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Research article

A nomogram prediction model for the risk of intra-abdominal infection after endoscopic full-thick resection of gastric submucosal tumors

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A R T I C L E I N F O

Keywords:
Gastric submucosal tumors
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A B S T R A C T

Background: This study aimed to investigate the risk factors for complication of intra-abdominal infection (IAI) after endoscopic full-thickness resection of gastric submucosal tumors (GSMT) and to establish a nomogram prediction model for the occurrence of IAI.
Methods: Clinical data of patients with GSMT who underwent endoscopic full-thick resection (EFR) from January 2018 to July 2023 were retrospectively analyzed. The patients were divided into IAI and non-IAI groups according to whether IAI occurred during postoperative hospitalization. Univariate and multivariate logistic regression analyses were performed on the relevant clinical data of patients in the two groups to screen the independent influencing factors for the occurrence of IAI. The nomogram model was constructed based on the independent influencing factors. Model discrimination was assessed by the area under the curve (AUC) of the receiver operating characteristic (ROC) curve. The consistency of model-predicted risk with actual risk was evaluated using the Hosmer-Lemeshow goodness-of-fit test. The clinical performance of the nomogram model was evaluated using decision curve analysis.
Results: A total of 240 GSMT patients who underwent EFR procedures were finally included in this study, including 14 patients (5.83 %) in the IAI group and 226 patients in the non-IAI group. Univariate and multivariate logistic regression analyses showed that age (OR = 1.283, 95 % CI = 1.029–1.600), preoperative albumin (OR = 0.575, 95 % CI = 0.395–0.837), duration of operation (OR = 1.222, 95 % CI = 1.060–1.409), and hospitalization time (OR = 4.089, 95 % CI = 1.190–14.043) were independent influencing factors for the incidence of IAI in GSMT patients undergoing EFR surgery ($P < 0.05$). A Nomogram model was established based on the above factors. The Hosmer‐Lemeshow test value of this model was 4.230 (P = 0.836). The AUC value of the predictive model was 0.992 (95 % CI: 0.983 to 1.000), with a C-index of 0.992 (95 % CI: 0.983–1.000), indicating that the nomogram model had good accuracy and discrimination. Decision curve analysis showed that the nomogram model had a good predictive performance.
Conclusions: Age, preoperative albumin, duration of operation, and hospitalization time were independent influences on the occurrence of IAI in GSMT patients undergoing EFR surgery. A nomogram model based on these factors had a high predictive efficacy and may provide a guiding intervention for the prevention of postoperative IAI in GSMT patients.

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1. Background

Gastric submucosal tumors (GSMT) are a group of lesions originating from the layers below the mucosal layer [1]. Normal mucosal tissues mostly cover the surface of GSMT, and accurate pathological diagnosis cannot be obtained by routine biopsy. Moreover, GSMT carries a certain risk of malignancy, but rarely has typical clinical symptoms and usually needs to be detected during endoscopy [2]. Regular ultrasonographic endoscopic review or performing endoscopic tumor resection is the treatment of choice for GSMT. Currently, endoscopic submucosal dissection (ESD) and endoscopic submucosal execution (ESE) are often used to treat such lesions [3]. In recent years, endoscopic full-thickness resection (EFR) has become a new clinical technique for the treatment of GSMT [4]. As a minimally invasive procedure, EFR is expected to become the main treatment for GSMT, as it is characterized by fast postoperative recovery and low impact on organ function.

Intra-abdominal infection (IAI) is a relatively common postoperative infectious complication of gastrointestinal diseases, which can seriously cause conditions such as sepsis and septic shock. In addition to making patients feel worse and having a lower quality of life, IAI can also be fatal [5]. Studies have confirmed that the occurrence of postoperative IAI in tumor patients is closely related to the long-term survival rate of patients [6]. Postoperative IAI is influenced by a multitude of variables, and its pathophysiology is complicated and may include several factors, such as surgical procedures, perioperative care, and patient clinical features [7]. However, there are fewer studies on postoperative complications in patients with GSMT, and no relevant reports on the factors influencing the occurrence of postoperative IAI after EFR have been reported. Investigating the risk variables associated with post-operative IAI and screening high-risk patients is crucial for improving patient outcomes and preventing IAI.

In this study, we identified the risk factors associated with the development of IAI after EFR by analyzing the clinical data of GSMT patients. In addition, we established a nomogram model for individualized prediction of IAI risk after EFR. We hope to provide a guiding significance for the clinical screening of high-risk groups and the development of more targeted intervention countermeasures.

2. Methods

2.1. Patient data

The clinical data of 308 patients with GSMT who underwent EFR treatment in the Shanghai Jinshan Branch of the Sixth People's Hospital from January 2018 to July 2023 were retrospectively analyzed. Inclusion criteria: (1) patients were confirmed by ultrasonic endoscopy that the lesion originated from the intrinsic muscular layer of the gastric wall, and enhanced CT examination of the upper abdomen confirmed that the tumor mainly grew toward the lumen and there was no deep and peripheral tissue infiltration and distant metastasis; (2) patients underwent postoperative metal clip combined with nylon cord suture to close the whole layer defect of the gastric wall after EFR treatment; (3) patients met the diagnostic criteria for abdominal infection in the Diagnostic Criteria for Hospital Infections; (4) patient had no infection or precursor symptoms of infection before the procedure; (5) patients were willing to receive endoscopic treatment and follow-up. Exclusion criteria: (1) patients with missing outpatient or hospitalized medical records and incomplete clinical data; (2) patients with other malignant tumors, organ failure, and other serious co-morbidities; (3) patients who

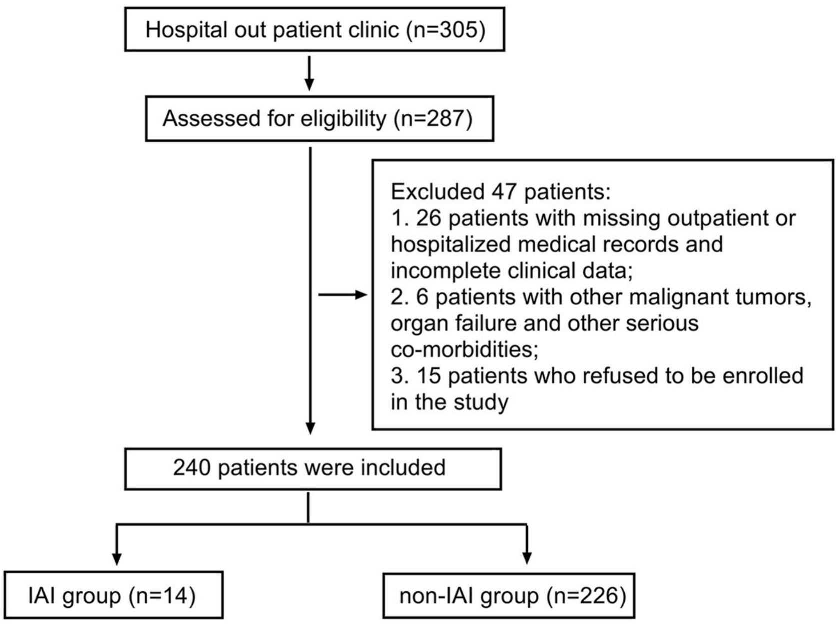

Fig. 1. Diagram for participant flow.

refused to be enrolled in the study; (4) patient with infection or precursor symptoms of infection. The study was approved by the Hospital Ethics Committee. Patients or their families signed the informed consent form. A total of 240 patients were finally enrolled in this study (Fig. 1).

2.2. Surgical approach and perioperative management

All surgeries were arranged in the operating room under general anesthesia and tracheal intubation. The patients were kept in the left lateral position with no food or drink for 8 h before the operation. All patients were connected to a general anesthesia ventilator after tracheal intubation and kept ventilated for endoscopic treatment. EFR procedure: electrocoagulation marking was performed along the periphery of the lesion using a knife with argon gas. A mixed solution of epinephrine, indigo carmine solution, and saline was injected to lift the mucosa at the lesion. The mucosa was incised along the lesion marking points using a Hook knife. After exposing the tumor, the IT knife or hook knife was used to separate the tumor from the lamina propria to the plasma membrane. The plasma membrane was incised along the edge of the tumor to create an active manual perforation. The wound was closed using titanium clips, and the active perforation caused by EFR was treated with titanium clips combined with nylon rope suture closure. Postoperatively, a gastrointestinal decompression tube was routinely left in place, and the patient was rested in a high semi-recumbent position. Postoperative fasting was performed for 24 h. The patient's symptomatic signs were observed for abdominal pain, vomiting of blood, black stools, and dyspnea, as well as subcutaneous emphysema and fever. If these symptoms are present, the patient requires prompt abdominal CT to rule out GI perforation. Proton pump inhibitors, hemostatic agents and anti-infection were routinely used.

2.3. Grouping and survey information

According to the occurrence of postoperative IAI, GSMT patients who underwent EFR surgery were categorized into the IAI group and the non-IAI group. Among them, the inclusion criteria for the IAI group met at least 1 of the following criteria [8]: (1) postoperative fever, abdominal pain, abdominal distension, or obvious signs of peritonitis with elevated leukocyte or neutrophil ratios; (2) positive cytologic culture of the abdominal drainage fluid or puncture fluid; and (3) imaging examinations such as abdominal ultrasound and CT or reoperation confirming the presence of infected lesions in the abdominal cavity such as septic exudates and localized abscesses. Those who did not meet any of the above criteria were included in the non-IAI group. Clinical data of patients in both groups were collected, including (1) basic data, such as gender, age, preoperative body mass index, smoking and alcohol consumption, and comorbidities; (2) preoperative hematological indexes, including lymphocyte ratio, hemoglobin, albumin, blood creatinine, alanine aminotransferase, alanine transaminase and creatine kinase isoenzyme; (3) intraoperative and postoperative indexes, including operation time and postoperative hospitalization time.

2.4. Statistical analysis

SPSS 22.0 software was used to analyze the data. The Kolmogorov-Smimov method was used to examine the normality of the measurement data. Measurement information that conformed to normal distribution was expressed as mean ± standard deviation, and a *t*-test was used for comparison between groups. Count data were expressed as percentages, and differences between groups were analyzed using the χ 2 test. The clinical variables were analyzed by univariate regression, and the results were considered statistically significant at $P < 0.05$. Subsequently, multivariate logistic regression analysis was performed by forward regression (LR method) to determine the independent risk factors, and odds ratio (OR) values and 95 % CI were obtained. The independent influences were introduced into the R software (R4.3.1), and the rms program package was applied to establish a nomogram prediction model. Internal validation of the nomogram model was performed by repeated sampling 1000 times using the Bootstrap method to quantify any overfitting. Harrell's C statistic was used to calculate the consistency index (C-index) to assess the discriminability of the nomogram model. The C-index ranged from 0.50 (no discriminatory power) to 1.00 (excellent discriminatory power), with a C-index $\geq$0.70 indicating acceptable discriminatory power of the predictive model. The predictive ability of the model was further assessed by internal validation and external validation of the nomogram model through calibration curves, the area under the curve (AUC) of the receiver operating characteristics (ROC), and the decision curve analysis (DCA) method. The difference was statistically significant at $P < 0.05$.

3. Results

3.1. General data

A total of 240 patients with GSMT who underwent EFR were finally enrolled in this study, including 109 males and 131 females with a mean of (59.90 ± 7.52) years. Postoperative abdominal infection occurred in 14 (5.83 %) of the 240 patients. Of these, 12 (85.71 %) had positive culture results of the abdominal drainage fluid. All of them were treated with antibiotics after the diagnosis of abdominal cavity infection, among which 2 cases formed abdominal abscess due to poor drainage, 1 case were reoperated with tube placement for flushing and drainage, and 1 case were punctured with tube placement for drainage under ultrasound guidance.

There was no statistically significant difference in gender, smoking history, alcohol consumption history, comorbid hypertension, preoperative leukocyte count, lesion location, histopathology, and tumor diameter between patients in the IAI group and the non-IAI group ($P > 0.05$). Statistically significant differences were seen between the two groups concerning age, body mass index, concomitant diabetes mellitus, preoperative lymphocyte count, preoperative hemoglobin, preoperative albumin, creatinine, and operational time ($P < 0.05$). No perioperative deaths occurred in neither of groups and all patients recovered and were discharged from the hospital, but the postoperative hospitalization time was significantly longer in the IAI group than in the non-IAI group ($P < 0.05$, Table 1).

3.2. Univariate analysis

The results of the univariate analysis showed that age, BMI, diabetes mellitus, preoperative lymphocyte count, preoperative hemoglobin, preoperative albumin, creatinine, duration of operation, and hospitalization time were associated with the occurrence of abdominal cavity infections after EFR ($P < 0.05$, Table 2).

3.3. Multivariate logistic regression analysis

Subsequently, variables with $p < 0.05$ in Table 2 were included in the multivariate logistic regression analysis. The results of multivariate logistic regression analysis showed that age (OR = 1.283, 95 % CI = 1.029–1.600), preoperative albumin (OR = 0.575, 95 % CI = 0.395–0.837), duration of operation (OR = 1.222, 95 % CI = 1.060–1.409), and hospitalization time (OR = 4.089, 95 % CI = 1.190–14.043) were independent influences on the occurrence of abdominal infections after EFR ($P < 0.05$, Table 3, Fig. 2).

3.4. Construction of the predictive model

Based on the four independent influencing factors mentioned above, a nomogram model was established to predict postoperative IAI after EFR in GSMT patients (Fig. 3). The results showed that age was 40 points, preoperative albumin was 100 points, operation time was 64 points and hospitalization time was 40 points. The total score was obtained by summing the individual scores for each risk factor. The value corresponding to the total score is the probability of occurrence of IAI after EFR as predicted by the model.

3.5. Evaluation of the predictive model

The Hosmer ‑ Lemeshow test result in the Calibration graph showed $\chi2 = 4.230$ ($P = 0.836$, Fig. 4) for the internal validation set, indicating that the prediction model was well calibrated in the internal validation set. Bootstrap internal validation results showed a C-index of 0.992 (95 % CI: 0.983–1.000), suggesting that predicting the risk of concurrent IAI in patients with GSMT has good accuracy and differentiation from the actual risk of occurrence. The ROC curve showed (Fig. 5) that the AUC of the model for predicting the risk of IAI after EFR was 0.992 (95 % CI: 0.983 to 1.000), suggesting that the model had good predictive performance. The DCA curve

Table 1
Clinicopathological features.

	non-IAI (n = 226)	IAI (n = 14)	$\chi2$ or *t*-value	*P* value
Age (years)	59.45 ± 7.41	67.21 ± 5.85	3.842	<0.001
Gender			0.039	0.843
Male	103	6		
Female	123	8		
Body mass index (kg/m^2)	24.61 ± 2.73	27.92 ± 2.28	4.445	<0.001
Smoking history	161	9	0.309	0.579
Alcohol consumption history	166	11	0.179	0.673
Hypertension	88	138	0.085	0.771
Diabetes mellitus	137	4	4.343	0.037
Abdominal surgery history	197	12	0.025	0.875
Preoperative white blood cell count (× 10^9/L)	5.95 ± 1.63	5.77 ± 1.28	0.404	0.687
Preoperative lymphocyte count (× 10^9/L)	1.53 ± 0.51	1.23 ± 0.4	2.192	0.029
Preoperative haemoglobin (g/L)	107.49 ± 14.16	98.14 ± 15.56	2.383	0.018
Preoperative albumin (g/L)	36.85 ± 6.84	25.27 ± 7.96	6.088	<0.001
Creatinine (g/L)	59.81 ± 9.54	65.76 ± 8.74	2.275	0.024
Alanine aminotransferase (U/L)	19.95 ± 4.34	22.11 ± 4.64	1.800	0.073
Alanine transaminase(U/L)	24.57 ± 5.09	26.46 ± 4.00	1.365	0.174
Creatine kinase isoenzyme(U/L)	11.95 ± 4.13	12.98 ± 3.92	0.901	0.369
Location of lesion			1.795	0.616
Cardia	115	8		
Gastric fundus	58	4		
Gastric Body	40	2		
Gastric sinus	13	0		
Histopathology			1.778	0.411
Gastric mesothelioma	159	0		
Smooth muscle tumor	57	5		
Ectopic pancreas	10	9		
Surgical time (min)	58.92 ± 11.51	89.86 ± 18.24	9.380	<0.001
Tumor Diameter (cm)	3.02 ± 0.55	3.14 ± 0.57	0.822	0.412
Hospitalization (day)	5.31 ± 1.47	6.93 ± 1.64	3.964	<0.001

Table 2
Univariate logistic regression analysis.

	β	Standard error	Wald	Odds ratio	95%Confidence interval	*p*
Age	0.230	0.068	11.403	1.259	1.101 ~ 1.438	0.001
Gender	0.110	0.556	0.039	1.117	0.375 ~ 3.322	0.843
Body mass index	0.592	0.158	13.982	1.807	1.325 ~ 2.465	<0.001
Smoking history	0.319	0.577	0.306	1.376	0.444 ~ 4.262	0.580
Alcohol consumption history	−0.282	0.669	0.177	0.755	0.204 ~ 2.797	0.674
Hypertension	−0.162	0.557	0.085	0.85	0.285 ~ 2.533	0.771
Diabetes mellitus	1.348	0.607	4.928	3.848	1.171 ~ 12.648	0.026
Abdominal surgery history	0.124	0.789	0.025	1.132	0.241 ~ 5.318	0.875
Preoperative white blood cell count	−0.070	0.172	0.164	0.933	0.666 ~ 1.306	0.686
Preoperative lymphocyte count	−1.415	0.666	4.517	0.243	0.066 ~ 0.896	0.001
Preoperative haemoglobin	−0.046	0.020	5.401	0.955	0.919 ~ 0.993	0.020
Preoperative albumin	−0.283	0.065	18.928	0.754	0.664 ~ 0.856	<0.001
Creatinine	0.067	0.030	4.906	1.069	1.008 ~ 1.134	0.027
Alanine aminotransferase (U/L)	0.117	0.066	3.136	1.124	0.988–1.278	0.077
Alanine transaminase(U/L)	0.077	0.057	1.841	1.080	0.966–1.207	0.175
Creatine kinase isoenzyme(U/L)	0.061	0.068	0.812	1.063	0.931–1.214	0.367
Location of lesion						
Cardia	−0.009	0.633	0.175	0.991	0.287–3.429	0.989
Gastric fundus	0.196	0.412	0.228	1.217	0.543–2.727	0.633
Gastric Body	−0.630	0.566	1.24	0.532	0.176–1.614	0.265
Gastric sinus	−0.397	1.055	0.141	0.673	0.085–5.315	0.707
histopathology						
Gastric mesothelioma	0.438	0.579	0.573	1.550	0.498–4.818	0.449
Smooth muscle tumor	0.092	0.425	0.047	1.096	0.476–2.524	0.829
Ectopic pancreas	0.721	0.786	0.841	2.056	0.440–0.9597	0.359
Surgical time	0.105	0.019	29.57	1.111	1.069 ~ 1.154	<0.001
Tumor Diameter	0.414	0.505	0.673	1.513	0.562 ~ 4.071	0.412
Hospitalization	0.639	0.179	12.671	1.894	1.333 ~ 2.693	<0.001

Table 3
Multivariate logistic regression analysis.

	β	Standard error	Wald	Odds ratio	95%Confidence interval	*p*
Age	0.249	0.113	4.904	1.283	1.029 ~ 1.600	0.027
Preoperative_albumin	−0.554	0.192	8.342	0.575	0.395 ~ 0.837	0.004
Surgical_time	0.201	0.073	7.610	1.222	1.060 ~ 1.409	0.006
Hospitalization	1.408	0.630	5.003	4.089	1.190 ~ 14.043	0.025

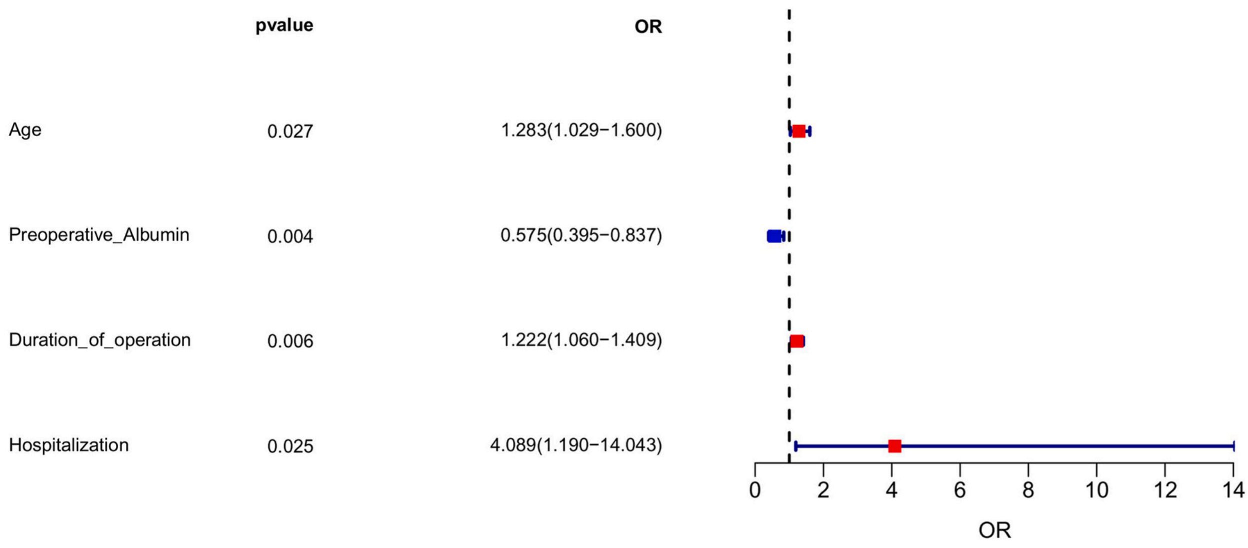

Fig. 2. Forest plot from multivariate logistic regression analysis.

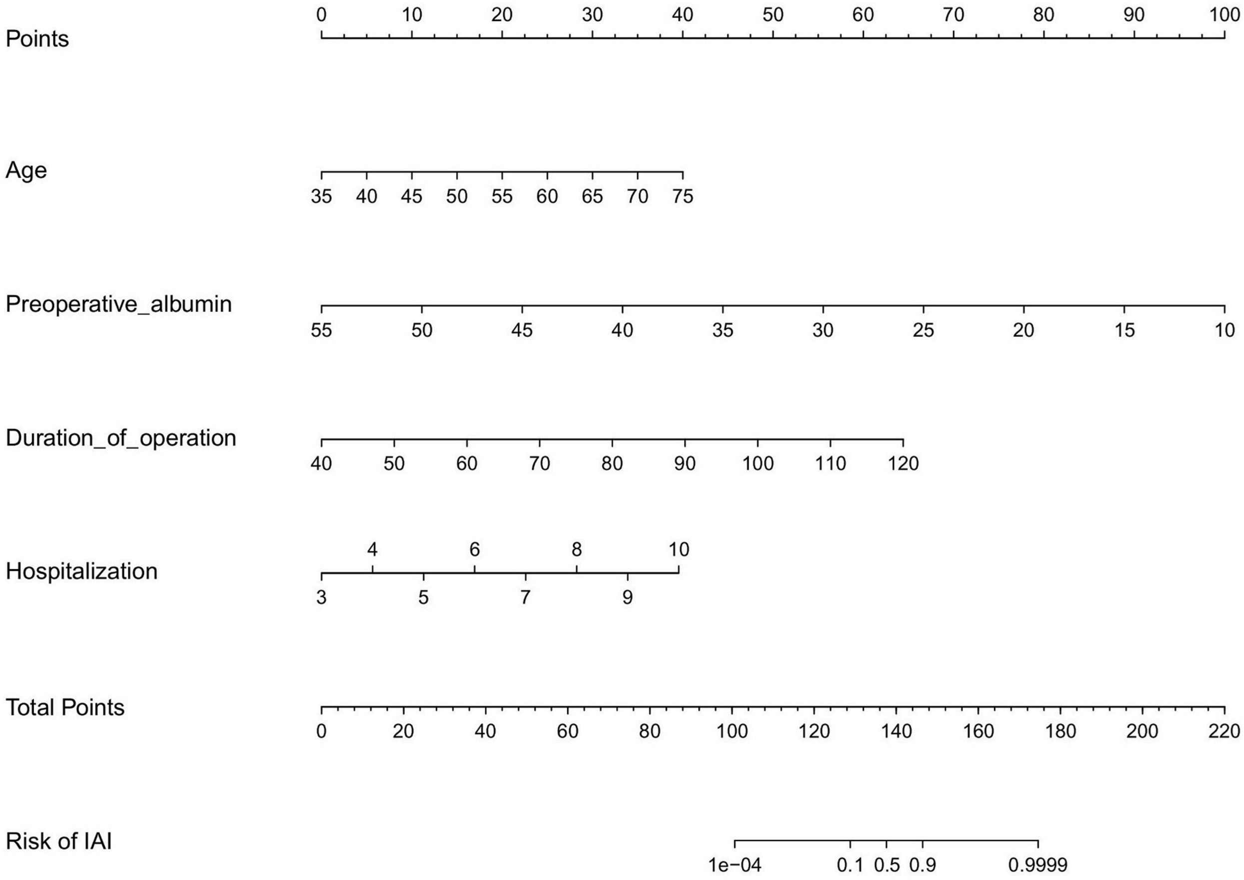

Fig. 3. Nomogram predictive model for the occurrence of intra-abdominal infections after EFR in patients with gastric submucosal tumors.

showed (Fig. 6) that the nomogram model had the highest net benefit when the risk threshold was 0.1–1.0.

4. Discussion

With the popularization of endoscopy, the detection rate of GSMT has greatly increased. While the majority of GSMT show no particular symptoms, those with malignant potential, such as mesenchymal stromal tumors, may exhibit symptoms similar to gastrointestinal bleeding when the tumor ruptures, such as vomiting blood and black stools, as the tumor size grows [9]. Regular endoscopic follow-up is generally recommended for GSMT with a diameter of less than 2 cm [10]. However, some GSMT have the risk of malignancy, and regular endoscopic review also brings economic burdens and great mental stress to patients. The preferred treatment for GSMT has historically been open or laparoscopic surgery. However, open surgery often necessitates an extended lesion resection and is associated with serious postoperative complications like reflux and stenosis, which can negatively impact the patient's quality of life. In cases where the tumor is small or the lesion is difficult to locate intraoperatively—for example, if it is located in the posterior wall or near the cardia—intraoperative endoscopy is still necessary to support the endoscopy [10]. Endoscopic resection does not have the problem of the inability to locate smaller GSMT and can reduce the resection of normal gastric tissue [11]. Rapid advances in endoscopic resection techniques in recent years have led to the emergence of ESD and its derivative technique, EFR, which have made it possible to safely resect GSMT through endoscopy. Although the main principle of endoscopic techniques for treating GI tumors is to avoid serious complications, conventional EFR may lead to an increased risk of complications because it disrupts the integrity of the gastric surface mucosa. IAI is one of the most common complications after EFR, occurring in the abdominal cavity, retroperitoneum, and abdominal organs, such as acute cholecystitis, biliary tract infection, bacterial liver abscess, and acute peritonitis [5]. IAI can lead to a rapid elevation of the inflammatory response, which can have serious adverse effects on the patient's post-operative recovery [12]. After abdominal surgery, IAI has a detrimental effect on tumor-free survival for patients with tumors [13]. This effect may be attributed to the quick escalation of the inflammatory response triggered by IAI, and inflammatory factors influence the immunological milieu at the lesion, leading to tumor recurrence or metastasis [14]. Therefore, it is important for the prevention of IAI after EFR by analyzing potential risk factors.

In this study, age, preoperative hemoglobin, preoperative albumin, duration of operation, and hospitalization time were all independent influencing factors for the occurrence of IAI in EFR surgery in GSMT patients. With increasing age, body organ function

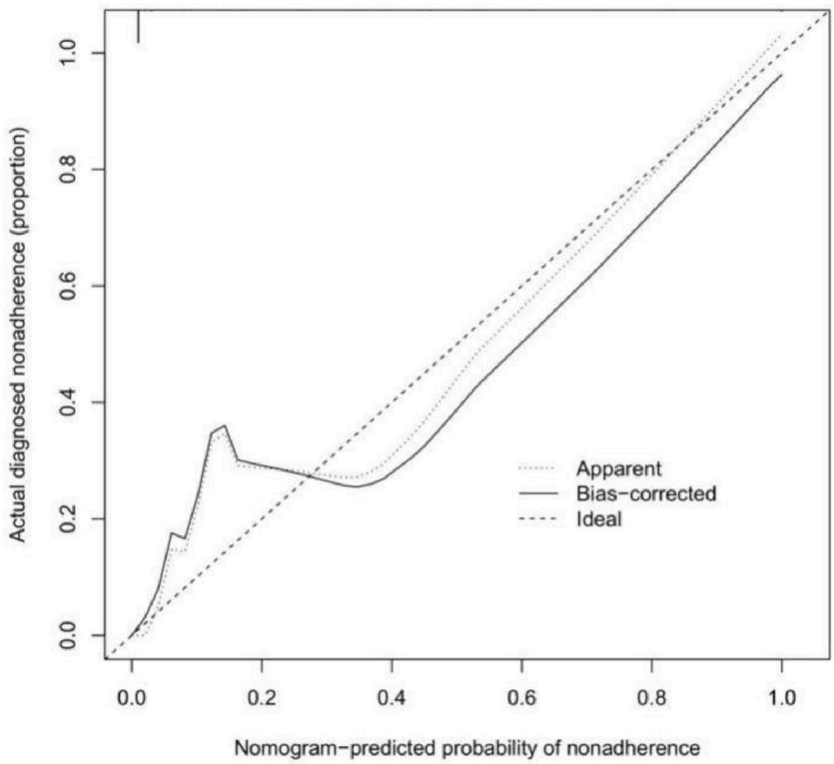

Fig. 4. Calibration curve of the nomogram model.

gradually deteriorates, often combined with a variety of medical diseases, leading to a subsequent increase in the risk of postoperative complications [15–17]. The proportion of obese people with cardiovascular, respiratory and metabolic diseases is higher than that of people with normal body mass, and they are less tolerant to surgical stress [18]. Moreover, the large amount of adipose tissue in the abdominal cavity makes the operating space limited, which affects the surgical operation process [19]. It has been demonstrated [20] that obese patients have a higher probability of intraoperative accidents, a slower postoperative recovery process, and a higher risk of postoperative complications. In this study, univariate regression analysis showed that body mass index was associated with the development of IAI, but it was not an independent risk factor for IAI after EFR, which we believe was due to the small sample size included. Preoperative low protein and anemia are reflective of the patient's nutritional status and independent risk factors for postoperative IAI [21]. According to Pei et al. [22], patients with low nutritional status had a considerably increased risk of post-operative infections. This finding may have to do with the delayed healing of surgical wounds and the patients' lowered immune response brought on by low albumin levels. Therefore, in patients with preoperative hypoalbuminemia, avoiding negative nitrogen balance in patients during the perioperative period may be one of the ways to reduce IAI. The conclusion that the duration of surgery affects postoperative incision infection remains controversial. While Ren et al. [23] came to the conclusion that the length of surgery did not raise the likelihood of IAI in patients having abdominal surgery, Lo et al. [8] and Lei et al. [24] discovered that the length of operation was a risk factor for postoperative IAI in abdominal surgery. In this study, we found that the association of prolonged operation time with the occurrence of IAI after EFR may be due to the fact that longer operation time means longer exposure of the abdominal cavity and increased probability of air contamination of various surgical instruments. Additionally, prolonged operations may result in the buildup of postoperative anesthetic medications, which may impair digestive, circulatory, and respiratory systems. Moreover, longer hospitalization recovery period increases the time of exposure to nosocomial pathogenic bacteria environment, which leads to a higher risk of infection [25]. Clinical prophylactic measures can be given based on the above risk factors to reduce the risk of postoperative IAI in GSMT patients.

The nomogram model makes it simple to advance clinical application by providing a graphical and visual representation of the logistic regression findings that can be utilized intuitively for predicting an individual's prognosis [26] The nomogram approach has greater application flexibility and can incorporate more predictive features than the standard score method. It has been widely used in the field of oncology and is a common predictive tool for assessing oncology and medical prognosis [27]. In this study, a nomogram prediction model for the occurrence of IAI after EFR was constructed based on four variables. Internal validation showed that the C-index of the model to predict the risk of patients developing IAI was 0.992 (95 % CI: 0.983–1.000), and the calibration curve showed better observed and predicted values. In addition, the model predicted that the risk threshold for patients to develop postoperative IAI after EFR could provide a net clinical benefit. Thus, the model constructed in this study was a robust and credible tool to quantify the risk of developing IAI after EFR. The development of the nomogram model might help visualize patient risk scores and make the

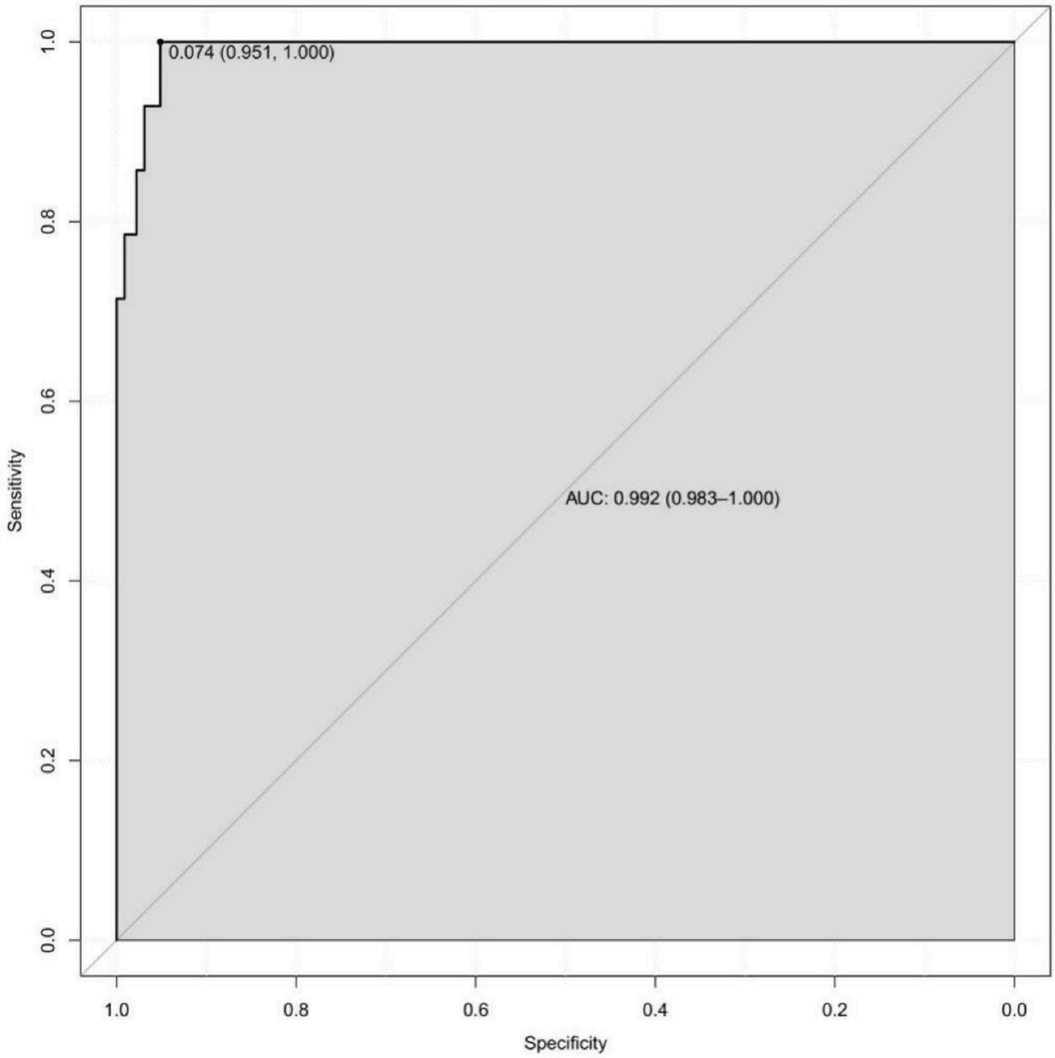

Fig. 5. Analysis of receiver operating characteristic curve (ROC) of the column-line diagram model for predicting the occurrence of abdominal infection after EFR in patients with gastric submucosal tumors. AUC, area under the subject's work characteristic curve.

aforementioned risk indicators easier to collect in clinical practice, which would improve early high-risk population monitoring. As a result, the nomogram model created in this study will aid in the creation of focused and useful preventative and intervention measures, serving as a reference point for the future prevention and mitigation of IAI in GSMT patients following EFR.

However, our study still has many shortcomings. First, this study was a retrospective clinical study, which may be subject to selection bias. Second, the sample size of patients included in this study was large but not validated with an external dataset. In addition, there are more relevant factors affecting the occurrence of IAI after EFR in GSMT patients, and this nomogram model may miss other important relevant variables. Therefore, external validation with larger sample sizes through multicenter prospective studies is still needed. In addition, in future studies, we will analyze the distribution of pathogenic bacteria and drug resistance in the drainage fluid of abdominal infections to provide ideas for disease prevention.

5. Conclusion

In conclusion, age, preoperative albumin, duration of operation, and hospital stay were independent risk factors for developing IAI after EFR in patients with GSMT, and the nomogram model based on these factors had high predictive efficacy.

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Neither researchers nor hospital received any additional funding for conducting the study.

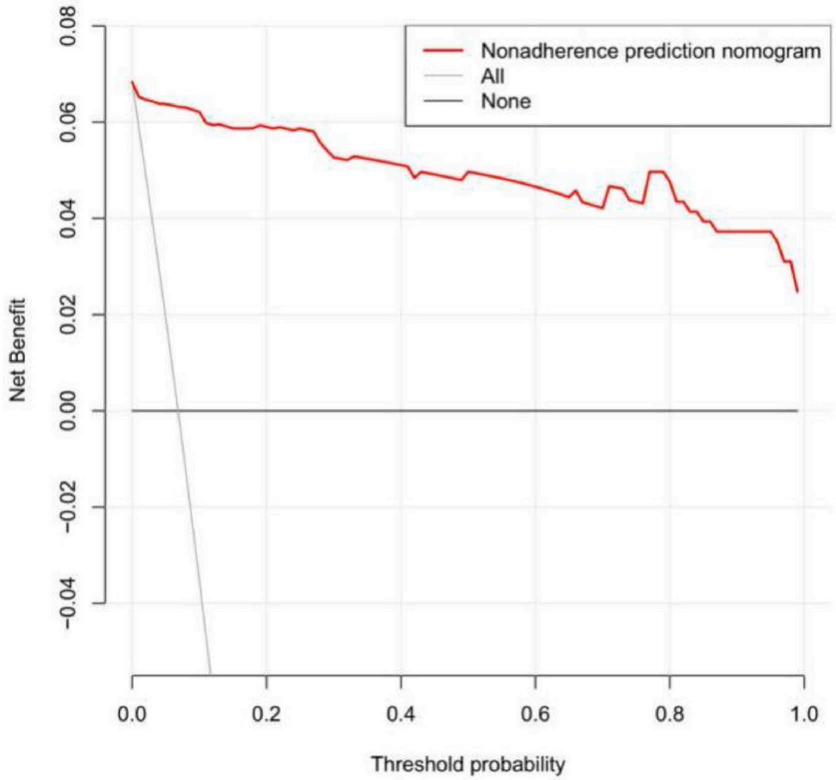

Fig. 6. Decision curve analysis of the nomogram model.

Data availability statement

All data included in this study are available.

Consent for publication

All authors approved the final version of the manuscript and agree to publication.

Reviewer disclosures

Peer reviewers on this manuscript have no relevant financial or other relationships to disclose.

Ethics statement

The ethical committee of Shanghai Jinshan Branch of the Sixth People's Hospital(2018-KY-02(K)) endorsed all of the study's procedures.

Consent for publication

Written informed consent for publication was obtained from all patients and their families included in this retrospective analysis.

CRediT authorship contribution statement

Liang Wang: Writing – original draft, Resources, Project administration, Methodology. **Wei Huang:** Writing – review & editing, Software, Methodology. **Jing-jing Zhao:** Writing – review & editing, Software, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Abbreviations

AUC	the area under the curve
body mass index	body mass index
C-index	consistency index
DCA	decision curve analysis
EFR	endoscopic full-thick resection
ESD	endoscopic submucosal dissection
ESE	endoscopic submucosal execution
GSMT	gastric submucosal tumors
IAI	intra-abdominal infection
OR	odds ratio
ROC	receiver operating characteristic

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