3 Vascular surgery patients at risk for malnutrition have an increased risk for postoperative complications

Submitted

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ABSTRACT

Objectives The aim of this study was to assess the relationship between the risk for malnutrition and postoperative complications in vascular surgery patients.

Design This is single-center prospective cohort study

Materials and Methods In 2015 and 2016, all vascular surgery patients visiting the outpatient clinic at the University Medical Center Groningen (UMCG) were included in this study. During this visit the patients were assessed for risk for malnutrition using the Scored Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF). In addition, data on age, sex, body mass index, smoking, alcohol, hypertension, comorbidities, type of planned surgery and ASA were collected. Postoperative complications were registered and analyzed using the Comprehensive Complication Index.

Results A total of 306 patients were included, with a mean age of 68.0 ± 10.6 years, of which 226 were men (73.9%). The mean BMI was 26.6 ± 4.6 kg/m^2. Seventy-four patients (24.2%) were found to be at risk for malnutrition, necessitating an intervention. The overall mean Comprehensive Complication Index was 6.8 ± 16.0. The mean Comprehensive Complication Index of patients at high risk for malnutrition was 5.3 points higher than those at low risk for malnutrition (P=0.008) and 4.1 points higher than those at medium risk for malnutrition (P=0.018).

Conclusions We found that a substantial proportion of vascular surgery patients, at medium to high risk for malnutrition at time of surgery, are more likely to develop postoperative complications. This finding suggests that awareness for nutritional status and preventive interdisciplinary interventions is indicated, to decrease the risk of postoperative complications in vascular surgery patients.

INTRODUCTION

Malnutrition is an important risk factor for adverse postoperative outcomes, including infection and delayed wound healing, resulting in a longer hospital stay and higher readmission and mortality rates.[1–6] Especially in cardiac, hepatobiliary and colorectal surgery, malnutrition has been associated with an increased risk for postoperative complications.[7–10] According to the European Society for Clinical Nutrition and Metabolism (ESPEN) malnutrition is defined as: *"a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size and composition) and function, and clinical outcome"*.[11] There are several screening tools to assess risk for malnutrition, and although they all slightly differ with regard to included factors, the body mass index (BMI) plays an important role in many of these tools. However, in the vascular surgery population, over 60% is classified as overweight/obese and therefore they often do not meet the criteria for risk for malnutrition according to these tools.[12,13] Moreover, a decreased fat-free mass is an important hallmark for malnutrition which is easily overlooked in patients with a high BMI.[11,14] This may lead to an underestimation of the number of patients at risk for malnutrition in this specific group. Another drawback of these tools is that they do not include nutrition impact factors such as pain or nausea that might possibly lead to a reduced intake of food and could be optimized pre-operatively.

In cardiac, general and vascular surgery patients, the prevalence of risk for malnutrition is estimated at 19% and 24% respectively.[4,9,15] However, the relation between risk for malnutrition, measured with a validated nutritional screening tool, and the occurrence of postoperative complications in vascular surgery patients is still lacking. Therefore, the aim of this study was to assess the relationship between the risk for malnutrition prior to vascular surgery and postoperative complications.

MATERIALS AND METHODS

Study design

In this observational study, all vascular surgery patients scheduled for surgery at the University Medical Center Groningen (UMCG) from January 2015 until April 2016 were included in this study. The majority of patients underwent surgery within three months after their last outpatient visit, when also the measurements for this study were performed. During this outpatient visit, the patients were assessed for risk for malnutrition using the Scored Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF) Dutch version 3.7.[16] For this study, the Medical Ethical Committee granted dispensation for the Dutch law regarding the patient-based medical research (WMO) obligation (reference 2016/322). As

a consequence no informed consent was obtained. Patient data were processed and electronically stored according to the declaration of Helsinki – Ethical principles for medical research involving human subjects.[17] Data were analyzed anonymously.

Baseline variables

Collected data included age (yrs), sex, body mass index (BMI), smoking (y/n), alcohol consumption (y/n), hypertension (y/n), comorbidities (Charlson Comorbidity Index), type of surgery, and American Society of Anesthesiologists (ASA) physical status classification system score (ASA). The Charlson Comorbidity Index is a weighted score, which predicts the 1-year mortality of a patient based on the coexisting medical conditions and age.[18]

Assessment of malnutrition risk

To assess the risk for malnutrition, patients completed the PG-SGA SF independently. The PG-SGA SF is a simple and validated screening tool that proved to be accurate in discriminating between patients at risk for malnutrition.[20,21] The PG-SGA SF includes four boxes. Box 1 addresses the history of weight loss (0-5 points); Box 2 evaluates changes in food intake in the past month (0-4 points); Box 3 addresses presence of nutrition impact symptoms in the past two weeks (0-13 points); and Box 4 evaluates activities and function in the past month (0-3 points). 'Low risk for malnutrition' relates to a total PG-SGA SF score of 0 to 3 points, 'medium risk for malnutrition' was defined as a total PG-SGA SF score of 4 to 8 points, and 'high risk for malnutrition' was defined as PG-SGA SF score ≥9 points, in accordance with the PG-SGA triage system.[21]

Postoperative complications

Postoperative complications were registered and analyzed using the Comprehensive Complication Index, which is a tool that summarizes all postoperative complications with regard to their severity according to the Clavien-Dindo classification of surgical complications, consisting of 5 complication grades, including 4 subgrades.[22] In short, grade one consists of any deviation from the normal postoperative course, without the need for surgical, endoscopic, radiological or pharmacological treatment (besides antiemetics, antipyretics, analgesics, diuretics and electrolytes). The second grade includes pharmacological treatments, blood transfusions and parenteral nutrition. Third grade complications require surgical, endoscopic or radiological treatment. Grade four includes life-threatening complications requiring ICU management, whereas grade five concerns death of the patient. The Comprehensive Complication Index takes the quantity of appearance of each complication into account, accumulating all the postoperative complications weighted for their severity, ranging from 0 (no complications) to 100 (death).[23]

Statistical methods

Categorical variables were presented as frequencies and percentages. Distribution was assessed by means of a Q-Q plot or histogram. Continuous variables were presented as mean ± standard deviation (SD) for normally distributed variables and as median ± inter-quartile range (IQR) for skewed variables. Differences between continuous variables were tested with the Student t-test for normally distributed data, and the Mann-Whitney U test for skewed distributed data. Differences between categorical variables were tested with the Chi-squared test. Significant differences in Comprehensive Complication Indices between the three malnutrition risk categories were tested with the Kruskal-Wallis test. Two tailed P-values were used and significance was set at $P<0.05$. To analyse the relationship between risk for malnutrition and the Comprehensive Complication Index, we used a linear regression model. The Comprehensive Complication Index had a skewed distribution so we transformed the variable using the natural logarithm (*ln*-transformation). After the analysis, the resulted coefficient was transformed back to the geometric mean. Besides the crude analysis, an adjusted analysis was performed with the confounders age, BMI, hypertension, smoking, ASA, and type of surgery. All statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS Version 23; IBM Corp.).

RESULTS

Participants and descriptive data

A total of 306 patients with a mean age of 68.0 ± 10.6 years were included, of which 226 were men (73.9%). Baseline characteristics are listed in Table 1, with the patients stratified for risk for malnutrition.

Median PG-SGA SF score for all patients was 1 (IQR: 0 to 3), with a range from 0 to 18. Two hundred thirty-two patients (75.8%) were found to be at low risk for malnutrition, 55 patients (18.0%) were estimated as medium risk, and 19 patients (6.2%) at high risk for malnutrition. As a result, 74 patients (24.1%) were considered to be at medium to high risk for malnutrition. The mean BMI of all patients was 26.6 ± 4.6 kg/m^2, and BMI was significantly higher (P=0.046) in the 'low risk for malnutrition' group. Sex was unequally distributed between the groups; the 'low risk for malnutrition' group included relatively more men than the 'high risk for malnutrition' group (P=0.017). Furthermore, in the 'medium' and 'high risk for malnutrition' group, patients were more likely to smoke (P=0.029).

Table 1. Baseline characteristics categorized per risk for malnutrition

Parameter	Low risk (PG-SGA SF 0-3 points)	Medium risk (PG-SGA SF 4-8 points)	High risk (PG-SGA SF ≥9 points)	Total	P-value
Number	232 (75.8%)	55 (18.0%)	19 (6.2%)	306 (100%)	-
Age (years)	68.2 ± 10.2	67.5 ± 12.5	67.2 ± 11.2	68.0 ±10.6	0.886
Sex					0.017
Male	180 (77.6%)	36 (65.5%)	10 (52.6%)	226 (73.9%)	
Female	52 (22.4%)	19 (34.5%)	9 (47.4%)	80 (26.1%)	
BMI (kg/m^2)	26.9 ± 4.4	25.4 ± 4.4	25.3 ± 6.5	26.6 ± 4.6	0.046
Smoking	73 (31.9%)	24 (43.6%)	11 (57.9%)	108 (35.3%)	0.029
Using alcohol	102 (53.3%)	24 (53.3%)	7 (38.9%)	133 (53.0%)	0.458
Hypertension	145 (63.3%)	39 (70.9%)	14 (73.7%)	198 (65.3%)	0.417
Comorbidities[c]	4.7 ± 1.7	5.4 ± 2.9	4.9 ± 1.8	4.8 ± 1.9	0.151
Type of planned surgery					0.026
Percutaneous	57 (24.6%)	15 (27.3%)	1 (5.3%)	73 (23.9%)	
Carotid	45 (19.4%)	9 (16.4%)	4 (21.1%)	58 (19.0%)	
Endovascular	52 (22.4%)	8 (14.5%)	3 (15.8%)	63 (20.6%)	
Peripheral bypass	36 (15.5%)	10 (18.2%)	5 (26.3%)	51 (16.7%)	
Abdominal	23 (9.9%)	3 (5.5%)	1 (5.3%)	27 (8.8%)	
Lower extremity amputation	11 (4.7%)	10 (18.2%)	4 (21.1%)	25 (8.2%)	
Other	8 (3.4%)	0 (0.0%)	0 (0.0%)	9 (2.9%)	
ASA[d]	2.4 ± 0.6	2.7 ± 0.5	2.7 ± 0.5	2.5 ± 0.6	0.002

[a] Standard deviation. [b] Interquartile range. [c] According to the Charlson Comorbidity Index, a weighted index which predicts the 1-year mortality by measuring the burden of comorbidities (range from 0 to 19). [d] American Society of Anesthesiologists score, categorizes the fitness of patients prior to surgery (range from 0 to 5)

Relation between risk for malnutrition and postoperative complications

The data on risk for malnutrition and postoperative complications are shown in Table 2 and Figure 1. The overall mean Comprehensive Complication Index was 6.8 ± 16.0, with a range from 0 to 100. The patients at low risk for malnutrition had a mean Comprehensive Complication Index of 6.3 ± 15.1. For the 'medium risk' group and the 'high risk' group, the Comprehensive Complication Indices were respectively 7.5 ± 20.2 and 11.6 ± 13.1.

Table 2. Postoperative complications per risk for malnutrition category

PG-SGA SF[a] group	Low risk (N=232) (0-3 points)	Medium risk (N= 55) (4-9 points)	High risk (N=19) (≥9 points)	Total (N=306)	P-value
Comprehensive Complication Index[b]	6.3 ± 15.1	7.5 ± 20.2	11.6 ± 13.1	6.8 ± 16.0	0.023

[a] Scored Patient-Generated Subjective Global Assessment Short Form (© FD Ottery 2005, 2006, 2015)
[b] According to the Comprehensive Complication Index, which takes all complications after a procedure and their respective severity into account (range from 0 to 100)

The Comprehensive Complication Index of patients with a high risk for malnutrition was significantly higher than those with a low risk (mean difference 5.3 points, P=0.008). Also, Comprehensive Complication Index of the patients who were at 'high risk' was significantly higher than those at 'medium risk' (mean difference 4.1 points, P=0.018).

Risk for malnutrition and postoperative complications

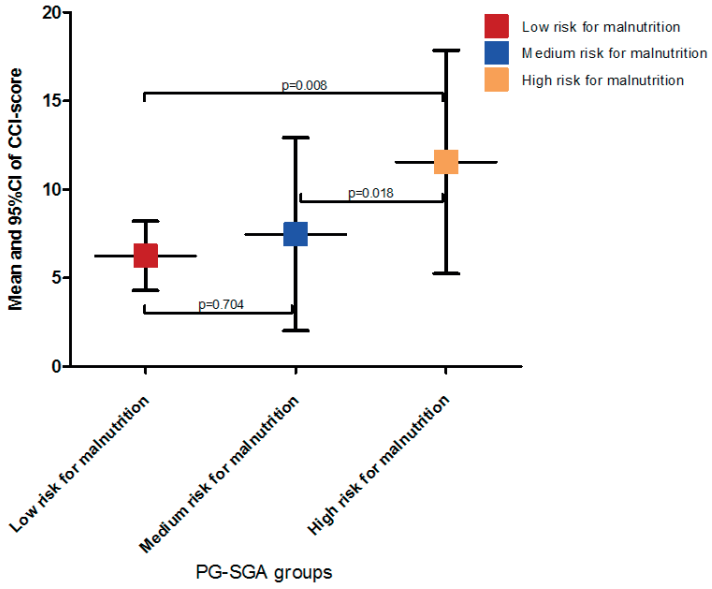

Figure 1 Differences between the mean Comprehensive Complication Index (CCI), categorized per risk for malnutrition.

Table 3 shows the results of the multivariable analysis of the relationship between risk for malnutrition and postoperative complications. The 'medium risk for malnutrition' group had a 1.39 (95% Confidence Interval [CI]: 0.93 – 2.08) times higher Comprehensive Complication Index than the 'low risk for malnutrition' group (reference group), and a 1.40 (95% CI: 0.93 – 2.10) times higher Comprehensive Complication Index than the 'low risk for malnutrition' group when adjusted for the confounders age, BMI, hypertension, smoking, ASA, and type of surgery. The 'high risk for malnutrition' group had a 0.91 (95% CI: 0.60 – 1.39) times higher Comprehensive Complication Index than the 'low risk for malnutrition' group, and a 1.05 (95% CI: 0.68 – 1.60) times higher Comprehensive Complication Index than the 'low risk for malnutrition' group when adjusted for the same confounders as described above.

Table 3. Multivariate linear regression analysis of the relationship between risk for malnutrition and postoperative complications

Risk for malnutrition category	Unadjusted			Adjusted [b]		
	β[a]	95% CI	P-value	β[a]	95% CI	P-value
Medium risk for malnutrition (PG-SGA SF 4-8 points)	1.39	0.93 – 2.08	0.106	1.40	0.93 – 2.10	0.106
High risk for malnutrition (PG-SGA SF ≥9 points)	0.91	0.60 – 1.39	0.664	1.05	0.68 –1.60	0.830

a Transformed back
b Adjusted for age, BMI, hypertension, smoking, ASA and type of surgery

DISCUSSION

This study is the first in demonstrating that electively operated vascular surgery patients with a medium to high risk for malnutrition are more prone to develop postoperative complications than patients with low risk for malnutrition. The patients at high risk for malnutrition had a significantly higher Comprehensive Complication Index, which means that they have a higher risk at developing either more complications or a more severe complication, than those at low or medium risk for malnutrition.

In a busy outpatient setting, measuring or estimating the nutritional status of a patient, for example by measuring fat-free mass and muscle strength, can be difficult.[24] As a result, nutritional status is often evaluated on body weight or BMI alone, which both proved to be not valid.[25] The nutritional screening instrument used in this study (PG-SGA SF) is found to be among the few nutritional assessment instruments covering all domains of the conceptual definition of malnutrition, as defined by ESPEN and ASPEN.[26] The PG-SGA SF is a sensitive instrument that can easily be used as a screening instrument and can be quickly completed by the patient in less than 5 minutes. It addresses weight change and changes in food intake and identifies nutrition-related impairments that can lead to future malnutrition.[21] By identifying these domains, the PG-SGA SF assesses the risk for malnutrition. Therefore, a more preventive treatment can be implemented, instead of reactive treatment when the patient is already malnourished. These aspects of the PG-SGA SF enable the ability for not only for the dietitians but also for physicians, nurses and physiotherapists, to intervene when a patient is at risk for malnutrition.[27] In surgical patients, malnutrition increases the risk of infections, due to a decreased immune response and impairs wound healing, leading to a poorer surgical outcome.[28,29] In general, malnutrition in patients admitted to the hospital is associated with a prolonged hospital length of stay and higher mortality.[30] In various studies, malnutrition has proved to be reversible with a suitable nutritional intervention.[31–33] In vascular surgery patients, a study investigating the effect of preventive nutritional treatment on postoperative outcomes is currently lacking. Adequate nutritional screening

can help detect those patients at highest risk for malnutrition and identify patients in need for interventions, which may require both nutritional and exercise interventions.[30, 34–37] Early and adequate nutritional consultation for malnourished patients has the ability to reduce the hospital length of stay (LOS) with an average of 3.2 days in severe malnourished patients.[31] In cancer patients, nutritional treatment significantly reduced the risk of adverse events.[32] Moreover, preventive nutritional interventions were also associated with an improvement in functional and cognitive status in elderly at risk for malnutrition.[33] These findings, supported by our results, suggest that a preventive nutritional intervention might also be helpful in vascular surgery patients at medium or high risk for malnutrition, to reduce complications and subsequently a shorter hospital length of stay.

This study has some limitations that need to be addressed. First, we estimated the risk for (future) malnutrition and we did not measure nutritional status. But by assessing the risk, we discovered that even the presence of risk factors for future malnutrition could lead to a higher risk for complications. Second, within the vascular surgery setting, the PG-SGA SF is not a validated instrument for nutrition assessment yet, but a gold standard is currently lacking. However, screening for nutritional risk is a positive step in improving the pre-operative care for the individual patient and the PG-SGA SF has proven to be a valuable tool, with good predictive validity. Third, the PG-SGA SF is a questionnaire that is completed by the patient him- or herself. Because of several coping strategies or cognitive impairments, the patient may report fewer or more problems than actually exist, leading to an under- or overestimation of the nutritional impairments. Fourth, the number of patients in the three malnutrition risk groups was not equal, and especially the number of patients in the 'high risk for malnutrition' group was very low. Because of this skewness, the statistical power was limited and this could have led to an underestimation of the relationship between risk for malnutrition and postoperative complications. We speculate that if the 'high risk' group had been larger, the association between risk for malnutrition and postoperative complications would have been stronger. Finally, our center is considered a tertiary referral center, providing advanced specialized care. This may have led to a selection of patients that may make our data somewhat less generalizable to other groups or cohorts of vascular surgery patients.

In conclusion, electively operated vascular surgery patients with an estimated medium to high risk for malnutrition are more likely to be at risk for developing postoperative complications. This finding suggests that preventive interdisciplinary interventions are needed in vascular surgery patients, to improve nutritional status and reduce the risk of postoperative complications. Future intervention studies are necessary to determine whether preventive strategies will lead to better surgical outcomes.

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