Validation of the Efficacy of the NUTRISCORE for Nutritional Screening of Cancer Patients in China

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Research article

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Abstract

Background: Malnutrition is common in cancer patients. The NUTRISCORE was a newly developed cancer-specific nutritional screening tool and validated by reference to the Patient-Generated Subjective Global Assessment (PG-SGA) and Malnutrition Screening Tool (MST) in Spain. We aimed to evaluate the performance of NUTRISCORE, MST, and PG-SGA in estimating the risk of malnutrition in Chinese cancer patients.

Methods: Data from an open parallel and multicenter cross-section study in 29 clinical teaching hospitals in 14 Chinese cities were used. Cancer patients were assessed for malnutrition using PG-SGA, NUTRISCORE, and MST. The sensitivity, specificity, and areas under the receiver operating characteristic curve were estimated for NUTRISCORE and MST using PG-SGA as a reference.

Results: A total of 1000 cancer patients were included. The mean age was 55.9 (19 to 92 years), and 47.5% were male. 450 patients (45.0%) had PG-SGA B and C, 29 patients (2.9%) had a NUTRISCORE ≥ 5, and 367 patients (36.7%) had MST ≥ 2. With PG-SGA as a reference method, the sensitivity, specificity, and area under the curve values of the NUTRISCORE was 6.2 %, 99.8%, and 0.53, respectively. The sensitivity, specificity, and area under the curve values of the MST were 50.9%, 74.9%, and 0.63, respectively. The kappa index between NUTRISCORE and the PG-SGA were 0.066 and 0.262 between MST and the PG-SGA ($P < 0.05$).

Conclusions: NUTRISCORE was found a higher specificity and lower sensitivity compared with MST using PG-SGA as a reference method in cancer patients in China. Further studies are needed.

Background

Malnutrition is common in cancer patients [1, 2]. Cancer and its related inflammatory factors could cause anorexia and skeletal muscle depletion. Besides, anti-cancer therapy may also cause impaired intake, weight loss, and malnutrition. Many cancer patients may die from cancer cachexia and malnutrition [3, 4]. Early nutritional diagnosis and treatment can intervene or treat tumor malnutrition, increase the tolerance of anti-tumor treatment, control the side effects of anti-tumor treatment, and improve the quality of life [5–8].

Patient-Generated Subjective Global Assessment (PG-SGA) was a standard nutritional assessment tool for cancer patients [9–12]. However, several factors, such as cancer type, stage, and anti-cancer therapy, may cause malnutrition and were not determined in PG-SGA [13]. PG-SGA was not cancer-specific. Recently, a new nutritional screening tool (NUTRISCORE) had been developed specifically for cancer patients and validated by reference to the PG-SGA and Malnutrition Screening Tool (MST) [14]. In this multicenter, cross-sectional study in Spain, NUTRISCORE was found a better performance compared with MST. NUTRISCORE had a good agreement with PG-SGA (kappa index = 0.88), and the time of the NUTRISCORE was much quicker than PG-SGA [14]. As a fast and cancer-specific nutritional screening tool, NUTRISCORE had also been validated in another study in Spain [15]. Whether it could be used in

predicting malnutrition risk of cancer patients in China was unclear. Therefore, we performed a multicenter, cross-sectional study to validate the performance of NUTRISCORE and MST compared with PG-SGA in estimating the risk of malnutrition in cancer patients in China.

Methods

Study design

Data from an open parallel and multicenter cross-section study were used. Cancer patients from the general surgery, thoracic surgery, gastroenterology, and oncology departments were enrolled in this open parallel and multicenter cross-section study in 29 clinical teaching hospitals in 14 Chinese cities [16]. The study was approved by the Ethics Committee of Peking Union Medical College Hospital (approval No. S-K 013) and all participants were included with written informed consent. Cancer patients were assessed for malnutrition using PG-SGA, NUTRISCORE, and MST. Inclusion criteria: 1) diagnosed with an oncologic disease, 2) aged over 60, 3) signed informed consent; 4) completed the questionnaires consciously. Excluding criteria: 1) confused.

The primary objective was to evaluate the performance of NUTRISCORE, MST, and PG-SGA in estimating the risk of malnutrition in Chinese cancer patients. The sensitivity, specificity, positive predictive values, negative predictive values, positive likelihood ratio, negative likelihood ratio, and areas under the receiver operating characteristic (ROC) curve were estimated for NUTRISCORE and MST using PG-SGA as a reference.

Nutritional screening tools

In this study, NUTRISCORE, MST, and PG-SGA were used to assess and compare the nutritional status of cancer patients, to clarify the applicability of NUTRISCORE in the nutritional status of Chinese cancer patients.

NUTRISCORE was used to screen the nutritional status of cancer patients and validated in the Spanish population. NUTRISCORE consists of four parts: involuntarily weight loss in the last 3 months, eating poorly in the last week due to decreased appetite, tumor location/neoplasm, and oncology treatment. ≥5 points were classified as a nutritional risk.

PG-SGA was widely used for cancer patients, developed for hospitalized patients, and recommended by the Oncology Nutrition Dietetic Practice Group of the American Dietetic Association [9]. PG-SGA consists of patients' self-reported section, food intake, symptoms, activities and function, weight loss and medical section, disease-related nutrition state, metabolic demand, and physical examination. The results of PG-SGA were classified as one of the following: well-nourished (A), moderately malnourished (B), or severely malnourished (C). For the purpose of comparison and consistency with the NUTRISCORE paper [14], PG-SGA stages B and C were also classified as a nutritional risk in this study.

The MST has been widely validated in cancer patients, although it was designed for older adults. MST had only two questions: Have you lost weight recently without trying? Have you been eating poorly because of a decreased appetite? ≥2 points was classified as a nutritional risk.

Data collection

The scores of NUTRISCORE, MST, and PG-SGA of cancer patients were assessed by a trained dietician using data from an open parallel and multicenter cross-section study. Data were abstracted and inputted independently by two trained investigators to ensure the consistency and integrity.

Statistical analysis

Measurement data were expressed by mean ± standard deviation, counting data by percentage description. To determine the accuracy of NUTRISCORE, MST, and PG-SGA and to predict malnutrition in cancer patients, the areas under the receiver operating characteristic curve were calculated using PG-SGA as a reference method. The sensitivity, specificity, positive predictive values, negative predictive values, and kappa index were also estimated. All statistical tests were two-sided, and P values <0.05 were considered statistically significant. Statistical analysis was performed with SPSS software (Version 19, SPSS Inc., IBM, NY, USA).

Results

1000 cancer patients were included. The mean age was 55.9 ± 11.8 (range, 19 to 92 years), and 47.5% (n = 475) were male. The proportions of cancer patients, who received college education, secondary education, and primary-school education, were 21.3%, 57.7%, and 21.0%, respectively. Furthermore, 6.1% of cancer patients had a family tumor history.

All of the pathological diagnosis of cancer patients were officially collected in the medical records. Lung cancer, breast cancer, and leukemia were the most common diseases, accounting for 34.4%, 19.6%, and 13.1%, respectively (Table 1). 29 patients (2.9%) had a NUTRISCORE ≥ 5; 367 patients (36.7%) had MST ≥ 2; 450 patients (45.0%) had PG-SGA B and C (Table 1).

Table 1. Patient characteristics.

Characteristics	n (%)
Age, y, mean ± SD	55.9+11.8
Range	19-92
Sex	
Male	475 (47.5)
Female	525 (52.5)
Education	
Primary school	210 (21.0)
Secondary Education	577 (57.7)
College education	213 (21.3)
Diagnose	
Lung cancer	344 (34.4)
Breast cancer	196 (19.6)
Gastric cancer	78 (7.8)
Liver cancer	39 (3.9)
Esophagus cancer	28 (2.8)
Colorectal cancer	83 (8.3)
Cervical cancer	24 (2.4)
Ovarian cancer	28 (2.8)
Leukemia	131 (13.1)
Lymphoma	39 (3.9)
Others	10 (0.1)
Family tumor history	60 (6.1)
NUTRISCORE≥5	29 (2.9)
MST≥ 2	367 (36.7)
PG-SGA B+C	450 (45.0)

BMI, Body Mass Index; MST, the Malnutrition Screening Tool; PG-SGA, Patient-Generated Subjective Global Assessment.

With PG-SGA as a reference method, the sensitivity, specificity, positive predictive values, negative predictive values, and AUC of the NUTRISCORE was 6.2%, 99.8%, 96.6%, 56.5%, and 0.53, respectively. The sensitivity, specificity, positive predictive values, negative predictive values, and AUC of the MST were 50.9%, 74.9%, 62.4%, 65.1% and 0.63, respectively (Table 2).

Table 2. Comparison of the performance.

	NUTRISCORE	MST
Sensitivity % (95% CI)	6.2 (4.2-8.9)	50.9 (46.2-55.9)
Specificity % (95% CI)	99.8 (98.8-100)	74.9 (71.0-78.4)
Positive predictive value % (95% CI)	96.6 (80.4-99.8)	62.4 (57.2-67.3)
Negative predictive value % (95% CI)	56.5 (53.4-59.7)	65.1 (61.2-68.8)
Area under the ROC curve	0.53 (0.49-0.57)	0.63 (0.59-0.66)
Kappa	0.066*	0.262*

MST, the Malnutrition Screening Tool; ROC, receiver operating characteristic. *P < 0.05

The sensitivity, negative predictive value, and AUC of MST were higher. NUTRISCORE had higher specificity and positive predictive values (Fig. 1). The kappa index between NUTRISCORE and the PG-SGA were 0.066, and 0.262 between MST and the PG-SGA (P < 0.05).

Discussion

In this study, NUTRISCORE was firstly validated in cancer patients in China. Among 1000 cancer patients, 2.9% had a NUTRISCORE ≥ 5; 36.7% had MST ≥ 2; 45.0% had PG-SGA B and C. The NUTRISCORE had higher specificity, while the sensitivity and AUC of MST were higher using PG-SGA as a reference method. MST had a higher kappa index.

Globally, the incidence and mortality of cancer patients significantly increased. In general, cancer patients had a hypermetabolism state, increased energy consumption, skeletal muscle depletion, and weight loss [17–19]. The oropharynx malignant tumors could decrease the ability to chew or swallow and lead to anorexia [20]. Obstruction caused by cancers of esophagus or stomach may be a mechanical cause of weight loss [21]. Gastrointestinal cancer could suffer from mechanical obstruction of the gastrointestinal tract, delayed gastric empty, digestive, and absorptive disorders, which can lead to anorexia and malnutrition [22]. Anti-cancer chemotherapy directly affects metabolism, causing nausea, vomiting, diarrhea, and anorexia. Nausea and vomiting are common acute reactions to chemotherapy and can lead to fluid or electrolyte imbalances, weight loss, and weakness [23, 24]. The effect of radiotherapy on nutrition may depend on the location of the tumor, the type of radiation used, the size of the exposure field, the patient's status, and the duration of the dose. Radiotherapy of the head and neck can cause

inflammation, reduced salivary secretion, dental caries, stomatitis, and difficulty swallowing [25, 26]. Malnutrition in cancer patients was common and could lead to increased complications and mortality and prolonged hospital stay [3, 4, 27].

Early diagnosis of malnutrition in cancer patients is particularly important [8]. Higher sensitivity and easy-to-use nutritional screening tools for cancer patients are required for improving clinical outcomes. PG-SGA was a standard nutritional assessment tool for cancer patients [28]. However, several factors, such as cancer type, stage, and anti-cancer therapy, may cause malnutrition and were not determined in PG-SGA. [13] PG-SGA was not cancer-specific. Actually, the incidence of malnutrition in different types of cancers was different. The incidences of malnutrition in pancreatic cancer, gastrointestinal cancers, esophageal cancers, and hematopoietic stem cell transplantation were higher, while incidences of malnutrition in breast cancer or prostate cancer were smaller [29]. Metastatic cancers or advanced cancers were more likely to develop malnutrition [29, 30]. Anti-cancer chemo-radiotherapy may also lead to malnutrition [31]. Therefore, cancer-specific nutritional screening tools may be more needed.

As a fast and cancer-specific nutritional screening tool, NUTRISCORE had been developed and validated in the Spanish population. The NUTRISCORE not only contains weight loss and decreased appetite, but also includes cancer type, location, and anti-cancer treatment. To validate the performance of NUTRISCORE in cancer patients in China, we enrolled 1000 cancer patients and found that only 2.9% of them had a NUTRISCORE ≥ 5, while the incidence was 22.6% (N = 394)in the study from Spain. Besides, the sensitivity, AUC, and kappa index of NUTRISCORE were lower than MST using PG-SGA as a reference method, while NUTRISCORE was found a better performance compared with MST in the Spain study [14].

This may be due to the different sample distribution of the two studies. In our study, the top three cancers (67.1%) were lung cancer (34.4%), breast cancer (19.6%), and leukemia (13.1%), while the scores of breast cancer and leukemia were 0 points in the NUTRISCORE. In the NUTRISCORE study, the top three cancers (45.7%) were abdominal and pelvic cancer (liver, biliary tract, renal and gynecologic cancer, 18.8%), breast cancer (14.5%) and head and neck cancer (12.4%). Malnutrition was more common in head and neck cancer [13, 29]. The distribution of the study sample may cause bias. Secondly, some of the patients in this study were inpatients, while NUTRISCORE was designed for outpatient patients.

In our study, NUTRISCORE had higher specificity and positive predictive values than MST using PG-SGA as a reference method, which was consistent with a study conducted in Spain [14]. As a cancer-specific nutritional screening tool, NUTRISCORE was associated with good specificity.

However, several cancer-specific factors such as metastasis, tumor staging, and the number of courses of chemotherapy were not included in NUTRISCORE. Metastasis was related to malnutrition and clinical outcomes [30]. Solid tumor and hematological malignancy had a different staging system. Moreover, malnutrition related to systemic inflammation [35] was not enrolled in the NUTRISCORE. Whether a single cancer-specific nutritional screening tool is more specific should be discussed. For example, the Onodera's prognostic nutritional index had been used for evaluating malnutrition in gastrointestinal cancer patients [32–34]. Besides, in our study, the cancer-specific NUTRISCORE did not have better

performance than MST, which only include weight loss and decreased appetite. And the cancer-specific factors were also not included in the diagnostic criteria of cancer cachexia [35, 36]. In view of this, standard nutritional screening tools, such as MST and NRS2002 [37], may be suitable for cancer patients.

This study had some limitations. Firstly, the distribution of cancer patients may strongly influenced the results of the study. There was more breast cancer patient in this study (19.6% vs. 14.5%), which usually were not malnourished. Secondly, most of the patients in this study were inpatients. Thirdly, the research data were from the database, which may cause bias. Further large sample studies are needed.

Conclusions

The NUTRISCORE was found a higher specificity and lower sensitivity compared with MST using PG-SGA as a reference method in cancer patients in China. Further studies are needed.

Abbreviations

PG-SGA: Patient-Generated Subjective Global Assessment

MST: Malnutrition Screening Tool

BMI: Body Mass Index

ROC: Receiver operating characteristic

Declarations

Ethics approval and Consent to participate: The study was approved by the Ethics Committee of Peking Union Medical College Hospital (approval No. S-K 013) and all participants were included with written informed consent.

Consent for publication: Not applicable

Availability of data and material: The datasets used during the current study available from the corresponding author on reasonable request.

Competing interest: The authors state that they have no conflict of interest.

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Authors' contributions: WC, EM and JK equally contributed to the conception and design of the research; EM and JK contributed to the design of the research; XS and HL contributed to the acquisition and analysis of the data; WC and JK contributed to the interpretation of the data; and JK and WC drafted the

manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

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Figures

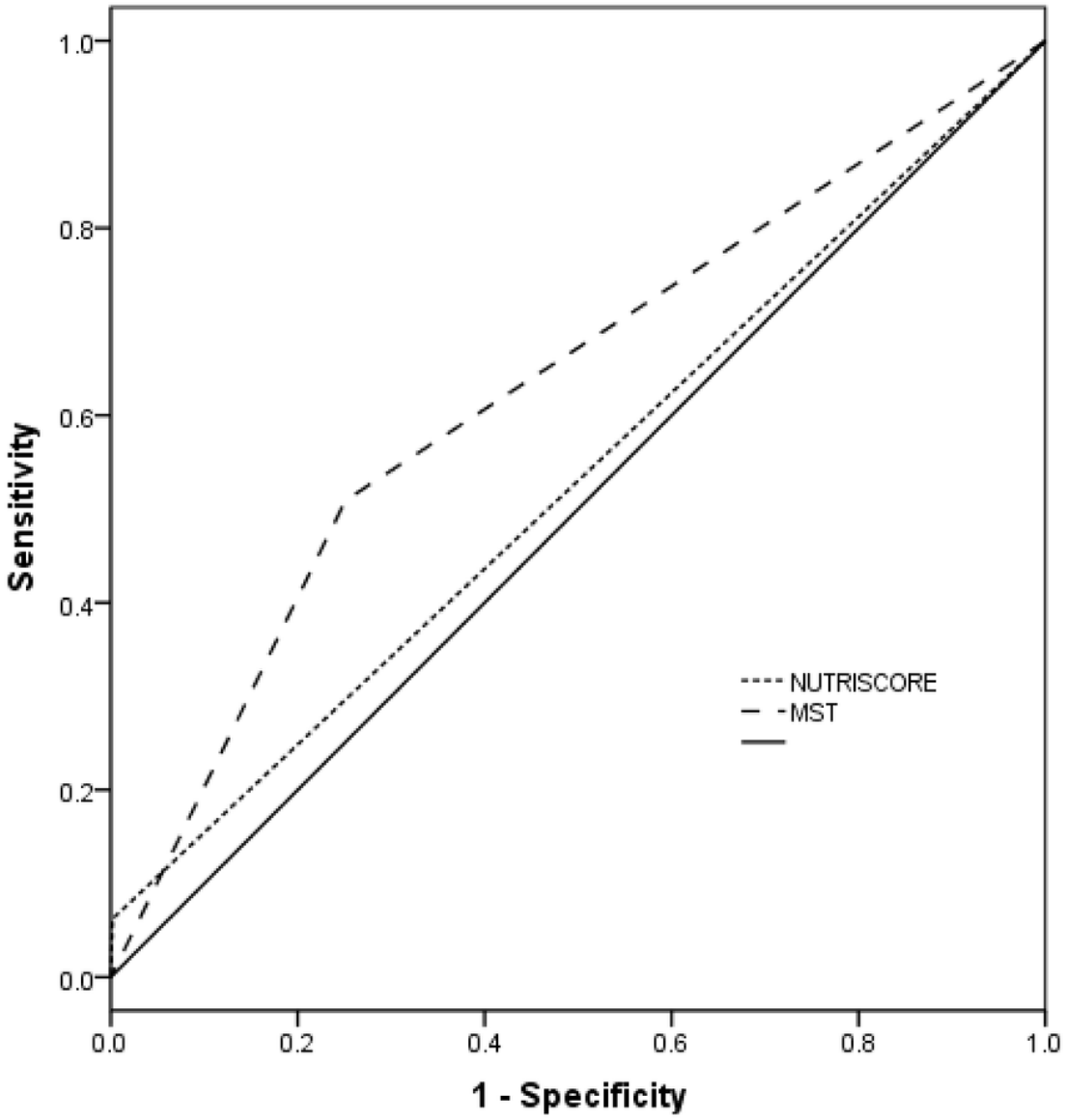

Figure 1

Receiver operating characteristic curve of the NUTRISCORE, MST and PG-SGA.