Research Article

Multivariate Nutritional Assessment of Patients Awaiting Liver Transplant and Impact on Clinical Outcomes

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Abstract

Introduction: Disease-related malnutrition (DRM) is a frequently underestimated complication in end-stage liver disease (ESLD) patients awaiting liver transplantation (LT). This study aimed to assess the prevalence of malnutrition using multivariate tools and evaluate the impact of nutritional intervention on clinical outcomes.

Methods: A prospective, single-center study was conducted from October 2014 to April 2018 involving adult patients listed for LT who met the inclusion criteria and provided informed consent. Data collected included demographic details, clinical parameters, anthropometry, handgrip strength (HGS), dietary intake, and nutritional assessments. Statistical analysis was performed using SPSS version 25.0.

Results: Of 401 patients screened, 291 met the inclusion criteria and had complete data available, were included. The mean age was 49.9±8.5 years, with 84.5% men and 68.4% in Child-Turcotte-Pugh class C. The mean MELD score was 20.5±5.7, with 20.6% scoring >25. Based on mSGA, 85% were moderately malnourished and 4% severely malnourished (mean score 19.9±4.0). GLIM classified 66% as severely malnourished, while RFHGA identified 84.5% as moderately and 9.3% as severely malnourished. Mean HGS was 23.1±8.1 kg; BMI was 26.4±5.3 kg/m². Nutritional support significantly improved achievement of ≥80% energy (p<0.0001) and protein (p=0.0004) targets. Among 98 patients on the LT waiting list, 55.1% died during waiting period. Higher MELD scores, severe malnutrition by mSGA/RFHGA, and HGS <19.5 kg were significantly associated with pre-LT mortality (p<0.05). Step-wise logistic regression analysis indicated that baseline MELD >25 and low HGS were independent predictors of mortality.

Conclusion: Early identification and intervention for malnutrition significantly improve nutritional status and reduce pre-transplant mortality in ESLD patients.

ABBREVIATION

DRM: Disease Related Malnutrition; ESLD: End-Stage Liver Disease; LT: Liver Transplant; CTP Child-Turcotte-Pugh; MELD: Model for End-Stage Liver Disease; Msga: Modified Subjective Global Assessment; GLIM: Global Leadership Initiative on Malnutrition; RFHGA: Royal Free Hospital-Global Assessment; BMI: Body Mass Index; HGS: Handgrip Strength; SBP: Spontaneous Bacterial Peritonitis; HE: Hepatic Encephalopathy; CLD: Chronic Liver Disease; ONS: Oral Nutritional Supplement; MAC: Mid-Arm Circumference; TSF: Triceps Skinfold Measurement; MAMC: Mid-Arm Muscle Circumference; MAMA: Mid-Arm Muscle Area; EN: Enteral Nutrition; PN: Parenteral Nutrition; SPSS: Statistical Package for Social Science; DCLD: Decompensated Chronic Liver Disease; NASH: Non-Alcoholic Steatohepatitis; HCC: Hepatocellular Carcinoma; ETF: Enteral Tube Feeding; LVP: Large Volume Paracentesis; HRS: Hepatorenal Syndrome; GI: Gastrointestinal; VHPHC: Very High-Protein High-Calorie Supplementation

INTRODUCTION

Liver cirrhosis is a culmination of several chronic liver disorders and usually goes unnoticed until the onset of decompensation marked by ascites, bleeding, spontaneous bacterial peritonitis (SBP), hepatic encephalopathy (HE). The disease course usually progresses more rapidly towards death without liver transplantation (LT)

[1]. In India, almost all of the cirrhotics (99.4%) had decompensation at the time of diagnosis [2]. Chronic liver disease (CLD) is a major contributor to global mortality, morbidity, and healthcare resource utilization [3].

In liver cirrhosis, the severity of protein-energy malnutrition is associated with increasing disease severity scores. About 20% of well-compensated disease patients are malnourished compared to >60% in advanced cirrhosis patients; >80% in decompensated liver disease reaching almost 100% in patients awaiting LT [4-7].

Disease related malnutrition (DRM) is one of the most under recognised problems of patients with ESLD awaiting a LT and is associated with a worse prognosis. It is recommended that patients awaiting LT undergo rapid nutritional screening and detailed nutritional assessment by a Clinical Dietitian using global assessment tools, a detailed dietary intake, and assessment of muscle mass [8].

Since the majority of liver transplants performed in India are from living donors where expediency is key, data regarding prevalence of nutritional deficits in patients with ESLD using multivariate assessment tools before LT and the influence of nutritional support on clinical outcomes are lacking.

The objectives of this study were;

1) To assess the nutritional status and identify nutritional deficits in patients with end-stage liver disease (ESLD) undergoing evaluation for LT, using standard anthropometric measurements, the Modified Subjective Global Assessment (mSGA), biochemical and clinical indicators such as the Model for End-Stage Liver Disease (MELD) score and Child-Turcotte-Pugh (CTP) score, dietary intake (energy and protein), and functional assessment through handgrip strength (HGS).

2) To plan and evaluate the efficacy of individualised nutrition support using either oral nutritional supplements (ONS) or enteral tube feed (nocturnal/continuous) according to the severity of deficit in spontaneous oral food intake of the patient.

MATERIALS AND METHODS

Consecutive patients evaluated for LT who met the inclusion criteria and provided informed consent were enrolled in the study between October 2014 and April 2018.

Inclusion Criteria: Patients who fulfilled the following criteria were included in the study. Each patient was enrolled only once.

i. Adults of both sex, aged between 18 and 60 years

ii. Patients enrolled for their first LT were considered eligible for the study.

Exclusion Criteria: Patients were excluded from the study if they met any of the following conditions:

i. Age below 18 years or above 60 years

ii. Pregnant or breastfeeding women

iii. Diagnosis of fulminant or subacute hepatic failure

iv. Presence of a mental condition that impaired comprehension of the study procedures

The study protocol received approval from the hospital's Institutional Ethics Committee.

SAMPLING TECHNIQUE

Purposive sampling technique was used, and those listed for LT were enrolled in this study according to the criteria for sample selection and consecutive patients who met the inclusion criteria were included.

Implementation of Nutrition Protocol – Pre-Transplant Phase

During the pre-transplant phase, nutritional requirements were calculated with a goal of providing at least 35 kcal/kg of body weight per day and 1.2–1.5 g/kg/day of protein8. Oral Nutrition Supplement (ONS) therapy was prescribed based on the patient's nutritional status, individual needs, dietary intake, and eating habits. Once patients were enrolled for LT, the nutrition intervention was reinforced and continued up to the day prior to the transplant.

Customized nutritional intervention and individualized counseling

A personalized diet regimen was formulated for each patient in the Pre-LT phase according to the dietary restrictions and nutritional requirements considering their cultural and religious beliefs. The summary of intervention is given in (Table1). This method also helped to maintain an anabolic state before LT.

Data collection tool

All patients' demographic data (age, sex, height, and body weight), a complete dietary history, physical examination, medical history (MELD and CTP score), and co-morbidities were documented. Furthermore, anthropometric measurements and biochemical parameters were also documented.

Table 1: Summary of the nutritional support protocol

Spontaneous oral intake	Nutrition Support Protocol	Dietary Habit/ Criteria	Customized ONS prescription
75%	Oral Nutrition Supplement	Vegetarian	VHPHC
<50%	Nocturnal tube feed	Ovo-vegetarian	VHPHC
<25%	Continuous tube feed	Non-vegetarian	HPHC
		Obese patients	VHPHC

1. Commercially available scientific Oral Nutrition Supplement (ONS) formula was used.
2. VHPHC: Very high-protein, high-calorie (225calories and 16.9g protein / 100ml)
3. HPHC : High-protein, high-calorie (178.4calories and 7.6g protein / 100ml)

Nutrition Intervention and monitoring

1. Customized oral nutrition supplement prescription as per oral intake, dietary habits and nutritional status with a highlight on nocturnal oral nutrition supplement.
2. Personalized Counseling and individualized meal plan emphasizing the quantity specifications of high protein foods and regular follow up.
3. Daily follow-up during hospitalization and weekly/monthly (depending upon nutritional status) follow-up as out-patients (telephonic or mail) to motivate patients, change care plan and to ensure nutritional targets were achieved.

NUTRITIONAL ASSESSMENT

The different tools used to assess nutritional status are as follows:

i. Anthropometric measurements:

Anthropometric measurements are imperative as they contribute to the basic descriptive information on nutritional status and body composition. They are related to energy intake, energy metabolism, physical activity, and metabolic efficiency [9]. The following anthropometric measurements were recorded:

a. **Body mass index (BMI kg/m2):** A BMI <18.5 kg/m2 is usually considered underweight. In case of fluid retention, bodyweight was calculated by subtracting a percentage of weight based upon severity of ascites (mild, 5%; moderate, 10%; severe, 15%), with an additional 5% subtracted if bilateral pedal edema as present. [8,10,11,12]

b. **Mid-arm circumference (MAC, cm):** MAC was measured at the midway between the tip of the acromion and the olecranon process on the non-dominant side of the body by using a flexible, inelastic measuring tape [13].

c. **Triceps skin fold measurement (TSF, mm):** TSF was taken on the non-dominant side of the body, with the patients standing in a relaxed position, using a Slim Guide skinfold calliper [14].

d. **Mid-arm muscle circumference (MAMC, cm):** MAMC was calculated using the MAC and the TSF according to standard equations. MAMC = MAC (cm) – [0.314 × TSF (cm)] [15].

e. **Mid-arm muscle area (MAMA, cm2):** MAMA was calculated using the equation given below [16].

MAMA cm2 = MAC (cm)2 / 4π – 10 (men)

MAMA cm2 = MAC (cm)2 / 4π – 6.5 (women)

ii. Modified Subjective Global Assessment (mSGA)

mSGA is a method for assessing nutritional status depending on a practitioner's clinical judgment compared to objective, quantitative measurements. mSGA aims to identify an individual's initial nutrition state using historical, symptomatic, and physical parameters, and analyses the factors impacting the progressive or regressive nutrition abnormalities. mSGA has been used to assess nutritional status in surgical and general medical patients, and it shows good convergent validity and good to excellent inter-observer reproducibility [17].

iii. Global Leadership Initiative on Malnutrition (GLIM)

The GLIM is a new diagnostic framework that focuses on building a global consensus around diagnostic criteria for DRM in adults [18,19].

Weight loss, reduced BMI, and reduced muscle mass were categorized as phenotypic criteria, and reduced food intake/ assimilation and disease burden/ inflammation as etiologic criteria. For the diagnosis of DRM, GLIM recommends that the combination of at least one phenotypic criterion and one etiologic criterion is required. While only the phenotypic criteria are proposed for the severity grading that follows, the inclusion of the etiologic criteria for DRM diagnosis is deemed a priority to guide appropriate intervention and anticipated outcomes [20].

iv. Royal Free Hospital-Global Assessment (RFHGA)

The RFHGA utilizes BMI, MAMC, and dietary intake for nutritional assessment.10 BMI is calculated using either objective scale weight or estimated dry weight when ascites or pedal edema are present. Estimated dry weight is adjusted as follows: subtract 5% of body weight for mild ascites, 10% for moderate ascites, and 15% for severe

ascites. An additional 5% is subtracted if bilateral pedal edema is present [8,10].

Dietary intake is assessed using the diet history method and categorized into three groups:

• Adequate: Intake meets estimated requirements.

• Inadequate: Intake is below estimated requirements but exceeds 500 kcal /day.

• Negligible: Intake is 500 kcal/day or less [10,21].

Based on RFH-GA criteria, patients are classified as adequately nourished, moderately malnourished, or severely malnourished.

v. Biochemical and Clinical Evaluation

Prognostic models are useful for estimating disease severity and survival and can serve as helpful medical decision-making tools for guiding patient care. In patients with cirrhosis, the CTP classification22 and MELD scores have been established as the leading tools to predict mortality.23 The CTP is used to determine the prognosis, as well as necessity of LT and the MELD score is found to be useful in determining prognosis and prioritizing for receipt of a LT [23, 24].

vi. Dietary Evaluation

As part of the nutritional evaluation, a comprehensive dietary intake assessment was conducted. This included an in-depth review of food habits, use of nutritional supplements, number and timing of meals throughout the day, and detailed analysis of food and fluid consumption. Particular attention was given to assessing both the energy intake and the quality and quantity of protein consumed. Patients were asked to maintain a detailed food diary; for those unable to comply or follow instructions, multiple 24-hour dietary recalls were utilized as an alternative method.

The clinical dietitian assessed each patient's spontaneous daily dietary intake during hospitalization and compared it to their individual nutritional requirements using calorie count methodology. Food and beverage consumption was visually estimated by nursing staff and documented in quartiles (0%, 25%, 50%, 75%, and 100%), a validated approach for estimating food intake [25]. During daily rounds, the clinical dietitian provided nutrition counselling or guidance to patients and/or nursing staff as needed.

Daily estimates of energy (caloric) and protein intake were documented by the clinical dietitian, who also made individualized recommendations to adjust the nutrition care plan based on these assessments. The primary objective was to evaluate the adequacy of caloric and protein intake while minimizing the risk of reporting bias. Caloric and protein values of foods and beverages were calculated using locally validated reference data [26].

For patients receiving nutritional support—either Enteral Nutrition (EN) or Parenteral Nutrition (PN)—the clinical dietitian conducted daily monitoring to evaluate nutritional adequacy, identify interruptions in feeding, and assess feed tolerance, making necessary modifications to the nutritional intervention accordingly.

vii. Functional Evaluation: Handgrip strength (HGS)

HGS was assessed using the Jamar Hydraulic Hand Grip Dynamometer (Patterson Medical Ltd), recognized as a sensitive indicator of body cell mass depletion [27]. Prior to the assessment, the procedure was clearly explained to each patient. Patients were seated either on a chair or in bed, with their arm positioned alongside the body and the forearm flexed at a 90° angle, unsupported [28]. The dominant hand was used to perform the test, and the mean value of three consecutive measurements was recorded.

II. Clinical Outcomes

During the pre-transplant phase, patients are frequently readmitted due to various complications. The reasons for readmission and the number of admission episodes were recorded. The mortality during the wait-listed period was also recorded.

STATISTICAL ANALYSIS

All data were analyzed using SPSS software version 25.0. Descriptive data were presented as frequencies and percentages for categorical variables, and as mean with standard deviation for parametric and laboratory variables. The Chi-square test and Mann–Whitney U test were used for comparing two groups of nonparametric data. Logistic regression analysis was performed to predict categorical outcomes based on selected predictor variables.

RESULTS

Patient characteristics and nutritional status

Out of 401 patients evaluated for LT, 319 met the inclusion criteria. Data from 291 patients were analyzed, while 27 were excluded due to incomplete data. The mean age of the patients was 49.9 ± 8.5 years (range: 19–60 years). The majority were male (85%), with females comprising 15% of the cohort. Baseline characteristics and nutritional status are detailed in (Table 2).

Table 2: Patient characteristics and nutritional status

Patient Characteristics (n=291)			n (%)	Mean±SD
Age			291(100%)	49.9±8.5
Sex	Male		246 (84.5%)	
	Female		45 (15.5%)	
i. Anthropometric measurements	Body Mass Index (BMI)	Underweight (<18.5 kg/m²)	12(4.1%)	16.8±1.7
		Normal (18.5-22.9 kg/m²)	63(21.6%)	21.1±1.2
		Overweight (23-24.9 kg/m²)	50(17.2%)	23.8±0.7
		Obese (≥25 kg/m²)	166 (57%)	29.9±4.2
	Mid arm circumference (cm)			26.2±4.4
	Triceps skinfold thickness (mm)			11.4±6.0
	Mid arm muscle circumference (cm)			22.6±3.2
	Mid arm muscle area (cm²)			32.0±11.9
ii. Subjective Global Assessment (SGA)	Well nourished		31(11%)	12.4±1.6
	Moderately malnourished		248(85%)	20.5±2.7
	Severely malnourished		12(4%)	28.3±0.8

The most common indication for LT was alcohol-related decompensated chronic liver disease (DCLD), accounting for 35.1% of cases. This was followed by cryptogenic liver disease (21%), non-alcoholic steatohepatitis (NASH) (11.7%), viral hepatitis (10%), hepatocellular carcinoma (HCC) (14.4%), and other causes (7.9%), including autoimmune hepatitis, Wilson's disease, Budd-Chiari syndrome, and primary or secondary biliary cirrhosis.

NUTRITIONAL ASSESSMENT

i. Anthropometric measurements

According to WHO Western Pacific Region: Asian Classification. (2000) [29], Body Mass Index (BMI) classification, 4.1% were under-weight, 21.6% had normal weight BMI, 17.2%were overweight, and 57% were obese (Table 2). The mean BMI was 26.4±5.3 kg/m2. In this cohort of 291 patients, 9.2% had a BMI of <20kg/m2.

The mean anthropometric measurements of the patients were MAC26.2±4.4cm; TSF 11.4±6.0mm; MAMC 22.6±3.2cm; and MAMA 32.0±11.9cm2.

ii. Subjective Global Assessment (mSGA)

In the present study, mSGA indicated 85% as moderately malnourished and 4% severely malnourished (Figure 1) during the LT evaluation with a mean mSGA score of 19.9±4.0.

iii. Global Leadership Initiative on Malnutrition (GLIM)

The GLIM indicated 33.7% as moderately malnourished and 66.3% as severely malnourished.

iv. Royal Free Hospital-Global Assessment (RFHGA)

The RFHGA assessed 84.5% as moderately malnourished and 9.3% severely malnourished.

v. Biochemical and Clinical Evaluation

According to the CTP classification, during the initial nutritional evaluation, 68.4% belonged to CTP-C category, 28.2% in CTP-B, and 3.4% in CTP-A category. The mean MELD score was 20.4±5.7, and 20.6% had a MELD score of ≥25.

vi. Dietary Evaluation

Dietary habits of the patients indicated that 55.3% were non-vegetarian, 24.4% vegetarian, and 20.3% ova-vegetarian. Regarding the route of feeding used in the nutrition support interventions: 92.8% were on ONS, 6.5% were fed using enteral tube feeding (ETF) along with oral diet, and 0.7% required exclusive ETF.

The prescribed energy and protein target and baseline intake during the evaluation were 2164.4±244.7 kilocalories and 79.7±11.9g and 1295.7±320.1 kilocalories and 38.5±12.2g, respectively. The average baseline energy and protein intakes were 60% and 49% of the target, respectively. The details of dietary evaluation including, food habits, route of feeding, and dietary intake, are presented in (Table 3).

After the nutritional intervention, the mean energy and protein intake improved to 1645.3±252.3 kilocalories and 61.0±12.5g, respectively and approximately 77% of the energy and protein requirements.

a. Impact of nutrition intervention on dietary intake

Managing the nutrition of patients with liver disease presents significant challenges. In patients with ESLD awaiting transplantation, oral intake—including ONS—serves as the first-line therapy to prevent and manage malnutrition. A comparison of baseline dietary intake and post-intervention data is provided in table 4 and (Figure 2).
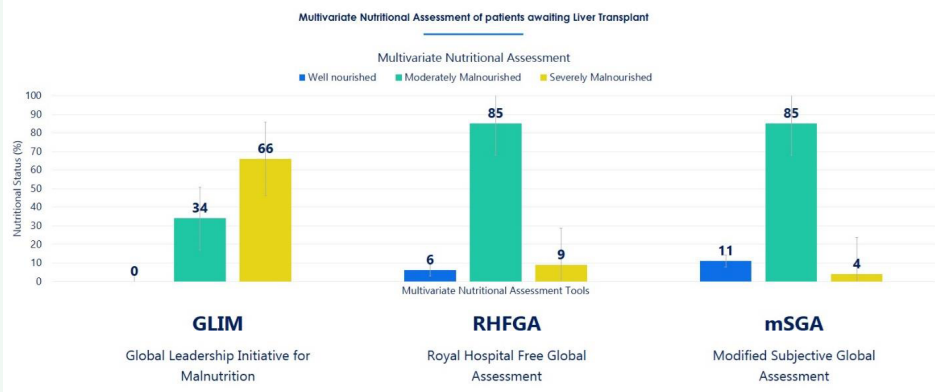
Table 1 Baseline pre-transplant nutritional status using multivariate assessment tools
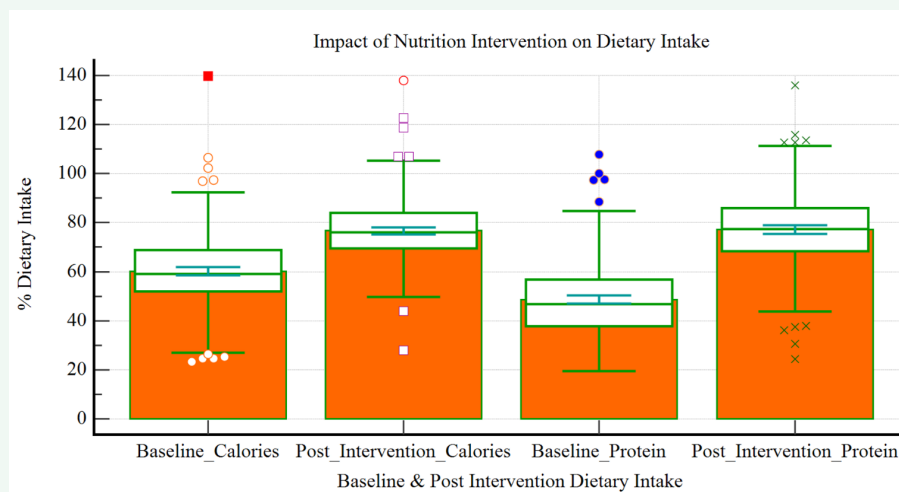

Table 2 Impact of nutrition intervention on dietary intake

Following the intervention, there was a statistically significant increase in the proportion of patients achieving ≥80% of their energy (p < 0.0001) and protein targets (p = 0.0004), as shown in (Table 4).

vii. Functional Evaluation: Handgrip Strength (HGS)

The mean baseline HGS of 291 patients who performed the functional assessment using a handgrip dynamometer was 23.1±8.1kg. Out of 291 patients who performed the test during nutritional assessment, 36.1% had values <19.5kg.

II. Clinical Outcome

i. Pre-transplant Readmission

During the wait-listed period, out of the 98 non-transplanted patients, 36 (36.7%) were readmitted to hospital. The clinical and nutritional factors influencing pre-transplant readmissions were increasing baseline MELD score (p=0.035), weaker baseline HGS of <19.5kg (p=0.006), non-vegetarians (p=0.005) and very high-protein high-calorie supplementation (VHPHC) (p=0.003).

Out of the 115patients who required hospital readmission during the waiting period, 16 patients (44.4%) were readmitted once whereas 8 (22.2%) twice, 5 (13.9%) thrice, 5 (13.9%) four times, and 2(5.6%) five times readmission to hospital. The pre-transplant

Table 3: Baseline clinical and biochemical characteristics and dietary Intake

Clinical Parameters n=291		n (%)
Child-Pugh Score [α]	Child A	10(3.4%)
	Child B	82(28.2%)
	Child C	199(68.4%)
Biochemical Parameters		Mean±SD
MELD Score		20.4±5.7
Food Habit	Vegetarian	71(24.4%)
	Ova-vegetarian	59(20.3%)
	Non-vegetarian	161(55.3%)
Route of Feeding	Oral	270(92.8%)
	Enteral + Oral	19(6.5%)
	Enteral	2(0.7%)
Oral Nutrition Supplement (ONS)	HPHC ONS [a]	152(52%)
	VHPHC ONS [b]	139(48%)
Dietary Intake		Mean±SD
Prescribed Energy (Calories)		2164.4±244.7
Baseline Energy Intake (Calories)		1295.7±320.1
Post Intervention Energy Intake (Calories)		1645.3±252.3
Prescribed Protein (g)		79.7±11.9
Baseline Protein Intake (g)		38.5±12.2
Post Intervention Protein Intake (g)		61.0±12.5

[a] HPHC, High-Protein High-Calorie Oral Nutrition Supplement
[b] VHPHC, Very High-Protein High-Calorie Oral Nutrition Supplement

Table 4: Comparison of baseline vs. post intervention dietary intake

Dietary intake			Post intervention (n=291)				x^2	p-value
			≥80%		<80%			
			n	%	n	%		
Baseline	Energy (%calories)	≥80%	19	95	1	5	30.2504	< 0.0001**
		<80%	90	33.2	181	66.8		
	Protein (%g)	≥80%	9	100	0	0.00	12.4648	0.0004**
		<80%	115	40.8	167	59.2		

Significant at **p<0.01 level

Table 5: Binary Logistic Regression to predict pre-transplant mortality

Predictor Variables		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)
								Lower
Step 1[a]	age	-.060	.762	.006	1	.937	.942	.212
	Sex	-.210	1.332	.025	1	.875	.811	.060
	Diagnosis	.006	.229	.001	1	.979	1.006	.642
	Child	1.097	.852	1.658	1	.198	2.995	.564
	Baseline MELD	2.310	1.040	4.929	1	**.026**	10.074	1.311
	Baseline BMI	.501	.489	1.051	1	.305	1.651	.633
	Baseline HGS	3.781	1.026	13.570	1	**<.001**	43.848	5.866
	Baseline mSGA	.869	1.326	.429	1	.512	2.384	.177
	Baseline RFHGA	2.969	2.187	1.843	1	.175	19.464	.268
	Baseline GLIM	-.798	1.132	.498	1	.481	.450	.049
	Food habits	1.236	.846	2.136	1	.144	3.443	.656
	ONS	2.858	1.530	3.487	1	.062	17.420	.868
	Baseline Calorie (%)	-.222	1.936	.013	1	.909	.801	.018
	Baseline Protein (%)	18.555	21978.997	.000	1	.999	114351424.311	.000
	Post Intervention Calorie (%)	-.500	1.061	.222	1	.637	.607	.076
	Post Intervention Protein (%)	1.199	.872	1.891	1	.169	3.315	.601
	Constant	-80.767	44618.580	.000	1	.999	.000	

complications related to the readmission during the wait-listed period were large volume paracentesis (LVP) 14(38.9%), Hepatorenal Syndrome (HRS) 5(13.9%), Hepatic Encephalopathy (HE) 10(27.8%), Spontaneous Bacterial Peritonitis (SBP) 4(11.1%), and Gastrointestinal (GI) bleed 6(16.7%).

Post-intervention analysis indicated that patients who achieved ≥80% of their protein intake targets had significantly fewer readmissions due to LVP compared to non-achievers (p = 0.016).

A weaker baseline HGS (<19.5kg) was significantly associated with readmission due to SBP, and HE, and a MELD >25 with readmissions due to SBP (p<0.05) whereas patients on VHPHC supplementation had significantly lower incidence of HE and GI bleed (p<0.05).

ii. Mortality

Of the 319 patients evaluated for LT, 152 patients (47.6%) underwent LT in our transplant unit and 53 patients (16.6%) in other units and 98 patients (35.7%) were awaiting transplant.

Out of the 98 patients awaiting transplant, 44 patients (44.9%) were alive and 55 (55.1%) deceased during the waiting period. Univariate analysis of various preoperative clinical and nutritional parameters showed that pre-transplant mortality was significantly associated with higher disease severity, including a baseline MELD score ≥25 (p < 0.001), malnutrition assessed by the mSGA (p = 0.032), RFHGA (p = 0.43), and weaker HGS <19.5 kg (p < 0.001).

Stepwise binary logistic regression analysis was conducted to determine independent predictors of pre-transplant mortality (Table 5). Among all significant predictors identified in the univariate analysis—MELD score, mSGA, RFHGA, and HGS—only two remained independently associated with pre-transplant mortality in the multivariate model: a baseline MELD score >25 (odds ratio [OR] = 10.074; 95% confidence interval [CI] = 1.311–77.411) and HGS <19.5 kg (OR = 43.848; 95% CI = 5.866–327.767), both statistically significant at $p < 0.01$. Notably, 64.8% of non-survivors had HGS <19.5 kg, while 84.1% of survivors had HGS ≥19.5 kg.

DISCUSSION

The prevalence of malnutrition in our cohort was 89%, higher than the 79% reported in a comparable Canadian cohort awaiting LT. [30] Previous studies have demonstrated that both underweight (BMI <18.5 kg/m²) and severe obesity (BMI >40 kg/m²) are associated with increased mortality and morbidity before LT [31-34]. Low BMI (<20kg/m2) has also been associated with reduced survival on the transplant waiting list [35]. The mean anthropometric measurements of our study cohort were comparable with alcoholic cirrhotics in a 1993 study conducted by Hirsch et al. [36]

The CTP-C category during listing in two other studies was 82% in the Egyptian cohort 37 and 27% in a European cohort [21], which were incomparable. The mean MELD score of this study, depicting the severity of the disease as illustrated by Gheorghe et al. [38]

The baseline dietary intake of this study population was 60% calories and 49% protein of the target. This is comparatively lower than 79.2% calories and 62.5% protein achieved by malnourished patients of the Egyptian cohort. The presence of cachexia in nearly 70% of patients with ESLD [39], likely explains the lower dietary intake in our study population.

HGS measured using the Jamar Hydraulic Dynamometer indicated that HGS <19.5 kg was a strong predictor of mortality among LT candidates [40], and another study with alcoholic cirrhotics, found that <17.5kg was a predictor of mortality using Camrey's mechanical handgrip dynamometer [41].

DRM has long been associated with adverse clinical outcomes, including a higher incidence of complications such as ascites, HE, infections [42] HRS, and diabetes mellitus. DRM remains a significant risk factor for both short- and long-term morbidity and mortality in patients before and after LT [43,44], and abdominal surgeries [45].

CONCLUSION

These data indicate that adult patients enrolling for LT are having higher disease severity scores, and nutritionally depleted with inadequate baseline energy, and protein intake and weak HGS, suggestive of declining muscle strength. This study concludes that early and timely comprehensive nutritional assessment and intervention helps to improve clinical outcomes in this vulnerable population.

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