

Figure S1 The calibration plots for prediction models in derivation and validation cohort. (A) For derivation cohort; (B) for validation cohort.

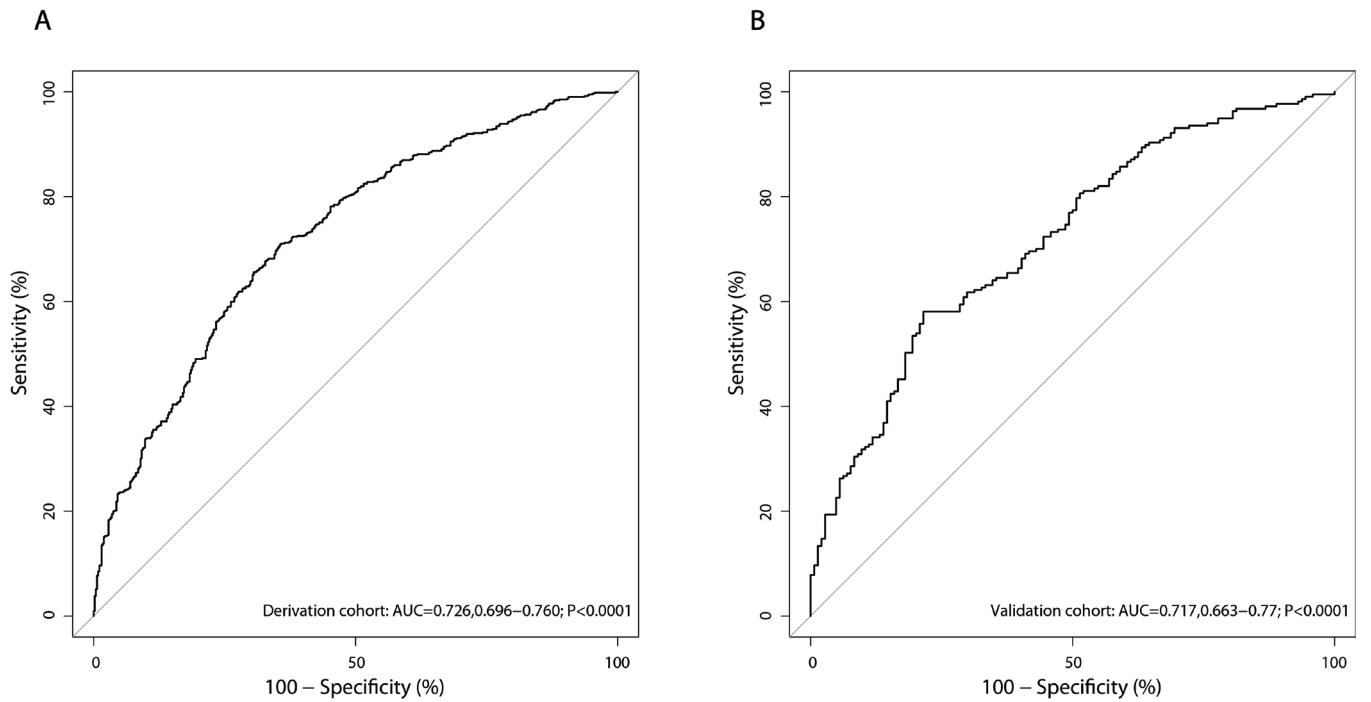


Figure S2 The receiver operating characteristic analysis of prediction models in derivation and validation cohort.

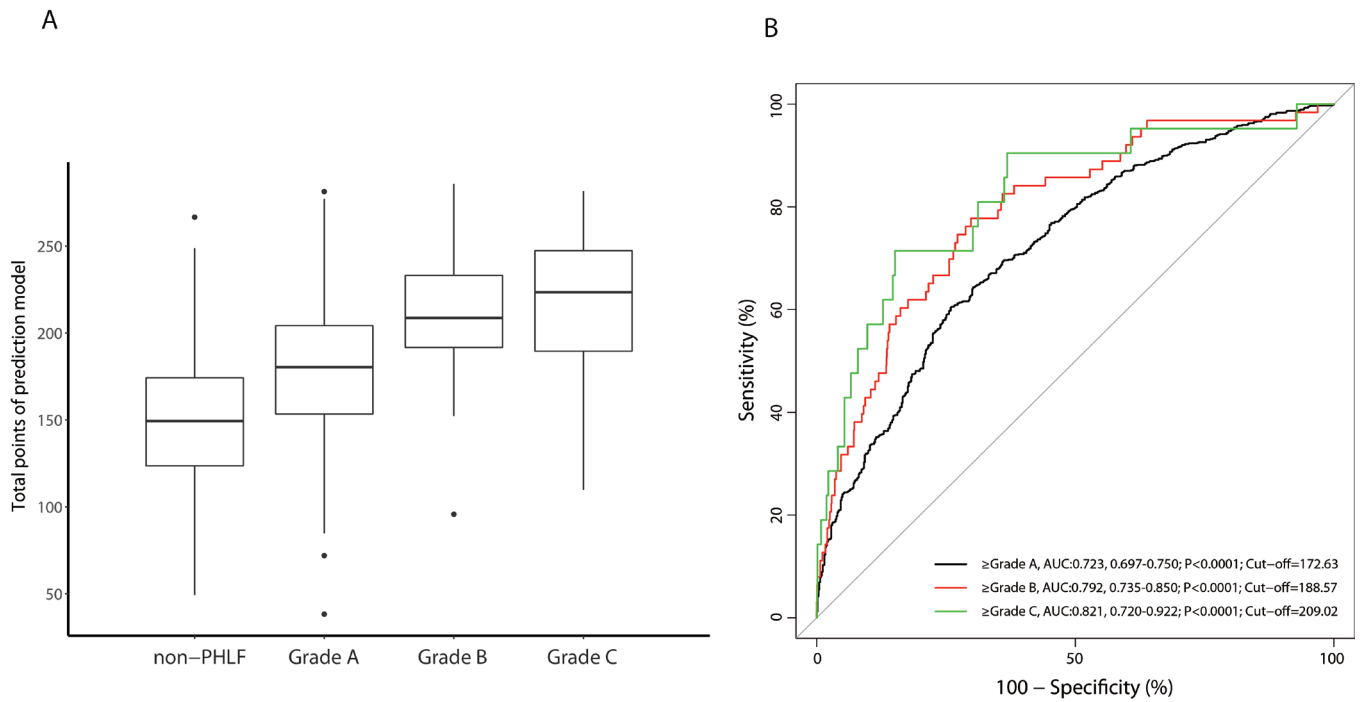


Figure S3 The box plot and receiver operating characteristic analysis for each ISGLS-PHLF grade in total cohort. (A) For box plot of total points in non-PHLF and three grades of PHLF, pairwise comparison with Nemenyi method indicated that all pairwise were significantly different except Grade B vs. Grade C ($P=0.9999$); (B) for receiver operating characteristic analysis of three PHLF grades, and the cut-off value is obtained based on the Youden index.

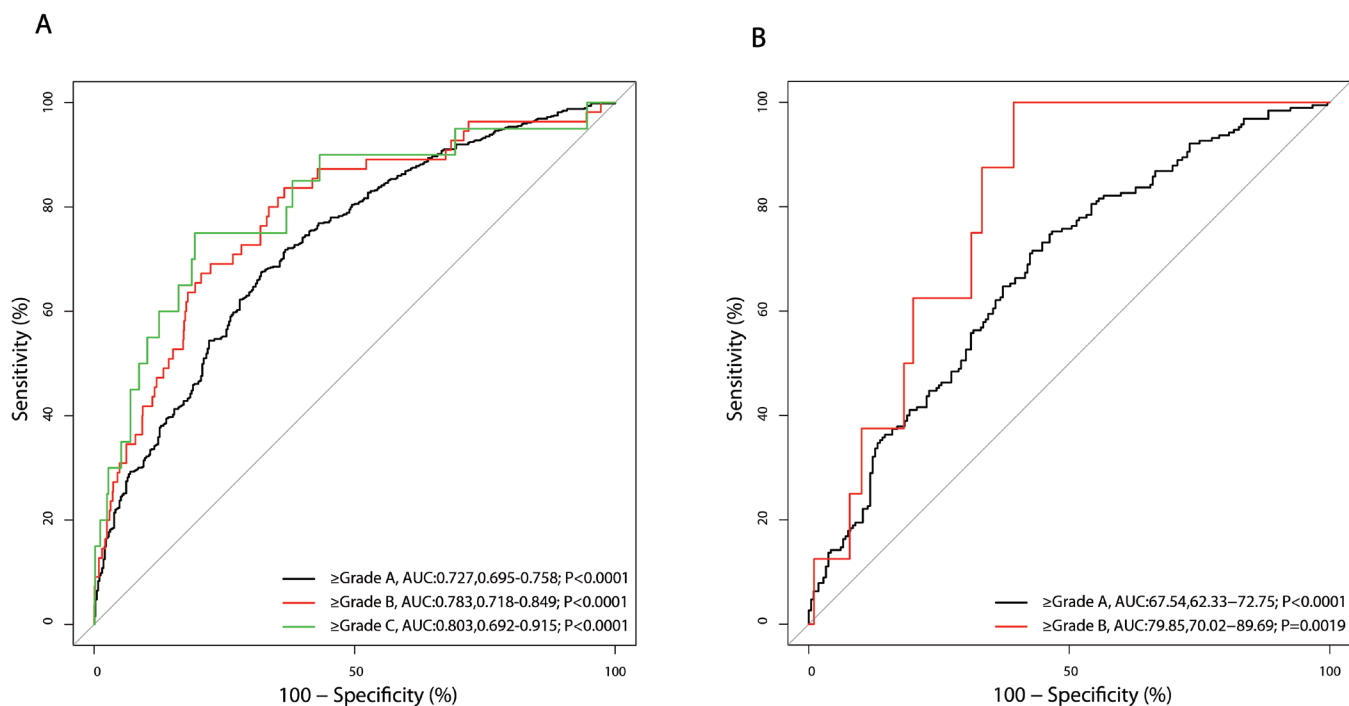


Figure S4 The receiver operating characteristic analysis for tumor and non-tumor disease in total cohort. (A) For common malignant neoplastic diseases of the liver, including hepatocellular carcinoma, intrahepatic cholangiocarcinoma, and metastatic hepatoma; (B) for hepatic hemangioma, intrahepatic cholelithiasis, and other rare occupational diseases of the hepatobiliary system (only 1 patient with grade C ISGLS-PHLF).

Table S1 Demographics and baseline characteristics in the derivation and validation cohort

Variable	Total cohort (N=1,441)	Derivation cohort (N=1,080)	Validation cohort (N=361)	P value
PHLF (yes)	839 (58.22)	622 (57.59)	217 (60.11)	0.4010
ISGLS-PHLF				0.5463
Non-PHLF	602 (41.78)	458 (42.41)	144 (39.89)	
Grade A	776 (53.85)	579 (53.61)	197 (54.57)	
Grade B	42 (2.91)	28 (2.59)	14 (3.88)	
Grade C	21 (1.46)	15 (1.39)	6 (1.66)	
Gender (female)	502 (34.84)	382 (35.37)	120 (33.24)	0.4623
Age	52.00 (44.00, 60.00)	52.00 (45.00, 60.00)	52.00 (43.00, 60.00)	0.7807
Blood type				0.9786
A	477 (33.10)	347 (32.13)	130 (36.01)	
B	371 (25.75)	290 (26.85)	81 (22.44)	
AB	144 (9.99)	115 (10.65)	29 (8.03)	
O	449 (31.16)	328 (30.37)	121 (33.52)	
BMI	22.68 (20.69, 24.90)	22.66 (20.62, 24.91)	22.86 (20.76, 24.68)	0.8521
Diabetes	23 (1.60)	14 (1.30)	9 (2.49)	0.1162
Cirrhosis	264 (18.32)	202 (18.70)	62 (17.17)	0.5155
A long history of heavy drinking	247 (17.14)	181 (16.76)	66 (18.28)	0.5061
History of chemotherapy before hepatectomy				0.3443
No	1,300 (90.22)	980 (90.74)	320 (88.64)	
TAE	124 (8.61)	87 (8.06)	37 (10.25)	
Systemic chemotherapy	17 (1.18)	13 (1.20)	4 (1.11)	
Preoperative ascites				0.1980
No	1,348 (93.55)	1,009 (93.43)	339 (93.91)	
Mild	92 (6.38)	71 (6.57)	21 (5.82)	
Moderate to severe	1 (0.07)	0 (0.00)	1 (0.28)	
Preoperative serum hemoglobin level (<130 g/L)	581 (40.32)	430 (39.81)	151 (41.83)	0.4996
Preoperative serum WBC count ($\times 10^9/L$)	5.49 (4.44, 6.77)	5.51 (4.44, 6.76)	5.45 (4.45, 6.81)	0.8512
Preoperative serum platelet count ($\times 10^9/L$)	190.00 (146.00, 248.00)	189.50 (148.00, 246.00)	191.00 (142.00, 257.00)	0.7326
Preoperative serum lymphocyte count ($\times 10^9/L$)	1.49 (1.18, 1.86)	1.49 (1.18, 1.85)	1.51 (1.16, 1.92)	0.7288
Preoperative serum neutrophil count ($\times 10^9/L$)	3.35 (2.58, 4.49)	3.36 (2.59, 4.49)	3.33 (2.55, 4.49)	0.9328
Preoperative serum creatinine level (umol/L)	64.00 (55.00, 74.00)	64.00 (55.00, 74.00)	64.00 (56.00, 73.00)	0.7251
Na ⁺ (mmol/L)	142.00 (140.00, 143.00)	142.00 (140.00, 143.00)	142.00 (140.00, 143.00)	0.6233
K ⁺ (mmol/L)	4.11 (3.90, 4.34)	4.11 (3.92, 4.34)	4.13 (3.90, 4.34)	0.5738
TBIL (umol/L)	12.40 (9.40, 16.40)	12.20 (9.40, 16.10)	12.60 (9.50, 17.30)	0.1083
DBIL (umol/L)	4.70 (3.50, 6.30)	4.70 (3.50, 6.30)	5.00 (3.60, 6.40)	0.2432
IBIL (umol/L)	7.40 (5.60, 9.80)	7.30 (5.70, 9.60)	7.70 (5.60, 10.30)	0.0935
TBA (umol/ml)				0.2419
<2.7	225 (15.61)	166 (15.37)	59 (16.34)	
2.7–5.4	405 (28.11)	316 (29.26)	89 (24.65)	
≥ 5.4	811 (56.28)	598 (55.37)	213 (59.00)	
ALT (≥ 50 U/L)	316 (21.93)	230 (21.30)	86 (23.82)	0.3152
AST (≥ 40 U/L)	534 (37.06)	389 (36.02)	145 (40.17)	0.1578
LDH (≥ 250 U/L)	217 (15.06)	164 (15.19)	53 (14.68)	0.8168
GGT (U/L)				0.5021
<60	458 (31.78)	351 (32.50)	107 (29.64)	
60–180	600 (41.64)	441 (40.83)	159 (44.04)	
≥ 180	383 (26.58)	288 (26.67)	95 (26.32)	
TP (g/L)	70.10 (66.20, 73.80)	70.10 (66.20, 73.75)	70.20 (66.60, 74.10)	0.7159
ALB (g/L)	41.50 (39.00, 43.90)	41.50 (39.00, 43.90)	41.50 (38.80, 43.90)	0.9914
GLB (g/L)	28.20 (25.40, 31.50)	28.10 (25.40, 31.50)	28.50 (25.50, 31.50)	0.5138
pALB (g/L)	221.00 (169.00, 270.00)	223.00 (169.00, 273.00)	215.00 (169.00, 260.00)	0.1097
APTT (s)	27.10 (24.90, 30.10)	27.20 (24.90, 30.10)	27.10 (25.10, 30.30)	0.7273
Preoperative serum fibrinogen concentration (g/L)	2.82 (2.29, 3.57)	2.80 (2.26, 3.58)	2.88 (2.30, 3.53)	0.5309
TT (s)	19.20 (18.20, 20.20)	19.20 (18.30, 20.15)	19.10 (18.20, 20.20)	0.6158
PT (s)	11.50 (10.90, 12.20)	11.50 (10.90, 12.20)	11.50 (11.00, 12.20)	0.8054
INR	0.96 (0.91, 1.02)	0.96 (0.91, 1.02)	0.97 (0.92, 1.02)	0.7282
Child-Pugh grade				0.7412
Grade A	1429 (99.17)	1072 (99.26)	357 (98.89)	
Grade B	12 (0.83)	8 (0.74)	4 (1.11)	
HCV-Ab (positive)	18 (1.25)	15 (1.39)	3 (0.83)	0.5806
HBs-Ag (positive)	731 (50.73)	550 (50.93)	181 (50.14)	0.7956
HBs-Ab (positive)	454 (31.51)	338 (31.30)	116 (32.13)	0.7670
HBe-Ag (positive)	167 (11.59)	123 (11.39)	44 (12.19)	0.6812
HBe-Ab (positive)	822 (57.04)	626 (57.96)	196 (54.29)	0.2227
HBc-Ab (positive)	1223 (84.87)	918 (85.00)	305 (84.49)	0.8140
Liver segment count excised				0.5925
3	742 (51.49)	549 (50.83)	193 (53.46)	
3+	120 (8.33)	95 (8.80)	25 (6.93)	
4	423 (29.35)	318 (29.44)	105 (29.09)	
4+	112 (7.77)	82 (7.59)	30 (8.31)	
≥ 5	44 (3.05)	36 (3.33)	8 (2.22)	
The segment of liver planned for resection has atrophied (yes)	320 (22.21)	248 (22.96)	72 (19.94)	0.2323
The planned reserved segment of the liver has developed compensatory hyperplasia (yes)	77 (5.34)	53 (4.91)	24 (6.65)	0.2030
Pathological diagnostic classification				0.3707
Hepatocellular carcinoma	728 (50.52)	535 (49.54)	193 (53.46)	
Intrahepatic cholangiocarcinoma	279 (19.36)	204 (18.89)	75 (20.78)	
Hepatic hemangioma	59 (4.09)	48 (4.44)	11 (3.05)	
Intrahepatic cholelithiasis	270 (18.74)	213 (19.72)	57 (15.79)	
Metastatic hepatoma	32 (2.22)	23 (2.13)	9 (2.49)	
Other rare occupational diseases of the hepatobiliary system	73 (5.07)	57 (5.28)	16 (4.43)	

Data are shown as n (%) or median (range).

Table S2 Intra-operative procedure and posthepatectomy outcomes in total cohort

Index	Non-PHLF	ISGLS-PHLF	P value
Intra-operative procedure			0.0017
Intraoperative hepatic portal block			
No	210 (34.88)	228 (27.18)	
Yes	392 (65.12)	611 (72.82)	
Intraoperative hepatic portal intermittent block			0.0241
No	528 (87.71)	700 (83.43)	
Yes	74 (12.29)	139 (16.57)	
Total intraoperative hepatic portal block time (min)	15.00 (0.00, 21.00)	18.00 (0.00, 25.00)	0.0001
Intraoperative blood loss (mL)	300.00 (200.00, 500.00)	400.00 (200.00, 800.00)	<0.0001
Intraoperative blood loss grading			<0.0001
Small	504 (83.72)	613 (73.06)	
Moderate	81 (13.46)	180 (21.45)	
Large	17 (2.82)	46 (5.48)	
Intraoperative infusion of erythrocyte suspension			<0.0001
No	494 (82.06)	572 (68.18)	
Yes	108 (17.94)	267 (31.82)	
Total amount of intraoperative infusion of erythrocyte (unit)	0.00 (0.00, 0.00)	0.00 (0.00, 3.00)	<0.0001
Posthepatectomy outcome			
Posthepatectomy ascites			<0.0001
No	587 (97.51)	714 (85.10)	
Yes	15 (2.49)	125 (14.90)	
ISGLS-PHBL			0.0002
No	554 (92.03)	726 (86.53)	
Grade A	13 (2.16)	9 (1.07)	
Grade B	34 (5.65)	103 (12.28)	
Grade C	1 (0.17)	1 (0.12)	
ISGLS-PHH			<0.0001
No	573 (95.18)	713 (84.98)	
Grade A	23 (3.82)	88 (10.49)	
Grade B	6 (1.00)	28 (3.34)	
Grade C	0 (0.00)	10 (1.19)	
Posthepatectomy intra-abdominal abscess			0.0005
No	590 (98.01)	791 (94.28)	
Yes	12 (1.99)	48 (5.72)	
Postoperative massive pleural effusion			0.0131
No	580 (96.35)	781 (93.09)	
Right	21 (3.49)	58 (6.91)	
Left	1 (0.17)	0 (0.00)	
Perioperative death			0.0002
No	602 (100.00)	820 (97.74)	
Yes	0 (0.00)	19 (2.26)	

Data are shown as n (%) or median (range). ISGLS, International Research Group of Liver Surgery; PHBL, posthepatectomy biliary leakage; PHH, posthepatectomy haemorrhage.

Table S3 Multivariable analyses of posthepatectomy outcomes in total cohort

Item	β value	OR (95% CI)	P value
Posthepatectomy ascites			
pALB (g/L)	-0.0078	0.992 (0.990-0.995)	<0.0001
Liver segment count excised			
3	-	Ref	
3+	0.2836	1.328 (0.533-3.306)	0.5423
4	1.6782	5.356 (3.378-8.493)	<0.0001
4+	1.6630	5.275 (2.817-9.878)	<0.0001
≥ 5	1.6352	5.130 (2.145-12.273)	0.0002
ISGLS-PHBL (yes vs. no)			
Cirrhosis			
No	-	Ref	
Yes	-0.6498	0.522 (0.307-0.888)	0.0165
History of chemotherapy before hepatectomy			
No	-	Ref	
TAE	0.5217	1.685 (0.988-2.872)	0.0552
Systemic chemotherapy	1.1278	3.089 (0.958-9.962)	0.0591
GGT (U/L)			
<60	-	Ref	
60-180	-0.3182	0.727 (0.474-1.116)	0.1447
≥ 180	0.3259	1.385 (0.906-2.118)	0.1325
Liver segment count excised			
3	-	Ref	
3+	0.4391	1.551 (0.808-2.979)	0.1872
4	0.7285	2.072 (1.375-3.123)	0.0005
4+	1.0352	2.816 (1.592-4.981)	0.0004
≥ 5	1.4917	4.445 (2.098-9.418)	<0.0001
The segment of liver planned for resection has atrophied			
No	-	Ref	
Yes	0.5088	1.663 (1.116-2.478)	0.0124
ISGLS-PHH (yes vs. no)			
Preoperative serum hemoglobin level (g/L)			
<130	-	Ref	
≥ 130	-0.9289	0.395 (0.279-0.560)	<0.0001
TT (s)	0.1616	1.175 (1.060-1.304)	0.0022
Liver segment count excised			
3	-	Ref	
3+	0.5245	1.690 (0.864-3.303)	0.1250
4	0.9316	2.539 (1.700-3.791)	<0.0001
4+	0.8558	2.353 (1.274-4.347)	0.0063
≥ 5	1.9472	7.009 (3.461-14.194)	<0.0001
Posthepatectomy intra-abdominal abscess			
Preoperative serum lymphocyte count ($\times 10^9/L$)	0.5113	1.667 (1.054-2.638)	0.0289
GGT (U/L)			
<60	-	Ref	
60-180	0.4976	1.645 (0.792-3.415)	0.1819
≥ 180	1.0532	2.867 (1.398-5.878)	0.0040
The segment of liver planned for resection has atrophied			
No	-	Ref	
Yes	1.3308	3.784 (2.097-6.828)	<0.0001
The planned reserved segment of the liver has developed compensatory hyperplasia			
No	-	Ref	
Yes	1.0580	2.881 (1.379-6.019)	0.0049
Postoperative massive pleural effusion			
Na+ (mmol/L)	-0.1797	0.836 (0.756-0.924)	0.0004
pALB (g/L)	-0.0060	0.994 (0.990-0.998)	0.0014
Liver segment count excised			
3	-	Ref	
3+	1.1608	3.192 (1.302-7.831)	0.0112
4	1.3661	3.920 (2.108-7.289)	<0.0001
4+	1.9286	6.880 (3.180-14.884)	<0.0001
≥ 5	1.5215	4.579 (1.504-13.941)	0.0074
Pathological diagnostic classification			
Hepatocellular carcinoma	-	Ref	
Intrahepatic cholangiocarcinoma	0.5595	1.750 (0.955-3.206)	0.0701
Hepatic hemangioma	-0.6336	0.531 (0.068-4.118)	0.5444
Intrahepatic cholelithiasis	0.6806	1.975 (0.900-4.336)	0.0898
Metastatic hepatoma	1.1211	3.068 (0.953-9.876)	0.0602
Other rare occupational diseases of the hepatobiliary system	1.5806	4.858 (2.084-11.322)	0.0003
Perioperative death			
Age	0.0662	1.068 (1.017-1.122)	0.0082
Preoperative serum platelet count ($\times 10^9/L$)	-0.0192	0.981 (0.972-0.990)	<0.0001
ALT (U/L)			
<50	-	Ref	
≥ 50	1.2719	3.568 (1.373-9.271)	0.0090
GLB (g/L)	0.1328	1.142 (1.050-1.242)	0.0020

The variables in Table 1 were included in multivariable logistic regression model. The stepwise selection method was used in multivariable logistic regression ($\alpha_{\text{step}}=0.05, \alpha_{\text{stop}}=0.10$).

Table S4 Analyses of preoperative serum creatinine level in male and female patients (umol/L)

Population	Non-PHLF	ISGLS-PHLF	P value
Total cohort			0.2260
Male			
Number of patients	318	621	
Mean (SD)	71.13 (12.85)	69.95 (11.84)	
Median (Q1, Q3)	70.00 (63.00, 78.00)	70.00 (62.00, 77.00)	
Female			0.0099
Number of patients	284	218	
Mean (SD)	55.56 (9.44)	53.57 (9.92)	
Median (Q1, Q3)	55.00 (49.00, 61.00)	52.00 (47.00, 59.00)	
Derivation cohort			
Male			0.0907
Number of patients	240	458	
Mean (SD)	71.62 (13.31)	69.84 (12.16)	
Median (Q1, Q3)	71.00 (63.00, 79.50)	69.00 (62.00, 77.00)	
Female			0.0252
Number of patients	218	164	
Mean (SD)	39.00, 123.00	35.00, 174.00	
Median (Q1, Q3)	55.00 (49.00, 61.00)	52.50 (46.00, 59.00)	
Validation cohort			
Male			0.5971
Number of patients	78	163	
Mean (SD)	69.63 (11.27)	70.25 (10.94)	
Median (Q1, Q3)	68.50 (63.00, 75.00)	70.00 (62.00, 77.00)	
Female			0.1959
Number of patients	66	54	
Mean (SD)	55.91 (10.60)	53.48 (8.90)	
Median (Q1, Q3)	55.00 (49.00, 62.00)	52.00 (48.00, 59.00)	

Data are shown as n (%) or median (range).