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Original Research Article

Early Risk Stratification Using Shock Index and Haemoglobin for Predicting Blood Transfusion in Acute Upper Gastrointestinal Bleeding

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Abstract

Introduction: Acute upper gastrointestinal bleeding (UGIB) is a common medical emergency. Clinicians need to triage who's at high risk so they can make smart transfusion decisions and use resources wisely. The Glasgow–Blatchford Score (GBS) is a trusted score that needs multiple clinical and laboratory parameters. That's not always practical, especially in busy or resource-limited hospitals. We studied whether a simpler model using shock index and haemoglobin could help predict earlier the needs of a blood transfusion.

Methods: In this cross-sectional observational study, 210 adults presenting with haematemesis or melaena were analysed. For each patient, we calculated the shock index (heart rate divided by systolic blood pressure) and recorded their haemoglobin on admission. Then we calculated a continuous variable: shock index × (8/haemoglobin), using 8 g/dL because that's a common transfusion threshold. The primary outcome was blood transfusions received during their hospital stay. We did multivariable logistic regression and receiver operator curve (ROC) analysis to assess predictive value of this variable in comparison to GBS.

Results: Blood transfusion was received by 64.8% of patients. They tended to have significantly higher shock index (1.12 vs 0.79) and lower haemoglobin (6.2 vs 8.7 g/dL). The composite variable was markedly higher in transfused patients (1.41 ± 0.48 vs 0.76 ± 0.29; $p<0.001$). On multivariable analysis, shock index ≥1 (adjusted OR 1.78; 95% CI 1.06–2.98; $p=0.028$), haemoglobin <8 g/dL (adjusted OR 2.47; 95% CI 1.39–4.39; $p=0.002$), and the composite variable (per 0.5 unit increase; adjusted OR 3.18; 95% CI 2.05–4.94; $p<0.001$) independently predicted transfusion. ROC analysis demonstrated AUC values of 0.68 for shock index, 0.72 for haemoglobin, 0.77 for the combined approach, and 0.75 for GBS.

Conclusion: Combining shock index and haemoglobin together offers a robust bedside option, about as good as the GBS, that helps the clinician in busy and resource limited setup in prompt triage and predicting early who'll need a blood transfusion.

Keywords: Upper Gastrointestinal Bleeding, Shock Index, Hemoglobin, Blood Transfusion, Risk Stratification.
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Introduction

Acute upper gastrointestinal bleeding (UGIB) is a frequently encountered emergency medical condition responsible for substantial morbidity, mortality & healthcare utilization. Early assessment of hemodynamic status and triaging patients at increased risk of requiring intervention are consequently important components of initial management. Current standards endorse earlier categorization of risk in patients suffering from UGIB, particularly before endoscopy, to expedite appropriate triage and management. [1-3]

Several clinical prediction tools have been developed for this purpose. The Glasgow–Blatchford Score (GBS) incorporates urea in blood, blood pressure (systolic) (SBP), hemoglobin, melena, pulse, syncope, liver disease and heart failure and is an established pre-endoscopic risk-stratification tool. [4] Its competence to forecast the requirement for blood transfusion and other clinical interventions has been demonstrated in several cohorts. [5] Although comprehensive, the GBS requires integration of multiple clinical and laboratory variables, which may be less convenient during the earliest phase of emergency triage, particularly in busy or resource-limited settings.

The shock index (SI), computed as heart rate (HR) upon systolic blood pressure (SBP), and provides a clear gauge of hemodynamic status using two routinely available vital signs. Originally described as a marker of acute circulatory compromise, SI

has subsequently been evaluated across several acute conditions. [6] In patients with UGIB, higher SI has been associated with clinically important outcomes, including blood-component transfusion and need for endoscopic or intensive care interventions. [7] These findings suggest that SI may provide useful information regarding the dynamic hemodynamic component of acute hemorrhage.

Hemoglobin provides complementary information regarding the degree of anemia but has an important limitation in acute bleeding: the initial concentration may not immediately reflect the magnitude of blood loss because equilibration of intravascular and extravascular fluid occurs over time. Thus, combining a dynamic marker of circulatory compromise with a hematological marker may provide a more informative assessment than either parameter alone. Blood transfusion is an important outcome in UGIB, but transfusion itself is not without risk, and contemporary evidence supports a generally restrictive transfusion strategy. [8] The ability to identify patients more likely to require transfusion may therefore assist early prioritization and preparation while definitive assessment continues. We therefore evaluated a simplified composite variable incorporating shock index and hemoglobin:

Composite variable = Shock Index x 8/ hemoglobin

The objective was to determine whether this two-parameter composite could predict blood transfusion requirement in acute UGIB and to compare its discriminatory performance with the established Glasgow–Blatchford Score.

Methods

Study's Design: It was a cross-sectional observational study executed at a tertiary-care centre. An aggregate of 210 consecutive adults presenting with acute upper gastrointestinal bleeding, manifested by haematemesis and/or melaena, were included in the analysis. Clinical and laboratory information required for assessment of bleeding severity and calculation of the Glasgow–Blatchford Score was recorded at presentation.

Clinical and Laboratory Assessment: Initial clinical assessment included measurement of heart rate and systolic blood pressure, from which shock index was calculated. Haemoglobin concentration measured at initial presentation was used for the analysis. Other clinical and laboratory parameters required for calculation of the Glasgow–Blatchford Score were also recorded.

Shock index was calculated as:

SI = HR / SBP

The proposed continuous composite variable was calculated as:

Composite variable = Shock Index x 8/ hemoglobin

The value of 8 was used as a clinically motivated scaling factor based on commonly used haemoglobin thresholds for red-cell transfusion. It was not intended to represent a universal transfusion threshold or an independently validated coefficient.

Comparator and Outcome: The Glasgow–Blatchford Score was calculated independently using its established clinical and laboratory components and served as the comparator model. The primary endpoint was necessity for transfusion of blood in the hospital stay. Patients were subsequently categorized according to whether they received blood transfusion.

Statistical Analysis: Continuous variables were outlined using suitable measures of central tendency and dispersion, whereas categorical variables were expressed as percentages and frequencies. Clinical and laboratory characteristics were contrasted amongst patients who received transfusion and those who didn't.

Multivariate logistic regression was employed to evaluate associations between the studied variables and transfusion requirement. Associations were expressed as adjusted odds ratios (ORs) with 95% confidence intervals (CIs).

Discriminatory performance was appraised by receiver operating characteristic (ROC) curve analysis for shock index, haemoglobin, the composite variable and Glasgow–Blatchford Score. The area under the ROC-curve (AUC) was utilised to quantify discrimination. Exploratory analysis also examined transfusion rates across tertiles of the composite variable and diagnostic performance at selected thresholds. A two-sided p value less than 0.05 was deeed significant statistically.

Results

Study Populace: A tally of 210 consecutive adults presenting as acute upper gastrointestinal bleeding were included in the analysis. Blood transfusion was required in 136 patients (64.8%) during the hospital stay. The mean age of the subjects was 49.6 ± 13.8 years, of which male patients were 176 (83.8%). Chronic liver disease accounted for 81 (38.6%) patients, alcohol use in 122 (58.1%), and 68 (32.4%) patients presented with shock. The overall haemoglobin concentration's mean was 7.1 ± 2.1 g/dL, mean shock index was 0.98 ± 0.29, and mean composite value was 1.18 ± 0.54. The median composite value was 1.07 (interquartile range, 0.82–1.42).

Table 1: The cohort's baseline features

Characteristic	Overall cohort (n=210)
Age(years)(mean ± SD)	49.6 ± 13.8
Male sex (n, (%))	176 (83.8)
Chronic liver disease, n(%)	81 (38.6)
Alcohol use, n (%)	122 (58.1)
Presenting in shock, n (%)	68 (32.4)
Haemoglobin, g/dL, (mean ± SD)	7.1 ± 2.1
Shock index, mean ± SD	0.98 ± 0.29
Composite variable, mean ± SD	1.18 ± 0.54
Composite variable, median (IQR)	1.07 (0.82–1.42)
Blood transfusion, n (%)	136 (64.8)

SD, standard deviation; IQR, interquartile range.

Comparison according to transfusion requirement: Patients who received transfusion demonstrated greater haemodynamic and haematological derangement than those who did not. Mean shock index was 1.12 among transfused patients compared with 0.79 among non-transfused patients, while mean haemoglobin was substantially lower in the transfused group (6.2 versus 8.7 g/dL). The Glasgow–Blatchford Score was also considerably higher among transfused patients (13.8 ± 3.4 versus 6.1 ± 2.9).

The greatest separation between the groups was observed with the composite variable, which was 1.41 ± 0.48 in transfused patients compared with 0.76 ± 0.29 in non-transfused patients (p<0.001).

Table 2: Comparison of key predictors according to blood transfusion requirement

Variable	Transfused	Not transfused
Number of patients	136	74
Shock index	**1.12**	**0.79**
Haemoglobin, g/dL	**6.2**	**8.7**
Glasgow–Blatchford Score, mean ± SD	**13.8 ± 3.4**	**6.1 ± 2.9**
Composite variable, mean ± SD	**1.41 ± 0.48**	**0.76 ± 0.29**

The composite variable was significantly higher among transfused patients (p<0.001).

This table is particularly important because it visually demonstrates the directional consistency of all four markers: transfused patients had higher shock index, higher Glasgow–Blatchford Score and higher composite values, while having substantially lower haemoglobin.

Multivariable Analysis: In the reported multivariable analysis, a shock index ≥1 was linked to increased odds of transfusion (odds ratio [OR] (adjusted), 1.78; 95% confidence interval [CI], 1.06–2.98; p=0.028).

Haemoglobin <8 g/dL was also allied to increased transfusion odds (adjusted OR, 2.47; 95% CI, 1.39–4.39; p=0.002).

For the composite variable, each 0.5-unit increase was associated to substantially higher transfusion odds (OR(adjusted), 3.18; 95% CI, 2.05–4.94; p less than 0.001).

Table 3: Multivariable predictors of blood transfusion

Predictor	OR (adjusted)	95% CI	p value
Shock index ≥1	**1.78**	1.06–2.98	0.028
Haemoglobin <8 g/dL	**2.47**	1.39–4.39	0.002
Composite variable, per 0.5-unit increase	**3.18**	2.05–4.94	<0.001

OR, odds ratio; CI, confidence interval.

ROC analysis: The composite variable demonstrated the highest numerical discriminatory performance among the evaluated predictors. The AUC was 0.68 for shock index, 0.72 for haemoglobin, 0.77 for the composite variable and 0.75 for the Glasgow–Blatchford Score.

Table 4: Discriminatory performance for forecasting blood transfusion

Predictor	AUC
Shock index	0.68
Haemoglobin	0.72
Composite variable	**0.77**
Glasgow–Blatchford Score	0.75

ROC, receiver operating characteristic.

The composite therefore demonstrated a higher numerical area under the curve than either of its individual components and a similar area under the curve to the Glasgow–Blatchford Score. Importantly, the difference between an area under the curve of 0.77 and 0.75 should not be described as superiority without a formal statistical comparison of the two ROC curves.

Tertile Analysis: An exploratory analysis demonstrated a progressive increase in transfusion requirement across increasing composite-variable tertiles. Transfusion occurred in 38% of patients in the lowest tertile (≤0.85), 67% in the middle tertile (0.86–1.30), and 89% in the highest tertile (>1.30), with p for trend < 0.001.

Table 5: Blood transfusion requirement across composite-variable tertiles

Composite-variable tertile	Composite value	Patients requiring transfusion	Relative risk
Lowest	≤0.85	**38%**	1
Middle	0.86–1.30	**67%**	1.8
Highest	>1.30	**89%**	2.3

p for trend <0.001.

The progressive increase in transfusion requirement across tertiles supports a graded association between increasing composite values and transfusion requirement rather than an association restricted to a single cutoff. Threshold analysis At the evaluated thresholds, shock index ≥1 demonstrated 67% sensitivity and 81% specificity, while haemoglobin <8 g/dL demonstrated 76% sensitivity and 75% specificity. The composite model demonstrated the highest sensitivity at 82%, with o 72% specificity, positive predictive value of 88% and negative predictive value of 60%.

Table 6: Diagnostic performance at evaluated thresholds

Predictor	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Shock index ≥1	67%	**81%**	87%	54%
Haemoglobin <8 g/dL	76%	75%	85%	**63%**
Composite model	**82%**	72%	**88%**	60%

These findings indicate that the composite model provided greater sensitivity for identifying patients who subsequently required transfusion than either individual component, although shock index alone demonstrated somewhat higher specificity.

Discussion

The principal finding of this study was that a simplified composite incorporating shock index and haemoglobin demonstrated meaningful discrimination for blood transfusion requirement in acute upper gastrointestinal bleeding, with an AUC of 0.77, compared with 0.75 for the Glasgow–Blatchford Score (GBS). The composite also outperformed shock index and haemoglobin individually (AUC 0.68 and 0.72, respectively). These findings support the underlying hypothesis that combining a dynamic haemodynamic marker with a readily available haematological parameter may provide useful early risk stratification.

The physiological rationale for the model is complementary. Shock index integrates systolic blood pressure and heart rate that provides a simple marker of acute circulatory stress. Its use in emergency and haemorrhagic states has been extensively studied, and previous work in acute upper gastrointestinal bleeding has demonstrated associations between higher shock index and clinically important outcomes, including transfusion requirement. [6,7] In our cohort, transfused patients had a higher mean shock index than non-transfused patients (1.12 versus 0.79), supporting its relevance to the haemodynamic component of bleeding.

Haemoglobin contributed a complementary dimension. Transfused patients had substantially lower haemoglobin than non-transfused patients (6.2 versus 8.7 g/dL), and haemoglobin alone demonstrated an AUC of 0.72.

However, haemoglobin has an important limitation in acute haemorrhage because the initial concentration may not immediately reflect the magnitude of blood loss. Consequently, combining haemoglobin with a dynamic physiological marker

may provide information that is not captured adequately by either parameter alone.

The performance of the composite was numerically comparable to that of the GBS. The GBS remains an established pre-endoscopic risk-stratification tool and incorporates a considerably broader range of clinical and laboratory variables. [4,5] Our findings therefore should not be interpreted as demonstrating superiority of the composite over GBS. Rather, they suggest that a two-parameter model may achieve similar discrimination within this cohort while requiring substantially fewer inputs. This distinction is clinically relevant because the potential role of the composite is as an early adjunctive triage tool, rather than a replacement for validated comprehensive scoring systems.

The progressive increase in transfusion requirement across composite tertiles—from 38% in the lowest tertile to 67% and 89% in the middle & highest tertiles, respectively (p for trend <0.001)—provides additional internal support for the observed association. At the evaluated thresholds, the composite demonstrated 82% sensitivity and 72% specificity. These findings suggest potential usefulness when the initial clinical objective is to identify patients who warrant closer observation, early preparation for possible transfusion and prioritization for definitive management.

The clinical implications should nevertheless be interpreted cautiously. Blood transfusion decisions in UGIB cannot appropriately be determined by a mathematical model alone. Transfusion strategy must incorporate haemodynamic status, ongoing bleeding, comorbidities and clinical context, and contemporary evidence supports a generally restrictive transfusion approach. [8] The present model should therefore be viewed as a means of risk stratification, not as a transfusion trigger.

Several limitations are important. The study was observational in a single centre, and the composite was evaluated in the same cohort from which it was derived; therefore, external validity remains uncertain.

The inclusion of haemoglobin also introduces potential circularity because haemoglobin directly influences transfusion decisions. Furthermore, the value of 8 in the composite was a clinically motivated scaling constant rather than a regression-derived coefficient. Finally, the study evaluated transfusion requirement rather than mortality, rebleeding, intensive-care admission or endoscopic intervention.

Future multicentre prospective studies should externally validate the composite, optimize its coefficients and thresholds, assess calibration and evaluate whether its use improves clinically meaningful outcomes. Until such validation is available, the composite should be considered a promising hypothesis-generating adjunct rather than a replacement for established UGIB risk scores.

Conclusion

In this single-centre cohort of adults presenting with acute upper gastrointestinal bleeding, a simplified composite variable incorporating shock index and haemoglobin demonstrated clinically meaningful discrimination for blood transfusion requirement, with an AUC of 0.77, similar to the Glasgow–Blatchford Score (AUC 0.75) and greater than either component individually. Increasing composite values were also associated with progressively higher transfusion requirements. These findings support the potential role of this simple two-parameter model as an adjunct for early bedside risk stratification, particularly where rapid assessment using readily available variables is desirable. However, given the single-centre design, potential circularity from inclusion of haemoglobin and absence of external validation, the model should not replace established scoring systems. Prospective multicentre external validation and threshold optimization are required before clinical implementation.

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