomach) and results in nutrition-related complaints such as early satiety, postprandial dumping syndrome, dysphagia, reflux, absence of hunger, altered stool frequency and fluctuations in body weight. A previous study indicated that these are persistent complaints. In contrast to findings reported in the literature, at twelve months postoperative, the majority of patients in this study still experienced nutrition-related complaints. These complaints can result in a persistently different or adapted nutritional intake, which can negatively influence patients’ nutritional status and, in turn, their recovery.

No studies have yet determined whether the altered anatomy actually affects nutrient intake after an esophagectomy. During nutrition-related follow-up, registered dietitians and surgeons focus mainly on counseling to maintain body weight. It was previously shown that approximately three quarters of the patients had lost weight – six kg on average – at discharge from the hospital, relative to their preoperative body weight. However, bodyweight by itself does not give any information about adequate intake of proteins and/or micronutrients (ie, vitamins, minerals and trace-elements). Watanabe and colleagues assumed that adequate protein intake also implied adequate micronutrient intake. However, no studies are available on either protein intake or micronutrient intake after esophagectomy, so this assumption could be erroneous.

Nutrient deficiencies result in a broad range of physical and psychological symptoms. It has been demonstrated that a long-term suboptimal intake negatively affects bodyweight, nutritional status, and quality of life. Symptoms of nutrient deficiency may not be evident to registered dietitians, surgeons and other caregivers.

If it can be determined to what extent the nutrient intake of esophagectomy patients does not meet the recommendations as defined by the Health Council of the Netherlands (described in Figure 1, item Definition of malnutrition), then a protocol can be drafted to improve postoperative nutritional care, ultimately resulting in improved recovery. In the present study, the following questions were therefore addressed: Do patients reach the intake recommendations for nutrients (ie, energy, proteins, micronutrients) at six and twelve months after esophagectomy with gastric tube reconstruction? If an inadequate intake occurs, which nutrients are most frequently suboptimal in the diet? Can nutrition-related complaints explain a serious suboptimal intake of nutrients?

Methods

Setting and patients

A prospective cohort study was conducted at the Academic Medical Center, Amsterdam, The Netherlands (2002-2006). This is a tertiary care university-affiliated hospital with 1,000
beds, specialized in the treatment of gastrointestinal oncological diseases (ie, esophagus, pancreas, bile-tract, liver, and colon).

Consecutive patients 18 years of age and older who underwent an esophagectomy were invited to participate in this study, which was approved by the Institutional Review Board of the hospital. All patients gave their written informed consent.

Exclusion criteria included inability to speak and/or read Dutch, suffering from diabetic-related neuropathy, neurological disease, ulcerative colitis, Crohn or celiac disease, severe postoperative chyle leakage, and proven allergy. Because recurrence of malignant disease can result in loss of appetite, reduced intake, increased nutrition-related complaints and unwanted weight loss, patients with a proven recurrence of the disease were also excluded from further analysis. 1,31

Baseline assessments
Baseline characteristics (ie, age, sex, presence of malignancy, neo-adjuvant treatment), physical status (ie, preoperative body weight, body mass index, comorbidity, preoperative nutritional complaints) and surgery-related characteristics (ie, American Society of Anesthesiologists [ASA] classification defining preoperative fitness, surgical procedure, postoperative complications, and admission duration) were collected from medical and dietetic records.

Prescription of proteins and energy
The postoperative nutritional care protocol is described in detail in Figure 1. To preserve body cell mass, 1.5–1.7 grams of protein/kg/24 hours during the first six months postoperative was prescribed. 32-37 After this period, the protein prescription was reduced to 1.2–1.3 grams/kg/24 hours, because patients were expected to be less catabolic by then. Energy requirements were calculated with the Harris and Benedict equation plus 30% for metabolic stress and activity. 38,39 Stable body weight is important because weight loss >10% implies loss of body cell mass, including muscle mass. 35,36,40-42

Tube feeding and oral foods
All postoperative patients were fed by polymeric tube-feeding during the first week postoperative. At day seven postoperative, if anastomotic leakage was excluded, food was gradually introduced (liquid meals for one day, solid foods thereafter).

If the oral intake was insufficient at discharge, tube-feeding was continued or sip-feeding introduced. Detailed information about modification and discontinuation of tube-feeding and sip-feeding is also shown in Figure 1.

Follow-up after discharge and evaluation of intake
After discharge, patients visited the departments of surgery and dietetics of the outpatient clinic at least once every three months during the entire first postoperative year. At three months postoperative, patients were instructed how to fill out the pre-printed
Table 1. Protocol postoperative nutritional care and procedures in patients after esophagectomy with gastric tube reconstruction

<table>
<thead>
<tr>
<th>Item reference</th>
<th>In general</th>
<th>Care during the study period</th>
<th>Adapted care, introduced after the study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protein, energy and micronutrients prescription</strong>&lt;sup&gt;27-30, 32-39&lt;/sup&gt;</td>
<td>Prescription of proteins ≤ 6 mo postoperative: 1.5 - 1.7 g of protein/kg body weight/24 h. Prescription of proteins &gt; 6 months postoperative: 1.2 – 1.3 g of protein/kg body weight/24 h. In case of overweight or obesity: protein prescription is adapted and calculated based on BMI&lt;sup&gt;a&lt;/sup&gt; = 27. Prescription of energy: Harris and Benedict equation (1984) + 30% (20% disease + 10% activity). RD&lt;sup&gt;b&lt;/sup&gt;: Calculation of protein and energy need.</td>
<td>Prescription of micronutrients: recommendations as defined by the Health Council of the Netherlands. RD: Calculation of the micronutrients needs.</td>
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<tr>
<td><strong>Tube feeding</strong></td>
<td>Surgeon: Surgically placed needle jejunostomy feeding-tube. RD: Calculation of polymeric tube-feeding according to protein and energy need. Nurse: Day 1 postoperative: 40 mL/h, increased with 20 mL/h every 6-8 h until requirements were met. In case of intestinal complaints (eg, cramps, pain, nausea): no increase or temporary decrease of enteral pump for 1-2 h, then continuation according to protocol.</td>
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<td><strong>Introduction of oral foods after surgery</strong></td>
<td>Radiologist and surgeon: Day 7 postoperative evaluation anastomotic leakage by water soluble contrast x-ray; no leakage: introduction of liquid foods. RD: Day 8 postoperative: introduction of solid foods. Protein- and energy-rich advice, 6-8 times/d. At discharge: Oral intake ≤50% prescribed energy and/or protein amount; maintaining tube-feeding. Oral intake &gt;50% - &lt;100% of prescribed energy and/or protein amount: introduction sip-feeding (protein or energy enriched depending on needs).</td>
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<td><strong>Follow-up after discharge</strong></td>
<td>In general: (Combined) visits to the outpatient clinic departments of surgery and dietetics every 3 mo first postoperative year. RD: In case of tube-feeding after discharge: evaluation oral intake and tube-feeding every other week (by telephone). Surgeon: For evaluation of physical recovery and in response to complaints (eg, pain, dysphagia, gastro-intestinal complaints); medical examinations (eg, dilation, CT, MRI) and/or treatment (eg, prescription of medication). Home care nurse (If necessary or desired): assisting patient by administering tube-feeding.</td>
<td>RD: 3 mo postoperative: instruction on how to fill out pre-printed nutritional diary. 6 and 12 months postoperative: evaluation of pre-printed nutritional diary.</td>
<td>RD: Evaluation and calculation of intake (macro and micronutrients), evaluation of body weight (gain or loss), and BMI. Practical advice on macronutrients and micronutrients and postoperative nutrition-related complaints. Surgeon: Information on surgery and postoperative nutrition-related complaints.</td>
</tr>
<tr>
<td>Item, reference</td>
<td>In general</td>
<td>Care during the study period</td>
<td>Adapted care, introduced after the study</td>
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<td><strong>Reduction of enteral nutrition</strong></td>
<td>RD: Modification of tube-feeding in case of increased oral intake. Discontinuation tube-feeding: oral intake of proteins ≥ 75% of prescribed amount; sip-feeding: continued until intake is sufficient after being prescribed in case of inadequate intake or loss of feeding tube (removal/obstruction).</td>
<td>RD: 3 mo postoperative: instruction how to fill out oral intake in nutritional diary. 6 and 12 mo postoperative: diary was sent to patient by mail two weeks in advance. Diaries were filled out at home during 3 d (2 weekdays and 1 weekend day) one week before planned follow-up assessment. Collection and evaluation of diary during visits to outpatient clinic. Attempts to reduce mis-reporting: filled out diary was combined with 24-h recall (foods consumed over the previous 24 hours); food frequency questionnaire (evaluating frequency of foods and amounts consumed over previous month); diary evaluation; showing pictures of servings to patient to help them estimate the amounts eaten; measuring the content of glasses, cups, bowls and mugs by patient at home.</td>
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<tr>
<td><strong>Evaluation of intake by pre-printed nutritional diary</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td><strong>Objective clinical assessment</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>RD: Body weight in kilograms using Seca 888, and height in centimeters (only first visit) using Seca stadiometer 222, without shoes and in light indoor clothing (Seca GMBH).</td>
<td>Measuring body composition (body cell mass) by using bioelectrical impedance analysis.</td>
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<td><strong>Definition of malnutrition</strong>&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Malnutrition was operationalized in accordance with the National Dutch Guideline on Perioperative Nutrition 2007: Involuntary weight loss of ≥5% within 1 month; and/or Involuntary weight loss of ≥10% within 6 months; and/or A BMI &lt;18.5.</td>
<td>RD: 6 mo postoperative: preoperative body weight was used in order to calculate % of weight loss within 6 months. Time point 6 and 12 mo postoperative: patients estimated their weight 1 mo before study assessment in order to calculate % of weight loss within 1 mo.</td>
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</table>

<sup>a</sup> BMI = Body Mass Index, calculated as kg/m<sup>2</sup>; <sup>b</sup> RD = registered dietitian; <sup>c</sup> CT = X-ray Computed Tomography; <sup>d</sup> MRI = Magnetic Resonance Imaging
nutritional diary. At six and twelve months postoperative, patients recorded their intake in these diaries during two weekdays and one weekend day during the week before follow-up assessment.

To optimize correct nutritional reports, the diaries were evaluated during the visits to the outpatient clinic, and pictures of food servings were shown to ensure a more exact estimate of the amounts eaten. In addition, patients were required to undergo a 24-h recall, an interview about their food and beverage consumption during the preceding 24 hours, and had to fill out a food-frequency questionnaire (Figure 1).

**Intake**
The nutritional diaries were imported into a digital program ‘Voeding’ (version 2, release 70, iSoft). The software then calculated the intake of the following nutritional components: energy, proteins, vitamins A, D, E, B-1, B-2, B-3, B-6, B-12, C, folic acid (vitamin B-11), calcium, magnesium, phosphorus, copper, iron, selenium and zinc. An average intake for the three reported days before the follow-up assessment was calculated for each nutrient. Because dietary self-reporting is prone to error, a margin of 10% below the recommendations and RDAs was used to define suboptimal intake.

For example, patients with an intake <90% of calculated energy requirements and <90% of the Recommended Dietary Allowances (RDAs) of protein and micronutrients were considered as patients with a suboptimal intake. If a patient’s intake showed more than four nutrients with inadequate intake (<90%), the patient was considered to have a serious suboptimal intake, placing him at higher risk for nutritional deficiency.

**Self-reported nutrition-related complaints**
In a previous study on nutrition-related complaints after esophagectomy, patients reported early satiety, postprandial dumping syndrome, inhibited passage, reflux and the absence of hunger as the most bothersome complaints. This set of five items was used to assess the number of nutrition-related complaints.

**Data analysis**
Continuous normally distributed variables were expressed as mean (± SD), and categorical variables were expressed as n (%). Time-related change in nutrient intake between six and twelve months after surgery was analyzed using McNemar’s test. Multivariate logistic regression was used to analyze the association between the number of nutrition-related complaints and the presence of a serious suboptimal intake of nutrients (more than four inadequate nutrients). Because the goal was to quantify the net effect of nutrition-related complaints on nutrients, the association was corrected for statistically significant univariate baseline characteristics and energy intake. Effect sizes were expressed in odds ratios with their corresponding 95% confidence intervals. All analyses were performed with Statistical Package for Social Sciences software (version 16.0, 2007, SPSS Corporation, Chicago, Illinois, USA).
Results

In total, 96 patients participated in the study (Figure 2). Of this total, 60 patients (63%) completed the one-year follow-up, and 36 patients dropped out during this period (78% because of recurrent disease). Baseline characteristics did not differ significantly ($P$ values $>0.05$) between the patients who completed the study and those who dropped out.

The diaries were completed by 70 patients at six months post operation and by 59 patients at twelve months post operation. At both time points, 54 patients had completed the diaries. Table 1 shows the patients’ baseline characteristics, indicating a representative sample of the target population seen in the Academic Medical Center.

Figure 2 Study flow chart. Description of participants throughout the study evaluating the intake of nutrients after esophagectomy with gastric tube reconstruction
Intake of energy and protein

At twelve months postoperative, 24% of the patients did not reach their energy goal and 7% had a protein intake below the recommendation (Table 2).

To safeguard sufficient energy and protein intake, 48% of the population continued tube-feeding after hospital discharge (mean daily intake = 1715 Kcal ± 575 and 65 g protein ± 20). At six months postoperative, only two patients still used nightly tube-feeding and only one after twelve months. Sip-feeding was started in 25% of the patients after discharge (mean daily intake = 230 ml, 280 Kcal ± 125 and 14 g of protein ± 8) and was still being used by 22% at twelve months postoperative.

Mean body weight did not substantially change the first postoperative year. At six months postoperative the mean body weight was 74.7 kg (± 12.1) and this was 73.9 kg (± 12.7) at twelve months post operation.
Intake of micronutrients

On average, patients reported a suboptimal intake of three vitamins and two minerals/trace elements. At twelve months post operation, intakes of folic acid (85% of the patients), vitamin D (61%), copper (56%), calcium (49%) and vitamin B-1 (48%) were most often reported as patients who completed their diaries at both time points (n = 54) showed no significant time-related change (range $P$ values = 0.05 to 1.00) for any of the micronutrients (data not shown). At twelve months post operation, only four patients (7%) had a sufficient intake of all calculated micronutrients, whereas 23 patients (39%) were considered to still have a serious suboptimal intake (more than four inadequate nutrients).

Table 2 Patients with an intake of macro- and micronutrients < 90% of the nutrient recommendations, 6 and 12 months after esophagectomy with gastric tube reconstruction

<table>
<thead>
<tr>
<th></th>
<th>6 months after surgery (n = 70)$^a$</th>
<th>12 months after surgery (n = 59)$^a$</th>
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<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td><strong>Macronutrients</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (KJ)</td>
<td>16 (23)</td>
<td>14 (24)</td>
</tr>
<tr>
<td>Proteins</td>
<td>6 (9)</td>
<td>4 (7)</td>
</tr>
<tr>
<td><strong>Vitamins</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A</td>
<td>21 (30)</td>
<td>18 (31)</td>
</tr>
<tr>
<td>Vitamin D $^b$</td>
<td>41 (59)</td>
<td>36 (61)</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>17 (24)</td>
<td>16 (27)</td>
</tr>
<tr>
<td>Vitamin B-1 $^b$</td>
<td>26 (37)</td>
<td>28 (48)</td>
</tr>
<tr>
<td>Vitamin B-2</td>
<td>20 (29)</td>
<td>14 (24)</td>
</tr>
<tr>
<td>Vitamin B-3</td>
<td>15 (21)</td>
<td>16 (27)</td>
</tr>
<tr>
<td>Vitamin B-6</td>
<td>16 (23)</td>
<td>18 (31)</td>
</tr>
<tr>
<td>Folic acid $^b$</td>
<td>58 (83)</td>
<td>50 (85)</td>
</tr>
<tr>
<td>Vitamin B-12</td>
<td>10 (14)</td>
<td>10 (17)</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>16 (23)</td>
<td>15 (25)</td>
</tr>
<tr>
<td><strong>Minerals and trace elements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium $^b$</td>
<td>32 (46)</td>
<td>29 (49)</td>
</tr>
<tr>
<td>Magnesium</td>
<td>24 (34)</td>
<td>20 (34)</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0 (0)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Copper $^b$</td>
<td>42 (60)</td>
<td>33 (56)</td>
</tr>
<tr>
<td>Iron</td>
<td>13 (19)</td>
<td>7 (12)</td>
</tr>
<tr>
<td>Selenium</td>
<td>18 (26)</td>
<td>19 (32)</td>
</tr>
<tr>
<td>Zinc</td>
<td>25 (36)</td>
<td>18 (31)</td>
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</tbody>
</table>

$^a$ An average intake during 3 days (2 weekdays and 1 weekend day) the week prior to the follow-up assessment was calculated for each nutrient. An average intake <90% of RDAs, corrected for age and gender, was defined as suboptimal intake

$^b$ The nutrients most often reported to have a suboptimal intake
Nutrition-related complaints and serious suboptimal intake

In the univariate logistic regression model, the baseline characteristic preoperative epigastrical pain (crude odds ratio = 3.99; 95% CI: 1.13 to 14.01) and energy intake (crude odds ratio = 5.39; 95% CI: 1.68 to 17.29) were found to be associated with a serious suboptimal intake at twelve months postoperative. Multivariate regression, adjusted for both baseline variables, no longer showed an independent impact of the number of nutrition-related complaints on the presence of a serious suboptimal intake of nutrients (adjusted odds ratio = 1.11; 95% CI: 0.94 to 1.31; \( P = 0.22 \)).

Discussion

This study demonstrates that the majority of esophagectomy patients do not reach the minimum RDA for most micronutrients at six and twelve months postoperative. The micronutrients with the most frequently reported suboptimal intake were folic acid, vitamin D, copper, calcium and vitamin B-1. No statistically significant associations between nutrition-related complaints and suboptimal intake could be demonstrated.

However, it is plausible that the number of patients identified as at risk of an inadequate nutrition after esophagectomy is an underestimation of the actual problem. There are three reasons for this. First, a conservative cut-off point was chosen, defining an intake <90% of recommendations as suboptimal. Although the focus of this analysis was on dietary intake approximating the RDA after esophagectomy, the analysis included an estimation of errors made by the patient and registered dietitian in recording and assessment of dietary intake.

Earlier studies described both under-reporting and over-reporting of nutrients in studies using nutritional diaries to evaluate the nutritional intake, but a summary of the literature shows a consistent under-reporting of the energy intake by approximately 10%. No (consistent) results with regard to misreporting of micronutrients could be demonstrated. Therefore, based on misreporting of energy intake the margin of 10% was built in to evaluate intake.

Second, the oral intake at six and twelve months postoperative was evaluated when patients were assumed to have reached a physically and emotionally stable situation. It generally requires three to nine months for patients to regain a defined eating pattern after this surgical procedure.

Finally, only patients without relapse of the malignancy were followed the complete first year after esophagectomy. In all likelihood, the patients excluded due to recurrence had an intake even more suboptimal than the full-term participants.

Limitations

Because the main goal was to quantify the net effect of nutrition-related complaints caused by the surgical procedure, patients experiencing from co-morbidities that affect the intestinal tract were excluded. Also excluded were patients who were unable to read
or speak Dutch, expecting that this would reduce the accuracy of filling out the diaries and increase misreporting. In addition, 34 patients declined to participate mainly because they assumed participation would be too stressful emotionally. Due to the possible effects of these exclusions and refusals, extrapolating and generalizing the results to the total population undergoing esophagectomy should be done with caution.

Another limitation of this study was the decision to use the five most clinically significant nutrition related complaints by the patients to explain the suboptimal intake of nutrients. However, most bothersome complaints do not necessarily increase the risk of a nutrient deficiency. It is probable that other complaints that are experienced as less bothersome, such as an altered defecation pattern (resulting in a reduced uptake of nutrients), could lead to greater risk of developing a nutrient deficiency.

Finally, the follow-up time of this study was limited. Twelve months might not be long enough to show an improved nutrient intake. According to the present clinical experience, the maximum improvement in physical status occurs two to three years after surgery.

Conclusions
The present study shows patients undergoing esophagectomy are at risk for micronutrient deficiency due to suboptimal intake up to twelve months after surgery. This implies that intake of micronutrients should be adequately monitored (and corrected when necessary) in post-esophagectomy patients, in addition to body weight. As a consequence of this study, an adapted nutritional support protocol was drafted (Figure 1). The adapted protocol first describes that attention is needed regarding optimum intake of energy and proteins. To achieve these goals, tube-feeding and sip-feeding must be continued, for a longer period of time if necessary, until sufficient oral intake of energy and proteins is safeguarded. In addition, extra attention should be given to the micronutrient intake. During tube-feeding and sip-feeding, the RDAs of micronutrients are assured, but after reduction or discontinuation of enteral nutrition, this needs extra attention. It is recommended to evaluate the intake of micronutrients every three months at least until twelve months postoperative and if necessary, to supplement specific nutrients.

References


