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Predicting clinical outcome of cardiac patients by six malnutrition screening tools

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Abstract

Background: Malnutrition is highly prevalent among hospital admissions and associated with, poor response to medical treatment, prolonged hospital stay, increased mortality and cost to the state. The aim of this study is to assess the ability of the nutrition screening tools to predict the clinical outcome of cardiac patients.

Methods: Five hundred and twenty six patients underwent nutritional screening via Malnutrition Screening Tool (MST), Malnutrition Universal Screening Tool (MUST), Short Nutritional Assessment Questionnaire (SNAQ), Mini Nutritional Assessment-Short Form (MNA-SF), Nutritional Risk Screening (NRS) and Subjective Global Assessment (SGA) tools on admission and each subject was followed up until discharge and after one month to identify the clinical course and outcome.

Results: The mean hospital stay was 5.3 days and median hospital stay was 4.0 days. The mean hospital stay is increasing with the malnutrition level in MUST, NRS, MNA-SF, MST, NRS and SGA tools. The inpatient mortality is higher in high risk nutritional categories of all six malnutrition screening tools. MNA-SF, MST and SGA tools demonstrate a positive relationship between non-prophylactic antibiotic usage and poor nutritional status. High risk nutritional categories of MNA-SF and MST are associated with prescription of multivitamin/minerals. According to MNA-SF, MST and SGA the follow up mortality was increased with worsening nutritional status. The incidence of readmissions was increased gradually with deteriorating nutritional status categorized by MUST, SNAQ, MST and SGA tools.

Conclusion: Malnutrition may be associated with poor clinical outcome of the cardiac patients during and after the hospital stay. Each tool reported a variable prediction in outcomes such as death, infection and prolonged hospital stay due to the poor nutritional status.

Keywords: Malnutrition, Cardiac patients, Clinical outcome, Nutrition screening tools, Sri Lanka

Background

Malnutrition is highly prevalent among hospital admissions, accounting for 25-40 % of hospital inpatients [1]. Malnutrition is associated with, poor response to medical treatment due to deterioration of muscular, respiratory, immune function and poor wound healing as well as increased mortality, increased length of hospital stay and increased cost to the state [2–5]. In patients with severe congestive cardiac failure, malnutrition is associated poor outcome as evidenced by increased right atrial pressure and tricuspid regurgitation [6]. Due to malnutrition the muscles in the heart are weakened, which in turn lead to cardiac dysfunction [7]. The presence of cardiac cachexia is an independent predictor of mortality [8]. Detecting those who are already malnourished and at risk of malnutrition, and intervening at an earlier stage will improve patients' outcome and will reduce the costs to the state [9].

In the absence of a gold standard to assess nutritional status various subjective and objective assessments are in practice. Their ability to predict clinical outcome is highly variable depending on the tool utilized and the patient population. Consequently, several studies have

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been done on different patient populations by means of different screening tools. A study has been carried out to assess the most appropriate nutritional screening tool for predicting unfavorable clinical outcomes in patients admitted to a Brazilian public university hospital. In that study three nutritional screening tools namely, Nutritional risk screening (NRS), Malnutrition universal screening tool (MUST) and Mini nutritional assessment-short form (MNA-SF) detected malnutrition risk in 27.9 %, 39.6 %, and 73.2 % of patients, respectively. NRS and MNA-SF found to have similar sensitivity to predict clinical outcomes, though NRS seems to provide the best acquiesce [10]. Malnutrition in cardiac surgical patients detected by modified version of the Malnutrition Universal Screening Tool (MUST) was associated with prolonged intensive care unit and hospital stay [11].

In a study done on acute stroke patients to determine the nutritional status and the association between nutritional status and health outcomes, 19.2 % of patients were malnourished on admission according to Subjective Global Assessment (SGA) [12]. Moreover malnutrition was found to be associated with increased length of stay and increased prevalence of dysphagia, enteral feeding and other complications. The ability of Mini Nutritional Assessment (MNA-SF) to predict increased risk of mortality and transfers is shown in a study done in a tertiary-care geriatric hospital in Switzerland [13] as well as in a study done in a sub acute care facility in Australia [14]. Cardiac patients are specially considered as at risk of malnutrition due to apparent factors including heart failure, anorexia, pre-investigate 'nil by mouth' and due to cardiac cachexia [15]. Mortality risk is two times more in cardiac patients with moderate or severe protein energy malnutrition [16]. The research evidence on predicting the clinical outcome according to nutritional status of the cardiac patients is limited. More than half of the cardiac patients and sixty percent of the patients with congestive cardiac failure were identified as malnourished according to SGA in study done in Brazil [16]. Though malnutrition is rarely the primary cause of death, it contributes to poor patient prognosis by aggravating pre-existing heart failure and increasing the susceptibility to infections [17].

The aim of this study is to assess the ability of six widely recommended nutrition screening and assessment tools to predict the clinical outcome when applied to a cardiac population admitted to a national level tertiary care institute in Sri Lanka.

Methods

Study design and subjects

All consecutive patients who were admitted for more than 24 hours to the Institute of Cardiology, National Hospital Sri Lanka, Colombo from March 2012 to July 2012 were enrolled in the current study. Patients who provided informed written consent were assessed using an interviewer-administered questionnaire on admission. It consisted of socio-demographic data, medical history of current disease status, subjective assessment of the nutritional status using patients' history and examination and objective assessment through anthropometric measurements. After determining the nutritional status on admission, each subject was followed up until discharge and after one month to identify the clinical course and outcome. Ethical approval was obtained from the ethical review committee of the National Hospital of Sri Lanka, Colombo, Sri Lanka.

Nutritional assessment tools

Nutritional status was assessed by Malnutrition Screening Tool (MST), Malnutrition Universal Screening Tool (MUST), Short Nutritional Assessment questionnaire (SNAQ), Mini Nutritional Assessment-Short Form (MNA-SF), Nutritional Risk Screening (NRS) and Subjective Global Assessment (SGA) tools.

MST is a three-question tool assessing recent unintentional weight and appetite loss [18]. MUST utilizes information on body mass index (BMI), unplanned weight loss in past 3–6 months and the presence or absence of acute illness or lack of nutritional intake >5 days [19]. NRS tool includes similar criteria as MUST [20]. MNA-SF assesses decreased food intake, recent weight loss, degree of mobility, recent psychological stress, acute illness, neuropsychological problems and BMI [21]. SNAQ appraises information on recent weight loss, recent decreased appetite, and recent intake of supplemental drinks or tube feeding [22]. SGA assess nutritional status using data on weight change, dietary intake change, gastrointestinal symptoms (dysphagia, anorexia, nausea, vomiting and diarrhea), and changes in functional capacity (normal, suboptimal or bedridden) in relation to malnutrition as well as assessment of fat and muscle stores and the presence of oedema and ascites [23]. The diagnosis made by the entire clinical team and clinical records of patients were utilized to calculate diagnosis related stress level measured in SGA.

Anthropometric assessment

Weight was measured to the nearest 0.1 kg using a digital scale (Seca 815, seca GmbH. Co. kg, Germany) and height was measured using a standard stadiometer to the nearest 0.1 cm (Stadiometer for mobile height measurement - Seca 217, seca GmbH. Co. kg, Germany) by a trained medical officer. BMI was calculated by dividing weight (kilograms) by the square of height (meter). Waist circumference (WC) at the mid-point between the lowest rib (10th) and iliac crest and mid arm circumference (MAC) at mid acromiale-radiale (to the nearest

0.1 cm) was measured by a standard measuring tape (Seca 203, seca GmbH. Co. kg, Germany).

Outcome measures

In hospital and follow up outcome after 1 month was assessed. During the hospital stay patients were followed up daily to detect deaths, cardiac and non-cardiac disease conditions, use of non-prophylactic antibiotics, prescription of multivitamin and mineral supplements, use of enteral and parenteral nutrition, intensive care admission , transfers to another wards for further management and performance of emergency procedures. Patients who were fit to be discharged were assessed after one month by means of a brief telephone interview. Those who were unable to be reached even after the third attempt of calling were dropped out. At one month follow up the details on deaths, readmissions and features of infections were acquired. The cause of death and the diagnosis on readmission were obtained from death certificates and the diagnosis cards respectively. Features of infections were confirmed by going through medical reports, clinical symptoms and drug history.

Statistical analysis

Data entry and statistical analysis was performed using the SPSS Version 16.0 statistical package. Categorical variables were presented as number and percentage and continuous variables were presented as mean, standard deviation, median, inter-quartile range. The relationship between nutrition screening tools and duration of hospital stay was investigated using Spearman correlation coefficient. Multiple linear regression was performed to identify the accuracy of, nutritional status, BMI, MAC and WC of each patient in predicting the duration of hospital stay and to identify the best score that predict the length of hospital stay from the tools that were studied. The Chi-square test for independence was used to detect relationship between different nutritional categories in predicting clinical outcome. P values less than 0.05 were taken as significant.

Results

Baseline characteristics of the study population are described in Table 1. Three hundred twenty three males (61.22 %) and 204 females (38.78 %) were participated in the study. The majority were Sinhalese ($n = 438$, 83.3 %) and a large proportion ($n = 175$, 33.3 %) had studied up to grade five. The mean age was 57.6 ± 12.5 years. The mean BMI was 23.33(±3.67) kgm^{-2} while the females had a higher BMI value than males ($p < 0.05$). The mean hospital stay was 5.31 days and median hospital stay was 4.0 days. The inter-quartile range was 2.0-6.0 days. Ten deaths (1.9 %) have occurred during the hospital stay consisting of 4 (1.2 %) males and 6 (2.9 %) females. Seventeen (3.2 %) cardiac complications and 9 (1.7 %) non-cardiac complications occurred during the hospital stay giving rise to a total of 26 (4.9 %) patients with complications. Sixty seven patients (12.7 %) received non-prophylactic antibiotics and 32 (6.1 %) patients received multivitamin mineral supplements. Only 2 (0.4 %) patients received high protein/high calorie supplements while none received enteral or parenteral feeding. One hundred and twelve patients (21.3 %) were transferred to the intensive care unit (ICU) and 50 patients (9.5 %) underwent emergency procedures such as defibrillation, temporary pacemaker implantation, percutaneous coronary intervention, percutaneous trans-venous mitral commissurotomy. Twenty one patients (4.0 %) were transferred to other medical and surgical wards for further management. Four hundred and seventy five patients (90.3 % of the total sample) were followed up at 1 month. Nine deaths (1.9 %), 19 (4.0 %) infections and 53 (11.1 %) readmissions were reported.

Hospital stay according to different categories of nutritional screening is shown in Table 2. The mean hospital stay is increasing with the malnutrition level in MUST, NRS, MNA-SF, MST, NRS and SGA tools. Furthermore median hospital stay is escalating with the poor nutrition in MUST and SGA tools. Inter-quartile range has a trend to increase with deteriorating nutrition status in MUST, NRS, MNA-SF, MST and SGA tools. According to Spearman correlation coefficient, MUST has a significant correlation with the duration of hospital stay at 0.05 confidence level, while MNA-SF,MST and SGA has a significant correlation with the duration of hospital stay at 0.01 confidence level.

Nutritional status assessed by each tool had a wide variation. SGA, SNAQ, MUST, MST, NRS and MNA-SF screening tools detected 4.2 % ($n = 23$), 22.7 % ($n = 27$), 40 % ($n = 45$), 47.9 % ($n = 250$), 50.0 % ($n = 263$) and 69.6 % ($n = 366$) malnutrition prevalence respectively. The outcome of patients during hospital stay according to nutritional status is summarized in Table 3. The mortality is increased in high-risk nutritional categories of all six malnutrition screening tools. No clear relationship between the cardiac/non-cardiac morbidity, performance of emergency procedures to improve survival and the nutrition status is shown from the current study. MNA-SF, MST and SGA tools demonstrates a positive relationship between non-prophylactic antibiotic usage and poor nutritional status. High-risk categories of malnutrition assessed by MNA-SF and MST are associated with multivitamin/ mineral usage. Only high-risk nutritional categories of SGA are associated with increasing incidence of ICU transfer. MNA-SF and MST tools show a positive relationship between poor nutrition status and transfers to other ward for further management. The Chi-square test for

Table 1 Socio-demographic and clinical characteristics of patients in the population

Patient characteristic	Population ($n = 526$)		Males ($n = 322$)		Females ($n = 204$)	
	Number	%	Number	%	Number	%
Ethnicity						
Sinhala	438	83.3	266	82.6	172	84.3
Muslim	43	8.2	24	7.5	19	9.3
Indian Tamil	4	.8	4	1.2	0	0
Sri Lankan Tamil	34	6.5	22	6.8	12	5.9
Other	7	1.3	6	1.9	1	.5
Education level						
Not educated	55	10.5	25	7.8	30	14.7
Up to Grade 5	175	33.3	96	29.8	79	38.7
Up to Grade 11	172	32.7	113	35.1	59	28.9
Up to Grade 13	101	19.2	73	22.7	28	13.7
Tertiary	23	4.4	15	4.7	8	3.9
Age	57.6[a] ± 12.5		59.9[a] ± 11.2		58.5[a] ± 12.0	
BMI	23.33[a] ± 3.67		24.03[a] ± 4.80		23.60[a] ± 4.15	
Hospital stay[d]	5.3[a] ± 5.3	4.0[b] 2.0-6.0[c]	5.3[a] ± 5.9	4.0[a] 2.0-6.0[c]	5.1[a] ± 4.1	4.0[b] 3.0-6.0[c]
During hospital stay						
Deaths	10	1.9	4	1.2	6	2.9
Cardiac and non cardiac complications	26	4.9	16	5.0	10	5.0
Non prophylactic antibiotics	67	12.7	39	12.1	28	13.7
Multivitamin mineral supplements	32	6.1	14	4.3	18	8.8
High protein/high calorie supplements	2	0.4	2	0.6	0	0.0
Enteral/parenteral nutrition	0	0.0	0	0.0	0	0.0
Intensive care transfer	112	21.3	79	24.5	33	16.2
Emergency procedures	50	9.5	36	11.2	14	6.9
Transfers	21	4.0	14	4.3	7	3.4
Follow up at 1 month[e]						
Deaths	9	1.9	7	2.4	2	1.1
Features of infection	19	4.0	10	3.4	9	5.0
Readmission	53	11.1	30	10.1	23	12.9

[a]Mean [b]Median [c]Inter-quartile range (Q_1-Q_3); [d]N = 516; [e]N = 475

independence indicated that there was no significant association between non-prophylactic antibiotic usage, ICU transfer, performing emergency procedures within three groups classified by NRS. Even though, there was a significant difference between the numbers of patients who received non-prophylactic antibiotics ($x^2 = 21.79$, $p < 0.01$, phi = 0.20) and numbers of patients who underwent emergency procedures ($x^2 = 7.69$, $p = 0.02$, phi = 0.12), there were no significant difference in the patients transferred to the ICU within the three nutritional categories classified by MNA-SF. According to MST non-prophylactic antibiotic usage, ICU transfer and transfers to other medical and surgical wards showed no significance. Requirement of emergency procedures ($x^2 = 6.05$, $p = 0.01$, phi = 0.11) had a significance difference between each nutritional categories.

The clinical outcome of patients after one month of discharge is presented in Table 4. According to MNA-SF, MST and SGA the follow up mortality was increased with worsening nutritional status. There was no significant trend between nutritional status and features of infections. The incidence of readmissions was increased gradually with deteriorating nutritional status categorized by MUST, SNAQ, MST and SGA tools. When Chi-square test was applied to MST to detect relationship between different nutritional categories, infections and readmissions ($x^2 = 3.57$, $p = 0.17$, phi = 0.08) between each category showed no statistical significance difference.

Table 2 Duration of hospital stay according to nutritional categories

Malnutrition screening tool	Mean hospital stay (days)	Median hospital stay (days)	Inter-quartile range (Q_1-Q_3)	Correlations		Regression[c]			
				Correlation coefficient	Significance (2-tailed)	R square	ANOVA	Coefficients	
								Standardized coefficients	Significance
							Significance	Beta	
MUST				0.217[a]	0.023	0.035	0.436	0.112	0.326
Low risk	4.4 ± 4.3	3.5	2.0 - 5.8						
Medium risk	4.5 ± 2.3	4.0	3.0 - 6.0						
High risk	7.9 ± 11.2	6.0	3.0 - 8.0						
NRS				0.053	0.368	-	-	-	-
Normal	4.5 ± 4.0	3.0	2.0 - 6.0						
Mild	5.7 ± 7.1	4.0	2.0 – 6.5						
Moderate	5.8 ± 6.2	4.0	3.0 – 7.0						
Severe	5.9 ± 5.6	4.0	3.0 – 7.0						
MNA				−0.123[b]	0.005	0.030	0.004	−0.139	0.016
Normal	4.3 ± 3.2	4.0	2.0 - 6.0						
At risk of malnutrition	5.5 ± 5.7	4.0	3.0 - 6.0						
Malnourished	7.9 ± 8.0	5.5	3.3 – 9.0						
SNAQ				0.237[a]	0.010	0.021	0.666	0.046	0.645
Well nourished	5.1 ± 6.4	4.0	2.0 - 6.0						
Moderately malnourished	8.8 ± 6.9	8.5	2.0 – 14.0						
Severely malnourished	6.1 ± 2.6	5.0	4.0 - 8.0						
MST				0.122[b]	0.006	0.020	0.035	0.043	0.356
No risk of malnutrition	5.0 ± 5.2	4.0	2.0 - 6.0						
Risk of malnutrition	5.5 ± 5.3	4.0	3.0 - 6.0						
SGA				0.233[b]	0.000	0.036	0.001	0.139	0.003
Well nourished	5.2 ± 5.2	4.0	2.0 - 6.0						
Moderately malnourished	7.1 ± 6.9	5.0	3.5 – 8.0						
Severely malnourished	-	-	-						

[a]Correlation is significant at the 0.05 level (2-tailed).
[b]Correlation is significant at the 0.01 level (2-tailed).
[c]Predictors: (Constant), malnutrition screening tool, WC, MAC, BMI, Dependent Variable: Hospital Stay

Discussion

To the extent of our knowledge, this is the first study to demonstrate the predictability of the clinical outcome of the cardiac patients according to six malnutrition screening tools. Malnutrition, which is common in hospital inpatients, is associated with increased morbidity, hospital stay and mortality [2]. Identifying those who are at nutritional risk will enable local and international health initiatives to be planned in order to utilize limited resources in a productive way [1].

Relationship between malnutrition and adverse clinical outcome has widely studied in diverse clinical settings. In a study done on acute stroke patients to identify the association between malnutrition and adverse clinical outcome, malnutrition assessed by SGA was found to be associated with increased length of stay and increased prevalence of dysphagia and complications [12]. Elderly population is highly susceptible to cardiovascular diseases and prone for malnutrition. In a study done in a tertiary-care geriatric hospital in Switzerland [13] as well

Table 3 Outcome during hospital stay

Malnutrition screening tool	Mortality	Morbidity	Non prophylactic antibiotics	Multivitamin mineral supplements	Intensive care transfer	Emergency procedure	Transfers
MUST							
Low risk (68)	0 (0.0 %)	6 (8.8 %)	10 (14.7 %)	3 (4.4 %)	13 (19.1 %)	6 (8.9 %)	2 (2.9 %)
Medium risk (23)	0 (0.0 %)	1 (4.3 %)	1 (4.3 %)	0 (0.0 %)	4 (17.4 %)	2 (8.6 %)	0 (0.0 %)
High risk (22)	3(13.6 %)	2 (9.0 %)	5 (22.7 %)	0 (0.0 %)	6 (27.3 %)	4 (18.2 %)	1 (4.5 %)
NRS							
Normal (230)	4 (1.7 %)	8 (3.4 %)	21 (9.1 %)	10 (4.3 %)	53 (23.0 %)	23 (10.0 %)	4 (1.7 %)
Mild (33)	0 (0.0 %)	3 (9.0 %)	8 (24.2 %)	0 (0.0 %)	4 (12.1 %)	0 (0.0 %)	4 (12.1 %)
Moderate (132)	2 (1.5 %)	4 (3.0 %)	17 (12.9 %)	8 (6.1 %)	29 (22.0 %)	14 (10.7 %)	6 (4.6 %)
Severe (131)	4 (3.1 %)	12 (9.1 %)	21 (16.0 %)	14 (10.7 %)	26 (19.8 %)	14 (10.7 %)	7 (5.3 %)
MNA							
Normal (160)	1 (0.6 %)	11 (6.8 %)	10 (6.2 %)	9 (5.6 %)	39 (24.4 %)	23 (14.3 %)	2 (1.2 %)
At risk of malnutrition (336)	7 (2.1 %0	15 (4.5 %)	46 (13.7 %)	20 (6.0 %)	67 (19.9 %)	24 (7.2 %)	15 (4.5 %)
Malnourished (30)	2 (6.7 %)	3 (10.0 %)	11 (36.7 %)	3 (10.0 %)	6 (20.0 %)	4 (13.3 %)	4 (13.3 %)
SNAQ							
Well nourished (92)	0 (0.0 %)	7 (7.6 %)	9 (9.8 %)	4 (4.3 %)	19 (20.7 %)	7 (7.6 %)	4 (4.3 %)
Moderately malnourished (6)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	2 (33.3 %)	2 (33.3 %)	0 (0.0 %)
Severely malnourished (21)	2 (9.5 %)	2 (9.5 %)	6 (28.6 %)	0 (0.0 %)	7 (33.3 %)	4 (19.0 %)	0 (0.0 %)
MST							
No risk of malnutrition (276)	3 (1.1 %)	22 (8.0 %)	30 (10.9 %)	15 (5.4 %)	62 (22.5 %)	36 (13.1 %)	7 (2.5 %)
Risk of malnutrition (250)	7 (2.8 %)	7 (2.8 %)	37 (14.8 %)	17 (6.8 %)	50 (20.0 %)	15 (6.0 %)	14 (5.6 %)
SGA							
Well nourished (503)	8 (1.6 %)	28 (5.6 %)	59 (11.7 %)	30 (6.0 %)	106(21.1 %)	49 (9.8 %0	20 (4.0 %)
Moderately malnourished (22)	1 (4.5 %)	0 (0.0 %)	7 (31.8 %)	2 (9.1 %)	5 (22.7 %)	2 (9.1 %)	1 (4.5 %)
Severely malnourished (1)	1 (100 %)	1 (100 %)	1 (100 %)	0 (0.0 %)	1 (100 %)	0 (0.0 %)	0 (0.0 %)

as in a study done in a sub acute care facility in Australia [14], the ability of MNA-SF to predict increased risk of mortality and transfers is reported. Length of hospital stay is a substitute marker of patients' well-being during treatment and is positively associated with malnutrition and other co-morbidities [24]. Nevertheless establishing a relationship between malnutrition and hospital death is a difficult task due to the various confounding factors [25, 26].

The availability of different malnutrition screening tools leads to the necessity of deriving the best tool in predicting clinical outcome in a target population. Controversy has persisted throughout on the level of predictability of the clinical outcome by different nutrition screening tools. Nutrition Risk Classification was found to have the best prediction compared to MNA-SF, MST and NRS in their ability to predict postoperative wound and infectious complications in a study done on patients undergoing abdominal surgery [27]. Velasco et al. has demonstrated a good agreement between NRS-2002 and MUST with SGA in assessing prevalence of nutritional risk in hospitalized patients [28]. The concurrent application of different tools as SGA and NRS also enhances the ability to predict adverse clinical outcomes in hospitalized patients [29].

Our results show the predictability of the clinical outcome by six different tools had been heterogeneous. Nevertheless, all six tools under study were able to predict increased mortality in all high-risk nutritional categories. In a study done on the Brazilian hospitalized patients, NRS and MNA-SF had similar performances in predicting deaths, complications and very long length of hospital stay compared to MUST [10]. MNA-SF and SGA had been able to predict increased mortality in geriatric malnourished patients classified according to above tools [30]. Stratton et al. have demonstrated that MUST is able to predict in hospital mortality as well as mortality after 3 months and 6 months after discharge in acutely ill elderly [19]. Patients who were at a higher nutritional risk classified by SGA, MUST and NRS-2002 were more likely to be hospitalized for a longer duration compared to the low-risk group [31]. Furthermore, Amaral et al. have reported MUST to have a higher ability to predict length of stay compared to NRS in a study

Table 4 Follow up outcome after 1 month

Malnutrition screening tool	Malnutrition prevalence	Follow up at 1 month	Follow up mortality	Features of infection	Readmission
MUST					
Low risk	68	62 (91.2 %)	1 (1.6 %)	2 (3.2 %)	6 (9.7 %)
Medium risk	23	23 (100.0 %)	0 (0.0 %)	2 (8.7 %)	4 (17.4 %)
High risk	22	19 (86.4 %)	0 (0.0 %)	1 (5.3 %)	5 (26.3 %)
NRS					
Normal	230	209 (90.8 %)	2 (1.0 %)	10 (4.8 %)	16 (7.7 %)
Mild	33	32 (97.0 %)	0 (0.0 %)	3 (9.4 %)	7 (21.9 %)
Moderate	132	121 (91.7 %)	4 (3.3 %)	4 (3.3 %)	14 (11.6 %)
Severe	131	113 (86.3 %)	3 (2.7 %)	2 (1.8 %)	16 (14.2 %)
MNA					
Normal	160	152 (95.0 %)	1(0.7 %)	7 (4.6 %)	17 (11.2 %)
At risk of malnutrition	336	298 (88.7 %)	7 (2.3 %)	11 (3.7 %)	34 (11.4 %)
Malnourished	30	25 (83.3 %)	1 (4.0 %)	1 (4.0 %)	2 (8.0 %)
SNAQ					
Well nourished	92	83 (90.2 %)	2 (2.4 %)	3 (3.6 %)	10 (12.0 %)
Moderately malnourished	6	6 (100.0 %)	0 (0.0 %)	1 (16.7 %)	1 (16.7 %)
Severely malnourished	21	19 (90.5 %)	0 (0.0 %)	1 (5.3 %)	4 (21.1 %)
MST					
No risk of malnutrition	276	252 (91.3 %)	3 (1.2 %)	10 (4.0 %)	22 (8.7 %)
Risk of malnutrition	250	223 (89.2 %)	6 (2.7 %)	9 (4.0 %)	31 (13.9 %)
SGA					
Well nourished	503	456 (90.7 %)	8 (1.8 %)	19 (4.2 %)	49 (10.7 %)
Moderately malnourished	22	19 (86.4 %)	1 (5.3 %)	0 (0.0 %)	4 (21.1 %)
Severely malnourished	1	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)

done in oncology patients [32].On the contrary in the present study the mean hospital stay has increased with the deteriorating nutrition level classified by MUST, MNA-SF, MST, NRS and SGA tools. We found a positive relationship between non-prophylactic antibiotic usage and poor nutritional status when assessed by MNA-SF, MST and SGA tools. Correspondingly, SGA has detected increased number of days requiring antibiotics in high-risk nutritional categories in a study done on Indian cancer patients [33]. In contrast to above, the nutritional assessment tools for predicting adverse hospital outcomes appeared to be weak predictors of death, infection and hospital stay in a study done on general medical and surgical patients, and in patients undergoing cardiac surgery [26, 34]. The present study was done in a cardiac setting of a tertiary care hospital, thus requiring a higher number of acutely ill patients to be transferred to the ICU. Yet only high-risk nutritional categories of SGA are associated with increasing incidence of ICU transfer though the values are not significant. Similarly, MUST and SNAQ had failed to detect any association between malnutrition and length of ICU stay in a study done on patients undergoing cardiac surgery [34]. We have found a positive relationship between poor nutrition status assessed by MNA-SF, MST stools and transfers to other ward for further management. In addition the incidence of readmissions increased gradually with deteriorating nutritional status categorized by MUST, SNAQ, MST and SGA tools although the values are not statistically significant. Furthermore, a significance difference in the number readmitted is not seen in the study done by Stratton et al. on a elderly population [19].

Our study was done in a tertiary care centre in a developing country. Patients with diverse cardiovascular disease conditions had been admitted to this centre from different parts of the island. Though the total number recruited is over five hundreds, the number of patients falling under each subcategory was low resulting in difficulties in applying statistical methods. Furthermore enteral or parenteral nutrition is not abundantly used in Sri Lanka giving low values under corresponding group. In developed countries, the disease course and comorbidities are the main influential factors in the final decision making. In contrary, factors such as availability of the resources and cost had been given more

importance in the setting under study. Furthermore, biochemical parameters such as serum albumin, lymphocyte count was not taken into account as increased cost associated with the investigations. There was only a few numbers of patients who received high calorie/ protein diet supplements as such treatment methods are not routinely practiced in this centre. Similar to above, difficulties in applying statistical methods have arisen owing to the low incidence of outcome measures seen at one month after discharge. The study team encountered with practical difficulties and high costs involved in getting down the patients who are living far from the treatment center and being followed up at the local clinics for post discharge one month assessment. Thus the decision was taken to proceed with a short telephone interview, though the reliability is constrained.

Conclusion

Our finding supports that malnutrition may be associated with adverse clinical outcome in cardiac patients during the hospital stay and one month after the discharge. However, different malnutrition screening tool report variable predictability of the poor clinical outcome. Hence the necessity of the development and validation of a malnutrition screening tool specific for the cardiology admissions have surfaced.

Abbreviations

MST: Malnutrition screening tool; MUST: Malnutrition universal screening tool; SNAQ: Short nutritional assessment questionnaire; MNA-SF: Mini nutritional assessment-short form; NRS: Nutritional risk screening; SGA: Subjective global assessment; BMI: Body mass index; WC: Waist circumference; MAC: Mid-Arm circumference; ICU: Intensive care unit.

Competing interests

The authors declare that they have no conflict of interests. No specific funding support was taken.

Authors' contributions

RJ, NCL and AKP have made substantial contribution to conception and design the study. WSS and AOW interpreted data. IR analyzed the data. IR, RJ, NCL and AKP were involved in drafting the manuscript. All authors read and approved the final manuscript.

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