Original Article

Survival analysis of gastric malignancy patients: identifying key prognostic factors

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Background: Gastric malignancies are common worldwide, with a high incidence rate and mortality. Relevant studies are needed to further demonstrate the harmfulness of gastric malignancies to promote awareness of its prevention. The aim of the study was to analyze the clinicopathological features and prognosis of gastric malignancies.

Methods: The Surveillance, Epidemiology, and End Results (SEER) database was used to obtain the clinical data of 122,793 patients diagnosed with gastric malignancies from 2000 to 2019. Along with performing univariate and multivariate analyses, the associated survival rates of each variable were analyzed using SPSS software. Columnar line graph prediction models were developed and validated using R software.

Results: In total, 122,793 gastric malignancy patients were included in this study, including 74,303 males (60.5%) and 48,490 females (39.5%). The predominant age group among patients was 60–74 years, comprising a total of 45,603 individuals (37.1%). The follow-up time was 0–239 months, the median follow-up time was 11.7 months, and 91,869 patients (74.8%) died. Gastric adenocarcinoma was the main pathological type, accounting for 96,259 patients (82.7%). The main disease site was the cardia of the stomach, accounting for 34,019 patients (34.0%); most (109,706; 89.3%) patients lived in cities. Univariate and multivariate analyses showed that gender, age, tumor size, tumor location, American Joint Committee on Cancer (AJCC) stage, pathological type, rural/urban, and treatment were independent risk factors for prognosis ($P<0.001$). The Concordance index (C-index) of the nomogram prognostic model was 0.763±0.002, and the areas under the receiver operating characteristic (ROC) curve (AUC) of the 1-, 3-, and 5-year survival rates were 0.76, 0.79, and 0.79, respectively. The calibration curve showed that the predicted survival rate of the nomogram was in good agreement with the observed survival rate.

Conclusions: The prognosis for tumors located in the greater curvature of the stomach is relatively favorable. The level of care available in a patient's city is directly correlated with their prognosis. Notably, the outcomes for gastric stromal tumors (GSTs) and gastric neuroendocrine neoplasms (G-NENs) are significantly more favorable compared to other pathological types. Patients who meet surgical criteria should undergo surgery as early as possible to enhance survival duration.

Keywords: Gastric malignancies; prognosis; survival; gastric neuroendocrine neoplasms (G-NENs); greater curvature

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Introduction

Gastric malignancies include gastric carcinomas (GCs), gastric stromal tumors (GSTs), and gastric neuroendocrine neoplasms (G-NENs), the most common of which are GCs. According to the histopathological classification of GCs, they can be divided into adenocarcinoma, adenosquamous carcinoma, squamous carcinoma, and so on. Gastric adenocarcinoma is the most common, representing approximately 90% of cases (1). Most patients with early gastric malignancies have no clinical symptoms, which makes it difficult to diagnose gastric malignancies clinically. Usually, when the tumor grows to a certain extent, patients will have pain and discomfort in the epigastric region, poor appetite, bleeding, anemia, emaciation, and even cachexia. Most of the patients are diagnosed via their physical examination and with gastroscopy, and most of them have local or distant metastasis at the time of diagnosis, which has a poor prognosis.

Worldwide, approximately 990,000 patients are diagnosed with GCs every year, accounting for 6.8% of the total number of new cancer cases each year; among them, approximately 738,000 people die of GC, accounting for 8.8% of the total number of cancer deaths (2-4). GCs have become the fourth most common cancer and the second most common cause of cancer deaths (5). Due to the continuous development of the gastroscopy technology and pathology, the incidence of G-NENs is approximately 0.4 cases per 100,000 individuals, representing 6.5% of all gastric malignancies. Notably, there has been a 15-fold increase in the incidence of G-NENs from 1973 to 2012 when compared to other primary neuroendocrine neoplasms (NENs) (6). The incidence rate of gastrointestinal stromal tumors is 2/100,000, among which GST accounts for 50–70%. From 2001 to 2015, the incidence rate of GST rapidly increased (7).

At present, it is difficult to have an overall understanding of GCs, G-NENs, GSTs and other malignancies within China and internationally. By studying the clinical and pathological features of malignant gastric tumors, it is possible to identify the basic characteristics of different types of gastric cancer, such as the morphology of the tumor, the histological type, and the degree of differentiation. This helps to improve the understanding and diagnostic accuracy of the disease. Understanding the clinicopathological features associated with the prognosis of gastric cancer can help doctors assess the survival rate and prognosis of patients and develop personalized treatment plans accordingly. Studying the results of clinicopathologic features can provide clinical data to support basic research, which in turn can promote the development of new treatments and drugs. We present this article in accordance with the TRIPOD reporting checklist (available at https://tcr.amegroups.com/article/view/10.21037/tcr-24-1285/rc).

Highlight box

Key findings

- Among gastric malignancies, tumors located in the greater curvature of the stomach are associated with a relatively good prognosis. Gastric mesenchymal tumors and gastric neuroendocrine neoplasms (G-NENs) have a significantly better prognosis than other pathologic types.

What is known and what is new?

- Gastric adenocarcinoma accounts for approximately 90% of all gastric malignancies. Rare G-NENs are gradually being recognized by the public and have become an important part of gastric malignancies. Studies have found that compared with gastric adenocarcinoma, gastric squamous cell carcinoma is more aggressive and has a worse prognosis.
- In this study, we found that patients with tumor sizes greater than 5 cm had a worse prognosis (P<0.001). This study found that patients with tumors located in the greater curvature of the stomach had the longest median survival time (MST) (26 months), with an overall survival (OS) rate of 37% at 5 years. The MST of the lesions in the anterior and posterior wall of the stomach was the shortest (8 months), and the OS rate was 16% at 5 years.

What is the implication, and what should change now?

- The results of this study provide clinical data support for the diagnosis and treatment of gastric malignancies and the prediction of the OS rate. Future health policy initiatives should take regional differences into consideration and should focus on the equitable distribution of medical resources to improve the gap between rural and urban areas.

Methods

Patients

We conducted a retrospective cohort study using the Surveillance, Epidemiology, and End Results (SEER) database. Patient information was obtained through SEER*Stat (version 8.4.0) software (National Cancer Institute, Bethesda, MD, USA). The information of all patients diagnosed with gastric malignancies from 2000 to 2019 was downloaded from the database, and the patient's age, sex, tumor morphology, tumor site, diagnosis to treatment time, tumor size, American Joint Committee on Cancer (AJCC) stage, histopathology, treatment method, rural/urban environment, survival time, survival status, and cause of death were extracted. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Study eligibility

The inclusion criteria were as follows: (I) the diagnosis year was from 2000 to 2019; (II) the pathological diagnosis was gastric malignancy; (III) the patient's information was relatively complete. The exclusion criteria were as follows: (I) the stomach was not the primary cancer site (for example, cases of gastric lymphoma); (II) the diagnosis was benign gastric tumors; (III) the patient refused to undergo regular follow ups.

The age classification standard was based on the latest regulations issued by the World Health Organization (WHO) in 2021: those under 45 years of age are young people; those between 45 and 59 years of age are middle aged people; those between 60 and 74 years of age are older people; and those over 74 years of age are elderly individuals. The tumor site was divided into the cardia, fundus, body, greater curvature, lesser curvature, antrum, pylorus, and anterior and posterior walls. For the pathological type, the WHO Digestive System Tumor Classification System [2019] was utilized (8). According to the main pathological types of the patients in this study, cases were divided into adenocarcinomas, squamous cell carcinomas, adenosquamous carcinomas, neuroendocrine neoplasms, stromal tumors, and other types. The AJCC 8th edition was used as the standard for tumor staging (9) (IA–IV). The following criteria were used for dividing urban and rural areas: counties in metropolitan areas with a population of 1 million or more; counties in metropolitan areas of 250,000 to 1 million; counties in metropolitan areas with a population of less than 250,000; nonmetropolitan counties adjacent to a metropolitan area; nonmetropolitan counties not adjacent to a metropolitan area. The total survival period was from the recorded date of diagnosis to the date of the last follow-up or death. In the survival analysis of this study, the end point is defined as death.

Statistical analysis

The data analysis was completed using SPSS 25.0 software (IBM Corp., Armonk, NY, USA). The measurement data were expressed as the mean ± standard deviation (SD), the follow-up time was expressed as the median (minimum–maximum), and the counting data were expressed as the number of cases (percentage). The life table method was used to calculate the median survival time (MST) and overall survival (OS) of each variable. The Kaplan-Meier method was used to draw the survival curve for survival analysis, and the log-rank test was used to evaluate the difference in each variable. A Cox regression model was used for multivariate analysis, and the evaluation indexes were hazard ratio (HR) and 95% confidence interval (CI).

Using the "rms" package of R software and the "nomogram" function, a nomogram was constructed to predict the 1-, 3-, and 5-year OS rates of gastric malignancies. The diversity of gastric malignancies leads to different prognoses. According to the prediction model, the scores corresponding to different clinical and pathological patient characteristics can be obtained, and the total scores can be used to predict the overall patient survival rate. The Concordance index (C-index), receiver operating characteristic (ROC) curve, and calibration curve were used to verify the prediction ability of the model. A P value <0.05 indicated that the difference is statistically significant. Missing or unknown data in some variables were treated as deleted data.

Results

Among 122,793 patients with gastric malignancies, 74,303 were male (60.5%), and 48,490 were female (39.5%); 89,157 patients (72.6%) were over 60 years of age; 31,754 patients (36.2%) had a diagnosis and treatment interval of ≤1 month; 56,061 patients (63.8%) had a diagnosis and treatment interval of >1 month; and 76,563 patients (62.5%) were mainly from metropolitan counties with a population of more than 1 million (*Table 1*).

Table 1 Clinicopathological characteristics of 122,793 patients with gastric malignancies and univariate analysis

Classification	N (%)	P value
Age (years)		<0.001
0–44	7,990 (6.5)	
45–59	25,646 (20.9)	
60–74	45,603 (37.1)	
≥75	43,554 (35.5)	
Gender		<0.001
Male	74,303 (60.5)	
Female	48,490 (39.5)	
Diagnosis to treatment (months)		0.73
≤1	31,754 (36.2)	
>1	56,061 (63.8)	
NR	34,978	
Tumor size (cm)		<0.001
0–5	25,964 (61.4)	
>5	16,293 (38.6)	
NR	80,536	
Primary site		<0.001
Cardia	34,019 (34.0)	
Fundus	6,042 (6.0)	
Gastric body	12,570 (12.6)	
Gastric antrum	21,238 (21.2)	
Pylorus	3,116 (3.1)	
Gastric lesser curvature	9,234 (9.2)	
Gastric greater curvature	5,275 (5.3)	
Anterior/posterior wall	8,593 (8.6)	
NR	22,706	
AJCC stage		<0.001
IA	6,066 (18.6)	
IB	2,973 (9.1)	
IIA	3,280 (10.0)	
IIB	3,146 (9.6)	
IIIA	1,693 (5.2)	
IIIB	1,967 (6.0)	
IIIC	1,115 (3.4)	
IV	12,419 (38.0)	
NR	90,134	
Pathology		<0.001
Adenocarcinoma	96,259 (82.7)	
Squamous carcinoma	991 (0.9)	
Adenosquamous carcinoma	2,092 (1.8)	
Neuroendocrine tumors	8,096 (7.0)	
Mesenchymal tumor	7,922 (6.8)	
Other	1,065 (0.9)	
NR	6,368	
Rural/urban		<0.001
1	76,563 (62.5)	
2	24,535 (20.0)	
3	8,608 (7.0)	
4	7,462 (6.1)	
5	5,273 (4.3)	
NR	352	
Treatment		<0.001
Surgery	31,494 (35.9)	
Chemotherapy	19,220 (21.9)	
Radiotherapy	3,282 (3.7)	
Surgery + chemotherapy	11,012 (12.6)	
Chemotherapy + radiotherapy	8,698 (9.9)	
Surgery + radiotherapy	1,168 (1.3)	
S + C + R	12,740 (14.5)	
NR	35,179	

AJCC stage: the American Joint Committee on Cancer 8th edition was the standard for tumor staging (IA–IV). Rural/urban: 1, counties in metropolitan areas with a population of 1 million or more; 2, counties in metropolitan areas of 250,000 to 1 million; 3, counties in metropolitan areas with a population of less than 250,000; 4, nonmetropolitan counties adjacent to a metropolitan area; 5, nonmetropolitan counties not adjacent to a metropolitan area. NR, not reported; S + C + R, surgery + chemotherapy + radiotherapy.

For the AJCC staging of tumors, stage IV was the most common stage, with 12,419 cases (38.0%); most lesions (25,964, 61.4%) were ≤5 cm in size; and in terms of tumor size, the proportion of tumors larger than 5 cm in GST (23.9%) was much higher than in GC and G-NEN (4.56% and 1.9%). The tumors were mainly located in

the cardia: 34,019 (34.0%). The main pathological type was adenocarcinoma, with 96,259 cases (82.7%), followed by neuroendocrine tumors in 8,096 cases (7.0%) and mesenchymal tumors in 7,922 cases (6.8%) (*Table 1*). The main treatment methods were surgical treatment in 31,494 patients (35.9%), chemotherapy in 19,220 patients (21.9%), surgery, chemotherapy, and radiotherapy in 12,740 patients (14.5%), surgery plus chemotherapy in 11,012 patients (12.6%), and chemotherapy plus radiotherapy in 8,698 patients (9.9%). By 2019, 91,869 (74.8%) of the 122,793 patients had died. The median follow-up time was 11.7 months (0–239 months). The MST of the patients with gastric malignancies was 13.7 months, and the OS rates at 1-, 3-, and 5-year were 38%, 28%, and 23%, respectively. In this study, patients with G-NENs and GSTs had the best prognosis, with MST of 140 and 130 months and 1-, 3-, and 5-year OS of 80% and 88%; 71% and 78%; and 65% and 69%, respectively.

Patients with GCs were predominantly male, 60,841 cases (63.2%); patients with G-NENs and GSTs were predominantly female, with 4,789 cases (59.2%) and 3,963 cases (50.3%), respectively. GCs had a higher probability of distant metastasis, which was observed in 10,704 cases (36.4%). G-NENs and GSTs had a lower probability of distant metastasis, which was observed in 321 cases (11.5%) and 401 cases (14.0%), respectively. The site of GCs was mainly dominated by the cardia (30,124 cases/36.8%). The site of G-NENs was mainly in the gastric body (2,162 cases/38.3%). The site of GSTs was mainly in the fundus (1,230 cases/22.6%).

Univariate analysis using the Kaplan-Meier method showed that gender, age, tumor size, tumor site, AJCC stage, rural/urban setting, pathology, and treatment were prognostic factors for gastric malignancy patients (log rank test P<0.001), but there was no significant difference between diagnosis and treatment (log-rank test P=0.73, *Table 1* and *Figure 1*).

A multivariate Cox regression model was used to analyze gender, tumor size, tumor site, AJCC stage, pathology, rural/urban setting, and treatment as prognostic factors and independent risk factors (P<0.001) (*Figure 2*). The 1-, 3-, and 5-year OS of each variable of gastric malignancy patients was obtained by the life table method (*Table 2*).

Based on the results of the multivariate Cox regression analysis, the nomogram included 8 variables with statistical significance in the construction of the nomogram prediction model for patients with gastric malignancies. According to the nomogram, the scores corresponding to different clinicopathological characteristics of the patient can be obtained, and the total scores obtained can be used to predict the OS of the patient at 1-, 3-, and 5-year (*Figure 3*). The C-index of the model was 0.763±0.002 after 1,000 self-service resampling verifications using the bootstrap method. ROC curve analysis was used to further evaluate the differentiation of the model, and the area under the curve (AUC) of the patients with OS rates at 1, 3, and 5 years were predicted to be 0.76, 0.79, and 0.79, respectively. All calibration curves and ROC curves indicated that the predicted OS of the nomogram had a good fit with the actual OS, indicating that the prognostic evaluation model had good calibration (*Figure 4*).

Discussion

The available statistics of the WHO show that gastric malignancies have caused a huge economic burden worldwide. Gastric adenocarcinoma accounts for approximately 90% of all gastric malignancies (10), and shows unique regional differences. The incidence rate of Asian countries is high, whereas that of European and American countries is low (11,12). The number of global GSTs and G-NENs is growing rapidly (6,13,14). Rare G-NENs are gradually being recognized by the public and have become an important part of gastric malignancies. Among the 116,425 patients with a known pathological classification in this study, G-NENs accounted for 7.0% and GST accounted for 6.8%.

One study showed that the incidence rate of GCs in men is approximately twice that in women, and that women have a better prognosis (15). In a study by Song *et al.* (16) there were 189,853 males and 90,902 females with GC. The prognosis of the female patients was better than that of the male patients. A total of 707 patients with gastrointestinal stromal tumors were recorded in an Italian region, 402 of whom were male and 305 of whom were female, and the women had a better prognosis (17). In this study, there were significantly more male patients (60.5%) than female patients (39.5%), and sex was an independent risk factor for prognosis. Song *et al.* (18) analyzed 10,092 GC patients. When the 50–59 years old group was used as the reference group, there was no significant difference between the 0–50 years old and older than 50 years groups. There is an increased risk of death in GC patients over 60 years of age (HR: 1.11), and the risk of death reaches a peak when patients are older than 80 years of age (HR: 1.60). Ren *et al.* (19) studied 4,596 GC patients, and the results showed

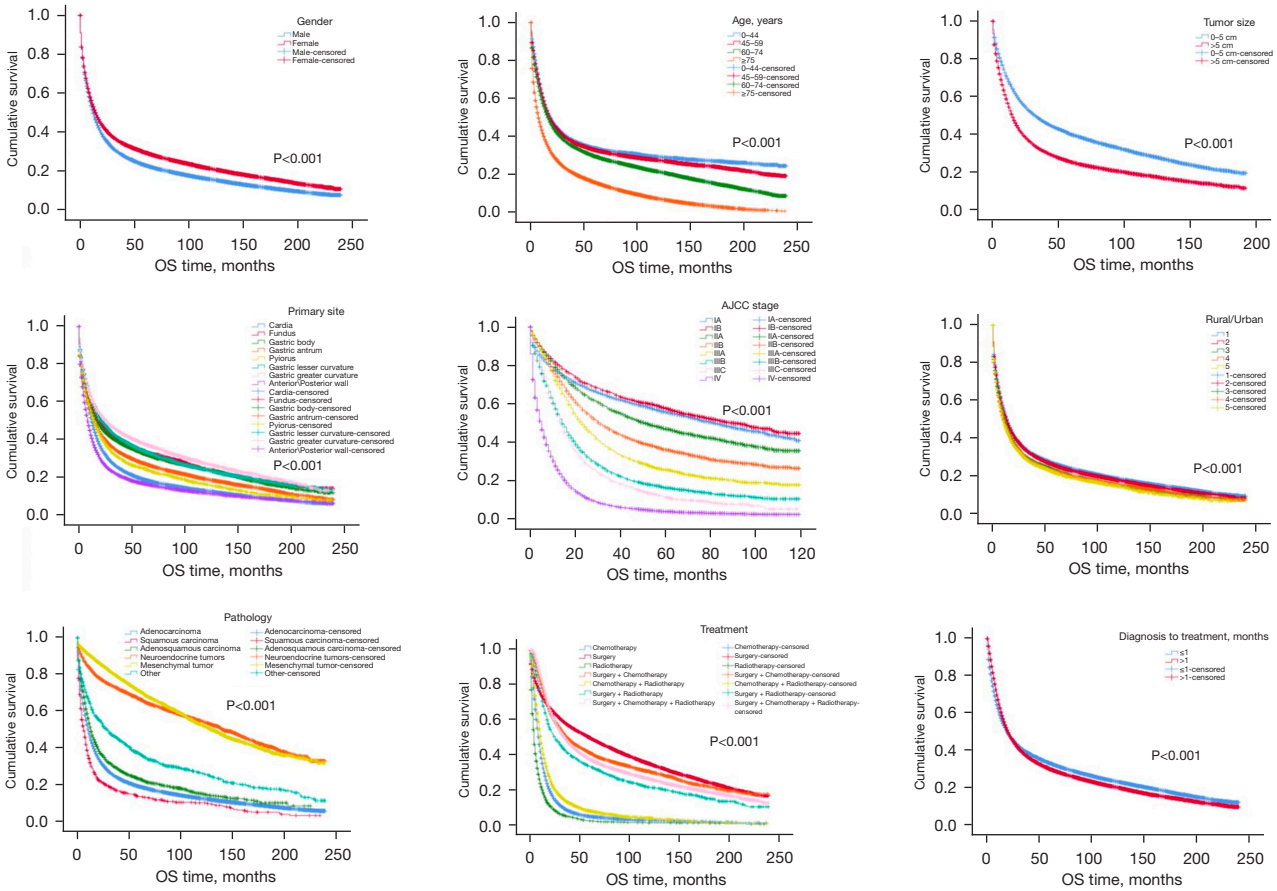

Figure 1 Kaplan-Meier univariate analysis. Rural/urban: 1, counties in metropolitan areas with a population of 1 million or more; 2, counties in metropolitan areas with a population of 250,000 to 1 million; 3, counties in metropolitan areas with a population of less than 250,000; 4, nonmetropolitan counties adjacent to a metropolitan area; 5, nonmetropolitan counties not adjacent to a metropolitan area. AJCC, American Joint Committee on Cancer; OS, overall survival.

that the survival rates of patients older than 74 years were worse than those younger than 45 years of age (HR: 1.84). This study found that the risk increased with age for patients over 59 years of age. Due to the patient and hospital factors and other factors, the interval between making a definite diagnosis of cancer and treatment may be prolonged (20,21). The impact of a delayed treatment on the survival of cancer patients is controversial. Okuno *et al.* (22) studied 332 patients with GCs and found no significant difference in the total OS of patients for whom treatment was delayed. Matsuzaka *et al.* (23) found that there was no significant difference in the prognosis of patients with gastric malignancies after delayed treatment, but it was suggested that patients with a confirmed diagnosis should be treated as early as possible to avoid tumor progression.

Park *et al.* (24) study showed that the prognosis of patients with GCs with lesions >4 cm is worse than that of patients with lesions ≤4 cm. Wang *et al.* (25) studied tumor size of 4.8 cm as a prognostic factor for patients with advanced GCs. In this study, we found that patients with tumor sizes greater than 5 cm had a worse prognosis (P<0.001). In this study, it was found that the main site of gastric malignancies was the cardia, which was consistent with the results of many studies conducted within China and internationally (26,27). The effect of the primary site on prognosis and survival is still controversial. The patients with primary gastric tumors at the greater curvature had better OS than those who had tumors in the gastroesophageal junction, antrum, and lesser curvature (P<0.05), and tumors of the gastric cardia had the worst OS (28). Jung *et al.* (29) found that tumors located in the greater curvature of the stomach had the worst OS,

Parameter	HR [95% CI]	P
Gender		
Male	1	
Female	0.899 [0.682–0.938]	<0.001
Age (years)		
0–44	1	
45–59	1.028 [0.936–1.128]	0.07
60–74	1.189 [1.088–1.300]	<0.001
≥75	1.728 [1.577–1.894]	<0.001
Tumor size (cm)		
0–5	1	
>5	1.172 [1.076–1.275]	<0.001
Primary site		
Cardia	1	
Fundus	0.903 [0.818–0.997]	0.76
Gastric body	0.840 [0.782–0.903]	<0.001
Gastric antrum	0.856 [0.808–0.907]	<0.001
Pylorus	0.935 [0.831–1.052]	0.06
Gastric lesser curvature	0.817 [0.760–0.878]	<0.001
Gastric greater curvature	0.859 [0.781–0.945]	<0.01
Anterior/posterior wall	1.005 [0.931–1.084]	0.06
AJCC stage		
IA	1	
IB	1.505 [1.370–1.655]	<0.001
IIA	2.092 [1.919–2.282]	<0.001
IIB	2.815 [2.581–3.072]	<0.001
IIIA	3.989 [3.633–4.381]	<0.001
IIIB	4.862 [4.432–5.334]	<0.001
IIIC	6.673 [6.121–7.275]	<0.001
IV	7.040 [6.363–7.790]	<0.001
Pathology		
Adenocarcinoma	1	
Squamous carcinoma	0.953 [0.784–1.158]	0.23
Adenosquamous carcinoma	1.003 [0.900–1.118]	0.08
Neuroendocrine tumors	0.578 [0.513–0.651]	<0.001
Mesenchymal tumor	0.297 [0.267–0.329]	<0.001
Other	0.685 [0.545–0.861]	0.02
Rural/urban		
1	1	
2	1.088 [1.036–1.142]	0.03
3	1.261 [1.166–1.362]	<0.001
4	1.273 [1.171–1.385]	<0.001
5	1.292 [1.174–1.423]	<0.001
Treatment		
Chemotherapy	1	
Surgery	0.673 [0.624–0.726]	<0.001
Radiotherapy	2.246 [2.000–2.524]	<0.001
Surgery + chemotherapy	0.448 [0.414–0.484]	<0.001
Chemotherapy + radiotherapy	0.966 [0.896–1.041]	0.08
Surgery + radiotherapy	0.518 [0.437–0.613]	<0.001
S + C + R	0.421 [0.389–0.455]	<0.001

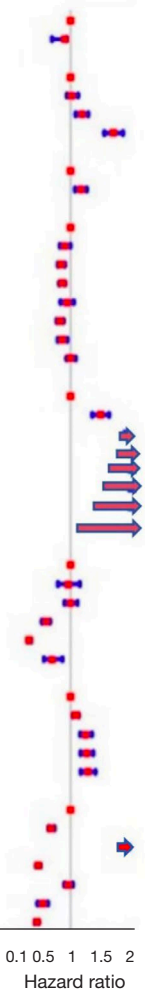

Figure 2 Multivariate Cox regression analysis of gastric malignancies. Rural/urban: 1, counties in metropolitan areas with a population of 1 million or more; 2, counties in metropolitan areas with a population of 250,000 to 1 million; 3, counties in metropolitan areas with a population of less than 250,000; 4, nonmetropolitan counties adjacent to a metropolitan area; 5, nonmetropolitan counties not adjacent to a metropolitan area. AJCC, American Joint Committee on Cancer; CI, confidence interval; HR, hazard ratio; S + C + R, surgery + chemotherapy + radiotherapy.

whereas those located in the anterior wall had the best prognosis (P=0.01). This study found that patients with tumors located in the greater curvature of the stomach had the longest MST (26 months), with an OS of 37% at 5 years. The MST of the lesions in the anterior and posterior wall of the stomach was the shortest (8 months), and the OS was 16% at 5 years (P<0.001). Studies on GCs, esophageal cancer, and oral cancer have shown no difference in the total survival time between rural and urban patients. This shows that there is not much difference in the medical security between urban and rural areas (30,31). Many studies have also shown that patients with GCs and esophageal cancer patients living in cities have better OS [urban *vs.* rural HR (95% CI), 0.44 (0.23–0.85)] (32,33). This study found that the prognosis of urban patients with gastric malignancies was better than that of those in remote areas (P<0.001). Future health policy initiatives should take regional differences into consideration and focus on the equitable distribution of medical resources to improve the gap between rural and urban areas.

Studies have found that compared with gastric adenocarcinoma, gastric squamous cell carcinoma is more

Table 2 Life table method to predict the survival of 122,793 patients with gastric malignancies for each variable

Classification	Median survival time (months) (95% CI)	1-year survival rate (%)	3-year survival rate (%)	5-year survival rate (%)
Gender				
Male	12 (11.799–12.201)	42	27	22
Female	14 (13.653–14.347)	46	33	28
Age (years)				
0–44	18 (16.892–19.108)	51	37	33
45–59	18 (17.465–18.535)	51	36	32
60–74	16 (15.628–16.372)	49	34	28
≥75	7 (6.804–7.196)	33	20	15
Diagnosis to treatment (months)				
≤1	19 (18.416–19.584)	52	38	32
>1	20 (19.633–20.364)	54	35	29
Tumor size (cm)				
0–5	32 (30.868–33.132)	56	40	33
>5	15 (14.546–15.454)	46	30	24
Primary site				
Cardia	12 (11.750–12.250)	41	24	18
Fundus	18 (16.399–19.601)	51	39	33
Gastric body	17 (16.094–17.906)	50	37	32
Gastric antrum	15 (14.494–15.506)	46	32	27
Pylorus	15 (13.814–16.186)	46	29	24
Gastric lesser curvature	22 (20.769–23.231)	55	39	33
Gastric greater curvature	26 (23.598–28.402)	56	43	37
Anterior/posterior wall	8 (7.618–8.382)	33	20	16
AJCC stage				
IA	82 (76.576–87.424)	73	62	54
IB	91 (82.061–99.939)	76	63	56
IIA	51 (46.354–55.646)	71	55	45
IIB	31 (28.745–33.255)	65	43	35
IIIA	23 (21.258–24.742)	60	33	24
IIIB	14 (13.025–14.975)	44	22	16
IIIC	14 (12.964–15.036)	41	18	10
IV	5 (4.814–5.186)	18	6	4

Table 2 (*continued*)

Table 2 (*continued*)

Classification	Median survival time (months) (95% CI)	1-year survival rate (%)	3-year survival rate (%)	5-year survival rate (%)
Pathology				
Adenocarcinoma	11 (10.853–11.147)	38	23	18
Squamous carcinoma	6 (5.068–6.932)	26	16	13
Adenosquamous carcinoma	13 (11.882–14.118)	43	28	22
Neuroendocrine tumors	140 (132.784–147.216)	80	71	65
Mesenchymal tumor	130 (123.949–136.051)	88	78	69
Other	29 (23.423–34.577)	57	44	35
Rural/urban				
1	14 (13.770–14.230)	45	31	25
2	13 (12.586–13.414)	44	30	24
3	11 (10.402–11.598)	41	27	22
4	11 (10.412–11.588)	40	26	21
5	10 (9.323–10.677)	39	26	21
Treatment				
Surgery	60 (58.041–61.959)	69	56	48
Chemotherapy	9 (8.836–9.164)	24	8	5
Radiotherapy	4 (3.772–4.228)	13	5	2
Surgery + chemotherapy	38 (36.124–39.876)	69	48	40
Chemotherapy + radiotherapy	11 (10.724–11.276)	32	12	8
Surgery + radiotherapy	25 (21.639–28.361)	60	40	32
S + C + R	35 (33.750–36.250)	71	46	36

AJCC stage: the American Joint Committee on Cancer 8th edition was the standard for tumor staging (IA–IV). Rural/urban: 1, counties in metropolitan areas with a population of 1 million or more; 2, counties in metropolitan areas with a population of 250,000 to 1 million; 3, counties in metropolitan areas with a population of less than 250,000; 4, nonmetropolitan counties adjacent to a metropolitan area; 5, nonmetropolitan counties not adjacent to a metropolitan area. CI, confidence interval; S + C + R, surgery + chemotherapy + radiotherapy.

aggressive and has a worse prognosis. It is speculated that the reason may be that gastric squamous cell carcinoma is mostly in an advanced stage at the time of diagnosis (34-36). This study found that the MST of gastric squamous cell carcinoma was the shortest, only 6 months, and the OS of 5 years was 13%. Since most gastrointestinal stromal tumors are low-grade malignant tumors, they have a high 5-year OS. A study conducted outside of China retrospectively analyzed 92 patients with gastrointestinal stromal tumors, reporting an MST of 36 months and an OS of 75% in 5 years (37). In this study, the MST of 7,922 patients with GST was 130 months, and the OS at 5 years was 69%. Tian *et al.* (38) retrospectively analyzed 506 patients with G-NENs, and the OS was 68.8% in 5 years. Hu *et al.* (39) showed that for patients with G-NENs, the MST exceeded 150 months, and the total OS rate was 81.1% in 5 years. Early G-NENs have weak invasiveness, a low malignancy rate, and a good prognosis, with an OS as high as 100% in 3 years (40). The results of the study showed that the 5-year survival rate for type I G-NENs was as high as 90–100%, whereas the 5-year survival rate for type III G-NENs was 70% (6). In this study, patients with G-NENs had the best prognosis, with an MST of 140 months and a 5-year OS of 65%.

This study showed that the early MST of GC patients

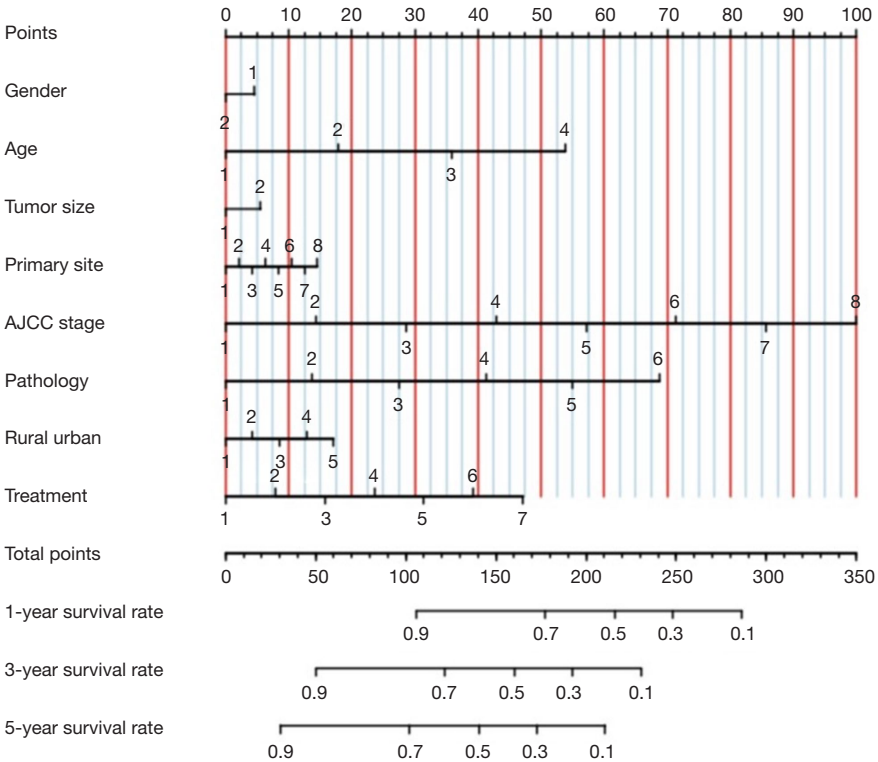

Figure 3 Nomogram for predicting 1-, 3-, and 5-year OS gastric malignancies. Gender: 1, male; 2, female. Age (years): 1, 0–44; 2, 45–59; 3, 60–74; 4, ≥75. Tumor size (cm): 1, 0–5; 2, >5. Primary site: 1, gastric greater curvature; 2, gastric lesser curvature; 3, fundus; 4, gastric body; 5, gastric antrum; 6, pylorus; 7, cardia; 8, anterior/posterior wall. AJCC stage: 1, IA; 2, IB; 3, IIA; 4, IIB; 5, IIIA; 6, IIIB; 7, IIIC; 8, IV. Pathology: 1, mesenchymal tumor; 2, neuroendocrine tumors; 3, other; 4, adenosquamous carcinoma; 5, adenocarcinoma; 6, squamous carcinoma. Rural/urban: 1, counties in metropolitan areas with a population of 1 million or more; 2, counties in metropolitan areas with a population of 250,000 to 1 million; 3, counties in metropolitan areas with a population of less than 250,000; 4, nonmetropolitan counties adjacent to a metropolitan area; 5, nonmetropolitan counties not adjacent to a metropolitan area. Treatment: 1, surgery; 2, surgery + chemotherapy; 3, surgery + chemotherapy + radiotherapy; 4, surgery + radiotherapy; 5, chemotherapy + radiotherapy; 6, chemotherapy; 7, radiotherapy. AJCC, American Joint Committee on Cancer; OS, overall survival.

was 98.53 months, the duration of local metastasis development was 29.7 months, and the duration of distant metastasis development was 6.21 months (P<0.001). The 5-year OS from IA to IV gradually decreased (89.6–14%) (41-43). This result is roughly consistent with the results of this study. Patients with early gastric malignancies can be cured by radical surgery. However, patients with late gastric malignancies are forced to choose to live with tumors due to the lack of surgical indications, and the prognosis is poor. It is still controversial whether patients with early gastric malignancies should receive adjuvant treatment after surgery. The CRITICS trial is the first trial to directly compare postoperative chemoradiotherapy and perioperative chemotherapy for patients with resectable GCs. This trial shows that compared with preoperative full chemotherapy and surgical radical treatment of GCs, postoperative chemoradiotherapy does not improve OS (44). For advanced GCs, radiotherapy and chemotherapy showed similar OS times compared with chemotherapy alone, with no significant difference (45). The ARTIST test showed that radiotherapy based on capecitabine/cisplatin chemotherapy after GC radical resection could not improve the 5 year OS (73% *vs.* 75%) (46). Yu *et al.* (47) showed that among 82 patients with locally advanced GCs undergoing radical surgery who were recruited, 39 received chemotherapy after surgery and 43 received radiotherapy and chemotherapy. After 6 cycles of treatment, it was found that the objective remission rate of the 2 groups was

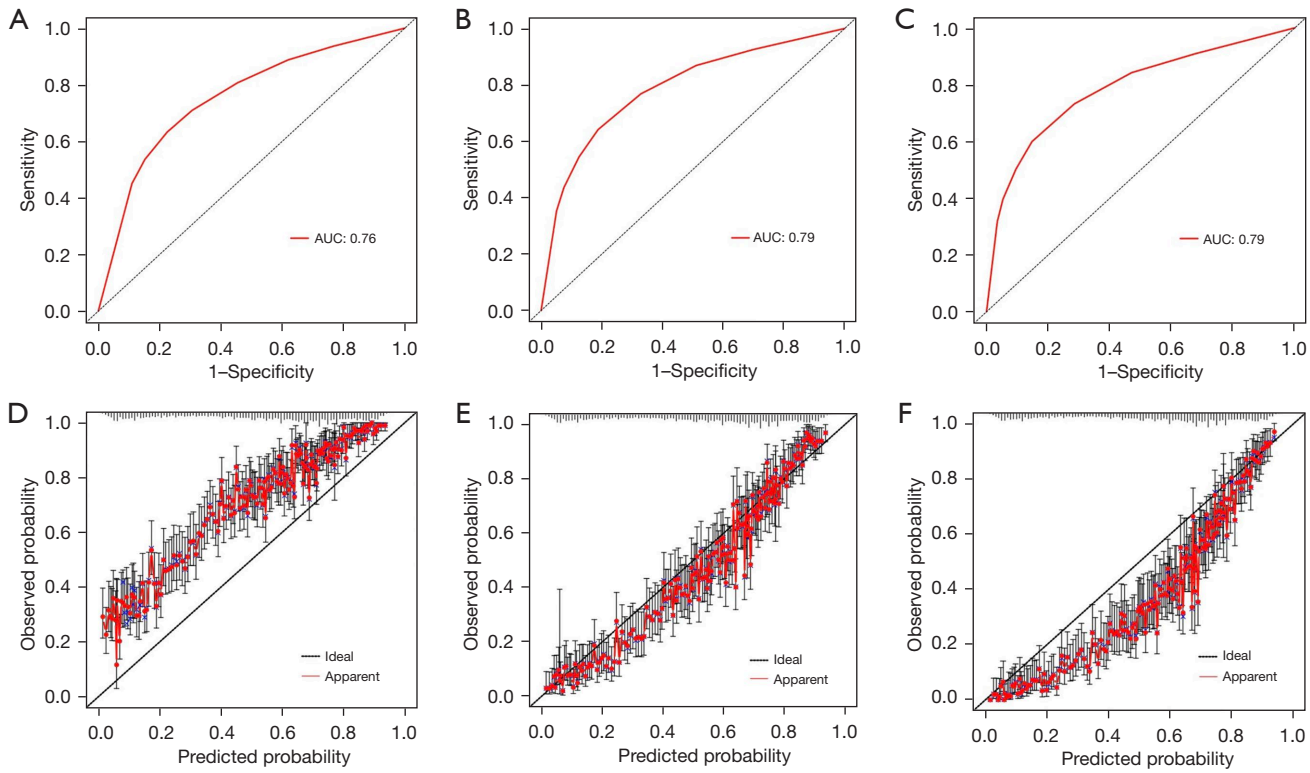

Figure 4 The closer the ROC curve is to the top left corner, the better the performance of the model. The closer the calibration curve is to the ideal line (45 degree line), the better the calibration of the model. (A-C) ROC curves of the column line graph model predicting the OS of gastric malignancies at 1, 3, and 5 years. (D-F) Calibration curves of the column line graph model predicting the OS of gastric malignancies at 1, 3, and 5 years. AUC, area under the curve; ROC, receiver operating characteristic; OS, overall survival.

not statistically significant. In this study, for patients with early gastric cancer, the best prognosis was surgery alone, with a 5-year OS of 48%. The 5-year OS of the surgery combined with chemotherapy group was better than that of the surgery combined with radiotherapy group (40% *vs.* 32%) and the surgery combined with radiotherapy and chemotherapy group (40% *vs.* 36%). Patients who only choose chemotherapy and radiotherapy had the worst prognosis. It was further verified that surgery is the only method for the radical treatment of gastric cancer. For patients with surgical indications, surgery should be performed as early as possible to avoid a delay in treatment. Chemotherapy, radiotherapy, palliative surgery, and other combined treatments should be selected as much as possible for patients in the late stage who are not suitable for surgery. Compared with single treatment, the prognosis of combined treatment is relatively good.

This study has some limitations. First, we selected patients who had data in the American SEER database, which makes it difficult to fully reflect global issues and, to some extent, weakens the credibility of the statistical results. Second, some clinical data of the patients are missing, such as tumor size, AJCC staging, treatment methods, and primary site, which may have led to data bias. Finally, for patients undergoing surgery and chemotherapy, there is no specific plan, so we cannot determine the impact of different specific treatment plans on the prognosis.

Conclusions

In patients with gastric malignancies, the most common site of the disease is the cardia, but tumors in the greater curvature of the stomach have the best prognosis. For people over 45 years of age, regular gastroscopy is required to detect, diagnose, and treat tumors in time. G-NENs and GST have gradually become more common tumors, and their prognosis is significantly better than that of GCs. Patients with early gastric malignancies should be operated

on in a timely manner, and whether adjuvant treatment should be given after surgery depends on the situation. In China, it is important to highlight the imbalance of medical resource distribution between rural and urban areas and vigorously improve the level of rural and grassroots medical care, which will help to improve the prognosis of the overall population with gastric malignancies.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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