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ORIGINAL ARTICLE – PERITONEAL SURFACE MALIGNANCY

Development of a Geriatric Prognostic Scoring System for Predicting Survival After Surgery for Elderly Patients With Gastrointestinal Cancer

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ABSTRACT

Background. The number of elderly patients with gastrointestinal cancer is rising as the population ages. This study aimed to assess the impact of a preoperative geriatric assessment on postoperative survival and to develop a geriatric prognostic scoring system (GPSS) for elderly patients.

Methods. Patients (n = 544) age 75 years or older who had undergone radical surgery for gastrointestinal cancer were recruited for this observational study. Geriatric assessments (GAs) using the Barthel Index, the Mini-Mental State Examination, Instrumental Activities of Daily Living, the Vitality Index, and the Geriatric Depression Score were administered before surgery. Multivariable analysis was performed using a Cox proportional hazard regression model to identify significant prognostic factors. The GPSS was developed using regression coefficients of the multivariable regression to predict overall survival (OS). Thereafter, 165 consecutive patients were prospectively validated to test the authors' model.

Results. The independent predictors of OS appeared to be GA as well as age, type of cancer, clinical stage, performance status, and body mass index. The patients were classified into high- and low-risk groups according to the GPSS. The overall 3-year survival was 79% in the low-risk group and 26% in the high-risk group (hazard ratio [HR], 5.69; 95% confidence interval [CI] 4.35–7.42; $p < 0.0001$). Furthermore, when GPSS was applied to independent cohorts, the patients in the high-risk group showed significantly poorer prognoses than those in the low-risk group (HR, 4.49; 95% CI 2.65–7.60; $p < 0.0001$).

Conclusions. Geriatric assessments were closely associated with postoperative OS. The GPSS is useful in predicting postoperative prognosis and may help determine treatment strategies for elderly patients with gastrointestinal cancer.

Gastrointestinal cancers comprise approximately 30% of cancer diagnoses and 37% of cancer-specific deaths worldwide.[1] The number of geriatric patients with gastrointestinal cancers is rising substantially as the population ages. Although surgery is regarded as a mainstay of management for gastrointestinal cancer, postoperative morbidity and mortality rates are higher for elderly patients than for younger patients.[2–4] Before elderly patients receive surgery, it is important to predict postoperative outcomes and classify the risk.

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The geriatric assessment (GA) is an interdisciplinary diagnostic tool that can be used to assess both cognitive function and frailty at a single point in time. The GA is widely used as a tool to identify problems in the daily life of elderly patients.[5,6]

Several studies have reported that the GA is an effective risk assessment tool for toxicity and postoperative complications in elderly patients with cancer who are receiving chemotherapy and undergoing surgery.[7–10] We also reported previously that the GA is useful for predicting postoperative delirium and complications after gastroenterologic cancer surgery in elderly patients.[11,12]

Recently, increasing evidence indicates that several approaches toward comprehensive geriatric assessments (CGAs), including GA, comorbidity, nutrition status, and performance status (PS), might be useful prognostic tools for a variety of malignant diseases and their associated treatments.[12–17] Several prognostic models for overall survival (OS) in the general geriatric population are proposed, but they have not been formally validated for older patients with cancer.

This study aimed to analyze the relationship of GA to OS. Furthermore, on the basis of these results, we developed a geriatric prognostic scoring system (GPSS) to predict OS after surgery for elderly patients with gastrointestinal cancer and validated the efficacy of the GPSS in an independent cohort.

METHODS

Patients

From December 2005 to December 2013, 688 patients age 75 years or older were treated for gastrointestinal cancer at Osaka University Hospital, and 544 of these patients who met the inclusion criteria were recruited for the study (Fig. 1). Patients were deemed eligible for the study if they (1) had been referred for surgery after a diagnosis of esophageal, gastric, duodenal, colonic, rectal, hepatic, or biliopancreatic cancer; (2) had received curative resection (R0); (3) could read Japanese and provide informed consent; and (4) had no documented diagnosis of dementia.

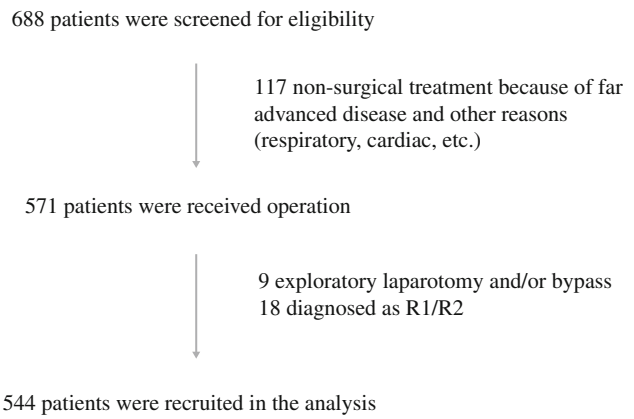

FIG. 1 Flow of patients in this study

This study was approved by the Ethics Committee of Osaka University Hospital, with the protocol entitled "observational study for discovery of beneficial factors influencing postoperative course in elderly undergoing surgery." Informed consent for gastrointestinal surgery and oral consent for the GA were obtained from each patient.

From January 2014 to December 2015, 165 patients were enrolled in the study as an independent cohort. These patients were eligible based on the aforementioned criteria.

Preoperative Multidimensional Geriatric Assessment

The geriatricians in the geriatric medicine department of the Osaka University Graduate School of Medicine performed the GA before admission or during the hospital stay before surgery. The instruments included in the GA were the Mini-Mental State Examination (MMSE),[18] the Geriatric Depression Score (GDS), the Vitality Index (VI), the Barthel Index, and Instrumental Activities of Daily Living (IADL).

The enrolled patients were classified based on the GA as those with a MMSE total score of 30 (normal function, > 24; cognitive dysfunction, ≤ 23), those with a GDS total score of 15 (normal function, < 6; mild-to-moderate depression, 6–10; severe depressionm, ≥ 11), those with a total VI score of 10 (quality of life of elderly subjects with dementia), those with a total Barthel Index score of 100 (functional status using activities of daily living [ADL]), those with a total IADL score of 5 for men and 8 for women (functional status using IADL). Only full marks were regarded as normal functioning for the VI, ADL, and IADL.

The GA cumulative index was calculated for each patient from the results of each GA domain (ADL, IADL, GDS, MMSE, and VI). The score was the sum of each domain (total score, 5), with a score of 5 indicating normal function (robust), a score of 4 indicating mild dysfunction (pre-frail), and a score lower than 4 indicating severe dysfunction (frail). Body mass index (BMI) was calculated by dividing weight by height squared (kg/m^2).

Follow-Up Evaluation

All the patients were followed up at 3- to 4-month intervals for the first 2 years, at 6-month intervals for 5 years, and at 12-month intervals thereafter. All the patients underwent a physical examination and computed

tomography (CT) scan and were assessed for recurrence or metastasis. The last general follow-up assessment of survivors was performed at the end of September 2017.

Statistical Analysis

Statistical analyses were performed with JMP 9.0.1 (SAS, Cary, NC, USA). Continuous variables are expressed as the mean ± standard deviation, and were compared using Student's *t* test. Categorical data are expressed as counts and percentages and were compared with the Chi square test or Fisher's exact test. The surviving patients were censored on the day of their last contact.

Overall survival was defined as the time between the date of the operation and the date of death from any cause. Prognostic variables were assessed by the log-lank test, and OS was analyzed using the Kaplan–Meier method. Cox's proportional hazard (PH) regression model was used to analyze independent prognostic factors. Regression coefficients from the Cox PH regression were used to compute the Geriatric Prognostic Score (GPS)[19] as follows:

$$\mathrm{GPS} = \mathrm{X(age)i} + \mathrm{X(sex)i} + \mathrm{X(cancer\,type)i} + \mathrm{X(cStage)i} + \mathrm{X(PS)i} + \mathrm{X(BMI)i} + \mathrm{X(PNI)i} + \mathrm{X(CGA)i},$$

where X()i is the score of each predictor in patient i.

The score was assigned to each factor by multiplying the regression coefficient ($\log_e$ hazard ratio) by 10 and rounding it to the nearest integer. The GPS for patient i was obtained from the sum of the score of each predictor.

To assess the discriminatory power of the GPS in predicting survival, a logistic regression model was used separately to compute the area under the receiver operating characteristic (ROC) curves for 1-year survival after surgery. The optimal cutoff point was identified with the maximal Youden index (sensitivity + specificity − 1). In addition, the corresponding sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated according to the ROC results. The statistical significance for each model was set at a two-sided significance level of 5%.

RESULTS

Patient Characteristics

The patient characteristics of the established cohort are listed in Table 1. The mean age of all 544 patients was 79.3 ± 3.7 years, and about 40% of the patients were 80 years or age or older. Of the 544 patients, 81 had esophageal, 139 had gastric/duodenal, 183 had colorectal, 68 had hepatic, and 73 had bile-duct/pancreatic cancer. About two-thirds of the patients had a diagnosis of stage 1 or 2 cancer, and about half of these patients underwent surgery laparoscopically and/or thoracoscopically.

Preoperative Geriatric Assessment

About 30 min were required to perform the interview and to retrieve all the relevant information for the GA components. The preoperative GA scores are shown in Table 1. According to each of the GA components, the number of patients regarded as frail in their physical function and mental status was 20 based on the ADL, 124 based on the IADL, 179 based on the MMSE, 101 based on the GDS, and 36 based on the VI. According to all the components of the GA, 254 patients were regarded as having normal function (robust). Of the 544 patients, 177 (33%) exhibited poor function in one component (pre-frail) and 113 (21%) exhibited poor function in at least two components (frail) of the GA. The distribution of the GA cumulative index is shown in Table 1.

Approximately 93% of the patients had a PS of 0 or 1. More than 70% of the patients had a BMI in the normal range (Table 1).

Prognostic Factors for Overall Survival

The mean follow-up period was 1125 days for the living patients and 634 days for the deceased patients. The 3-year OS was 65.7%, and the 5-year OS was 53.4%.

Age, sex, cancer type, clinical stage, PS, BMI, and GA were entered into multivariate analyses for OS (Table 2). Six variables (excluding sex) were identified as significant prognostic factors. The patients regarded as robust according to the GA had a significantly longer survival than those regarded as pre-frail or frail (pre-frail: hazard ratio [HR], 1.69; 95% confidence interval [CI] 1.23–2.32 vs frail: HR, 2.19; 95% CI 1.53–3.13).

Cancer type was significantly related to prognosis. The prognosis for the patients with colorectal cancer was significantly better than for those with the other four types of cancer. The prognoses did not differ among the four other types of cancer (data not shown). More advanced cancer stage was closely related to shorter survival compared with stages 1 and 2 disease (HR, 1.63; 95% C, 1.11–2.41), stage 3 disease (HR, 3.87; 95% CI 2.76–5.48), or stage 4 disease (HR, 8.37; 95% CI 4.43–15.07). The patients with poorer PS and excessively low BMI had a significantly shorter survival.

Development of the GPSS

We developed the GPSS to predict the OS of elderly patients after surgery. The HR, regression coefficient, and score of each predictor are shown in Table S1. The areas

TABLE 1 Baseline clinical and demographic variables

Age (years)		79.3 ± 3.6	%
Sex	Male	367	67.5
	Female	177	32.5
Performance status	0	409	75.2
	1	99	18.2
	2	24	4.4
	3	10	1.8
	4	2	0.4
BMI (kg/m^2)	< 18.5	72	13.2
	18.5–25.0	385	70.8
	≥ 25	87	16
Site of primary tumor	Esophageal site	81	14.9
	Gastric/duodenal site	139	25.6
	Colorectal site	183	33.6
	Hapatic site	68	12.5
	Biliopancreatic site	73	13.4
Clinical stage	1	231	42.5
	2	142	26.1
	3	155	28.5
	4	16	2.9
Surgery type	Open	292	53.7
	Laparo-/thoraco-scopic	252	46.3
Operating time (min)		283 ± 1387	
Blood loss (g)		487 ± 794	
Transfusion	Yes	136	25.9
	No	389	74.1
	Unknown	20	
ADL	≤ 80	20	3.7
	> 80	524	96.3
IADL	Male < 5; female < 8	124	22.8
	Male 5; female 8	420	77.2
MMSE	< 24	179	33
	≥ 24	365	67
GDS	< 6	443	81.4
	≥ 6	101	18.6
VI	< 10	36	6.6
	10	508	93.4
CGA cumulative index	Robust	254	46.7
	Pre-frail	177	32.5
	Frail	113	20.8

BMI, body mass index; ADL, activities of daily living; IADL, instrumental activities of daily living; MMSE, Mini-Mental State Examination; GDS, Geriatric Depression Score; VI, Vitality Index; CGA, comprehensive geriatric assessment

under the ROC curve for the GPS and 1-year mortality both were 0.80 (Fig. S1).

When the optimal GPS cutoff value of 30 was used to predict the 1-year mortality, the sensitivity and specificity were respectively 64.8% and 80.8%, and the PPV and NPV were respectively 33.6 and 93.9. The patients were classified into high- and low-risk groups on the basis of the optimal cutoff point. The number of patients in the high- and low-risk groups were respectively 137 and 407.

The Kaplan–Meier analysis of OS based on GPS risk-group status showed good linear separation of the survival distribution across the risk categories (Fig. 2). The 1- and 3-year OS rates were respectively 94.3% and 79.0% in the low-risk group compared with 66.4% and 26.0% in the

TABLE 2 Multivariate analysis of overall survival

		n	HR	95% CI	*p* Value
Age (years)	75–79	325	1		0.0002
	80–84	171	1.68	1.25–2.24	
	85–	47	2.13	1.32–3.35	
Sex	Female	176	1		0.12
	Male	367	1.27	0.94–1.72	
Cancer type	Colorectal	182	1		< 0.0001
	Stomach	139	2.29	1.56–3.37	
	Esophagus	81	2.92	1.92–4.43	
	Liver	68	2.40	1.44–3.93	
	Bile duct/pancreas	73	3.50	2.25–5.42	
cStage	1	231	1		< 0.0001
	2	142	1.63	1.11–2.41	
	3	155	3.87	2.76–5.48	
	4	16	8.37	4.43–15.07	
PS	0	408	1		0.0003
	1	99	1.85	1.33–2.52	
	2–	36	1.91	1.16–3.05	
BMI (kg/m^2)	> 25	87	1		0.022
	18.5–25.0	384	0.91	0.63–1.34	
	< 18.5	72	1.56	0.96–2.54	
CGA cumulative index	Robust	254	1		< 0.0001
	Pre-frail	177	1.69	1.23–2.32	
	Frail	113	2.19	1.53–3.13	

HR, hazard ratio; CI, confidence interval; PS, performance status; BMI, body mass index; CGA, comprehensive geriatric assessment

high-risk group. The high-risk group was associated with increased mortality compared with the low-risk group (HR, 5.69; 95% CI 4.35–7.42; $p < 0.0001$).

Considering the influence of cStage, which was a strong prognostic factor, we performed a subanalysis. The patients were classified into four stages (cStages 1, 2, 3, and 4). Kaplan–Meier analysis of OS based on GPSS risk status was performed for each stage (Fig. 2B–E). The 3-year OS rates for the low- and high-risk groups were respectively 83.2% and 43.8% for cStage 1 disease, 74.7% and 33.0% for cStage 2 disease, and 68.5% and 27.2% for cStage 3 disease.

The patients in the low-risk group had a significantly longer survival than those in high-risk group for cStages 1 to 3 disease. On the other hand, for cStage 4 disease, the 3-year OS in the low- and high-risk groups were respectively 16.7% and 26.5%, and the two GPSS risk statuses did not differ significantly.

Validation of GPSS by Independent Cohort

The patient characteristics in the independent cohort are listed in Table 3. We validated the ability of GPSS to predict OS in the independent cohort. When the previous optimal cutoff value of 30 for the GPS was applied to predict 1-year mortality, 43 patients were classified into the high-risk group, and 122 patients were classified into the low-risk group, with a sensitivity of 70% and a specificity of 80.7%. The PPV was 33, and the NPV was 95.1. The predictive power of the GPSS in the independent cohort was the same as in the established cohort.

Kaplan–Meier analysis of OS based on the GPS risk-group status also showed a linear separation of the survival distributions across the risk categories in the independent cohort (Fig. 3). The 1- and 2-year OS rates were respectively 95.1% and 84.6% in the low-risk group compared with 72.1% and 40.3% in the high-risk group.

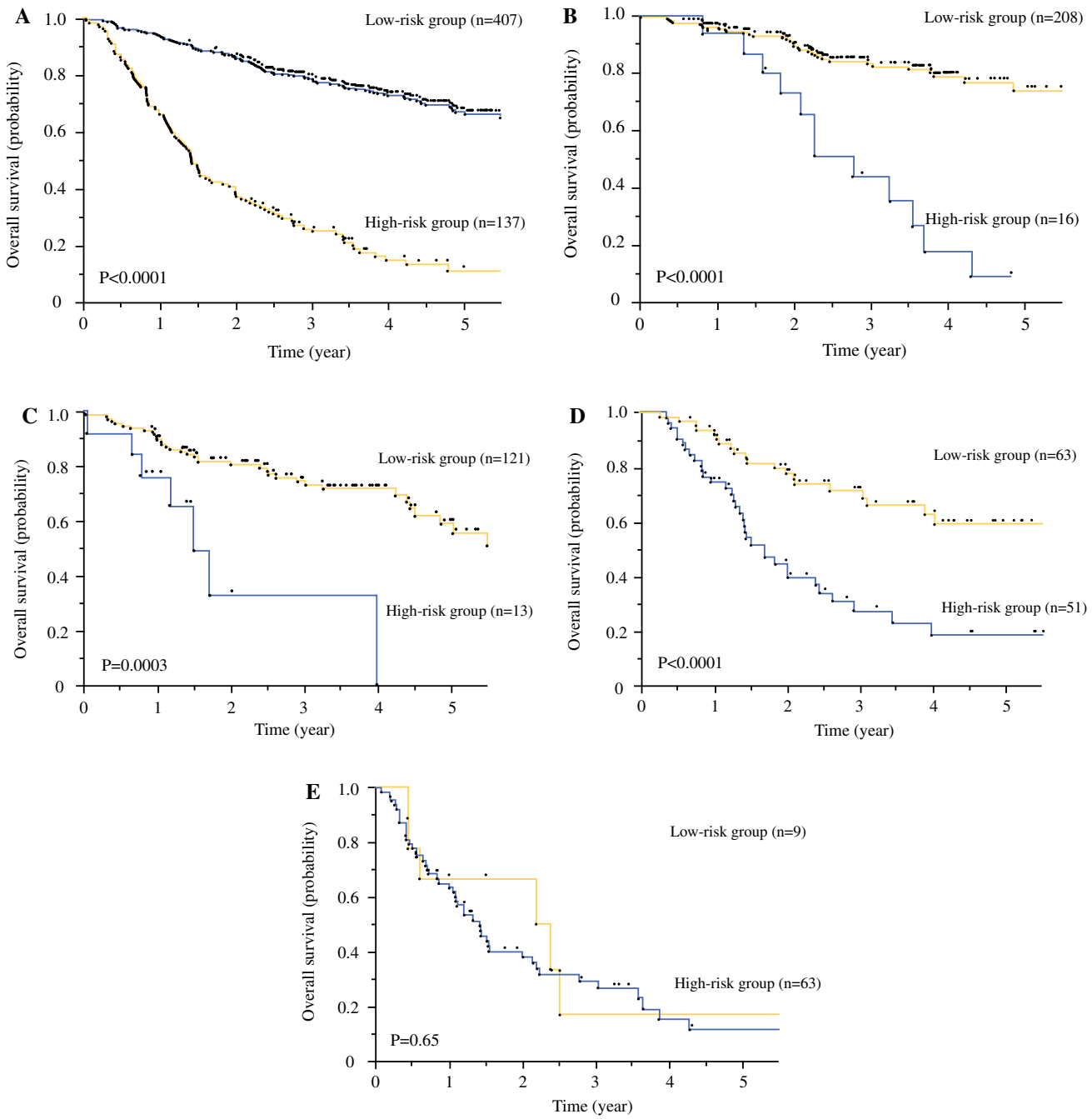

FIG. 2 Overall survival curves for patients with gastrointestinal cancer classified according to the GPSS in established cohort. **A** All stages, **B** cStage 1, **C** cStage 2, **D** cStage 3, **E** cStage 4

DISCUSSION

We investigated whether a preoperative geriatric assessment could enable us to predict the postoperative prognosis for elderly patients with gastrointestinal cancer. The GA as well as cancer type, stage, age, and so on were independent prognostic factors in the multivariate analysis of OS for elderly patients undergoing curative resection for gastrointestinal cancer.

In this study, we evaluated overall survival as the end point for the usefulness of GA and GPSS, but we examined the cause of death. The rate of death from cancer for the patients with each GA score was 21% (53/254 patients) for the patients regarded as robust, 23% (41/177 patients) for those considered pre-frail, and 27% (30/113 patients) for those considered frail. On the other hand, the rate of death from another cause for the patients with each GA score was 8% (21/254) for the patients considered robust, 15% (26/

TABLE 3 Patient characteristics in the independent cohort

Age (years)		79.1 ± 3.1	%
Sex	Male	117	70.5
	Female	49	29.5
PS	0	139	83.7
	1	23	13.9
	2	4	2.4
	3	0	0.0
	4	0	0.0
BMI (kg/m^2)	<18.5	29	17.4
	18.5–25	120	72.2
	≥25	17	10.2
Site of primary tumor	Esophageal site	29	17.5
	Gastric/duodenal site	38	22.9
	Colorectal site	57	34.3
	Hapatic site	13	7.8
	Biliopancreatic site	29	17.5
Clinical stage	1	71	42.8
	2	37	22.3
	3	49	29.5
	4	9	5.4
ADL	≤ 80	4	2.4
	> 80	162	97.6
IADL	Male < 5; female < 8	43	25.9
	Male 5; female 8	123	74.1
MMSE	< 24	84	50.6
	≥ 24	82	49.4
GDS	< 6	136	81.9
	≥ 6	30	18.1
VI	< 10	12	7.2
	10	154	92.8
CGA cumulative index	Robust	32	19.3
	Pre-frail	98	59.0
	Frail	36	21.7

PS, performance status; BMI, body mass index; ADL, activities of daily living; IADL, instrumental activities of daily living; MMSE, Mini-Mental State Examination; GDS, Geriatric Depression Score; VI, Vitality Index; CGA, comprehensive geriatric assessment

177) for those considered pre-frail, and 24% (27/113) for those considered frail. The poorer the GA score, the worse was the rate of death from another cause.

The impact of the GA score on overall survival might have been due to geriatric-related death rather than cancer death. The results suggest that the GA is a multidisciplinary evaluation tool that can add to the definition of frailty in elderly patients and should be incorporated to help guide treatment decisions.

Surgeons and oncologists have been skeptical of GAs because they have regarded performing GAs as a time-consuming task. In this study, the approximate time needed to perform the GA test by the geriatrician was 30 min. However, some studies report that a systematic GA is superior to physicians' clinical judgment in identifying frailty.[20–22] Although performing the GA test certainly was a time-consuming task, it was not so complicated that it must be administered only by geriatricians. The GA can be performed not only by physician, but also by nurses and patients' self-report.[20] Thus, education and awareness about applying the GA to routine clinical practice may enable us to identify patients with unrecognized vulnerability, to prevent undertreatment and harmful overtreatment, and to provide adequate intense treatment.

In this study, we developed a GPSS that integrates these factors, including a GA, to predict OS after surgery for elderly patients with gastrointestinal cancer. It was possible to stratify the postoperative prognosis according to GPS. Furthermore, the GPSS was validated as useful for prognostic predictions in an independent cohort.

According to our results, the GPSS could be very useful in predicting postoperative OS for these patients. Our findings indicate that surgery should be offered to elderly patients, even to the oldest old, as a curative treatment when they are considered fit by the GPSS. In addition, surgical indications for patients in the high-risk GPSS group should be carefully determined, even if they received their diagnosis at an early stage of cancer.

This study had several limitations. The study comprised a single-center cohort. Some selection bias could not be avoided because our hospital is a large academic center. Some of the patients had already been referred by their primary care physician and had undergone a preoperative surgical evaluation. Thus, the patients in this study may be not representative of the general population. However, the GA and GPS had discriminative power with respect to postoperative survival despite this selection bias. Further studies with larger and more widespread populations at multiple centers (both nonreferral and referral centers) are needed to validate the utility of the GPSS for elderly patients with gastrointestinal cancer. In addition, the GPSS should be investigated with elderly patients who have other types of cancer.

In conclusion, the current study suggests that GA and nutrition status as well as cancer type and stage are closely associated with postoperative survival for patients with gastrointestinal cancer. The current prognostic model (i.e., the GPSS) may provide indications for treatment strategies for elderly patients with gastrointestinal cancer. However, the predictive ability of the GPSS for postoperative survival should be prospectively validated with a larger number of patients.

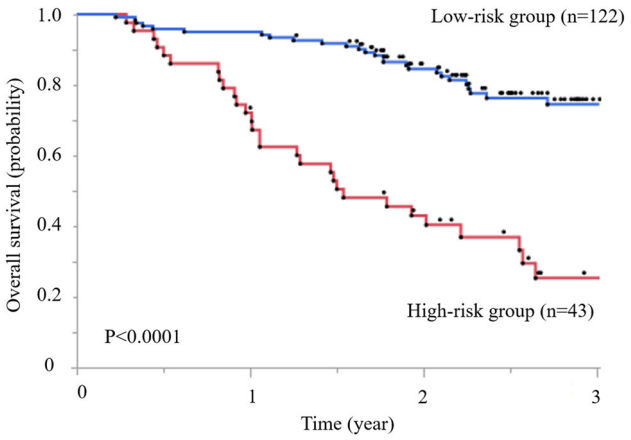

FIG. 3 Overall survival curves for patients with gastrointestinal cancer classified according to the GPSS in independent cohort

REFERENCES

1. Brugel L, Laurent M, Caillet P, et al. Impact of comprehensive geriatric assessment on survival, function, and nutritional status in elderly patients with head and neck cancer: protocol for a multicentre randomised controlled trial (EGeSOR). *BMC Cancer.* 2014;14:427.
2. Hosking MP, Warner MA, Lobdell CM, et al. Outcomes of surgery in patients 90 years of age and older. *JAMA.* 1989;261:1909–15.
3. Turrentine FE, Wang H, Simpson VB, et al. Surgical risk factors, morbidity, and mortality in elderly patients. *J Am Coll Surg.* 2006;203:865–77.
4. Ramesh HS, Jain S, Audisio RA. Implications of aging in surgical oncology. *Cancer J.* 2005;11:488–94.
5. Epstein AM, Hall JA, Besdine R, et al. The emergence of geriatric assessment units: the "new technology of geriatrics". *Ann Intern Med.* 1987;106:299–303.
6. Stuck AE, Siu AL, Wieland GD, et al. Comprehensive geriatric assessment: a meta-analysis of controlled trials. *Lancet.* 1993;342:1032–6.
7. Maione P, Perrone F, Gallo C, et al. Pretreatment quality of life and functional status assessment significantly predict survival of elderly patients with advanced non-small cell lung cancer receiving chemotherapy: a prognostic analysis of the multicenter Italian lung cancer in the elderly study. *J Clin Oncol.* 2005;23:6865–72.
8. Freyer G, Geay JF, Touzet S, et al. Comprehensive geriatric assessment predicts tolerance to chemotherapy and survival in elderly patients with advanced ovarian carcinoma: a GINECO study. *Ann Oncol.* 2005;16:1795–800.
9. Fukuse T, Satoda N, Hijiya K, et al. Importance of a comprehensive geriatric assessment in prediction of complications following thoracic surgery in elderly patients. *Chest.* 2005;127:886–91.
10. Dale W, Hemmerich J, Kamm A, et al. Geriatric assessment improves prediction of surgical outcomes in older adults undergoing pancreaticoduodenectomy: a prospective cohort study. *Ann Surg.* 2014;259:960–5.
11. Maekawa T, Sugimoto K, Yamasaki M, et al. Comprehensive geriatric assessment is a useful predictive tool for the duration of postoperative delirium after gastrointestinal surgery in old-old adults. *Geriatr Gerontol Int.* 2016;16:1036–42.
12. Yamamoto M, Yamasaki M, Sugimoto K, et al. Risk evaluation of postoperative delirium using comprehensive geriatric assessment in elderly patients with esophageal cancer. *World J Surg.* 2016;40:2705–12.
13. Giantin V, Valentini E, Iasevoli M, et al. Does the Multidimensional Prognostic Index (MPI), based on a Comprehensive Geriatric Assessment (CGA), predict mortality in cancer patients? Results of a prospective observational trial. *J Geriatr Oncol.* 2013;4:208–17.
14. Soubeyran P, Fonck M, Blanc-Bisson C, et al. Predictors of early death risk in older patients treated with first-line chemotherapy for cancer. *J Clin Oncol.* 2012;30:1829–34.
15. Girones R, Torregrosa D, Gomez-Codina J, et al. Prognostic impact of comorbidity in elderly lung cancer patients: use and comparison of two scores. *Lung Cancer.* 2011;72:108–13.
16. Aaldriks AA, Giltay EJ, le Cessie S, et al. Prognostic value of geriatric assessment in older patients with advanced breast cancer receiving chemotherapy. *Breast.* 2013;22:753–60.
17. Kanesvaran R, Li H, Koo KN, et al. Analysis of prognostic factors of comprehensive geriatric assessment and development of a clinical scoring system in elderly Asian patients with cancer. *J Clin Oncol.* 2011;29:3620–7.
18. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state." A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12:189–98.
19. Moons KG, Harrell FE, Steyerberg EW. Should scoring rules be based on odds ratios or regression coefficients? *J Clin Epidemiol.* 2002;55:1054–5.
20. Kirkhus L, Benth JS, Rostoft S, et al. Geriatric assessment is superior to oncologist' clinical judgement in identifying frailty. *Br J Cancer.* 2017;117:470–77.
21. Tucci A, Ferrari S, Bottelli C, Borlenghi E, Drera M, Rossi G. A comprehensive geriatric assessment is more effective than clinical judgment to identify elderly diffuse large cell lymphoma patients who benefit from aggressive therapy. *Cancer.* 2009;115:4547–53.
22. Wedding U, Kodding D, Pientka L, Steinmetz HT, Schmitz S. Physicians' judgment and comprehensive geriatric assessment (CGA) select different patients as fit for chemotherapy. *Crit Rev Oncol Hematol.* 2007;64:1–9.