The value of nutritional assessment in major abdominal surgery
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Chapter 1

General introduction and outline of the thesis
The main goal of this thesis is to determine the value of nutritional assessment in pre-operative and postoperative patients, in particular those undergoing major abdominal surgery. This introduction addresses the consequences of malnutrition for these patients, discusses frequently used tools for assessing malnutrition and pays attention to bioelectrical impedance as a method to measure body composition. Finally, an outline of the thesis is given.

**Nutrition**

Inadequate intake of fluids, macronutrients (proteins, carbohydrates and fat) and micronutrients (vitamins, minerals and trace elements) results in deterioration of physical condition and may ultimately lead to death. The need for specific nutrients in relation to optimal nutritional status has been understood and described for centuries. Examples of breakthroughs in nutrition research are the following discoveries: the association between the symptoms of scurvy and eating citrus fruit, published in 1753 by the British naval physician J. Lind (1716-1794),\(^1\) the cause of beri beri (vitamin B1 deficiency) by the Dutch physician and later Nobel prize winner C. Eijkman,\(^2,3\) and the impact of fatty acids on the occurrence of cardiovascular disease, resulting from information gathered by H.O. Bang, J. Dyerberg and A. Brøndum Nielsen among the Inuit in Greenland.\(^4\)

**Nutrition and illness in ancient times**

Thousands of years ago, the Egyptians were aware that certain nutrients or food products had a positive influence on the course of an illness. They used herbs not only for preparing their food, but they also used indigenous and imported herbs for healing. Their papyrus scrolls described the effect of acacia in relation to cough, the use of pomegranate against tapeworms, henbane against colic, cumin and coriander against intestinal cramps and celery and saffron in the treatment of rheumatic complaints.

In the Far East, the knowledge of medicine among the Chinese emperors was approximately equal to that of the Egyptians; for an optimal balance between yin and yang they also used medicinal herbs.

Described and preserved on stone tablets, in sanatoriums such as Epidaurus (500 BC), the ancient Greeks treated their patients with a combination of relaxation therapies, physical exercise, intellectual entertainment and dietary therapies. However, Hippocrates (460-377 BC) should be regarded as the founder of scientific, modern dietetics, as he definitively broke with the mythical and religious basis of Greek medicine. Next to hygiene, he was convinced that good eating and drinking habits were essential to optimal health.

In the Roman period, Aulus Cornelius Celsus (25 BC–50) and Claudius Galenius (129–199) were respected physicians who improved on various dietary requirements and therapies initiated by Hippocrates.

During the Middle Ages, monks had extensive medical knowledge but were not allowed by the clergy to apply their knowledge and skills. In these dark ages, surgeons and quacks carried out surgical procedures and bloodletting, but only doctors were concerned
with diets and lifestyle. It was not until the Renaissance that medicine and the associated knowledge about dietary therapies underwent a revival and improvement.

**Nutrition in the present era**
Current knowledge about nutrition has resulted in the formulation of requirements for energy and the recommended dietary allowances (RDAs) for macronutrients and micronutrients. The RDAs are the daily intake level of a nutrient considered to be sufficient to meet the requirements of 97-98% of healthy people in every demographic segment of a country. It should be noted that RDAs differ between countries, and that some nutrients are specified by some countries while others are not. In healthy adults, the aim of optimal nutrition is to meet the RDAs to safeguard health, and for children and adolescents to ensure proper growth.\(^5\)\(^-\)\(^{13}\)

**Nutrition during illness**
It is widely assumed that the nutritional requirements of ill people differ from those of healthy subjects. Depending on their physical condition, patients are often advised to increase or decrease the intake of certain nutrients. However, the actual needs for patients in terms of macronutrients and micronutrients are mostly unknown.\(^14\)\(^-\)\(^{15}\)

**Nutritional goals and malnutrition in surgical patients**
Nutrition assessment and therapy in surgical patients during the preoperative, perioperative and postoperative phase is of major clinical importance. The primary goal of nutritional therapy in these patients is the maintenance or restoration of the protein mass of the body, as it is assumed that substantial loss of fat-free mass negatively influences the course of disease and treatment.\(^16\)\(^-\)\(^{18}\) In this context, the evaluation of body weight and body mass index is crucial. For example, substantial involuntary loss of body weight within a certain time frame and/or a body mass index below a defined cut-off point – which is defined as malnutrition – have been widely described as having a negative influence on adjuvant therapy and postoperative outcome.\(^18\)\(^-\)\(^{24}\)

Malnutrition in hospitals is a serious problem, with an international prevalence range between 5% and 55%, depending on type of patient, department, hospital and intervention.\(^25\)\(^-\)\(^{33}\) Information about the presence of malnutrition in outpatient clinics is scarce, but recent studies have indicated a prevalence between 6% and 12%.\(^34\)\(^-\)\(^{36}\) Risk factors for malnutrition are older age, co-morbidities and care dependency.\(^16\),\(^25\),\(^27\) Diseases of the intestinal tract may also lead to malnutrition as a result of dysphagia, obstruction, vomiting, reduced digestion, impaired absorption or diarrhoea.\(^16\),\(^37\),\(^38\) Malignant disease and the corresponding treatment also increase the risk of becoming malnourished. This is caused by or is in response to tumour-released inflammatory cytokines and hormones, catabolism (metabolic pathway to release energy) and cancer cachexia (loss of body weight, inflammation, and significant loss of appetite).\(^26\),\(^39\)\(^-\)\(^{42}\)

Malnutrition reduces the fat-free mass resulting in a decline of vital physiological
functions: a perceptible loss of muscle strength and muscle function and reduced organ function, including the immune system.\textsuperscript{43 - 48} In addition, malnutrition may reduce the response to chemotherapy and radiotherapy and increase the risk of postoperative morbidity, surgery related mortality, impaired quality of life and prolonged hospital stay.\textsuperscript{25, 49 - 52}

**Major abdominal surgery**

Within the population of surgical patients, patients undergoing major abdominal surgery are a special subgroup, as the disease and the required surgical procedure have a direct impact on the functioning of the gastrointestinal tract. Patients in this subgroup often suffer from cancer of the esophagus, stomach and pancreas and are therefore at high risk of malnutrition during all phases – preoperative, perioperative and postoperative. In the preoperative phase the malignant process in the gastro-intestinal tract often results in difficulties such as obstruction of swallowing, vomiting, nausea, pain, poor digestion, malabsorption and diarrhoea. In the perioperative phase patients in this subgroup are often not allowed, or are unable, to eat and drink for at least several days; artificial nutritional support is then often required. In the post-operative phase, all patients experience, to a greater or lesser extent, the physiological consequence of their major surgical procedure in terms of changes in the dietary pattern and inadequate food intake.\textsuperscript{53 - 74}

To increase the 5-year survival rate, the current treatment for cancer patients selected for major abdominal surgery often consists of the surgical procedure in combination with chemo and/or radiation therapy. It may be evident that side effects of these neo-adjuvant and adjuvant treatments like nausea, vomiting, pain and obstruction increases the risk of inadequate oral intake and can result in a deterioration of nutritional status in the preoperative and postoperative phase.\textsuperscript{75}

**Nutrition-related consequences of esophagectomy with gastric tube reconstruction**

As described above, major abdominal surgery can strongly influence the functioning of the gastrointestinal tract and negatively affect the postoperative nutritional status in terms of body weight, nutrient intake and malnutrition. However, evidence-based nutrition related guidelines to support patients in the postoperative phase are scarce.

The literature on this topic has indicated that patients who undergo an esophagectomy with gastric tube reconstruction (esophagectomy) are confronted with a range of nutrition-related difficulties and complaints such as dysphagia (difficulty in swallowing), reflux, early satiety, altered gastric emptying, dumping syndrome as well as deterioration of nutritional status.\textsuperscript{53 - 69, 76 - 78} Unfortunately, a systematic in-depth evaluation with regard to the nutrition related complaints lacks, and little is known about the short-term and long-term course of these symptoms, the nutrition-related adjustments needed, and the patient’s nutritional status in terms of body weight and intake of macronutrients and micronutrients in the first postoperative year.
Dietary advice for patients undergoing major abdominal surgery

The protein requirement of healthy adults in the Netherlands is set at 0.8 grams/kilogram body weight/24 hours. However, in vivo neutron activation analysis has indicated that this level of intake does not maintain the protein body mass after major abdominal surgery. A limited number of studies have demonstrated that the maximal protein synthesis for healthy persons and in case of sepsis is 1.5–1.7 grams/kg body weight/24 hours and this advice was adopted by the National Dutch Guideline on Perioperative Nutrition. This higher level of protein intake is prescribed during chemotherapy and radiotherapy, the preoperative phase and in the postoperative phase until six months after major abdominal surgery. Thereafter, protein intake can be reduced to 1.2–1.3 grams/kg/24 hours, as patients are expected to be less catabolic by then.

According to the National Guideline on Perioperative Nutrition for the Netherlands, the energy requirements for surgical patients are calculated with the Harris and Benedict equation (1984) plus 30% extra (20% for metabolic stress and 10% for activity). A stable body weight is assumed to be important, as substantial weight loss indicates loss of fat-free mass, including muscle mass.

Screening tools to detect malnutrition

Early detection and treatment of malnutrition is important, as the adverse consequences of malnutrition for both patient and society are considerable. However, systematically measuring height and weight to calculate the patient's body mass index (BMI) is time consuming for caregivers. Our unpublished data shows that measuring height and weight requires 2-3 minutes extra time per patient. If healthcare professionals were to measure all preoperative outpatients in the Netherlands, this would result in over 32,000 additional working hours yearly.

To save time for caregivers, malnutrition screening tools have been introduced to obtain a rough estimate of patients' nutritional status. In the Netherlands, the Short Nutritional Assessment Questionnaire (SNAQ) and the Malnutrition Universal Screening Tool (MUST) are frequently used for adults, and the Mini Nutritional Assessment (MNA) for the elderly. Not all of these screening tools have been validated for preoperative outpatients, and some of the tools must be used by trained personnel. In addition, ‘at risk’ patients need a complementary and more comprehensive assessment.

Self-reported anthropometric data as indicator for malnutrition

Self-reported anthropometric data on height and weight has been suggested as a substitute for screening tools. However, previous studies have indicated that healthy persons and patients suffering from eating disorders tend to under-report their body weight and over-report their height, which results in an underestimated body mass index. In underweight patients this relationship seems to be reversed; patients over-report their body weight, which leads to an underestimation of malnutrition. In preoperative surgical outpatients, no studies have yet determined the adequacy of self-reported weight and height data to screen for malnutrition.
Handgrip strength measurement by dynamometry as indicator of malnutrition

Earlier studies demonstrated significant associations between low handgrip strength and aspects such as malnutrition, postoperative complications, prolonged hospital stay, reduced ability to return home, reduced mobility, impaired quality of life and mortality. A number of algorithms based on handgrip strength are available to screen for malnutrition or an increased risk for postoperative complications. Frequently used algorithms are those proposed by Mathiowetz et al., Álvares-da-Silva et al., Klidjian et al., Matos et al., and Webb et al. Each of these algorithms uses its own cut-off points of normal values, but little is known about the screening abilities of these algorithms in individual patients.

Measurement of body composition to assess nutritional status

In recent years, it has been increasingly recommended to not only measure body weight and calculate body mass index, but also to measure the various body compartments in order to determine nutritional status more accurately. A number of reference methods are available to evaluate body compartments. For the measurement of total body water, deuterium dilution and tritiated water dilution are used. Extracellular water is measured by bromide dilution. Intracellular water is measured by radioactive 40K total body potassium. Fat-free mass, fat mass and lean tissue mass can be estimated by hydrostatic weighing (hydro densitometry or underwater weighing) and by air-displacement plethysmography and dual energy X-ray absorptiometry. Magnetic resonance imaging and computed tomography are used for the measurement of fat mass, muscle, skin, viscera and bone tissue. Body cell mass can be estimated by radioactive total body potassium; and total body nitrogen by neutron activation. However, the applicability of these methods in clinical populations is limited, due to the fact that most of these methods are expensive, time consuming and not always harmless.

Bioelectrical impedance analysis of the entire body to evaluate nutritional status

In the 1990s, estimations of body compartments by bioelectrical impedance analysis (BIA) became available. BIA is an easy, non-invasive method to estimate aspects such as total body water, extracellular water, fat-free mass and fat mass. The method is based on measuring the resistance and reactance of an alternating electrical current in the human body. Intracellular fluids, body fluids and electrolytes behave as electrical conductors (resistance) and cell membranes act as electric al condensers and are involved in capacitance (reactance). To actually estimate the body compartments, the measured resistance and reactance are incorporated into a statistical regression equation considered most suitable for a certain target population. The equation usually consists of a set of person-related variables such as age, sex, height and body weight.

BIA estimates can be performed by various devices. In clinical practice, BIA estimates are routinely used in patients undergoing major abdominal surgery (often for cancer), but it is unclear whether BIA provide a valid estimation of body compartments.
Outline of this thesis

The overall aim of this thesis objective is to investigate the value of nutritional assessment in major abdominal surgery. The first four chapters present the clinimetric properties and the applicability of nutritional status related methods and techniques in both a general preoperative population and a group of patients undergoing major abdominal surgery. A detailed nutritional assessment in terms of nutrition related complaints, nutrition related adjustments, body weight and intake of nutrients after esophagectomy with gastric tube reconstruction is described in the subsequent chapters.

The first two chapters of the thesis report on a study of the applicability of two methods for the detection of malnutrition in preoperative individual outclinic patients. Chapter 2 focuses on the reliability and validity of self-reported anthropometric data on height and weight of preoperative surgical patients compared to anthropometric data assessed by healthcare professionals and three commonly used malnutrition screening tools. In Chapter 3 the diagnostic accuracy of handgrip strength by dynamometry in preoperative surgical patients is addressed.

Chapters 4 and 5 pay attention to the measurement of body composition to assess nutritional status. Chapter 4 reports on an evaluation of the estimates of two bioelectrical impedance analysis (BIA) devices with respect to the body compartments fat-free mass and fat mass among patients undergoing major abdominal surgery. Inter-observer agreement between the two devices was analysed in order to determine whether their estimations result in a similar classification of body composition. In Chapter 5 a systematic review is presented with the aim of determining the validity of BIA estimations in adult surgical and oncological patients.

Chapters 6 and 7 address the impact of major surgery on nutrition-related complaints, nutritional intake and risk of deterioration of the nutritional status in patients after esophagectomy with gastric tube reconstruction. Chapter 6 describes the presence of persistent nutrition-related complaints and the necessity of nutrition-related adjustments, and Chapter 7 reports on the intake of nutrients and potential risks of nutrient deficiencies one year after esophagectomy.

In Chapter 8 the main results of the studies are summarised, and unexpected study findings are discussed. Furthermore, the clinical implications and recommendations for future research are described. A summary in English and Dutch concludes the thesis.

References

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