Original Article

Nutritional status of patients admitted to a metropolitan tertiary care vascular surgery unit

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Background and Objectives: Undernutrition in vascular surgery patients has a significant impact on clinical outcomes. This observational study aimed to investigate the nutritional status of a heterogeneous sample of vascular surgery inpatients and to determine the prevalence of nutritional risk, malnutrition (including nutrient deficiencies) and sarcopenia. **Methods and Study Design:** All participants were screened for risk of malnutrition using the Malnutrition Universal Screening Tool (MUST) and assessed using the Patient-Generated Subjective Global Assessment (PG-SGA). Micronutrient status was examined via plasma/serum samples. The presence of sarcopenia was explored using an accepted algorithm incorporating gait speed, muscle mass (DEXA) and grip strength. **Results:** 322 participants (69% male, mean age 67.6±14.1y) consented to the study. 12.5% were identified as at risk of malnutrition by the MUST while 15.8% were deemed malnourished by the PG-SGA. Only 5% were diagnosed as sarcopenic. Prevalence of malnutrition was much higher when micronutrients were examined with 79% showing low vitamin C levels, 56% low vitamin D and over 40% having low zinc, vitamin B-12 and folate levels. A smaller proportion were also low in selenium (19%). **Conclusions:** Patients with vascular disease are a nutritionally vulnerable group. The MUST and PG-SGA did not identify the full extent of nutritional deficiencies. Further investigation is warranted to assess tool validity in this group. A number of micronutrients are crucial in these patients and hence a more comprehensive assessment that encompasses a wider range of parameters, including micronutrient status appears warranted.

Key Words: vascular disease, nutritional status, micronutrient, PG-SGA, MUST

INTRODUCTION

Vascular disease is an increasing problem with an ageing population and growing prevalence of chronic disease.[1,2] Vascular surgery encompasses a wide range of conditions including venous disease, occlusive arterial disease, aneurysmal disease and diabetic foot infections and therefore is a heterogeneous population with varying comorbidities.

It is well understood that overweight/obesity is strongly associated with the development and progression of vascular disease including peripheral arterial disease (PAD), venous and aneurysmal disease.[3-5] However, concerning rates of malnutrition (defined as undernutrition) ranging from 61-90%[6-8] have been observed in vascular disease patients and is associated with poor clinical outcomes.[7,9-11]

Sarcopenia is defined as the age-related loss of muscle mass and strength and has multiple contributing factors including less-than-optimal diet, bed rest or sedentary lifestyle, chronic diseases and certain drug treatments.[12] These contributing factors are common in vascular disease patients placing them at risk of sarcopenia,[12-15] which could be masked by the high prevalence of overweight and obesity in this group. Recent work has shown that a reduction in muscle mass is not limited to vascular patients with occlusive disease, with larger aortic abdominal aneurysms showing an association with a reduction in muscle mass.[16] Muscle mass and strength is crucial in the performance of activities of daily living, and in the management of vascular disease via exercise[17] hence the prevalence of sarcopenia in this population warrants further investigation.

The development of atherosclerosis and progression of vascular disease has a pro-oxidative and pro-inflammatory component which would suggest that optimal micronutrient status, particularly those micronutrients with anti-oxidative properties and/or those important in the prevention and management of wounds and ulcers is important. Micronutrient status has been explored in vascular patients with consistent reports of suboptimal levels

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of vitamin D (25(OH) D), vitamin C, vitamin B-12, folate and iron which worsens with disease progression.[18-21] The impact of micronutrient deficiencies are significant with higher rates of amputations observed in PAD patients with low vitamin D levels.[22] Other micronutrients such as vitamin C, vitamin A and zinc are involved in wound healing and epithelial integrity, along with immune function, hence deficiency prolongs wound healing time and contributes to reduced resistance to infection.[23]

This study aimed to investigate the nutritional status of vascular surgery inpatients and to determine and compare the prevalence of nutritional risk according to the Malnutrition Universal Screening Tool (MUST), and malnutrition (according to the Patient-Generated Subjective Global Assessment PG-SGA and also micronutrient status). The prevalence of sarcopenia was also investigated.

METHODS

Study sample

Participants were recruited consecutively from patients with vascular disease/conditions admitted to a metropolitan vascular surgery unit in Australia between October 2014 and August 2016. Patients admitted to the unit can undergo surgical intervention or be managed conservatively depending on their vascular condition and admitting reason. Potential participants were approached in-person by the researchers on admission to the unit where the study requirements were verbally explained and also provided in writing. If patients agreed to participate they were asked to sign a consent form prior to data collection. Participants were eligible if they were 18 years and over, able to provide informed written consent or where this wasn't appropriate, consent was able to be obtained from the legal next of kin/guardian. Patients were excluded if admitted for day procedures only, unable to be recruited within 72 hours of admission, or were subsequently transferred to a private hospital within 72 hours. Previous participants were also excluded. Ethical approval was obtained from the Southern Adelaide Health Research and Ethics Committee (approval number 258.14) and governance approval from the participant recruitment site.

Demographic data including age, gender and vascular disease type was collected from medical records. Vascular disease types were classified as aneurysmal, peripheral arterial disease (PAD) (encompassing aorto-iliac and infra-inguinal disease), occlusive other (encompassing carotid and upper limb ischaemia), venous disease, diabetic foot infection and 'other' based on the admitting vascular surgeon's diagnosis. Those classified as other included renal access, surgical management of thoracic outlet syndrome, trauma, ulcers of mixed or unknown aetiology, admission for post-operative complications and lower limb infection not attributed to occlusive disease or diabetes.

Determination of nutritional risk

Malnutrition screening is conducted within the local health system using the MUST.[24] The MUST is a validated 3-item instrument to identify adults who are either malnourished or at risk of malnutrition. A score is awarded for each item; body mass index (BMI), recent weight loss and presence of acute disease with an overall score of 1 indicating low risk of malnutrition and ≥2 indicating high risk. The MUST is completed by nursing staff on admission and those with a score of ≥2 are referred to a dietitian for a full assessment.

Within 24 hours of consent being obtained, vascular surgery nursing staff conducted a questionnaire with participants incorporating questions from the MUST. Body weight was measured using a calibrated seated weighing scales (HVL-CS Hospital Chair Scale, A&D Mercury Pty Ltd) to the nearest 0.1 kg in light clothing without shoes. Ulna length was measured using a flexible non-stretch steel measurement tape to the nearest 0.5 cm according to standard protocol[24] and converted to estimated height using the MUST conversion table to the nearest 1 cm.[24] BMI was calculated as weight (kg) divided by the square of height (m^2) estimated from ulna length. Age-appropriate BMI cut-offs were used to classify participants as underweight, normal weight or overweight/obese for those 65 years or older (<22 kg/m^2, 22-27 kg/m^2, >27 kg/m^2 respectively)[25] and under 65 (<18.5 kg/m^2, 18.5-24.9 kg/m^2, >25 kg/m^2 respectively).[26] Scoring of the MUST was completed post-discharge by the research staff to allow sufficient time to pass between the assessment of nutritional status and the scoring of the screening tool to reduce bias.

Nutritional assessment

A full nutrition assessment using the scored PG-SGA[27] was conducted within 72 hours of admission by a Dietitian. The PG-SGA was adapted from the Subjective Global Assessment specifically for patients with cancer[28] but has since been validated in other inpatient groups.[29-31] The scored PG-SGA is a further development of the PG-SGA incorporating a numerical score as well as providing a global rating of nutritional status. Each participant was awarded a PG-SGA score and a PG-SGA global rating of A (well nourished), B (suspected or moderately malnourished) or C (severely malnourished).

Determination of micronutrient status

Blood samples were collected by a trained phlebotomist prior to breakfast after an overnight fast on the morning after consent was obtained. Where possible, blood samples for the research study were collected at the same time as routine blood samples for clinical care to reduce participant burden. Fasting blood samples were analysed by the hospital or state pathology service depending on the analytical test. Micronutrient status was determined as suboptimal, normal or high according to reference ranges (shown in parentheses) provided by the analysing laboratory, for iron (8-30 umol/L), vitamin B-12 (>260 ng/L) and folate (6.5-45 ug/L), vitamin A (1-3.1 umol/L), vitamin C (26-85 umol/L), vitamin E (12-46 umol/L) vitamin D (60-160 nmol/L) and the trace elements zinc (9-21 umol/L) and selenium (0.8-1.64 umol/L).

Identification of sarcopenia

Parameters used to define sarcopenia are the amount of muscle and its function measured via muscle mass, strength and physical performance.[12] Various techniques can be used to assess these parameters including dual-energy x-ray absorptiometry (DEXA) for muscle mass,

handgrip strength (muscle strength) and gait speed (physical performance) which were used in this study.[12] Measurements for each parameter were converted into the relevant low/normal cut-offs and incorporated into the EWGSOP-suggested algorithm for diagnosing sarcopenia.[12] The cut-offs for each parameter are summarised in Table 1. Muscle mass was determined using the Lunar Prodigy Pro dual-energy x-ray absorptiometer (DEXA) in conjunction with Encore software version 7.5. Participants were scanned in light clothing and positioned in the supine position, feet in neutral position with hands flat by their sides. Appendicular lean soft tissue (ALST) mass was calculated as the sum of the lean soft tissue in both upper and lower limbs which was then converted to SMM (kg) according to the equation of Kim et al.[32] SMM was subsequently adjusted for height to produce the Skeletal Muscle Index (SMI) (kg/m^2) according to the equation by Baumgartner et al.[33]

Sarcopenia was defined as SMI being less than two standard deviations below the mean of a young reference group of 229 non-hispanics as suggested by Baumgartner et al.[33]

Gait speed (metres/second) was determined using a validated six metre walk test.[34] Participants stood with their toes positioned behind the line in non-slip footwear or bare feet depending on participant preference and medical instructions regarding footwear. Timing began with an electronic stopwatch as toes crossed the zero metre line, and ceased when toes crossed the 6 metre line. Participants walked at their usual pace and a handrail was available for the full 6 metres for safety. An average (recorded to the nearest 0.1 second) of triplicate measures was used for the determination of sarcopenia.[12]

Grip strength was measured from the dominant hand unless affected by disease or disability, using an Advanced Hand Dynomometer (Mentone Educational, Australia) with the participant standing facing forward, legs straight and feet approximately 15 cm apart. If unable to stand, grip strength was collected in a seated position as this has been deemed as an appropriate alternative.[35] Participants held the dynamometer so that it did not touch the thigh and squeezed with maximum force, without swinging the arm, for three seconds. The average of triplicate measures was used in analysis. Gender specific cut-offs were adopted using data from the North West Adelaide Health Study, at two standard deviations below the mean of young adults.[36]

Statistical analysis

Analysis was conducted using SPSS for Windows version 22 (SPSS Inc, Chicago, IL). Continuous variables were assessed for normality using the Kolmogorv-Smirnov test and reported as mean (SD) or median (IQR). Sample characteristics were expressed as frequencies (n, %). Chi-square analyses to determine differences between types of vascular participants for the categorical variables gender, age categories, live in their own home, whereas Fishers Exact test was employed for the variables BMI categories, lives in aged care and lives in supported care. One-way ANOVA with Tukey post hoc test or Kruskal-Wallis test was used for continuous variables. Statistical significance was set at $p<0.05$.

RESULTS

Participant characteristics

A total of 2229 patients were admitted and screened for eligibility during the study period. Of these, 1327 were ineligible (day admissions, unable to be recruited within 72 hr, previous participant), 568 declined to participate, and 12 withdrew before data collection resulting in 322 participants. Table 2 displays participant demographics. The majority of participants were male (69.3%) and over 65 years old (61.6%). Sixty-four per cent were overweight or obese. The most prevalent comorbidities across all participants were hypertension (66.9%), type 2 diabetes (51.1%) and hyperlipidaemia (45.5%).

Subgroup analysis showed some differences amongst the types of vascular disease. There was a significant difference in age across the groups with post-hoc analyses finding the participants in the aneurysmal group were significantly older ($p<0.001$) than the diabetic foot and "other" participants. Significant differences were also observed across subgroups in median BMI ($p<0.001$), BMI category ($p<0.001$), median LOS ($p=0.003$) and in the prevalence of all comorbidities except for smoking status.

Table 3 displays the range of parameters measuring nutritional status and/or nutritional risk. According to the PG-SGA, 15.5-20% of participants were moderately/suspected malnourished (PG-SGA-B) or severely malnourished (PG-SGA-C), with no differences across the groups ($p=0.607$). The MUST identified 12.5% of participants overall as being at risk of malnutrition with a significantly different proportion of at risk according to subgroups ($p=0.024$) where the PAD, occlusive other and venous groups were deemed to have a lower proportion at risk of malnutrition compared to other groups.

Micronutrient status varied however the majority of participants (78.6%) had suboptimal vitamin C levels and over half (55.6%) had low vitamin D levels (Table 3). Other nutrients of note were zinc, iron and vitamin B-12 with over 40% of participants showing low levels. No significant differences were observed between the vascular types for any of the nutrients or nutrition related biochemistry.

Assessment of sarcopenia using appropriate cut-offs

Table 1. Cut-offs used for the three parameters utilised in the diagnosis of sarcopenia in 322 vascular surgery inpatients

Parameter	Cut-off		Reference
	Male	Female	
Skeletal muscle index (SMI) (kg/m^2)	<6.4	<5.5	Baumgartner et al, 1998
Grip strength (kg)	<28	<16	Massy-Westropp et al , 2011
Gait speed (m/s)	<1.0		Cruz-Jentoft et al, 2010

Table 2. Characteristics of 322 participants admitted to a vascular surgery unit

	Aneurysmal (n=35, 10.9%)	PAD (n=94, 29.2%)	Occlusive other (n=28, 8.7%)	Venous (n=20, 6.2%)	DM foot infection (n=92, 28.6%)	Other (n=53, 16.5%)	Total (n=322)	*p*-value
Male (n, %)	28 (80)	63 (67.0)	17 (60.7)	13 (65)	67 (72.8)	35 (64.3)	223 (69.3)	0.549
Age (median, IQR)	75.0 (60, 90)	72.5 (52.5, 92.5)	70.0 (11.86)	69.5 (49.5, 89.5)	63.0 (45,81)	68.0 (48, 88)	68.0 (48, 88)	<0.001
Age categories (n, %)								<0.001
<65 years	2 (5.7)	31 (33.0)	11 (39.3)	7 (35)	52 (56.5)	20 (37.7)	123 (38.2)	
65 and above	33 (94.3)	63 (67.0)	17 (60.7)	13 (65)	40 (43.5)	33 (62.3)	199 (61.8)	
Median BMI (IQR) (n=319)	26.4 (24.1, 29.7)	26.4 (23.4, 28.9)	27.9 (26.2, 30.9)	30.6 (24.4, 35.3)	31.5 (27.4, 37.1)	28.9 (25.6, 34.0)	28.2 (20.3, 35.2)	<0.001
BMI category (n, %) (n=319)								<0.001
Underweight	2 (5.7)	15 (15.8)	1 (3.6)	3 (15.8)	0 (0)	7 (13.2)	28 (8.8)	
Normal	16 (45.7)	36 (37.9)	8 (28.6)	3 (15.8)	11 (12.0)	12 (22.6)	86 (26.9)	
Overweight/Obese	17 (48.6)	44 (46.3)	19 (67.9)	13 (68.4)	81 (88)	32 (60.4)	206 (64.4)	
Living situation (n, %)								
Lives alone	11 (31.4)	32 (33.7)	11 (39.3)	6 (30)	28 (30.4)	17 (32.1)	105 (32.6)	0.97
Lives with another person/s	24 (68.6)	54 (57.4)	17 (60.7)	12 (60)	62 (67.4)	34 (64.2)	203 (63.0)	0.78
SCF	0	0	0	1 (5)	1 (1.1)	0	2 (0.6)	0.18
RACF	0	8 (8.5)	0	1 (5)	1 (1.1)	2 (3.8)	12 (3.7)	0.09
Comorbidities (n, %)								
Hyperlipidaemia	17 (48.6)	47 (50.0)	13 (46.4)	5 (25)	48 (52.2)	18 (32.1)	146 (45.3)	0.048
Hypertension	27 (77.1)	61 (64.9)	23 (82.1)	9 (45)	67 (72.8)	30 (53.6)	215 (66.8)	0.009
Diabetes	10 (28.6)	39 (41.5)	5 (17.9)	5 (25)	92 (100)	14 (25)	164 (50.9)	<0.001
IHD	13 (37.1)	27 (28.7)	5 (17.9)	1 (5)	15 (16.3)	11 (19.6)	71 (22)	0.027
Current smoker	6 (17.1)	18 (18.9)	4 (14.3)	3 (15)	10 (10.9)	8 (14.3)	49 (15.2)	0.777
LOS (median, IQR)	10 (6, 16)	8 (5, 14)	6 (4, 11)	4 (3, 8.75)	8.5 (6, 13)	7 (3.5, 10)	8 (1,15)	0.003

SCF: supported care facility; RACF: residential care facility; LOS: length of stay.

Table 3. Proportion of 322 vascular surgery inpatients identified as at risk of malnutrition, malnourished or sarcopenic

	Aneurysmal (n=35, 10.9%)	PAD (n=94, 29.2%)	Occlusive other (n=28, 8.7%)	Venous (n=20, 6.2%)	DM foot infection (n=92, 28.6%)	Other (n=53, 16.5%)	Total (n=322)	*p*-value
Nutritionally at risk (n, %)								
MUST (n=320)	6 (17.1%)	7 (7.4)	0	1 (5.3)	15(16.3)	11 (20.8)	40 (12.5)	0.024
PG-SGA rating (n, %)								0.607
A	28 (80)	76 (80)	27 (96.4)	16 (80)	81 (88)	44 (83.0)	272 (84.2)	
B	7 (20)	18 (18.9)	1 (3.6)	4 (20)	11 (12)	9 (17.0)	50 (15.5)	
C	0	1 (1.1)	0	0	0	0	1 (0.3)	
Micronutrients (n, %)								0.169
Vitamin A (n=241)	10 (37)	12 (16.7)	1 (5.3)	2 (14.3)	15 (19.7)	5 (14.7)	45 (18.7)	
Vitamin C (n=243)	21 (77.8)	57 (78.1)	18 (94.7)	10 (71.4)	59 (77.6)	27 (77.1)	191 (78.6)	0.323
Vitamin D (n=243)	12 (44.4)	43 (58.1)	10 (55.6)	8 (57.1)	49 (64.5)	14 (40)	135 (55.6)	0.389
Vitamin E (n=240)	0	0	0	0	1 (1.3)	0	1 (0.4)	0.826
Zinc (n=244)	14 (51.9)	37 (50)	7 (36.8)	7 (50)	29 (38.2)	14 (40)	107 (43.9)	0.569
Selenium (n=244)	6 (22.2)	17 (23)	0	2 (14.3)	10 (13.2)	10 (28.6)	45 (18.4)	0.229
Iron (n=270)	17 (58.6)	40 (50.6)	12 (52.2)	3 (17.6)	31 (38.3)	22 (51.2)	124 (45.9)	0.065
Vitamin B-12 (n=258)	10 (35.7)	35 (45.5)	11 (50)	8 (50)	30 (39)	18 (45)	111 (43)	0.833
Folate (n=254)	0	0	0	0	1 (1.3)	0 (0)	1 (0.4)	0.951
Sarcopenic[†] (n, %)	1 (3.8)	6 (10.3)	0	1 (7.1)	2 (3.4)	0	10 (5)	0.386

[†]Only calculated for those aged 65 years and over (n=199; aneurysmal, n=33; PAD, n=63; occlusive other, n=17; venous, n=13; DM foot infection, n=40; other, n=33).

(Table 1) and algorithm,[12] found only 5% (n=10) to be sarcopenic with no significant difference observed between the groups.

DISCUSSION

This study found a high prevalence of nutritional deficits, particularly micronutrient deficits, in this patient group that were not recognised by the MUST or PG-SGA as neither of these tools include micronutrient status as a component of the tool. This has implications for the timely identification of those at risk and expedient nutrition intervention in a vulnerable patient group where malnutrition has a significant impact on patient outcomes.[7,9-11]

To identify patients who warrant a comprehensive nutrition assessment, an appropriate nutrition screening tool is crucial. Currently, the MUST is used in our health care setting however the results of this study showed that only 12.5% of participants were identified as requiring further nutrition assessment. This result is not surprising when we consider the parameters included in the MUST.[24] Given the study participants were mostly overweight/obese with minimal reporting of unintentional weight loss and while acutely unwell, they were not deemed (for the most part) critically unwell or unlikely to have no intake for 5 days they were unlikely to score highly. There are screening tools available that may be more appropriate that encompass parameters known to be prevalent in this group that affect nutritional status, such as impaired mobility, psychological stress and depression.[37-40] Exploration of the appropriateness of alternative screening tools is warranted.

The prevalence of malnutrition according to the PG-SGA was 15.5% overall which is much lower than other studies in vascular patients.[6-8] A key difference between the current study and other is the heterogeneity of our sample and the types of pathologies included. A large proportion of the previous research has been conducted in a single type of vascular disease (e.g. PAD patients only) and given the variation in pathophysiological processes of different vascular diseases, varying manifestations of symptoms and nutritional deficiencies it is not surprising that results from this pragmatic study are different to previous studies. There were 6 subgroups of participants in this study and within those groups, there was variation in the severity of disease, the presence of wounds/ulcers and whether surgical intervention occurred. Despite being managed by a vascular surgery unit, some participants (e.g. renal access patients, thoracic outlet syndrome and diabetic foot ulcers) do not have a defined cardiovascular process, which would impact on the results and make it difficult to draw comparisons with the literature.

Other potential reasons for the lower prevalence of malnutrition in this study are the different methods of identifying and assessing nutritional status and also much smaller sample sizes of 23-71 participants[6-8] compared to our large sample size. Higher rates of malnutrition were observed in studies which incorporated albumin as a measure of nutritional status and physical examination/anthropometry however there were insufficient details to determine how the physical measures were completed or utilised in the assessment.[6,7] The highest rate of malnutrition at 90% was observed in 32 participants all undergoing trans-tibial amputation for either gangrene or uncontrollable pain and hence had more progressive disease which may explain the higher rate of malnutrition.[8]

We observed alarming rates of micronutrient deficits between 40-78% depending on the nutrient studied. Previous literature has reported on the micronutrient status of vascular surgery patients, however these studies have again been conducted in a single type of vascular disease making it more difficult to compare to the current study. A number of studies report that low vitamin D is common in PAD patients[18,41-43] and diabetic foot infections[44] with worsening deficits as the disease progresses,[45] and association with increased rates of amputation and CVD events.[46] Given the prevalence of suboptimal vitamin D status and the impact of limb amputation and CVD on morbidity, correcting vitamin D status is crucial. Subclinical vitamin C levels were common in our sample at 78%, substantially higher than the 14% reported by Langlois et al.[21] Suboptimal vitamin C status is of concern due to its antioxidant properties and role in wound healing which is of significance in this population.[23] Literature supports the current findings regarding vitamin B-12 and iron,[20,47,48] and while prevalence may be lower than the current study deficits of a variety of micronutrients appear to be common in vascular surgery patients.

The difference in the rates of malnutrition according to PG-SGA and the rates of micronutrient deficits indicates that a more thorough nutritional assessment that considers malnutrition beyond the traditional weight loss is warranted.

In this study, the prevalence of sarcopenia was low at 5%. This was surprising given the proposal that adults with PAD have a decline in skeletal muscle mass or atrophy of skeletal muscle when compared to age-matched controls,[13] particularly as the disease progresses[49] and that reduced SMM has also been observed in aneurysmal patients.[16] Muscle disuse due to pain in claudication and an increased requirement for protein and energy associated with ischaemic ulcers and vascular interventions[50,51] is common as well as reduced functional ability and mobility[13] which would affect gait speed. Matsubara et al[52] found that almost 44% of their CLI patients had sarcopenia when determined by skeletal muscle area assessed using computed tomography (CT), a much higher rate than observed in the present study. A possible reason for the lower than expected prevalence could relate to the cut-offs and algorithm used to diagnose sarcopenia in this study. There is no definitive method to diagnose sarcopenia, however the most common, widely accepted consensus method was utilised.[12] Also, there are no defined cut-offs for grip strength, gait speed and SMI in this patient group and while the most appropriate cut-offs were used based on the literature, they are based on populations dissimilar to the population studied

This study has a number of strengths, the first of which is its large sample size encompassing a range of vascular pathologies making it more generalizable to the general vascular surgery population. A wide range of nutritional parameters, including nutritional biochemistry were collected enabling researchers to assess multiple markers of nutritional status and all assessments were conducted by professionally trained dietitians.

This study is not devoid of limitations. The heterogeneity of our sample may be a limitation in terms of being able to make comparisons to previous research where single vascular disease types have been studied in isolation. However it is reflective of the patient population that clinicians encounter and hence results of this pragmatic study are useful for clinicians working in the area. This study measured nutritional status on admission and hence any deterioration and resultant malnutrition that may have occurred during admission was not determined. Available literature has shown that nutritional status affects clinical outcomes, however this was not investigated in this study. Future studies would benefit from exploring this relationship.

Conclusions

This study demonstrates the nutritionally vulnerability of vascular surgery patients and a clear screening process to identify and then assess these patients is warranted. Neither the MUST nor PG-SGA identified the full extent of nutritional vulnerability when micronutrient status was included. A number of micronutrients are crucial in these patients and hence a more comprehensive assessment that encompasses a wider range of parameters, including micronutrient status appears warranted.

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AUTHOR DISCLOSURES

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