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Are nutritional targets in the ERAS® bowel module achievable? – Evaluation of postoperative calorie and protein intake in elective bowel surgery during a pilot-RCT

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Abstract

Background & Aims: Patient recovery may be delayed if postoperative calorie requirements and daily nutritional targets recommended by the ERAS® protocol are not achieved. The ability and willingness of patients to fulfil those targets and the evidence-base are not clarified. This study evaluates calorie and protein requirements and intake within the setting of a pilot-RCT to discuss realistic guideline values for patients.

Methods: 60 patients (≥ 18 years) were included, following the certified surgical ERAS® bowel protocol. Patients used a study smartphone to record food intake. The amount of protein shakes drunk was recorded by the study personnel. Validated body sensors were used to record calorie consumption. Key endpoints were the number of protein-shakes drunk, proteins ingested and overall calorie intake.

Results: A total of 60 patients (34 men; mean age, 60.7 years) on median, drank a total of 4 protein-shakes for postoperative days 0-3 and a median of 1 shake per day. 43 patients had a higher calorie consumption (average 5642.4 kcal days 1-3) compared to their calorie intake (average 4452.8 kcal days 1-3). The ERAS® goal of drinking the specified number of sip-feeds on all postoperative days was achieved by only 9 of 59 patients (15.25%).

Conclusions: The ERAS®-targets for postoperative nutrition seems more arbitrary than evidence-based. They aim rather at detecting obstacles of delayed food intake and at establishing further approaches to counteract the postoperative protein and calorie deficit. We propose to identify more patient-centered, goal-oriented approaches like motivational interviewing to support patients towards their recovery goals.

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; CCM, Cardiac contractility modulation; CRT, Cardiac resynchronization therapy; ERAS®, Enhanced Recovery after Surgery; ICD, Implantable cardioverter-defibrillator; IBD, inflammatory bowel disease; MI, Motivational Interviewing; PEG, percutaneous endoscopic gastrostomy; PG-SGA SF, Patient-Generated Subjective Global Assessment short form; RCT, randomized controlled trial; SAS, Statistical Analysis Software

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Keywords: ERAS®; Perioperative nutrition; Elective bowel surgery; Protein intake; Calorie intake; Motivational Interviewing

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Introduction

Enhanced Recovery After Surgery (ERAS®) protocols are multimodal approaches to the perioperative care of surgical patients. These protocols represent a paradigm shift in the multidisciplinary approach to surgical recovery through an early reconstitution of the physiological body homeostasis [1,2]. Research reports indicate that implementing the ERAS® clinical pathway can lead to reduced hospital stays and lower complication rates [1,3]. In the context of bowel surgery, the overall complication rates decreased by 50%, and patients experienced a reduction in their inpatient stay by two to three days [4]. Postoperative nutritional care plays a crucial role in the ERAS® programme to promote successful patient recovery [2].

Research indicates that patients with inadequate nutritional status are more likely to experience delayed wound healing and complications [5], which were also established for abdominal surgery [6,7]. Approximately one-third of patients undergoing elective colorectal surgery are considered to be at nutritional risk [8]. Patients undergoing surgery may experience malnutrition or an elevated demand for nutrients due to the stress of the operation, leading to impaired bodily function [6]. On account of the occurrence of related consecutive reactions, surgical stress triggers catabolic processes, including protein breakdown, which further contributes to exhaustion, weariness and eating disorders [9,10]. Approximately two kg of lean body mass may be lost in six weeks after uncomplicated elective colon surgery and subsequent recovery [9,11]. This loss of lean body mass in patients is accompanied by loss of function and fatigue in the first postoperative weeks. Depending on the surgery and clinical status, patients do not recover until three to six months, delaying the convalescence phase with return to activities of daily living [9]. To promote endogenous healing and counteract severe catabolism, it's essential to provide sufficient perioperative nutrition.

The ERAS® programme suggests various nutritional strategies, including preoperative carbohydrate-rich shakes, perioperative nutritional screening, and an early feeding strategy starting on the day of surgery to aid in patient recovery. This diet adheres to the ERAS®-recommended daily nutritional targets, which include 300 kcal sip-feeds on day 0, 600 kcal sip-feeds on days 1-3 and meeting the daily energy requirements. It also serves to monitor compliance with ERAS® guidelines [2,12]. Nevertheless, the majority of patients do not meet their calorie requirements or achieve the recommended daily nutritional goals according to the ERAS® guidelines [13,14]. This was also partly due to the fact that spontaneous food intake rarely exceeded 1200-1500 kcal/day [15]. Consumption of ≥ 60% of protein requirements after surgery during the first three days of hospitalization were independent predictors of shorter length of hospital stay. Despite the higher protein intake in the ERAS® group, total protein intake still remained inadequate to meet recommendations [16]. Less emphasis has been placed on the adequate intake of the important sip-feeds. Since it was found that the ERAS® guidelines on food intake in particular were often difficult to implement and were mostly set in a blanket manner, the question arises as to whether they are set too high and which targets are more realistic.

To be able to evaluate the targets for postoperative food intake of the ERAS® programme and their implementation and to place them in the clinical context, an objective evaluation of the corresponding parameters is required. This study combines the innovative and objective measurement of postoperative calorie intake by photo-documentation of the daily actual calorie intake, the number of sip-feeds drunk, and calorie consumption by scientifically validated body sensors. Only through these data a detailed comparison can be made between the targets set in the ERAS® programme and the actual implementation. In addition, it can be analyzed whether the targets are realistic for the majority of patients or whether personalized targets should be preferred.

The aim of the present study was to re-evaluate the generalized nutritional content of the ERAS® programme.

Materials and Methods

Study design and intervention

This randomized controlled trial (RCT) is a component of the research project "Evaluation der postoperativen Mobilität und Nahrungsaufnahme im Enhanced Recovery after Surgery (ERAS®) – Klinikpfad und der Einfluss von patientenzentrierter Gesprächsführung auf ERAS®-Ziele bei elektiver Darmchirurgie – eine randomisierte Pilot-Studie". The study focuses on collecting data related to both nutrition and mobilization.

This study also served to test exploratively whether participation in the intervention of five Motivational Interviewing (MI) sessions led to significantly higher adherence to the dietary goals recommended by ERAS®. The results of this group comparison, in which 30 patients took part in this additional intervention, have been recently published in "Motivational Interviewing improves postoperative nutrition goals within the Enhanced Recovery after Surgery (ERAS®) pathway in elective bowel surgery - A randomized clinical pilot trial" [17] and "Influence of motivational interviewing on postoperative mobilization in the enhanced recovery after surgery (ERAS®) pathway in elective colorectal surgery - a randomized patient-blinded pilot study" [18]. In this paper the cohort of all 60 study participants (intervention and control group) are analyzed with focus on the feasibility of ERAS®-nutritional-target-achievement.

This study followed a clinical single-center pilot RCT

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design with a two-arm, patient-blinded parallel group structure. Patient enrollment occurred between March and August 2022, and data analysis took place from August 2022 to February 2023. The study protocol received approval from the Ethics Committee 2 of the University of Heidelberg (protocol number 2021-698) and was prospectively registered in the German Register of Clinical Trials. All participating patients provided written informed consent.

All study participants received treatment at the surgical clinic of the University Medical Center Mannheim, following the certified ERAS® protocol for bowel surgery. Additionally, they were visited on five occasions: preoperatively during premedication, on the day of surgery (day 0), and on days 1-3 after surgery. These visits also involved charging the validated ECG Move 4 sensor [19] and collecting additional data, such as questionnaires. The background to the ERAS® objectives was also discussed in the control group, but without the use of MI.

Inclusion and Exclusion Criteria

Inclusion criteria: Adult patients aged 18 years or older who underwent elective bowel surgery and agreed to therapy based on the certified ERAS® protocol for colorectal surgery. Furthermore, they were willing to adhere to the protocol requirements and demonstrated the capacity to comprehend the study's implications.

Exclusion criteria: Ineligible patients included those with percutaneous endoscopic gastrostomy (PEG) feeding, parenteral feeding, limited mobility (walking with assistance < 50 meters), cardiac devices (such as Cardiac Contractility Modulation (CCM), Implantable Cardioverter-Defibrillator (ICD), and Cardiac Resynchronization Therapy (CRT)), anticipated non-compliance, mental health conditions that rendered Motivational Interviewing intervention unfeasible, language barriers, non-compensable hearing impairments affecting fluent conversation, and concurrent participation in another study with matching key endpoints.

Outcomes: The primary outcome measures included the quantity of consumed protein shakes, protein and overall caloric intake.

The baseline demographic and clinical features encompassed gender, age, American Society of Anesthesiologists (ASA) classification, body mass index (BMI), surgical indication, and surgical procedure. Additionally, preoperatively collected variables included the consumption and receive of preload shakes, and Patient-Generated Subjective Global Assessment short form (PG-SGA SF) questionnaire [20].

Additionally included in the S1 Table 1 are preoperative variables nutrition treatment, diabetes mellitus, and use of immunosuppressants, as well as postoperative variables ERAS® brochure taken to hospital and filled in on days 0-3, sensor attached on day 0, sensor problems days 1-3, nausea, pain, nutritional form days 0-3, appetite on day 0, patients' self-assessment of whether you have eaten enough, number of meals received and objectively assessable based on photo documentation.

The variables collected after surgery included complications from days 0-3, the length of postoperative hospital stay, total calorie consumption during days 1-3, and the difference between calorie intake and calorie consumption over the same period. Additionally, we assessed whether calorie intake was lower or higher than calorie consumption (≤/>), the number of individual days on which the ERAS® target of shakes drunk was achieved, and the ERAS® target of daily number of shakes drunk reached sum days 0-3.

Data collection: During the postoperative hospital stay (days 1-3), study participants were provided with a study smartphone [21]. They were instructed to photograph each meal before starting and after finishing their food intake. Additionally, all participants were required to consume a protein shake three times a day with their meals, starting from day one. The number of shakes consumed was assessed during the visits. To verify whether the reported number of shakes was indeed consumed by each patient, closer scrutiny required evidence from collected emptied bottles. Unfortunately, photo documentation was not feasible due to the non-transparent nature of the bottles. Additionally, the calorie intake from other liquids, such as sweet drinks or juices, was not recorded. The meals documented through photos were assessed using the Necta - cooking up profits [22] inventory management programme, which stored menu plans and nutritional values for ingredients prepared by the clinic kitchen. Using photo-documented meals, researchers estimated the total amount patients consumed by analyzing before-and-after images. The nutritional values stored in Necta allowed them to calculate the calories ingested. For foods not on the hospital menu (e.g. from a snack machine), photo-documented calorie information from packaging was used. Additionally, protein and calorie intake from protein shakes were calculated based on the number of shakes consumed (300 kcal and 20 g protein per shake).

To assess calorie consumption, patients were affixed with the validated and individually configured ECG Move 4 sensor after surgery. They wore the sensor continuously until 8 pm on day 3. Individual calorie basal metabolic rates are determined using the WHO formula, adjusted for the number of hours in a day. These basal metabolic rates values are then combined with patients' recorded activity levels to calculate the total active calorie consumption, resulting in the final total calorie expenditure. Patients received technical instructions once before and after surgery on how to wear the motion sensors and how to photo-document food intake.

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Statistical analysis

Qualitative, nominally scaled factors were presented by absolute and relative frequencies (percentages). For quantitative variables, the mean (SD) was calculated. For ordinally scaled characteristics, the median (IQR) was calculated. Statistical Analysis Software (SAS), release 9.4 (SAS Institute Inc., Cary, NC, USA) was used for statistical analysis.

Only data collected up to the end of day 2 were used for evaluation for patients discharged on the third postoperative day. To account for the missing data from day 3, we employed an imputation method based on individual patient characteristics. We estimated missing data by analyzing previously collected data using linear regression analysis. We evaluated data from a total of 60 patients. Block randomization was carried out using SAS software, with a fixed block size of 4 patients (comprising two experimental and two control group patients each). Before data collection, a computer-generated randomization list was created for all 60 patients.

Results

Study participants

In total 97 patients underwent screening at the surgical outpatient clinic. Among them, 60 patients provided informed consent and were included in the randomization process. After analyzing data from the intervention group, which consisted of 30 patients, a death on day 2 resulted in a final analysis of 29 patients in the control group. The number of patient data analyzed is indicated in the corresponding tables. Baseline demographic and clinical characteristics of all patients (34 men [56.7%]; mean [SD] age, 60.7 [13.3] years) are shown in table 1.

Table 1: Baseline Demographic and Clinical Characteristics[a]

Characteristics	Study group (n=60)
Sex	
Male	34 (56.67)
Female	26 (43.33)
Age (years)	60.7 (± 13.3)
BMI (kg/m^2)	26.4 (± 5.0)
ASA classification	
I	2 (3.33)
II	45 (75.00)
III	13 (21.67)
Surgical indication	
Malignant	28
IBD	2
Diverticulitis	3
Stoma reversal/Restoration of bowel continuity after Hartmann`s	21
Rectal prolapse	3
Other	3
Surgical procedure	
Colon	12
Rectum	19
Stoma	21
Other	8

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; IBD, inflammatory bowel disease

[a]Data presented as mean (± SD) and number (percentage).

Clinical Outcomes

On median, the 60 patients drank a total of 4 protein-shakes for postoperative days 0-3 (Table 2). Distributed over the individual days, all patients drank a median of 1 shake per day, except for the day of surgery (median 0). The ingested calories by the shakes are 1200.0 kcal (median) and the ingested proteins 80.0 g (median). The average of the ingested calorie count of each meal (breakfast, lunch, dinner) over days 1-3 ranged from 946.0 (lunch) - 1095.8 kcal (breakfast). Total calorie intake for each day increased on average from 142.8 kcal on day 0 to 1569.1 kcal on day 2 and decreased to 1401.8 kcal on day 3. Overall, an average of 4452.8 kcal was consumed over postoperative days 0-3. However, in exceptional cases, results could vary widely for an individual patient from a minimum of 0 to a maximum of 4 shakes per day and a minimum of 0 kcal to a maximum of 3237.4 kcal on any one day.

Preoperative nutritional screening to detect malnutrition and corresponding risk factors showed no relevant need for nutritional intervention for the majority of patients at median (1.0) (Table 3). Three patients received preoperative therapy by oral (+ parenteral) nutritional supplements (supplements) (S1 Table 1). 92.59% of patients who received two carbohydrate-rich preload shakes preoperatively drank them. Eight patients suffered a complication postoperatively. The median postoperative hospital stay was 5 days. Calorie consumption for postoperative days 1-3 averaged 5642.4 kcal. The difference in calorie intake from calorie consumption on days 1-3 was a median of -1222.5 kcal. Overall, there were more patients who had higher calorie consumption compared to their calorie intake (43 vs. 16). The number of individual days that the ERAS® goal of shakes drunk was met by patients is 89 of 231 days. The ERAS® goal of drinking the specified number of sip-feeds on the day of surgery and on all postoperative days was achieved by only nine patients.

Preoperative factors influencing nutrition were present in isolated cases (7 patients with diabetes mellitus and 3 with immunosuppressive therapy) (S1 Table 1). Of the postoperative factors influencing nutrition, pain was notable, with a median score of 4 decreasing to 2 over the course of

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Table 2: Key endpoints in patients[a]

Variables	Study group[b]	95% confidence interval
Protein shakes drunk		
Day 0	0.0 (0.0 – 1.0)	0.0 – 0.5
Day 1	1.0 (0.0 – 2.0)	0.3 – 2.0
Day 2	1.0 (0.0 – 2.0)	1.0 – 2.0
Day 3	1.0 (0.0 – 2.0)	0.0 – 1.0
Sum days 0-3	4.0 (1.0 – 7.0)	2.0 – 5.0
Calorie intake protein shakes sum days 0-3 [kcal]	1200.0 (300.0 – 2100.0)	600.0 – 1500.0
Protein intake protein shakes sum days 0-3 [g]	80.0 (20.0 – 140.0)	40.0 – 100.0
Total calorie intake sum days 1-3 [kcal]		
Breakfast	1095.8 (± 579.7)	944.73 – 1246.9
Lunch	946.0 (± 525.8)	809.0 – 1083.0
Dinner	1043.1 (± 558.4)	897.6 – 1188.6
Other food (days 0-3)	0.0 (0.0 – 275.3)	0.0 – 130.6
Total calorie intake [kcal]		
Day 0	142.8 (± 211.5)	88.2 – 197.4
Day 1	1314.4 (± 737.4)	1123.9 – 1504.9
Day 2	1569.1 (± 740.4)	1376.2 – 1762.1
Day 3	1401.8 (± 779.9)	1198.5 – 1605.0
Sum days 0-3	4452.8 (± 2088.3)	4350.3 – 4755.7

[a] Data presented as mean (± SD) and median (IQR).
[b] Days 0-1 n=60; days 2-3, sum days 0-3 and sum day 1-3 n=59

Table 3: Other endpoints in patients[a]

Variables	Study group
Preoperative variables	n=60
2 Preload Shakes	
Received (yes/no/unclear)	54 (90.00) / 5 (8.33) / 1 (1.67)
Drunk (yes/no)[b]	50 (92.59) / 4 (7.40)
PG-SGA SF questionnaire (score 0-36)[c]	1.0 (0.0 – 4.0)
Postoperative variables	n=59
Complications sum days 0-3 (yes/no) (n=60)	8 (13.33) / 52 (86.67)
Postoperative length of hospital stay (days)	5.0 (4.0 – 7.0)
Total calorie consumption sum days 1-3 [kcal]	5642.4 (± 1035.1)
Difference of calorie intake to kcal consumption sum days 1-3 [kcal]	- 1222.5 (-2648.0 – 264.2)
Calorie intake lower or higher than kcal consumption (≤/>)	43 (72.88) / 16 (17.12)
Number of individual days on which the ERAS® target of shakes drunk was achieved (yes/no)	89 (38.53) / 142 (61.47)
ERAS® target of daily number of shakes drunk reached sum days 0-3 (yes/no)	9 (15.25) / 50 (84.75)

Abbreviations: ERAS®, Enhanced Recovery after Surgery; PG-SGA SF, Patient-Generated Subjective Global Assessment short form

[a] Data presented as mean (± SD), number (percentage) and median (IQR).

[b] Based on all patients who received a Preload Shake (n=54).

[c] Screening of malnutrition and corresponding risk factors (score from 0 to 36; 36 = maximum risk of malnutrition). Score 0-1 = no intervention needed; score 2-3 = Patient education regarding pharmacological intervention; score 4-8 = symptom-based intervention needed; score ≥ 9 = critical need for a (nutritional) intervention.

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days 0 to 3. Appetite on day 0 was estimated at a median of 3. In the course, the percentage of patients who received a light full diet increased daily. Patients' self-assessment of whether they ate enough on each day decreased slightly on average from day 1 (2.02) to day 3 (1.75). The median number of meals received was 9.0, and the median number of objectively assessable photo-documentations was 8.0.

Discussion

Feasibility of the key endpoints

Overall, the results of the key endpoints show that the ERAS®-recommended daily nutritional goals of the sip-feeds were not achieved by the 60 patients at median. Accordingly, protein intake (median 80 g sum days 0-3) was also limited by the sip-feeds. Despite beneficial use, compliance with sip-feeds is often subject to the set targets and limited [23,24]. The median number of sip-feeds drunk on all days (day 0 - day 3) was one sip-feed per day too low to meet ERAS® requirements. Considering all 231 individual days on which patients could have drunk a sufficient number of sip-feeds, the ERAS® target was achieved on only 89 days (38.53%). In addition, only nine patients (15.25%) fully achieved the ERAS® goals in terms of sip-feeds over all four days. Moreover, these nine patients were all from the intervention group who received the intervention with MI. In this research project, an intervention using MI was conducted in addition to the collection of nutrition-specific data, the results of which are discussed in detail in independent papers [17,18]. The preload shakes, on the other hand, were drunk significantly more frequently, at over 90%.

Discrepancy between required and actual calorie and protein intake

However, both the preoperative and postoperative nutritional supplements are essential for the perioperative recovery process. Surgical stress response triggers catabolism and hyperglycemia by mobilizing energy reserves [9]. A sufficient post-operative energy supply supports protein utilization. But Amino acids in particular are required for optimal patient recovery and anabolism [9]. As a consequence, ensuring sufficient protein intake, such as through supplementation with shakes, is crucial. To prevent further protein loss, it’s essential to ensure adequate calorie consumption. A calorie deficit can exacerbate protein breakdown. Focusing solely on adequate protein intake is therefore negligent and should be supplemented by management of the postoperative energy supply [2,9,25]. According to the 2015-2020 Dietary Guidelines for Americans, women are likely to need between 1.600 and 2.400 calories a day, and men from 2.000 to 3.000. However, this depends on their age, size, height, lifestyle, overall health, and activity level etc [26]. As everyone has their own personal daily calorie requirement, in exceptional cases a daily caloric intake of, for example, 1569.1 kcal (see total calorie intake Day 2 Table 2) may still be sufficient. When compared to the mentioned usual caloric requirement of the 2015-2020 Dietary Guidelines for Americans, it appeared that the study group did not consume anywhere near an average number of calories on any of the days except for day 2 (1569.1 kcal). From these results, we could estimate an average caloric deficit of about 1000 kcal. However, since we collected the average actual calorie consumption (5642.4 kcal sum days 1-3) of our study group through the worn body sensors (Table 3), we could accurately compare this with the calorie intake from table 2. The median of this caloric deficit was 1222.5 kcal, which reflects the estimated value of 1000 kcal and is even higher. However, as described in the results section, the individual food intake of patients can vary greatly. A total of 16 patients were able to meet their postoperative caloric requirements up to and including the third postoperative day. Nevertheless, the majority of over 70% were not able to achieve this important part of nutrition.

Importance of perioperative nutritional screening

Determining the caloric needs of each patient after elective intestinal surgery by means of body sensors is not feasible in everyday clinical practice. Therefore, it is even more important to determine and meet at least the basic daily caloric needs of each patient and to apply appropriate screening procedures. The key aspect of perioperative care from a nutritional and metabolic perspective is the integration of a nutritional assessment into overall management [25]. In order to intervene at all, it is therefore essential to identify nutritional deficiencies and patients at risk. Especially in the elderly, functionality and nutritional status should be included in a complex geriatric assessment [27,28]. Several parameters are suitable for screening and can be collected by different methods. For surgical patients, for example, the Nutritional Risk Score (NRS) of the ESPEN guideline has been well validated [29]. Postoperative nutrition screening is also recommended [25], although one study found that more than a quarter of their ERAS® patients did not receive postoperative nutrition screening [30].

However, the elements of the ERAS® programme focused mainly on the intraoperative and postoperative phases, which may not sufficiently improve recovery if preoperative factors were not adequately addressed before surgery. Therefore, it is recommended that the process of surgical recovery should begin before incision [31]. It has been postulated that prehabilitation, including nutritional support or physical training before surgery, may be effective in reducing patient frailty and improving outcomes after visceral surgery [32-40]. This knowledge has been partially incorporated into the guidelines. The benefit of perioperative intake of a high-calorie drinkable food alone has been clearly demonstrated with a reduction in complications and resulting economic savings for surgical patients [41].

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Obstacles to successful implementation of the ERAS® programme and new solutions to support perioperative nutritional intake

In order to meet the higher postoperative calorie requirements, new ways must be found to convince patients to increase their food intake. Since a higher compliance to the ERAS® protocol led to a significant improvement of the patients' outcome, it is of great importance that the implementation does not show any problems. A shorter recovery time was observed in patients who had ≥70% compliance with all ERAS® guidelines [42].

At the same time, the area of nutrition and protein intake is one of the biggest challenges to achieving high target compliance, even in experienced ERAS® centers [43]. Diverse influences must be considered when attempting to improve postoperative nutrition in patients undergoing colorectal surgery. Male sex correlated independently with early tolerance to normal feeding, whereas an ASA score ≥3, abdominal drains, right colectomy surgery, and Hartmann surgery were risk factors for delayed tolerance to normal feeding. Prophylactic drain use was the only independent modifiable risk factor for delayed oral feeding [44]. That management of postoperative nausea and vomiting (PONV) is an important element of ERAS® can be inferred from several research findings. Structured management was shown to be an important prerequisite for successful early nutritional onset after visceral surgery [45]. Nausea was considered a predictor of lower protein intake after colorectal surgery [16].

Establishing a nutrition protocol, improving interdisciplinary communication, and ensuring the availability of appropriate, nutrient-dense foods are critical to improving nutrition practices and intakes [46]. Furthermore, giving patients greater autonomy over the foods they choose after surgery (e.g., enabled by teaching them about dietary habits), involving patients in treatment decisions, and providing simple, clear, and encouraging nutrition information are all beneficial. These strategies can improve postoperative patients' oral intake and participation in care [47]. Some of these factors that hindered increased food intake were also described by our patients. Occasionally, patients complained that they would eat more if the taste of the provided hospital food would improve. Even though not all shakes met the patients' taste, there is a large selection of flavours that can be chosen at short notice on the ward. However, the different flavours should also be available and the shakes should be refrigerated, which was not always the case. For patients who cannot drink sip-feeds, for example because they associate them too strongly with the nausea of chemotherapy, attempts should be made to cover their protein requirements with protein-rich alternatives (e.g. via other types of nutritional supplementation in the form of bars). In addition, it would also be useful to offer healthy smaller snacks according to the patients' wishes, which would make it easier to meet both the protein requirement and the overall calorie requirement.

It was described that the main barrier to adherence to perioperative feeding protocols was poor provision of information. Targeted information on postoperative nutrition and coping with PONV would be beneficial for patients. Easily accessible food provided by the ward staff also proved to be beneficial in helping to build up patient´s diet [48]. It was therefore hypothesised that increasing compliance could thus primarily be a question of will, information and support for patients [23]. Applying a patient-centred care model that focuses on personalisation of ERAS**®** nutritional elements could therefore be a useful strategy to correct old beliefs, promote nutritional intake and improve patient recovery [49]. For this reason, in addition to collecting nutrition-specific data, this research project included an intervention using MI. However, MI intervention has been shown to improve compliance with the nutritional goals of the certified ERAS® protocol by increasing the total caloric and protein intake of ERAS® patients. Without this additional intervention in 30 patients, the results of all 60 patients analyzed in this evaluation would have been even worse.

Individual objectives instead of generalised values

Overall, the ERAS®-recommended daily nutritional goals are not feasible for most patients. However, adjusting the targets from, for example, two shakes per day to one shake would not pursue the purpose of the high-level goals. In principle, the implementation of the goals is feasible, at least for a small part. As both the daily calorie requirement and the number of shakes drunk could only be adequately met by a few patients, it is much more important to find new alternatives that make it possible to achieve the goals. A promising approach has shown, for example, the intervention by the conversation technique using MI, which was additionally carried out in this research project. It is especially important to address the individual needs of patients and set individual goals to be motivating for them. Patients who are already eating little before surgery are unlikely to achieve the goals after surgery. Therefore, the blanket goal of two shakes per day should also be viewed as an adaptive value and not a goal for all patients.

Limitations

The number of cases (n = 60) for the investigation of the pure ERAS®-recommended daily nutritional goals in elective bowel surgery is probably not sufficient to represent a broad patient population and to draw general conclusions. This is due to the study design, which primarily aimed to test the implementation of the intervention by means of MI in the daily clinical routine within the framework of a pilot study.

Furthermore, the accuracy of the evaluation of calorie intake is limited by many factors such as the photo documentation, the stored information on the meals, slightly unequal portioning of the patient meals or incorrect information of the shakes drunk by the patients.

Conclusions

The ERAS®-recommended daily nutritional goals from sip-feeds, as well as meeting daily caloric needs, were not feasible for most patients following elective bowel surgery. However, changing to more easily achievable goals would not help patients, as the deficit in protein and calories would prevail. Rather, a wide variety of barriers to delayed food intake should be identified, and new clinically appropriate solutions should be sought that increase food intake to counteract postoperative catabolism. To this end, we propose a more patient-centered, goal-directed approach. The intervention using Motivational Interviewing, for example, has shown promising results in this regard.

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eTable 1. Further endpoints[a]

Variables	Study group
Preoperative variables	n=60
Preoperative nutritional treatment	
Normal food	57 (95.00)
Oral supplements	2 (3.33)
Oral + parenteral supplements	1 (1.67)
Diabetes Mellitus (yes/no)	7 (11.67) / 53 (88.33)
Immunosuppression (yes/no)	3 (5.00) / 57 (95.00)
Postoperative variables[b]	
ERAS®-Brochure taken to the hospital (yes/no)	51 (85.00) / 9 (15.00)
ERAS®-Brochure filled in (yes/no)	
Day 0	6 (10.00) / 54 (90.0)
Day 1	23 (38.33) / 37 (61.67)
Day 2	29 (49.15) / 30 (50.85)
Day 3 (n=53)	23 (43.40) / 30 (56.60)
Sensors attached day 0 (yes/no)	58 (96.67) / 2 (3.33)
Sensor problems (yes/no)	
Day 1	2 (3.33) / 58 (96.67)
Day 2	0 (0.00) / 59 (100.00)
Day 3	1 (1.85) / 53 (98.15)
Nausea (0-10)[c]	
Day 0	0.0 (0.0 – 2.0)
Day 1	0.0 (0.0 – 0.0)
Day 2	0.0 (0.0 – 0.0)
Day 3	0.0 (0.0 – 0.0)
Pain (0-10)[c]	
Day 0 (n=59)	4.0 (2.0 – 5.0)
Day 1	3.0 (2.5 – 5.0)
Day 2	3.0 (1.0 – 4.0)
Day 3	2.0 (1.0 – 4.0)
Appetite day 0 (scale 0-10)[d] (n=59)	3.0 (0.0 – 6.0)
Form of nutrition on day 0	
Tea	44 (73.33)
Soup	6 (10.00)
Porridge	8 (13.33)
Light wholefood	2 (3.33)
Form of nutrition on day 1	
Tea	1 (1.67)
Soup	3 (5.00)
Porridge	2 (3.33)
Light wholefood	54 (90.00)
Form of nutrition on day 2	
Soup	1 (1.69)
Porridge	2 (3.39)
Light wholefood	56 (94.92)
Form of nutrition on day 3	
Soup	1 (1.85)
Light wholefood	53 (98.15)
Self-assessment of whether you have eaten enough (score 1-4)[e]	
Day 1	2.02 (± 1.12)
Day 2	1.81 (± 0.99)
Day 3 (n=59)	1.75 (± 0.92)
Total meals received sum days 1-3 (0-9)	9.0 (9.0 – 9.0)
Photo documentation of meals (sum days 1-3) objectively assessable (0-9)	8.0 (6.0 – 9.0)

Abbreviations: ERAS®, Enhanced Recovery after Surgery

[a] Data presented as mean (± SD), number (percentage) and median (IQR).

[b] Days 0-1 n=60, day 2 n=59, day 3 n=54 (except otherwise marked); sum days 1-3 n=59

[c] Score ascending from 0 to 10 (10 = maximum nausea/pain).

[d] Appetite ascending from 0 to 10 (10 = maximum appetite).

[e] Score ascending from 1 to 4 (1 = maximum agreement that enough was eaten).

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