ORIGINAL RESEARCH

An observational study of perioperative nutrition and postoperative outcomes in patients undergoing laparotomy at Queen Elizabeth Central Hospital in Blantyre, Malawi

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Abstract

Background
Nutritional status in patients undergoing surgery can influence their immune function, tissue repair and, hence, clinical outcomes. This study aimed to assess the perioperative nutrition and postoperative outcome of patients undergoing laparotomy at a tertiary hospital in Malawi.

Methods
A total of 25 patients were included in this prospective, observational study. The Subjective Global Assessment was used to classify each patient according to nutritional status. Handgrip strength was measured for each patient preoperatively and at day 3 postoperatively. Anthropometric measurements were also done. Protein and energy requirements for each participant were estimated and compared to the quantities provided by the hospital diet. Patients were followed up until discharge and outcome variables which included length of hospital stay and wound dehiscence or infectious complications were recorded.

Results
Of the study participants, 20% were well-nourished, 52% were moderately malnourished and 28% were severely malnourished. The median handgrip strength decreased at day 3 postoperatively from the preoperative handgrip strength. Well-nourished patients had higher handgrip strength than malnourished patients both preoperatively and postoperatively. Total energy and protein provided by the hospital diet were significantly lower than the estimated requirements for the patients. Severely malnourished patients had increased median length of hospital stay and increased rate of postoperative complications. Preoperative and postoperative day 3 handgrip strength correlated negatively with the number of postoperative complications and length of hospital stay.

Conclusion
This study showed high rates of malnutrition and inadequate in-hospital nutritional support which were associated with poor clinical outcomes, especially in severely malnourished patients. Proper nutritional assessment and provision of adequate nutritional support should be reinforced in surgical patients to promote favourable clinical outcomes postoperatively. Further studies with larger sample sizes in other patient populations and hospitals in Malawi are required in this area.

Introduction

Malnutrition remains a challenge and is highly prevalent among in-patients[1,2] . Globally, current data suggest that 19 to 59% of hospitalised adults have malnutrition, with the higher range in low-income and middle-income countries[3-10]. Malnutrition is of special importance for the surgical patient due to its influence on postoperative patient outcomes. The association between preoperative weight loss and surgical mortality was first documented in 1936 by Studley[11]. Since then, considerable evidence has shown that preoperative malnutrition is associated with postoperative complications, including infection, delayed wound healing, and increased length of hospital stay[12]. Furthermore, several studies have shown that treatment of severe malnutrition before surgery improves postoperative clinical outcomes[13-15].

Malnutrition refers to a state of inadequate or excess nutrition, with or without the presence of inflammation, which leads to changes in body composition and impaired physiologic function[16]. An individual who presents for surgical evaluation may have comorbidities that predispose to chronic disease-related malnutrition, such as HIV, organ failure, cancer, metabolic syndrome, and many other conditions characterised by persistent moderate inflammation[17]. Preoperative malnutrition could also result from simple starvation-related malnutrition, defined as chronic undernutrition in the absence of an inflammatory condition. Regardless of preoperative nutrition status, all patients are at an increased risk of acute disease-related malnutrition after surgery[17]. Any physiologic injury stimulates a metabolic stress response mediated by inflammatory cytokines and catecholamines. Collectively, these increase energy expenditure and muscle proteolysis in proportion to the severity of the injury[18]. Coupling this with decreased or restricted nutrient intake and decreased mobility postoperatively leads to rapid deterioration of lean body mass and function[19]. Thus, even a well-nourished or over-nourished patient who undergoes a major surgery can develop severe acute disease-related malnutrition within as little as 10 days if not fed appropriately[17].

Evidence-based recommendations are available to guide nutritional care in the perioperative period. Preoperative nutrition therapy recommendations are dependent on the patient's nutritional status. As such, all patients should be screened for malnutrition risk prior to surgery and evaluated by a dietitian if identified as high risk. If the patient is diagnosed with severe malnutrition and the surgical intervention is not emergent, the surgery should be postponed 7 to 10 days while the patient is given appropriate nutritional support[20,21].

On the day of surgery, the European Society of Anesthesiology recommends that patients be allowed to eat solid food up to 6 hours before surgery[22]. Intake of clear liquids is encouraged up to 2 hours before surgery, from which point the patient should take nothing by mouth. The Enhanced Recovery After Surgery (ERAS) protocol, which has repeatedly shown significant benefits for patients undergoing gastrointestinal surgery, includes preoperative carbohydrate loading with a clear liquid beverage to possibly reduce postoperative insulin resistance, nausea, and vomiting[22].

After surgery, most patients can resume a normal diet. There is no evidence that gastric decompression or fasting after surgery is beneficial[23]. Rather, enteral feeding or a solid diet should commence within 24 hours[22]. Due to the metabolic stress response, surgical patients have increased protein and kilocalorie requirements after surgery[18]. At least 60% of protein requirements should be met within 7 to 10 days to prevent complications of malnutrition[20,24]. Thus, the European Society of Enteral and Parenteral Nutrition guidelines state that all patients should be fed by mouth soon as possible, preferably within 24 hours, or initiated on enteral tube feeding if not anticipated to eat orally in 7 days[25]. In cases of intestinal failure, parenteral nutrition should be initiated as soon as possible for a malnourished patient, or after 7 days for a well-nourished patient when oral or enteral nutrition does not seem feasible in the following 3-7 days[26,27].

Currently, there is paucity of data on the quality of nutrition care services offered to surgical patients in Malawi, against these evidence-based guidelines. Furthermore, there is dearth of data regarding the nutrition status of adult hospitalised patients in Malawi. Therefore, this prospective observational study was aimed at assessing the preoperative nutrition status and the currently available nutrition interventions for adult surgical patients undergoing laparotomy at a tertiary referral hospital in Malawi. The nutrition provided to patients by the hospital was evaluated for adequacy of protein and kilocalorie content, as surgical patients require increased intake of these nutrients to mitigate the catabolic effect of metabolic stress. The influence of these factors on postoperative outcomes was also investigated.

Methods

Study population

This prospective observational study was conducted at Queen Elizabeth Central Hospital (QECH) in Blantyre, Malawi, and enrollment was done between July and September 2016. Adult patients admitted to the male and female surgical wards and scheduled for laparotomy were enrolled in the study. Because immunosuppression is one of the main drivers of malnutrition-related consequences, 28 participants with HIV infection and confirmed cancer diagnosis were excluded from the study. Participants aged 65 years and above were also excluded. Using an alpha error of 5% and power of 80%, the sample size was calculated at 25 patients, to detect at least 20% prevalence of malnutrition in the study population. The study protocol was approved by College of Medicine Research and Ethics Committee (MBBS/08/16/02). Written informed consent was sought and provided by all the participants before their inclusion into the study. To ensure the protection of privacy and confidentiality of the information provided, study codes (and not names) were used on the data collection sheets for individual participants. Data that could identify the individual participants was securely stored and was only accessible to the study investigators.

Nutrition assessment

The Subjective Global Assessment (SGA) was used to assess and classify each patient's nutritional status as severe malnutrition (SGA Class C), mild or moderate malnutrition (SGA Class B), or well nourished (SGA Class A). The SGA is a globally recognised, validated nutrition assessment tool that uses clinical history and physical exam to evaluate nutrition status and predict outcomes[29,30]. SGA uses a scoring system based on the clinician's subjective assessment (mild, moderate, or severe) of the patient's reported dietary intake, weight changes, gastrointestinal symptoms and functional capacity along with the degree of metabolic stress in their diagnosis, and a physical examination. A registered dietitian trained medical students who were part of the study team how to use the SGA method.

Handgrip dynamometry was used to assess functional capacity. Height and weight were measured preoperatively. The anthropometrics were used to calculate body mass index (BMI). Postoperative protein and energy requirements for each participant were also estimated. Energy (kilocalorie) needs were estimated using the Harris-Benedict equation with an individualised stress factor of 1.2 or 1.3. Protein requirements were dosed between 1.2-1.5 grams/kg body weight[25,27]. The specific stress factor and protein requirements were determined by an experienced registered dietitian, according to the severity of the surgery and other metabolic stressors.

Outcome monitoring

Patients were followed prospectively until discharge. Outcome variables including length of hospital stay and development of wound dehiscence or infectious complications were recorded. An infectious complication was considered when there was persistent fever (temperature >38 ºC) 72 hours after surgery. Lastly, handgrip strength was measured in all patients on day 3 postoperative.

Menu analysis

The recipes for food provided to patients on a standard diet from the hospital kitchen were collected. The hospital menu was referenced and cross-checked with kitchen staff. Portion sizes are not standardised. Therefore, the researchers estimated the average portion sizes by observing the meal service. All the food served to one patient in one day was then analysed for protein and kilocalorie content using the Tanzania Food Composition Table[31]. Since the menu is generally the same day to day, only one day's menu was analysed.

Statistical analysis

Statistical analysis of the data was done using Stata version 12 (StataCorp, USA) and GraphPad Prizm version 7.01 (GraphPad Software, Inc, USA). Normality for the data was assessed using the Shapiro-Wilks test. Descriptive statistics were expressed as median (IQR) for the continuous data. The Wilcoxon rank-sum test (or Mann-Whitney U-test) was used to test the equality of two medians, to investigate differences in the measured variables. To test for differences between medians of the analysed variables at different points in time, the Wilcoxon paired rank-sum test and the Friedman test (K-related samples) were used. To measure the associations between the variables, Spearman's test of association was used. A p-value of <0.05 was considered statistically significant.

Results

A total of 34 patients were screened and 25 patients who fit the study criteria were included (see Figure 1). The characteristics of the study population are given in Table 1. The sample was well distributed between males and females. The major indication for laparotomy in the study sample was prostatectomy due to benign prostatic hypertrophy and intra-abdominal tumours that had not yet been diagnosed by histopathology. With regards to post-operative complications, 72 % of the study participants either developed incision-wound infection or dehiscence. No deaths were recorded from the participants during the study period. According to the BMI classification of nutritional status, most of the patients (76%) had normal weight, only a few were overweight

Table 1. Characteristics of the study population

Gender, n (%)	
Males	13 (52%)
Females	12 (48%)
Age [years], median (IQR)	38 (28.5-49)
Indication for laparotomy n (%)	
Prostatectomy	11 (44%)
Bowel obstruction	4 (16%)
Intra-abdominal tumours	8 (32%)
Exploratory laparotomy	2 (8%)

(6%) and none was underweight or obese (see Table 1). Nevertheless, using the SGA classification of nutritional status, only 20% of the participants were categorised as well-nourished. The remaining 80% were either moderately malnourished (52%) or severely malnourished (28%).

Handgrip strength was assessed in this study to measure the functional capacity of the patients both preoperatively and day 3 postoperatively. Figure 2 shows a comparison of the handgrip strength between the two-time points. Notably, the median handgrip strength for the entire study group was 22.3 kg (20-33) preoperatively but decreased significantly to 18.4 kg (14-27) postoperatively (p<0.0001). Handgrip strength was then analysed per SGA categories (Figure 3). Notably, the handgrip strength was associated with SGA class, where class A had a higher median handgrip strength than classes B and C both preoperatively (class A 33 kg (25.25 - 40.4), class B 25.55 kg (21.85 – 34), class C 20 kg (16 – 22)) (p<0.0001) and postoperatively (class A 27 kg (16.5 - 39), class B 20 kg (17.25 – 27.75), class C 14 kg (12 – 15)) (p=0.0004).

The daily energy and protein requirement for each patient was calculated, accounting for both the basal physiological needs and the stress associated with surgery. The typical diet provided by the hospital was porridge with some sugar in the morning and nsima (thick maize porridge) with beans, cabbage or both for lunch and supper.

The diet was analysed and an estimate of the total energy and protein provided through the diet was calculated. Figures 4 and 5 depict comparisons between the total energy requirements and what was provided; and the protein requirements against what was provided. Both the total energy (1279.8 kcal) and protein (31.54) provided by the

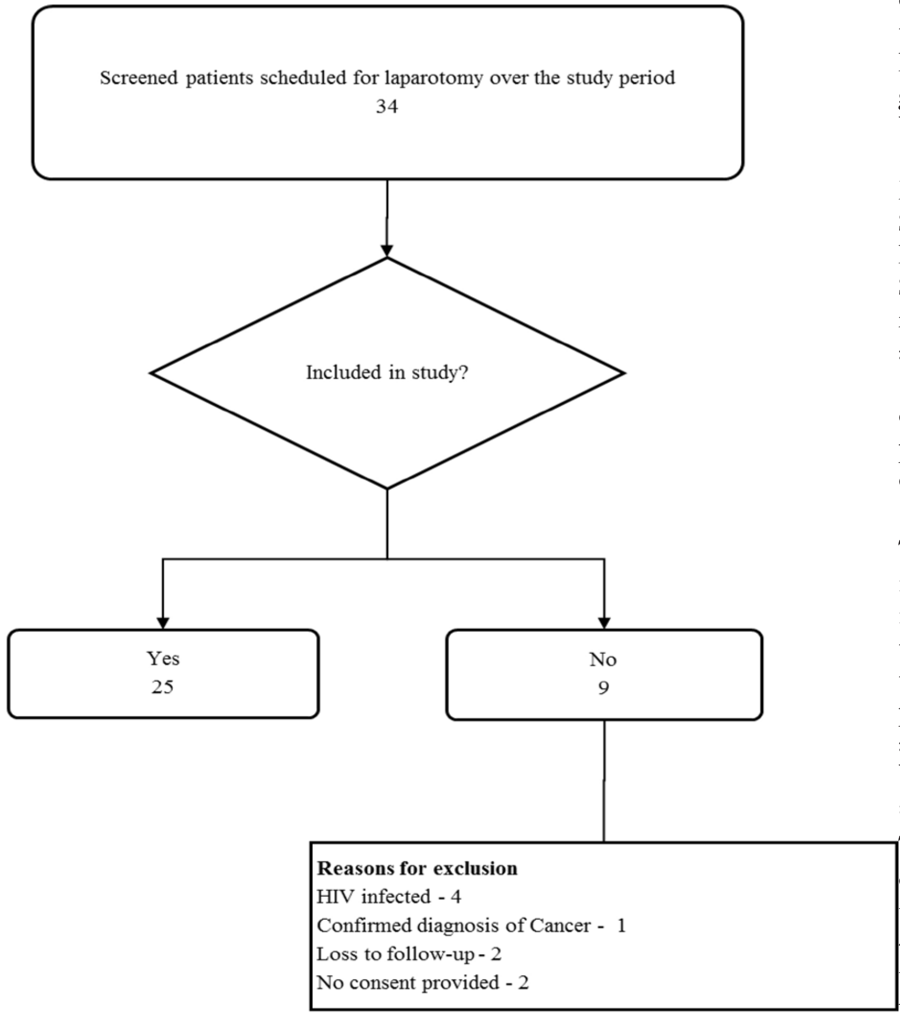

Figure 1. Flowchart of patients who met inclusion/exclusion criteria for the Study

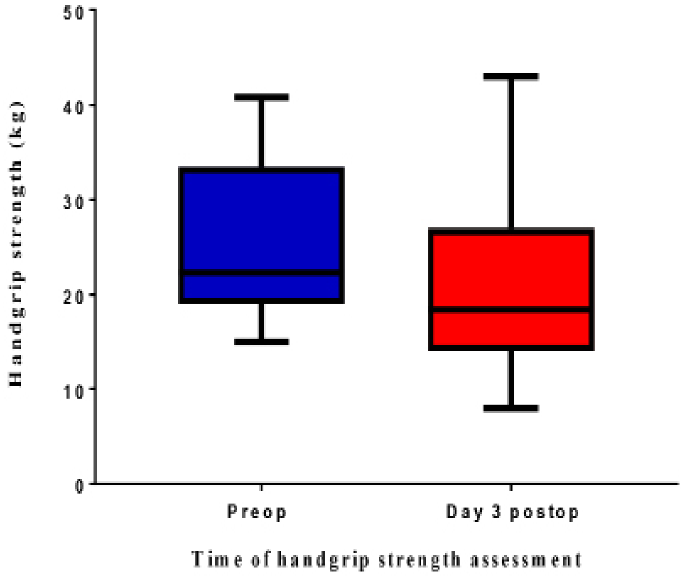

Figure 2. Box plot of handgrip strength of the dominant hand preoperatively and at day 3 postoperatively. The median handgrip strength at day 3 postoperative was significantly lower than the preoperative handgrip strength (Wilcoxon paired rank-sum test p<0.0001).

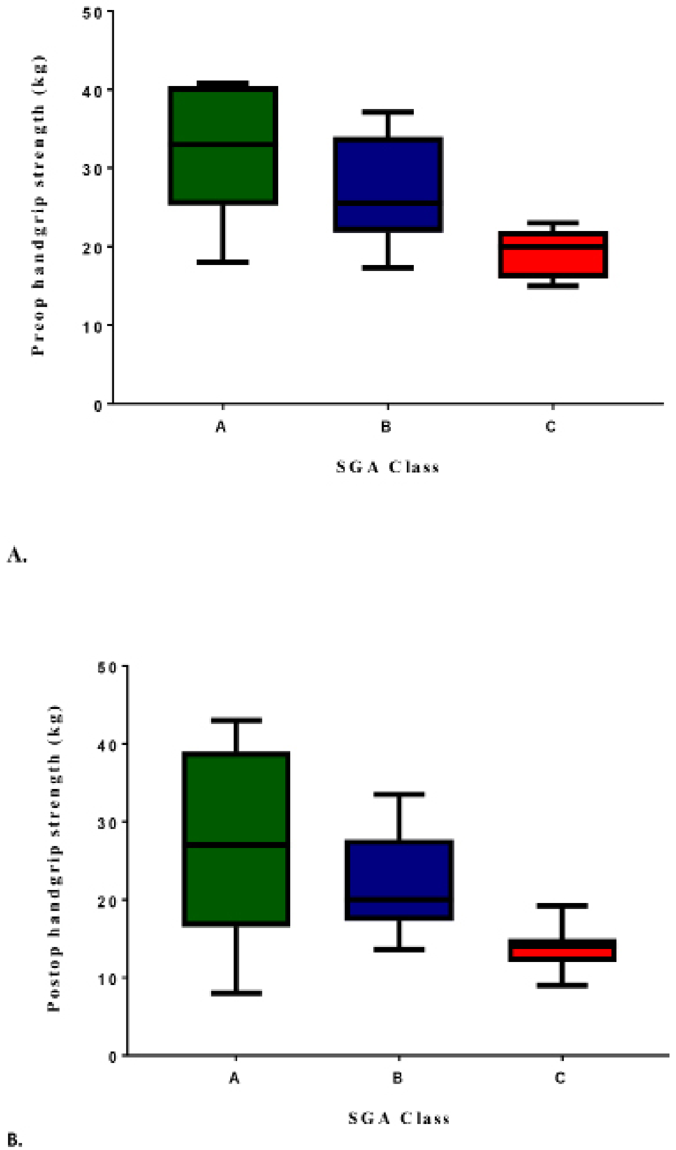

Figure 3. Handgrip strength among the SGA classes preoperatively (A) and at day 3 postoperatively (B). Lower SGA classes B and C had decreased handgrip strength compared to SGA class A using Friedman test, both preoperatively (p<0.0001) and at day 3 postoperatively (p=0.0004).

hospital diet were statistically significantly lower than the estimated requirements (1564 kcal (1488 – 1809 and 72 g (60.52 - 81) respectively) (p<0.0001). According to the calculated estimates, none of the patients met their energy and protein requirements by the provided hospital diet alone. It should be noted, however, that none of the patients was provided with enteral or parenteral nutrition. Also, these calculations were based on a patient who solely depended on the nutritional support provided by the hospital, and hence no food items provided from other sources were included in the energy and protein analysis of this study. The proportion of postoperative complications in the study group was 72%. Of all these complications, 59% were observed in patients who were in SGA class C, while those of class B contributed 31% and only 10% SGA class A. The median length of hospital stay was 5 days (4 – 7). However, severely malnourished patients (SGA class C) had a median length of hospital stay of 8 days (7 - 9). Well-nourished patients (SGA class A) had a median length of stay of 4 days (4 - 4).

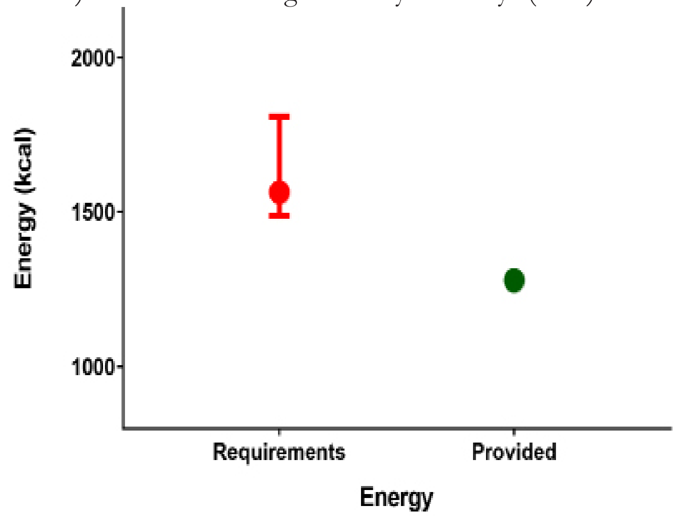

Figure 4. Comparison between the median (IQR) total energy requirements for the patients and the actual provision from the hospital diet. Total energy provided was significantly lower than the median energy requirement for patients (Wilcoxon rank-sum test p<0.0001).

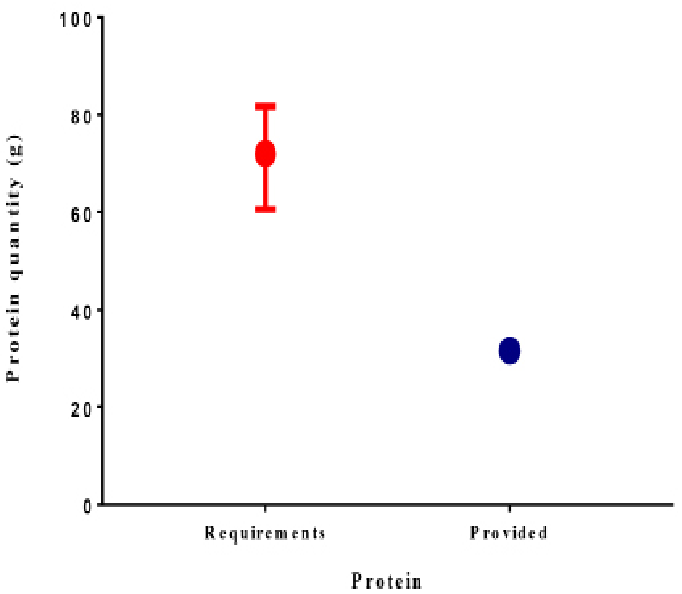

Figure 5. Comparison between the median (IQR) protein requirements for the patients against provision from the hospital diet. Total protein provided was significantly lower than the median protein requirement for patients using the Wilcoxon rank-sum test (p<0.0001).

Those who were mildly or moderately malnourished (class B) had a median length of stay of 5 days (4 - 5) (p<0.0001). Association between handgrip strength and outcome variables was assessed. Notably, both preoperative and day 3 postoperative handgrip strength significantly correlated negatively with the number of postoperative complications and length of hospital stay (see Table 2).

Table 2. Association between handgrip strength and outcome variables

	handgrip strength v. complications		handgrip strength v. hospital stay	
Study time	*Spearman's rho*	*p-value*	*Spearman's rho*	*p-value*
Preoperative	-0.46	0.02	-0.49	0.01
Day 3 postop	-0.49	0.01	-0.48	0.01

Discussion

To our knowledge, this is the first study to assess the nutritional status, nutritional interventions and outcomes in a subset of surgical patients undergoing laparotomy at a tertiary referral hospital in Malawi. The study has revealed that 80% of the patients had some degree of malnutrition with 28% severely malnourished. Considering that at least 39% of Malawians are food insecure and that patients at QECH are referred from district hospitals that serve rural communities, this result is not very surprising[32]. Other studies from low-income settings in Africa have reported lower rates of in-hospital adult malnutrition. Uganda and Burundi reported rates of 47% and 59%, respectively[33,34]. However, low-income regions within Brazil found 78% of adult inpatients, of which more than 50% were surgical patients, were malnourished[8]. Multiple upper-middle income countries have found about 50% of adult inpatients as malnourished[3,9]. Even in high-income settings, for example Australia and the United States of America, the rate of malnutrition in surgical inpatients may be as high as 48%.5,6 The higher rate of malnutrition in the current Malawian study, therefore, is likely due to the coupled effect of the disease processes and inadequate nourishment owing to food insecurity, which increases the risk of malnutrition in the population.

Nutritional status in this study was assessed using the SGA classification, a validated tool for nutritional assessment for hospital patients[29,30]. We observed that even though 80% of the patients were categorised as malnourished using the SGA classification, BMI did not identify anyone as undernourished (BMI <18.5). This confirms the limitation of BMI as a less sensitive tool for assessing malnutrition in acute and complicated clinical conditions which obscure undernutrition[35,36]. BMI is a useful measure in the general population, where it correlates with mortality, although the traditional cutoffs for underweight (<18.5 kg/m^2), overweight (>25 – 29.9 kg/m^2), and obesity (>30 kg/m^2) are derived from data in predominantly Caucasian populations[37]. In an acutely ill individual, when metabolic changes and fluid shifts occur rapidly, BMI is not useful because weight changes are confounded by fluid status[38]. The use of SGA is, therefore, preferable to BMI in such clinical settings. Since SGA does not rely on laboratory or anthropometric measures, it is a practical and cost-effective tool for Malawian hospitals[38].

Our finding that the severity of preoperative malnutrition according to SGA class correlated with postoperative complications and length of hospital stay is consistent with the literature[5-7,12,39]. Poor SGA class has also been associated with increased mortality in other studies[39]. This finding draws attention to the critical importance of nutritional assessment by a trained professional prior to surgery. Currently, to our knowledge, there is no formal nutritional screening or assessment performed in adult inpatients at QECH. Consequently, patients who would benefit from 7-10 days of nutrition repletion before surgery are not identified[20,21]. There are simple screening tools such as the Nutrition Risk Score 2002 (NRS 2002), Mini Nutrition Assessment (MNA) and the Malnutrition Universal Screening Tool (MUST) that could be implemented to identify patients at high risk of malnutrition for potential preoperative nutrition therapy[40].

In this study, handgrip strength was significantly lower at day 3 postoperatively than that at preoperative assessment. This is an indication of a decline in functional capacity due to loss of lean body mass[19]. Major surgery elicits metabolic responses associated with increased muscle proteolysis and increased energy expenditure that puts patients at risk of acute disease-related malnutrition, where even an excess of adipose tissue will not prevent catabolism of lean tissue[17,18]. This catabolic state cannot be reversed via protein and energy intake; however, adequate provision slows lean body mass wasting, mitigates the inflammatory response, and, if provided enterally, maintains the integrity of the gastrointestinal tract as a major immune organ[25]. Handgrip strength correlates highly with nutrition status in hospitalised patients, as is replicated in the present study. Moreover, this tool objectively captures a change in nutrition status faster than any anthropometric or laboratory marker[41]. The present study showed that handgrip strength both preoperatively and postoperatively correlated negatively with the length of hospital stay and the rate of complications postoperatively. These results indicate that in-hospital decline in nutritional status was associated with increased risk of complications. These findings, therefore, call to the importance of both the optimal nutritional status of patients before surgery and appropriate nutritional interventions postoperatively. The goal of nutrition therapy after surgery is to ensure the preservation of lean body mass and immune function, which is essential for healing in these patients[42,43]. For a patient who already exhibits severe muscle wasting, it is imperative that oral, enteral, or parenteral nutrition support be initiated as soon as possible after surgery[26]. Postoperatively, the usual practice at QECH is to start the patient on a liquid diet only after 24 hours and in the presence of bowel sounds. The diet is then gradually advanced to a regular solid diet. In special cases, clinicians prescribe a high protein diet (HPD), which might include an egg and milk. However, HPD is rarely feasible for the kitchen to provide due to budgetary constraints. Otherwise, there are no specialised nutritional interventions available. The analysis of the standard hospital diet in this study showed gross deficiencies in energy

(284.2kcal) and protein quantity (40.46g). Such a deficient diet cannot ameliorate lean body mass wasting. It is also inadequate for tissue repair and several immune functions in an adult. According to ESPEN guidelines, four patients (16%) in the current study had indications for postoperative parenteral nutrition, which could not be provided[26]. The overall decline in handgrip strength and high rate of complications, especially in malnourished patients, may be another indication of inadequate postoperative nutrition support. The resulting unmitigated muscle catabolism has consequences. Literature has shown that a 10% loss of lean mass is associated with impaired immunity and skin integrity, and that loss of 40-45% of lean body mass is incompatible with life[42].

Appropriate nutritional management is an effective intervention. A recent meta-analysis of randomised controlled trials showed that nutrition interventions in malnourished patients reduced the risk of postoperative infectious complications by 42% and noninfectious complications by 26%[15]. The length of hospital stay was also reduced by 2.6 days[15]. Appropriate nutritional interventions are also cost-effective. Studies indicate that, on average, malnourished patients (SGA class B and C) have 31-38% higher hospital costs than well-nourished patients.4 Nutritional interventions would, therefore, reduce morbidity, mortality and the associated hospital costs.

Given the findings of this study, nutrition interventions have the potential to catalyse significant improvement to health care delivery in Malawi. Availability of registered clinical dietitians to assess and manage an individualised nutrition care plan is critical. Currently, there are no dietitians in Malawian government hospitals. However, a program to train dietitians is presently training its first cohort. Availability of adequate nutrients, in the form of food, supplements, enteral formula, and parenteral solutions is also essential. This study identifies the need for hospitals in Malawi to integrate nutritional management as an essential part of health service delivery in adult patients, especially in conditions where the evidence points to its efficacy in improving outcomes.

Study Limitations

This study is limited by its design as an observational study, and, as such, can only report associations. Interpretation of the results of this study should be made in light of its design. The calculations of energy and protein content from the diet were based on a patient who solely depended on the nutritional support provided by the hospital, and hence no food items provided from other sources were included. Further to this, the calculations were based on what was provided by the hospital, and not on the actual intake. Considering that some patients may not have taken all the food provided, actual intake may have been lower than the provision. Another limitation of the study is its sample size of 25, and even though this was adequate to provide baseline data on the topic, subgroup analyses may not be feasible. Lastly, due to the limited time frame for this study, we were unable to follow up patients after discharge to monitor mortality or rate of readmission.

Conclusions

This observational study has shown that the prevalence of malnutrition in surgical patients undergoing laparotomy at a tertiary hospital in Malawi is high. Patients with severe malnutrition experienced more postoperative complications and had increased length of hospital stay compared to well-nourished patients. The standard diet provided at the hospital for the patients was deficient in both energy and protein. Improved nutrition care may improve outcomes in surgical laparotomy patients. Further studies, with larger sample sizes in other patient populations and hospitals in Malawi, are required in this area.

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References

1. Pathirana AK, Lokunarangoda N, Ranathunga I, Santharaj WS, Ekanayake R, Jayawardena R: Prevalence of hospital malnutrition among cardiac patients: results from six nutrition screening tools. Springerplus 2014, 3:412-1801-3-412.

2. Souza TT, Sturion CJ, Faintuch J: Is the skeleton still in the hospital closet? A review of hospital malnutrition emphasizing health economic aspects. Clin Nutr 2015, 34(6):1088-1092.

3. Correia MI, Campos AC, ELAN Cooperative Study: Prevalence of hospital malnutrition in Latin America: the multicenter ELAN study. Nutrition 2003, 19(10):823-825.

4. Curtis LJ, Bernier P, Jeejeebhoy K, Allard J, Duerksen D, Gramlich L, Laporte M, Keller HH: Costs of hospital malnutrition. Clin Nutr 2017, 36(5):1391-1396.

5. Garth AK, Newsome CM, Simmance N, Crowe TC: Nutritional status, nutrition practices and post-operative complications in patients with gastrointestinal cancer. J Hum Nutr Diet 2010, 23(4):393-401.

6. Mosquera C, Koutlas NJ, Edwards KC, Strickland A, Vohra NA, Zervos EE, Fitzgerald TL: Impact of malnutrition on gastrointestinal surgical patients. J Surg Res 2016, 205(1):95-101.

7. Thomas MN, Kufeldt J, Kisser U, Hornung HM, Hoffmann J, Andraschko M, Werner J, Rittler P: Effects of malnutrition on complication rates, length of hospital stay, and revenue in elective surgical patients in the G-DRG-system. Nutrition 2016, 32(2):249-254.

8. Waitzberg DL, Caiaffa WT, Correia MI: Hospital malnutrition: the Brazilian national survey (IBRANUTRI): a study of 4000 patients. Nutrition 2001, 17(7-8):573-580.

9. Wyszynski DF, Perman M, Crivelli A: Prevalence of hospital malnutrition in Argentina: preliminary results of a population-based study. Nutrition 2003, 19(2):115-119.

10. Correia MI, Hegazi RA, Diaz-Pizarro Graf JI, Gomez-Morales G, Fuentes Gutierrez C, Goldin MF, et al. Addressing Disease-Related Malnutrition in Healthcare: A Latin American Perspective. JPEN J Parenter Enteral Nutr 2016, 40(3):319-325.

11. Studley HO: Percentage of weight loss: a basic indicator of surgical risk in patients with chronic peptic ulcer. 1936. Nutr Hosp 2001, 16(4):141-3; discussion 140-1.

12. Ho JW, Wu AH, Lee MW, Lau SY, Lam PS, Lau WS, et al. Malnutrition risk predicts surgical outcomes in patients undergoing gastrointestinal operations: Results of a prospective study. Clin Nutr 2015, 34(4):679-684.

13. Veterans Affairs Total Parenteral Nutrition Cooperative Study Group: Perioperative total parenteral nutrition in surgical patients. N Engl J Med 1991, 325(8):525-532.

14. Buzby GP: Overview of randomized clinical trials of total parenteral nutrition for malnourished surgical patients. World J Surg 1993, 17(2):173-177.

15. Zhong JX, Kang K, Shu XL: Effect of nutritional support on clinical outcomes in perioperative malnourished patients: a meta-analysis. Asia Pac J Clin Nutr 2015, 24(3):367-378.

16. Soeters PB, Schols AM: Advances in understanding and assessing malnutrition. Curr Opin Clin Nutr Metab Care 2009, 12(5):487-494.

17. Jensen GL, Mirtallo J, Compher C, Dhaliwal R, Forbes A, Grijalba RF, H et al. Adult starvation and disease-related malnutrition: a proposal for etiology-based diagnosis in the clinical practice setting from the International Consensus Guideline Committee. JPEN J Parenter Enteral Nutr 2010, 34(2):156-159.

18. Long CL, Schaffel N, Geiger JW, Schiller WR, Blakemore WS: Metabolic response to injury and illness: estimation of energy and protein needs from indirect calorimetry and nitrogen balance. JPEN J Parenter Enteral Nutr 1979, 3(6):452-456.

19. Finnerty CC, Mabvuure NT, Ali A, Kozar RA, Herndon DN: The surgically induced stress response. JPEN J Parenter Enteral Nutr 2013, 37(5 Suppl):21S-9S.

20. Weimann A, Braga M, Harsanyi L, Laviano A, Ljungqvist O, Soeters P, et al. ESPEN Guidelines on Enteral Nutrition: Surgery including organ transplantation. Clin Nutr 2006, 25(2):224-244.

21. Abunnaja S, Cuviello A, Sanchez JA: Enteral and parenteral nutrition in the perioperative period: state of the art. Nutrients 2013, 5(2):608-623.

22. Braga M: The 2015 ESPEN Arvid Wretlind lecture. Evolving concepts on perioperative metabolism and support. Clin Nutr 2016, 35(1):7-11.

23. Andersen HK, Lewis SJ, Thomas S: Early enteral nutrition within 24h of colorectal surgery versus later commencement of feeding for postoperative complications. Cochrane Database Syst Rev 2006, (4):CD004080. doi(4):CD004080.

24. Braga M, Ljungqvist O, Soeters P, Fearon K, Weimann A, Bozzetti F, et al. ESPEN Guidelines on Parenteral Nutrition: surgery. Clin Nutr 2009, 28(4):378-386.

25. Meier R, Ockenga J, Pertkiewicz M, Pap A, Milinic N, Macfie J, et al. ESPEN Guidelines on Enteral Nutrition: Pancreas. Clin Nutr 2006, 25(2):275-284.

26. Gianotti L, Meier R, Lobo DN, Bassi C, Dejong CH, Ockenga J, et al. ESPEN Guidelines on Parenteral Nutrition: pancreas. Clin Nutr 2009, 28(4):428-435.

27. Taylor BE, McClave SA, Martindale RG, Warren MM, Johnson DR, Braunschweig C, et al.Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). Crit Care Med 2016, 44(2):390-438.

28. Takele Y, Adem E, Getahun M, Tajebe F, Kiflie A, Hailu A, R et al.Malnutrition in Healthy Individuals Results in Increased Mixed Cytokine Profiles, Altered Neutrophil Subsets and Function. PLoS One 2016, 11(8):e0157919.

29. van Bokhorst-de van der Schueren,M.A., Guaitoli PR, Jansma EP, de Vet HC: Nutrition screening tools: does one size fit all? A systematic review of screening tools for the hospital setting. Clin Nutr 2014, 33(1):39-58.

30. da Silva Fink J, Daniel de Mello P, Daniel de Mello E: Subjective global assessment of nutritional status - A systematic review of the literature. Clin Nutr 2015, 34(5):785-792.

31. Zohra Lukmanji AND Ellen Hertzmark Nicolas Mlingi, Vincent Assey, Godwin Ndossi, Wafaie Fawzi: Tanzania Food Composition Tables: Harvard School of Pubic Health (HSPH), Boston, USA: Muhimbili University of Health and Allied Sciences (MUHAS), Dar es Salaam - Tanzania and Tanzania Food and Nutrition Centre (TFNC), Dar es Salaam - Tanzania and Harvard School of Pubic Health (HSPH), Boston, USA; 2008.

32. Government of Malawi: 2016/2017 FOOD INSECURITY RESPONSE PLAN. 2016, .

33. Asiimwe SB, Muzoora C, Wilson LA, Moore CC: Bedside measures of malnutrition and association with mortality in hospitalized adults. Clin Nutr 2015, 34(2):252-256.

34. Niyongabo T, Henzel D, Ndayishimyie JM, Melchior JC, Ndayiragije A, Ndihokubwayo JB, Nikoyagize E, Rwasa T, Aubry P, Larouze B: Nutritional status of adult inpatients in Bujumbura, Burundi (impact of HIV infection). Eur J Clin Nutr 1999, 53(7):579-582.

35. Shah NR, Braverman ER: Measuring adiposity in patients: the utility of body mass index (BMI), percent body fat, and leptin. PLoS One 2012, 7(4):e33308.

36. Li H, Yang G, Xiang YB, Zhang X, Zheng W, Gao YT, Shu XO: Body weight, fat distribution and colorectal cancer risk: a report from cohort studies of 134255 Chinese men and women. Int J Obes (Lond) 2013, 37(6):783-789.

37. Prospective Studies Collaboration, Whitlock G, Lewington S, Sherliker P, Clarke R, Emberson J, et al. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. Lancet 2009, 373(9669):1083-1096.

38. Abe Vicente M, Barao K, Silva TD, Forones NM: What are the most effective methods for assessment of nutritional status in outpatients with gastric and colorectal cancer? Nutr Hosp 2013, 28(3):585-591.

39. Ozbilgin S, Hanc V, Omur D, Ozbilgin M, Tosun M, Yurtlu S, et al. Morbidity and mortality predictivity of nutritional assessment tools in the postoperative care unit. Medicine (Baltimore) 2016, 95(40):e5038.

40. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M, Educational and Clinical Practice Committee, et al: ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003, 22(4):415-421.

41. Guerra RS, Fonseca I, Pichel F, Restivo MT, Amaral TF: Handgrip strength and associated factors in hospitalized patients. JPEN J Parenter Enteral Nutr 2015, 39(3):322-330.

42. Kotler DP, Tierney AR, Wang J, Pierson RN,Jr: Magnitude of body-cell-mass depletion and the timing of death from wasting in AIDS. Am J Clin Nutr 1989, 50(3):444-447.

43. Demling RH: Nutrition, anabolism, and the wound healing process: an overview. Eplasty 2009, 9:e9.