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The role of Shock Index and its derivatives in predicting mortality in patients with upper gastrointestinal bleeding

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Abstract

Upper gastrointestinal bleeding (UGIB), a life-threatening emergency, causes significant morbidity, mortality, and healthcare costs. The mortality rate for UGIB is approximately 10%, but this rate rises to 15% in hemodynamically unstable patients. Identifying factors related to mortality and morbidity can help early detection of critical patient groups, guiding initial treatment approaches and patient management for clinicians. This study aims to investigate the performance of the Shock Index (SI) and its derivatives in predicting mortality. In the study, patients diagnosed with UGIB who presented to the Emergency Department (ED) between 2022 and 2024 were analyzed retrospectively. Patients aged 18 and over who were confirmed to have UGIB following internal medicine and/or gastroenterology consultation and were subsequently admitted to the hospital were included in the study. Of the 201 patients included in the study, 112 (55.7%) were male, with a mean age of 70.68±16.617. In-hospital mortality occurred in 17 patients (8.5%), and 30-day mortality was observed in 22 patients (10.9%). When examining the area under the curve (AUC), Age-SI (ASI) showed the best performance in predicting in-hospital mortality (AUC 0.837), followed by Age-Modified Shock Index (AMSI, AUC 0.829), MSI (AUC 0.810), and SI (AUC 0.806). ASI and AMSI can be calculated easily, cost-effectively, quickly, and practically at the time of ED presentation in UGIB patients, aiding in the early identification of critical patient groups and guiding clinicians.

Keywords: Emergency medicine, mortality, risk assessment, Shock Index, upper gastrointestinal bleeding

Introduction

Acute upper gastrointestinal bleeding (UGIB) is a common pathology in the community, with an incidence thought to be over 100 per 100,000 individuals [1,2]. UGIB is associated with significant morbidity, mortality, and healthcare costs. The clinical presentation of the disease ranges from chronic blood loss due to occult bleeding to shock and death due to massive bleeding. The mortality rate for UGIB is approximately 10%, but this rate rises to 15% in hemodynamically unstable patients [3-6]. Identifying factors associated with mortality and morbidity can help early detection of critical patient groups, guiding initial treatment approaches and patient management, and contributing to improving prognosis [7,8]. To this end, scoring tools such as the AIMS-65, Glasgow Blatchford and Rockall Score have been developed and validated. Despite their clinical benefits, there are limitations to the use of these scoring systems in the ED. These include the complexity of score calculations and the need for laboratory findings and endoscopic results [2,8,9].

The Shock Index (SI) is easily calculable and simple index based on the patient's vital signs that do not require laboratory testing. It is obtained by dividing the heart rate (HR) by the systolic blood pressure (SBP). SI is an important indicator of hemodynamics, even when HR and SBP are normal. SI has shown promising performance in predicting mortality in the geriatric patient population with UGIB [8,10]. Modified Shock Index (MSI) and Age-SI (ASI) derived from SI have been used to predict the prognosis of critically ill patients [9]. MSI is defined as the ratio of HR to mean arterial pressure (MAP). MAP is thought to be a better indicator of hemodynamic status than SBP and diastolic blood pressure (DBP). Some studies in the literature have shown that MSI performs better than SBP, DBP, HR and SI [9,11,12]. ASI is obtained by multiplying age by SI. A study found that

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ASI was superior to both SI and MSI in predicting mortality in patients with acute myocardial infarction. Another study found that ASI performed similarly better in predicting mortality in geriatric patients presenting to the ED with trauma [9,13,14]. Age-MSI (AMSI), which is obtained by multiplying age by MSI, is a new index and has shown superior performance than SI and MSI in predicting mortality in a study conducted on patients with myocardial infarction [14]. For these reasons, the study aimed to examine the performance of SI and its derivatives in predicting in-hospital and 30-day mortality in UGIB patients presenting to the ED.

Material and Methods

Study Data and Settings

This study was conducted retrospectively on patients aged 18 and over who presented to the ED of a tertiary Hospital and were diagnosed with UGIB between 01.03.2022-16.03.2024. The study was initiated after the approval of the local ethics committee (Decision Number:2024/23).

Patients admitted to the ED with a preliminary diagnosis of UGIB were retrospectively analyzed. Patients aged 18 and over who were confirmed to have UGIB following internal medicine and/or gastroenterology consultation and were subsequently admitted to the hospital were included in the study. Patients identified with variceal bleeding during evaluations at the time of admission and during hospitalization or diagnosed with conditions other than UGIB based on endoscopic examination were excluded from the study. Additionally, patients under 18 years of age, pregnant patients, those who experienced cardiac arrest at the time of ED presentation, those who died before the confirmation of UGIB diagnosis, and patients with incomplete data in their medical records were excluded from the study.

Data Collection and Measurements

The data collection form included demographic data such as age and gender from patients' records; vital signs at the time of ED presentation, including SBP (mmHg), DBP (mmHg), HR (beats/min), SI, MSI, ASI, and AMSI; and history characteristics such as chronic kidney disease, chronic liver disease, malignancy, previous history of UGIB, presence of atrial fibrillation or flutter, use of nonsteroidal anti-inflammatory drugs (NSAIDs), antiplatelet medication use, and anticoagulant medication use. NSAID use was defined as current use or use within the last week.

Clinical characteristics at presentation included symptoms such as fatigue or weakness, syncope, vomiting blood or coffee ground-like material, bloody or dark stool, nausea and vomiting, abdominal pain, and other symptoms. Additionally, patients were separately classified according to their reports of syncope. Rectal examination findings including normal stool, empty ampulla, melena and hematochezia and the presence of hematemesis after nasogastric tube placement were recorded.

Laboratory data included white blood cell count (WBC), hemoglobin (HGB), hematocrit (HCT), red cell distribution width (RDW-CV), platelets (PLT), glucose, creatinine, blood urea nitrogen (BUN), BUN/creatinine ratio, lactate dehydrogenase (LDH), alanine aminotransferase (ALT), aspartate aminotransferase (AST) and lactate levels. Hospital admission status (ward/intensive care), in-hospital and 30-day mortality were assessed and recorded.

- SI was defined as the ratio of heart rate to SBP. SI=HR (beats/min) / SBP (mmHg)
- The MSI was defined as the ratio of heart rate to MAP. MSI=HR (beats/min) / MAP (mmHg)
- ASI was defined as the product of age and SI. ASI=Age (year) x SI
- AMSI was defined as the product of age and MSI: AMSI=Age(year) x MSI

Outcomes

The primary outcome of this study was in-hospital mortality, defined as death occurring during the ED stay or hospitalization. The secondary outcome was 30-day mortality, defined as death occurring within 30 days from the time of ED presentation. The relationships between demographic characteristics, clinical and laboratory findings, and mortality were analyzed.

Statistical Analysis

SPSS v.26 software was used for data analysis. Normal distribution of variables was analyzed using visual and analytical methods. Variables were presented as frequency and percentage, median (IQR 25-75) and mean±standard deviation depending on whether they were continuous or categorical. Independent T-tests or Mann-Whitney U test were used in the analysis of continuous and categorical variables if they were appropriate according to their normal distribution status.

The diagnostic performance of the variables in predicting in-hospital and 30-day mortality was evaluated using Receiver Operating Characteristics (ROC) curve analysis and 95% confidence interval (CI) and area under the curve (AUC). Cut-off points of the variables were determined according to Youden index results. Statistical significance was set at $p<0.05$.

Results

Of the 201 patients included in the study, 112 (55.7%) were male, and 89 (44.3%) were female. The age range of the patients was 21-94 years, with a mean age of 70.68±16.617. In-hospital mortality, occurred in 17 patients (8.5%), while 30-day mortality, occurred in 22 patients (10.9%). The most common presenting complaint was bloody stool in 83 patients (41.3%), and the most common examination finding was melena in 137 patients (68.2%).

In-hospital mortality occurred in 8 male (7.1%) and 9 female patients (10.1%), while 30-day mortality occurred in 9 males (8%) and 13 females (14.6%), with no statistically significant difference between genders for in-hospital and 30-day mortality ($p=0.452$ and $p=0.138$, respectively). Median ages for in-hospital mortality were 81 years (IQR 25-75: 75-84) in the deceased patient group and 75 years (IQR 25-75: 59.5-82) in the surviving patient group and were not statistically significant ($p=0.072$). For 30-day mortality, the median ages were 81.5 years (IQR

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25-75: 75-84) and 74 years (IQR 25-75: 59.5-82), which was statistically significant (p=0.041). Nine patients (15.8%) with hematemesis on physical examination died, while 8 patients (5.6%) without hematemesis died, showing a statistically significant relationship between hematemesis and in-hospital mortality (p=0.019). Patients not using anticoagulants did not experience either in-hospital or 30-day mortality (p=0.032 and 0.013, respectively). The relationships between patients' demographic characteristics, clinical and history features, and mortality are shown in Table 1.

Table 1. Relationship between mortality and patients' demographic characteristics and clinical findings

		In hospital mortality (n = 17)			30-day mortality (n = 22)		
		Alive (n=184)	Deceased (n=17)	p	Alive (n=179)	Deceased (n=22)	p
Sex	**Male**	104 (92.9%)	8 (7.1%)	0.452	103 (92%)	9 (8%)	0.138
	Female	80 (89.9%)	9 (10.1%)		76 (85.4%)	13 (14.6%)	
Age (years)		75 (59.5-82)	81 (75-84)	0.072	74 (59.5-82)	81.5 (75-84)	**0.041**
Symptom	**Diziness**	36 (94.7%)	2 (5.3%)	0.883	35 (92.1%)	3 (7.9%)	0.936
	Syncope	14 (87.5%)	2 (12.5%)		14 (87.5%)	2 (12.5%)	
	Hematemesis	36 (92.3%)	3 (7.7%)		34 (87.2%)	5 (12.8%)	
	Bloody feces	76 (91.6%)	7 (8.4%)		74 (89.2%)	9 (10.8%)	
	Nausea/vomiting	8 (88.9%)	1 (11.1%)		8 (88.9%)	1 (11.1%)	
	Abdominal pain	4 (100%)	0 (0%)		4 (100%)	0 (0%)	
	Others	10 (83.3%)	2 (16.7%)		10 (83.3%)	2 (16.7%)	
Hematemesis	**None**	136 (94.4%)	8 (5.6%)	**0.019**	132 (91.7%)	12 (8.3%)	0.059
	Yes	48 (84.2%)	9 (15.8%)		47 (82.5%)	10 (17.5%)	
Syncope	**None**	170 (91.9%)	15 (8.1%)	0.545	165 (89.2%)	20 (10.8%)	0.836
	Yes	14 (87.5%)	2 (12.5%)		14 (87.5%)	2 (12.5%)	
Rectal examination	**Normal gaita**	35 (89.7%)	4 (10.3%)	0.795	34 (87.2%)	5 (12.8%)	0.936
	Empty ampulla	5 (83.3%)	1 (16.7%)		5 (83.3%)	1 (16.7%)	
	Hematochesia	17 (89.5%)	2 (10.5%)		17 (89.5%)	2 (10.5%)	
	Melena	127 (92.7%)	10 (7.3%)		123 (89.8%)	14 (10.2%)	
History of chronic kidney diseasea	**None**	163 (92.6%)	13 (7.4%)	0.148	159 (90.3%)	17 (9.7%)	0.121
	Yes	21 (84%)	4 (16%)		20 (80%)	5 (20%)	
History of chronic liver failure	**None**	180 (91.8%)	16 (8.2%)	0.348	176 (89.8%)	20 (10.2%)	**0.035**
	Yes	4 (80%)	1 (20%)		3 (60%)	2 (40%)	
History of malignity	**None**	162 (92%)	14 (8%)	0.496	159 (90.3%)	17 (9.7%)	0.121
	Yes	22 (88%)	3 (12%)		20 (80%)	5 (20%)	
History of upper gastrointestinal bleeding	**None**	153 (92.2%)	13 (7.8%)	0.487	148 (89.2%)	18 (10.8%)	0.920
	Yes	31 (88.6%)	4 (11.4%)		31 (88.6%)	4 (11.4%)	
History of atrial fibrillation or flutter	**None**	149 (90.9%)	15 (9.1%)	0.460	145 (88.4%)	19 (11.6%)	0.541
	Yes	35 (94.6%)	2 (5.4%)		34 (91.9%)	3 (8.1%)	
History of NSAID use	**None**	143 (89.9%)	16 (10.1%)	0.112	138 (86.8%)	21 (13.2%)	**0.046**
	Yes	41 (97.6%)	1 (2.4%)		41 (97.6%)	1 (2.4%)	
History of antiplatelet use	**None**	120 (91.6%)	11 (8.4%)	0.966	117 (89.3%)	14 (10.7%)	0.873
	Yes	64 (91.4%)	6 (8.6%)		62 (88.6%)	8 (11.4%)	
History of anticoagulant use	**None**	144 (89.4%)	17 (10.6%)	**0.032**	139 (86.3%)	22 (13.7%)	**0.013**
	Yes	40 (100%)	0 (0%)		40 (100%)	0 (0%)	

Values are presented as median (25th and 75th quartile), or n (%); NSAID: nonsteroidal anti-inflammatory drug

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SI, MSI, ASI, and AMSI values were significantly associated with both in-hospital and 30-day mortality (p<0.001). For in-hospital mortality, the mean hemoglobin value of patients who died was 8.72±2.49, while it was 9.31±3.15 in surviving patients (p=0.454). For 30-day mortality, the mean hemoglobin value of patients who died was 8.62±2.76, while it was 9.34±3.14 in surviving patients (p=0.306). Lactate was associated with in-hospital mortality (p=0.003), but not with 30-day mortality (p=0.129). The relationships between clinical and laboratory parameters and mortality are shown in Table 2.

Table 2. Relationship between mortality and patients' clinical and laboratory findings

	In hospital mortality (n=17)			30-day mortality (n=22)		
	Alive (n=184)	**Deceased (n=17)**	**p**	**Alive (n=179)**	**Deceased (n=22)**	**p**
SBP	118 (100-123)	90 (80-110)	**<0.001**	118 (100-122)	95 (90-120)	**0.006**
DBP	70 (60-80)	60 (50-67)	**0.001**	70 (60-80)	60 (60-70)	**0.007**
MAP	86.67 (75.83-93.33)	70 (56.67-76.67)	**<0.001**	86.67 (75-93.33)	73.33 (70-90)	**0.006**
Pulse rate	81 (75-91.5)	98 (80-121)	**0.003**	80 (75-91.5)	94 (80-120)	**0.001**
SI	0.69 (0.63-0.86)	1.07 (0.87-1.6)	**<0.001**	0.7 (0.63-0.86)	0.95 (0.69-1.36)	**<0.001**
MSI	0.92 (0.83-1.14)	1.5 (1.09-2.07)	**<0.001**	0.92 (0.83-1.14)	1.27 (1-1.85)	**<0.001**
ASI	51.2 (40.18-63.36)	79.2 (64.38-120)	**<0.001**	51.25 (39.26-63.77)	77.39 (53.62-101.33)	**<0.001**
AMSI	68.45 (52.76-86.72)	111.21 (79.36-157.43)	**<0.001**	68.45 (52.36-86.87)	103.61 (72.1-135.38)	**<0.001**
WBC	9.47 (7.69-12.27)	11.35 (10.1-15.12)	**0.044**	9.47 (7.73-12.27)	11.32 (7.01-15.12)	0.165
Hemoglobin	9.31±3.15	8.72±2.49	0.454	9.34±3.14	8.62±2.76	0.306
Hematocrite	29.04±8.95	27.96±7.64	0.631	29.11±8.9	27.7±8.33	0.482
RDW-CV	14.6 (13.35-15.9)	17.2 (14.3-19.8)	**0.013**	14.6 (13.3-15.9)	17.35 (14.3-20)	**0.002**
Platelet	255 (213.5-304.5)	187 (159-320)	0.144	255 (212-305.5)	211.5 (159-301)	0.178
Glucose	131 (108-166)	145 (123-165)	0.308	133 (108.5-166.5)	140 (112-159)	0.916
BUN	32.4 (19.5-48.1)	47 (21-70.4)	**0.046**	32.4 (19.5-47.4)	44.5 (20.9-70.2)	0.091
Creatinine	0.9 (0.76-1.28)	1.71 (1.02-2.33)	**0.005**	0.9 (0.76-1.28)	1.48 (0.65-2.02)	0.063
BCR	33.93 (19.82-49.78)	33.43 (21.91-34)	0.716	32.48 (19.53-49.63)	33.68 (21.91-43.12)	0.895
ALT	11 (9-17.5)	12 (9-31)	0.560	11 (9-17.5)	12.5 (9-21)	0.516
AST	16 (12-21)	34 (16-74)	**0.005**	16 (12-21)	23 (14-50)	**0.007**
LDH	176 (148.5-226)	291 (225-369)	**<0.001**	175 (148-226)	276 (209-300)	**<0.001**
Lactate	2 (1.4-2.7)	3.3 (1.8-13.1)	**0.003**	2 (1.4-2.7)	1.9 (1.5-10.9)	0.129

Values are presented as mean ± SD, median (25th and 75th quartile); ALT: alanine aminotransferase, AMSI: age-MSI, ASI: age-SI, AST: aspartate aminotransferase, BCR: BUN creatinine ratio, BUN: blood urea nitrogen, DBP: diastolic blood pressure, MAP: mean arterial pressure, LDH: lactate dehydrogenase, MSI: modified Shock Index, RDW-CV: red blood cell distribution width, SBP: systolic blood pressure, SD: standart deviation, SI: Shock Index, WBC: white blood cell

ROC analysis was conducted to evaluate the diagnostic performance of clinical and laboratory parameters According to ROC analysis in predicting in-hospital mortality, AUCs were determined as 0.837, 0.829, 0.810 and 0.806 for ASI, AMSI, MSI and SI, respectively. According to ROC analysis, in predicting 30-day mortality AUCs were determined as 0.775, 0.772, 0.770, 0.738, 0.737 for LDH, ASI, AMSI, MSI and SI, respectively. Table 3 and Table 4 show the performance of clinical and laboratory parameters in predicting in-hospital and 30-day mortality, respectively. Figure 1 and Figure 2 show the ROC graphs of SI and its derivatives in predicting in-hospital and 30-day mortality, respectively.

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Table 3. Cutoff points and performance characteristics of clinical and laboratory findings in predicting in hospital mortality

Parameters	AUC	95% CI	Cutoff	Sensitivity	Specificity	+LR	-LR	p values
SBP	0.755	(0.622-0.888)	101	0.706	0.739	2.705	0.398	**0.001**
DBP	0.742	(0.615-0.87)	67.5	0.765	0.663	2.270	0.354	**0.001**
MAP	0.761	(0.635-0.887)	82.667	0.824	0.679	2.567	0.259	**<0.001**
Pulse	0.720	(0.571-0.868)	87.5	0.706	0.701	2.361	0.419	**0.003**
SI	0.806	(0.689-0.923)	0.846	0.824	0.739	3.157	0.238	**<0.001**
MSI	0.810	(0.694-0.926)	1.253	0.706	0.832	4.202	0.353	**<0.001**
ASI	0.837	(0.751-0.924)	61.095	0.824	0.712	2.861	0.247	**<0.001**
AMSI	0.829	(0.737-0.921)	92.67	0.706	0.821	3.944	0.358	**<0.001**
WBC	0.648	(0.492-0.803)	11.245	0.647	0.696	2.128	0.507	**0.044**
RDW-CV	0.682	(0.558-0.806)	16.95	0.529	0.799	2.632	0.589	**0.013**
BUN	0.647	(0.492-0.801)	57.25	0.471	0.864	3.463	0.612	**0.046**
Creatinine	0.704	(0.531-0.876)	1.59	0.647	0.902	6.602	0.391	**0.006**
AST	0.703	(0.534-0.873)	33.5	0.529	0.951	10.796	0.495	**0.006**
LDH	0.779	(0.642-0.915)	253.5	0.647	0.87	4.977	0.406	**<0.001**
Lactate	0.715	(0.578-0.852)	4.2	0.471	0.94	7.850	0.563	**0.003**

AMSI: age-MSI, ASI: age-SI, AST: aspartate aminotransferase, BUN: blood urea nitrogen, CI: confidence interval, DBP: diastolic blood pressure, MAP: mean arterial pressure, MSI: modified Shock Index, RDW-CV: red blood cell distribution width, SBP: systolic blood pressure, SI: Shock Index, WBC: white blood cell

Table 4. Cutoff points and performance characteristics of clinical and laboratory findings in predicting 30-day mortality

Parameters	AUC	95% CI	Cutoff	Sensitivity	Specificity	+LR	-LR	p values
Age	0.634	(0.52-0.748)	74.5	0.773	0.503	1.555	0.451	**0.041**
SBP	0.678	(0.541-0.814)	91.5	0.5	0.838	3.086	0.597	**0.007**
DBP	0.671	(0.54-0.802)	67.5	0.682	0.665	2.036	0.478	**0.009**
MAP	0.680	(0.546-0.814)	82.667	0.727	0.682	2.286	0.400	**0.006**
Pulse	0.710	(0.589-0.831)	87.5	0.636	0.704	2.149	0.517	**0.001**
SI	0.737	(0.614-0.86)	0.846	0.727	0.743	2.829	0.367	**<0.001**
MSI	0.738	(0.613-0.863)	1.248	0.636	0.832	3.786	0.438	**<0.001**
ASI	0.772	(0.676-0.869)	77.155	0.545	0.86	3.893	0.529	**<0.001**
AMSI	0.770	(0.675-0.866)	64.728	1	0.419	1.721	0.000	**<0.001**
RDW-CV	0.698	(0.587-0.808)	16.95	0.545	0.81	2.868	0.562	**0.002**
AST	0.675	(0.53-0.819)	30.5	0.455	0.944	8.125	0.577	**0.008**
LDH	0.775	(0.664-0.887)	253.5	0.591	0.877	4.805	0.466	**<0.001**

AMSI: age-MSI, ASI: age-SI, AST: BUN: blood urea nitrogen, CI: confidence interval, DBP: diastolic blood pressure, MAP: mean arterial pressure, MSI: modified Shock Index, RDW-CV: red blood cell distribution width, SBP: systolic blood pressure, SI: Shock Index, WBC: white blood cell

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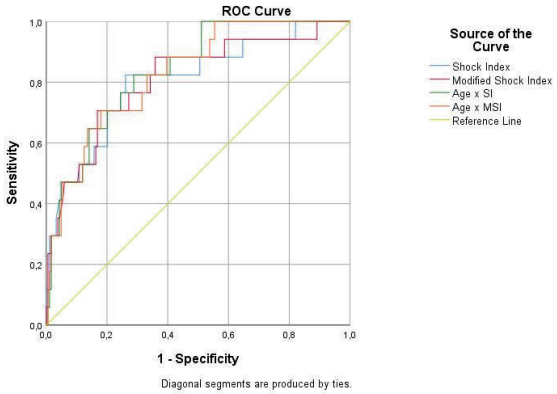

Figure 1. ROC curve of Shock Index and its derivatives in predicting in hospital mortality; AMSI: age-MSI, ASI: age-SI, MSI: modified Shock Index, ROC: receiver operating characteristics, SI: Shock Index

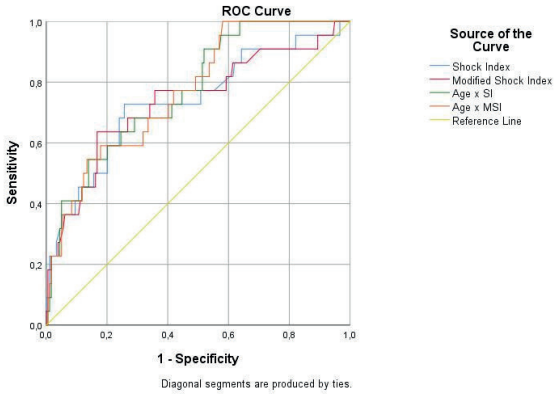

Figure 2. ROC curve of Shock Index and its derivatives in predicting 30-daysmortality; AMSI: age-MSI, ASI: age-SI, MSI: modified Shock Index, ROC: receiver operating characteristics, SI: Shock Index

Discussion

This study is the first in the literature to compare the performance of ASI and AMSI in predicting in-hospital and 30-day mortality in UGIB patients presenting to the ED. Patients with higher ASI, AMSI, SI and MSI values at presentation had higher in-hospital and 30-day mortality. In this study, we found that AMSI and ASI performed better than MSI and SI in predicting both in-hospital and 30-day mortality. Additionally, AMSI and ASI were better at predicting in-hospital mortality than all other parameters. However, LDH showed the most successful performance in predicting 30-day mortality.

UGIB constitutes a significant portion of ED visits and is among the common reasons for hospital admissions [8,15]. Despite advancements in the diagnosis and treatment of the disease, mortality rates remain around 10%. In hemodynamically unstable patients, mortality rates are estimated to rise up to 15% [16,17]. In our study, consistent with the general patient population, in-hospital mortality occurred in 8.5% of patients, while 30-day mortality occurred in 10.9%. In a study by Aljarada et al., the mortality rate was found to be 9.40%, and in another study by Saffouri et al., the 30-day mortality rate was 7%, while Gulen et al. reported a rate of 10.79%, similar to our findings [16,18,19].

Lactate accumulates in hypoxic tissues as a result of anaerobic respiration. Studies have shown that increased lactate levels are associated with adverse outcomes in critically ill patients [20]. Shawky et al. found that high venous lactate levels are a determinant of mortality [21]. Gulen et al. examined the relationship between lactate and in-hospital mortality in UGIB patients, finding a successful performance with an AUC of 0.664 [19]. In another study, Shah et al found that lactate was predictive of mortality with an AUC of 0.740 in patients with gastrointestinal bleeding [22]. In our study, increased lactate levels were associated with mortality. Lactate showed successful performance in predicting in-hospital mortality (AUC: 0.715) and could be useful for clinicians in identifying critical patient groups and as a predictor of mortality.

LDH is a cytoplasmic enzyme present in many organs. LDH levels increase in response to conditions such as cell damage, inflammation, and hypoxia [23-25]. In a study on patients with aneurysmal subarachnoid hemorrhage, LDH was shown to be a successful predictor of all-cause death [25]. Güngörer et al. also found that increased serum LDH levels were associated with in-hospital mortality in UGIB patients [26]. In our study, LDH successfully predicted in-hospital mortality (AUC: 0.779). Additionally, we also found that LDH (AUC: 0.775) performed better than other variables in predicting 30-day mortality.

Hypotension and shock are observed in patients due to blood loss from the gastrointestinal system. UGIB is among the common causes of non-traumatic hemorrhagic shock. Studies on UGIB have used SBP and shock as important parameters in predicting morbidity and mortality. SI is a better predictor of hemodynamic status than SBP and HR. It is a reliable indicator of hemodynamic stability, even when SBP and HR are normal. It has been studied in pathologies causing shock, such as sepsis, trauma, and gastrointestinal bleeding, and has been found successful in predicting mortality [8-13]. Rassameehiran et al. observed that an SI>0.78 was associated with increased mortality and the need for transfusion [27]. Doğru et al. found that SI had a successful performance in predicting 30-day mortality with an AUC of 0.911 in UGIB patients in 2022 [2]. In another study by Jung et al., the AUC for predicting in-hospital mortality was found to be 0.601 [8]. In our study, SI was successful in predicting both in-hospital mortality (AUC 0.806, 95% CI 0.689-0.923) and 30-day mortality (AUC 0.737). Doğru et al.'s study included only geriatric patients, while Jung et al. conducted their study on hemodynamically stable UGIB patients [2,8]. These differences might have contributed to the varying performance of SI in predicting mortality in different studies.

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MSI was developed with the rationale that DBP is as effective as SBP in evaluating hemodynamic status. MAP is believed to be better than SBP and DBP in reflecting hemodynamic status [11,28]. ASI and AMSI are newer indices derived from SI. ASI is obtained by multiplying age by SI, and AMSI is obtained by multiplying age by MSI [9,14]. There are several studies in the literature comparing the performance of SI, MSI, and ASI [12-14,28]. In a study by Liu et al., MSI was found to have better performance in predicting mortality compared to SI, SBP, and HR [12]. Torabi et al. compared SI, MSI, and ASI in predicting mortality in ED patients and found that ASI had better performance [28]. In a study conducted in patients with ST-elevation myocardial infarction, AMSI (AUC: 0.813) and ASI (AUC: 0.805) was found to have better performance in predicting in-hospital mortality compared to SI (AUC: 0.710) and MSI (AUC: 0.702) [14]. Kim et al. evaluated the performance of SI, MSI, and ASI in predicting ED and in-hospital mortality in geriatric trauma patients and found that ASI was superior to SI and MSI [13]. In this study, ASI (AUC: 0.837) and AMSI (AUC: 0.829) showed better performance than MSI (AUC: 0.810) and SI (AUC: 0.806) in predicting in-hospital mortality. Similarly, ASI (AUC: 0.772) and AMSI (AUC: 0.770) showed superior performance to MSI (AUC: 0.738) and SI (AUC: 0.737) in predicting 30-day mortality. Therefore, we believe that ASI and AMSI can be used as indicators for identifying critical patient groups in UGIB patients presenting to the ED.

Study Limitations

The study was designed as a retrospective and single-center study, which may have introduced selection bias. The researchers collecting the data were not blinded to the study's objective. Additionally, the sample size and the number of patients meeting the outcome criteria were small. Therefore, the generalizability of the study is limited, and multicenter prospective studies are needed.

Conclusion

ASI and AMSI are successful parameters in predicting both in-hospital and 30-day mortality in UGIB patients, showing better performance than SI and MSI. ASI and AMSI can be calculated easily, cost-effectively, quickly, and practically at the time of ED presentation in UGIB patients, aiding in the early identification of critical patient groups and guiding clinicians. Additionally, we believe they may be useful in predicting patients requiring early intervention as early predictors of mortality.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
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Ethical Approval
Study approval was obtained from the clinical ethics committee of Ordu University Faculty of Medicine. Ethics Committee Decision Date: 26.04.2024. Decision Number: 2024/23.

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