Title

Prediction of postoperative complications and survival after laparoscopic gastrectomy using preoperative Geriatric Nutritional Risk Index in elderly gastric cancer patients

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Journal

Surgical endoscopy 35(3):1202-1209

Published

2020 Mar 9

URL

https://link.springer.com/article/10.1007%2Fs00464-020-07487-7

Original Article

Prediction of postoperative complications and survival after laparoscopic gastrectomy using preoperative Geriatric Nutritional Risk Index in elderly gastric cancer patients

Running title: GNRI overall survival predictive ability

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Source of Funding:

This study received no external funding.

ABSTRACT

Background. Preoperative nutritional assessment of cancer patients is important to reduce postoperative complications. Several studies have reported the Geriatric Nutritional Risk Index (GNRI) to be useful in assessing underlying diseases and long-term outcomes of hospitalized patients. The present study aimed to evaluate the impact of preoperative GNRI on short- and long-term outcomes in elderly gastric cancer patients who underwent laparoscopic gastrectomy.

Methods. We retrospectively reviewed consecutive patients aged ≥65 years who underwent laparoscopy-assisted gastrectomy and had R0 resection for histologically confirmed gastric adenocarcinoma. The cutoff value for preoperative GNRI was determined to be 85.7 based on the incidence of postoperative complications. Patients were categorized into two groups: low GNRI group and normal GNRI group.

Results. Univariate analyses of the 303 patients revealed that the incidence of postoperative complications was significantly associated with the American Society of Anesthesiologists Physical Status classification (ASA-PS), C-reactive protein (CRP), GNRI (p <0.001), and operative procedure. Multivariate analyses revealed that preoperative GNRI (odds ratio [OR] 2.716; 95% confidence interval [CI]=1.166–6.328; p=0.021) and operative procedure (OR=2.459; 95% CI=1.378–4.390; p=0.002) were independently associated with the incidence of postoperative complications.

Univariate analyses showed that overall survival (OS) was significantly associated with ASA-PS, tumor size, tumor differentiation, pathological tumor node metastasis (TNM) stage, carcinoembryonic antigen (CEA), CRP, GNRI, and postoperative complications. Multivariate analysis demonstrated that ASA-PS (hazard ratio [HR], 3.755; 95% CI=2.141–6.585; p<0.001), tumor differentiation (HR=1.898; 95% CI=1.191–3.025; p=0.007), CEA (HR=1.645; 95% CI=1.024–2.643; p=0.040), and GNRI (HR 2.093; 95% CI=1.105–3.963; p=0.023) independently predicted OS.

Conclusion. GNRI is an important predictor of postoperative complications and overall survival in elderly gastric cancer patients. It is a reliable and cost-effective prognostic indicator that should be routinely evaluated.

Key words: gastric cancer, Geriatric Nutritional Risk Index, postoperative complications, overall survival

Introduction

Due to the diversity of various influencing factors, the objective evaluation of the nutritional status of cancer patients is difficult, and it remains unclear whether malnutrition is associated with decreased survival. However, preoperative nutritional assessment of cancer patients is essential to reduce postoperative complications, which have a negative impact on both short- and long-term outcomes after surgery [1-3]. As a nutrition-related prognostic assessment tool for hospitalized patients, the Geriatric nutritional risk index (GNRI) has been established by Bouillanne et al. [4], who classified the patients into the following four groups based on the GNRI values: high risk (GNRI <82), moderate risk (82–92), low risk (92–98), and normal (GNRI >98). GNRI has been developed as an index for predicting at-risk elderly hospitalized patients. GNRI comprises two parameters: serum albumin concentration and present body weight compared to ideal body weight. Several studies have reported the GNRI to be useful in assessing age-related factors, underlying diseases, and long-term outcomes of hospitalized patients [5-7]. Therefore, preoperative GNRI has recently attracted great attention as a novel predictor of postoperative complications as well as a prognostic indicator in elderly cancer patients [8-10].

Recent advances in minimally invasive surgery and perioperative patient care allow elderly patients to undergo laparoscopic gastrectomy, and acceptable short-term outcomes have been reported [11-13]. However, the incidence of postoperative complications remains high in the elderly and has been approximately 20% for the past several decades [14]. With aging populations, there is a growing demand to establish reliable preoperative indexes that can enhance informed decision making and subsequently result optimal outcomes of surgical interventions in elderly patients. This study aimed to evaluate the impact of preoperative GNRI on short- and long-term outcomes in elderly gastric cancer patients who underwent laparoscopic curative gastrectomy.

Patients and Methods

Patients

We retrospectively reviewed 303 consecutive patients aged ≥65 years who underwent laparoscopy-assisted gastrectomy with R0 resection for histologically confirmed gastric adenocarcinoma from January 2010 to December 2017, in our institute. R0 resection was defined as complete resection without any microscopic margin involvement. The extent of gastrectomy and lymph node dissection was determined per the Japanese Gastric Cancer Treatment Guidelines (version 4) [15]. We provided preoperative enteral nutrition to optimize preoperative conditions as much as possible, with the aim of decreasing the incidence rate of postoperative complications.

The pathological classification was performed according to the International Union Against Cancer Tumor Node Metastasis (TNM) classification (seventh edition) [16]. The requirement for informed consent was waived because of the retrospective nature of this cohort study.

The retrospective protocol of this study was approved by the Ethical Review Board of Shimane University, Faculty of Medicine (Shimane, Japan), and the study is registered with the University Hospital Medical Information Network Clinical Trials Registry (UMIN000030472).

Nutritional assessment using GNRI

All laboratory data used for calculating the preoperative nutritional status were obtained within a week before surgery.

The GNRI formula used was as follows: GNRI = 1.487 × serum albumin concentration (g/L) + 41.7 × present body weight/ideal body weight (kg). The ideal body weight is calculated as follows: ideal body weight = 22 × square of height (m) [4]. The body weight/ideal body weight was set to 1 when the patient's body weight exceeded the ideal body weight.

In this study, GNRI ranged from 54.4 to 115.0, with a mean GNRI of 99.0 and a median GNRI of 97.2. Using receiver operating characteristic (ROC) curve analysis, an accurate GNRI cutoff value of 85.7 (sensitivity, 19.0%; specificity, 94.1%; AUC = 0.534) was determined to identify malnourished patients based on the incidence of postoperative complications (**Fig. 1**). Patients were categorized into two groups—low GNRI group (GNRI <85.7) and normal GNRI group (GNRI ≥85.7)—based on GNRI values.

Outcome evaluation

Postoperative complications were evaluated according to the Clavien-Dindo (CD) classification, and serious complications were defined as grade II or higher [17]. Postoperative complications after laparoscopic gastrectomy included surgical site infection, anastomotic leakage, pancreatic fistula, intra-abdominal abscess, and pneumonia. Overall survival (OS) was defined as the period between surgery and death, with OS censored at the last follow-up date for patients who were alive.

Statistical analyses

Non-normally distributed data were expressed as median and interquartile range and compared using the non-parametric Mann–Whitney *U* test. The differences between the study groups were evaluated using the Chi-squared test or Student's *t*-test for categorical variables. OS was calculated according to the Kaplan–Meier method, and the difference between survival curves was evaluated by the log-rank test. Hazard ratios were calculated, and univariate and multivariate analyses were performed using Cox proportional hazards regression models. Variables with *p*-value <0.05 following univariate analysis were subjected to multivariate logistic regression analysis. All statistical analyses were performed using JMP software (version 14 for

Windows; SAS Institute), and p-values <0.05 were considered to be statistically significant.

Results

Clinicopathological features and postoperative complications

Of the 303 patients, 100 (33.0%) experienced postoperative complications (**Table 1**). The incidence of postoperative complications was significantly associated with the American society of anesthesiologists-PS (ASA-PS) (p = 0.026), C-reactive protein (CRP) level (p = 0.013), location of tumor (p = 0.009), operative procedure (p <0.001), and GNRI (p <0.001), but not with age, body mass index (BMI), WBC, serum albumin concentration, operation time, and intraoperative blood loss.

Univariate and multivariate analyses of risk factors for postoperative complications

Univariate analyses revealed that the incidence of postoperative complications of CD grade II or higher was significantly associated with ASA-PS (p = 0.016), CRP (p = 0.003), GNRI (p <0.001), and operative procedure (p <0.001). Multivariate analyses revealed that preoperative GNRI (odds ratio [OR], 2.716; 95% confidence interval [CI] = 1.166–6.328; p = 0.021) and operative procedure (OR = 2.459; 95% CI = 1.378–4.390; p = 0.002) were independently associated with the incidence of postoperative complications (**Table 2**).

Postoperative overall survival stratified by postoperative complications

Patients with postoperative complications had a 3-year OS rate of 65.1% and a 5-year OS rate of 57.0%. In patients without postoperative complications, the 3-year and 5-year OS rates were 86.3% and 73.0%, respectively. Patients with postoperative complications had significantly worse OS than did those without complications (p <0.001) (**Fig. 2**).

Univariate and multivariate analyses of overall survival

On univariate analyses, OS was significantly associated with ASA-PS (p <0.001), tumor size (p = 0.005), tumor differentiation (p <0.001), pathological TNM (pTNM) stage (p <0.001), serum CEA level (p <0.001), CRP level (p = 0.004), GNRI (p <0.001), and postoperative complications (p <0.001). Multivariate analysis demonstrated that ASA-PS (hazard ratio [HR], 3.755; 95% CI = 2.141–6.585; p <0.001), tumor differentiation (HR = 1.898; 95% CI = 1.191–3.025; p = 0.007), CEA (HR = 1.645; 95% CI = 1.024–2.643; p = 0.040), and GNRI (HR 2.093; 95% CI = 1.105–3.963; p = 0.023) independently predicted OS (**Table 3**).

Postoperative overall survival stratified by GNRI

Patients with a low GNRI had 3-year and 5-year OS rates of 52.8% and 32.6%, respectively. Patients with a normal GNRI had 3-year and 5-year OS rates of 82.7% and 72.3%, respectively. The log-rank test demonstrated that patients with a low GNRI had a significantly worse prognosis in terms of OS than that of those with a normal GNRI (p <0.001) (**Fig. 3**).

Discussion

Recent investigations have shown that the GNRI is well associated with the prognosis of cardiovascular diseases, chronic obstructive pulmonary disease, and peritoneal dialysis patients [18-20]. However, most of them focused on long-term outcomes in hospitalized elderly patients, and few studies have evaluated the usefulness of GNRI in short-term outcomes in patients who underwent surgical treatment [21]. Gastrectomy is the gold standard treatment for gastric cancer. However, the incidence of postoperative complications remains high, despite recent advances in surgical techniques and instruments [14]. It is well known that malnutrition increases the incidence of postoperative complications in various cancers and has an adverse effect on long-term survival [1-3]. In addition, recent studies have shown that nutritional support reduces morbidity and hospitalization after surgery [22]. GNRI is a simple and low-cost tool because it requires only measurement of present/ideal body weight ratio and serum albumin concentration. Serum albumin is well associated with malnutrition and is expected to decrease with cancer progression in the presence of cancer-related metabolic dysregulation [23]. In addition, several studies have reported that weight loss and malnutrition are considered to be adverse prognostic factors in cancer patients [24].

In this study, multivariate logistic regression analysis demonstrated that low GNRI and operative procedures were independent risk factors for the incidence of postoperative complications following gastrectomy. This study also confirmed that the incidence of postoperative complications was significantly associated with a worse prognosis. Postoperative complication-induced inflammation may cause a nutritional imbalance in cancer patients and lead to an impaired cell-mediated immunity for host defense against cancer [25, 26]. Hypercytokinemia associated with cancer-related systemic inflammation increases catabolism, resulting in anorexia and a negative effect on nutritional status [27, 28]. In addition, a decreased metabolic reserve of albumin reduces the ability to cope with stresses such as malignancy and surgery [29, 30]. Based on these findings, malnutrition, such as low GNRI, may also be responsible for poor outcomes in cancer patients. Thus, we speculate that GNRI could be a useful comprehensive indicator of the nutritional and immunological status of gastric cancer patients, and that perioperative nutritional support based on the preoperative GNRI assessment may reduce the incidence of postoperative complications and subsequently improve long-term outcomes.

Previous studies have reported the correlation between preoperative sarcopenia and immuno-nutritional parameters such as GNRI and controlling nutritional status (CONUT) in several cancers. Additionally, sarcopenia is considered a poor prognostic factor of cancer [31]. Sarcopenia, which means depletion of skeletal muscle mass, was identified using a cross-sectional CT image at the L3 level. However, GNRI can be easily calculated from routine hematological data, and from anthropometric measurements, including body height and weight. Therefore, preoperative GNRI is a simple and useful parameter for malnutrition or cachexia.

The most important limitation of this study is the lack of statistical robustness due to the small sample size. Considering the weak discriminatory power of GNRI (AUC=0.534) for estimating postoperative complications, large-scale multicenter studies are needed to establish the role of GNRI as a prognostic predictor in elderly gastric cancer patients. In the future, it is necessary to improve the diagnostic accuracy of postoperative complications and to examine other more effective predictive markers. In addition, GNRI should be compared with other tools that are commonly used to assess nutritional status. Finally, Monitoring of GNRI during perioperative dietetic assessment or supplementation, or both, may provide more useful information. However, we failed to evaluate the postoperative dynamic changes of GNRI.

Future multi-center prospective validation of our findings is desirable prior to the implementation of GNRI as a valuable predictive biomarker in clinical settings.

Conclusion

GNRI proved to be a new predictor of both postoperative complications and overall survival in elderly gastric cancer patients who underwent laparoscopic gastrectomy. GNRI is reliable and cost-effective; thus, it is beneficial to routinely evaluate GNRI in elderly gastric cancer patients before surgery.

Acknowledgments: None.

Disclosures

Disclosures: Drs. Noriyuki Hirahara, Yoshitsugu Tajima, Yusuke Fujii, Shunsuke Kaji, Tetsu Yamamoto, Ryoji Hyakudomi, Takahito Taniura, and Yasunari Kawabata have no conflicts of interest or financial ties to disclose.

Source of Funding:

This study received no external funding.

References

1. Laky B, Janda M, Kondalsamy-Chennakesavan S, Cleghorn G, Obermair A (2010) Pretreatment malnutrition and quality of life - association with prolonged length of hospital stay among patients with gynecological cancer: a cohort study. BMC Cancer 25;10:232. https://doi:10.1186/1471-2407-10-232.

2. Ho JW, Wu AH, Lee MW, Lau SY, Lam PS, Lau WS, Kwok SS, Kwan RY, Lam CF, Tam CK, Lee SO (2015) Malnutrition risk predicts surgical outcomes in patients undergoing gastrointestinal operations: Results of a prospective study. Clin Nutr 34(4):679-684. https://doi:10.1016/j.clnu.2014.07.012.

3. Fujiya K, Kawamura T, Omae K, Makuuchi R, Irino T, Tokunaga M, Tanizawa Y, Bando E, Terashima M (2018) Impact of Malnutrition After Gastrectomy for Gastric Cancer on Long-Term Survival. Ann Surg Oncol 25(4):974-983. https://doi:10.1245/s10434-018-6342-8.

4. Bouillanne O, Morineau G, Dupont C, Coulombel I, Vincent JP, Nicolis I, Benazeth S, Cynober L, Aussel C (2005) Geriatric Nutritional Risk Index: a new index for evaluating at-risk elderly medical patients. Am J Clin Nutr 82(4):777-783

5. Abd-El-Gawad WM, Abou-Hashem RM, El Maraghy MO, Amin GE (2014) The validity of Geriatric Nutrition Risk Index: simple tool for prediction of nutritional-relatedcomplication of hospitalized elderly patients. Comparison with Mini Nutritional Assessment. Clin Nutr 33(6):1108-1116. https://doi:10.1016/j.clnu.2013.12.005.

6. Sze S, Zhang J, Pellicori P, Morgan D, Hoye A, Clark AL (2017) Prognostic value of simple frailty and malnutrition screening tools in patients with acute heart failure due to left ventricular systolic dysfunction. Clin Res Cardiol 106(7):533-541. https://doi:10.1007/s00392-017-1082-5.

7. Wang H, Hai S, Zhou Y, Liu P, Dong BR (2018) The Geriatric Nutritional Risk Index predicts mortality in nonagenarians and centenarians receiving home care. Asia Pac J Clin Nutr 27(1):78-83. https://doi:10.6133/apjcn.022017.10.

8. Yamana I, Takeno S, Shibata R, Shiwaku H, Maki K, Hashimoto T, Shiraishi T, Iwasaki A, Yamashita Y. (2015) Is the Geriatric Nutritional Risk Index a Significant Predictor of Postoperative Complications in Patients with Esophageal Cancer Undergoing Esophagectomy? Eur Surg Res 55(1-2):35-42. https://doi:10.1159/000376610.

9. Kubo N, Sakurai K, Tamura T, Toyokawa T, Tanaka H, Muguruma K, Yashiro M, Ohira M (2019) The impact of geriatric nutritional risk index on surgical outcomes after esophagectomy in patients with esophageal cancer. Esophagus 16(2):147-154. https://doi:10.1007/s10388-018-0644-6.

10. Funamizu N, Nakabayashi Y, Iida T, Kurihara K (2018) Geriatric nutritional risk index predicts surgical site infection after pancreaticoduodenectomy. Mol Clin Oncol 9(3):274-278. https://doi:10.3892/mco.2018.1671.

11. Gertsen EC, Brenkman HJF, Seesing MFJ, Goense L, Ruurda JP, van Hillegersberg R; Dutch Upper Gastrointestinal Cancer Audit (DUCA) group (2019) Introduction of minimally invasive surgery for distal and total gastrectomy: a population-based study. Eur J Surg Oncol 45(3):403-409. https://doi:10.1016/j.ejso.2018.08.015.

12. Sawazaki S, Numata M, Morita J, Maezawa Y, Amano S, Aoyama T, Tamagawa H, Sato T, Oshima T, Mushiake H, Yukawa N, Shiozawa M, Rino Y, Masuda M (2018) Safety of Laparoscopic Surgery for Colorectal Cancer in Patients with Severe Comorbidities. Anticancer Res 38(6):3767-3772. https://doi:10.21873/anticanres.12659.

13. Isani MA, Schlieve C, Jackson J, Elizee M, Asuelime G, Rosenberg D, Kim ES (2018) Is less more? Laparoscopic versus open Ladd's procedure in children with malrotation. J Surg Res 229:351-356. https://doi:10.1016/j.jss.2018.04.016.

14. Yoshida K, Honda M, Kumamaru H, Kodera Y, Kakeji Y, Hiki N, Etoh T, Miyata H, Yamashita Y, Seto Y, Kitano S, Konno H (2017) Surgical outcomes of laparoscopic distal gastrectomy compared to open distal gastrectomy: A retrospective cohort study based on a nationwide registry database in Japan. Ann Gastroenterol Surg 22;2(1):55-64. https://doi:10.1002/ags3.12054.

15. Japanese Gastric Cancer Association (2017) Japanese gastric cancer treatment guidelines 2014 (ver. 4). Gastric Cancer 20(1):1-19. https://doi:10.1007/s10120-016-0622-4.

16. Sobin L, Gospodarowicz M, Wittekind C (eds) (2010) International Union against Cancer (UICC). TNM classification of malignant tumors, 7th edn. Wiley-Blackwell, New York

17. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, de Santibañes E, Pekolj J, Slankamenac K, Bassi C, Graf R, Vonlanthen R, Padbury R, Cameron JL, Makuuchi M (2009) The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg 250(2):187-196. https://doi:10.1097/SLA.0b013e3181b13ca2.

18. Matsumura T, Mitani Y, Oki Y, Fujimoto Y, Ohira M, Kaneko H, Kawashima T, Nishio M, Ishikawa A (2015) Comparison of Geriatric Nutritional Risk Index scores on physical performance among elderly patients with chronic obstructive pulmonary disease. Heart Lung 44(6):534-538. https://doi:10.1016/j.hrtlng.2015.08.004.

19. Kuo IC, Huang JC, Wu PY, Chen SC, Chang JM, Chen HC (2017) A Low Geriatric Nutrition Risk Index Is Associated with Progression to Dialysis in Patients with Chronic Kidney Disease.

Nutrients 9;9(11). pii: E1228. doi: 10.3390/nu9111228.

20. Wada H, Dohi T, Miyauchi K, Doi S, Naito R, Konishi H, Tsuboi S, Ogita M, Kasai T, Hassan A, Okazaki S, Isoda K, Suwa S, Daida H (2017) Prognostic Impact of the Geriatric Nutritional Risk Index on Long-Term Outcomes in Patients Who Underwent Percutaneous Coronary Intervention. Am J Cardiol 119(11):1740-1745. doi: 10.1016/j.amjcard.2017.02.051.

21. Abd-El-Gawad WM, Abou-Hashem RM, El Maraghy MO, Amin GE (2014) The validity of Geriatric Nutrition Risk Index: simple tool for prediction of nutritional-related complication of hospitalized elderly patients. Comparison with Mini Nutritional Assessment. Clin Nutr 33(6):1108-1116. https://doi:10.1016/j.clnu.2013.12.005.

22. Poziomyck AK, Weston AC, Lameu EB, Cassol OS, Coelho LJ, Moreira LF (2012) Preoperative nutritional assessment and prognosis in patients with foregut tumors. Nutr Cancer 64(8):1174-1181. doi: 10.1080/01635581.2012.721157.

23. Lai CC, You JF, Yeh CY, Chen JS, Tang R, Wang JY, Chin CC (2011) Low preoperative serum albumin in colon cancer: a risk factor for poor outcome. Int J Colorectal Dis 26(4):473-481. https://doi:10.1007/s00384-010-1113-4.

24. Ri M, Miyata H, Aikou S, Seto Y, Akazawa K, Takeuchi M, Matsui Y, Konno H, Gotoh M, Mori M, Motomura N, Takamoto S, Sawa Y, Kuwano H, Kokudo N (2015) Effects of body mass index (BMI) on surgical outcomes: a nationwide survey using a Japanese web-based database.

Surg Today 45(10):1271-1279. https://doi:10.1007/s00595-015-1231-2.

25. Chen L, Hasni MS, Jondal M, Yakimchuk K (2017) Modification of anti-tumor immunity by tolerogenic dendritic cells. Autoimmunity 50(6):370-376. doi: 10.1080/08916934.2017.1344837.

26. Bárta I, Smerák P, Polívková Z, Sestáková H, Langová M, Turek B, Bártová J (2006) Current trends and perspectives in nutrition and cancer prevention. Neoplasma 53(1):19-25.

27. Márton S, Garai J, Molnár V, Juhász V, Bogár L, Köszegi T, Falusi B, Ghosh S (2011) Kinetics of inflammatory markers following cancer-related bowel and liver resection. Ups J Med Sci 116(2):124-128. https://doi:10.3109/03009734.2010.519446.

28. Krzystek-Korpacka M, Matusiewicz M, Diakowska D, Grabowski K, Blachut K, Kustrzeba-Wojcicka I, Terlecki G, Gamian A (2008) Acute-phase response proteins are related to cachexia and accelerated angiogenesis in gastroesophageal cancers. Clin Chem Lab Med 46(3):359-364. doi: 10.1515/CCLM.2008.089.

29. Antonelli M, Kushner I (2017) It's time to redefine inflammation. FASEB J 31(5):1787-1791. https://doi:10.1096/fj.201601326R.

30. Patterson BM, Cornell CN, Carbone B, Levine B, Chapman D (1992) Protein depletion and metabolic stress in elderly patients who have a fracture of the hip. J Bone Joint Surg Am. 74(2):251-260.

31. Shoji F, Matsubara T, Kozuma Y, Haratake N, Akamine T, Takamori S, Katsura M, Toyokawa G, Okamoto T, Maehara Y (2019) Relationship Between Preoperative Sarcopenia Status and Immuno-nutritional Parameters in Patients with Early-stage Non-small Cell Lung Cancer. Anticancer Res. 37(12):6997-7003.

Figure legends

Fig. 1 ROC for GNRI as a predictive factor for postoperative complications was plotted to verify the optimum cutoff value of GNRI.

Fig. 2 Kaplan-Meier curves of postoperative OS based on postoperative complications in 303 elderly gastric cancer patients.

Fig. 3 Kaplan-Meier curves of postoperative OS based on GNRI in 303 elderly gastric cancer patients.

Table 1. Relationships between GNRI and clinicopathological features in 303 elderly patients with gastric cancer

Characteristics	Number of patients	Postoperative complications		
		Absent (n = 203)	Present (n= 100)	*p*-value
Age (years old)		76 (65 - 91)	76 (65 - 90)	0.670
Sex				0.288
Male	209	136	73	
Female	94	67	27	
BMI		22.5 (14.7 – 40.4)	15.6 (15.6 – 29.8)	0.400
ASA-PS				0.026
1	8	7	1	
2	260	179	81	
3	35	17	18	
WBC (μl)		5630 (1830 - 12730)	5625 (510 - 13700)	0.500
RBC (x 10^4μl)		414 (262 - 570)	407 (142 - 579)	0.615
Albumin (g/dl)		3.9 (2.4 - 5.0)	3.9 (1.1 - 5.0)	0.193
CRP (mg/l)		0.08 (0.01 - 6.31)	0.11 (0.01 - 11.10)	0.013
Location of tumor				0.009
EGJ	11	5	6	
U	57	29	28	
M	123	88	35	
L	112	81	31	
Tumor size (mm)		43 (3 - 176)	42 (5 - 180)	0.430
Procedure				<0.001
LTG	67	33	34	
LPG	30	16	14	
L(A)DG	206	154	52	
Tumor differentiation				0.102
Well	66	41	25	
Moderate	123	91	32	

書式付きの表

Poor	114	71	43	
Depth of tumor				0.226
T1a-1b	146	106	40	
2	46	30	16	
3	45	27	18	
4a-4b	66	40	26	
Lymph node metastasis				0.213
N0	194	136	58	
N1	40	26	14	
N2	36	24	12	
N3	33	17	16	
Pathological stage				0.137
1a-1b	173	123	50	
2a-2b	56	37	19	
3a-3c	74	43	31	
Operation time (min)		391 (70 - 911)	419 (207 - 714)	0.095
Intraoperative blood loss (ml)		50 (0 - 4070)	100 (0 - 5850)	0.069
CEA antigen (ng/ml)		3.4 (0.7 - 106.0)	3.6 (1.1 - 163.3)	0.436
GNRI				<0.001
< 85.7	31	12	19	
≥ 85.7	272	191	81	
Adjuvant chemotherapy				0.393
Yes	79	56	23	
No	224	147	77	

BMI body mass index, ASA-PS American Society of Anesthesiologists-Physical Status classification, WBC white blood cell, RBC red blood cell, CRP C-reactive protein, EGJ esophagogastric junction, U upper, M middle, L lower, LTG laparoscopic total gastrectomy, LPG laparoscopic proximal gastrectomy, L(A)DG laparoscopic (assisted) distal gastrectomy, CEA carcinoembryonic, GNRI Geriatric Nutritional Risk Index, antigen,

Table 2. Univariate and multivariate analyses to assess the risk factors for postoperative complications

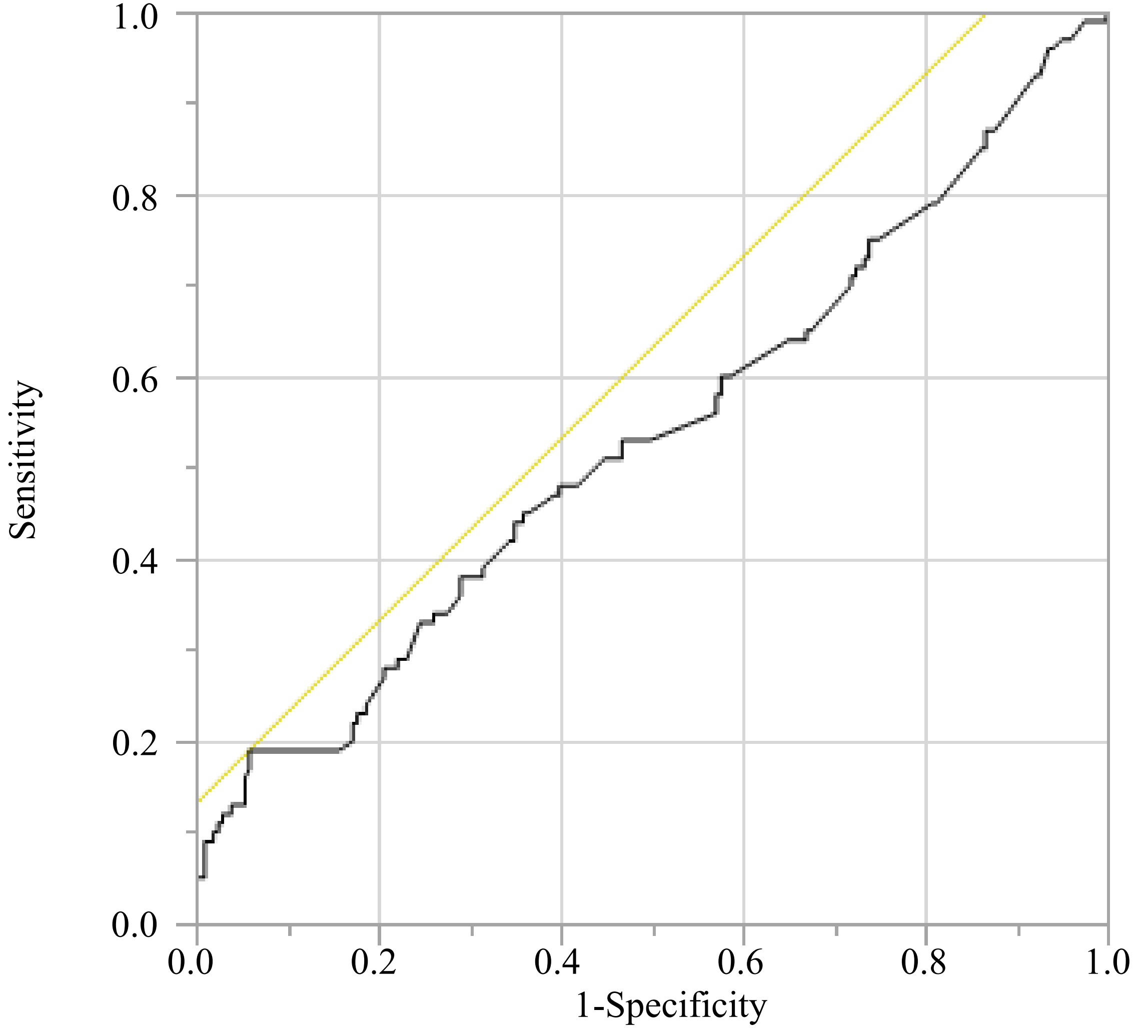
Variables	Category or characteristics	Patients (n = 303)	Univariate			Multivariate		
			OR	95% CI	*p* value	OR	95% CI	*p*-value
Gender	(female / male)	94 / 209	1.332	0.784 – 2.262	0.289			
ASA-PS	(< 3 / ≥ 3)	268 / 35	2.402	1.178 – 4.178	0.016	2.073	0.966 – 4.449	0.061
BMI	(≥ 18.5 / < 18.5)	274 / 29	1.105	0.484 – 2.524	0.813			
Tumor size	(< 5 / ≥ 5)	167/ 136	1.007	0.622 – 1.630	0.977			
Differentiation of tumor	(well & mod / poor)	188 / 115	1.461	0.896 – 2.382	0.129			
pStage	(1,2 / 3)	229 / 74	1.686	0.991 – 2.867	0.054			
CEA	(< 5.0 / ≥ 5.0)	228 / 75	1.194	0.690 – 2.065	0.525			
CRP	(≦ 0.5 / > 0.5)	252 / 51	2.502	1.356 – 4.615	0.003	1.473	0.731 – 2.970	0.279
GNRI	(≥ 85.7 / < 85.7)	272 / 31	3.734	1.732 – 8.048	< 0.001	2.716	1.166 – 6.328	0.021
Procedure	(proximal & distal / total)	236 / 67	2.654	1.521 – 4.632	< 0.001	2.459	1.378 – 4.390	0.002

ASA American Society of Anesthesiologists-Physical Status classification, BMI body mass index, pStage pathological stage, CEA carcinoembryonic, CRP C-reactive protein, GNRI Geriatric Nutritional Risk Index, antigen, proximal laparoscopic proximal gastrectomy, distal laparoscopic (assisted) distal gastrectomy, total laparoscopic total gastrectomy

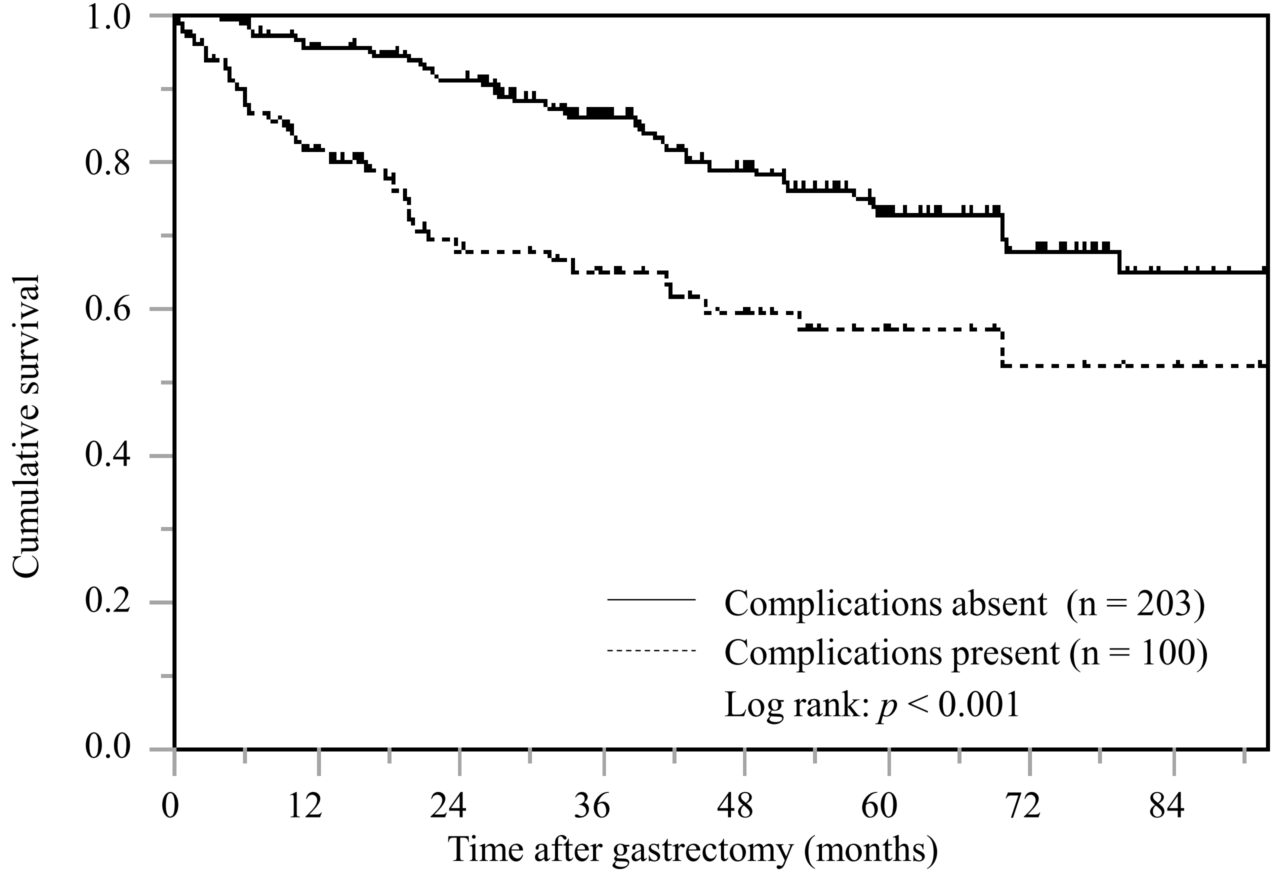
Table 3. Univariate and multivariate analyses of clinicopathological factors for overall survival

Variables	Category or characteristics	Patients	Univariate			Multivariate		
		(n = 303)	HR	95% CI	*p* value	HR	95% CI	*p*-value
Gender	(female / male)	94 / 209	1.204	0.741 – 1.958	0.453			
ASA-PS	(< 3 / ≥ 3)	268 / 35	4.162	2.460 – 7.4041	< 0.001	3.755	2.141 – 6.585	<0.001
BMI	(≥ 18.5 / < 18.5)	274 / 29	1.630	0.862 – 3.084	0.133			
Tumor size	(< 5 / ≥ 5)	167/ 136	1.892	1.207 – 2.967	0.005	1.234	0.711 – 2.141	0.455
Differentiation of tumor	(well & mod / poor)	188 / 115	2.217	1.419 – 3.464	< 0.001	1.898	1.191 – 3.025	0.007
pStage	(1,2 / 3)	229 / 74	2.610	1.671 – 4.076	< 0.001	1.628	0.947 – 2.800	0.078
CEA	(< 5.0 / ≥ 5.0)	228 / 75	2.231	1.415 – 3.519	< 0.001	1.645	1.024 – 2.643	0.040
CRP	(≦ 0.5 / > 0.5)	252 / 51	2.071	1.265 – 3.389	0.004	1.017	0.544 – 1.902	0.958
GNRI	(≥ 85.7 / < 85.7)	272 / 31	3.289	1.942 – 5.569	< 0.001	2.093	1.105 – 3.963	0.023
Complications	(absent / present)	236 / 67	2.179	1.396 – 3.401	< 0.001	1.594	0.988 – 2.571	0.056
Adjuvant	(no / yes)	94 / 209	1.427	0.896 – 2.272	0.135			

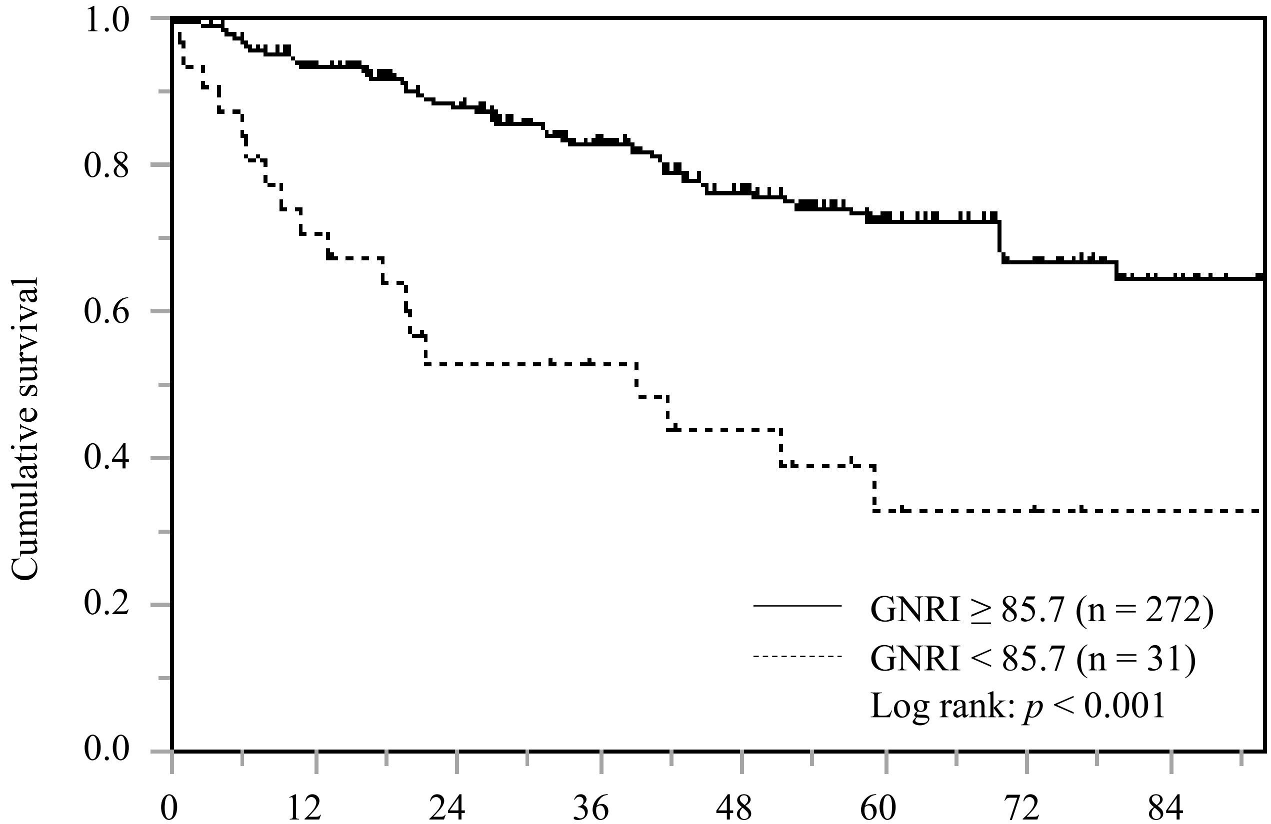
ASA American Society of Anesthesiologists-Physical Status classification, BMI body mass index, pStage pathological stage, CEA carcinoembryonic, CRP C-reactive protein, GNRI Geriatric Nutritional Risk Index, Adjuvant Adjuvant chemotherapy



1.0
0.8
0.6
0.4
0.2
0.0
Sensitivity
0.0
0.2
0.4
0.6
0.8
1.0
1-Specificity



No. at risk	0	12	24	36	48	60	72	84
Complications absent (n = 203)	203	178	155	119	88	64	39	16
Complications present (n = 100)	100	73	50	41	29	19	11	8



No. at risk								
GNRI ≥ 85.7 (n = 272)	272	229	191	148	109	78	45	20
GNRI < 85.7 (n = 31)	31	21	14	12	9	6	5	3