Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Construction of machine-learning-based prediction models for recurrence risk in patients with acute pancreatitis: a single-center retrospective cohort study

Yinyin LI
First People's Hospital of Yunnan Province
Xiaomin LI
First People's Hospital of Yunnan Province
Lingli DAI
First People's Hospital of Yunnan Province
Mei LUO
2708221731@qq.com

First People's Hospital of Yunnan Province

Research Article

Keywords: acute pancreatitis, disease recurrence, risk factors, machine learning, prediction model, retrospective cohort study

Posted Date: November 20th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11320952/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Acute pancreatitis (AP) is a common acute gastrointestinal disease with rising global incidence and represents a frequent cause for hospital admission[1-3]. Although many patients recover after initial hospitalization, a notable subset will suffer recurrent acute pancreatitis. Repeated pancreatic inflammatory episodes increase the risk of chronic pancreatic complications, cause patient suffering and raise medical-economic burdens[4-5].

Background

Acute pancreatitis (AP) is an acute inflammatory disorder triggered by abnormal activation of pancreatic enzymes. Its global incidence is gradually rising, and it represents one of the most common gastrointestinal causes for hospital admission[1–3]. A proportion of patients progress to recurrent acute pancreatitis. Repeated episodes aggravate patient suffering, raise the long-term risk of pancreatic disorders, and consume considerable healthcare resources[4–5].

Prediction models can integrate multiple clinical and laboratory indicators to quantitatively assess individual recurrence probability and support early intervention, discharge follow-up, and health education for high-risk patients[6]. Although many prediction models focus on severity assessment of acute pancreatitis, few tools are specifically designed to predict post-discharge recurrence risk[7].

In the present study, clinical data from 486 patients with acute pancreatitis from a single tertiary hospital were collected. We screened risk factors for recurrence and compared five machine-learning algorithms to build recurrence-risk prediction models. This work aims to provide a preliminary screening tool for clinicians and clinical nurses to identify patients at high risk of recurrence.

Methods

Study design and participants

This was a single-center retrospective cohort study. Hospitalized patients diagnosed with acute pancreatitis between January 2018 and June 2024 at a tertiary-level hospital in Yunnan Province were enrolled. The full dataset was randomly split: 80 % as the training set for model construction and 20 % as the internal test set for validation. This research followed the TRIPOD reporting guideline for clinical prediction models.

Inclusion criteria

1.Diagnosis of acute pancreatitis, defined by satisfying any two of the three criteria: persistent epigastric pain; serum amylase or lipase at least three times the upper limit of normal; typical imaging findings of acute pancreatitis.

2.Age ≥ 18 years old.

Exclusion criteria

1.Acute pancreatitis induced by pregnancy or trauma.

2.Patients who withdrew treatment and were discharged against medical advice during the index admission.

3.Cases with missing key clinical or laboratory data.

Variable definition and data collection

Recurrence was defined as a new episode of acute pancreatitis meeting diagnostic criteria after recovery from the index hospitalization.

A data extraction form was developed based on published literature, clinical guidelines, and consultation with gastroenterology specialists. Collected variables included demographic characteristics, personal history, comorbidities, clinical features of AP, and laboratory test results obtained within 24 h of admission, with a total of 38 indicators.

Data were extracted from the hospital Hospital Information System (HIS). Two uniformly trained researchers performed independent double data entry. Discrepancies were resolved through review by a third investigator.

Statistical analysis and model construction

Statistical analyses were performed using R-4.4.3 and Python-3.12.0. Normally distributed continuous variables were described as mean ± standard deviation and compared using independent-sample t-test. Non-normally distributed continuous variables were presented as median (P25, P75) and compared by rank-sum test. Categorical variables were summarized as frequencies and percentages and compared with χ^2-test.

Univariate logistic regression was performed to screen potential recurrence-related variables. Variables with $P < 0.05$ and clinically meaningful variables were entered into multivariate logistic regression to identify independent risk factors for recurrence.

Five algorithms were applied: Logistic Regression (LR), Random Forest (RF), Support Vector Machine (SVM), Back-Propagation Neural Network (BPNN), and XGBoost. Model discrimination was evaluated by AUC, sensitivity, specificity, and accuracy. For calibration assessment, the Hosmer-Lemeshow test was used for the logistic regression model. For RF, SVM, BPNN, and XGBoost, decile-stratified calibration curves were generated to assess calibration performance.

Ethics approval and consent to participate

This retrospective cohort study was approved by the Clinical Research Ethics Committee of the First People's Hospital of Yunnan Province (Ethics approval No. KHLL-LCYJ2026-131). Since this was a retrospective observational study using anonymized historical data extracted from the hospital HIS system, the requirement for individual patient informed consent was waived by the ethics committee. All research procedures were performed in accordance with the Declaration of Helsinki.

Clinical trial number:

not applicable.

Results

Baseline clinical characteristics of participants

A total of 486 patients with acute pancreatitis were enrolled, including 167 patients with recurrence and 319 patients without recurrence. Statistically significant differences between the two groups were observed for age, etiology, precipitating factors, SIRS, disease severity, triglyceride (TG), D-dimer (DD), and fibrinogen degradation products (FDP) ($P < 0.05$). No significant inter-group differences were found for the remaining variables (Table 1).

Table 1 Baseline clinical characteristics of patients with and without recurrence of acute pancreatitis

Variables	AP recurrent group	AP non-recurrent group	χ^2/Z value	**P** value
Age, years				
<50	111	182	4.057	0.044
≥50	56	137		
Gender				
Male	116	205	1.321	0.25
Female	51	114		
Education level				
Illiterate	1	2	7.05	0.133
Primary school	21	65		
Middle school	78	119		
College and above	67	133		
BMI, kg/m²				
<24	78	135	0.857	0.355
≥24	89	184		
Dietary habits				
Light diet	57	104	0.116	0.734
Spicy and greasy diet	110	215		
Sleep status				
Normal	116	212	0.451	0.502
Frequent dreaminess and easy awakening	51	107		
Smoking history				
Yes	81	136	1.528	0.216
No	86	183		
Drinking history				
Yes	61	197	0.138	0.711
No	106	122		

Variables	AP recurrent group	AP non-recurrent group	χ^2/Z value	**P** value
Hypertension				
Yes	32	78	1.752	0.186
No	135	241		
Diabetes mellitus				
Yes	28	43	0.949	0.33
No	139	276		
Fatty liver				
Yes	92	176	0.0	0.986
No	75	143		
Etiology				
Biliary	93	193	10.853	0.013
Hyperlipidemic	21	58		
Alcoholic	51	59		
Others	2	9		
Predisposing factors				
None	49	123	6.482	0.039
High-fat diet	106	164		
Alcohol consumption	12	32		
SIRS				
Yes	24	24	5.775	0.016
No	143	295		
Pseudocyst				
Yes	11	12	1.94	0.164
No	156	307		
Sepsis				
Yes	5	8	0.1	0.752
No	162	311		

Variables	AP recurrent group	AP non-recurrent group	χ^2/Z value	**P** value
Disease severity				
Mild	89	243	28.36	<0.01
Moderately severe	58	63		
Severe	20	13		
HCT[M(P_{25},P_{75}),L/L]	0.421(0.387,0.453)	0.419(0.385,0.453)	-0.115	0.908
Hb[M(P_{25},P_{75}),g/L]	144(132,155)	141(129,157)	-0.499	0.618
ANC[M(P_{25},P_{75}),10^9/L]	6.84(4.27,9.7)	6.32(4.29,9.32)	-0.916	0.36
PLT[M(P_{25},P_{75}),10^9/L]	210(172,259)	216(174,266)	-0.625	0.532
RBC[M(P_{25},P_{75}),10^9/L]	4.69(4.24,5.03)	4.68(4.21,5.14)	-0.244	0.807
WBC[M(P_{25},P_{75}),10^9/L]	8.76(6.46,11.99)	8.84(6.4,11.54)	-0.749	0.454
CRP[M(P_{25},P_{75}),mg/L]	33.392(6.52,121.34)	37.75(7.33,104.04)	-0.508	0.611
ALB[M(P_{25},P_{75}),g/L]	39.8(34.6,42.9)	39.8(35.7,42.4)	-0.046	0.963
AMY[M(P_{25},P_{75}),U/L]	129(61,304)	99(52,424)	-0.776	0.438
BUN[M(P_{25},P_{75}),mmol/L]	4(3.1,5.4)	4.2(3,5.5)	-0.544	0.587
TC[M(P_{25},P_{75}),mmol/L]	5.17(3.86,6.59)	4.88(3.99,5.95)	-1.223	0.221
Ca[M(P_{25},P_{75}),mmol/L]	2.16(2.06,2.25)	2.15(2.05,2.24)	-0.77	0.441
Scr[M(P_{25},P_{75}),umol/L]	64(52,76)	61(52,73)	-0.905	0.366
GLU[M(P_{25},P_{75}),mmol/L]	5.8(4.6,8.5)	5.3(4.4,7.6)	-1.804	0.071
K[M(P_{25},P_{75}),mmol/L]	3.9(3.6,4.2)	3.84(3.6,4.12)	-1.583	0.113
LPS[M(P_{25},P_{75}),U/L]	203(67,695)	172(56,770)	-0.971	0.331
TBIL[M(P_{25},P_{75}),umol/L]	16.1(11.7,22)	15.8(11.35,23)	-0.198	0.843
TG[M(P_{25},P_{75}),mmol/L]	2.45(1.32,5.78)	2(1.06,3.66)	-2.895	0.004
CT[M(P_{25},P_{75}),ng/ml]	0.083(0.04,0.255)	0.077(0.039,0.22)	-0.458	0.647

Variables	AP recurrent group	AP non-recurrent group	χ^2/Z value	**P** value
DD[M(P_{25},P_{75}),ug/ml]	1.4□0.54□2.81□	0.84□0.42□2.24□	-3.001	0.003
FDP[M(P_{25},P_{75}),ug/ml]	4.79□2.45□10.41□	4.09□2.24□8.11□	-2.222	0.026
FIB[M(P_{25},P_{75}),g/L]	4.51□3.44□6.31□	4.46□3.54□5.97□	-0.068	0.946

Logistic-regression analysis of recurrence risk factors

Univariate logistic regression indicated that age, SIRS, disease severity, TG, DD, and FDP were associated with recurrence of acute pancreatitis. Variables with statistical significance in univariate analysis plus clinically relevant variables were included in multivariate logistic regression. The results showed that BMI, disease severity, serum calcium, TG, DD, and FDP were independent risk factors for recurrence (Table 2, Table 3).

Table 2 Univariate logistic regression analysis for recurrence of acute pancreatitis

Variables	**β**value	**S.E**value	**Z**value	**OR** value（**95%CI**）	**P** value
Age	0.4	0.199	4.037	1.492(1.01-2.204)	0.045
Gender	-0.235	0.205	1.318	0.791（0.529-1.181）	0.251
Education level	0.119	0.123	0.93	1.126（0.885-1.434）	0.335
BMI	0.178	0.192	0.856	1.195（0.82-1.741）	0.355
Dietary habits	-0.069	0.202	0.116	0.933（0.628-1.388）	0.734
Sleep status	0.138	0.206	0.45	1.148（0.767-1.718）	0.502
Smoking history	0.237	0.192	1.526	1.267（0.87-1.846）	0.217
Drinking history	-0.073	0.198	0.138	0.929（0.631-1.369）	0.711
Hypertension	-0.311	0.236	1.744	0.732（0.461-1.163）	0.187
Diabetes mellitus	0.257	0.264	0.946	1.293（0.77-2.17）	0.331
Fatty liver	-0.003	0.192	0.000	0.997(0.684-1.452)	0.986
Etiology	0.166	0.105	2.511	1.181（0.961-1.451）	0.113
Predisposing factors	0.17	0.156	1.184	1.185(0.873-1.608)	0.277
SIRS	0.724	0.306	5.595	2.063(1.132-3.759)	0.018
Pseudocyst	0.59	0.429	1.893	1.804(0.778-4.181)	0.169
Sepsis	0.182	0.578	0.099	1.2(0.386-3.727)	0.753
Disease severity	0.802	0.157	25.974	2.229(1.638-3.305)	0.000
HCT	-0.465	1.647	0.08	0.628（0.025-15.86）	0.778
Hb	0.001	0.004	0.016	1.001（0.992-1.009）	0.899
ANC	0.033	0.024	1.847	1.034（0.986-1.084）	0.174
PLT	0.000	0.901	0.088	1（0.997-1.002）	0.767
RBC	-0.044	0.133	0.109	0.957（0.737-1.243）	0.741
WBC	0.027	0.023	1.408	1.028（0.982-1.075）	0.235
CRP	0.002	0.001	2.1	1.002（0.999-1.004）	0.147
ALB	-0.004	0.008	0.317	0.996（0.981-1.011）	0.573
AMY	0.000	0.000	1.373	1（0.999-1）	0.241
BUN	-0.01	0.023	0.189	0.99（0.946-1.036）	0.664
TC	0.081	0.042	3.74	1.085（0.999-1.178）	0.053

Variables	**β**value	**S.E**value	**Z**value	**OR** value（**95%CI**）	**P** value
Ca	0.237	0.577	0.169	1.268（0.409-3.93）	0.681
Scr	0.002	0.002	0.73	1.002（0.997-1.007）	0.393
GLU	0.033	0.023	2.039	1.034（0.988-1.083）	0.153
K	0.37	0.215	2.973	1.448（0.951-2.206）	0.085
LPS	0.000	0.000	0.721	1（0.999-1.002）	0.396
TBIL	0.001	0.004	0.061	1.001（0.994-1.008）	0.805
TG	0.044	0.014	9.625	1.045（1.016-1.075）	0.002
CT	0.015	0.025	0.348	1.015（0.966-1.066）	0.555
DD	0.119	0.037	10.354	1.127（1.048-1.212）	0.001
FDP	0.024	0.01	5.824	1.024（1.005-1.044）	0.016
FIB	0.004	0.053	0.007	1.004（0.905-1.115）	0.934

Table 3 Multivariate logistic regression analysis for recurrence of acute pancreatitis

Variables	**B** value	**S.E** value	**Z**value	**OR** value（95%CI）	**P** value
Age	0.114	0.256	0.197	1.121（0.678-1.852）	0.657
Education level	-0.022	0.143	0.023	0.978（0.739-1.295）	0.879
BMI	0.592	0.233	6.443	1.807（1.144-2.854）	0.011
Dietary habits	-0.139	0.232	0.358	0.87（0.552-1.372）	0.55
Etiology	0.085	0.121	0.495	1.089（0.859-1.381）	0.482
Predisposing factors	0.186	0.179	1.086	1.205（0.849-1.71）	0.297
SIRS	-0.319	0.415	0.589	0.727（0.322-1.641）	0.443
Pseudocyst	0.223	0.476	0.218	1.249（0.491-3.178）	0.64
Sepsis	-1.361	0.719	3.584	0.257（0.063-1.049）	0.058
Disease severity	1.076	0.231	21.669	2.934（1.865-4.617）	0.000
CRP	0.000	0.001	0.011	1（0.997-1.003）	0.915
AMY	0.000	0.001	2.082	1（0.999-1）	0.149
TC	-0.022	0.076	0.081	0.978（0.843-1.136）	0.775
Ca	1.865	0.759	6.043	6.453（1.459-28.538）	0.014
GLU	-0.008	0.031	0.063	0.992（0.934-1.054）	0.802
K	0.187	0.252	0.552	1.206（0.736-1.975）	0.457
TG	0.052	0.026	3.911	1.053（1-1.109）	0.048
DD	0.226	0.085	7.108	1.254（1.062-1.481）	0.008
FDP	-0.032	0.022	1.974	0.969（0.927-1.013）	0.16

Performance of machine-learning prediction models

The samples were randomly divided into two groups in a 8:2 ratio (training set and test set). RF, SVM, LR, BPNN, and XGBoost models were constructed for predicting the recurrence of acute pancreatitis. The discrimination and calibration results of these five machine learning models are shown in Table 4, Figure 1, and Figure 2. In terms of discrimination, the Random Forest model had the highest AUC value in the test set (0.751); followed by Support Vector Machine (0.743) and XGBoost (0.691). Regarding calibration, the Hosmer-Lemeshow test showed that the predicted probabilities from Logistic Regression (P=0.793), XGBoost (P=0.226), and Random Forest (P=0.100) did not differ significantly from the actual recurrence rate. Considering both discrimination and calibration, the Random Forest model achieved the

best balance between them (AUC=0.751, HLP=0.100). Therefore, the Random Forest model was chosen as the final model for predicting the risk of recurrence.

Table 4 Prediction performance of five machine-learning models in training set and test set

Model	AUC	Sensitivity	Specificity	Accuracy
Test set				
RF	0.7512	0.7041	0.1111	0.9296
SVM	0.7433	0.7245	0.0000	1.0000
LR	0.6886	0.7347	0.1111	0.9718
BPNN	0.4377	0.7245	0.0000	1.0000
XGBoost	0.6907	0.7347	0.2593	0.9155
Training set				
RF	0.9151	0.7680	0.1852	0.9929
SVM	0.7786	0.7216	0.0000	1.0000
LR	0.6681	0.7191	0.0556	0.9750
BPNN	0.4185	0.7216	0.0000	1.0000
XGBoost	0.9971	0.9562	0.8611	0.9929

Discussion

Recurrent acute pancreatitis repeatedly damages pancreatic tissue, increases risks of chronic pancreatic diseases, and brings heavy economic burden to patients. In this cohort, the recurrence rate among AP patients reached 34.4 %, which is consistent with previously reported ranges in domestic studies[7]. Therefore, recurrence-risk assessment, stratified follow-up, and health education after discharge are essential components of clinical and nursing practice[8].

Risk factors for recurrence of acute pancreatitis

BMI, disease severity, serum calcium, triglyceride, D-dimer, and fibrinogen degradation products were independent risk factors for recurrence in the present study. Hypertriglyceridemia is a well-recognized risk factor for recurrence[9]. Elevated BMI and hypertriglyceridemia are closely related to metabolic

disturbance, which may trigger repeated pancreatic inflammatory activation. Increased D-dimer and FDP reflect hypercoagulable and inflammatory status, suggesting that coagulation system activation may participate in the progression of recurrent AP[10]. Differences in coagulation-fibrinolysis indicators exist among different etiological subtypes of acute pancreatitis[11]. Several laboratory indicators related to coagulation and inflammation have shown predictive potential for acute pancreatitis outcomes[12], and combined biomarkers including D-dimer can assist risk evaluation for hypertriglyceridemic acute pancreatitis[13]. Nevertheless, some traditional risk factors such as drinking and biliary etiology were not identified as independent predictors in our multivariate analysis, which may be related to the single-center source and case composition of our cohort.

Poor control of serum triglyceride significantly increases relapse risk even after resolution of the initial episode. Patients with moderate-to-severe acute pancreatitis suffer more substantial pancreatic injury and altered pancreatic microenvironment, leading to higher recurrence risk. Elevated BMI was also independently associated with recurrence, suggesting that weight management should be integrated into post-discharge transitional care. For patients at high recurrence risk, clinical nursing should strengthen discharge-related health education[14], focus on lipid control and dietary guidance[15], arrange regular laboratory re-examinations[16], and increase follow-up frequency to reduce recurrence probability[17],[18]. Dietary factors also play an important role in the relapse of biliary and hypertriglyceridemic acute pancreatitis[19-20]. Domestic meta-analysis also emphasized the high recurrence burden of acute pancreatitis in Chinese population[21-22].

Application value of machine-learning prediction models

Five machine-learning algorithms were compared for predicting recurrence risk of acute pancreatitis. Random Forest achieved the relatively best comprehensive performance with a test-set AUC of 0.751 corresponding to moderate discriminative power. SVM, BPNN, and XGBoost exhibited prominent over-fitting phenomena and limited generalizability in the present single-center dataset.

Machine-learning models can integrate multiple clinical and laboratory indicators to output individualized recurrence probability, and are suitable for preliminary risk stratification during nursing-led post-discharge follow-up. Nevertheless, the optimal model in this study only achieved moderate AUC performance. It should be used solely for initial risk screening and cannot serve as the sole basis for clinical decision-making[23].

Innovations and limitations of this study

Innovations: This study compared multiple machine-learning algorithms for constructing recurrence-risk prediction models for acute pancreatitis. The Random Forest model with relatively balanced performance was identified. Predictors adopted in this model are routine admission laboratory indicators, which facilitates potential application within clinical-nursing scenarios and provides a preliminary screening tool for recurrent acute pancreatitis.

Limitations:

This is a single-center retrospective study with a limited sample size and no external validation cohort, so the generalizability of the model remains to be verified.

Partial past-history information was extracted from medical records; information bias cannot be completely excluded.

SVM, BPNN, and XGBoost showed obvious over-fitting and poor stability in this dataset. Even the optimal Random Forest only achieved moderate discriminative power and should be used only for preliminary screening rather than definitive clinical decisions.

Only internal split-sample validation was performed. Future multi-center prospective external validation is required for parameter optimization before clinical adoption.

Conclusion

In this single-center retrospective cohort, BMI, disease severity, serum calcium, triglyceride, D-dimer, and fibrinogen degradation products were independent risk factors for recurrence of acute pancreatitis. The Random Forest model demonstrated moderate predictive performance for recurrence risk and can be used as an initial risk-screening tool in clinical and nursing follow-up. Further multi-center external validation and optimization are required before wide-ranging clinical application.

Declarations

Consent for publication

Not applicable.

Availability of data and materials

The raw clinical data used in this study were extracted from the Hospital Information System (HIS) of The First People's Hospital of Yunnan Province. The de-identified case dataset table was created during data collection and double-entry verification. Due to hospital patient privacy regulations and data protection restrictions, the raw dataset cannot be publicly deposited. However, the anonymized dataset supporting the conclusions of this study is available from the corresponding author upon reasonable request after approval by the hospital ethics committee.

Competing interests

The authors declare that they have no competing interests.

References

1. Lee PJ, Papachristou GI. New insights into acute pancreatitis. Nat Rev Gastroenterol Hepatol. 2019;16(8):479–496. doi:10.1038/s41575-019-0158-2.
2. Iannuzzi JP, King JA, Leong JH, et al. Global incidence of acute pancreatitis is increasing over time: a systematic review and meta-analysis. Gastroenterology. 2022;162(1):122–134. doi:10.1053/j.gastro.2021.09.043.
3. Petrov MS, Yadav D. Global epidemiology and holistic prevention of panc-reatitis. Nat Rev Gastroenterol Hepatol. 2019;16(3):175–184. doi:10.1038/s41575-018-0087-5.
4. Côté GA, Yadav D, Abberbock JA, et al. Recurrent acute pancreatitis significantly reduces quality of life even in the absence of overt chronic pancr-eatitis. Am J Gastroenterol. 2018;113(6):906–912. doi:10.1038/ajg.2018.114.
5. Munigala S, Almaskeen S, Subramaniam DS, et al. Acute pancreatitis recurrences augment long-term pancreatic cancer risk. Am J Gastroenterol. 2023;118(4):727–737. doi:10.1038/s41575-023-00864-7.
6. Anderson KM, Wilson PW, Odell PM, et al. An updated coronary risk profile. A statement for health professionals. Circulation. 1991;83(1):356–362. doi:10.1161/01.CIR.83.1.356.
7. Ban MM, Shi LG, Wang D, et al. Research progress on risk factors of recurrent acute pancreatitis (in Chinese). J Dalian Med Univ. 2018;40(2):171–175,180.
8. Zerem E, Kurtcehajic A, Kunosić S, et al. Current trends in acute pancreatitis: diagnostic and therapeutic challenges. World J Gastroenterol. 2023;29(18):2747–2763. doi:10.3748/wjg.v29.i18.2747.
9. Gómez Pérez A, Aparicio Serrano A, Serrano Ruiz FJ. Etiological diagnosis of recurrent acute pancreatitis. Rev Esp Enferm Dig. 2024;116(8):399–403. doi:10.17235/reed.2024.9872/2024.
10. Wang JY, Liu YN, Chen HY, et al. Effect of Dachaihu decoction combined with phloroglucinol on pancreatitis and serum interleukin-6 and D-dimer levels (in Chinese). Chin J Surg Integr Tradit West Med. 2026;32(1):60–64.
11. Wang XQ, Qi WJ. Comparison of coagulation-fibrinolysis indexes between hypertriglyceridemic and biliary acute pancreatitis (in Chinese). Chin Crit Care Med. 2025;37(11):1040–1046.
12. Li PK, Yin XW. Value of C-reactive protein/albumin combined with D-dimer for predicting severity of acute pancreatitis (in Chinese). Chin J Med Eng. 2023;31(8):23–28.
13. Cui Y, Wang XY, Zhang J. Predictive value of serum CRP-albumin ratio combined with D-dimer for early-stage hypertriglyceridemic acute pancreatitis (in Chinese). Chin J Clin Doct. 2023;51(11):1330–1333.
14. Abou Saleh M, Chouhan V, Mansoor E, et al. Characterization of long-term prognosis in acute pancreatitis: an explorative analysis. Pancreatology. 2019;19(1):163–168. doi:10.1016/j.pan.2018.10.014.

15. Zhang XY, Zhu J, Zhang XW, et al. Effect of WeChat-based transitional nursing on recurrence and readmission rate of patients with acute pancreatitis (in Chinese). Chin J Pract Nurs. 2020;36(1):26–30.
16. Mao J, Pan WM, Li Y, et al. Follow-up nursing intervention for patients with biliary acute pancreatitis: effects on treatment compliance and recurrence (in Chinese). Nurs Res. 2025;39(13):2264–2269.
17. Zhang HH, Wang KH, Xu Y. Multidisciplinary transitional nursing on health-related quality of life for patients with acute pancreatitis (in Chinese). J Clin Res. 2023;31(8):147–150.
18. Dong YH, Gu H, Wang R. Step-wise dietary intervention strategy for middle-aged patients based on behavior change theory (in Chinese). Hebei Med J. 2024;46(14):2234–2237.
19. Coutinho L, Bernardo WM, Rocha RS, et al. Early endoscopic retrograde cholangiopancreatography versus conservative treatment in patients with acute biliary pancreatitis: systematic review and meta-analysis of randomized controlled trials. Pancreas. 2018;47(4):444–453. doi:10.1097/MPA.0000000000001031.
20. Setiawan VW, Pandol SJ, Porcel J, et al. Dietary factors reduce risk of acute pancreatitis in a large multiethnic cohort. Clin Gastroenterol Hepatol. 2017;15(2):257–265. doi:10.1016/j.cgh.2016.09.015.
21. Guo YJ, Song W, Li XY, et al. Meta-analysis of etiology and clinical characteristics of recurrent acute pancreatitis in China in recent ten years (in Chinese). Chin J Pancreatol. 2017;17(4):231–237.
22. Cao X, Lu L. Predictive value of TyG-BMI and AIP for recurrent acute pancreatitis in type 2 diabetic patients (in Chinese). Chin J Convalescent Med. 2025;34(12):97–101.
23. Obuchowski NA, Bullen JA. Receiver operating characteristic (ROC) curves: review of methods with applications in diagnostic medicine. Phys Med Biol. 2018;63(7):07TR01. doi:10.1088/1361-6560/aab4b1.

Figures

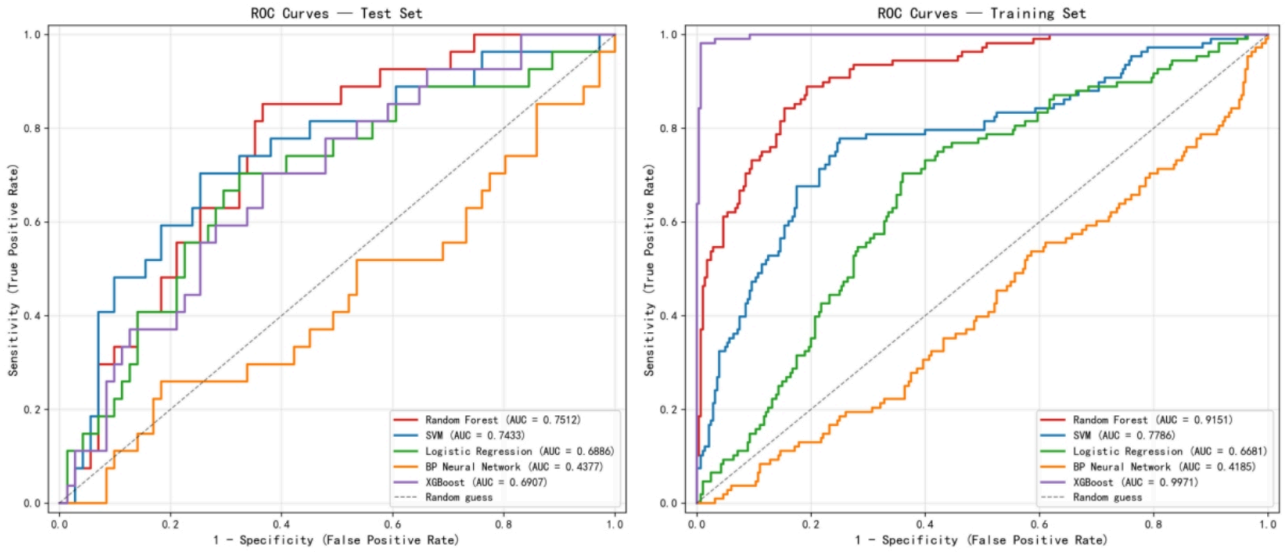


Figure 1

ROC curves of five prediction models in training set and test set

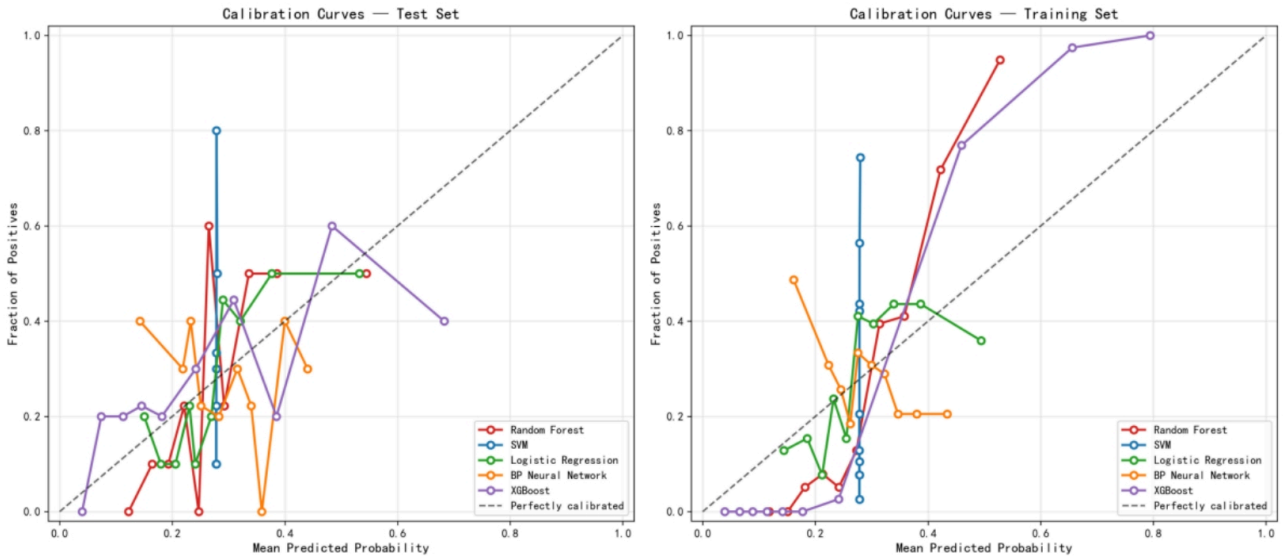


Figure 2

Calibration curves of five prediction models