ISSN: 3065-3630
Research Article

Journal of Clinical Nursing & Reports

Construction and Validation of a Risk Prediction Model for Postoperative Dysphagia in Patients with Head and Neck Cancer

Li Jiaping[1], Zhu Yunxia[2]*, Zhu Yu[3] &Wei Yipan[4]

[1]*Shaoxing Hospital of Traditional Chinese Medicine, China*
[2]*Zhejiang cancer hospital, China*
[3]*Zhejiang Chinese Medical University, China*

***Corresponding author:** Zhu Yunxia, Shaoxing Hospital of Traditional Chinese Medicine, China.

Submitted: 12 January 2026 **Accepted:** 21 January 2026 **Published:** 28 January 2026

Citation: *Li, J., Zhu, Y., Zhu, Y., & Wei, Y. (2026). Construction and Validation of a Risk Prediction Model for Postoperative Dysphagia in Patients with Head and Neck Cancer. J of Clin Nur Rep, 5(1), 01-14.*

Abstract

Objective: *This study aimed to construct a nomogram and web calculator for predicting the risk of dysphagia in patients with head and neck cancer after surgery.*

Design: *A prospective study*

Methods: *patients who met the exclusion criteria in a class III a hospital in Zhejiang Province from October 2023 to June 2024 were selected as the modeling group, and patients in the same hospital from July 2024 to October 2024 were selected as the validation group. SPSS software was used for single factor and multi factor analysis to build the prediction model, and R software was used to draw the nomogram and web calculator. Internal and external validation of the constructed prediction model.*

Results: *the incidence of dysphagia in the modeling group and the validation group were 56.4% and 53.8%, respectively. Age (OR = 2.332), smoking history (OR = 2.423), tumor T stage (OR = 1.818), primary tumor location, neck lymph node dissection (OR= 2.342), flap transplantation (OR = 2.954), nutritional risk (OR = 1.772) and Beck oral score (OR = 2.482) were independent predictors of dysphagia in patients with head and neck cancer after surgery. The areas under the receiver operating characteristic curve of the modeling group and the validation group were 0.893 and 0.890, respectively.*

Conclusion: *the incidence of postoperative dysphagia in patients with head and neck cancer is high. The risk prediction model for early postoperative dysphagia in patients with head and neck cancer constructed in this study has good discrimination, calibration and clinical applicability. It can be used as an evaluation and prediction tool to help clinical medical staff early identify high-risk groups of postoperative dysphagia in patients with head and neck cancer.*

Keywords: Head and Neck Cancer, Dysphagia, Risk Assessment, Nomogram, Risk Prediction Model.

Introduction

Swallowing is a physiological process of transporting food from the mouth to the stomach. When the jaw, lips, tongue, soft palate, throat or esophagus are abnormal, food may not be transported smoothly, that is, dysphagia occurs [1]. Dysphagia can be caused by pathology that affects any point in the swallowing pathway. The three major diseases at risk for dysphagia include: cerebrovascular disease, neurodegenerative disease, and head and neck cancer [2]. Head and Neck Cancer is one of the most common cancers in the world, with the seventh highest incidence rate. It is usually a group of malignant tumors originating from soft tissues such as oral cavity, nasal cavity, paranasal sinuses, pharynx, larynx and salivary glands [3]. With the increase in the incidence of HNC, and the progress of treatment methods, the number of head and neck cancer survivors is increasing, and there are different degrees of dysphagia among these survivors. Research shows

that, the incidence of postoperative dysphagia in patients with HNC is as high as 65 %, and the incidence of dysphagia in patients with pharyngeal and oral tumors is higher [4, 5]. The main treatment of HNC is surgery, supplemented by radiotherapy and chemotherapy. Whether it is treated alone or in combination, it will cause different degrees of damage to the anatomy and physiological structure of the swallowing organ, Swallowing-related muscle edema and fibrosis can lead to decreased tongue muscle strength and limited mouth opening, which in turn affects swallowing function [6]. In severe cases, swallowing movement can be weakened or disappeared. Despite advances in surgical techniques and reconstruction methods, dysphagia is still one of the major problems faced by patients with HNC after surgery [7] . Dysphagia in patients withHNC can lead to complications such as aspiration pneumonia, malnutrition, weight loss, prolonged hospital stays and increased catheter dependence [8-12]. Postoperative swallowing dysfunction leads to a decline in the quality of life of patients, accompanied by psychological problems such as anxiety, depression and social isolation [13,14].In addition, with the improvement of survival rate, people pay more and more attention to the long-term function of swallowing [15] .Therefore, early identification of dysphagia after head and neck cancer surgery and improvement of postoperative swallowing function are urgent problems for medical staff.

Background

The 《China Chronic Disease Prevention and Control Plan (2017-2025) 》 lists “healthy oral cavity”as a special action and elevates it to a national strategic height [16]. The introduction of relevant policies highlights the important role of oral health in the development of health undertakings, national strategies and health service systems [17]. The 2021 European Society of《Dysphagia White Paper》summarizes best practices in the management of dysphagia in HNC, and calls for early screening and identification of swallowing function in patients with head and neck cancer treatment [18]. Loni et al. [19]. reported that two-thirds of patients with head and neck cancer were examined for swallowing function by television fluoroscopy Video-fluoroscopic Swallowing Study (VFSS) found that there was already dysphagia，but still in the oral food. Studies have shown that 69 % of patients with advanced head and neck cancer have aspiration after treatment, basically no symptoms [20]. Therefore, patients with poor perception of dysphagia and hidden symptoms need to identify risk factors in time and evaluate and intervene as soon as possible. A number of evidence summary points out，early identification of high-risk groups of dysphagia in head and neck cancer can start dysphagia training as early as possible before and after surgery, which is helpful to improve the swallowing function of patients after surgery [21-23]. Therefore, understanding the prevalence and influencing factors of dysphagia in patients with head and neck cancer, and constructing a risk prediction tool for dysphagia after head and neck cancer surgery are of great significance for medical staff to carry out early identification of dysphagia and oral health management.

Materials and Methods

Study Design

This is a study of patients in two head and neck cancer wards in a tertiary comprehensive cancer hospital in China. The study was approved by the hospital ethics committee and informed patients and signed informed consent. The ethical review approval number is: IRB-2023-1021.

Setting and Participants

In this study, a convenient sampling method was used to select patients with postoperative head and neck cancer who met the inclusion and exclusion criteria in the head and neck surgery department of a tertiary hospital in Zhejiang Province from October 2023 to June 2024 as the modeling group. A prospective study was conducted in the validation group. Patients with postoperative head and neck cancer who met the inclusion and exclusion criteria in the same hospital from July to October 2024 were selected as the subjects of the validation group. The inclusion criteria are as follows: 1 Patients ≥ 18 years old were confirmed as primary malignant tumors of head and neck such as oral cavity, nasal cavity, paranasal sinuses, pharynx and larynx by pathology or cytology. 2 patients with normal swallowing function before operation; 3 patients with smooth operation and postoperative eating; 4 patients who had no history of radiotherapy and chemotherapy within one month after surgery; 5 patients with clear consciousness, no dyslexia, and simple written and language communication; 6 Patients who were willing to participate in the study and informed consent. Exclusion criteria are as follows: 1 patients with mental illness and speech communication disorders; 2 patients with other malignant tumors; patients with unstable postoperative condition; 4 Patients who could not cooperate with the investigation. The shedding criteria are as follows: 1 During the study, the patient died due to aggravation of the disease; 2 Patients required to withdraw voluntarily for any reason.

Variables and Instruments

On the basis of literature review and expert meeting, the researcher designed a questionnaire on the influencing factors of postoperative dysphagia in patients with head and neck cancer, including three aspects : patient-related, tumor-related and treatment-related factors : (1) Patient-related factors include age, gender, drinking history, smoking history, respiratory disease history, diabetes history, preoperative functional exercise, BMI, tooth loss, hemoglobin decline level, albumin decline level, oral status, pain score and nutritional risk assessment ; (2) Patient-related factors include age, gender, drinking history, smoking history, respiratory disease history, diabetes history, preoperative functional exercise, BMI, tooth loss, hemoglobin decline level, albumin decline level, oral status, pain score and nutritional risk assessment ; (2) Tumor-related factors include primary tumor location and tumor T stage ; (3) The treatment-related factors included intraoperative blood loss, operation time, operation method, neck dissection, tracheotomy, skin flap transplantation, postoperative time and gastric tube indwelling time. Nutritional risk assessment using the Chinese Anti-Cancer Association recommended the use of Nutritional Risk Screening-2002(NRS-2002) Routine nutritional screening for patients with head and neck cancer [24]. The scale includes three dimensions: disease severity score, nutritional impairment score and age score≥3 points indicate the risk of malnutrition in patients.

Swallowing Function Assessment

Water Swallow Test (WST)

This method is mainly used for initial screening and bedside

screening of dysphagia [45]. Evaluation method: patients take a seat, let the patient drink 2-3 spoons of water first, if there is no abnormality, then drink 30 ml warm boiled water at one time, medical staff record drinking time, drinking water and whether cough. Evaluation criteria : Level 1 : one-time drinking, no cough ; level 2 : drink more than twice, no cough ; level 3 : one-time drinking, choking cough ; level 4 : drinking more than twice, with choking cough ; level 5 : unable to drink, frequent cough. Grade 3-5 indicates dysphagia.

Eating Assessment Tool-10(EAT-10)

The scale is used for the preliminary screening of dysphagia. It contains 10 items, each score is 0-4 points, and the total score ≥ 3 points indicates abnormality. The higher the score, the more significant the self-perception of dysphagia. The scale is easy to operate, and patients can usually complete self-assessment within 2 minutes to quickly identify dysphagia. Printz et al [25]. applied EAT-10 to patients with head and neck cancer and neurogenic dysphagia, which showed good internal consistency (Cronbach 's a = 0.963). They believe that the questionnaire is an effective, reliable and highly specific tool for assessing dysphagia.

The screening criteria were that one of the two assessment methods was positive and diagnosed as dysphagia.

Data Collection

The assessment of dysphagia was performed after eating in patients with head and neck cancer early after surgery, that is, within one month after surgery. Before data collection, the approval of the hospital ethics committee was obtained, and the consent of the department was obtained. Data collection methods mainly take the form of face-to-face, patients signed informed consent. The relevant data of patients, nutritional status score and EAT-10 self-rating scale can be stated by the researcher, and the subjects can be recorded after answering the questions. Tumor-related and treatment-related data were queried and recorded through the medical record system ; the Kubota drinking water test and Beck oral score were evaluated by the researchers. A total of 356 valid questionnaires were collected in this study, including 250 patients in the modeling group and 106 patients in the validation group.

Sample Size

According to the rough estimation method of logistic regression sample size, the sample size satisfies 5 ~ 10 times EPV, so the sample size calculation formula of this study is $N=10\times\frac{k}{p}$ is the number of factors, and P is the incidence of postoperative dysphagia in patients with head and neck cancer. In this study, 24 factors were finally included through literature review and expert meeting, and some studies pointed out that the incidence of postoperative dysphagia in patients with head and neck cancer was as high as 65 %, Considering that there may be 10 % of the sample loss, the above factors, according to the clinical risk prediction model modeling sample size calculation needs to be included in 203 ~ 406 cases [4]. According to the actual situation of this study, 250 cases were included in the modeling group, which met the sample size requirements. According to the ratio of 7 : 3 between the modeling group and the verification group, 106 patients with head and neck cancer at different times in the same hospital were included in the verification group.

Statistical Analysis

SPSS was used for statistical analysis. The indicators with $P < 0.05$ in univariate analysis were included in multivariate logistic regression analysis. The variables finally included in the model were screened by backward stepwise regression method. The entry standard was 0.05 and the removal standard was 0.01. The regression equation was constructed according to the partial regression coefficient and intercept corresponding to the independent risk factors, and the prediction model was established. At the same time, the R software program was used to draw the nomogram and web calculator to visualize the risk of patients. The Bootstrap re-sampling method was used for internal verification, and the data of the modeling group were used to verify the prediction efficiency of the model. The ROC curve was drawn, the Area Under Curv was calculated, and the C-Index was used to evaluate the discrimination of the model. Calibration calibration curve was drawn, and the calibration degree of Brier score evaluation model was calculated. Draw Decision Curve Analysis to evaluate the clinical practicability of the model. External validationThe validation group data collected at different time periods were used to evaluate the performance of the model from three aspects : discrimination, calibration and clinical effectiveness.

Results

Characteristics of the Participants

A total of 356 patients with head and neck cancer were included in this study. The overall incidence of dysphagia was 55.6 %, of which the incidence of the modeling group was 56.4 %, and the incidence of the validation group was 53.8 %. Among the participants, 253 (71.1 %) were males and 103 (28,9 %) were females. After chi-square test and t test, it was found that there was no statistically significant difference between the data of the modeling group and the validation group ($P > 0.05$).

Univariate Analysis of Dysphagia

Taking the presence of dysphagia as the dependent variable, the samples of the modeling group were used for univariate analysis. The results showed that the age, BMI, smoking history, tooth loss, malnutrition risk, and Beck oral score of the patient-related factors were compared between the two groups of non-dysphagia and dysphagia. The difference was statistically significant ($P < 0.05$),(Table 1). Among the tumor-related factors, the primary location of the tumor and the T stage of the tumor were statistically significant between the two groups ($P < 0.05$),(Table 2); the operation time, operation method, cervical lymph node dissection, tracheotomy and skin flap transplantation were statistically significant between the two groups ($P < 0.05$), (Table 3)

Table 1: Patient-related conditions and univariate analysis

Project	Classification	Non-swallowing disorder group (n=109)	Swallowing disorder group (n=141)	χ^2/Z	P
Age(%)	＜60	69(63.3)	50(35.5)	19.106	<0.001

	≥60	40(36.7)	91(64.5)		
Sex (%)	Male	79(72.5)	103(73.0)	0.010	0.920
	Female	30(27.5)	38(27.0)		
BMI(%)	＜18.5 kg/m²	9(8.3)	23(16.3)	8.281	0.041
	18.5-23.9 kg/m2	65(59.6)	92(65.2)		
	24-27.9 kg/m²	32(29.4)	23(16.3)		
	＞28 kg/m²	3(2.8)	3(2.1)		
Drinking (%)	No	66(60.6)	70(49.6)	2.947	0.086
	Yes	43(39.4)	71(50.4)		
Smoking(%)	No	83(76.1)	63(44.7)	25.054	＜0.001
	Yes	26(23.9)	78(55.3)		
Disease of respiratory system (%)	No	93(85.3)	126(89.4)	0.924	0.336
	Yes	16(14.7)	15(10.6)		
Diabetes(%)	No	99(90.8)	117(84.4)	2.276	0.131
	Yes	10(9.2)	22(15.6)		
Functional exercise (%)	No	101(92.7)	125(88.7)	1.138	0.286
	Yes	8(7.3)	16(11.3)		
Tooth loss (%)	No	66(60.6)	57(40.4)	9.962	0.002
	Yes	43(39.4)	84(59.6)		
Pain(%)	0	68(62.4)	81(57.4)	4.917	0.086
	1-3	41(37.6)	54(38.3)		
	4-6	0(0.0)	6(4.3)		
Nutritional risk (%)	No	77(70.6)	45(31.9)	36.902	＜0.001
	Yes	32(29.4)	96(68.1)		
Decreased level of albumin (%)		4.30(1.50,7.75)	5.30(2.40,8.65)	-1.604	0.110
Decreased level of hemoglobin (%)		11.00(5.00,19.50)	13.00(4.00,25.00)	-1.419	0.158
Beck oral scoring (%)	5分	37(33.9)	11(7.8)	45.965	＜0.001
	6-10分	60(55.0)	69(48.9)		
	11-15分	11(10.1)	52(38.3)		
	16-20分	1(0.9)	7(5.0)		

Table 2: Tumor-related conditions and single factor analysis

Project	Classification	Non-swallowing disorder group(n=109)	Swallowing disorder group(n=141)	χ^2	P
Primary location of tumor (%)	oral cavity	44(30.4)	71(50.4)	47.602	＜0.001
	pharyngeal	17(15.6)	30(21.3)		
	throat	7(6.4)	33(23.4)		
	Nasal cavity and sinuses	41(37.6)	7(5.0)		
Tumor T staging (%)	T1	68(62.4)	37(27.7)	36.464	＜0.001
	T2	34(31.2)	62(44.0)		
	T3	6(5.5)	31(22.0)		
	T4	1(0.9)	9(6.4)		

Table 3: Treatment-related conditions and single factor analysis

Project	Classification	Non-swallowing disorder group(n=109)	Swallowing disorder group(n=141)	χ^2值	P值
Blood loss (%)	＜50ml	73(67.0)	78(56.0)	4.508	0.177

	50-100ml	17(15.6)	22(16.3)		
	100-400ml	19(17.4)	37(26.2)		
	＞400ml	0(0.0)	2(1.4)		
Operation time (%)	＜3h	88(80.7)	88(62.4)	9.904	0.002
	＞3h	21(19.3)	53(37.6)		
Surgical approach (%)	Under the microscope	26(23.9)	12(8.5)	11.227	＜0.001
	Open	83(76.1)	129(91.5)		
Neck lymph node dissection (%)	No	72(66.1)	36(25.5)	41.141	＜0.001
	Yes	37(33.9)	105(74.5)		
Tracheotomy (%)	No	99(90.8)	90(63.8)	24.288	＜0.001
	Yes	10(9.2)	51(36.2)		
Flap transplantation (%)	No	87(79.8)	67(47.5)	27.112	＜0.001
	Yes	22(20.2)	74(52.5)		
Postoperative time (%)	1week	65(59.6)	76(53.9)	7.073	0.065
	2 weeks	37(33.9)	40(28.4)		
	3 weeks	6(5.5)	21(14.9)		
	4 weeks	1(0.9)	4(2.8)		
Gastric tube retention time (%)	0day	71(65.1)	73(51.8)	7.440	0.059
	1-7 days	22(20.2)	28(19.9)		
	8-14 days	11(10.1)	31(22.0)		
	＞15 days	5(4.6)	9(6.4)		

Logistic Regression Analysis of Dysphagia

According to the results of univariate analysis, with dysphagia as the dependent variable, the variables with statistical significance in univariate analysis, age, BMI, smoking history, primary tumor location, tumor T stage, surgical method, surgical time, flap transplantation, tracheotomy, cervical lymph node dissection, tooth loss, nutritional risk and Beck oral score as independent variables were included in the binary logistic regression analysis (backward stepwise method). The assignment table is shown in table 4. The results showed that age, smoking history, tumor T stage, primary tumor location, cervical lymph node dissection, flap transplantation, nutritional risk and Beck oral score were independent predictors of postoperative dysphagia in patients with head and neck cancer, as shown in table 5.

Table 4: Multivariate Logistic regression analysis of risk factors for postoperative dysphagia in patients with head and neck cancer

Variable type	Variable name	Variable assignment
independent variable	Age	＜60 =0, ≥60=1
	BMI	＜18.5 kg/m2=0, 18.5-23.9 kg/m²=1, 24-27.9 kg/m²=2, ＞28 kg/m²=3
	Smoking	No 0, Yes =1
	Tooth loss	No 0, Yes =1
	Primary location of tumor	oral cavity =(1,0,0), pharyngeal =(0,1,0), throat =(0,0,1), Nasal cavity and sinuses =(0,0,0)
	Tumor T staging	T1=0, T2=1,T3=2, T4=3
	Operation time	＜3h=0＞3h=1
	Surgical approach	Under the microscope =0, Open=1
	Tracheotomy	No 0, Yes =1
	Neck lymph node dissection	No 0, Yes =1
	Flap transplantation	No 0, Yes =1
	Beck oral scoring	5points=0, 6-10 points =1,11-15 points =2, 16-20 points =3
	Nutritional risk	No 0, Yes =1
dependent variable	Dysphagia	No 0, Yes =1

Table 5: Multivariate Logistic regression analysis of risk factors for postoperative dysphagia in patients with head and neck cancer

Variable type		B	SE	Wald χ2	P	OR	95%CI
Constant		-4.043	0.591	46.727	＜0.001	0.018	
Age		0.847	0.355	5.682	0.017	2.332	1.162-4.678
Smoking		0.885	0.375	5.564	0.018	2.423	1.161-5.055
Primary location of tumor	Nasal cavity and sinuses *			10.445	0.015		
	oral cavity	1.126	0.540	4.347	0.037	3.083	1.070-8.887
	pharyngeal	1.481	0.607	5.948	0.015	4.397	1.337-14.454
	throat	2.107	0.676	9.701	0.002	8.220	2.184-30.946
Tumor T staging		0.598	0.255	5.506	0.019	1.818	1.103-2.996
Neck lymph node dissection		0.851	0.381	4.992	0.025	2.342	1.110-4.940
Flap transplantation		1.083	0.391	7.658	0.006	2.954	1.372-6.360
Nutritional risk		0.572	0.267	4.598	0.032	1.772	1.050-2.989
Beck oral scoring		0.909	0.361	6.337	0.012	2.482	1.223-5.038

Construction and Verification of Risk Prediction Model

Model Construction

The partial regression coefficients of each variable were calculated according to the Logistic regression equation. The risk prediction model of postoperative dysphagia in patients with head and neck cancer was constructed: Logit (P) =-4.043+0.847×age assignment+0.885×smoking history assignment+1.126×oral tumor assignment +1.481×pharyngeal tumor assignment+2.107×laryngeal tumor assignment +0.598×tumor T stage assignment+0.851×cervical lymph node dissection assignment+1.083×skin flap transplantation assignment+0.572×nutritional risk assignment+0.909×Beck oral score assignment.

Internal Validation of the Model

The internal validation results of the model showed that the area under the ROC curve AUC value was 0.893, and the 95 % CI was 0.854-0.933. Since the AUC value is greater than 0.7, the prediction model has a good ability to distinguish (Fig.1). In this study, the optimal cut-off value of the model was determined by maximizing the Youden index. The optimal cut-off value of the model was 0.669, suggesting that the probability of dysphagia calculated by the model was greater than 66.9 % as high risk, less than 66.9 % as low risk, the specificity was 0.908, and the sensitivity was 0.759. The calibration degree is an indicator of the goodness of fit of the model. This study uses Brier score and calibration curve, Brier = 0.1300.05. The calibration curve shows that the model 's prediction of the probability of dysphagia in patients after head and neck cancer surgery is highly consistent with the actual observation value. The results show that the predicted results are in good agreement with the actual results. The detailed calibration parameters are shown in Fig.2. This study used decision curve analysis to evaluate clinical effectiveness. It can be seen from the decision curve that within the probability threshold range of 0.2-0.9, the model decision curve ' model line ' is always above the ' All line ' and ' None line ', indicating that when the model probability threshold is 0.2-0.9, the clinical decision made using this model can obtain greater net income than the ' no intervention ' or ' all intervention ' scheme, indicating that the clinical applicability of this model is better. Figure 3.

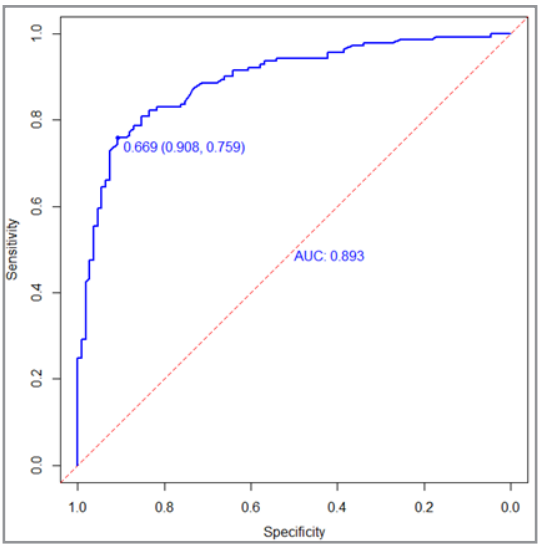

Figure 1: ROC curve of internal validation of the model

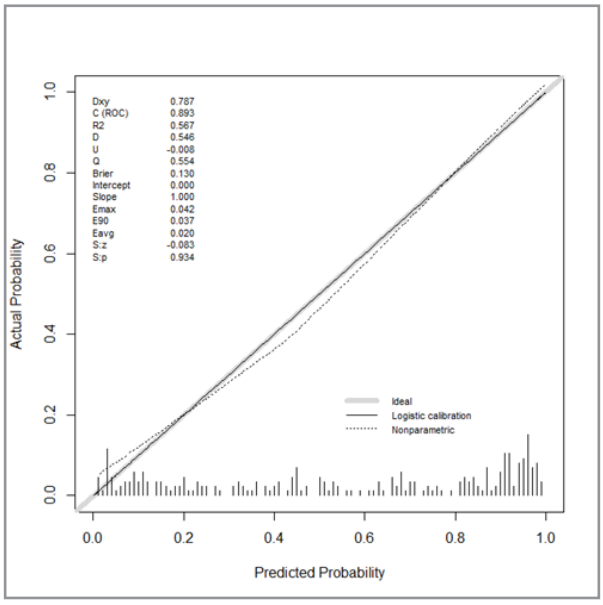

Figure 2: Calibration curve for internal validation of the model

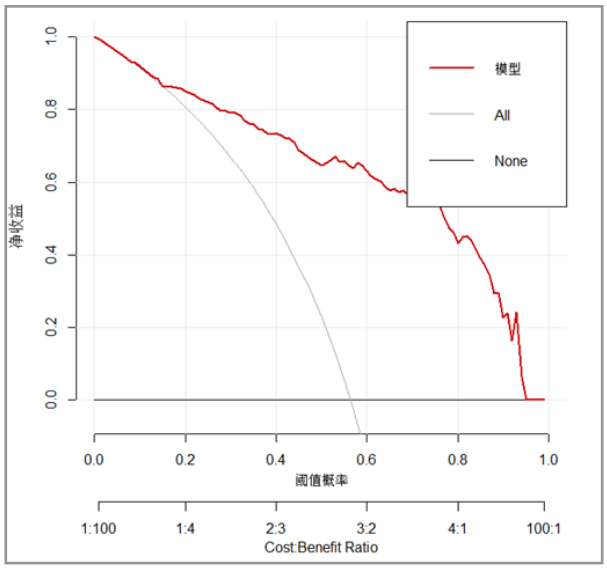

Figure 3: Decision curve of internal validation of the model

External Validation of the Model

In this study, 106 cases of validation group data were used for external verification, and the effectiveness of the model was measured from three aspects : discrimination, calibration and clinical effectiveness. In the external validation of the model, the AUC value under the ROC curve was 0.890, the 95 % CI was 0.826-0.954, and the AUC value was greater than 0.7, indicating that the model also had a good discrimination in the validation group (Fig.4). The optimal cut-off value of this model was 0.579, the specificity was 0.820, and the sensitivity was 0.875. In the calibration curve of external validation, Brier = 0.1320.05, indicating that the model predicts the probability of dysphagia in patients after head and neck cancer surgery and the actual probability of occurrence in the validation group has a good agreement. The detailed calibration parameters are shown in Fig.5. In the external verification of the model, the decision curve is within the probability threshold range of 0.1-0.9, and the ' model line ' of the model decision curve is always above the ' All line ' and ' None line ', indicating that when the probability threshold of the model is 0.1-0.9, the clinical decision made using this model can obtain a greater net benefit than the ' no intervention ' or ' all intervention ' scheme, indicating that the clinical practicability of this model is better. Figure 6.

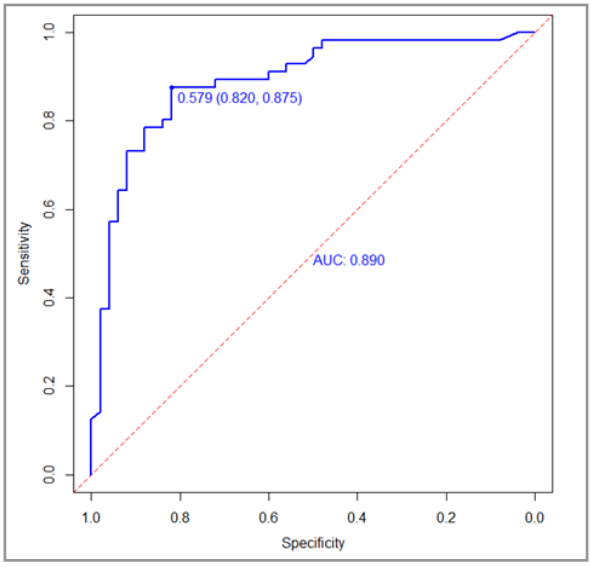

Figure 4: ROC curve of external validation of the model

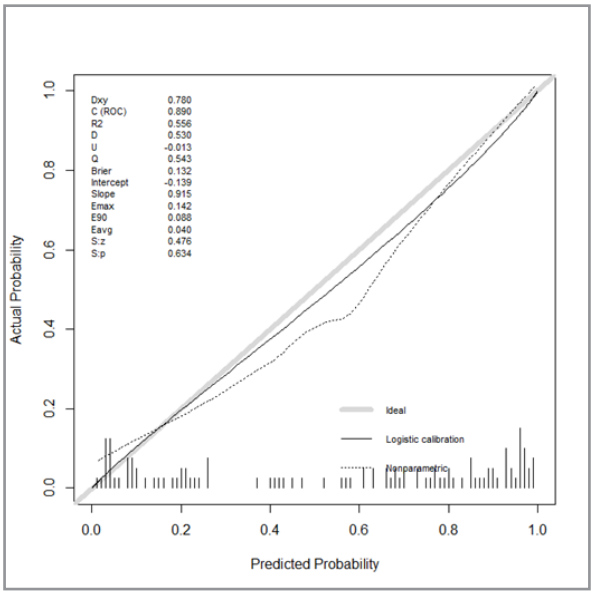

Figure 5: Calibration curve for external validation of the model

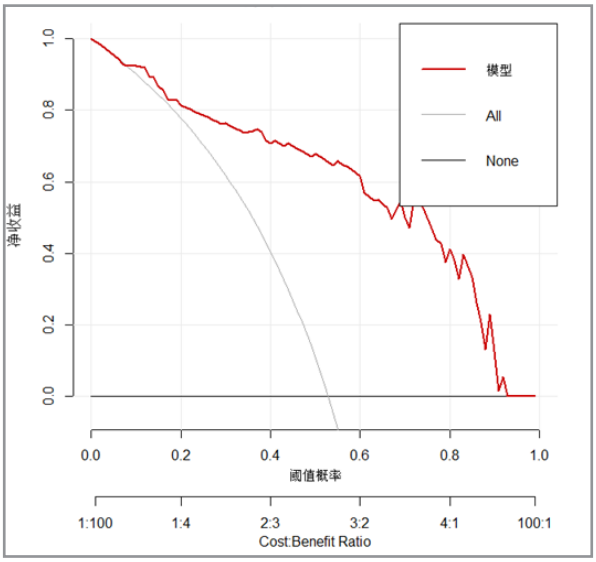

Figure 6: Decision curve of model external validation

The Presentation form of Model Nomogram

In this study, R language was used to draw the nomogram and visualize the model, as shown in Figure 7. The eight horizontal

axes in the figure correspond to different risk factors, and the top (Points) is the reference standard for the risk score. Researchers can calculate the total points according to the corresponding scores of different risk factors of the subjects, and finally determine the probability of dysphagia through the “Diagnosticpossibility”.

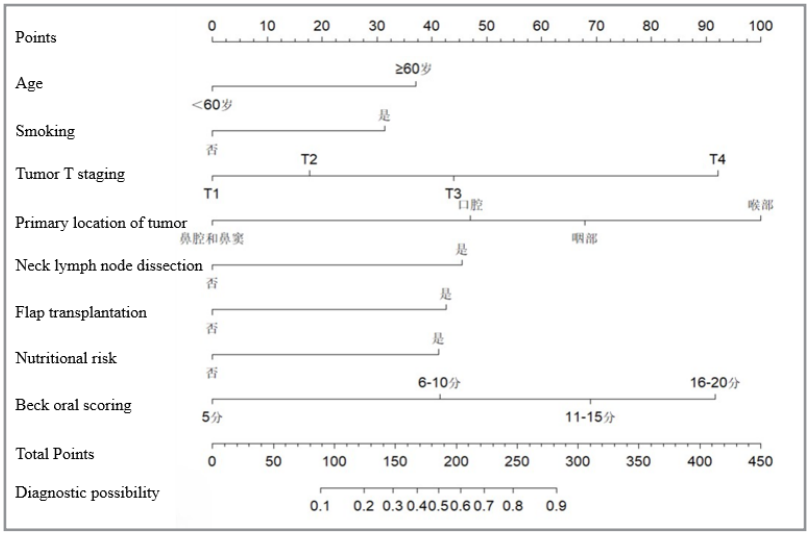

Figure 7: Model Nomogram

Webpage Calculator

In this study, the Shiny framework of R language was used to develop a web calculator for the prediction model of postoperative dysphagia in patients with head and neck cancer. The usage address of the calculator is :https://wynomo.shinyapps.io/dynnomapp/Figure 8 shows the operation interface of the calculator. The left side of the page is the drop-down box of the predictor. The patient 's information is entered in turn, including age, smoking history, tumor T stage, primary tumor location, cervical lymph node dissection, flap transplantation, malnutrition risk, and Beck oral score. Then click the prediction button below, and the probability of the model predicting the patient 's dysphagia and the 95 % confidence interval can be displayed on the right side.

Figure 8: Risk Prediction Web Calculator

Discussion

A total of 356 patients with head and neck cancer were included in this study. The overall incidence of dysphagia was 55.6 %, which was 45 % ~ 65 % higher than the incidence of dysphagia integrated in the previous literature review, The results of this study are at a medium level, and Giannotto et al. results were similar. In this study, Watian drinking water test and EAT-10 scale were used. The study showed that the combination of the two tools greatly improved the sensitivity and specificity of dysphagia screening [27]. Therefore, the combination of the two tools in this study improved the screening rate of occult dysphagia, resulting in a higher incidence of dysphagia. Different assessment tools will lead to differences in the detection rate of dysphagia. Therefore, a unified quantitative bedside assessment tool or standard provides the possibility to achieve accurate monitoring of the incidence of dysphagia and promote the standardization and scientificity of swallowing function assessment. Domestic and foreign research and the results of this study show that, the incidence of postoperative dysphagia in patients with head and neck cancer is high [28-30]. Despite advances in surgical treatment and reconstruction methods, dysphagia is still one of the most serious consequences after surgery in patients with head and neck cancer. Therefore, early identification of dysphagia after head and neck cancer surgery and improvement of postoperative swallowing function are issues that medical staff urgently need to pay attention to.

Patient-Related Factors

The results of this study show that age (≥60 years old) is one of the risk factors for dysphagia after head and neck cancer surgery.

The older the age, the greater the risk of dysphagia after head and neck cancer surgery, which is consistent with the results of Aylward et al [31]. With the increase of age, self-aging will lead to the decline of body organ function, which is often accompanied by physiological problems such as tooth loss, decreased tongue pressure, difficulty in closing the soft palate, decreased chewing ability and decreased swallowing-related muscle endurance, There will also be problems such as pharyngeal oral hypoesthesia, decreased coordination of the swallowing center, and decreased brain compensatory ability, resulting in decreased pharyngeal swallowing reflex or impaired function during the process of food reaching the stomach through the mouth, resulting in neurogenic swallowing problems [32,33]. Therefore, the elderly are a high-risk group of dysphagia. In addition, for elderly patients after head and neck cancer surgery, surgical factors lead to swallowing-related muscle or nerve damage, and surgical stimulation also accelerates the development of oral weakness and increases the risk of dysphagia [34,35].

This study found that smoking history is a risk factor for postoperative dysphagia in patients with head and neck cancer, which is consistent with the results of many studies at home and abroad [36-40]. In this study, patients with a history of smoking accounted for 33.4 %, and patients with postoperative dysphagia accounted for 65.5 %. Some scholars have proposed that harmful compounds produced by combustion in tobacco, such as nicotine, can inhibit fibroblast proliferation, increase platelet adhesion and micro-plaque formation, reduce microcirculation perfusion, affect the healing of oropharyngeal mucosal tissue, and thus affect the postoperative swallowing function of patients. In the study of Ge et al. 47.1 % of patients with hypopharyngeal cancer had a history of smoking, of which 75.8 % had swallowing problems. Multivariate logistic regression found that smoking history was an independent predictor of postoperative dysphagia in patients with hypopharyngeal cancer (OR = 8.580,95 % CI : 1.849-39.804). Therefore, it is necessary to carry out smoking cessation education for patients with head and neck cancer before and after surgery, accelerate the repair of oral and throat mucosa, and reduce the risk of infection [41,42]. Smoking cessation education should continue the whole treatment process and follow-up life, which is conducive to the recovery of swallowing and speech function, and improve the quality of life related to swallowing after surgery.

This study found that oral condition is a predictor of postoperative dysphagia in patients with head and neck cancer. In this study, the modified Beck oral score was used to evaluate the five aspects of lips, teeth, mucosa, tongue and saliva. The higher the total score, the worse the oral function and health status of the patients [43]. In this study, it was found that the higher the Beck oral score of patients with head and neck cancer after surgery, the greater the risk of dysphagia. The main reasons are as follows : First, the surgical area of head and neck cancer covers the key parts of the mouth and throat. After the formation of the wound, if the oral health status is poor, the oral mucosa is edematous and damaged, and the resistance is decreased, it is prone to serious postoperative complications such as oral infection and flap vascular crisis, affecting wound healing and swallowing function recovery [44]. Second, poor oral hygiene causes the nature of oral secretions to change, the amount to increase and become more viscous, hindering the transmission of swallowing signals and thus affecting the coordination of swallowing [45]. If the infection in the mouth is not controlled, the infection will spread to the swallowing muscles of the throat and neck, which will lead to the obstruction or interruption of the swallowing process [46]. In this study, there is a certain relationship between dysphagia and oral health status in patients with head and neck cancer after surgery. The higher the Beck oral score, the greater the risk of dysphagia. Therefore, medical staff can carry out oral care practice under the guidance of the Beck oral assessment form, and formulate personalized oral care programs according to different scoring levels. The washing method, gargle method and spray method can be used to improve the oral cleanliness of patients, so as to improve the oral sensation and swallowing ability.

This study found that malnutrition is a risk factor for postoperative dysphagia in patients with head and neck cancer, which is consistent with the results of Ayumi et al [47]. Cancer is a high-consumption disease, and tumor-induced protein consumption is significantly increased. Postoperative patients with head and neck cancer combined with invasive surgery and oral intake restrictions lead to increased protein catabolism and malnutrition . Malnutrition can cause muscle loss and weight loss, increase the risk of dysphagia, and increase the risk of infection and delay wound healing by destroying the immune system [48]. Studies have shown that the prevalence of sarcopenic dysphagia in hospitalized patients requiring dysphagia rehabilitation is 32 %, and the decrease of oropharyngeal swallowing muscle group and digastric muscle mass caused by nutritional deficiency is an independent risk factor for sarcopenic dysphagia [49]. In addition, the study pointed out that albumin, hemoglobin and other laboratory tests can be used as nutritional indicators to reflect the nutritional status, but the results of this study were not shown. The reason may be that the changes of albumin and hemoglobin were used as variables in this study, and the hospitalization time of patients was shorter. The index did not change significantly, resulting in a statistically significant result. The study points out that good nutrition can improve the swallowing function of patients, and impaired swallowing function can also affect nutritional absorption [50]. The two are closely related. Therefore, medical staff should regularly evaluate the nutritional status of patients. The nutritional status of patients can be detected by laboratory indicators such as albumin and hemoglobin, so as to prevent or discover nutritional risks in time. It is of great significance in improving the swallowing function of patients with head and neck cancer after surgery.

Tumor-Related Factors

The results of this study showed that the primary location of the tumor was a predictor of postoperative dysphagia. Among them, the incidence of dysphagia in pharyngeal tumors was the highest (68.06 %), and the incidence of nasal and sinus tumors was the lowest (13.24 %). In patients with pharyngeal tumors, the removal of tongue base, pharyngeal wall, pharyngeal constrictor, epiglottis, etc.destroys the swallowing structure of the pharynx during the operation, and it is difficult to promote the movement of the food mass, resulting in dysphagia ; pharyngeal surgery can also affect the hypoglossal nerve, vagus nerve and glossopharyngeal nerve, which can lead to decreased swallowing coordination and pharyngeal sensory defects, resulting in aspiration or dysphagia [51]. A number of studies at home and abroad and the results of this study have shown that the incidence of

dysphagia in pharyngeal tumors such as oropharyngeal cancer and hypopharyngeal cancer is high. Attention should be paid to patients with such tumors. Nerve monitoring technology can be used during operation to monitor nerves related to swallowing function in real time, such as glossopharyngeal nerve and vagus nerve, so as to avoid nerve injury. Before and after the operation, the nursing staff guided the patients to carry out functional training such as tongue movement and Masako training, as well as swallowing skills training such as forced swallowing method and Shaker training, so as to prevent the retention or accidental inhalation of the food mass in the trachea after pharyngeal surgery [52].

This study shows that tumor T stage is a predictor of postoperative dysphagia in patients with head and neck cancer. The higher the tumor T stage, the greater the risk of postoperative dysphagia in patients with head and neck cancer. In this study, T staging refers to the 8th edition of AJCC.In addition to the size of the primary tumor, the depth of invasion is also considered. Therefore, the higher the T staging of the tumor, the deeper the tumor infiltration. It is necessary to choose complex surgical methods such as lymph node dissection and skin flap transplantation. Extensive and complex surgical resection will cause swallowing-related tissues such as tongue muscles and pharyngeal constrictors and vagus nerves, glossopharyngeal nerves and other injuries, seriously affecting the postoperative swallowing function of patients. For patients with higher T stage, health education should be done before and after surgery, including treatment methods, complications, preventive measures, etc., to improve the compliance of patients with swallowing rehabilitation training. There is evidence that, patient compliance is an important factor to ensure the effect of postoperative swallowing rehabilitation. Therefore, patients should be encouraged to carry out active preventive and therapeutic swallowing rehabilitation training to reduce the incidence and severity of postoperative dysphagia [53].

Associated-Therapeutic Factors

This study found that flap transplantation is a risk factor for postoperative dysphagia in patients with head and neck cancer. At present, for patients with head and neck cancer with large surgical defects, flap transplantation is performed. Flap transplantation can provide sufficient tissue to cover the wound, restore the shape of the surgical site to a certain extent, and improve the quality of life of patients [54]. However, flap transplantation has changed the original anatomical structure of the mouth, throat, etc., affecting the morphology and function of these parts, resulting in uncoordinated swallowing function; in addition, due to the lack of nerve innervation in the flap, its mobility and flexibility are limited, and the coordinated movement of the oropharyngeal muscle group cannot be achieved. In the process of flap transplantation, the glossopharyngeal nerve will also be damaged, such as glossopharyngeal nerve, vagus nerve and other injuries, which directly affect the swallowing reflex and the movement of the throat muscles [55]. In addition, in clinical practice, the psychological factors of patients with head and neck cancer undergoing flap transplantation will also affect the swallowing function. Patients worry about the damage to the flap caused by the swallowing process, and there is a fear of not daring to swallow, which aggravates the occurrence of postoperative dysphagia. However, there is no relevant research to prove that in the future, a qualitative study on the correlation between psychological factors and swallowing in patients undergoing flap transplantation can be carried out to promote the recovery of postoperative function. Some scholars pointed out that flap transplantation is different from local resection. There are risks such as wound dehiscence, bleeding, and thrombosis in the early stage. Early or inappropriate swallowing intervention can cause the above risks. This study shows that the best time for intervention is 1-2 weeks after surgery. The intervention method is mainly oral training, and emphasizes the evaluation of surgical wounds and free flaps before training. However, due to the differences in various research protocols, outcome indicators, and the lack of reports on postoperative complications, the specific best time and methods for swallowing rehabilitation in such patients are still difficult to determine, and more research is needed in the future.

This study found that cervical lymph node dissection is a risk factor for postoperative dysphagia in patients with head and neck cancer. In cervical lymph node dissection, the separation of enlarged lymph nodes may cause damage to the hypoglossal nerve, glossopharyngeal nerve and vagus nerve, affect the related functions of the muscles innervated by the nerve, and directly cause damage to the swallowing-related muscles, which in turn leads to a decrease in the function and coordination of swallowing [56]. Débora et al [57]. pointed out that lymphedema is a common postoperative complication in patients with head and neck cancer. Lymphatic dissection destroys the lymphatic system and limits the ability of lymph fluid to be transported to the tissue, resulting in lymphedema caused by normal reflux obstruction. In addition, the inflammatory response caused by tissue damage during surgery can also affect lymph reflux and aggravate lymphedema. At present, people do not pay enough attention to the postoperative lymphedema of patients with head and neck cancer, and there are few relevant reports in China, and its incidence and severity are ignored. Therefore, for patients with head and neck cancer lymph node dissection, attention should be paid to early prevention of lymphedema, and postoperative guidance should be given to patients to raise their heads and shoulders appropriately to promote lymph reflux. Reducing salt intake reduces the risk of tissue edema ; it can also be used as an auxiliary means for early prevention of dysphagia through bandage compression, artificial lymphatic drainage, skin care, shoulder and neck functional exercise, etc [58, 59].

Conclusion

In this study, multivariate logistic regression was used to construct a risk prediction model for early postoperative dysphagia in patients with head and neck cancer. The predictors included patient-related factors (age, smoking history, nutritional risk, Beck oral score), tumor-related factors (tumor T stage, primary tumor location) and treatment-related factors (cervical lymph node dissection, flap transplantation). The prediction model of this study has good discrimination, calibration and clinical practicability in internal and external verification. The nomogram and web calculator visualize the model and improve the convenience of the model. It can be considered as a universal predictive tool for early postoperative dysphagia in patients with head and neck cancer. It can help medical staff to identify and intervene in high-risk groups of dysphagia as soon as possible, and provide reference for clinical medical staff to formulate diagnosis, treatment and nursing measures.

Limitations

Although the nomogram shows satisfactory performance, our research has certain limitations. First of all, the research object of this study is only a tertiary hospital in Zhejiang Province, and the external verification uses non-synchronous samples rather than other hospital samples, and the verification of the generalization ability of the model has limitations ; when conducting related research in the future, it is suggested to use multi-center research to verify the model externally and improve the extrapolation of the model. In addition, this study only investigated patients, tumors and treatment-related factors. In the future, patients ' psychological status, sleep quality and other factors can be considered in the collection of predictors, and more clinical objective indicators such as biological indicators can also be considered in the model to improve the accuracy of the model. In clinical practice, the evaluation tools can be integrated into the existing head and neck surgery information management system to identify patients with potentially high-risk dysphagia more quickly and conveniently. In addition, a longitudinal study of swallowing function in patients with head and neck cancer after operation can be carried out to understand the rehabilitation of swallowing function in depth, so as to provide relevant basis for the formulation of targeted and effective prevention and intervention measures.

List of Abbreviations

HNC: Head and Neck Cancer
EAT-10: Eating Assessment Tool-10
ROC: Receiver Operating Characteristic
AUC: Area Under Curve
C-Index: Concordance Index

Statement

Acknowledgements

The authors would like to express their sincere gratitude to all participants involved in this study. We also thank the staff at Zhejiang cancer hospital for their support and assistance throughout the research process.

Clinical Trial Number

not applicable.

Author's Contributions

Li Jiaping was responsible for the study design, data compilation, and analysis and completed the draft manuscript. Zhu Yu and Wei Yipan participated in the data collection and coordination of the study. Zhu Yunxia were responsible for the quality control and manuscript review. All the authors have read and approved the final version of the manuscript.

Funding

This research was supported by the 2023 graduate education and teaching reform project of Zhejiang University of traditional Chinese medicine (No. YJSJD2023004)

Data Availability

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics Approval and Consent to Participate

This was a prospective study that concealed patient information before the study. It was approved by the ethics review board of Zhejiang cancer hospital. The ethical review approval number is: IRB-2023-1021.The manuscript has been provided. My study adhered to the Declaration of Helsinki. All authors have provided their consent for publication of this manuscript.

Consent for Publication

This study conceals the personal information of patients, and this part is not applicable.

Competing Interest

The authors declare no competing interests

References

1. Zhang, Y., & Xi, S. (2020). Research progress on the mechanism and rehabilitation of dysphagia after laryngectomy. Chinese Rehabilitation Theory and Practice, 26(8), 908–912.
2. Steuer, C. E., El-Deiry, M., & Parks, J. R. (2017). Chinese Society of Clinical Oncology (CSCO) diagnosis and treatment guidelines for head and neck cancer 2018 (English version). Gastroenterology Research and Practice, 2017(1), 1–9. https://doi.org/10.1155/2017/3125805
3. Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA: a cancer journal for clinicians, 71(3), 209–249. https://doi.org/10.3322/caac.21660
4. Kuhn, M. A., Gillespie, M. B., Ishman, S. L., Ishii, L. E., Brody, R., Cohen, E., Dhar, S. I., …& Dhepyasuwan, N. (2023). Expert Consensus Statement: Management of Dysphagia in Head and Neck Cancer Patients. Otolaryngology--head and neck surgery: official journal of American Academy of Otolaryngology-Head and Neck Surgery, 168(4), 571–592. https://doi.org/10.1002/ohn.302
5. Forastiere, A. A., Ismaila, N., Lewin, J. S., Nathan, C. A., Adelstein, D. J., Eisbruch, A., Fass, G., …& Wolf, G. T. (2018). Use of Larynx-Preservation Strategies in the Treatment of Laryngeal Cancer: American Society of Clinical Oncology Clinical Practice Guideline Update. Journal of clinical oncology: official journal of the American Society of Clinical Oncology, 36(11), 1143–1169. https://doi.org/10.1200/JCO.2017.75.7385
6. Pezdirec, M., Strojan, P., & Boltezar, I. H. (2019). Swallowing disorders after treatment for head and neck cancer. Radiology and oncology, 53(2), 225–230. https://doi.org/10.2478/raon-2019-0028
7. Hey, C., Goeze, A., Sader, R., & Zaretsky, E. (2023). FraMaDySc: dysphagia screening for patients after surgery for head and neck cancer. European archives of oto-rhino-laryngology: official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery, 280(5), 2585–2592. https://doi.org/10.1007/s00405-023-07865-6
8. Hutcheson, K. A., Lewin, J. S., Barringer, D. A., Lisec, A., Gunn, G. B., Moore, M. W., & Holsinger, F. C. (2012). Late dysphagia after radiotherapy-based treatment of head and neck cancer. Cancer, 118(23), 5793–5799. https://doi.org/10.1002/cncr.27631

9. Simon, S. R., Pilz, W., Hoebers, F. J. P., Leeters, I. P. M., Schols, A. M. W. J., Willemsen, A. C. H., Winkens, B., & Baijens, L. W. J. (2021). Malnutrition screening in head and neck cancer patients with oropharyngeal dysphagia. Clinical nutrition ESPEN, 44, 348–355. https://doi.org/10.1016/j.clnesp.2021.05.019
10. Deschuymer, S., Nevens, D., Duprez, F., Laenen, A., Dejaeger, E., De Neve, W., Goeleven, A., & Nuyts, S. (2018). Clinical factors impacting on late dysphagia following radiotherapy in patients with head and neck cancer. The British journal of radiology, 91(1088), 20180155. https://doi.org/10.1259/bjr.20180155
11. Badr, H., Sobrero, M., Chen, J., Kotz, T., Genden, E., Sikora, A. G., & Miles, B. (2019). Associations between pre-, post-, and peri-operative variables and health resource use following surgery for head and neck cancer. Oral oncology, 90, 102–108. https://doi.org/10.1016/j.oraloncology.2019.02.004
12. Dragan, T., Van Gossum, A., Duprez, F., Lalami, Y., Lefebvre, Y., Mootassim-Billah, S., Beauvois, S., …& Van Gestel, D. (2022). Patient-reported outcomes in terms of swallowing and quality of life after prophylactic versus reactive percutaneous endoscopic gastrostomy tube placement in advanced oropharyngeal cancer patients treated with definitive chemo-radiotherapy: Swall PEG study. Trials, 23(1), 1036. https://doi.org/10.1186/s13063-022-06991-6
13. Qin, S. H., Li, X. M., & Li, W. L. (2018). Hua xi kou qiang yi xue za zhi = Huaxi kouqiang yixue zazhi = West China journal of stomatology, 36(3), 271–276. https://doi.org/10.7518/hxkq.2018.03.008
14. Krebbers, I., Simon, S. R., Pilz, W., Kremer, B., Winkens, B., & Baijens, L. W. J. (2021). Patients with Head-and-Neck Cancer: Dysphagia and Affective Symptoms. Folia phoniatrica et logopaedica : official organ of the International Association of Logopedics and Phoniatrics (IALP), 73(4), 308–315. https://doi.org/10.1159/000508367
15. Loewen, I., Jeffery, C. C., Rieger, J., & Constantinescu, G. (2021). Prehabilitation in head and neck cancer patients: a literature review. Journal of otolaryngology - head & neck surgery = Le Journal d'oto-rhino-laryngologie et de chirurgie cervico-faciale, 50(1), 2. https://doi.org/10.1186/s40463-020-00486-7
16. Lian, B., Wang, J., & Wu, Q. (2023). Integration of medicine and health care: Connotation, characteristics and promotion path. Chinese Journal of Rehabilitation Medicine, 38(4), 534–538.
17. Guo, Y., & Zhang, H. (2022). Exploration on the construction of ideological and political case bank of otolaryngology head and neck surgery. China Continuing Medical Education, 14(18), 173–176.
18. Baijens, L. W., Clavé, P., Cras, P., Ekberg, O., Forster, A., Kolb, G. F., ... & Walshe, M. (2016). European Society for Swallowing Disorders–European Union Geriatric Medicine Society white paper: oropharyngeal dysphagia as a geriatric syndrome. Clinical interventions in aging, 1403-1428. doi: 10.2147/CIA.S107750. PMID: 27785002; PMCID: PMC5063605.
19. Arrese, L. C., Schieve, H. J., Graham, J. M., Stephens, J. A., Carrau, R. L., & Plowman, E. K. (2019). Relationship between oral intake, patient perceived swallowing impairment, and objective videofluoroscopic measures of swallowing in patients with head and neck cancer. Head & Neck, 41(4), 1016-1023.
20. Xu, J., Zhu, Y., Wu, H., Yang, C., Zhang, J., & Yang, Y. (2023). Early swallowing intervention after free flap reconstruction for oral cancer: a systematic review and meta-analysis. Head & Neck, 45(6), 1430-1444.
21. Li, H., Chen, C., & Zhang, X. (2023). A review of the scope of swallowing function management in patients with esophageal cancer after surgery. Journal of Nursing, 38(9), 112–117.
22. Lei, B., Li, Z., & Xie, C. (2023). Evidence summary of swallowing function promotion strategies for patients with head and neck cancer. Chinese Journal of Nursing, 58(1), 85–91.
23. Zhang, X., Liu, Y., & Xie, C. (2023). Summary of the best evidence of preventive training guidance programs for dysphagia in patients with head and neck cancer undergoing radiotherapy and chemotherapy. Journal of Nursing, 30(2), 54–59.
24. Kuhn, M. A., Gillespie, M. B., & Ishman, S. L. (2023). Expert consensus statement: Management of dysphagia in head and neck cancer patients. Otolaryngology–Head and Neck Surgery, 168(4), 571–592.
25. Printza, A., Kyrgidis, A., Pavlidou, E., Triaridis, S., & Constantinidis, J. (2018). Reliability and validity of the Eating Assessment Tool-10 (Greek adaptation) in neurogenic and head and neck cancer-related oropharyngeal dysphagia. European archives of oto-rhino-laryngology: official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery, 275(7), 1861–1868. https://doi.org/10.1007/s00405-018-5001-9
26. Ni, P., Chen, J., & Liu, N. (2010). Sample size estimation of quantitative research in nursing research. Chinese Journal of Nursing, 45(4), 378–380.
27. Yang, W. (2022). Study on the effect of preventive swallowing intervention on swallowing rehabilitation of patients with laryngeal cancer after partial laryngectomy (Master's thesis). Jilin University.
28. Cheng, W., Xue, L., & Dong, L. S. (2022). Clinical related factors of early dysphagia after head and neck squamous cell carcinoma surgery. Chinese Rehabilitation Theory and Practice, 28(9), 1074–1078.
29. Côté, M. G., Bossola, I., & Favez, F. (2021). The health risks of dysphagia for patients with head and neck cancer: A multicentre prospective observational study. Journal of Translational Medicine, 19(1), 472. https://doi.org/10.1186/s12967-021-03125-1
30. Li, Z., Yue, L., & Xie, C. (2020). Analysis of influencing factors of dysphagia in patients after hypopharyngeal cancer surgery. Journal of Nursing, 35(7), 37–39.
31. Andersen, A., Petersen, J., & Sørensen, A. (2020). Individualized prediction of late-onset dysphagia in head and neck cancer survivors. Head & Neck, 42(6), E73–E80. https://doi.org/10.1002/hed.26069
32. Xu, S., Cai, W., & Li, C. (2024). Current situation and influencing factors of dysphagia among community-dwelling older adults: A cross-sectional study. Chinese General Practice, 27(17), 2083–2090.
33. Obaid, A. T., Bader, M. Z., & Shroof, B. H. (2018). Evaluation of objective and subjective swallowing outcomes in

patients with dysphagia treated for head and neck cancer. Supportive Care in Cancer, 26(11), 3692–3699. https://doi.org/10.1007/s00520-018-4249-1
34. Yao, G., Qu, X., & Sun, X. (2020). Research progress on the correlation between dysphagia and asthenia in the elderly. Chinese Journal of Clinical Health Care, 23(5), 590–593.
35. Jiang, L. (2021). Construction of a frailty risk prediction model for elderly inpatients with head and neck cancer (Master's thesis). University of Electronic Science and Technology of China.
36. Ueda, T., Yumii, K., & Urabe, Y. (2022). Swallowing function after transoral surgery for laryngopharyngeal cancer. PLoS ONE, 17(6), e0270509. https://doi.org/10.1371/journal.pone.0270509
37. Chen, J., Huang, Y., & Wei, X. (2022). Analysis of influencing factors of swallowing dysfunction and oral feeding dysfunction in patients with nasopharyngeal carcinoma after surgery. Journal of Changchun University of Traditional Chinese Medicine, 38(2), 200–204.
38. Ou, M., Zhu, L., & Chen, H. (2023). Perioperative change trajectories and predictors of swallowing function and swallowing-related quality of life in patients with oral cancer: A longitudinal observational study. BMJ Open, 13(12), e075401. https://doi.org/10.1136/bmjopen-2023-075401
39. Wei, X., Chen, J., & Li, Q. (2021). Research progress on risk factors of dysphagia in patients with head and neck cancer. China Rehabilitation, 36(4), 249–253.
40. Wang, J., Meng, X., & Wang, Y. (2024). Analysis of influencing factors of dysphagia in patients with head and neck cancer after radiotherapy. Cancer Progression, 22(7), 792–795.
41. Huang, Z. S., Chen, W. L., & Huang, Z. Q. (2016). Dysphagia in tongue cancer patients before and after surgery. Journal of Oral and Maxillofacial Surgery, 74(10), 2067–2072. https://doi.org/10.1016/j.joms.2016.05.018
42. Ge, L. (2021). Establishment and validation of a nomogram model for individualized risk prediction of dysphagia after hypopharyngeal cancer surgery in the elderly. Journal of Yan'an University (Medical Science Edition), (3), 49–54.
43. Wang, Z., & Li, K. (2021). Application of graded nursing based on Beck score in the perioperative period of oral cancer patients. General Nursing, 19(6), 795–798.
44. Li, M., Li, C., & Wan, F. (2021). Effect of personalized nursing on oral cleanliness and recovery of patients with tongue cancer after surgery. Qilu Nursing Journal, 27(2), 19–21.
45. Robbins, J., Butler, S. G., & Daniels, S. K. (2008). Swallowing and dysphagia rehabilitation: Translating principles of neural plasticity into clinically oriented evidence. Journal of Speech, Language, and Hearing Research, 51(1), S276–S300. https://doi.org/10.1044/1092-4388(2008/021)
46. Scannapieco, F. A. (2023). Poor oral health in the etiology and prevention of aspiration pneumonia. Clinics in Geriatric Medicine, 39(2), 257–271. https://doi.org/10.1016/j.cger.2022.11.006
47. Sadakane-Sakuramoto, A., Hasegawa, Y., Sugahara, K., Horii, N., Saito, S., Nakao, Y., ... & Kishimoto, H. (2009). Change in nutritional status and dysphagia after resection of head and neck cancer. European Journal of Oncology Nursing, 13(2), 102–109. https://doi.org/10.1016/j.ejon.2008.11.003
48. Soares, C. H., Beuren, A. G., Friedrich, H. J., Gabrielli, C. P., Stefani, G. P., & Steemburgo, T. (2024). The Importance of Nutrition in Cancer Care: A Narrative Review. Current nutrition reports, 13(4), 950–965. https://doi.org/10.1007/s13668-024-00578-0
49. Mizuno, S., Wakabayashi, H., & Wada, F. (2022). Rehabilitation nutrition for individuals with frailty, disability, sarcopenic dysphagia, or sarcopenic respiratory disability. Current Opinion in Clinical Nutrition & Metabolic Care, 25(1), 29–36. https://doi.org/10.1097/MCO.0000000000000805
50. Wen, L., Duan, Y., & Li, J. (2024). Research progress on nutritional status and influencing factors of the elderly in the community. China Geriatric Health Care Medicine, 22(3), 123–126.
51. Baijens, L. W. J., Walshe, M., & Aaltonen, L. M. (2021). European white paper: Oropharyngeal dysphagia in head and neck cancer. European Archives of Otorhinolaryngology, 278(2), 577–616.
52. Li, Z., & Xie, C. N. (2020). Research progress on risk factors and nursing interventions of dysphagia in patients with throat tumors. Nursing Rehabilitation, 19(8), 25–29.
53. Xu, J. Q., Zhang, J., & Zhu, Y. K. (2023). Summary of evidence on the management of dysphagia in patients with oral cancer after surgery. China Nursing Management, 23(12), 1854–1859.
54. Lahtinen, S., Koivunen, P., & Ala-Kokko, T. (2019). Swallowing-related quality of life after free flap surgery due to cancer of the head and neck. European Archives of Otorhinolaryngology, 276(3), 821–826.
55. Ravindra, A., Nayak, D. R., & Devaraja, K. (2022). Functional outcomes after surgical resection of tongue cancer: A comparative study between primary closure, secondary intention healing, and flap reconstruction. Indian Journal of Otolaryngology and Head & Neck Surgery, 74(Suppl 3), 6296–6306.
56. Ma, K. L., & Qiu, S. F. (2020). Risk factors and protective strategies for postoperative swallowing function in patients with oropharyngeal cancer. Nursing Practice Research, 17(14), 18–20.
57. Queija, D. D. S., Dedivitis, R. A., Arakawa-Sugueno, L., de Castro, M. A. F., Chamma, B. M., Kulcsar, M. A. V., & de Matos, L. L. (2020). Cervicofacial and pharyngolaryngeal lymphedema and deglutition after head and neck cancer treatment. Dysphagia, 35(3), 479-491.
58. Smith, A., & Smith, A. (2024). Managing lymphoedema following treatment for head and neck cancer: Is complete decongestive therapy an effective intervention to improve dysphagia outcomes? Current Opinion in Otolaryngology & Head and Neck Surgery, 32(3), 178–185.
59. Hu, J., Ye, S., & Liu, G. (2022). Nursing care of patients with lymphedema after comprehensive treatment of head and neck cancer. Journal of Nursing, 37(14), 47–49.