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ORIGINAL ARTICLE

Controlling Nutritional Status (CONUT) score is a prognostic marker for gastric cancer patients after curative resection

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Abstract

Background Controlling Nutritional Status (CONUT), as calculated from serum albumin, total cholesterol concentration, and total lymphocyte count, was previously shown to be useful for nutritional assessment. The current study investigated the potential use of CONUT as a prognostic marker in gastric cancer patients after curative resection.

Methods Preoperative CONUT was retrospectively calculated in 416 gastric cancer patients who underwent curative resection at Kumamoto University Hospital from 2005 to 2014. The patients were divided into two groups: CONUT-high (≥ 4) and CONUT-low (≤ 3), according to time-dependent receiver operating characteristic (ROC) analysis. The associations of CONUT with clinicopathological factors and survival were evaluated.

Results CONUT-high patients were significantly older ($p < 0.001$) and had a lower body mass index ($p = 0.019$), deeper invasion ($p < 0.001$), higher serum carcinoembryonic antigen ($p = 0.037$), and higher serum carbohydrate antigen 19-9 ($p = 0.007$) compared with CONUT-low patients. CONUT-high patients had significantly poorer overall survival (OS) compared with CONUT-low patients according to univariate and multivariate analyses (hazard ratio: 5.09, 95% confidence interval 3.12–8.30, $p < 0.001$). In time-dependent ROC analysis, CONUT had a higher area under the ROC curve (AUC) for the prediction of 5-year OS than the neutrophil lymphocyte ratio, the Modified Glasgow Prognostic Score, or pStage. When the time-dependent AUC curve was used to predict OS, CONUT tended to maintain its predictive accuracy for long-term survival at a significantly higher level for an extended period after surgery when compared with the other markers tested.

Conclusions CONUT is useful for not only estimating nutritional status but also for predicting long-term OS in gastric cancer patients after curative resection.

Keywords CONUT · Gastric cancer · Gastrectomy · Prognostic factor · Time-dependent ROC

Abbreviations

PNI	Prognostic nutritional index
mGPS	Modified Glasgow Prognostic Score
CONUT	Controlling Nutritional Status
BMI	Body mass index
CEA	Carcinoembryonic antigen
CA19-9	Carbohydrate antigen 19-9
OR	Odds ratio
CI	Confidence interval
RFS	Relapse-free survival
HR	Hazard ratio
OS	Overall survival
ROC	Receiver operating characteristic
AUC	Area under the curve

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Introduction

Despite the development of diagnostic and therapeutic modalities for gastric cancer, it remains one of the main causes of disease-related death globally. It is the fourth most

common cancer by incidence and the third leading cause of cancer death worldwide [1]. Multidisciplinary treatment, perioperative chemotherapy, surgery, and radiotherapy are the main options for the treatment of gastric cancer. Selection of the optimal treatment according to gastric cancer progression and the general condition of the patient is important in order to improve the patient's prognosis.

The nutritional status of the gastric cancer patient is a crucial factor because it allows the prediction of treatment tolerability and cancer progression [2]. A poor nutritional condition is reported to be associated with tumor invasion, and may reflect metabolic elevation caused by the cancer, immune-compromised status due to tumor progression, and an intolerance to cancer treatment [3, 4].

Immunological status is also reported to be associated with cancer patient prognosis. Blood neutrophil, lymphocyte [5], monocyte [6], and platelet [7] counts are reported to reflect systemic and local inflammation associated with cancer progression and prognosis.

Controlling Nutritional Status (CONUT) is a newly proposed scoring system that is used to assess patient nutritional status [8]. Previous studies have proposed several systems for the assessment of nutritional status and/or immune status, and have proved their usefulness for the prediction of cancer patient prognosis. Such assessments include the modified Glasgow Prognostic Score (mGPS) [9] and the neutrophil to lymphocyte ratio (NLR) [5]. CONUT is calculated from the serum albumin concentration, total blood cholesterol level, and total peripheral lymphocyte count, and reflects the host's nutritional and immune status. CONUT is easily calculated from the data obtained in a blood examination, and allows the comprehensive evaluation of patients in hospital settings. Some studies have investigated the usefulness of CONUT for evaluating survival in gastrointestinal cancer patients, but there has been no such report for gastric cancer patients. Therefore, this study reported here evaluation of the usefulness of CONUT for determining the prognoses of gastric cancer patients with curative resection, and it compared the prognostic accuracy of CONUT to the corresponding accuracies of TNM stage, mGPS, and NLR.

Methods

Patients

There were 464 consecutive gastric cancer patients who underwent gastrectomy with curative intent at Kumamoto University Hospital in Kumamoto, Japan, from 2005 to 2011. Preoperative CONUT scores of the patients were calculable from their medical records. Of those 464 patients, we excluded 24 who were treated with neoadjuvant chemotherapy, 21 who underwent surgery that turned out to be noncurative based on histopathologic examination, and three who died within 30 days of surgery; the remaining 416 patients underwent the subsequent analyses. Of those, 275 (66.1%) were classified as stage I, 81 (19.5%) as stage II, and 60 (14.4%) as stage III according to the TNM classification (AJCC, 7th edition) [10].

Treatment data were retrospectively obtained from the medical records of each patient. The median follow-up period was 61.2 months (range 1–134 months). Surgical procedures including the type of gastrectomy and extent of lymph node dissection, pathological and final staging, and postoperative surveillance were performed based on the Japanese Classification of Gastric Cancer Guidelines [11]. Postoperative complications and their grade were defined according to the Clavien–Dindo classification. Complications included surgical site infection, anastomotic leakage, any organ disease, any organ infection, abscess, pleural effusion, ascites, bleeding, obstruction, pancreatic fistula, and lymphorrhea. The use of clinical data was approved by the human ethics review committee of the Graduate School of Medicine, Kumamoto University.

CONUT score and other scoring systems

Serum samples were collected and assayed within three weeks before surgery. Laboratory measurements included serum albumin, total cholesterol level, total peripheral neutrophils, lymphocyte count, C-reactive protein (CRP), carcinoembryonic antigen (CEA), and carbohydrate antigen 19-9 (CA19-9), and each cut-off value of CEA and CA19-9 was defined as 3.4 ng/ml and 3.7 U/ml, respectively based on the recommendations of the measuring kit our institute adopted. CONUT scores were calculated from the serum albumin concentration, total blood cholesterol level, and total peripheral lymphocyte count (Table 1), and mGPS and NLR were determined based on previous reports [7, 9].

Body mass index (BMI) was calculated from the preoperative heights and weights of the patients, which were measured by our medical staff within a few days before surgery. Patients were divided into two groups using 18.5 kg/m^2 as the minimum of the normal range indicated by the World Health Organization, as generally adopted in studies.

Statistical analysis

All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan) and RStudio (Affero General Public License v3), which are graphical user interfaces for R (The R Foundation for Statistical Computing, Vienna, Austria), and Excel 2016 (Microsoft, Redmond, WA, USA).

Table 1 Definition of CONUT

Parameters	CONUT			
	Normal	Light	Moderate	Severe
Serum albumin (g/dL)	3.5–4.5	3.0–3.49	2.5–2.9	<2.5
Alb score	1	2	4	6
Total lymphocyte (count/mm^3)	≥1600	1200–1599	800–1199	<800
TLC score	0	1	2	3
Total cholesterol (mg/dL)	>180	140–180	100–139	<100
T-cho score	0	1	2	3
CONUT score (total)	0–1	2–4	5–8	9–12
Assessment	Normal	Light	Moderate	Severe

CONUT is calculated as the sum of the Alb score, TLC score, and T-cho score

Alb albumin, *TLC* total lymphocytes, *T-cho* total cholesterol

Univariate analyses were performed to investigate the correlation between CONUT and clinicopathological factors. Categorical variables were analyzed by the chi-square test or Fisher's exact test, and age was analyzed by Student's t test. All p values were two-sided and significance was assumed when $p < 0.05$. The Kaplan–Meier method and log-rank test were utilized for survival analysis. Cox proportional hazards regression models were utilized to calculate hazard ratios (HRs) and 95% confidence intervals (CIs). The "survivalROC" and "timeROC" R packages were utilized to estimate time-dependent receiver operating characteristic (ROC) curves of CONUT, pStage, NLR, and mGPS for prognosis (https://cran.r-project.org/web/packages/survivalROC/index.html, https://cran.r-project.org/web/packages/timeROC/index.html). The former was used to calculate the correct cutoff value of CONUT, and the latter to compare the area under the curve (AUC) for each marker.

Results

Correlations between CONUT and clinicopathological factors

Of the 416 gastric cancer patients included in the study, 267 (64.2%) were male and 149 (35.8%) were female, and their mean age was 67.2 years (range 25–94 years). They were divided into four groups based on the originally proposed CONUT classification: 236 patients (57.6%) were normal; 142 (31.6%) were classified as light; 33 (10.0%) as moderate; and five (0.7%) as severe. Based on the time-dependent ROC curve to predict 5-year overall survival (OS), a CONUT score of 3 was defined as the optimal cutoff value (Fig. S2 in the Electronic supplementary material, ESM); therefore, the cohort was divided into two groups: patients with a CONUT score of 3 or less ($n = 354$) were termed the CONUT-low group, and patients with a score of 4 or more ($n = 62$) were termed the

CONUT-high group in the analysis of correlations with clinicopathological factors (Table 2). CONUT was significantly associated with several clinicopathological factors. CONUT-high was associated with older age (CONUT-low vs. CONUT-high: 65.5 ± 12.7 vs. 74.3 ± 9.4, $p < 0.001$) and lower BMI (<18.5 kg/m^2) (CONUT-low vs. CONUT-high: 8.5 vs. 19.4%, $p = 0.019$). Regarding tumor factors, CONUT was not significantly associated with tumor location, histological differentiation, or the presence of lymph node metastasis; however, it was strongly associated with tumor size (CONUT-low vs. CONUT-high: 38.1 ± 27.2 vs. 52.9 ± 40.4 mm, $p < 0.001$), infiltrative primary tumor (class 3 or 4 by Borrmann classification) (CONUT-low vs. CONUT-high = 18.6 vs. 33.9%, $p = 0.010$), deeper invasion ($p < 0.001$), and higher pStage ($p = 0.001$). CONUT-high was also significantly associated with high CEA level (>3.4) (CONUT-low vs. CONUT-high: 18.9 vs. 33.9%, $p = 0.037$) and high CA19-9 level (>37.0) (CONUT-low vs. CONUT-high: 14.1 vs. 30.6%, $p = 0.007$).

Correlations of the CONUT score with survival rates

CONUT was significantly associated with 5-year OS, relapse-free survival (RFS), and cancer-specific survival (CSS). Five-year OS rates in the CONUT-low and CONUT-high groups were 84.8 and 43.8% ($p < 0.001$) (Fig. 1a), 5-year RFS rates were 90.6 and 77.8% ($p = 0.017$) (Fig. 1b), and 5-year CSS rates were 94.0 and 82.3% ($p = 0.019$) (Fig. 1c), respectively. Adjusted for pStage, CONUT-high was strongly associated with 5-year OS in both pStage I and pStage II patients, but not in pStage III patients (Fig. 1d–f).

In univariate analysis, CONUT-high was associated with poor OS (HR 5.09, 95% CI 3.12–8.30, $p < 0.001$) (Table 3). Regarding patient factors, a lower BMI (<18.5 kg/m^2) was significantly associated with poor OS

Table 2 Characteristics of Patients, Tumor, and Surgical procedures

	Total (n = 416)	CONUT		p value
		0–3 (n = 354)	≥4 (n = 62)	
Age (years)				<0.001
<75	284 (68.3%)	257 (72.6%)	27 (43.5%)	
≥75	132 (31.7%)	97 (27.4%)	35 (56.5%)	
Sex				1.000
F	149 (35.8%)	127 (35.9%)	22 (35.5%)	
M	267 (64.2%)	227 (64.1%)	40 (64.5%)	
BMI (kg/m^2)				0.019
≤18.5	374 (89.9%)	324 (91.5%)	50 (80.6%)	
<18.5	42 (10.1%)	30 (8.5%)	12 (19.4%)	
DM				1.000
Absent	353 (84.9%)	300 (84.7%)	53 (85.5%)	
Present	63 (15.1%)	54 (15.3%)	9 (14.5%)	
Tumor location				0.880
Upper	118 (28.4%)	100 (28.2%)	18 (29.0%)	
Middle/lower	298 (71.6%)	254 (71.8%)	44 (71.0%)	
Tumor size (mm)				0.001
<30	174 (41.9%)	160 (45.3%)	14 (22.6%)	
≥30	241 (58.1%)	193 (54.7%)	48 (77.4%)	
Borrmann classification				0.010
0/1/2	329 (79.1%)	288 (81.4%)	41 (66.1%)	
3/4	87 (20.9%)	66 (18.6%)	21 (33.9%)	
Histology				0.169
Pap/tub	220 (52.9%)	182 (51.4%)	38 (61.3%)	
Por/sig/muc	196 (47.1%)	172 (48.6%)	24 (38.7%)	
T stage				<0.001
T1	242 (58.2%)	221 (62.4%)	21 (33.9%)	
T2	48 (11.5%)	36 (10.2%)	12 (19.4%)	
T3	88 (21.2%)	71 (20.1%)	17 (27.4%)	
T4	38 (9.1%)	26 (7.3%)	12 (19.4%)	
N stage				0.030
N0	305 (73.3%)	268 (75.7%)	37 (59.7%)	
N1	57 (13.7%)	46 (13.0%)	11 (17.7%)	
N2	34 (8.2%)	24 (6.8%)	10 (16.1%)	
N3	20 (4.8%)	16 (4.5%)	4 (6.5%)	
pStage				0.001
I	275 (66.1%)	246 (69.5%)	29 (46.8%)	
II	81 (19.5%)	65 (18.4%)	16 (25.8%)	
III	60 (14.4%)	43 (12.1%)	17 (27.4%)	
ly				0.053
Absent	287 (69.0%)	251 (70.9%)	36 (58.1%)	
Present	129 (31.0%)	103 (29.1%)	26 (41.9%)	
				0.025
Absent	242 (58.6%)	216 (61.0%)	28 (45.2%)	
Present	171 (41.4%)	138 (39.0%)	34 (54.8%)	
CEA				0.037
≤3.4	326 (78.4%)	285 (80.5%)	41 (66.1%)	
3.4<	88 (21.2%)	67 (18.9%)	21 (33.9%)	
Unknown	2 (0.5%)	2 (0.6%)	0 (0.0%)	

Table 2 continued

	Total (n = 416)	CONUT		p value
		0–3 (n = 354)	≥4 (n = 62)	
CA19-9				0.007
≤37.0	343 (82.5%)	300 (84.7%)	43 (69.4%)	
<37.0	69 (16.6%)	50 (14.1%)	19 (30.6%)	
Unknown	4 (1.0%)	4 (1.1%)	0 (0.0%)	
Complication (Clavien–Dindo ≥II)				0.133
Absent	295 (70.9%)	256 (72.3%)	39 (62.9%)	
Present	121 (29.1%)	98 (27.7%)	23 (37.1%)	
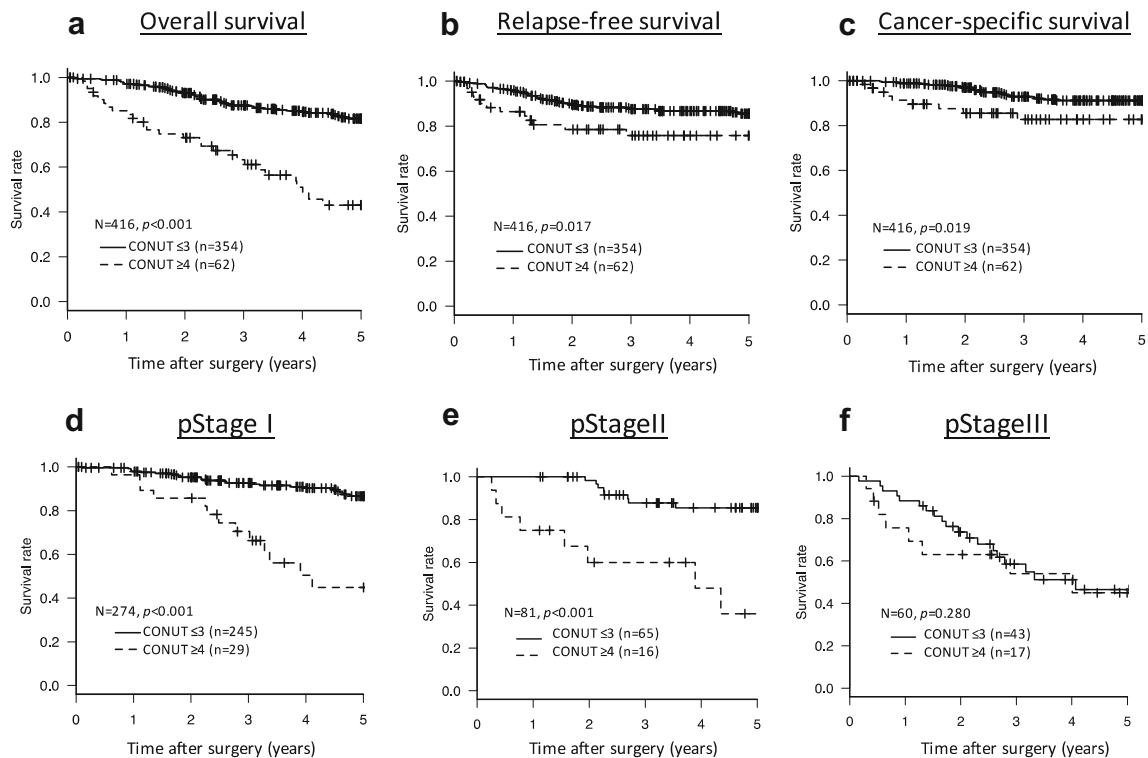
Fig. 1a–f Kaplan-Meier curves for overall survival (**a**), relapse-free survival (**b**), and cancer-specific survival (**c**) in the CONUT-high (≥4) or CONUT-low (<4) groups, and overall survival for each pStage (**d–f**)

(HR 2.86, 95% CI 1.53–5.34, $p < 0.001$). In addition, male gender tended to be associated with poor OS (HR 1.66, 95% CI 0.96–2.87, $p = 0.070$). Regarding tumor factors, depth of invasion (T2–3 vs. T1, HR 2.43, 95% CI 1.62–3.66, $p < 0.001$) and the presence of lymph node metastasis (present vs. absent: HR 2.50, 95% CI 1.67–3.75, $p < 0.001$) were significantly associated with poor prognosis. In multivariate analysis by stepwise regression using AIC, CONUT was an independent prognostic factor for OS (HR 2.72, 95% CI 1.74–4.25, $p < 0.001$). The other independent prognostic factors were older age, male gender, lower BMI, and the presence of lymph node metastasis.

In the analysis of associations of CONUT with RFS and CSS, CONUT-high was significantly associated with poorer RFS (HR 2.63, 95% CI 1.16–5.98, $p = 0.021$) and CSS (HR 4.13, 95% CI 1.62–10.55, $p = 0.003$) in univariate analysis. However, CONUT was not an independent prognostic factor for RFS and CSS in multivariate analysis.

Comparison of CONUT with its components (serum albumin, total cholesterol, and total lymphocytes) in terms of prognostic accuracy in the prediction of 5-year overall survival

We explored the prognostic accuracies of CONUT and each of its components—albumin (Alb) score, total cholesterol (T-cho) score, and total lymphocytes (TLC)

Table 3 Results of univariate and multivariate analyses of factors associated with overall survival in gastric cancer patients with curative resection ($n = 416$)

	Univariate analysis			Multivariate analysis		
	HR	95% CI	*p* value	HR	95% CI	*p* value
Age (years), ≥75 vs. <75	3.00	2.01–4.48	<0.001	2.31	1.51–3.52	<0.001
Sex, male vs. female	1.66	0.96–2.87	0.070	1.89	1.16–3.07	0.010
BMI (kg/m^2), <18.5 vs. ≥18.5	2.86	1.53–5.34	<0.001	2.29	1.26–4.16	0.007
CONUT, ≥4 vs. ≤3	5.09	3.12–8.30	<0.001	2.72	1.74–4.25	<0.001
Tumor location, upper vs. middle or low	1.25	0.81–1.91	0.310			
Histology, por/sig/muc vs. pap/tub	0.93	0.62–1.39	0.712	1.46	0.95–2.23	0.087
T stage, T2, T3, T4 vs. T1	2.43	1.62–3.66	<0.001			
Lymph node metastasis, present vs. absent	2.50	1.67–3.75	<0.001	2.20	1.46–3.32	<0.001
Complication (Clavien–Dindo ≥II), present vs. absent	1.49	0.98–2.27	0.060	1.45	0.95–2.23	0.087

BMI body mass index, *CI* confidence interval, *HR* hazard ratio
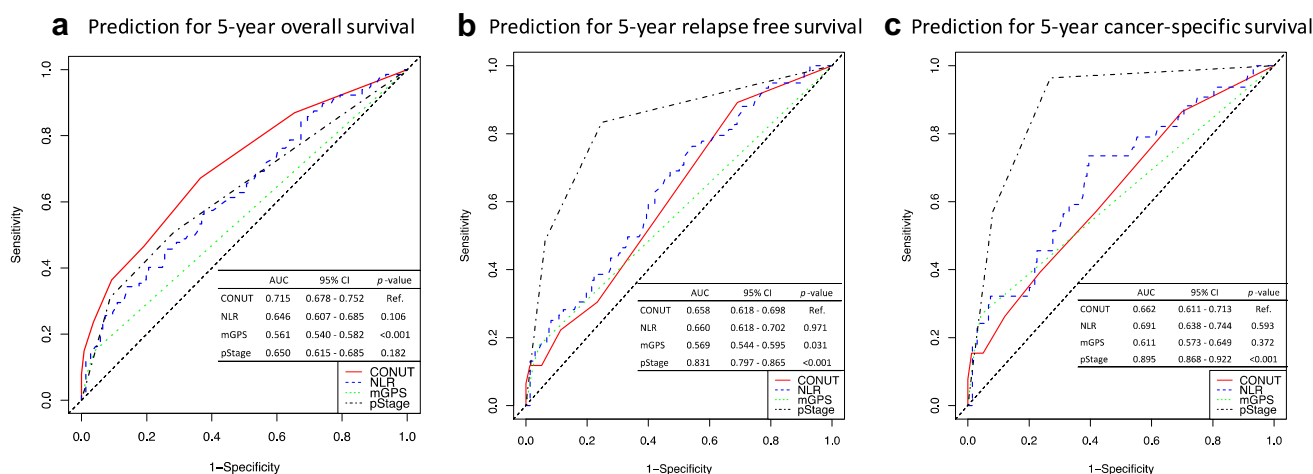
Fig. 2a–c Time-dependent ROC curves of CONUT, NLR, mGPS, and pStage for the prediction of 5-year overall survival (**a**), relapse-free survival (**b**), and cancer-specific survival (**c**). AUC-of-ROC curves and *p* values of NLR, mGPS, and pStage were compared with the AUC of CONUT

score, as calculated from the serum albumin value, total cholesterol level, and total lymphocytes (see Table 1)—using the AUC of the time-dependent ROC curve for the prediction of 5-year OS. The AUCs of CONUT, Alb score, T-cho score, and TLC score were 0.715 (95% CI 0.678–0.752), 0.634 (95% CI 0.604–0.664), 0.628 (0.592–0.664), and 0.630 (0.593–0.667), respectively. The AUC of CONUT was significantly higher than the AUC of each component of CONUT (Table S1 in the ESM).

Comparison of CONUT with other prognostic factors (NLR, mGPS, and pStage) in terms of prognostic accuracy
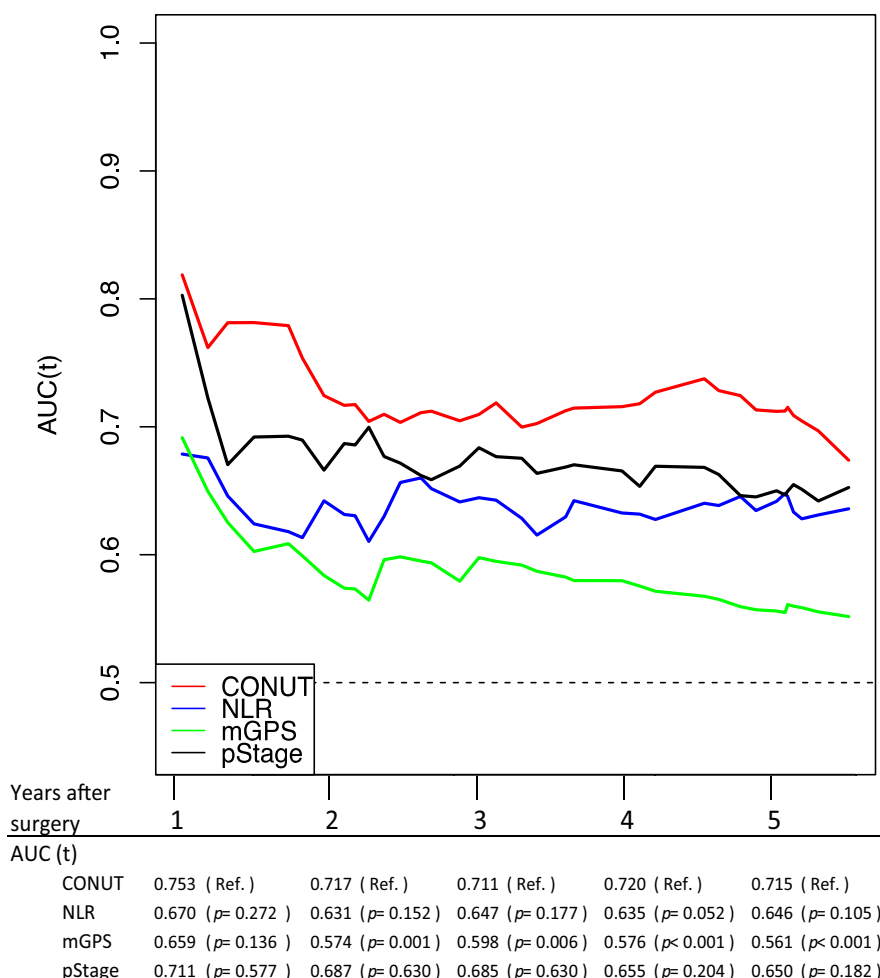
Using the same method as employed for the comparison of CONUT with its components, a comparison of the AUCs of CONUT, NLR, mGPS, and pStage was performed. The AUCs of NLR, mGPS, and pStage to predict 5-year OS (Fig. 2a) were 0.646 (95% CI 0.607–0.685), 0.561 (0.540–0.582), and 0.650 (0.615–0.685), respectively. CONUT showed significantly higher accuracy than mGPS and equivalent accuracy to NLR and pStage in the prediction of 5-year OS. However, the predictive accuracy of CONUT was not significantly superior to those of the other scoring systems or pStage in relation to 5-year RFS (Fig. 2b) and CSS (Fig. 2c).

A comparison of the time-dependent AUC-of-ROC curves of these scoring systems for the prediction of OS showed that the AUCs for all of them were relatively high in the period recently after surgery and tended to decrease over time, but that the AUC of CONUT tended to be higher than the other scoring systems and pStage at all times tested (Fig. 3).

Fig. 3 Time-dependent AUC curves of CONUT, NLR, mGPS, and pStage for the prediction of overall survival. The time dependence of each AUC for overall survival is shown for the period up to five years after surgery

Years after surgery	1	2	3	4	5
AUC (t)					
CONUT	0.753 (Ref.)	0.717 (Ref.)	0.711 (Ref.)	0.720 (Ref.)	0.715 (Ref.)
NLR	0.670 ($p = 0.272$)	0.631 ($p = 0.152$)	0.647 ($p = 0.177$)	0.635 ($p = 0.052$)	0.646 ($p = 0.105$)
mGPS	0.659 ($p = 0.136$)	0.574 ($p = 0.001$)	0.598 ($p = 0.006$)	0.576 ($p < 0.001$)	0.561 ($p < 0.001$)
pStage	0.711 ($p = 0.577$)	0.687 ($p = 0.630$)	0.685 ($p = 0.630$)	0.655 ($p = 0.204$)	0.650 ($p = 0.182$)

Discussion

In gastric cancer patients, the BMI [12], amount of visceral fat [13], and degree of sarcopenia [14], which are indicators of body composition, were demonstrated to be associated with tumor proliferation and prognosis in gastric cancer patients. This study was the first to assess the associations between preoperative CONUT, clinicopathological factors, and survival, and demonstrated the prognostic power of CONUT in gastric cancer patients who underwent curative resection. It revealed that CONUT was strongly correlated with age, BMI, tumor size, infiltrative primary tumor, and depth of invasion. CONUT-high was significantly associated with a poor OS, RFS, and CSS in univariate analysis. Importantly, CONUT was an independent prognostic factor for OS, and an especially strong association was observed at earlier pStages. The prognostic accuracy of CONUT was compared with those of previously reported scoring systems or classifications, mGPS, NLR, and pStage. An evaluation of the accuracy of each prognostic system revealed that CONUT tended to be superior to the other scoring systems for the prediction of 5-year OS, but not for 5-year RFS and CSS. CONUT maintained a high accuracy for the prediction of OS at all time points tested. Thus, these results suggested that CONUT may be not only an oncological predictor but also a comprehensive prognostic marker that accounts for the long-term nutritional effect after gastrectomy compared with other markers. Regarding nutritional supplementation after gastrectomy, many trials have reported on omega-3 fatty acid-supplemented immunonutrition [15] and elemental nutrition [16], but have so far found the clinical benefit of such supplementation to be limited. It may be important to select patients who require intensive nutritional support after gastrectomy. Because CONUT has a high ability to predict long-term overall survival, CONUT may be useful not only for predicting cancer progression but also for screening patients for nutritional reserve capacity and for selecting candidates for intensive nutritional support after gastrectomy.

CONUT is a nutritional evaluation score [8] that is calculated from the serum albumin value, the total cholesterol level, and the total lymphocyte count, which are obtained easily from a blood examination. CONUT was

first proposed as a comprehensive scoring system for assessing the nutritional and immune status of a patient, and was demonstrated to correlate with the length of hospitalization [17]. In addition to its usefulness for assessing nutrition, CONUT has been reported to be a prognostic factor for patients with chronic diseases such as end-stage liver disease [18] or chronic heart failure [19]. The progression of cancer in a patient and its prognosis have been shown to be closely related to the general condition of the patient, including their nutritional and inflammation status [20], and CONUT has been reported to be predictive of esophageal squamous cell carcinoma patient survival [21].

With regards to the three components of CONUT, serum albumin value has twice the weight of the other parameters. Serum albumin is a strong marker of host nutritional status, is closely correlated with the degree of malnutrition, and was reported to correlate with prognosis in patients with gastric cancer [22]. Low levels of serum albumin might be caused by pro-inflammatory cytokines such as interleukin-6 or tumor necrosis factor-alpha, which modulate the synthesis of albumin by hepatocytes [23, 24]. Serum albumin values are also affected by liver function and changes in body fluid volume [25]. Total cholesterol level was reported to correlate with tumor progression and patient survival in various cancers [26]. Several studies have found an inverse association between total cholesterol and increased risk of cancers, including gastric cancer [27], because tumor tissues reduce plasma cholesterol levels or calorie intake [28]. Total lymphocyte count is an indicator of immunological status and lower peripheral lymphocyte count was associated with a worse prognosis in diverse cancer patients [29–31] because of the insufficient host immune response to cancer cells and intolerance to chemotherapy. The combination of these three parameters into CONUT allows various phases of nutrition to be included and enhances its ability to accurately assess general condition.

This study had some limitations. It was retrospectively designed, patients were included from just one institution, and the cohort was ethnically homogeneous. Also, because they had not participated in any nutritional support trial and the support provided depended on the attending doctor, we did not follow-up nutritional support in detail after surgery, so we could not obtain the postoperative CONUT and determine its significance. In addition, the evaluation and assignment of a cutoff value for CONUT were performed with the same cohort in this study, so the significance of CONUT needs to be validated using other cohorts.

In conclusion, this study suggests that CONUT is useful for not only estimating nutritional status but also for predicting long-term OS in gastric cancer patients undergoing curative resection.

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