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ORIGINAL RESEARCH

Predictive Utility of Pre- and Post-Endoscopic Risk Scores and Hemodynamic Indexes in Acute Upper Gastrointestinal Bleeding in the Emergency Department

Bedriye Müge Sönmez[1], Elif Hamzaçebioğlu Kayışoğlu[1], Gülşen Akçay[1], Necip Gökhan Güner[2]

[1]Department of Emergency Medicine, Dışkapı Yıldırım Beyazıt Training and Research Hospital, University of Health Sciences, Ankara, Turkey; [2]Department of Emergency Medicine, University of Sakarya, Sakarya, Turkey

Correspondence: Bedriye Müge Sönmez, Email mugesonmez06@yahoo.com

Purpose: There is a controversy about risk scores for risk stratification of acute upper gastrointestinal bleeding (AUGIB) in the emergency department (ED). This study aimed to compare the prognostic utility of UGIB scores with perfusion index (PI) and shock index (SI) in these patient groups in the ED.

Patients and Methods: A prospective cross-sectional study was conducted on a convenience sample of patients with AUGIB who were admitted to the ED of a tertiary care hospital. Areas under the receiver operating characteristic curve (AUROC) were used to evaluate the predictive performance of pre- and post-endoscopic risk scores, as well as hemodynamic indexes (PI and SI), in terms of composite endpoints.

Results: Rockall Score (RS), Cedars Sinai Medical Centre Predictive Index (CSMCPI), Progetto nazionale emorragia digestiva score (PNED), Glasgow Blatchford Score (GBS), and albumin, international normalized ratio, mental status, systolic blood pressure, age ≥65 years score (AIMS65) were significantly higher for endoscopic intervention (p=0.002, p<0.001, p=0.001, p=0.002, p=0.004, respectively). RS, Cedarsiani, PNED, and GBS were significantly higher in hospitalized patients (p = 0.001, p < 0.001, p = 0.021, p = 0.002, respectively). RS, PNED, and AIMS65 scores were significantly higher for recurrent hemorrhage (p = 0.019, p = 0.005, p = 0.008, respectively). RS, Baylor Bleeding Score (BBS), Cedarsinai, PNED, and AIMS65 were significantly higher for mortality (p = 0.01, p = 0.013, p = 0.026, p = 0.005, p = 0.003, respectively). SI was statistically significant only for the transfusion need of patients (p = 0.019).

Conclusion: AIMS-65 seems to be more valuable and feasible than the others in the ED. Hemodynamic indexes should be used in conjunction with risk scores.

Keywords: upper gastrointestinal bleeding, pre- and post-endoscopic risk scores, perfusion index, shock index, emergency department

Introduction

Acute upper gastrointestinal bleeding (AUGIB) is a common life-threatening medical emergency, and emergency physicians play a crucial role in the management of these patients because of being the first medical contact.[1] The priority in these patients is to stratify the risk of adverse events associated with AUGIB to discriminate between critical cases and those that are not critical, in order to decide whether to perform any invasive intervention (endoscopic or surgical), administer blood products, or discharge without intervention.[2–4]

The initial evaluation should be based on the severity of the bleeding and the patient's hemodynamic status.[5] Recently, there has been increasing attention and a plethora of studies in the literature about the clinical risk scores to prognosticate AUGIB patients.[6] Beyond this, measurement of peripheral tissue perfusion with perfusion index (PI) or

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using shock index (SI), which is one of the most commonly used perfusion indices due to its feasibility at the bedside, have become crucial for tracking hemodynamic condition[7,8] and can be utilizable for AUGIB in the ED.

Although the timely estimation of the highest likelihood of unwanted clinical sequels in patients with AUGIB in the ED may help inform decisions about patient management, efforts to individualize outcomes and treatment goals have yet to reach a consensus as to which one best suits an ED. Risk stratification scores and clinical decision rules can accelerate the evaluation of patients in terms of diagnosis, door-to-disposition time, and limit unnecessary testing in the ED.[9] There are several studies in the literature about pre- and post-endoscopic risk scores,[3,6] and despite the fact that endoscopic examination is the gold standard in diagnosing and management of such patients,[10] everything may not always be perfect in the environment of the ED. Furthermore, endoscopy (if performed) is frequently postponed for up to 24 hours or longer, which limits the utility of risk scores that require it; contrary to risk classifications, which can be available as soon as possible following presentation, especially in an ED with a very high turnover rate, and early discharge also reduces healthcare costs and resource utilization.[11,12] Beyond this, implementation of hemodynamic signs-dependent decision criteria can decrease undesirable outcomes, such as pre- and post-endoscopic scores, in the early stages of the patient pathway. Thus, in this study, we aimed to compare pre- and post-endoscopic risk scores, PI and SI, regarding the predetermined combined outcomes in the ED, and to the best of our knowledge, this is the first study in the literature about this topic.

Methods

Study Design

This prospective cross-sectional study was conducted on a convenience sample of patients with AUGIB who were admitted to the ED of a tertiary healthcare facility between June 15, 2021, and June 15, 2022. This study involves human participants and was approved by the Ethics Committee of Ankara Dışkapı Yıldırım Beyazıt Training and Research Hospital (approval number:112/5). Informed consent was either obtained from the patients themselves or their first-degree relatives, who were unable to provide it, by the criteria of the Helsinki Declaration (2013).

Study Population

A G*Power analysis performed to determine the sample size before the study revealed a total of 54 cases, with a power of 95% and $\alpha = 0.05$, when the difference between the two PI groups was considered significant as 1 unit or more. Fifty-four patients aged 18 years or older with AUGIB were eligible for the study. AUGIB was defined as any hemorrhage from the upper gastrointestinal tract, which manifested with coffee-ground vomiting, hematemesis, or melena, and the absence of an alternative diagnosis.[13] Data analysis included both variceal and non-variceal AUGIB. The exclusion criteria were as follows:

Patients under the age of 18
Patients referred from an external center
Patients who did not undergo endoscopic evaluation
Patients diagnosed other than UGISK after hospitalization
Patients who could not be followed up
Patients who did not consent to participate in the study
The flow diagram is presented in Figure 1.

Primary and Secondary Outcomes

The primary outcome was the composite endpoint, defined as the need for hospital-based interventions, including blood transfusions, endoscopic treatments, interventional radiology, and surgery, or mortality within 7 and 28 days. The secondary outcome was the predictive ability of scores and indices. UGIB scores and hemodynamic indexes were the predictors.

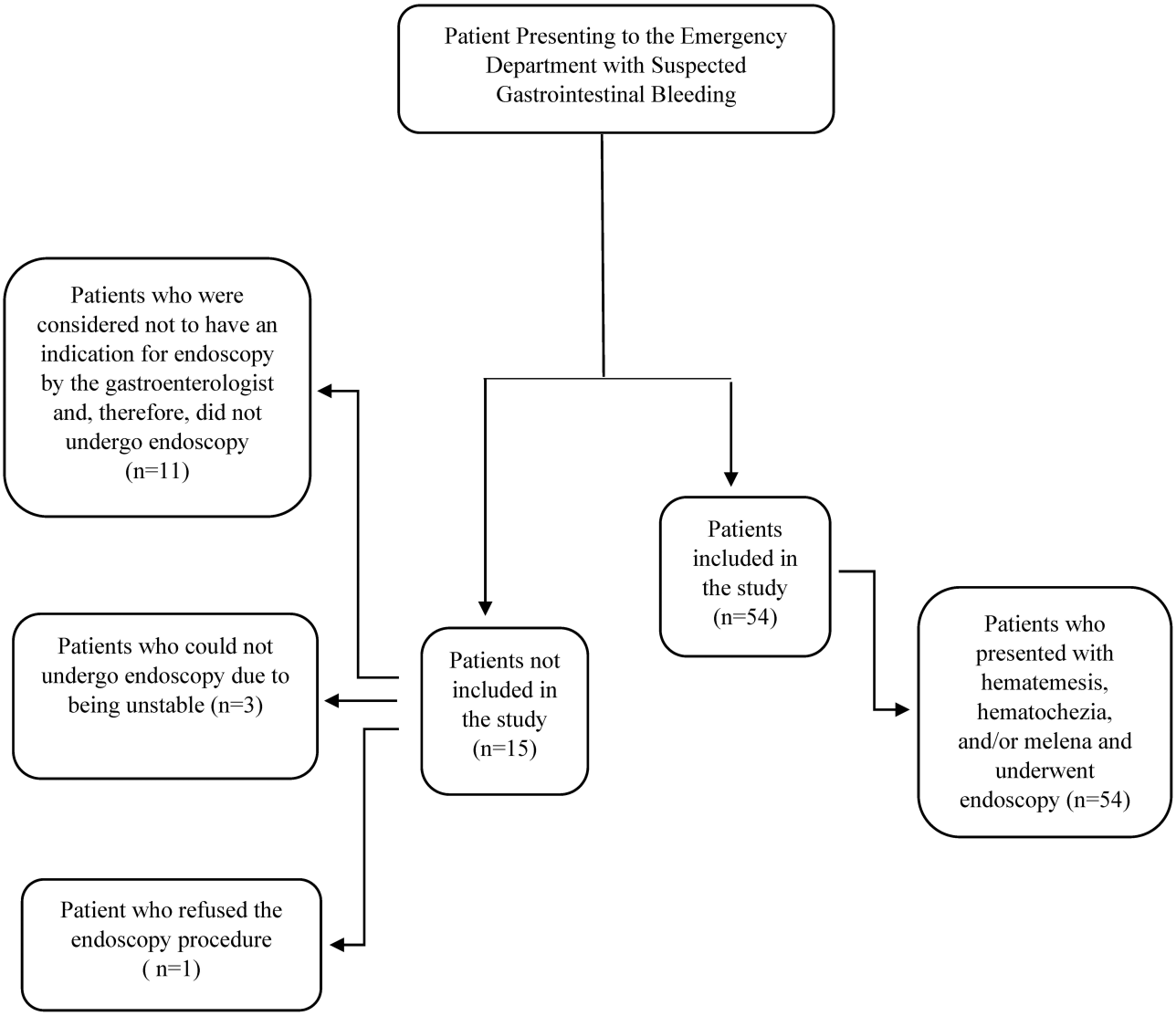

Figure 1 Flow diagram of the study.

Data Collection

Age, sex, known diseases, medications, vital parameters at admission, SI, PI, endoscopic classification, lesion type, laboratory results, pre- and post-endoscopic risk scores, and clinical outcome were recorded on previously prepared forms. Endoscopic classification was performed according to the Forrest Classification.[7] Pre- and post-endoscopic risk scores were calculated using the collected data.

As per the American College of Gastroenterology (ACG) guidelines, rebleeding was defined as sudden hemorrhage from the upper gastrointestinal (hematemesis from the nasogastric tube or melena) tract after successful treatment or a 1-mg/dl hemoglobin drop or development of orthostatic hypotension, which was considered to be present when a persistent systolic blood pressure drop of at least 20 mmHg or diastolic blood pressure drop of at least 10 mmHg occurred in the first three minutes after assuming an upright position after laying in supine position for five minutes or on a tilt table tilted at 60 degrees.[3,14]

According to ACG and British Society of Gastroenterology guidelines, Glasgow Blatchford (GBS) and National Early Warning Score or a similarly early warning score should be used in AUGIB patients for risk stratification, and a score of 0–1 for GBS can be safely discharged from ED.[1,15] The post-endoscopic risk scores used in this study were Rockall (RS), Progetto nazionale emorragia digestiva score (PNED), Cedars Sinai Medical Centre Predictive Index

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(CSMCPI), and Baylor Bleeding Score (BBS). The pre-endoscopic risk scores include GBS, albumin, international normalized ratio, mental status, systolic blood pressure, age ≥65 years score (AIMS-65), and the Timing score (T-score).[6]

PI was measured by Radical-7® Pulse CO-Oximeter® which is a noninvasive monitor and measures oxygen saturation (SaO2), heart rate (HR) and PI with optional (with a disposable removable additional probe) hemoglobin (Hb), carboxyhemoglobin (COHb), total oxygen content (TOC), methemoglobin (MetHb), pleth variability index, acoustic respiratory rate (RR) and pleth RR. The device utilizes rainbow technology, which employs 7+ wavelengths of light to continuously and non-invasively measure COHb, MetHb, and total Hb, providing more reliable closed-probe detection. The TOC provides a calculated measure of the amount of oxygen present in arterial blood, which can provide useful information on both oxygen dissolved in plasma and oxygen bound to hemoglobin (Hb). RR can be determined via acoustic or plethysmographic waveform. It can take the form of a detachable, portable handheld device for carrying the patient [Radical-7 User Manual. Irvine, California: Masimo Corporation; 2013]. According to the manufacturer's recommendations, if the PI is 1% or less, the perfusion of the measured region is considered low, and if it is above 1%, the perfusion is normal. SI was defined as HR divided by the systolic blood pressure (SBP).[16]

Statistical Analysis

The study data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 21.0. Categorical data were presented as numbers and percentages, while continuous variables with a normal distribution were reported as mean ± standard deviation (SD). Continuous variables with a normal distribution were also reported as median and interquartile range (IQR). Missing data were addressed by discarding invalid data from further analyses. The Kolmogorov–Smirnov test was used to determine if the data were normally distributed. The chi-square test was used to compare categorical variables between independent groups, the independent samples *t*-test was used for continuous variables with a normal distribution, and the Mann–Whitney *U*-test was used for continuous variables without a normal distribution. The predictive values of continuous variables were assessed using receiver operating characteristic (ROC) analysis, and the point with the highest sensitivity and specificity was used as the cut-off point. When this point was used as the cut-off, negative and positive predictive values (except for sensitivity and specificity) predicting composite end-points were calculated. All tests were performed with 5% two-sided significance, and any p-value of less than 0.05 was considered statistically significant. Spearman's rho correlation test was used for the correlation analyses between nonparametric variables.

Results

Baseline Characteristics of the Study Population

The mean age of the participating patients with AUGIB was 62.65 ±18.61 years. AUGIB was more common in males (61.1%). It was noted that most (63%) patients with UGIB used both anticoagulant and antiplatelet medications. Among patients whose classification could be made during endoscopy, Forrest classification 3 was the most common (27.8%), and the most common lesions were esophageal, peptic, or duodenal ulcers (44.4%). Seven (13%) patients underwent transfusion, while 14 (25.9%) were intervened during endoscopy. Twenty-nine (53.7%) patients were admitted to the hospital from the emergency department. Five (9.3%) patients were found to have recurrent bleeding, and 4 (7.4%) patients died (Table 1).

Outcomes and Mortality

An analysis of the relationship between UGIB scores and clinical outcomes revealed that patients who underwent transfusion had a significantly higher CSMCPI but a considerably lower T score ($p = 0.018$ and $p = 0.002$, respectively). While patients who required intervention during endoscopy had significantly higher RS, CSMCPI, PNED, GBS, and AIMS65 scores, they had substantially lower T scores ($p = 0.002$, $p < 0.001$, $p = 0.001$, $p = 0.002$, $p = 0.004$, $p < 0.001$, respectively). Patients who were admitted to the hospital as a clinical outcome had significantly higher RS, CSMCPI, PNED, and GBS scores; they had a considerably lower T score ($p = 0.001$, $p < 0.001$, $p = 0.021$, $p = 0.002$, $p < 0.001$, respectively). When patients with recurrent hemorrhage were analyzed, it was noted that they had significantly higher RS,

Table 1 Demographic, Clinical, and Laboratory Characteristics of the Study Population (n=54)

Variables	Values
Demographic Characteristics	
Age (mean ± SD)	62.65 ± 18.61
Gender, n (%)	
Female	21 (38.9)
Male	33 (61.1)
Clinical Characteristics	
Medication Use, n (%)	
Antiplatelet	9 (16.7)
Anticoagulant	10 (18.5)
Both	34 (63.0)
None	1 (1.9)
Comorbidity, n (%)	
Bleeding Diathesis	2 (3.7)
GIB History	3 (5.6)
Malignancy	7 (13.0)
Absent	42 (77.8)
Vital Parameters at Admission (median, IQR)	
Systolic Blood Pressure (mmHg)	110 (100–139)
Diastolic Blood Pressure (mmHg)	63 (60–80)
Heart Rate (bpm)	97 (80–111)
Forrest Classification, n (%)	
Forrest 1A	1 (1.9)
Forrest 1B	2 (3.7)
Forrest 2A	3 (5.6)
Forrest 2B	2 (3.7)
Forrest 2C	1 (1.9)
Forrest 3	15 (27.8)
Out of Classification	30 (55.6)
Endoscopic Lesion, n (%)	
Esophagitis, Gastritis, Duodenitis	13 (24.1)
Esophageal, Peptic, Duodenal Ulcer	24 (44.4)
Variceal	6 (11.1)
Malignancy	1 (1.9)
Normal	6 (11.1)
Mallory Weiss, Boerhave	4 (7.4)
Laboratory Parameters (mean ± SD)	
Hemoglobin (g/dL)	10.74 ± 3.23
Hematocrit (%)	32.2 ± 8.6
Platelet (x10^3/μL)	264.11 ± 143.05
MPV (fL)	10.22 ± 1.00
Lactate (mmol/L)	3.45 ± 2.54
INR	1.43 ± 1.26
Urea (mg/dL)	68.22 ± 43.20
Creatinine (mg/dL)	1.17 ± 0.68
eGFR (mL/min/1.73m^2)	72.69 ± 29.78
Perfusion Index	3.26 ± 2.99
Treatment and Outcomes	
Transfusion, n (%)	
Present	7 (13.0)
Absent	47 (87.0)

(*Continued*)

Table 1 (Continued).

Variables	Values
Endoscopic Intervention, n (%)	
Present	14 (25.9)
Absent	40 (74.1)
Clinical Outcome, n (%)	
Hospitalization	29 (53.7)
Discharge	25 (46.3)
Rebleeding, n (%)	
Present	5 (9.3)
Absent	49 (90.7)
Mortality, n (%)	
Within 7 days	2 (3.7)
7-28 days	2 (3.7)
Absent	50 (92.6)
Endoscopic Scores (median, IQR)	
Rockall	4 (2–5)
BBS	6 (3–10)
CSMCPI	2 (1–4)
PNED	2 (0–4)
GBS	10 (4.8–13)
AIMS65	1 (0–1.3)
T-score	10 (9–12)

Abbreviations: n, number of patients; SD, Standard Deviation; IQR, Interquartile Range; GIB, Gastrointestinal Bleeding; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; HR, Heart Rate; MPV, Mean Platelet Volume; INR, International Normalized Ratio; eGFR, estimated Glomerular Filtration Rate; bpm, beats per minute; BBS, Baylor Bleeding Score; CSMCPI, Cedars Sinai Medical Centre Predictive Index; PNED, Progetto nazionale emorragia digestiva score; GBS, Glasgow-Blatchford Bleeding Score, AIMS-65; albumin, international normalized ratio, mental status, systolic blood pressure, age ≥65 years), T-score, Timing score.

PNED, and AIMS65 scores (p = 0.019, p = 0.005, p = 0.008, respectively). Deceased patients had considerably higher RS, BBS, CSMCPI, PNED, and AIMS65 scores (p = 0.01, p = 0.013, p = 0.026, p = 0.005, p = 0.003, respectively) (Table S1). SI was statistically significant only for the transfusion need of patients (p = 0.019, Table 2).

Table 2 Composite Endpoints Analysis in Terms of Hemodynamic Indexes

Composite Endpoints	Group	Shock Index (mean±SD)	p-value	Perfusion Index (mean±SD)	p-value
Transfusion	Present	1.13 ± 0.59	0.250	2.46 ± 2.14	0.457
	Absent	0.80 ± 0.21		3.38 ± 3.10	
Endoscopic Intervention	Present	1.04 ± 0.43	**0.019**	2.70 ± 2.40	0.423
	Absent	0.78 ± 0.21		3.45 ± 3.18	
Discharge Hospitalization	Present	0.90 ± 0.37	0.313	3.17 ± 2.71	0.825
	Discharge	0.78 ± 0.17		3.35 ± 3.34	
Recurrent Bleeding	Present	1.09 ± 0.36	0.077	2.56 ± 1.61	0.590
	Absent	0.82 ± 0.29		3.32 ± 3.10	
Mortality	Present	1.04 ± 0.37	0.202	1.36 ± 1.39	0.190
	Absent	0.83 ± 0.29		3.41 ± 3.04	

Note: P values were calculated according to the Mann Whitney *U*-test, p<0.05 was considered statistically significant.

Table 3 Performance of Various Clinical Scores and Hemodynamic Indexes

Scores	Cutoff	Accuracy (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Rockall	>3.5	70	88	62	52	92
BBS	>6.5	60	65	62	44	79
CSMCPI	>2.5	78	82	76	61	90
PNED	>2.5	74	82	70	56	90
GBS	>10.5	65	71	62	46	82
AIMS65	>0.5	65	88	54	47	91
T-score	>9.5	20	29	16	14	33
Shock Index	>0.9	69	71	73	50	79

Abbreviations: BBS, Baylor Bleeding Score; CSMCPI, Cedars Sinai Medical Centre Predictive Index; PNED, Progetto nazionale emorragia digestiva score; GBS, Glasgow-Blatchford Bleeding Score, AIMS-65; albumin, international normalized ratio, mental status, systolic blood pressure, age ≥65 years), T-score, Timing score.

Sensitivity Analysis

The sensitivity and accuracy values of the scores, along with the assigned cut-off values, are shown in Table 3. *RS* and AIMS-65 scores had a sensitivity of 88% with the assigned cut-off values. T score had the lowest sensitivity and specificity (29% and 16%, respectively). The negative predictive value of the AIMS65 score was comparable to that of RS, CSMCPI, and PNED, all of which are endoscopy-dependent risk scores.

Receiver Operating Characteristic Curve Analysis

ROC analysis was performed to develop a scoring system that more accurately predicted adverse combined endpoints in patients with AUGIB. As is known, ROC analysis is a powerful tool to assess the discriminative thresholds of diagnostic tests among individuals. Area under the curve (AUC) shows the diagnostic performance of the clinical decision rule in terms of the presence or absence of any specified variable, which in general an AUC of 0.5 means the test cannot distinguish, 0.7 to 0.8 is regarded as satisfactory, 0.8 to 0.9 is indicated as to have excellent discrimination. A value greater than 0.9 is interpreted as indicating excellent diagnostic performance.[17] A comparison of the area under the ROCs (AUROCs) of each score revealed that pre-endoscopic AIMS65 score was as good as RS, CSMCPI, and PNED, in predicting all combined outcomes (0.791 95% CI: 0.658–0.924; 0.795 95% CI: 0.676–0.914; 0.841 95% CI: 0.717–0.965; 0.831 95% CI: 0.713–0.950; respectively) (Table 4 and Figure 2).

Table 4 The Area Under the Receiver-Operating Curve of Scoring Systems for Predicting the All Composite End-Points

Test Result Variable(s)	Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Rockall	0.795	0.061	0.001	0.676	0.914
BBS	0.684	0.079	0.031	0.529	0.839
CSMPI	0.841	0.063	0.000	0.717	0.965
PNED	0.831	0.060	0.000	0.713	0.950
GBS	0.744	0.071	0.004	0.606	0.882
AIMS65	0.791	0.068	0.001	0.658	0.924
T Score	0.125	0.055	0.000	0.016	0.233

Abbreviations: BBS, Baylor Bleeding Score; CSMCPI, Cedars Sinai Medical Centre Predictive Index; PNED, Progetto nazionale emorragia digestiva score; GBS, Glasgow-Blatchford Bleeding Score, AIMS-65; albumin, international normalized ratio, mental status, systolic blood pressure, age ≥65 years), T-score, Timing score.

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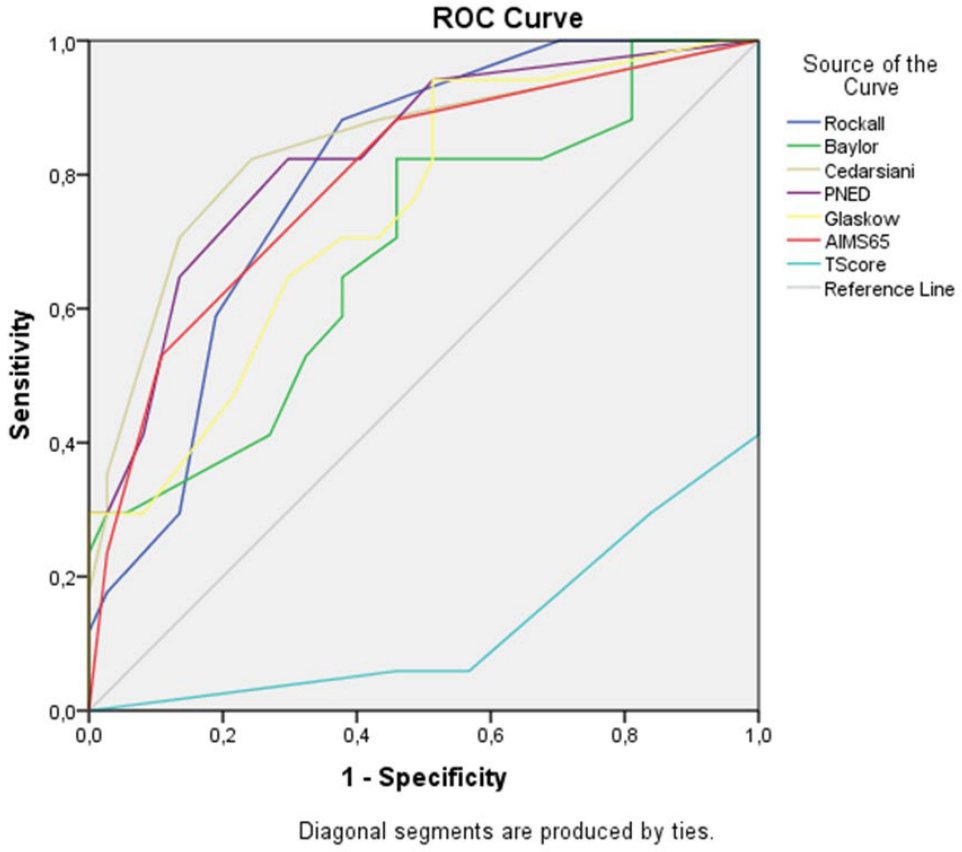

Figure 2 ROC curves of risk scores.

Discussion

The present study examined the role of 7 different pre- and post-endoscopic scoring systems in predicting the outcomes of AUGIB at the ED. Since AUGIB represents a medical emergency where timely decisions should be made, it is of paramount importance for physicians to have a thorough understanding of the reliability of the available risk scores for individual clinical endpoints. However, the development of novel risk scores and the disparities between the old ones can make risk assessment more tedious, and unfortunately, physicians are less compliant with risk stratification in daily practice, even though the latest guidelines emphasize the importance of risk assessment for patients with UGIB when they are admitted.[10,13] The results of the present study suggest that different scores can predict different endpoints (Table S1). Nevertheless, there is yet to be a perfect scoring system for predicting untoward clinical endpoints in AUGIB. Studies in the literature have used various cut-off values.[18–20] The findings of the present study indicate that pre-endoscopic AIMS65 and post-endoscopic RS, Cedarsiani, and PNED scores are likely to show good discriminatory potential for predicting any untoward combined outcomes and can distinguish true positive and false positive cases from each other (Tables 3 and 4, Figure 2).[21]

Nevertheless, the results for SI and PI were not comparable in terms of scores, although most of them utilized vital parameters as clinical scoring (Table 2). Inconsistent with the literature,[7,22] PI has no prognostic value on predicting any of the composite endpoints (Table 2). However, the decreasing pattern of the PI values in terms of composite endpoints suggests that it may be a promising hemodynamic monitoring tool with non-invasive properties. We think that the statistical insignificance can be due to the small sample size. Beyond this, SI was predictable in terms of the transfusion needs of our study group. Especially, in patients who we assume to be hemodynamically stable at admission, even when macrohemodynamical parameters are normal, it can be a signal of impending hemodynamic instability.

Among all scores, only CSMCPI showed statistical significance in predicting the need for transfusion (Table S1). This raises the question of whether transfusion should have priority over other adverse clinical outcomes in the available risk

scores. Current AUGIB management guidelines recommend that limited transfusion be used as long as patients are not in circulatory shock or have significant comorbidities. However, since the factors dictating decisions regarding transfusion at the ED are poorly defined, it is unclear whether guideline recommendations can be effectively implemented in the ED.[23] Our study indicated that only seven patients required transfusion, as the literature suggests (Table 1). This may have resulted from the individual variability in transfusion needs, which should be separately scrutinized in another study.

Our study demonstrated that BBS was the sole score that failed to predict any requirement for endoscopic therapy. Prediction of endoscopic study results can likely be the most relevant point for using scores to predict untoward clinical endpoints at the ED. An endoscopic study is pivotal not only to identify the culprit lesion but also to treat the underlying cause. However, there may be no available endoscopy unit or interventionalist. The endoscopic study should be considered when ED management fails to stabilize a patient. In that case, pre-endoscopic scores likely offer promise for decision-making at the ED.

In AUGIB, recurrent bleeding is the most important predictor of mortality, which makes it necessary to predict at-risk patients and prevent recurrent bleeding to improve patient outcomes. Our study showed that RS, PNED, and AIMS65 had good predictive performance for recurrent bleeding (Table S1). As is well known, endoscopic classification predicts recurrent bleeding risk by taking into account the lesion type;[24] then again, however, one asks the question of whether endoscopy units or interventional gastrointestinal physicians are 7/24 available or accessible at every ED. To serve this purpose, AIMS65 appears as a simple and accurate non-endoscopic risk score that can be used at ED admission for patients with AUGIB.

Among the available pre-endoscopic scores, AIMS65 is preeminent due to its higher sensitivity compared to GBS, as recommended by the guidelines. This translates into a better ability of AIMS65 to differentiate between urgent and non-urgent patients, allowing for the discharge of non-urgent patients from the ED.[10] This finding is in accordance with the literature.[25,26] Compared to GBS, this score is simpler and easier to calculate at the ED, where time is of the essence. The AIMS65's sole dependency on clinical findings of AUGIB draws our attention when considering resource constraints in specific emergency situations. As response time is one of the most important factors in evaluating quality assurance in the ED, the viability of deploying more sophisticated scoring methods can be compelling.[27] At this point, the twenty-four-hour demand for its comprehensive treatment capability strains the ED's resources for special processing requirements, such as endoscopy.[28] We believe that quick assessment scores in the ED, such as the AIMS-65, are more beneficial than post-endoscopic scores, which are equipment and expertise-dependent, in terms of patient safety, satisfaction, and improving ED throughput.

The present study has some limitations. First, it was a single-center, low-volume study, which might result in sample-size bias and affect the generalizability of the results. Although sample-size bias can threaten the extrapolation of the results, our study population is representative of the target population, allowing us to focus on the clinical significance of the scoring systems rather than statistical significance. Since the researcher worked on a shift-based work schedule, access to the study population who were eligible for the study was provided on the days when the researcher was on duty. This situation creates ascertainment bias rather than convenience, as there is a systematic inaccuracy due to the inability to equally identify all individuals intended to be represented in the sample.[29] Although we express it as convenience sampling due to time or day dependency, the study is actually a pilot study, and sampling did not depend on the researchers' discretion. This sampling method limitation can compromise external validity, particularly population validity, as results can only be extrapolated to populations that exhibit similar traits, thereby limiting the generalizability of the results to a single geographic area. The ramifications of geographical constraints can lead to behavioral and attitudinal predispositions or environmental variables that may subject the study cohort to particular risk factors or income inequalities, resulting in disparate access to healthcare resources or epidemiological variations.[30,31] But because the institution where the study was conducted is a tertiary care hospital that accepts patients from all over the country, our sample was representative of the entire country, which decreases bias and captures a wider variety of participants. The other issue is our insufficient subgroup sample size for determining the composite adverse events individually, based on all scores with statistical measurements. However, this statistical limitation can be attributed to the fact that the sample size in the study is determined to assess the main goal with adequate power, not just a subset of it; therefore, the

interaction test is often underpowered. This so-called limitation of underestimated subgroup analysis can lead to future research based on unproven theories and potentially result in less-than-ideal patient care.[32] During study planning, inclusion may be restricted by specific confounding variables, such as age, which could result in underestimation bias due to accompanying comorbidities or medications used to manage these conditions, or changes in physiological response capacity that affect hemodynamic responses. Although these appear to lack of adjustment, the scores are compared with confounders that are likely to be affected by comorbidities, such as age, gender, vital signs, or the drugs used. Therefore, regarding their role in the causal pathway of the study question, we believe that adjusting for these factors will actually create over- or underestimate bias.[33] In this study, we do not draw robust conclusions across multiple scoring systems and endpoints, given our small sample size; however, we believe it is helpful to see the comparison between them. It may help clinicians to choose the right scores for the right scenario.

Conclusion

The mentioned limitations of the available scores translate into the fact that none of the 7 studied scores, nor the hemodynamic indexes, could be used alone to predict all clinically relevant endpoints in AUGIB. Nevertheless, when all adverse combined endpoints are considered, AIMS65 appears to be more applicable and beneficial for use in the ED. Beyond this, hemodynamic indexes should be used in conjunction with risk scores. Future multicenter studies would be valuable to validate our assumption.

Data Sharing Statement

Data is available from the corresponding author upon reasonable request.

Ethics Approval and Informed Consent

This study involves human participants and was approved by the Ethics Committee of Ankara Dışkapı Yıldırım Beyazıt Training and Research Hospital (approval number:112/5). Participants gave informed consent to participate in the study before taking part. Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of our research.

Consent for Publication

No any images, videos, recordings, etc were used in the manuscript.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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.

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