A comparative study of three nutritional risk screening tools in surgical inpatients with laryngeal cancer

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ABSTRACT

Background and Objectives: Nutritional screening has been recommended for hospitalized patients. The goal of this study was to compare the screening value of Nutritional Risk Screening 2002 (NRS-2002), Malnutrition Universal Screening Tool (MUST), and Malnutrition Screening Tool (MST) in inpatients with laryngeal cancer, and to identify which is the most accurate. **Methods and Study Design:** An observational cross-sectional study of 197 laryngeal cancer patients admitted for surgery was conducted using continuous sampling. NRS-2002, MUST, and MST were used to screen the nutritional risk of patients after admission and before discharge. Diagnostic information and the length-of-hospital stay (LOS) data were extracted from the hospital HIS system. **Results:** The detection rates of NRS-2002, MUST, and MST in admission or discharge patients were 14.7%/27.9%, 22.3%/26.9%, and 4.6%/11.2%, respectively. Using NRS-2002 as the reference, high sensitivity (82.8%) and a Kappa coefficient (k=0.584) were achieved using MUST in admission patients, while MST presented the lowest sensitivity (17.3%) and Kappa coefficient (k=0.208). MST maintained low sensitivity (25.5%) and Kappa coefficient (k=0.243) in discharge patients. NRS-2002 ≥3 was an independent risk factor for longer LOS in patients with laryngeal cancer (odds ratio (OR)=5.588, 95% confidence interval (CI)=1.858–16.811, p=0.002). The MUST and MST scores did not predict long LOS. **Conclusions:** Compared with NRS-2002, MUST is superior to MST in sensitivity, specificity, and Kappa coefficient. NRS-2002 better identified patients at risk for longer LOS, but a consistent conclusion was not reached with MUST and MST. Further validation in larger samples is needed.

Key Words: Nutrition Risk Score, Malnutrition Screening Tool, Malnutrition Universal Screening Tool, oncology, laryngeal cancer

INTRODUCTION

Laryngeal carcinoma is a common malignant tumor of the head and neck, and squamous cell carcinoma accounts for 96–98% of these cases.[1] According to GLOBOCAN,[2] there were 177,422 new laryngeal cancer cases and 94,771 laryngeal cancer deaths worldwide in 2018. In 2012, there were approximately 20,114 new cases of laryngeal cancer and 12,308 laryngeal cancer deaths in China, and the standardized incidence and mortality rates were 1.1/100,000 and 0.7/100,000, respectively, which is lower than the world average.[3] Surgery and radiotherapy are the most common treatment methods for laryngeal cancer, while chemotherapy is often used as an adjuvant therapy. Due to the distinctive anatomical position of head and neck tumors, which are closely associated with the patient's digestive system, the presence of the tumor in addition to adverse reactions to treatment render patients prone to nutritional risk.[4]

Nutritional risk is defined as “existing or potential nutrition-related risk of adverse clinical outcomes in patients”.[5] It has been reported that nutritional risk can reduce patient tolerance and sensitivity to anti-cancer treatments, prolong the length-of-hospital stay (LOS), increase the risk of postoperative complications, and influence treatment effects.[6-9] However, nutritional intervention can improve patient nutritional status, clinical outcomes, and the effectiveness of chemoradiotherapy where reduced food intake is prevalent and is not accompanied by severe metabolic derangements.[10] Some studies have found that patients with head and neck cancer did not exhibit significant weight loss over the course of treatment after receiving nutritional intervention, and their quality of life score was significantly better than that of those who did not receive intervention.[11,12] Some domestic scholars have reported that individualized nutritional intervention can shorten LOS after laryngeal cancer surgery and reduce postoperative complications.[13]

Although severe malnutrition may be diagnosed without screening tools, risk screening is the first step in nutritional treatment. Due to potential hidden malnutrition in patients not exhibiting physical signs of severe malnutrition, patients at nutritional risk must rely on nutrition screening tools. Nutritional screening has been widely recommended as a standard procedure for hospitalized patients;[10,14-17] however, it has not been well implemented in clinical practice. There are two main reasons for this: one is poor implementation by medical staff, and the other is a lack of precise nutrition screening and evaluation tools.[16,18]

There are several screening tools commonly used in clinical practice, the Nutritional Risk Screening 2002 (NRS-2002),[5,19] the Malnutrition Universal Screening Tool (MUST),[20] and the Malnutrition Screening Tool (MST).[21] The NRS-2002 was developed by the Danish, Swiss, and ESPEN task force. A retrospective analysis of 128 randomized controlled trials showed that the NRS-2002 has good predictive validity.[5] The MUST was developed by the multi-disciplinary Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition and published officially.[20] This group reported that “MUST” had “excellent” agreement (k=0.775) with NRS-2002 and "fair-good” agreement (k=0.707) with MST.[20] MST was developed by the Centre for Public Health Research at the Queensland University of Technology.[21] It was considered the simplest and fastest nutrition screening tool and is easily accepted by patients.[21,22] However, there is insufficient evidence to show that these tools can accurately identify patients in need of nutritional intervention. Therefore, agreement on which is the most accurate nutritional tool for screening laryngeal cancer patients is still open to debate. A good screening tool should be simple, quick, and easy for medical personnel to accept and perform, and should be sensitive enough to screen all patients who are at nutritional risk.[10,18]

Due to the unique effects of laryngeal cancer on the nutritional status of patients and the lack of evidence evaluating the effectiveness of nutritional screening tools in this population, this study compared the applicability of three nutritional screening tools, NRS-2002, MUST, and MST, in hospitalized patients with laryngeal cancer. We also explored whether these tools can accurately screen patients at risk for long LOS due to nutritional risk.

MATERIALS AND METHODS

Design and setting

An observational, cross-sectional study was conducted between November 2018 and June 2019 in the head and neck surgery group and throat group in a third-class special hospital in Shanghai, China. NRS-2002, MUST, and MST were used to screen the nutritional risk of patients within 48 h after admission and 24 h before discharge. Basic information gathered included height, weight, changes in food intake in the last week, and changes in body weight in the last 3 months. Diagnostic information and the LOS data were extracted from the hospital HIS system (Figure 1). Questionnaire surveys and nutrition screening were completed by unified training nutritionists and nurses. Height was measured to the nearest 0.01 m in the standing position using a stadiometer (Seca, Hangzhou, China) and weight was measured to the nearest 0.01 kg using a calibrated floor scale (Seca, Hangzhou, China). Patients were shoeless and wearing pajamas. The study was conducted in accordance with the Helsinki declaration and approved by the ethics committee of the Eye & ENT Hospital of Fudan University in Shanghai, China (No.2018024).

Sample

A total of 197 patients with laryngeal cancer who received surgical treatment in the Eye & ENT Hospital of Fudan University in Shanghai, China from November 2018 to June 2019 were enrolled via continuous sampling. Inclusion criteria included: patients between 18 and 90 years old, diagnosed with laryngeal malignancy via pathology results, no history of chemoradiotherapy, no communication disorders, and gave informed consent to participate in nutritional risk screening. Patients with hydrothorax, ascites, edema, or who were discharged within 24 h were excluded.

Definitions

Body mass index (BMI): an index that combines height and weight to determine whether a person is undernourished, overweight or obese; calculation formula used was weight/height^2 (kg/m^2). The BMI cut-off points for Chinese adults were: <18.5 for underweight, 18.5–23.9 for normal weight, 24–27.9 for overweight, and ≥28 for obese.[23]

NRS-2002: The total NRS-2002 score was 0–7, including impaired nutritional status (BMI, weight loss, and reduced food intake), disease severity (presence of cancer, diabetes, or acute onset of chronic disease), and age ≥70 years old. A score less than 3 was defined as "not at-risk", and a score greater than or equal to 3 was defined as "nutritionally at-risk".[5]

MUST: The total MUST score was 0–6, including BMI, degree of weight loss, and duration of fasting due to disease. A score of 0 was classified as "low nutritional risk", a score of 1 was considered "medium nutritional risk", and a score greater than or equal to 2 was "high nutritional risk". Due to the insufficient sample size of the nutritional risk group, a new variable was established by merging the data of the medium and the high nutritional risk groups.[20]

MST: The MST score ranged from 0 to 5, including recent involuntary weight loss and dietary loss due to decreased appetite. A score less than 2 was defined as "not at-risk," and a score greater than or equal to 2 was defined as "at risk of malnutrition".[21]

Kappa coefficient: The Fleiss' Kappa values were classified at five levels to indicate differential consistency: 0.0–0.20 was slight, 0.21–0.40 was fair, 0.41–0.60 was moderate, 0.61–0.80 was substantial, and 0.81–1.0 was almost complete agreement.[24]

LOS: LOS was defined as the discharge date minus the admission date. The median distribution of all laryngeal cancer samples (15 days) was used to establish the cut-off for LOS. If a patient was in the hospital for 15 days or longer, they were classified as having a long LOS.

Statistical analysis

An EpiData 3.1 database was used, and double entry and verification of data accuracy were performed. The statistical software package IBM SPSS Statistical version 19.0 was used for data analysis. Using NRS-2002 as the reference method for identifying nutritional-at-risk patients, sensitivity, specificity, positive and negative predictive values, agreement, and Kappa coefficient were used to compare the screening accuracy of MUST and MST. Unconditional logistic regression analysis was performed to assess the ability of the three screening tools to predict a long LOS. One model was fitted separately for each nutritional risk screening method. A $p<0.05$ was considered statistically significant. For description of the results, count data (n and %) and measurement data (mean and SD) were used.

RESULTS

One hundred and ninety-seven patients were screened during the study period. Of these, 181 (91.8%) were male and 16 (9.2%) female. Age ranged from 34–84 years, with a mean age of 61.82 (8.77) years.

The patient characteristics based on the NRS-2002 and compared with patients not at nutritional risk are presented in Table 1. A low educational status was found among the respondents, with 67.0% (132/197) patients having an education level of Junior high or below, with no difference found between the two groups. Patients with a history of smoking and drinking accounted for 87.3% (172/197) and 77.2% (152/197) of the sample, respectively. The detection rate of nutritional risk using NRS-2002 at admission was 14.7% (29/197). Thirteen underweight patients were identified in the sample. In the overweight range, four patients were classified as nutritionally-at-risk using NRS-2002. When TNM stage was taken into consideration, it was determined that the nutritional risk of patients at stages III and IV was significantly higher than those in stages I and II ($p=0.015$). The nutritional at-risk group had higher weight loss in the previous 6 months (−2.64±4.24 kg vs −0.24±1.51 kg, $p<0.001$) and while in the hospital (−1.67±2.24 kg vs −0.88±1.41 kg, $p=0.012$), compared to the group not at nutritional risk. The LOS of the nutritionally at-risk group was longer than the group not at-risk (17.69±5.39 vs 14.98±4.87, $p=0.007$).

The stratification of patients identified as nutritionally at-risk/high risk as determined by NRS-2002, MUST, and MST is presented in Table 2. The risk detection rates of NRS-2002, MUST, and MST in admission or discharge patients were 14.7%/27.9%, 22.3%/26.9%, and 4.6%/11.2%, respectively. The nutritional risk detection rate of the surveyed samples was higher at discharge than at admission.

Using NRS-2002 as the reference, high sensitivity (82.8%) and specificity (88.1%) were achieved by MUST in the patients at admission. This method also had the highest agreement percentage (87.3%) and a high Kappa coefficient (k=0.584).

MST had lower sensitivity (17.3%) and Kappa coefficient (k = 0.208) but had the highest specificity (97.6%). Interestingly, MUST did not have high sensitivity (56.4%) in discharged patients, and the agreement percentage (76.6%) and Kappa coefficient (k=0.413) were also reduced. MST still maintained very low sensitivity (25.5%) and Kappa coefficient (k=0.243).

If a patient was in the hospital for 15 days or longer, they were classified as having a long LOS. The occurrence of a long LOS was identified as the dependent variable (coded as 1 = long LOS; 0 = No long LOS).

Multivariate Logistic regression results showed that an NRS-2002 score ≥3 was an independent risk factor for a long LOS in patients with laryngeal cancer (odds ratio (OR)=5.588, 95% confidence interval (CI)=1.858–16.811, p=0.002). Results with MUST were statistically significant when the crude OR or adjusted OR contained sex and age. Unexpectedly, when variables such as sex, age, TNM stage, tumor location, and surgical method were adjusted for, MUST scores did not predict a long LOS. The effect was not shown when MST was used.

DISCUSSION

The focus of this study was to explore the applicability of three nutritional screening tools in patients with laryngeal cancer, and whether these tools could predict a long LOS. The goal was to provide a basis for subsequent nutritional screening work in this field. Patients with negative nutritional screening results after admission should be screened again one week later. Therefore, it is imperative that the applicability of different screening methods is verified in different stages of the perioperative phase for timely detection of patients with nutritional risk.[25]

The results of this study showed that among patients admitted for laryngeal cancer surgery, the risk detection rate of MUST was the highest (22.3%), followed by NRS-2002 (14.7%), and MST (4.6%). At discharge, NRS-2002 had the highest detection rate (27.9%), followed by MUST (26.9%), and MST (11.2%). The different screening methods exhibited different detection rates in this study, and they were lower than those reported in recent studies.[9,10,26,27] This may be due to differences in the patient sample between studies. Further, we observed that the nutritional risk detection rate of the surveyed samples at discharge was higher than at admission, showing that nutritional status may deteriorate during hospitalization, thus requiring the attention of medical staff. A study conducted by scholars to evaluate the admission and discharge of a cohort of elderly patients reported similar conclusions.[28]

At the same time, we identified limitations when using BMI to determine the risk of malnutrition. For example, the percentage of patients with a BMI ratio <18.5 was only 6.60% (13/197), making it difficult to accurately analyze this subgroup of the patient sample. In addition, four patients identified as overweight (BMI=24–27.9) were also determined to be nutritionally-at-risk by NRS-2002. This is important because studies have reported that both weight loss and obesity are related risk factors for increased medical expense in patients undergoing elective surgery.[29]

NRS2002 is the preferred nutritional screening tool recommended by ESPEN and CSPEN.[14,19] Chen et al reported that it is feasible to screen the nutritional risk of inpatients in China with NRS-2002 to determine whether nutritional support is needed.[30] The results of this study support the recommendations of current guidelines and also show that an NRS-2002 score ≥3 is an independent risk factor for a long LOS in patients after laryngeal cancer surgery (OR=5.588, 95% CI=1.858–16.811, *p*=0.002). Tran et al reported that the first choice for the most appropriate screening tool for hospitalized patients in Vietnam is the NRS-2002, followed by the MST+BMI and MUST.[31]

Amaral et al found that MUST exhibited the highest agreement with NRS-2002 in hospitalized cancer patients and better identified patients at risk for a longer LOS.[26] Fu and Lu screened patients before surgery and found that the specificity and positive predictive value of NRS-2002 and MUST were good, and the screening results were correlated with LOS.[32] The MUST score is considered an independent predictor of postoperative complications.[33,34] However, the conclusions drawn from the current analysis are in conflict with these other studies. After adjusting for age, sex, TNM stage, surgical method, and tumor location, the MUST score failed to predict a long LOS. It is possible that confounding factors, such as lack of adjustment or only adjusting for age and gender, could be responsible for the conclusion of statistical significance in the other studies.

In the current study, the sensitivity of MUST was higher at admission (82.8%) but decreased at discharge (56.4%). This may be due to several factors. First, patients with laryngeal cancer after surgery can begin nasal feeding after evaluation by a nurse, making the possibility of a fasting time ≥5 days very small. Second, although pain or gastrointestinal reactions may cause a decrease in nasal feeding, weight loss is not generally significant. These factors may affect the screening results of the MUST: the option of "≥5 days of fasting due to disease" in the scoring index is 0, and the other option "≥5% of weight loss in the past 3-6 months" is not sensitive. There is also no option in MUST to indicate whether the amount of food intake in the past week has decreased, where the NRS-2002 has this option.

Different scholars have confirmed the sensitivity and specificity of MST in radiotherapy,[34] chemotherapy,[35] and tuberculosis patients.[36] MST score has also been shown to predict the risk of death.[34-37] However, Lawson et al reported that MST exhibited poor prediction of malnutrition in patients with chronic kidney disease.[38] In our study, the sensitivity and Kappa value of MST were both low at admission and discharge, which may be because food intake in patients with laryngeal cancer did not occur in response to decreased appetite. The patients were given nasal feeding tubes after surgery. The MST option “eating less because of decreased appetite” was more likely to have a score of 0. In NRS-2002, the option “less food intake in the last week” was not required to be caused by decreased appetite. In addition, results showed that MST score did not predict a long LOS.

It is worth mentioning that the detection rate of nutritional risk was increased following surgery even with use of a nasal feeding tube. Using the NRS-2002, the nutrition risk detection rate was 14.7% at admission and 27.9% at discharge. The at-risk group had higher weight loss in the previous 6 months and while in the hospital, compared to the group not at risk.

There are some limitations to this study. First, after the postoperative laryngeal cancer patients were discharged from the hospital, they could gradually transition to a normal diet after a trial period. We did not track nutritional risk and clinical outcomes after discharge. It is also important to focus on and validate nutritional risk screening tools for patients with laryngeal cancer after discharge. Second, there were only 197 patients in the sample that had not received radiotherapy and chemotherapy in addition to laryngeal cancer surgery, limiting the representation of patients receiving different types of treatment. Therefore, more accurate data could be obtained by expanding the sample size.

Conclusion

Compared with NRS-2002, MUST was superior to MST with respect to sensitivity, specificity, and Kappa coefficient. In addition, NRS-2002 better identified patients at risk for a longer LOS compared to MUST and MST. Although this study provides insight into the applicability of the three screening tools in laryngeal cancer patients, further validation in a larger patient sample is needed to definitively confirm the results.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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Table 1. Characteristics of the sample

Variable	Not at-risk at admission (NRS-2002 <3) (n=168)	Nutritionally at-risk at admission (NRS-2002 ≥3) (n=29)	*p*
Gender, n (%)			
Male	154 (85.1)	27 (14.9)	1.000
Female	14 (87.5)	2 (12.5)	
Age (years), mean (SD)	62.09±8.03	60.28±12.27	0.305
Education level, n (%)			
Junior high or below	113 (85.6)	19 (14.4)	0.644
Senior high school	43 (82.7)	9 (17.3)	
College degree or above	12 (92.3)	1 (7.7)	
Native place, n (%)			
Shanghai	50 (86.2)	8 (13.8)	0.857
Not from Shanghai	118 (84.9)	21 (15.1)	
Smoking history, n (%)			
Yes	148 (86.0)	24 (14.0)	0.425
No	20 (80.0)	5 (20.0)	
Drinking history, n (%)			
Yes	130 (85.5)	22 (14.5)	0.815
No	38 (84.4)	7 (15.6)	
Number of Chronic illnesses, n (%)			
0	106 (86.9)	16 (13.1)	0.585
1	52 (83.9)	10 (16.1)	
≥2	10 (76.9)	3 (23.1)	
A family history of laryngeal cancer, n (%)			
Yes	2 (66.7)	1 (33.3)	0.359
No	166 (85.6)	28 (14.4)	
TNM stage, n (%)			
I	55 (94.8)	3 (5.2)	0.015*
II	62 (86.1)	10 (13.9)	
III	27 (71.1)	11 (28.9)	
IV	24 (82.8)	5 (17.2)	
Tumor location, n (%)			
supraglottic	15 (83.3)	3 (16.7)	0.412
glottis	118 (86.8)	18 (13.2)	
hypolarynx	32 (84.2)	6 (15.8)	
transglottic	3 (60.0)	2 (40.0)	
Surgical method, n (%)			
total laryngectomy	106 (88.3)	14 (11.7)	0.310
partial laryngectomy	48 (80.0)	12 (20.0)	
others	14 (82.4)	3 (17.6)	
BMI at admission, n (%)			
<18.5	0 (0.0)	13 (100)	<0.001***
18.5–23.9	109 (90.1)	12 (9.9)	
24.0–27.9	54 (93.1)	4 (6.9)	
≥28.0	5 (100)	0 (0.0)	
Weight Loss in the last six months, mean (kg, SD)	−0.24±1.51	−2.64±4.24	<0.001***
Weight Loss in hospital, mean (kg, SD)	−0.88±1.41	−1.67±2.24	0.012*
LOS, mean (SD)	14.98±4.87	17.69±5.39	0.007**

†NRS-2002: Nutritional Risk Screening 2002; BMI: body mass index; LOS: length-of-hospital stay.
Significance in shown by **p*<0.05, ***p*<0.01, ****p*<0.001.

Table 2. Cross-tabulation of nutrition risk screening

Time	Screening Tool	NRS-2002, n		
		Not at-risk	At-risk	Total
Admission				
	MUST			
	Low risk	148	5	153
	High risk	20	24	44
	Total	168	29	197
	MST			
	Not at-risk	164	24	188
	At-risk	4	5	9
	Total	168	29	197
Discharge				
	MUST			
	Low risk	120	24	144
	High risk	22	31	53
	Total	142	55	197
	MST			
	Not at-risk	134	41	175
	At-risk	8	14	22
	Total	142	55	197

NRS-2002: Nutritional Risk Screening 2002; MUST: Malnutrition Universal Screening Tool; MST: Malnutrition Screening Tool.

Table 3. Agreement of MUST and MST versus NRS-2002

Variable	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Agreement (%)	Kappa
Admission						
MUST	82.8	88.1	54.5	96.7	87.3	0.584
MST	17.3	97.6	55.6	87.2	85.8	0.208
Discharge						
MUST	56.4	84.5	58.5	83.3	76.6	0.413
MST	25.5	94.4	63.6	76.6	75.1	0.243

NRS-2002: Nutritional Risk Screening 2002; MUST: Malnutrition Universal Screening Tool; MST: Malnutrition Screening Tool; PPV: positive predictive value; NPV: negative predictive value.

Table 4. Risk of long LOS (≥15 days) in the multivariate analysis

Method	Crude OR (95% CI)	*p*	Adjusted OR (95% CI)†	*p*	Adjusted OR (95% (CI)‡	*p*
NRS-2002	4.800(1.748–13.177)	0.002***	5.661 (1.974–16.237)	0.001**	5.588 (1.858–16.811)	0.002**
MUST	2.060 (1.014–4.187)	0.046*	2.156 (1.048–4.436)	0.037**	2.054 (0.960–4.395)	0.064
MST	3.015 (0.610–14.894)	0.176	3.394 (0.676–17.048)	0.138	3.385 (0.632–18.129)	0.154

LOS: length-of-hospital stay; OR: odds ratio; .CI: confidential interval; NRS-2002: Nutritional Risk Screening 2002; MUST: Malnutrition Universal Screening Tool; MST: Malnutrition Screening Tool.
†Adjusted for sex, age;
‡Adjusted for sex, age, TNM stages, tumor location, surgical method;
Significance in shown by $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$.

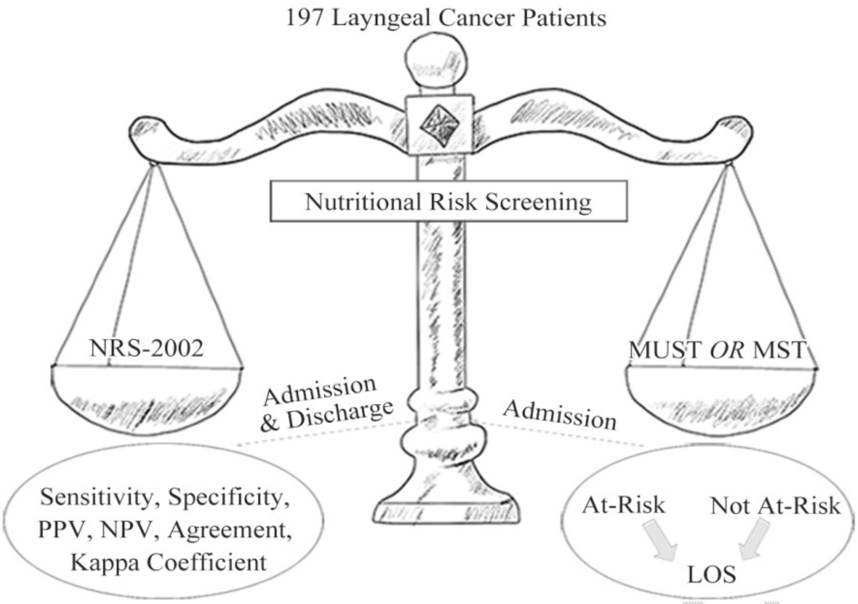

Figure 1. Diagram of study design. 197 patients with laryngeal cancer were enrolled. Using NRS-2002 as the reference, sensitivity, specificity, PPV, NPV, agreement, and Kappa coefficient were used to compare the nutritional risk screening accuracy of MUST and MST. Unconditional logistic regression analysis was performed to assess ability of the three screening tools to predict a long LOS. NRS-2002: Nutritional Risk Screening 2002; MUST: Malnutrition Universal Screening Tool; MST: Malnutrition Screening Tool; PPV: positive predictive value; NPV: negative predictive value; LOS: length-of-hospital stay.