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Early emergency department risk signals in upper gastrointestinal bleeding: The hemoglobin-to-red cell distribution width ratio

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Abstract:

OBJECTIVES: Upper gastrointestinal bleeding (UGIB) is a common emergency associated with substantial morbidity and mortality. Early risk assessment is important, but some established scores require laboratory or endoscopic data not immediately available. We evaluated whether the hemoglobin (Hb)-to-red cell distribution width ratio (Hb/RDW) at emergency department presentation was associated with intensive care unit admission or mortality during the index episode.

METHODS: This retrospective single-center study included adults presenting with UGIB between 2019 and 2023. Patients with incomplete evaluation, missing Hb or RDW values, or non-UGIB bleeding sources were excluded. Hb/RDW was calculated at presentation. Group comparisons, receiver operating characteristic analyses, and multivariable logistic regression were performed for the primary composite outcome. Additional adjusted models compared Hb/RDW with Hb and RDW individually.

RESULTS: Among 942 patients, the primary composite outcome occurred in 121 (12.8%). Hb/RDW was lower in patients with the primary outcome (0.398 [0.296–0.539] vs. 0.568 [0.411–0.780]; $P < 0.001$). Discrimination was moderate (area under the curve: 0.712, 95% confidence interval [CI]: 0.664–0.757); a threshold near 0.593 yielded sensitivity 0.851 and negative predictive value 0.956. Hb/RDW remained independently associated with the primary outcome (adjusted odds ratio: 0.023, 95% CI: 0.007–0.073; $P < 0.001$). It performed better than Hb alone and similarly to RDW, with the greatest incremental discrimination when added to the clinical base model. Lower values were also observed in variceal bleeding.

CONCLUSION: Lower Hb/RDW at presentation was independently associated with adverse outcomes in UGIB and may serve as an adjunctive early triage marker.

Keywords:

Endoscopy, gastrointestinal bleeding, gastrointestinal hemorrhage, hemoglobin-to-red cell distribution width, hemoglobin, intensive care, red cell distribution width

Introduction

Upper gastrointestinal bleeding (UGIB) is a frequent reason for emergency

department (ED) presentation and remains associated with substantial morbidity and mortality, ranging from self-limited bleeding to hemodynamic collapse and death.^[1-3] Early identification of patients at risk for adverse outcomes is therefore central to UGIB management, both because

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Box-ED section**What is already known on this topic?**

- Early risk stratification is central to UGIB management
- Commonly used scores, such as Glasgow–Blatchford Score, Rockall, and AIMS65, may require laboratory or endoscopic variables not fully available during initial ED triage
- RDW and other erythrocyte indices have been associated with adverse outcomes in several acute and chronic conditions.

What is the knowledge gap or unresolved issue?

- Evidence remains limited on whether simple hematologic ratios can support early UGIB risk assessment at ED presentation
- The prognostic role of Hb/RDW in a real-world ED UGIB population has not been well defined.

How is this study structured?

- This was a single-center, retrospective, cohort study of adults presenting to the ED with UGIB between 2019 and 2023
- Hb/RDW at presentation was evaluated against a composite of intensive care unit (ICU) admission or mortality during the index episode, hospital admission from the ED, and endoscopic findings.

What does this study add to clinical practice?

- Lower Hb/RDW at presentation was associated with ICU admission or mortality during the index episode.
- Hb/RDW showed moderate discrimination but high sensitivity at lower thresholds, supporting its use as an adjunctive early triage marker rather than a definitive decision tool
- Values above the cutoff may help support the identification of patients at relatively lower immediate risk when interpreted with clinical assessment and established risk scores.

of the risk of early deterioration and because some patients may subsequently re-present after initial ED evaluation.^[4] The current guidelines emphasize hemodynamic stabilization, pharmacologic therapy, timely endoscopy, and early risk stratification to guide disposition and management.^[1,2,5]

Risk scores such as the Glasgow–Blatchford Score (GBS), Rockall Score, and AIMS65 are widely used for this purpose.^[6-8] However, their value during early triage may be limited because some components – particularly laboratory and endoscopic variables – may not yet be available.^[9] Because complete blood count testing is almost universally available at ED presentation, simple hematologic indices may offer practical early support before more comprehensive risk stratification can be completed.

Hemoglobin (Hb) reflects blood loss but is influenced by hydration status, bleeding timing, and chronic comorbidity. Red cell distribution width (RDW), a marker of anisocytosis, has been linked to inflammation, oxidative stress, nutritional deficiency, and chronic organ dysfunction.^[10-12] In UGIB, higher RDW has been associated with high-risk bleeding and improved discrimination when added to the pre-endoscopic Rockall score.^[13]

The Hb-to-RDW ratio (Hb/RDW) integrates oxygen-carrying capacity with erythrocyte size variability and has shown prognostic value in heart failure, postpercutaneous coronary intervention outcomes, and malignancy.^[14-17] In critically ill patients with gastrointestinal bleeding, lower Hb/RDW was independently associated with higher 180-day mortality in an intensive care unit (ICU) cohort.^[18]

However, evidence remains limited regarding the value of Hb/RDW measured at ED presentation in a broader, real-world UGIB population. We therefore evaluated whether Hb/RDW at ED presentation was associated with ICU admission or mortality during the index episode and also explored its relationship with hospital admission from the ED and endoscopic findings.

Methods

This single-center retrospective cohort study was conducted between January 01, 2019, and December 31, 2023, and is reported in accordance with the STROBE statement.^[19]

Ethics approval

The study was approved by the Clinical Research Ethics Committee of Marmara University Faculty of Medicine, Istanbul, Türkiye (protocol no. 09.2024.103, January 12, 2024). Because of the retrospective design, the requirement for individual informed consent was waived. The study followed the Declaration of Helsinki. Data were obtained in anonymized form from hospital information systems, laboratory records, and patient charts.

Patient selection

Adults (≥ 18 years) presenting to the ED with symptoms suggestive of UGIB (hematemesis, melena, or less commonly hematochezia in massive UGIB) and diagnosed with UGIB by the ED physician or subsequent evaluation were screened. Patients whose course could not be followed, those missing Hb or RDW values, and those ultimately diagnosed with non-UGIB bleeding sources were excluded.

Variables and measurements

Recorded variables included age, sex, vital signs at presentation, comorbidities (atrial fibrillation, hypertension,

diabetes mellitus, congestive heart failure, chronic kidney disease, coronary artery disease/myocardial infarction, cerebrovascular event, and malignancy), medication use (antiplatelets, anticoagulants, and nonsteroidal anti-inflammatory drugs), and laboratory values (Hb, RDW, platelet count, international normalized ratio, creatinine, and blood urea nitrogen). Hb/RDW was calculated by dividing Hb by RDW. Shock index was calculated as heart rate divided by systolic blood pressure.

Patient location during the index episode was categorized as ED, ward, or ICU. Death location, when applicable, was recorded separately as ED death, ward death, or ICU death. Endoscopy performance was recorded as yes/no. For patients who underwent endoscopy, findings were categorized using the Forrest classification: Ia, spurting bleeding; Ib, oozing bleeding; IIa, nonbleeding visible vessel; IIb, adherent clot; IIc, flat pigmented spot/hematin; and III, clean-based ulcer.^[20] Gastritis, varices, and mass lesions were coded separately. Patients without endoscopy were retained as a descriptive subgroup.

Outcomes

The primary outcome was a composite of ICU admission or mortality during the index episode. Mortality during the index episode included all deaths during the index ED/hospital episode, including ED, ward, and ICU deaths. Because death could occur after ICU admission, overlap between these components was counted once at the patient level.

The secondary outcomes were hospital admission from the ED (ward or ICU) versus no hospital admission from the ED, ICU admission alone, mortality during the index episode alone, and differences in Hb/RDW across the endoscopic findings. Exploratory analyses evaluated variation in Hb/RDW according to comorbidities and antithrombotic medication use.

Statistical analysis

Analyses were performed using jamovi version 2.4.0 (The jamovi project, Sydney, Australia). The continuous variables are presented as median with interquartile range, and categorical variables as counts and percentages. Between-group comparisons used the Mann-Whitney *U* test for two-group analyses and the Kruskal-Wallis test for comparisons across more than two groups; *post hoc* pairwise comparisons, when needed, were performed using Dunn's test with Benjamini-Hochberg false discovery rate correction. The categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate.

Discrimination of Hb/RDW for the primary and secondary outcomes was assessed using receiver

operating characteristic analysis. Area under the curve (AUC) values and 95% confidence intervals (CIs) were estimated using outcome-stratified bootstrap resampling with 4,000 iterations, and optimal cutoffs were determined using the Youden J statistics. For the primary outcome, positive predictive value, negative predictive value, and positive and negative likelihood ratios were also calculated.

A multivariable logistic regression model was constructed for the primary outcome using prespecified covariates: age, sex, shock index, chronic kidney disease, active malignancy, and anticoagulant use. Additional models assessed the incremental performance of Hb/RDW, Hb, and RDW when added separately to the same clinical base model. Because Hb/RDW is mathematically derived from Hb and RDW, these variables were not entered simultaneously into the same adjusted model. Model performance was compared using AUC, likelihood-ratio testing, and Akaike's information criterion.

Sensitivity analyses replaced chronic kidney disease with serum creatinine and repeated the primary model in the nonvariceal subgroup. Internal validation of the final multivariable model was performed using bootstrap resampling to estimate optimism-corrected discrimination. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

Results

During the study period, 1053 patients were screened. Seventeen patients left the ED before completion of evaluation, and 94 were excluded because the final diagnosis indicated a non-UGIB source. The final analytic cohort comprised 942 patients.

The median age was 66.0 years (52.2–78.0), and 32.5% ($n = 306$) were female. Baseline clinical and laboratory characteristics are presented in Table 1.

Primary outcome: Intensive care unit admission or mortality during the index episode

The primary composite outcome occurred in 121/942 patients (12.8%). Hb/RDW was significantly lower in patients with the primary outcome than in those without it (0.398 [0.296–0.539] vs. 0.568 [0.411–0.780]; $P < 0.001$). Hb/RDW showed moderate discrimination for the primary outcome (AUC: 0.712, 95% CI: 0.664–0.757). A threshold near 0.593 yielded high sensitivity (0.851) but limited specificity (0.472) [Table 2]. At this threshold, the positive predictive value was 0.192, the negative predictive value was 0.956, the positive likelihood ratio was 1.61, and the negative likelihood ratio was 0.32. Mortality during the index episode occurred in

39 patients, comprising 17 deaths in the ED, 8 on the ward, and 14 in the ICU.

Table 1: Baseline clinical and laboratory characteristics of patients with upper gastrointestinal bleeding

Variables	Value (median [IQR] or n (%))
Age (years)	66.0 (52.2–78.0)
Female sex	306 (32.5)
Systolic blood pressure (mmHg)	114 (98–126)
Diastolic blood pressure (mmHg)	69 (60–80)
Heart rate (beats/min)	91 (78–107)
Shock index	0.82 (0.66–0.99)
Hb (g/dL)	8.80 (6.90–11.10)
RDW (%)	15.60 (13.90–18.30)
Hb-to-RDW ratio	0.541 (0.394–0.757)
Platelet count ($\times 10^9/L$)	229.5 (160.0–301.5)
INR	1.33 (1.11–1.73)
Creatinine (mg/dL)	0.90 (0.71–1.26)
BUN (mg/dL)	29.9 (20.0–47.0)
Comorbidities	
Hypertension	321 (34.1)
Diabetes mellitus	216 (22.9)
Atrial fibrillation	84 (8.9)
Congestive heart failure	65 (6.9)
CKD	109 (11.6)
Coronary artery disease/ myocardial infarction	199 (21.1)
Cerebrovascular event	76 (8.1)
Active malignancy	192 (20.4)
History of gastrointestinal bleeding	348 (36.9)
Medication use	
Antiplatelet therapy	214 (22.7)
Anticoagulant therapy	197 (20.9)
Initial ED disposition/hospital course	
No hospital admission from the ED, survived	308 (32.7)
ED death	17 (1.8)
Ward admission from the ED	521 (55.3)
ICU admission from the ED	96 (10.2)
Mortality during the index episode	39 (4.1)

Data are presented as median (IQR) or n (%). Shock index was calculated as heart rate divided by systolic blood pressure. Initial ED disposition categories are mutually exclusive. Mortality during the index episode is reported separately and includes ED, ward, and ICU deaths; therefore, it may overlap with ED, ward, or ICU categories. IQR: Interquartile range, ED: Emergency department, ICU: Intensive care unit, CKD: Chronic kidney disease, RDW: Red cell distribution width, Hb: Hemoglobin, BUN: Blood urea nitrogen, INR: International Normalized Ratio

Secondary outcomes

A total of 617 patients had ED disposition to hospital admission (ward or ICU). These patients had lower Hb/RDW ratios than those without hospital admission from the ED (0.503 [0.376–0.712] vs. 0.611 [0.427–0.829]; $P < 0.001$), although discrimination for this broader outcome remained limited (AUC: 0.593, 95% CI: 0.555–0.631) [Table 2].

For ICU admission alone ($n = 96$), Hb/RDW was lower in those requiring ICU care (0.453 [0.344–0.581] vs. 0.554 [0.402–0.775]; $P < 0.001$), with an AUC of 0.650 (95% CI: 0.602–0.698). For mortality during the index episode alone ($n = 39$), Hb/RDW was markedly lower among nonsurvivors (0.296 [0.256–0.363] vs. 0.552 [0.404–0.765]; $P < 0.001$), and discrimination was stronger (AUC: 0.870, 95% CI: 0.830–0.906) [Table 2].

Multivariable analysis

In multivariable logistic regression adjusted for age, sex, shock index, chronic kidney disease, active malignancy, and anticoagulant use, Hb/RDW remained independently associated with the primary composite outcome (adjusted OR: 0.023, 95% CI: 0.007–0.073; $P < 0.001$). Shock index was also independently associated with the primary outcome (adjusted OR: 5.37, 95% CI: 2.97–9.70; $P < 0.001$) [Table 3].

Comparative performance of hemoglobin-to-red cell distribution width, hemoglobin, and red cell distribution width

In single-marker ROC analyses, Hb/RDW showed an AUC of 0.712, compared with 0.673 for Hb and 0.698 for RDW. When added separately to the same clinical base model, Hb/RDW provided the highest overall discrimination (AUC: 0.778) and the best model fit (AIC: 637.0), outperforming the base model plus Hb (AUC: 0.753; AIC: 659.6) and the base model plus RDW (AUC: 0.759; AIC: 649.9) [Table 4].

Endoscopic findings

Endoscopy was performed in 731 patients (77.6%), whereas 211 patients (22.4%) did not undergo endoscopy. Across endoscopic categories, Hb/RDW values differed significantly (Kruskal–Wallis $H = 22.71$, $P = 0.0069$).

Table 2: Discriminative performance of hemoglobin/red cell distribution width for the primary and secondary clinical outcomes

Outcomes	AUC	95% CI	Optimal cut-off (Hb/RDW $\leq$)	Sensitivity	Specificity	n (event/ nonevent)
ICU admission or mortality during the index episode (primary outcome)	0.712	0.664–0.757	0.593	0.851	0.472	121/821
Hospital admission from the ED (ward or ICU)	0.593	0.555–0.631	0.495	0.485	0.677	617/325
ICU admission	0.650	0.602–0.698	0.593	0.813	0.458	96/846
Mortality during the index episode	0.870	0.830–0.906	0.387	0.846	0.789	39/903

Lower Hb/RDW values indicate higher assumed risk. Cutoff values were determined using the Youden J statistic. AUC: Area under the curve, CI: Confidence interval, ED: Emergency department, ICU: Intensive care unit, RDW: Red cell distribution width, Hb: Hemoglobin

Table 3: Multivariable logistic regression analysis for the primary composite outcome of intensive care unit admission or mortality during the index episode

Variables	Adjusted OR	95% CI	P
Hb/RDW	0.023	0.007–0.073	<0.001
Age	1.005	0.992–1.018	0.438
Sex (female)	0.97	0.58–1.61	0.907
Shock index	5.37	2.97–9.70	<0.001
CKD	1.56	0.88–2.76	0.130
Active malignancy	1.04	0.67–1.63	0.857
Anticoagulant use	0.75	0.45–1.27	0.258

The model was adjusted for age, sex, shock index, CKD, active malignancy, and anticoagulant use. For clinical interpretability, each 0.1-unit decrease in Hb/RDW corresponded to an adjusted OR of 1.46 (95% CI 1.30–1.64) for the primary outcome. OR: Odds ratio, CI: Confidence interval, CKD: Chronic kidney disease, RDW: Red cell distribution width, Hb: Hemoglobin

Table 4: Comparative performance of hemoglobin/red cell distribution width, hemoglobin, and red cell distribution width for the primary composite outcome

Single-marker discrimination for the primary outcome				
Markers	AUC	95% CI		
Hb/RDW	0.712	0.664–0.757		
Hb	0.673	0.624–0.720		
RDW	0.698	0.650–0.747		
Incremental value beyond the clinical base model				
Model	AUC	95% CI	AIC	LR test versus base model (<i>P</i>)
Clinical base model*	0.699	0.644–0.749	684.2	-
Base model+Hb/RDW	0.778	0.734–0.822	637.0	2.31×10 ⁻¹²
Base model+Hb	0.753	0.705–0.799	659.6	2.46×10 ⁻⁷
Base model+RDW	0.759	0.713–0.802	649.9	1.53×10 ⁻⁹

*The clinical base model included age, sex, shock index, CKD, active malignancy, and anticoagulant use. Because Hb/RDW is mathematically derived from Hb and RDW, these variables were not entered simultaneously into the same adjusted model. One observation with an invalid Hb entry was excluded from Hb-based model comparisons. 95% CI for model AUCs were estimated by bootstrap resampling, consistent with the main ROC analyses. CI: Confidence interval, AUC: Area under the curve, ROC: Receiver operating characteristic, LR: Likelihood ratio, Hb: Hemoglobin, CKD: Chronic kidney disease, RDW: Red cell distribution width, AIC: Akaike's information criterion

Lower ratios were observed in variceal bleeding and in some higher-risk ulcer categories, whereas higher values were seen in gastritis and clean-based ulcers [Table 5].

Sensitivity analyses and internal validation

Sensitivity analyses were consistent with the primary findings. Replacing chronic kidney disease with serum creatinine did not materially change the association between Hb/RDW and the primary outcome (adjusted OR: 0.022, 95% CI: 0.007–0.072; $P < 0.001$), and the corresponding model AUC was 0.777. In the nonvariceal subgroup, Hb/RDW also remained independently associated with the primary outcome (adjusted OR: 0.020, 95% CI: 0.005–0.080; $P < 0.001$), with an AUC of 0.787. Bootstrap internal validation of the final multivariable model showed an apparent AUC of 0.778 and an optimism-corrected AUC of 0.763 [Supplementary Table 1].

Table 5: Hemoglobin/red cell distribution width ratio according to endoscopic category

Endoscopic category	n	Median	Q1	Q3
No endoscopy performed	211	0.539	0.380	0.767
Normal endoscopy	64	0.505	0.374	0.759
Forrest Ia (spurting active bleeding)	13	0.503	0.372	0.606
Forrest Ib (oozing active bleeding)	46	0.511	0.386	0.809
Forrest IIa (nonbleeding visible vessel)	32	0.572	0.403	0.822
Forrest IIb (adherent clot)	36	0.503	0.401	0.743
Forrest IIc (pigmented spot/hematin)	33	0.500	0.371	0.646
Forrest III (clean-based ulcer)	169	0.606	0.434	0.823
Gastritis	127	0.601	0.414	0.827
Mass lesion	48	0.499	0.390	0.670
Varices	163	0.491	0.366	0.652

Values are presented as median and IQR (Q1–Q3). Overall comparisons were performed across endoscopic categories among patients who underwent endoscopy; the "No endoscopy performed" group is shown descriptively only. Q1: First quartile, Q3: Third quartile, IQR: Interquartile range

Discussion

In our study, lower Hb/RDW at ED presentation was associated with adverse outcomes in adults with UGIB. The ratio showed moderate discrimination for the primary composite outcome of ICU admission or mortality during the index episode, supporting its role as an early supportive marker rather than a standalone decision tool. Its high sensitivity, high negative predictive value, and modest negative likelihood ratio suggest a rule-out-oriented triage role when the values are above the cutoff, particularly in a condition in which early disposition decisions are important. In practical terms, this threshold is best viewed as a supportive aid during the earliest phase of care, when full endoscopic or laboratory risk stratification may not yet be available. It should not be used in isolation to justify discharge and should instead be interpreted alongside established clinical assessment and guideline-based risk stratification approaches.^[1,2,5]

Established risk scores such as GBS, Rockall, and AIMS65 remain central to UGIB management,^[6–8] but their usefulness may be limited early in care because complete laboratory or endoscopic data may not yet be available.^[9] In that setting, a parameter derived from the routine complete blood count has practical appeal. RDW has previously been associated with high-risk UGIB and improved discrimination when incorporated into the pre-endoscopic Rockall score.^[13] Our findings extend this concept by suggesting that Hb/RDW may also provide useful early prognostic information at ED presentation.

Hb/RDW remained independently associated with the primary composite outcome after adjustment for age, sex, shock index, chronic kidney disease, active malignancy, and anticoagulant use. This supports the interpretation that the ratio captures prognostically relevant information

beyond unadjusted baseline differences. Shock index also remained strongly associated with the primary outcome, suggesting that hematologic reserve and hemodynamic instability provide complementary information during early ED assessment.

An important secondary finding was the strong discrimination of Hb/RDW for mortality during the index episode, with an AUC of 0.870. Although this result should be interpreted cautiously, given the limited number of deaths, it is still noteworthy for a marker derived from routine complete blood count parameters. This pattern may indicate that Hb/RDW captures not only acute bleeding severity but also broader physiologic vulnerability and chronic disease burden, consistent with prior evidence linking RDW-related indices to inflammation, oxidative stress, and adverse outcomes across acute and chronic conditions.^[10-13] From a disease-specific perspective, this interpretation is also in line with prior data suggesting that lower Hb/RDW is associated with worse outcomes in critically ill patients with gastrointestinal bleeding.^[18] Clinically, this raises the possibility that Hb/RDW may be particularly useful in identifying patients at the highest end of the risk spectrum, while still requiring confirmation in larger external cohorts.

When compared with its individual components, Hb/RDW performed better than Hb alone and similarly to RDW in single-marker analyses. However, when added to the same clinical base model, Hb/RDW provided the highest overall discrimination and the best model fit. These findings support the practical utility of the ratio as a parsimonious composite marker. Although Hb/RDW did not clearly outperform RDW alone in single-marker analysis, it may still be useful because it integrates two biologically relevant dimensions of risk: oxygen-carrying capacity and erythrocyte size variability, a concept that has also been associated with prognostic value in other clinical settings.^[14-18]

The endoscopic analyses also support the biological plausibility of these findings. Lower Hb/RDW values were observed in variceal bleeding and in some higher-risk ulcer categories, whereas higher values were seen in gastritis and clean-based ulcers. These observations suggest that Hb/RDW may reflect both bleeding severity and underlying lesion morphology. Lower values in higher-risk ulcer categories are also consistent with the Forrest endoscopic classification of peptic ulcer bleeding.^[20] Lower values in variceal bleeding are likewise clinically plausible, given the distinct hemodynamic burden and chronic disease profile commonly present in this subgroup.^[21]

The association between lower Hb/RDW values and multiple comorbidities further suggests that the ratio may

partly reflect chronic disease burden rather than acute bleeding alone. RDW is influenced by inflammation, oxidative stress, nutritional deficiency, and chronic organ dysfunction,^[10-12] and chronic kidney disease, malignancy, and other chronic illnesses may affect both Hb and RDW before the bleeding episode. Accordingly, although the adjusted analysis supports an independent association, residual confounding remains plausible.

Clinically, a reduced Hb/RDW ratio may help identify patients who warrant heightened monitoring, expedited resuscitation, earlier endoscopic evaluation, or preparation for transfusion. However, because specificity is limited, the ratio should complement rather than replace clinical assessment, vital signs, comorbidity evaluation, and established risk scores.

The sensitivity analyses strengthen these findings. The association remained materially unchanged both when chronic kidney disease was replaced by serum creatinine and when the analysis was repeated in the non-variceal subgroup. In addition, bootstrap internal validation showed only modest optimism, with an optimism-corrected AUC of 0.763, supporting the relative stability of the final model while underscoring the need for external validation before broader clinical implementation.

Limitations

This study has several limitations. First, its retrospective single-center design may limit generalizability to other settings and patient populations. Second, the relatively small number of deaths during the index episode may have reduced the precision of some mortality-related estimates despite the strong discrimination observed for this outcome. Third, among patients who did not undergo endoscopy, the reasons for not performing the procedure – such as hemodynamic instability, comorbidity burden, or procedural deferral – were not systematically recorded, introducing heterogeneity into that subgroup. Fourth, although we used multivariable adjustment, residual confounding remains possible because potentially relevant variables such as chronic anemia, nutritional status, inflammatory burden, transfusion practices, and endoscopy timing were not fully available. Fifth, Hb/RDW did not clearly outperform RDW alone in single-marker analyses, and its incremental value should therefore be interpreted cautiously. In addition, lower Hb/RDW values observed in variceal bleeding may reflect both acute bleeding severity and the chronic disease profile associated with portal hypertension and advanced liver disease. Finally, although internal bootstrap validation suggested retained model performance after optimism correction, the findings have not been externally validated in an independent cohort.

Conclusion

Lower Hb/RDW at ED presentation was independently associated with adverse clinical outcomes in adults with UGIB, including ICU admission or mortality during the index episode. Although discrimination was moderate, its high sensitivity and high negative predictive value at a threshold near 0.59 support its use as an adjunctive early triage marker, particularly for identifying patients at relatively low immediate risk when values are above the cutoff. Hb/RDW performed better than Hb alone and similarly to RDW in single-marker analyses, while providing the greatest incremental discrimination when incorporated into an adjusted clinical model. As an inexpensive and immediately available parameter derived from routine complete blood count testing, Hb/RDW may offer practical value during the earliest phase of ED assessment, but it should be used as a complement to – rather than a replacement for – comprehensive clinical evaluation and established UGIB risk stratification tools.

Author contributions

The authors contributed to this work as follows: conception or design of the study; acquisition, analysis, or interpretation of data; and drafting or critical revision of the work for important intellectual content. The initials of contributing authors are listed in brackets after the corresponding aspects of the research: literature search (ABU, EK, and MA), study design (ABU, EK, SK, ÖEO, and AD), legislative applications (ABU and EK), data collection (ABU, EK, and MA), supervision and quality control (SK, ÖEO, and AD), statistical advice (ABU, EK, and SK), statistical data analysis (ABU and EK), data interpretation (ABU, EK, and MA), and drafting the manuscript (ABU, EK). All authors contributed to writing and critically revising the manuscript, approved the final version, and agreed to be accountable for all aspects of the work. All authors read and approved the final manuscript. ABU, EK, MA, SK, ÖEO, and AD take responsibility for the paper as a whole.

Conflicts of interest

None Declared.

Ethical approval

This retrospective study was approved by the Ethics Committee of Marmara University (protocol no. 09.2024.103, January 12, 2024) and was conducted in accordance with the principles of the Declaration of Helsinki.

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Supplementary Table 1: Sensitivity analyses and internal validation of the primary multivariable model

Analysis	Hb/RDW adjusted OR	95% CI	<i>P</i>	Model AUC
Primary adjusted model	0.023	0.007–0.073	<0.001	0.778
CKD replaced by serum creatinine	0.022	0.007–0.072	<0.001	0.777
Nonvariceal subgroup	0.020	0.005–0.080	<0.001	0.787

Bootstrap internal validation of the final multivariable model showed an apparent AUC of 0.778 and an optimism-corrected AUC of 0.763. CKD: Chronic kidney disease, Hb: Hemoglobin, RDW: Red cell distribution width, AUC: Area under the curve, CI: Confidence interval, OR: Odds ratio