

# ABC score is an effective predictor of outcomes in peptic ulcer bleeding

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## Research Article

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# Abstract

## Background

Risk stratification is recommended for patients presenting with gastrointestinal bleeding. The ABC score is a new scoring tool with high accuracy for both upper and lower gastrointestinal bleeding. This study aimed to evaluate the effectiveness of the ABC score in predicting the outcomes of patients with peptic ulcer bleeding.

## Methods

This single-center retrospective study was conducted between October 2011 and March 2021. We identified 812 patients presenting with symptoms of upper gastrointestinal hemorrhage who were diagnosed with ulcerative lesions on endoscopy. The association between the ABC score's variables and the patients' outcome was analyzed using the chi-square test, Fisher's exact test, and t-test. Additionally, the performance of the score in predicting the patients' outcome was validated using ROC curve analysis and compared to the performance of other scores.

## Results

A total of 772 patients with peptic ulcer bleeding were analyzed. The primary outcome measure (20 patients) was all-cause 30-day mortality. Secondary outcome measures (91 patients) included rebleeding within 30 days and need for radiologic/surgical intervention. Age ( $p = 0.013$ ), serum albumin ( $p < 0.001$ ), serum creatinine ( $p = 0.004$ ), mental status ( $p < 0.001$ ), and ASA score ( $p < 0.001$ ) were factors associated with the primary outcome. The ABC score was 7, with a sensitivity of 90.0% and a specificity of 86.0%. It predicted the primary outcome with good accuracy (area under the receiver operating characteristic curve [AUROC] 0.927; 95% confidence interval [CI] 0.899–0.956), surpassing other scores. However, it was less accurate in predicting rebleeding (AUROC 0.630; 95% CI 0.563–0.697) and need for radiologic/surgical intervention (AUROC 0.641; 95% CI 0.550–0.732).

## Conclusions

The ABC score is a good predictor of 30-day mortality in patients with peptic ulcer bleeding. However, it may not be suitable for predicting rebleeding or the need for radiologic/surgical interventions.

## Background

Acute upper gastrointestinal bleeding (UGIB) is an emergency condition with high morbidity and economic burden [1, 2]. The reported incidence of UGIB is 37–172/100,000 adults [3, 4]. Peptic ulcer disease (PUD) is the main cause of bleeding and is responsible for 28–59% of UGIB cases [5]. Despite advances in the treatment of PUD, such as endoscopic techniques and anti-ulcer medication, it is still associated with a high admission rate and mortality [6]. Several factors may increase the incidence of

PUD, such as age and use of non-steroidal anti-inflammatory drugs [7]. Elderly patients have more comorbidities and tend to experience worse outcomes than younger patients [8].

Patients with UGIB present with a range of severities, from insignificant bleeding to death [9]. Several prognostic systems are available to identify high-risk patients, including the Glasgow-Blatchford score (GBS) [10], AIMS65 [11], and MAP(ASH) [12] score. The ABC score is a relatively new scoring tool proposed by Laursen et al. in 2021 to predict mortality in acute upper and lower gastrointestinal (GI) bleeding [13]. The eight parameters of the ABC score are as follows: age, urea, albumin, creatinine, altered mental status, liver cirrhosis, disseminated malignancy, and ASA score (Table 1). As parameters such as albumin, altered mental status, and liver cirrhosis may be associated with variceal bleeding, we wanted to know whether this scoring tool can be used in patients with peptic ulcer bleeding. Therefore, we statistically analyzed the association between the parameters and patients' outcome. We also checked the validity of the ABC score by comparing it with other scoring tools.

Table 1  
The ABC score for the prediction of 30-day mortality

Variable	Assigned score
Age	
60–74 years	1
≥ 75 years	2
Blood tests	
Urea > 10 mmol/L	1
Albumin < 30 g/L	2
Creatinine	
100–150 µmol/L	1
> 150 µmol/L	2
Comorbidity	
Altered mental status	2
Liver cirrhosis	2
Disseminated malignancy	4
ASA score	
3	1
≥ 4	3
ABC: age, blood tests, and comorbidities; ASA: American Society of Anaesthesiologists	

## Methods

### Study design and population

This study was designed as a single-center retrospective analysis and included patients with peptic ulcer bleeding between October 2011 and March 2021 at the Chungnam National University Hospital. Peptic ulcer bleeding was defined as the occurrence of melena, hematemesis, hematochezia, and an unexplained decrease in hemoglobin levels, in which subsequent endoscopy revealed the source of bleeding to be peptic ulcer [14]. This study included only patients who visited the emergency room or outpatient department; therefore, patients already hospitalized for other causes were not considered. Our exclusion criteria were as follows: patients with iatrogenic ulcer caused by therapeutic procedures such as endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD); ulcer diagnosed as cancer; Mallory-Weiss tear; esophageal ulcer; and loss to follow-up for 30 days from the presentation of symptoms.

### Study Outcomes

The primary outcome measure was all-cause 30-day mortality. Secondary outcome measures included (1) rebleeding within 30 days and (2) need for radiologic and surgical intervention to stop bleeding.

### Statistical Analyses

Variables examined for the primary outcome included demographic factors (age and sex), eight components of the ABC score, rebleeding, and need for radiologic/surgical intervention. The chi-square test, Fisher's exact test, and t-test were used to determine the relationship between the variables and the patients' outcome. Statistical significance was set at  $p < 0.05$ .

The discriminative abilities of the ABC score to predict the primary and secondary outcomes were evaluated by ROC curve analysis with 95% confidence intervals (CIs). The optimal cutoff value was determined using the Youden index [15]. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated at the cutoff point. The performance of the ABC score was compared with that of other known scoring tools, including AIMS 65, MAP(ASH), and GBS. Data were analyzed using IBM SPSS Statistics for Windows version 26 (IBM Corp., Armonk, NY, USA).

## Results

### Patients' characteristics

We reviewed 812 patients hospitalized with symptoms of GI bleeding. All patients had been diagnosed with ulcer bleeding in the upper GI tract by endoscopy. We excluded 40 patients: 33 patients diagnosed

with diseases other than peptic ulcer (16: iatrogenic ulcer due to EMR or ESD, 12: cancer bleeding, 3: Mallory-Weiss tear, 2: esophageal ulcer), and 7 patients who were lost to follow-up for 30 days. The remaining 772 patients were used in this study (Fig. 1), whose median age was 65.2 years and 73.8% were male. Patients presented with the following symptoms: melena, 461 (59.7%); hematemesis, 233 (30.2%); hematochezia, 47 (6.1%); and a decrease in hemoglobin levels, 31 (4.0%). Sources of bleeding were revealed to be gastric ulcer in 553 (71.6%) patients and duodenal ulcer in 219 (28.4%) patients.

## Primary Outcome

The primary outcome group comprised 20 patients (2.6%). Among the ABC score parameters, age ( $p = 0.004$ ), serum albumin ( $p < 0.001$ ), serum creatinine ( $p = 0.004$ ), mental status ( $p < 0.001$ ), and ASA score ( $p < 0.001$ ) were significantly associated with 30-day mortality. Additionally, rebleeding ( $p < 0.001$ ) was associated with 30-day mortality (Table 2).

Table 2  
 Characteristics of alive and dead patients, n (%)

Characteristic		Total (n = 772)	Alive (n = 752)	Dead (n = 20)	p-value
Sex	Male	570 (73.8)	555 (73.8)	15 (75.0)	0.904
	Female	202 (26.2)	197 (26.2)	5 (25.0)	
Age	Mean ± SD	65.2 ± 15.5	64.9 ± 15.6	75.0 ± 10.9	0.004
	< 60	260 (33.7)	259 (34.4)	1 (5.0)	0.013
	60–74	266 (34.5)	258 (34.3)	8 (40.0)	
	≥ 75	246 (31.8)	235 (31.3)	11 (55.0)	
Urea (mmol/L)	Mean ± SD	15.5 ± 9.2	15.4 ± 9.2	19.0 ± 10.2	0.085
	≤ 10	220 (28.5)	216 (28.7)	4 (20.0)	0.394
	> 10	552 (71.5)	536 (71.3)	16 (80.0)	
Albumin (g/dL)	Mean ± SD	3.2 ± 0.6	3.17 ± 0.6	2.49 ± 0.6	< 0.001
	< 3	281 (36.4)	263 (35.0)	18 (90.0)	< 0.001
	≥ 3	491 (63.6)	489 (65.0)	2 (10.0)	
Creatinine (µmol/L)	Mean ± SD	130.6 ± 165.5	128.6 ± 163.7	205.8 ± 213.6	0.039
	< 100	524 (67.9)	517 (68.8)	7 (35.0)	0.004
	100–150	130 (16.8)	124 (16.4)	6 (30.0)	
	> 150	118 (15.3)	111 (14.7)	7 (35.0)	
Mental status	Alert	750 (97.2)	735 (97.7)	15 (75.0)	< 0.001
	Altered	22 (2.8)	17 (2.3)	5 (25.0)	
Liver cirrhosis	No	738 (95.6)	720 (95.7)	18 (90.0)	0.219
	Yes	34 (4.4)	32 (4.3)	2 (10.0)	
Disseminated malignancy	No	736 (95.3)	719 (95.6)	17 (85.0)	0.061
	Yes	36 (4.7)	33 (4.4)	3 (15.0)	
ASA score	≤ 2	341 (44.2)	341 (45.3)	0 (0.0)	< 0.001
	3	343 (44.4)	340 (45.2)	3 (15.0)	
	≥ 4	88 (11.4)	71 (9.4)	17 (85.0)	
Mean ± SD tested using the t-test					
n (%) tested using the chi-square test and Fisher's exact test					

Characteristic		Total (n = 772)	Alive (n = 752)	Dead (n = 20)	p-value
Rebleeding	No	692 (89.6)	680 (90.4)	12 (60.0)	< 0.001
	Yes	80 (10.4)	72 (9.6)	8 (40.0)	
Radiologic/surgical intervention	No	739 (95.7)	721 (95.9)	18 (90.0)	0.209
	Yes	33 (4.3)	31 (4.1)	2 (10.0)	
Mean ± SD tested using the t-test					
n (%) tested using the chi-square test and Fisher's exact test					

The ABC score outperformed other scoring tools in predicting 30-day mortality (area under the receiver operating characteristic curve [AUROC] 0.927; 95% CI 0.899–0.956). In comparison, scores of the other tools were as follows: AUROC 0.821 (95% CI 0.745–0.898) for AIMS65, AUROC 0.825 (95% CI 0.736–0.914) for MAP(ASH), and AUROC 0.752 (95% CI 0.636–0.869) for GBS (Fig. 2, Table 3).

Table 3  
AUROC for the four scoring tools for the primary outcome

Score	AUROC	SE	95% CI		Significance
			Lower	Upper	
ABC	0.927	0.015	0.899	0.956	< 0.001
AIMS65	0.821	0.039	0.745	0.898	< 0.001
MAP(ASH)	0.825	0.045	0.736	0.914	< 0.001
GBS	0.752	0.059	0.636	0.869	< 0.001
AUROC: area under the receiver operating characteristic curve; SE: standard error; CI: confidence interval.					

The ABC score also had the highest accuracy in predicting 30-day mortality, with an optimal cutoff point of 7, as determined by the Youden index. The sensitivity and specificity at the cutoff point were 90.0% and 86.0%, respectively. The sensitivity, specificity, PPV, NPV, and accuracy of the four scores are shown in Table 4.

Table 4  
Discriminative abilities of the four scoring tools for the primary outcome

Score	Cutoff point	Sensitivity	Specificity	PPV	NPV	Accuracy
ABC	7	90.0	86.0	14.6	99.7	85.5
AIMS65	2	85.0	68.9	6.8	99.4	68.8
MAP(ASH)	4	80.0	75.9	8.1	99.3	75.4
GBS	12	75.0	63.8	5.2	99.0	63.6

PPV: positive predictive value; NPV: negative predictive value.

## Secondary Outcomes

Rebleeding occurred in 80 (10.4%) patients within 30 days, and radiologic or surgical intervention was required in 33 (4.3%) patients. The ABC score was less accurate at predicting secondary outcomes (AUROC 0.632, 95% CI 0.570–0.694) (Fig. 3). AUROC, sensitivity, specificity, PPV, NPV, and accuracy of the ABC score for each secondary outcome are shown in Table 5.

Table 5  
Discriminative abilities of the ABC score for the secondary outcomes

Outcome	AUROC (95% CI)	Cutoff point	Sensitivity	Specificity	PPV	NPV	Accuracy
Rebleeding	0.630 (0.563– 0.697)	7	36.3	86.4	23.6	92.1	80.6
Radiologic/surgical intervention	0.641 (0.550– 0.732)	5	57.6	62.7	6.4	97.1	62.0

AUROC: area under the receiver operating characteristic curve; PPV: positive predictive value; NPV: negative predictive value.

## Discussion

As risk assessment in patients with peptic ulcer bleeding can be used to predict rebleeding and mortality rate, it is recommended to use scoring tools as an indicator to decide admission, treatment in the intensive care unit, and timing of endoscopy [16, 17]. The ability to select patients who will benefit the most from intensive treatment is an important step in the rational use of resources [18]. There are many scoring tools to indicate patients at high risk of adverse outcomes and identify those in need of urgent endoscopic evaluation [19]. GBS, AIMS65, and MAP(ASH) are scoring tools used to predict outcomes in

patients with bleeding. However, these scores have been developed based on Western populations; hence, they might be influenced by ethnic differences. For example, the AIMS65 was reported to be insufficient in predicting the outcomes of peptic ulcer bleeding in a study conducted in Korea [20].

In this study, we validated the ABC score in Korean populations with peptic ulcer bleeding. The ABC score was developed to predict the outcomes of patients with acute GI bleeding, regardless of the source [13]. In the original article, it was reported to have a high accuracy in predicting 30-day mortality in both upper and lower GI bleeding. Some parameters of the ABC score such as albumin level and liver cirrhosis are associated with variceal bleeding. Hence, its utility in cases of non-variceal upper GI bleeding, such as peptic ulcer, should be investigated.

Our retrospective single-center study in patients with peptic ulcer bleeding found that the ABC score is superior to other well-known scores such as GBS, AIMS65, and MAP(ASH) in predicting 30-day mortality. However, the scores were similar in their ability to predict the secondary outcomes of rebleeding and the need for radiologic or surgical intervention to stop bleeding.

Area under the ROC curve is a popular measure of diagnostic test accuracy. The closer the ROC curve area is to 1.0, the better the diagnostic test [21]. In general, a test is considered excellent if its AUROC is between 0.9 and 1, good if it is between 0.8 and 0.9, fair if the AUROC is between 0.7 and 0.8, and poor if the AUROC is between 0.5 and 0.7 [22]. We found that the ABC score was an excellent predictor of 30-day mortality, with an AUROC of 0.927 (95% CI 0.899–0.956). This result was higher than those of AIMS65, GBS, and MAP(ASH).

In the current study, five out of the eight variables of the ABC score showed a statistically significant association with 30-day mortality. However, three components (namely, serum urea, liver cirrhosis, and disseminated malignancy) were not associated with 30-day mortality. In the original article describing the ABC score, liver cirrhosis and disseminated malignancy were identified as significant predictors of 30-day mortality. In contrast, serum urea was not a significant predictor of mortality. Nevertheless, it improved the identification of patients with a low mortality risk [13]. In our study, all of these three factors were not significant predictors of 30-day mortality. This may be attributable to the different characteristics of patients as well as the small population size of the mortality group. Patients with upper GI bleeding and liver cirrhosis usually present with variceal bleeding; however, they were not included in this study. Patients with disseminated malignancy accounted for 4.4% in the survival group and 15% in the mortality group, although these rates were not statistically significant. This might have been due to the small population size of the mortality group (20 patients). Hence, more studies with a larger number of patients are necessary.

Interestingly, lower serum albumin levels were associated with 30-day mortality ( $p < 0.001$ ). Hypoalbuminemia is associated with several debilitating clinical conditions, such as malnutrition and diabetes, and is a widely accepted risk factor for mortality in some diseases [23].

Our study has certain limitations. First, the present study was a single-center study conducted at a local tertiary hospital; thus, the patient group may not be representative of the general population. The results may be different from those of studies involving more patients from multiple centers and other areas. Second, the small sample size of the mortality group might have influenced the results. Third, only patients who underwent endoscopy were included, and those who did not undergo endoscopy because of any reason were excluded, which might have created a selection bias. Fourth, this study was limited to patients with peptic ulcer bleeding; therefore, the results can be different in other clinical settings. Finally, ethnic differences should be considered, as this study only included Korean patients.

## Conclusions

The present study targeted patients with peptic ulcer bleeding irrespective of their age, sex, or underlying diseases. In this study, an AUROC of 0.927 was obtained, which is quite favorable; this can be used as evidence to support that the ABC score can aid in predicting mortality with high accuracy in patients with peptic ulcer bleeding. Nonetheless, this study included only Korean patients and was performed in a single center where the endoscopic procedure could be performed 24 hours a day by endoscopists. The results may be influenced by different races of patients or different availability of medical resources in other centers. Therefore, further accumulation of data is recommended.

## Abbreviations

AUROC

Area under the receiver operating characteristic curve

CI

Confidence interval

EMR

Endoscopic mucosal resection

ESD

Endoscopic submucosal dissection

GI

Gastrointestinal

GBS

Glasgow-Blatchford score

NPV

Negative predictive value

PUD

Peptic ulcer disease

PPV

Positive predictive value

UGIB

## Declarations

### **Ethics approval and consent to participate**

Ethics approval was obtained for all protocols from the local institutional review board (IRB) (IRB file number: CNUH2021-10-058), confirming that the study met national and international guidelines for research involving humans and was conducted in accordance with the tenets of the Declaration of Helsinki or comparable ethical standards. The requirement for the acquisition of informed consent from patients was waived owing to the retrospective nature of this study.

### **Consent for publication**

Not applicable.

### **Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### **Competing interests**

The authors declare that they have no competing interests.

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### **Authors' contributions**

All authors contributed to the study conception and design. HSM and HYJ designed and directed the study. HSK and JKS collected and processed the data. SWC performed the statistical analysis and designed the figures. The first draft of the manuscript was written by H, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Not applicable

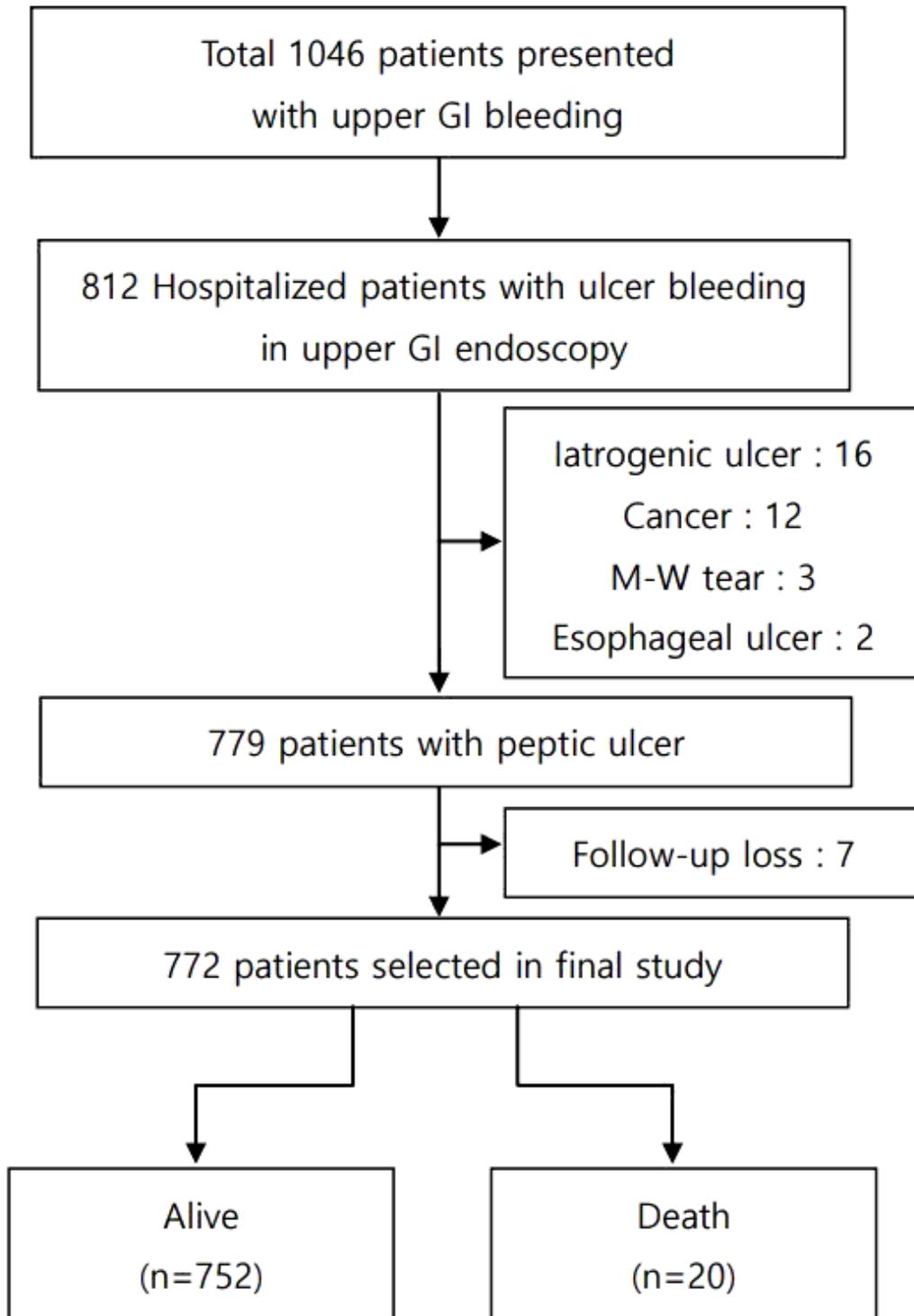
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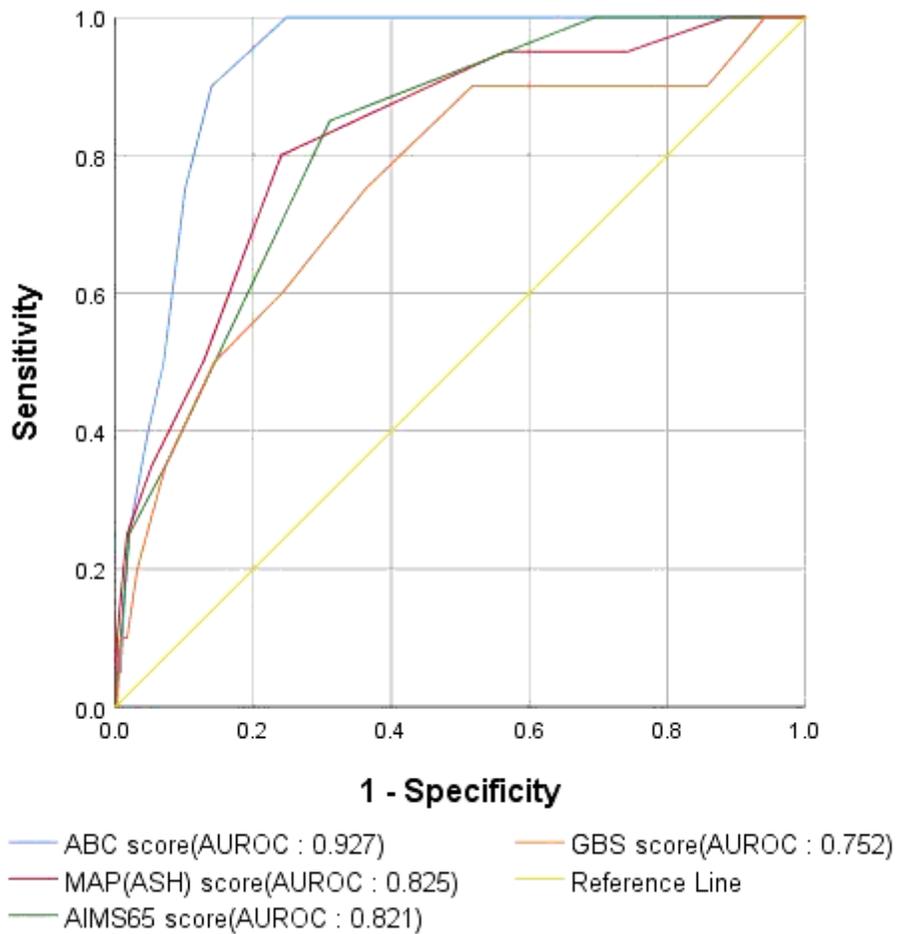
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## Figures



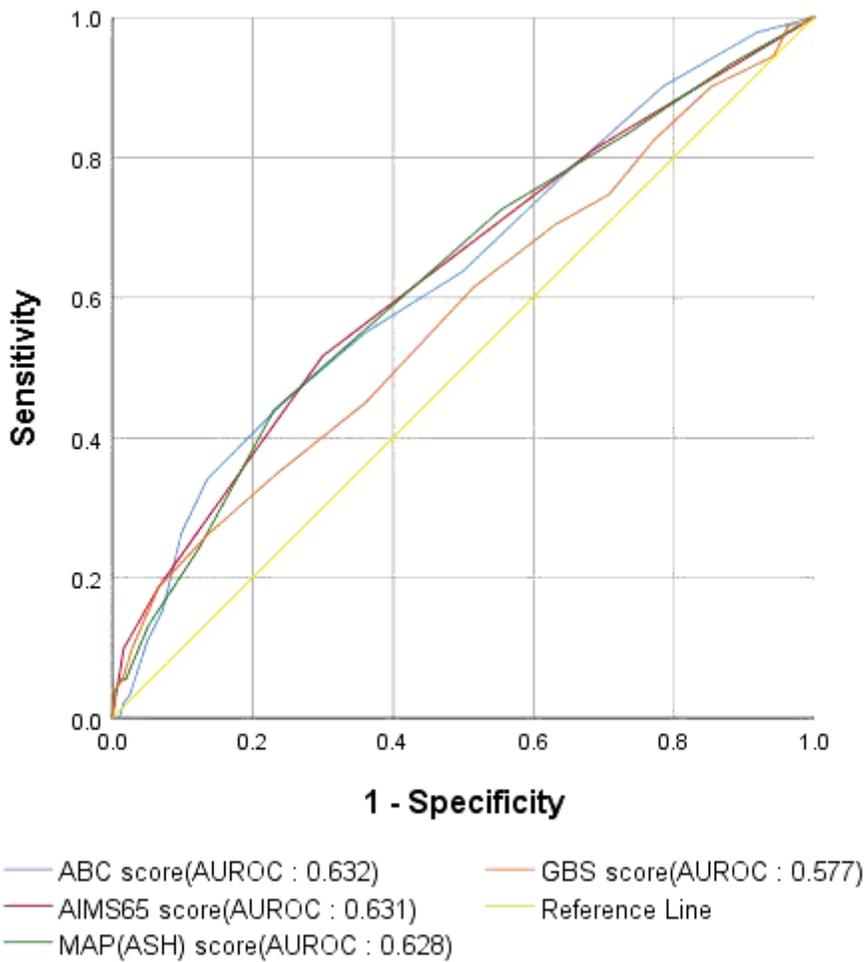
**Figure 1**

Study enrollment. GI: gastrointestinal.



**Figure 2**

Comparison of the ABC score, AIMS65, MAP(ASH), and GBS in the prediction of primary outcome (30-day mortality) in peptic ulcer bleeding. AUROC: area under the receiver operating characteristic curve.



**Figure 3**

Comparison of the ABC score, AIMS65, MAP(ASH), and GBS in the prediction of secondary outcomes (rebleeding, need for radiologic/surgical intervention) in peptic ulcer bleeding. AUROC: area under the receiver operating characteristic curve.