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Original Research

Construction and Validation of a Prediction Model for Time to Flatus Discharge Following Elective Gynecologic Laparoscopic Surgery

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Abstract

Background: Postoperative intestinal distension in patients undergoing gynecologic laparoscopic surgery may impair wound healing and restrict respiratory function and mobility, potentially leading to serious complications. Reports on factors influencing flatus discharge after gynecologic laparoscopic surgery are limited, and no prediction model for delayed flatus discharge within 24 hours postoperatively has been previously described in this population. This study addresses this gap and provides a nomogram for clinical prediction of this outcome. **Methods:** Using R version 4.3.3, 70% of the samples were randomly selected using the caret package as the training set for model development, with the remaining 30% retained as the validation set for internal validation. Least absolute shrinkage and selection operator (LASSO) regression was applied for variable selection, and the retained variables were incorporated into a multivariable logistic regression model. A nomogram was constructed and validated using receiver operating characteristic (ROC) curves and calibration curves. Decision curve analysis (DCA) was performed to assess clinical applicability. **Results:** A total of 194 patients with complete data were included in the analysis, of whom 74 (38.1%) failed to pass flatus within 24 hours of surgery. Five predictive variables were identified through LASSO regression: analgesic pump usage, postoperative anxiety, early in-bed activity, surgical duration, and postoperative serum potassium level. These five variables were integrated into a nomogram to intuitively predict the risk probability for delayed flatus discharge beyond 24 hours after surgery. The model demonstrated good discriminative performance, with an area under the curve (AUC) of 0.866 (95% confidence interval [CI]: 0.806–0.926) in the training set and 0.812 (95% CI: 0.702–0.922) in the validation set. Calibration curves demonstrated good consistency between predicted and observed values. Clinical DCA indicated a high net clinical benefit across threshold probabilities ranging from 0 to 0.75. **Conclusions:** The constructed nomogram demonstrates good discrimination, calibration, and clinical applicability for predicting the risk of delayed flatus discharge beyond 24 hours following gynecologic laparoscopic surgery. This tool facilitated individualized risk assessment, informed clinical decision-making, and supported proactive management of high-risk populations.

Keywords: laparoscopy; flatus; nomograms; prediction model

1. Introduction

At present, gynecologic laparoscopic surgery has been widely adopted in the management of gynecologic conditions [1]. However, patients frequently experience postoperative gastrointestinal complications such as abdominal distension, constipation, and delayed flatus discharge following laparoscopic surgery [2]. These gastrointestinal complications may impair wound healing, restrict respiratory function and mobility, and potentially lead to serious complications such as lower extremity venous thromboembolism [3]. Time to flatus discharge serves as a critical indicator of early postoperative intestinal motility recovery [4]. Despite its clinical importance, research on factors influencing delayed flatus discharge after gynecologic laparoscopic surgery remains limited. More critically, no validated predictive model exists to identify patients at high risk of failing to pass flatus within 24 hours postoperatively. To address this gap, the present study developed a visualized nomogram model [5,6] to predict the probability of delayed flatus discharge beyond 24 hours following gynecologic laparoscopic surgery, thereby providing a theoretical basis for lowering the incidence of postoperative gastrointestinal complications.

2. Materials and Methods

2.1 Study Design and Participants

This was a cross-sectional observational study. The study participants consisted of 194 patients who underwent gynecologic laparoscopic surgery at the Jiading Branch of Shanghai General Hospital, Shanghai, China, between February 1, 2023, and April 30, 2024. Data were collected at a single time point during the perioperative period. Inclusion criteria were as follows: ① age 18 to 65 years old, with a diagnosis of uterine fibroids, ovarian cysts, infertility, or endometriosis and scheduled for laparoscopic surgery; and ② ability to read and write and to complete the study questionnaire independently. Exclusion criteria were: ① severe systemic complications before surgery (e.g., severe anemia or hemodynamic instability); ② ectopic pregnancy; ③ emergency surgery; ④ postoperative pathology confirming malignancy; ⑤ conversion from laparoscopic to open surgery; ⑥ intraoperative adverse events (e.g., intestinal or urinary tract injury); and ⑦ history of mental illness. This study was approved by the Ethics Committee of Jiading Branch of Shanghai General Hospital, Shanghai, China (Approval No.: [2025] 023).

2.2 Study Variables

A total of 15 variables were selected for analysis. These variables were: patient age, body mass index (BMI), history of hypertension and diabetes, postoperative eating status (defined as early eating within 6–12 hours after surgery, or delayed eating if initiated more than 12 hours after surgery), preoperative oral bowel preparation with compound polyethylene glycol electrolyte powder (I) (Jiangxi Hengkang Pharmaceutical Co., Ltd., Shangrao, Jiangxi, China), postoperative analgesic pump usage (containing sufentanil plus esketamine), early in-bed activity (defined as initiation of in-bed activity within 2 hours after surgery; coded as 1 for activity initiated ≤2 hours postoperatively, and 0 for >2 hours), time to first ambulation, preoperative and postoperative serum albumin and potassium levels, and time to urinary catheter removal after return to the ward. The dependent variable was defined as whether passage of flatus occurred within 24 hours of gynecologic laparoscopic surgery (0 = occurrence; 1 = non-occurrence).

2.3 Psychological Assessment Tools

Postoperative anxiety was assessed using the Self-Rating Anxiety Scale (SAS), developed originally by Zung et al. [7], with its scoring and application informed by previous studies [8,9]. The SAS comprises 20 items evaluating the frequency of anxiety symptom occurrence. Among them, 15 items are positively worded and scored directly based on symptom frequency (occasional/absent = 1 point, sometimes = 2 points, often = 3 points, persistent = 4 points), while the remaining 5 items are reverse-scored (occasional/absent = 4 points, sometimes = 3 points, often = 2 points, persistent = 1 point). The initial total score is calculated by summing all item scores and then multiplying by 1.25 to derive the standardized score (ranging from 25 to 100). A standardized score of ≥50 indicates the presence of anxiety, with higher scores reflecting greater anxiety levels. The Cronbach's α coefficient for this scale was 0.862 [10].

2.4 Statistical Analysis

All statistical analyses and graph generation were performed using R software (Version 4.3.3; R Foundation for Statistical Computing, Vienna, Austria). Baseline tables were constructed using the CBCgrps package. Normally distributed continuous variables are presented as mean ± standard deviation (SD) and were compared using the independent samples *t*-test. Non-normally distributed continuous variables were analyzed using the Mann-Whitney U test and are expressed as median [interquartile range, Q1, Q3]. Categorical variables meeting the assumptions of the chi-square test were analyzed accordingly and are presented as frequencies and percentages. Categorical variables not meeting these criteria were analyzed using Fisher's exact test, with the results expressed as frequencies and percentages. Results of all intergroup comparisons are presented as *p*-values.

Variables with a missing data rate exceeding 20% were directly excluded, while those with a missing rate below 20% underwent missing value imputation. The caret package was used to randomly select 70% of the cases as the training set for establishing the risk prediction model, with the remaining cases assigned to the validation set for internal model validation. Variable selection was based on the least absolute shrinkage and selection operator (LASSO) regression. Prior to analysis, continuous variables included in the LASSO regression were standardized using the min-max normalization method [11]. LASSO regression was implemented via the glmnet package with nfolds set to 10. The optimal number of variables was determined as that corresponding to the one-standard-error-away criterion, and the relevant variables were thus screened out.

The rms package was used to construct the logistic regression model. Variables incorporated into the logistic regression were selected for inclusion based on LASSO regression results, with nonsignificant variables subsequently excluded to refine the model. Variance inflation factor (VIF) values were calculated using the car package. Calibration curves of the prediction model, which were plotted using the rms package. The ResourceSelection package was used to perform the Hosmer-Lemeshow goodness-of-fit test. The pROC and ggplot2 packages were applied to calculate and plot the receiver operating characteristic (ROC) curves, respectively. Additionally, the decision curve of the model was generated using the rmda package in R, with threshold probabilities ranging from 0 to 1 at increments of 0.01, with all other parameters set to their default values in the package. The net benefit was calculated across this range of thresholds by weighting true positives (correctly identified high-risk individuals who would benefit from intervention) against false positives (low-risk individuals unnecessarily subjected to intervention), where the relative harm of an unnecessary intervention compared to the benefit of a true positive is implicitly defined by the selected probability threshold—reflecting the clinical trade-off between benefit and harm.

3. Results

3.1 Patient Characteristics and Clinical Statistical Data

A total of 194 patients were included in the study, among whom 12 (6.2%) exhibited combined hypertension,

Table 1. Comparison of clinical characteristics between patients with and without flatus discharge within 24 hours of gynecologic laparoscopic surgery.

Variables	Total (n = 194)	Flatus passage within 24 hours 0 (n = 120)	Delayed flatus discharge within 24 hours 1 (n = 74)	p-value
6–12 h postoperative feeding, n (%)				0.363
Yes	88 (45.4)	58 (48.3)	30 (40.5)	
No	106 (54.6)	62 (51.6)	44 (59.5)	
Hypertension, n (%)				0.541
No	182 (93.8)	111 (92.5)	71 (95.9)	
Yes	12 (6.2)	9 (7.5)	3 (4.1)	
Diabetes, n (%)				1.000
No	189 (97.4)	117 (97.5)	72 (97.3)	
Yes	5 (2.6)	3 (2.5)	2 (2.7)	
Electrolyte powder, n (%)				0.445
No	60 (30.9)	40 (33.3)	20 (27.0)	
Yes	134 (69.1)	80 (66.7)	54 (73.0)	
Analgesic pump usage, n (%)				0.005
No	124 (63.9)	67 (55.8)	57 (77.0)	
Yes	70 (36.1)	53 (44.2)	17 (23.0)	
Postoperative anxiety, n (%)				<0.001
No	58 (29.9)	54 (45.0)	4 (5.4)	
Yes	136 (70.1)	66 (55.0)	70 (94.6)	
Early in-bed activity, n (%)				<0.001
No	98 (50.5)	42 (35.0)	56 (75.7)	
Yes	96 (49.5)	78 (65.0)	18 (24.3)	
Out-of-bed (h), Median (Q1, Q3)	17.0 (13.0, 20.0)	17.0 (13.0, 19.0)	16.5 (13.0, 20.0)	0.545
Age (years), Median (Q1, Q3)	38.0 (33.0, 46.0)	38.0 (34.0, 42.0)	40.0 (30.0, 47.0)	0.446
Surgical duration (min), Median (Q1, Q3)	120.0 (70.0, 175.0)	110.0 (65.0, 150.0)	137.5 (77.5, 217.5)	0.010
BMI (kg/m^2), Median (Q1, Q3)	23.4 (21.5, 25.4)	23.2 (21.1, 25.0)	23.5 (23.0, 29.1)	0.007
Preoperative albumin (g/L), Median (Q1, Q3)	44.4 (42.3, 46.7)	44.8 (42.5, 46.7)	44.0 (42.1, 46.5)	0.146
Preoperative serum potassium (mmol/L), Median (Q1, Q3)	3.8 (3.6, 4.0)	3.8 (3.6, 4.0)	3.8 (3.4, 4.0)	0.385
Postoperative serum potassium (mmol/L), Median (Q1, Q3)	3.6 (3.3, 3.8)	3.7 (3.4, 3.9)	3.5 (3.2, 3.7)	<0.001
Urinary catheter removal (h), Median (Q1, Q3)	22.0 (17.0, 26.0)	20.0 (16.0, 24.0)	26.0 (23.0, 26.0)	<0.001

BMI, body mass index.

and 5 (2.6%) had combined diabetes. The median age was 38.0 (33.0, 46.0) years, and the median BMI was 23.4 (21.5, 25.4). All patients were divided into two groups: the group without flatus discharge within 24 hours after gynecologic laparoscopic surgery (74 cases, accounting for 38.1%) and the group with flatus passage within 24 hours postoperatively (120 cases, accounting for 61.9%). The results were presented clearly and intuitively. As shown in Table 1, regarding perioperative interventions, the delayed flatus discharge group had a significantly lower rate of analgesic pump usage (23.0% vs. 44.2%, p = 0.005.) and a markedly higher incidence of postoperative anxiety (94.6% vs. 55.0%, $p < 0.001$). Early postoperative in-bed activity was significantly lower in this group (24.3% vs. 65.0%, $p < 0.001$). In terms of postoperative physiological parameters, patients in the delayed flatus discharge group presented with a significantly lower postoperative serum potassium (3.5 [3.2, 3.7] vs. 3.7 [3.4, 3.9] mmol/L, $p < 0.001$) and longer time to urinary catheter removal (26.0 vs. 20.0 h, $p < 0.001$). These findings suggest that delayed recovery of postoperative gastrointestinal function may be associated with electrolyte disturbances and restricted ambulation caused by indwelling urinary catheters. However, univariate analysis failed to account for multicollinearity or mutual interference among variables. In contrast, LASSO regression performs comprehensive variable selection based on the global variable set, yielding outcomes with higher clinical value and reliability. To further identify the core predictive factors, all independent variables were entered into the LASSO regression model, which ultimately identified five independent influencing factors (Fig. 1A,B). Moreover, the total cohort was randomly divided into a training set (n = 136) and a validation set (n = 58). No statistically significant differences were observed between the two sets with respect to any of the included variables, as shown in Table 2.

Table 2. Comparison of clinical characteristics between the training set and the validation set.

Variable	Total (n = 194)	Validation set 0 (n = 58)	Training set 1 (n = 136)	*p*-value
Group, n (%)				1.000
Passage of flatus within 24 hours 0	120 (61.9)	36 (62.1)	84 (61.8)	
Without discharge of flatus within 24 hours 1	74 (38.1)	22 (37.9)	52 (38.2)	
6–12 h postoperative feeding, n (%)				1.000
Yes	88 (45.4)	26 (44.8)	62 (45.6)	
No	106 (54.6)	32 (55.2)	74 (54.4)	
Hypertension, n (%)				0.516
No	182 (93.8)	56 (96.6)	126 (92.6)	
Yes	12 (6.2)	2 (3.4)	10 (7.4)	
Diabetes, n (%)				1.000
No	189 (97.4)	57 (98.3)	132 (97.1)	
Yes	5 (2.6)	1 (1.7)	4 (2.9)	
Electrolyte powder, n (%)				0.596
No	60 (30.9)	20 (34.5)	40 (29.4)	
Yes	134 (69.1)	38 (65.5)	96 (70.6)	
Analgesic pump usage, n (%)				0.428
No	124 (63.9)	40 (69.0)	84 (61.8)	
Yes	70 (36.1)	18 (31.0)	52 (38.2)	
Postoperative anxiety, n (%)				0.773
No	58 (29.9)	16 (27.6)	42 (30.9)	
Yes	136 (70.1)	42 (72.4)	94 (69.1)	
Early in-bed activity, n (%)				0.950
No	98 (50.5)	30 (51.7)	68 (50.0)	
Yes	96 (49.5)	28 (48.3)	68 (50.0)	
Out-of-bed (h), Median (Q1, Q3)	17.0 (13.0, 20.0)	16.0 (13.0, 18.0)	17.5 (13.0, 20.0)	0.252
Age (y), Median (Q1, Q3)	38.0 (33.0, 46.0)	38.0 (34.0, 44.8)	38.0 (32.0, 46.0)	0.820
Surgical duration (min), Median (Q1, Q3)	120.0 (70.0, 175.0)	110.0 (71.3, 162.5)	120.0 (70.0, 180.0)	0.510
BMI (kg/m^2), Median (Q1, Q3)	23.4 (21.5, 25.4)	23.2 (21.3, 24.9)	23.4 (21.9, 25.6)	0.288
Preoperative albumin (g/L), Median (Q1, Q3)	44.4 (42.3, 46.7)	43.8 (42.4, 46.0)	44.8 (42.4, 47.1)	0.116
Preoperative serum potassium (mmol/L), Median (Q1, Q3)	3.8 (3.6, 4.0)	3.8 (3.7, 4.0)	3.8 (3.6, 4.0)	0.412
Postoperative serum potassium (mmol/L), Median (Q1, Q3)	3.6 (3.3, 3.8)	3.6 (3.4, 3.8)	3.6 (3.3, 3.8)	0.752
Urinary catheter removal (h), Median (Q1, Q3)	22.0 (17.0, 26.0)	21.0 (17.0, 26.0)	22.5 (17.0, 26.0)	0.996

Table 3. Multivariate logistic regression analysis of predictive factors selected by LASSO regression.

Independent variables	B	SE	Wald	*p*-value	OR (95% CI)	VIF
Intercept	6.979	2.820	6.122	0.013	1073.437 (4.882~344,267.828)	-
Analgesic pump usage	–1.619	0.521	9.648	0.002	0.198 (0.068~0.529)	1.201
Postoperative anxiety	1.635	0.745	4.820	0.028	5.130 (1.290~26.081)	1.151
Early in-bed activity	–1.892	0.564	11.233	<0.001	0.151 (0.047~0.438)	1.398
Surgical duration	0.006	0.003	4.540	0.033	1.006 (1.001~1.011)	1.057
Postoperative serum potassium	–2.323	0.746	9.702	0.002	0.098 (0.021~0.402)	1.073

OR, odds ratio; CI, confidence interval; VIF, variance inflation factor; LASSO, least absolute shrinkage and selection operator; SE, standard error.

3.2 Risk Factor Identification and Nomogram Construction

Among the 194 patients, 15 potential predictive variables were evaluated. LASSO regression analysis identified 5 variables for inclusion (Fig. 1A,B). These factors included: analgesic pump usage, postoperative anxiety, early postoperative in-bed activity, duration of surgery, and postoperative serum potassium levels. These 5 variables were subsequently included in a multivariate logistic regression analysis, and all 5 were confirmed as independent risk factors for delayed flatus discharge, as shown in Table 3. The independent risk factors identified by the multivariate analysis were included in a nomogram for predicting the probability of delayed flatus discharge within 24 hours following gynecologic laparoscopic surgery (Fig. 2).

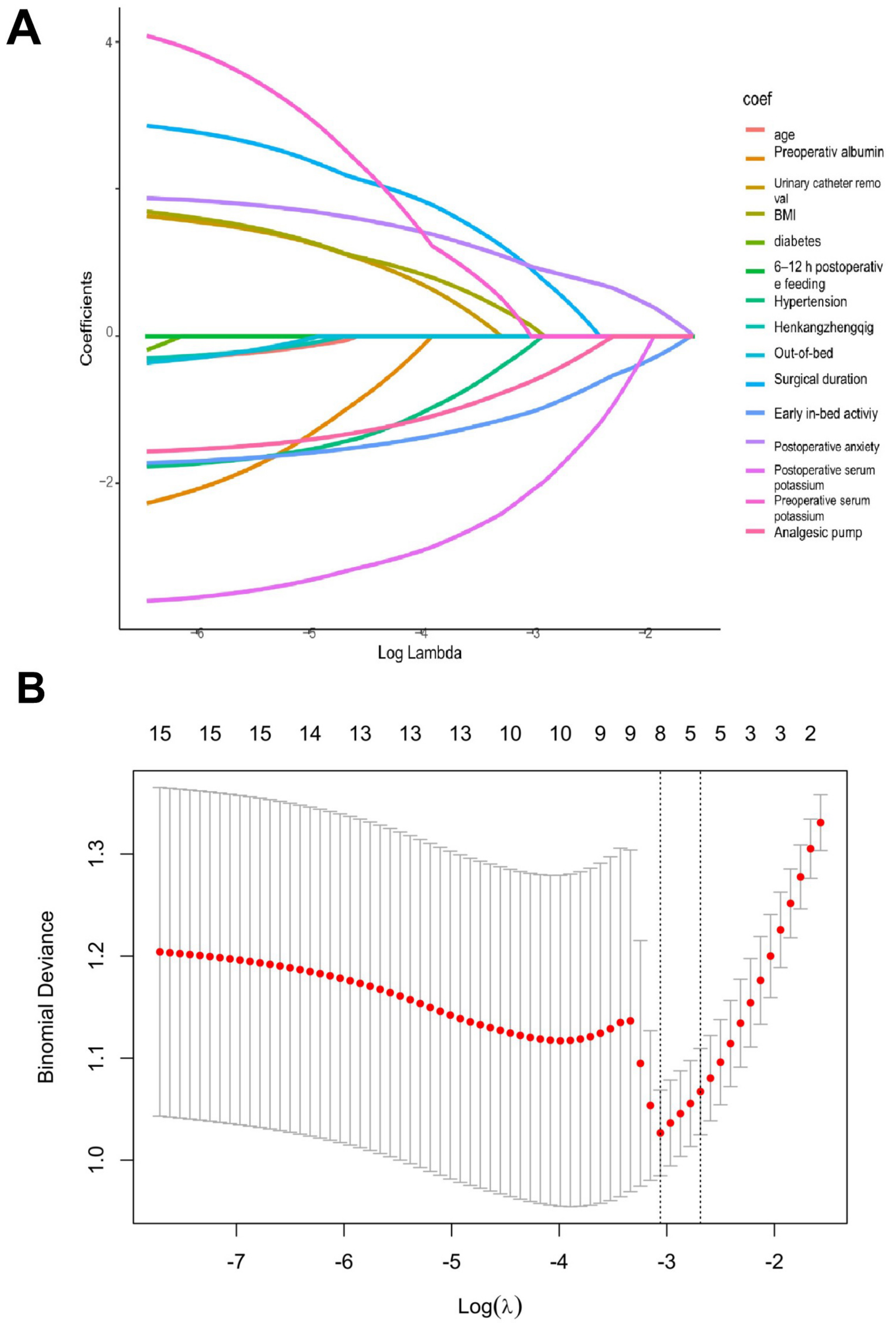

Fig. 1. LASSO regression analysis for profiles of flatus discharge. (A) LASSO regression coefficient path diagram. (B) Cross-validation curve for LASSO regression. LASSO, Least absolute shrinkage and selection operator.

3.2.1 Nomogram Validation

ROC curves were plotted using data from the modeling cohort and validation cohort, as shown in Fig. 3A,B. The area under the curve (AUC) for the training set (AUC = 0.866, 95% confidence interval [CI]: 0.806–0.926) and the validation set (AUC = 0.812, 95% CI: 0.702–0.922) were greater than 0.70, indicating good discriminative ability of the nomogram. The calibration performance of the prediction model was evaluated using the Hosmer-Lemeshow goodness-of-fit test. The absence of a statistically significant difference between predicted and actual values ($p > 0.05$) indicates good calibration of the constructed nomogram (Fig. 4).

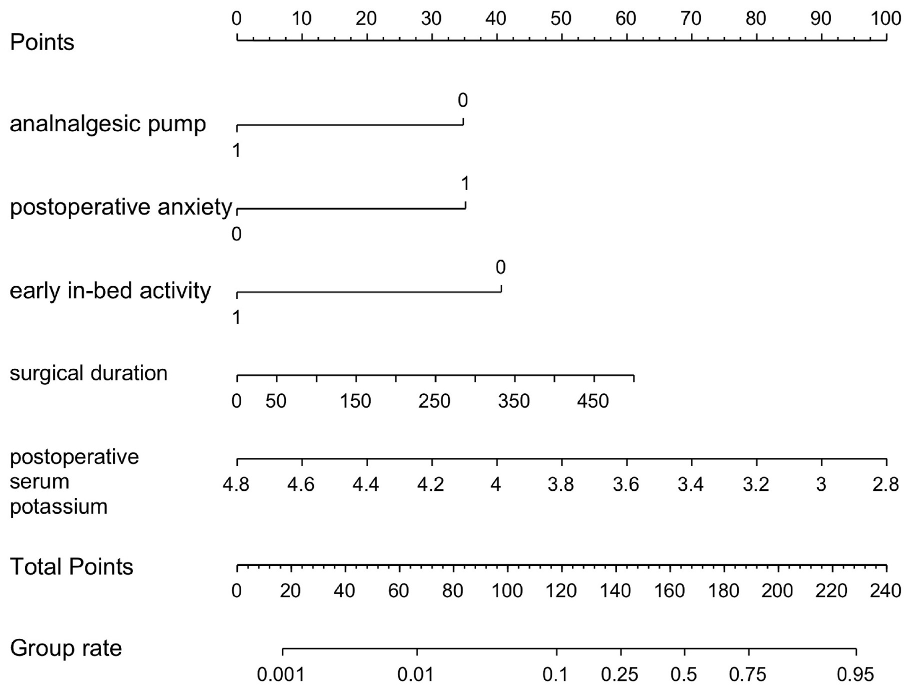

Fig. 2. Nomogram for predicting the risk of delayed flatus discharge within 24 hours following gynecologic laparoscopic surgery in patients. Each predictor variable indicates a corresponding score. The total score was generated by a summary of the individual scores for all predictors, and corresponds to the predicted probability of delayed flatus discharge. Variable coding: postoperative analgesic pump use: 0 = absent, 1 = present; postoperative anxiety: 1 = present, 0 = absent; early in-bed activity: 0 = activity initiated after >2 hours postoperatively, 1 = activity initiated within ≤2 hours postoperatively.

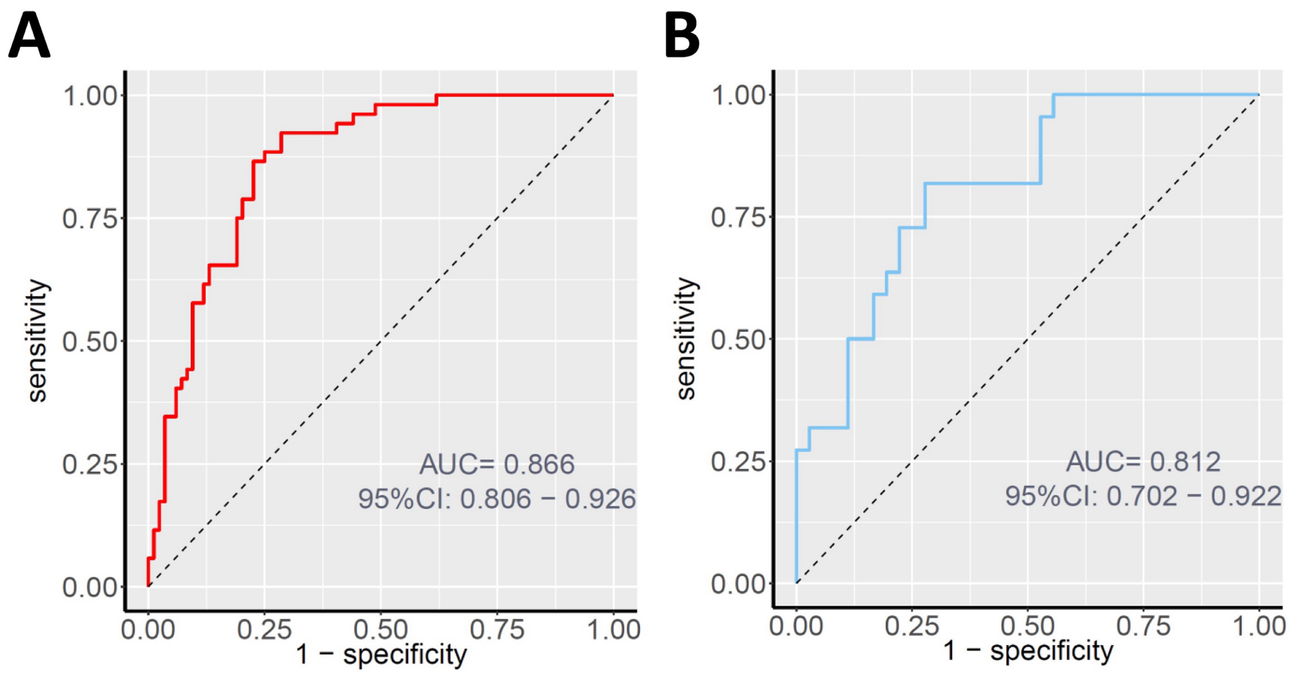

Fig. 3. ROC curve and AUC of the predictive model. (A) The ROC in the training set. (B) The ROC in the validation set. ROC, receiver operating characteristic; AUC, area under the curve.

3.2.2 Nomogram Clinical Utility Assessment

Decision curve analysis (DCA) exhibited favorable clinical utility for this model (Fig. 5). Across threshold probabilities ranging from 0.0 to 0.75, this nomogram yielded a higher net benefit than the treat-all or treat-none strategies. Therefore, within a certain range, the

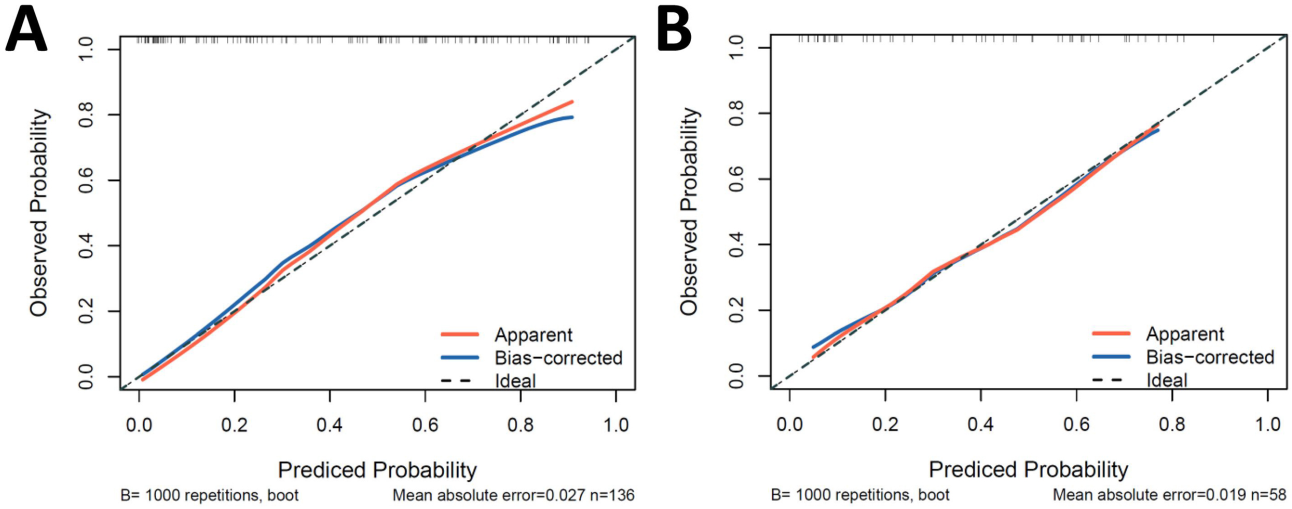

Fig. 4. Training (A) and validation (B) set calibration curves. Calibration curves were generated separately for the training and validation populations to assess the predictive accuracy of the nomogram. The calibration curve approximates the ideal diagonal, indicating good agreement between predicted and observed probabilities.

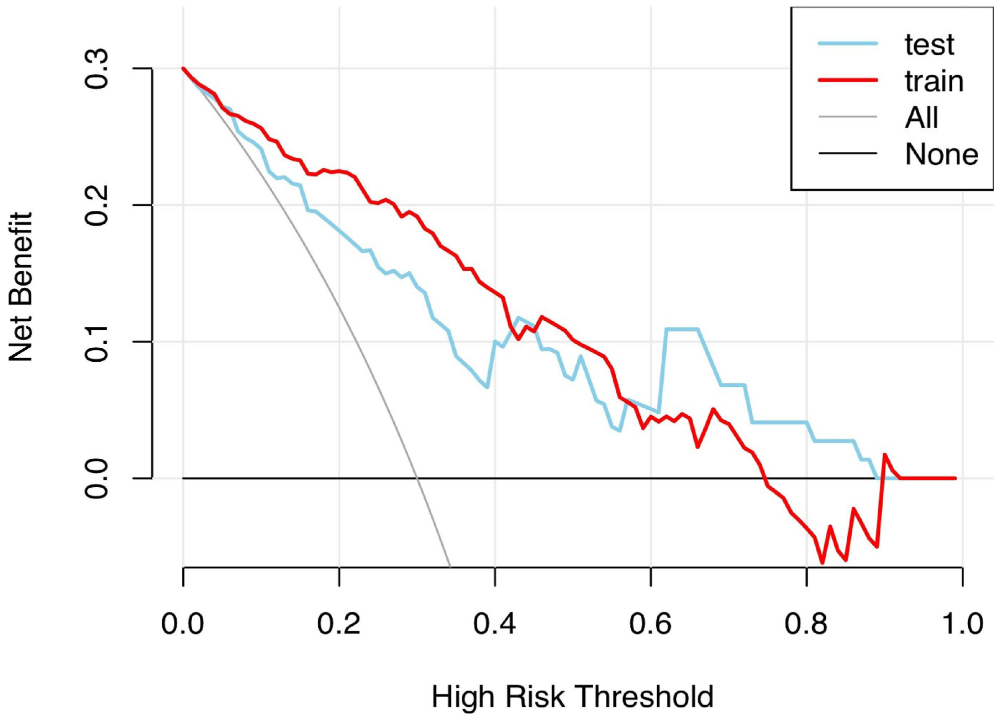

Fig. 5. DCA of the nomogram. The horizontal line represents the net benefit of the treat-none strategy (net benefit = 0). The grey solid line represents the net benefit if all patients are treated. The area enclosed between these reference lines and the nomogram curve represents the clinical utility of the nomogram. DCA, decision curve analysis.

constructed nomogram presented good clinical utility in predicting delayed flatus discharge within 24 hours after surgery.

4. Discussion

The results of this study show that the incidence of delayed flatus discharge within 24 hours after gynecologic laparoscopic surgery was 38.1%. The independent risk factors identified for this outcome were: postoperative analgesic pump usage, postoperative anxiety, early in-bed activity within 2 hours of return to the ward, surgical duration, and postoperative serum potassium level. A nomogram was constructed based on these 5 risk factors demonstrated an AUC of 0.866, indicating good predictive performance and clinical utility.

The results show that early postoperative in-bed activity can effectively promote the recovery of intestinal peristalsis and facilitate flatus discharge, consistent with the findings of Ni et al. [12], who reported that early in-bed activity can shorten the recovery time of intestinal peristalsis by stimulating the vagus nerve and increasing intestinal blood flow and smooth muscle contractility.

This study identifies postoperative anxiety as a risk factor for delayed flatus discharge, with a significant positive correlation between anxiety level and delayed recovery, consistent with the findings of Li et al. [13]. In this study, the postoperative analgesic pump contained sufentanil combined with esketamine. Although sufentanil is an opioid that may independently contribute to intestinal dysmotility, the present findings found that patient-controlled analgesia (PCA) with this combination was associated with delayed postoperative flatus passage. This phenomenon may be associated with effective postoperative pain and anxiety relief, increased frequency of early ambulation, and enhanced patient confidence in rehabilitation [14], as well as reduced air intake due to pain-related vocalization and improvements in SpO_2 and PaO_2 [15], collectively promoting rapid postoperative recovery and shortening flatus passage.

Surgical duration was identified as an independent risk factor for delayed flatus discharge, consistent with previously reported findings [16]. Firstly, prolonged laparoscopic surgery requires greater anesthetic exposure, which extends the duration of postoperative ileus [17]. Secondly, longer operative time increases the duration of abdominal surgical manipulation, stimulating catecholamine release, and thereby impairing gastrointestinal function [18], leading to intestinal distension and delaying flatus passage. Thirdly, prolonged surgical duration exacerbates the intraoperative inflammatory response, leading to impaired intestinal motility and delaying the recovery of intestinal peristalsis, thereby increasing the time to flatus. Therefore, minimizing surgical duration may effectively reduce the risk of delayed flatus discharge and promote postoperative recovery.

Postoperative serum potassium: The incidence of serum potassium levels <3.5 mmol/L during the anesthesia recovery period was approximately 43.75% [19]. Hypokalemia reduces intestinal peristalsis activity, resulting in gastrointestinal dysmotility and delayed flatus, manifesting as nausea, vomiting, and abdominal distention, and increasing the risk of serious complications such as intestinal obstruction, all of which are not conducive to postoperative recovery. These findings are consistent with previous reports [20,21]. Therefore, early postoperative assessment of serum potassium levels and timely intervention for hypokalemia may effectively reduce the risk of delayed flatus discharge within 24 hours of surgery.

Clinical application example: To illustrate the practical application of the nomogram, consider the following examples: a 56-year-old patient undergoing laparoscopic surgery with postoperative analgesia pump usage, postoperative anxiety, no in-bed activity within 2 hours of surgery, a 150-minute surgical duration, and a postoperative serum potassium level of 4.0 mmol/L. Based on the assigned scores of each variable in the nomogram, the total score was calculated as the sum of individual predictor scores: 0 + 35 + 40 + 20 + 40 = 135 points. Referring to the total score-to-risk probability scale of the nomogram, a total score of 135 corresponds to a predictive probability of delayed flatus discharge of 21.25% (risk probability = 0.213). Given that the DCA-derived clinical intervention threshold spans 0 to 0.75, this patient falls within the actionable interval, and an individualized intervention plan may be formulated based on clinical practice.

Limitations

This study has several limitations. First, the limited sample may introduce selection bias. Second, the single-center design limits the generalizability of the model. Third, the limited literature on factors affecting postoperative flatus discharge following gynecologic laparoscopy surgery may have resulted in incomplete capture of potential risk factors. Future studies should adopt multicenter, large-sample datasets and conduct external validation to confirm the generalizability and clinical applicability of the model.

5. Conclusions

In summary, nomograms have been widely adopted in predictive risk assessment and early disease diagnosis across multiple clinical fields [22]. Reports on factors influencing flatus discharge after laparoscopic surgery remain limited.

This study not only contributes to the theoretical literature on factors influencing postoperative recovery but also pioneers the construction of a nomogram for predicting the risk of delayed flatus discharge within 24 hours in patients undergoing gynecologic laparoscopic surgery. This tool enables clinicians to rapidly assess the likelihood of delayed flatus passage within 24 hours postoperatively, thereby facilitating early identification of high-risk patients and timely intervention, and ultimately achieving primary prevention of postoperative flatus retention. It also equips clinical nursing staff with a targeted framework for optimizing intestinal recovery care in this patient population, thereby contributing to improved clinical outcomes. This predictive model identifies key modifiable factors associated with delayed flatus discharge within 24 hours following gynecologic laparoscopic surgery. By targeting these factors, healthcare providers can implement evidence-based interventions, such as optimizing electrolyte balance and encouraging early in-bed activity, to shorten time to first flatus passage, thereby accelerating postoperative recovery and improving patient comfort.

Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

JZ designed the study, drafted the manuscript, developed the statistical analysis plan, revised the manuscript, and oversaw process management. ZL designed the study, drafted the manuscript, developed the statistical analysis plan, and revised the manuscript. XS was responsible for data collection and process management. WL developed the statistical analysis plan, analyzed the data, interpreted the results, and reviewed and revised the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by the ethics committee at the Jiading Branch of Shanghai General Hospital, Shanghai, China (Ethics Approval Number: [2025] 023). Our research only involves the collection, statistical analysis, and modeling of anonymized clinical data and medical records, without any interventional procedures or invasive operations. It does not impose any additional medical risks or burdens on participants. Therefore, informed consent was waived by the Ethics Committee.

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Conflicts of Interest

The authors declare no conflicts of interest.

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