Nutritional Support in the Perioperative Period

Topic 17

Module 17.3

Nutritional Therapy in the Perioperative Period

Prof. Dr. A. Weimann, MA
Klinik für Allgemein-, Viszeral- und Onkologische Chirurgie
Klinikum St. Georg gGmbH
Delitzscher Str. 141
04129 Leipzig

Learning Objectives

- Necessity of nutritional risk screening in surgical patients;
- Definition of "high nutritional risk";
- Indications and concepts for perioperative nutritional therapy according to the ESPEN guidelines;
- Preoperative conditioning – "Prehabilitation";
- Enteral, parenteral, and combined enteral/parenteral nutrition;
- Macro-, and micronutrients;
- Indications for immune-enhancing diets;
- Nutritional monitoring and follow-up after discharge.

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Key Messages

- Nutritional status is a prognostic factor in surgical patients;
- Nutritional screening is essential for the early identification of patients at metabolic risk before surgery;
- Prehabilitation is a concept of conditioning including nutrition;
- Nutritional therapy is required if a longer period of inadequate oral intake has to be anticipated;
- The enteral route should be always preferred;
- If nutritional supply is inadequate, the combination of enteral and parenteral "dual" nutrition will be advantageous.

1. Introduction

Malnutrition is generally considered to be associated with starving and lack of food. Its presence in a third world society with an increasing percentage of obese people is frequently neither realized nor well understood. Undernutrition is more subtle than suggested by the World Health Organization (WHO) definition based on a body mass index (BMI) <18.5kg/m^2. Recently a global consensus of PEN Societies (GLIM) has been achieved regarding the definition of malnutrition including phenotypical (non-volitional weight loss, low BMI, reduced muscle mass) and aetiological criteria (reduced food intake or assimiliation, inflammation or disease burden) (1).
Disease related weight loss in patients with overweight is not necessarily associated with a low BMI as in the definition of the WHO. However, this weight loss results in changes of body composition inducing a loss of fat-free mass bearing a „metabolic risk" which must be kept in mind for patients undergoing major surgery especially those with cancer.

ESPEN has defined diagnostic criteria for malnutrition according to two options (2):
-option 1: BMI <18.5kg/ m
-option 2: combined: weight loss >10% or >5% over 3 months and reduced BMI or a low fat free mass index (FFMI).
Reduced BMI <20 or <22 kg/m^2 in patients younger and older than 70 years, respectively. Low FFMI is <15 and <17kg/m^2 in ^{2}females and males, respectively.

Because under- and malnutrition are frequently not recognized and therefore untreated, metabolic factors will usually not be considered in the critical analysis of surgical morbidity and outcome. Many retrospective and prospective major trials have however elucidated the association with impaired nutritional status and postoperative complication rate and mortality (3-5). Data from the European "NutritionDay" from about 15000 patients clearly showed that "metabolic risk" is a factor increasing hospital mortality particularly in the elderly (6).
According to the prospective data from a multicentric trial the highest risk patients will be found in hospital in the departments of surgery, oncology, geriatrics, and intensive care medicine. Univariate analysis revealed significant impact on the hospital complication rate from: severity of the disease, age >70 years, surgery and cancer disease (5). A clear association between sarcopenia and major complications after surgery has again been shown recently (7). Bearing in mind the demographic developments in the western world, surgeons will surely be dealing with a risk accumulation in the functionally impaired elderly undergoing major surgery for cancer (8).

Therefore, nutritional management is an interprofessional challenge, and in times of limitations in the health care economy a "must" for rationalization in order to save resources. As a basic requirement a systematic nutritional risk screening must be considered in all patients on hospital admission. For the surgeon to the mechanical approach to the patient must be added the metabolic dimensions of the surgery planned.

Table 1
Nutritional aspects in the surgical patient

- Nutritional Risk Screening on admission or first contact - Observation and documentation of oral intake - Regular follow-up of weight and BMI

2. Screening Tools

Several screening tools are available. Well validated and officially recommended by ESPEN with widespread use is the **Nutritional Risk Screening (NRS),** the so-called Kondrup-Score (9). Patients classified as at risk by the NRS have significantly higher complication rates during hospital admission (4).

Table 2
Complication rate in NRS classified patients

	no complication % (n)	complication % (n)	Total in % (n)
No risk	88.7 (3021)	11.4 (383)	100 (3404)
Risk	69.4 (1143)	30.6 (504)	100 (1647)
			$p < 0.001$

According to Sorensen et al, 2008 (4)

Nutritional Risk Score (9):
The prescreening which takes only a few minutes includes the following items:
- BMI < 20.5 kg/m^2
- weight loss within 3 months
- diminished food intake
- severity of the disease

A severe metabolic risk (3):
must be considered in the presence of one or more of the following criteria:
- weight loss > 10-15 %
- BMI < 18.5kg/m^2
- NRS >5, SGA C
- Serum albumin < 30g/l (no hepatic or renal disease)

3. Indications for Nutritional Support

The key issues of perioperative nutritional care include: avoidance of long periods of pre-operative starving and re-establishment of oral feeding as early as possible after surgery. Nutrition is an integral part of the Enhanced Recovery After Surgery (ERAS) or so-called multimodular "Fast Track" concept, which has been widely accepted as the primary goal (3, 10). Its implementation may still be improved. It is evidence based that early oral/enteral nutrition will diminish postoperative ileus and accelerate solid food tolerance (11, 12). Early oral nutrition is a key issue for re-establishing normal bowel motility and therefore an important step for enhanced recovery (3, 10, 13, 14). From a metabolic viewpoint catabolism will be attenuated and nitrogen spared (15). Ideally, oral nutrition can be reestablished within a few hours after surgery (3, 11-14). These patients do not require artificial nutritional support or infusion therapy. However, the tolerance and the

amount of food intake should be carefully observed. If tolerance to oral fluid and food intake is limited for more than 4 days, it is recommended that peripheral parenteral hypocaloric nutrition is started (e.g. two-chamber bag with glucose 8-10% and amino acids 10%).
Despite convincing and clear metabolic advantages of the ERAS concept, there is also a risk from hypocaloric nutrition and delay of adequate nutritional support in patients who have not been identified as at metabolic risk and of higher risk of developing postoperative complications.
The indications for nutritional support in surgery are the prevention and treatment of undernutrition. During the perioperative period this is primarily the substitution of calories and protein for preservation of the nutritional status and prevention of undernutrition. Nutritional intervention may also focus on improvements in outcome – for this indication the criteria of success are complication rate, mortality rate, hospital length of stay and cost-benefit ratio.
The following recommendations are in accordance with the ESPEN Guidelines for Enteral and Parenteral Nutrition in Surgery from 2006 and 2009 with the Update Clinical Nutrition in Surgery from 2017, (3, 16, 17).
Inadequate oral intake for more than 14 days is associated with a higher mortality. Nutritional support is therefore indicated, even in patients without obvious undernutrition, if it is anticipated that the patient will be unable to eat for more than 5 days perioperatively. It is also indicated in patients who cannot maintain oral intake above 50% of recommended intake for more than 7 days. In these situations nutritional support (by the enteral route if possible) should be initiated without delay. Combination with parenteral nutrition should be considered in patients in whom there is an indication for nutritional support and in whom nutritional needs cannot be met (e.g. <50% of caloric requirement) via the oral/enteral route, e.g. in upper GI fistulae (3, 16, 17).
Whenever possible the enteral route should be preferred (7, 16-18). If necessary, in the case of limited gastrointestinal tolerance, enteral nutrition should be supplemented using combined enteral / parenteral support. Parenteral nutrition is beneficial in undernourished patients in whom enteral nutrition is not feasible or not tolerated, as well as in patients with postoperative complications impairing gastrointestinal function who are unable to receive and absorb adequate amounts of oral / enteral feeding for 7 days or more (17).

4. Preoperative Nutrition – Prehabilitation

The "prehabilitation" concept has been recently introduced, and is an interprofessional multimodal approach (19). The premise of the multimodal prehabilitation approach, which includes nutrition and physical exercise components, rests on their synergy. Regarding the clinical impact of prehabilitation two recent meta-analyses concluded that preoperative exercise therapy contributed to decreased postoperative complication rates and shortened length of stay in patients undergoing cardiac and abdominal surgery (19). The training of inspiratory muscles was also associated with decreased postoperative pulmonary complications.
While physical activity is the main focus of this multimodal prehabilitation programme, other functional reserve factors need to be included, such as adequate nutrition, medical and pharmacological optimization and psychological support. There is still insufficient evidence supporting prehabilitation to confirm a lowered rate of complications.

Meaningful changes in functional capacity take 4-5 weeks of prehabilitation and were recently shown for patients undergoing liver resection. However, no significant difference in the postoperative complication rate was observed (20). Patients with low functional and physiological reserve such as the elderly, frail, sarcopenic and cancer patients could benefit more from prehabilitation than other patient populations. In a recent blinded randomized controlled trial (RCT) a significant reduction in the number of complications was shown in elderly high risk patients with American Society of Anesthesiologists (ASA) classifications Grade III and IV (21).
There are different concepts of patient conditioning which may be combined as well. These are:
- substitution of caloric deficiency in case of severe metabolic risk
- metabolic conditioning (carbohydrate load)
- immunologic preconditioning.

4.1 Caloric Deficiency

It is still true, that "most patients will benefit from prompt surgery" (22). Deferring surgery in order to restore caloric deficiency can only be justified in cases of severe undernutrition and metabolic risk. If nutritional support is indicated the enteral route should always be preferred. Whenever possible enteral nutrition should be performed as an outpatient before the hospital stay in order to avoid nosocomial infections (3). Parenteral nutrition is recommended in severely undernourished patients who cannot be adequately fed orally or enterally (3, 17).
Usually nutritional support will be administered for 7 to 14 days.

4.2 Metabolic Conditioning

Preoperative starving is unnecessary for most patients. The metabolic burden of perioperative hypoglycaemia related to overnight fasting has been clearly shown. Oral food intake the night before and fluids until 2-3 hrs before surgery do not increase the risk of aspiration during anaesthesia. Preoperative carbohydrate drinks can be recommended for most patients without significantly impairing gastric emptying. There are clear advantages for "carbohydrate loading" in the early postoperative period. In the rare situation of patients who cannot be fed by the oral/enteral route a glucose infusion should be administered intravenously (3, 17). In several RCTs significant advantages were shown in favour of carbohydrate loading. These included less postoperative discomfort as well as shortened length of hospital stay after colorectal surgery (23). A meta-analysis showed that it was associated with significantly shorter hospital length of stay in patients undergoing abdominal surgery (24). Another recent meta-analysis included numerous studies in patients undergoing minor surgery, and it is not unexpected that in this meta-analysis no significant advantage was found (25). A more recent multicentric RCT from Italy presented significantly better glucose sensitivity with less insulin requirement in the intervention group. No differences were found in the clinical outcomes (26).

4.3 Immunologic Preconditioning

The so called "immunonutrition" refers to the use of formulae enriched with (for example) arginine, glutamine, omega-3-fatty acids and nucleotides. Patients with obvious severe nutritional risk, such as those undergoing major cancer surgery of the neck (laryngectomy, pharyngectomy) and of the abdomen (oesophagectomy, gastrectomy, and pancreatoduodenectomy) as well as those who have experienced severe trauma may benefit from these formulae. This recommendation was emphazised in the ESPEN Guidelines for nutrition in cancer patients (27), because immune modulating formulae contributed to a decreased rate of postoperative infections and consequently to a decreased length of stay in hospital.
Meta-analyses have brought up concerns about any superiority in comparison with standard oral nutritional supplements and the appropriate "timing" (28-30). In a recent meta-analysis focusing on gastrointestinal cancer patients a significantly decreased rate of infectious complications was found for the sole preoperative use of immunonutrition when compared with or without standard oral nutritional supplements (31). Benefits have been also shown for the perioperative and postoperative administration with respect to complication rates and hospital length of stay (32, 33).
Cost-effectiveness of these formulae has been shown confirming net reduction in resource consumption and total cost (34, 35).

5. Postoperative Nutrition

In general interruption of nutritional intake is unnecessary after surgery. Oral intake should however be adapted to individual tolerance and to the type of surgery carried out. Usually, oral intake can be initiated within hours after surgery (3).
It is evidence based, that early oral and/or enteral food intake diminishes the risk of infectious complications and favours a shorter length of hospital stay (36-38). There is also no increase in the risk of developing anastomotic leakage after gastrointestinal tract surgery. Therefore, there is no reasonable rationale for longer periods of fasting after surgery. There is evidence that even after colorectal surgery with bowel anastomoses oral nutrition can be started without delay. When anastomoses of the upper GI tract have been performed, the patients may drink clear fluids with enteral nutrition delivered via a tube whose tip is placed distal to the anastomosis (3).
Even if oral feeding can be started within a short term after surgery some patients may benefit from supplementary postoperative tube feeding: those after major surgery for cancer of the abdomen and head and neck – laryngectomy, pharyngectomy, oesophageal resection, gastrectomy, partial pancreato-duodenectomy – as well as those after severe trauma. In these patients it is reasonable to create safe enteral access by naso-jejunal tube or fine needle catheter jejunostomy (NCJ) placement at the time of surgery. It had been shown that a nasojejunal tube, which entails considerable discomfort for many patients, may be unnecessary for decompression after gastrectomy (39), but this constitutes another argument for NCJ insertion for feeding (40).
Enteral tube feeding can be started with low amounts (5-10ml/h) within 24 hrs after surgery. The administration rate should be cautiously increased stepwise (for example by 10-20ml/h per day). Gastrointestinal tolerance must be monitored carefully (e.g. gastric residual volume, abdominal distension, peristalsis). In the event of haemodynamic

instability in the ICU the administration rate should be reduced to 5-10ml or even stopped for a few hours (41).
For early enteral nutrition, especially in the Surgical Intensive Care Unit, a slow increase of administration rate is recommended: e.g. to 50ml/h with small steps of 10-20ml/h over four days, observing the enteral tolerance by abdominal distension and gastric aspirate. Standard enteral diets may be used which will initially need appropriate addition of sufficient volume of fluid and electrolytes (3).

6. Indications for Parenteral Nutrition (PN)

Parenteral nutrition is indicated in undernourished patients in whom enteral nutrition is not feasible or not tolerated, in patients with postoperative complications impairing gastrointestinal function who are unable to receive and absorb adequate amounts of oral/enteral feeding for at least five days. Combined enteral and parenteral feeding should be considered in all patients in whom there is an indication for nutritional support and in whom >50% of nutritional needs cannot be met via the enteral route. This may occur for example in high output enterocutaneous fistulae or short bowel syndrome. In preoperative patients with completely obstructing lesions, because of the risk of aspiration or severe bowel distension leading to peritonitis, surgery should not be postponed (3, 17).

The main contraindications to enteral nutrition are

- Bowel obstruction or ileus
- Severe shock with haemodynamic instability
- Lack of integrity of the proximal GI tract (eg anastomotic breakdown)

In patients with prolonged gastrointestinal failure after surgery (as for example in short bowel syndrome) total parenteral nutrition will be a life-saving treatment (3, 17, 41).
In most patients individualized nutrition is unnecessary. Special attention must however be given to patients with serious comorbidity (3, 17). Standardization may follow a protocol, and "All-In-One" mixtures (AIO) (two-chamber-bag with glucose and amino acids, three chamber bag with glucose, amino acids and lipids) may be used. The advantages of AIO mixtures have been shown with regard to feasibility, time and cost saving, and the lower risks of contamination (42, 43).

6.1 Amino Acids

For the catabolic patient with proteolysis and loss of body cell mass the supply of amino acids is essential. Because protein synthesis is an energy consuming process, appropriate utilization of amino acids will be only realized if glucose (and lipids) are supplied at the same time. In order to limit nitrogen losses during illness and perioperative stress guidelines now recommend a supply of amino acids equivalent to 1.5-2 g/kg of ideal body weight (IBW) (about 20 % of total energy requirement) (3, 17). An increase to more than 1.5g/kg may offer no advantages for protein synthesis, because there is then a greater risk that amino acids will be utilized as an energy source. In the case of TPN or near total PN meta-analyses have favoured supplementation with intravenous glutamine in a standard dosage of 0.35-0.4g/kg BW/d (3, 17, 44). However a recent randomized controlled trial in surgical ICU patients could not find a significant difference with regard

to 6 month survival (45). No data are yet available with regard to glutamine supplementation in combined enteral and parenteral nutrition.

6.2 Glucose

„Intensified insulin therapy" has increased metabolic awareness regarding hyperglycaemia. A metaanalysis including data from 38 studies clearly showed the evidence favouring insulin therapy for the decrease of mortality, in particular in surgical and diabetic ICU patients (46). However, intensified insulin treatment bears a considerable risk of hypoglycaemia and should be performed continuously only with the equipment and staff of an ICU (47). On the normal ward reduction of glucose supply should be considered to help avoid hyperglycaemia. At present, the optimal serum glucose level appears to be about 140 -150 mg% (7.7-8.3mmol/l) (17, 18).

6.3 Lipids

Nowadays, administration of lipid emulsions is considered to be an integral part of PN especially in long-term ICU patients (3, 17, 18).
For a long time there were major concerns about administering lipids earlier than 10 days after the start of PN (48). This was related to a study in trauma patients, in whom the patients with lipid infusion had shown a significantly higher rate of infections, respiratory failure, and length of ICU stay (49). In this study a soy-bean based lipid emulsion had been used. Soy-derived long-chain-triglycerides (LCT) have a high content of polyunsaturated omega-6 fatty acids which are involved in the synthesis of leucotrienes and prostaglandins which in turn have a high inflammatory potential. This may induce adverse effects during the systemic inflammatory response syndrome (SIRS) and sepsis.
In order to reduce the content of omega-6-fatty acids, mixed emulsions with medium- and long-chain triglycerides were developed. The tolerance of mixed LCT/MCT lipid emulsions in standard use is sufficiently documented. Several studies have shown specific advantages over soybean LCT alone (50). Another approach is to use omega-9 rich olive-oil based lipids, which are well tolerated in critically ill patients (18, 50). In another formula MCT and LCT are combined with omega-3-fatty acids and olive oil. A ratio of omega-6 to omega-3 of 3:1 is considered to be immune neutral (50). Supplementation of PN with omega-3 fatty acids may decrease mortality in critically ill patients with abdominal sepsis (51). For surgical patients advantages have been shown in meta-analyses with regard to infection rate, and length of hospital and intensive care unit stay (52).

6.4 Ratio of Macronutrients

The protein:fat:glucose ratio should approximate to 20:30:50. At present, there is a tendency to increase the glucose:fat ratio from 50:50 to 60:40 or even 70:30% of the non-protein calories, due to the problems encountered regarding hyperlipidaemia and fatty liver (17).

6.5 Caloric Amount

In the acute phase of critical illness limited substrate tolerance reflects the severity of the disease. An inadequate amount of macronutrients is an additional burden for the organism and may negatively influence outcome. Therefore, in the acute phase calorie supply should refer to individual tolerance and should not exceed 25kcal/kg of IBW. The recommended rates of supply are glucose 3-4g/kg IBW (blood glucose level about 140-150mg%, 7.7-8.3mmol/l), lipids 0.7-1,5g/kg IBW (serum triglyceride <300mg/dl, 3.3mmol/l) and amino acids 1-1.5-2g/kg/IBW.
During the phase of recovery substrate tolerance will normalize. In this period the amount of administered calories should be 1.2 to 1.5 fold higher than the calculated energy requirement. In this phase indirect calorimetry in selected patients will provide useful information about the optimal energy supply (18).

6.6 Vitamins and Trace Elements

In well nourished patients who recover with oral or enteral nutrition by postoperative day 5 there is little evidence that intravenous supplementation of vitamins and trace elements is required. In those patients after surgery who are unable to be fed via the enteral route or in whom total or near total parenteral nutrition is required a full range of vitamins and trace elements should be supplemented on a daily basis (17, 18). Vitamins and micronutrients should be separately added to the PN. New lipid emulsions containing alpha-tocopherol which is the biologically active vitamin E component provide an additional supply of vitamin E. Although it is possible that the present ranges underestimate requirements in the critically ill surgical patient, so far, there is no clear evidence for the administration of higher dosages of single micronutrients, because toxicity cannot be excluded (18).

7. Monitoring

After major abdominal surgery follow-up of nutritional status (minimum BMI) including documentation of the amount of oral food intake is necessary. Dietary counselling is recommended as well which is usually appreciated by the patient.
Typical short term problems of parenteral nutrition are:
- hyperglycaemia
- hyperlipidaemia
- reversible micro- and macrovesicular steatosis of the liver
- cholestasis

Table 3
Blood chemistry

- electrolytes including phosphate and magnesium
- blood glucose
- triglycerides
- creatinine
- liver enzymes and bilirubin
- serum lactate and procalcitonin in the critically ill

8. Follow up

Follow up of the nutritional status is required in all patients who have needed perioperative nutritional therapy and with special regard to those with a complicated postoperative course (53). Weight and BMI are not sensitive enough because differences in body composition without change of BMI may occur. Bioelectrical Impedance Analysis (BIA) is a feasible noninvasive tool which is also convenient for outpatients (see Topic 3). The intraindividual course can be well documented in a three-compartment-model including extracellular (ECM) and body cell mass (BCM) as well as fat mass (FM). From body impedance, the fat free mass (FFM), the ratio of ECM/BCM and the phase angle may be easily calculated providing fairly reliable information about the cell content in the body. Ideally, the first measurement will be performed before surgery.

9. Post Discharge Nutrition

After major abdominal surgery dietary counselling is a reasonable expectation and will be appreciated by most patients. In a considerable number of patients after major gastrointestinal or pancreatic surgery the oral calorie intake will remain inadequate for several months (54). Vitamin deficiencies also have to be taken into account (55). Possible reasons may be a decrease in appetite, impaired enteral tolerance with dumping symptoms, meteorism and diarrhoea. There is a guideline recommendation for insertion of a fine needle catheter jejunostomy (NCJ) at the time of surgery in case of oesophageal resection, total gastrectomy, and partial pancreato-duodenectomy (3). The NCJ should not be removed at the time of discharge from the hospital (56, 57). If necessary supplementary enteral nutrition can be continued e.g. with 500 or 1000kcal/d via the NCJ. After teaching, most patients will be able to administer jejunostomy tube feeding themselves. Although further weight loss cannot be completely avoided, attenuation of weight loss is shown, as well as can be shown for oral nutritional supplements (58, 59). Other authors have found a significantly better quality of life in patients receiving nutritional supplementation (60). While this is still a matter of debate, further data from controlled studies should elucidate the benefits.

10. Concluding Remarks

Nutritional risk screening and, if indicated, nutritional therapy are essential parts of perioperative management in ERAS programmes. With special regard to the elderly the early identification of patients at metabolic risk remains essential. Prehabilitation including nutritional therapy may be considered in high risk patients. According to the ESPEN guidelines these patients should undergo nutritional support very early on if a longer period of inadequate oral intake is anticipated. The enteral route should be preferred whenever possible.

11. Summary

Aiming for enhanced recovery and the reduction of postoperative morbidity, ERAS programmes do not preclude the necessity for appropriate perioperative nutritional and metabolic care. Early detection and observation of patients with nutritional risk remains an essential part of perioperative management. Whenever possible, artificial nutritional support should be avoided. However, if in high risk patients inadequate oral intake is anticipated then nutritional therapy should be started early via the enteral route, maybe even in combination with parenteral nutrition. Long term total parenteral nutrition will be limited to special indications. This review incorporates the 2006, 2009, and 2017 guideline recommendations of the European Society for Clinical Nutrition and Metabolism (ESPEN) (www.espen.org) for nutritional management of surgical patients.

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