

Possibility of Real-Time Risk Assessment of Acute Upper Gastrointestinal Bleeding by Using TRI (TIMI Risk Index) Model

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ABSTRACT

Purpose: The purpose of this study is to evaluate the predictive value of TRI(Thrombolysis in myocardial infarction risk index) in predicting UGIB(upper gastrointestinal bleeding), by comparing it to Rockall scores. **Methods:** We retrospectively studied 583 patients who admitted with the diagnosis of UGIB. Based on the recorded data, we compared AUCs(area under curves) of TRI and Rockall scores for rebleeding and death. Rebleeding rates and mortalities of all risk groups of TRI were obtained to check up the difference significances between neighboring groups. **Results:** AUC of TRI for rebleeding was 0.599, which was lower than AUCs of clinical and completed Rockall scores-0.655, 0.696. AUC of TRI for death was 0.741, which was also lower than AUCs of clinical and completed Rockall scores-0.838, 0.846. Rebleeding rates did not increase correlatively with the step-up of the risk grades of TRI. Mortality rates were 2.9%, 6.3%, 17.2%, 46.7%, 57.1%, respectively in 5 risk grades of TRI with increasing tendency by grade step-up, however, there were significant differences between rebleeding rates of low(10-<30) and moderate(30-60) risk groups, and between moderate and high(>60-80) risk groups(P=0.00017, 0.01763 respectively), but not between lowest(<10) and low risk groups, and between high and highest(>80) risk groups(P=0.41, not applicable respectively). **Conclusion:** Predictive value of TRI to forecast the outcomes of acute upper gastrointestinal bleeding is lower than Rockall scores. However, TRI is useful to predict UGIB mortality quickly, since this score shows significant risk stratification for mortality rate when divided into 3 risk groups-low(<30), moderate(30-60), and high risk group(>60).

Keywords: TRI, TIMI Risk Index, Rockall Score, Upper Gastrointestinal Bleeding, Myocardial Infarction.

Article Information

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INTRODUCTION

Acute upper gastrointestinal bleeding is one of the most dangerous gastrointestinal emergencies, so that early prediction of its prognosis is clinically worthy to reduce adverse outcomes(as rebleeding or death) and to use

medical costs effectively. Effectiveness of well-established scores such as Rockall scores, Glasgow-Blatchford score, and AIMS65 score were proved, but new attempts have been remaining not only to compare these scores,

but to create new scores.[0-4] Up to now, were developed many scoring systems for the upper gastrointestinal bleeding and validated their efficacies, but not so much are the scores for emergent UGIB such as clinical Rockall score and pre-endoscopic Baylor score. Advantages of these scores are that they are very easy to be calculated and are possibly assessed in any time, despite of their lower predictive accuracy(than those scores not emergently used), because they contain fewer laboratory and endoscopic parameters which are more concerned with outcomes of UGIB. However, real-time changing characteristics of acute UGIB make them possible to be used.

Unlike the other scoring systems, TRI, or TIMI(thrombolysis in myocardial infarction) risk index, was not developed for the purpose of UGIB(upper gastrointestinal bleeding) prediction, but a simpler model derived for the risk prediction of STEMI(ST segment elevation myocardial infarction).[5] A large-scaled trial for TRI reported 0.6% of in-hospital mortality in lowest TRI group(0-10) and 60% in highest TRI risk group(>80).[6] The reason why we interested in TRI is that this score involved the parameters(age, systolic blood pressure, pulse) which were validated as the risk factors after UGIB and applied in several risk scoring systems.[7] Although expected efficacy of TRI may be worse than Rockall score, because it is composed of fewer risk indices, it is so much easier to calculate and it may be possibly used for the quick risk stratification and primary management of UGIB patients in emergency department.

Therefore, we studied TRI model with the purpose to define its utility in UGIB prediction(especially death, rebleeding) by comparing with Rockall score.

METHODS

Cohort Selection

We retrospectively studied 583 patients who admitted to Gastroenterology Department,

Hospital of Pyongyang University of Medical Science with the diagnosis of UGIB since Jan, 2018 to Dec, 2021.

Clinically significant UGIB was diagnosed with one of the following criteria.[8]

- Melena and/or blood vomiting with hemodynamic insufficiency(which needs medical or mechanical support to maintain normal blood pressure or enough cardiac output) or
- Detection of fresh or black-red colored blood by gastroendoscopic approach

Data Collection

Epidemiological(sex, age, blood pressure), clinical(blood vomiting, melena, suspected inducing factors, past diagnosis of liver disease, chronic kidney disease, cardiovascular disease, cancerous disease, etc., alcohol abuse, smoking, or NSAID use, blood pressure, pulse, body temperature, respiration rate, Glasgow coma scale), laboratorial(routine blood tests) and endoscopic features(stigmata of recent hemorrhage, malignant lesion, varix) of all patients were investigated. In-hospital mortality, in-hospital rebleeding, and length of hospital stay were the outcome indices we purposed.

Calculation of Risk Scoring Systems

Based on the patients' database, we calculated TRI model of myocardial infarction and Rockall scores of UGIB.

TRI model was calculated as follow.[5]

$$TRI = \text{Pulse}(bpm) \times [\text{Age}(\text{years})/10]^2 / \text{Systolic blood pressure}(mmHg)$$

TRI results are divided into 5 risk groups as follows. 0-10: lowest risk group, 10-<30: low risk group, 30-60: moderate risk group, >30-80: high risk group, >80: highest risk group.

Rockall scores(clinical Rockall score, complete Rockall score) are calculated as the total sum of indices in Table 1.[7]

Table 1. Calculation of Rockall scores

Clinical Rockall Score	• Aged(years): <60(0 point), 60-79(1 points), >80(2 points) • Hemodynamic shock: SBP(mmHg)≥100 and HR(beats/min)<100(0 point), SBP<100 and HR≥100(1 point), SBP<100(2 points) • Comorbidity: none(0 point), CVD(2 points), COPD(2 points), DM(2 points), CRF(3 points), Cancer(3 points), hepatic failure(3 points)
Complete Rockall Score	Followings are added to 3 criteria above. • Endoscopic diagnosis: Mallory-Weiss tear, but no major lesions and no SRB(0 point), other nonmalignant gastrointestinal diagnoses(1 point), upper gastrointestinal tract malignancy(2 points) • Endoscopic findings of recent hemorrhage: none(0 point), blood found in upper gastrointestinal tract(2 points)

Statistical Analysis

Microsoft Excel 2010 and SPSS 20.0 were used to analyze data. Receiver operating curves(ROC) of TRI model and Rockall scores in prediction of rebleeding and death were analyzed respectively, and AUROCs(area under receiver operating curve) were compared.

RESULTS

Clinical Characteristics

The mean age of 583 patients admitted with the diagnosis of UGIB were 49.8 ± 13.6 years, among them, 412 patients(70.7%) were male and 171(29.3%) were female. ABO blood types of 410 cases(70.3%) were recorded, varying 150 cases(36.6%) of O type, 133(32.4%) of A type, 99(24.1%) of B type and 28(6.8%) of AB type, respectively. As the source of bleeding, gastric or duodenal ulcers were 239 cases(41.0%), acute gastric mucosal lesions were 52 cases(8.9%), erosive gastritis were 61 cases(10.5%), gastric cancers were 39 cases(6.7%), gastric malignant lymphomas were 2 cases(0.3%), gastric sarcomas were 2 cases(0.3%), anastomotic ulcer was 1 case(0.2%), Mallory-Weiss tears were 25 cases(4.3%), gastroesophageal varices were 138 cases(23.7%), esophageal ulcers were 6 cases(1.0%), corrosive esophagitis were 3 cases(0.5%), esophageal angioma was 1

case(0.2%), esophageal cancer was 1 case(0.2%) and not identified lesions were 9 cases(1.5%). Patients who had more than 1 comorbidity were 144 cases(24.7%).

Patients who admitted after blood vomiting were 367 cases(63.7%), who admitted after melena or black tarry stool were 509(87.3%), and those who came after both of blood vomiting and melena were 293 cases(50.3%). Only 202 patients(34.6%) were correctly aware of inducing factors of their bleeding, 116 cases(57.4%) of which were NSAID(non-steroid anti-inflammatory drug) use, 51(25.2%) were over-consumption of alcohol, 31(15.3%) were diet-induced, 3(1.5%) were post-gastroendoscopic bleeding, and 1 patient(0.5%) was after exercise. 233(40.0%) of patients would drink more than 50g of alcohol per day, and 206 patients(35.3%) were smokers. Mean systolic blood pressure of all patients at admitting time was 98.8 ± 19.6 mmHg and mean heart rate was 95.2 ± 16.3 bpm.

Of all patients, 81 patients(13.9%) rebled during admission, and 60 patients(10.3%) died. Mean LOS(length of stay) of the patients were 16.0 ± 11.9 days. Averaged clinical Rockall score was 1.08 ± 1.22 , averaged complete Rockall score was 2.36 ± 1.6 , and averaged TRI was 25.5 ± 18.0 .

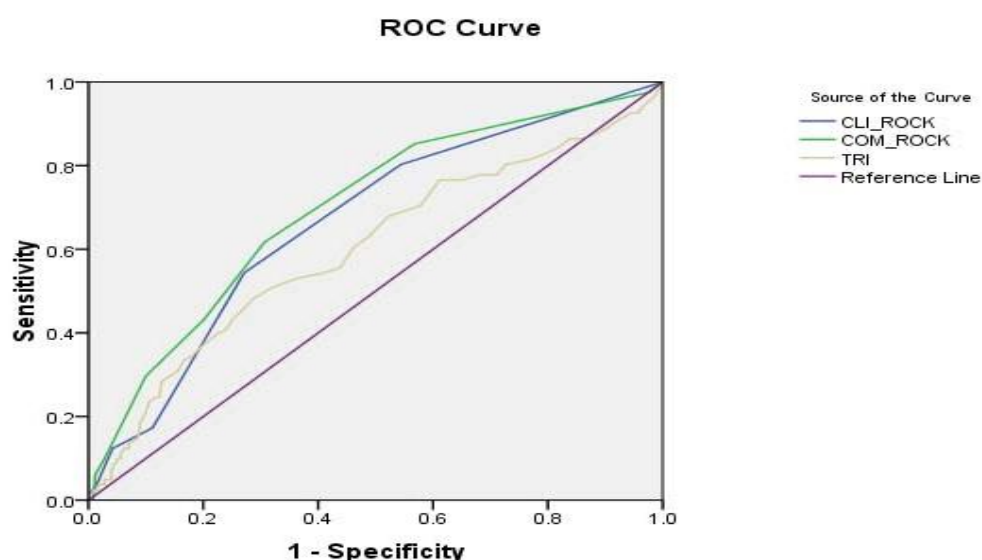


Figure 1. Receiver operating curves of Rockall scores and TRI in rebleeding prediction.

Table 2. AUCs of Rockall scores and TRI in rebleeding prediction.

Scoring system	AUC	S.E.	95% CI	P-Value
Clinical Rockall score	0.665	0.032	0.603-0.727	0.000
Complete Rockall score	0.696	0.032	0.634-0.758	0.000
TRI	0.599	0.036	0.528-0.671	0.004

Table 3. AUCs of Rockall scores and TRI in mortality prediction

Scoring system	AUC	S.E.	95% CI	P-Value
Clinical Rockall score	0.838	0.030	0.779-0.896	0.000
Complete Rockall score	0.846	0.028	0.792-0.900	0.000
TRI	0.741	0.036	0.670-0.813	0.000

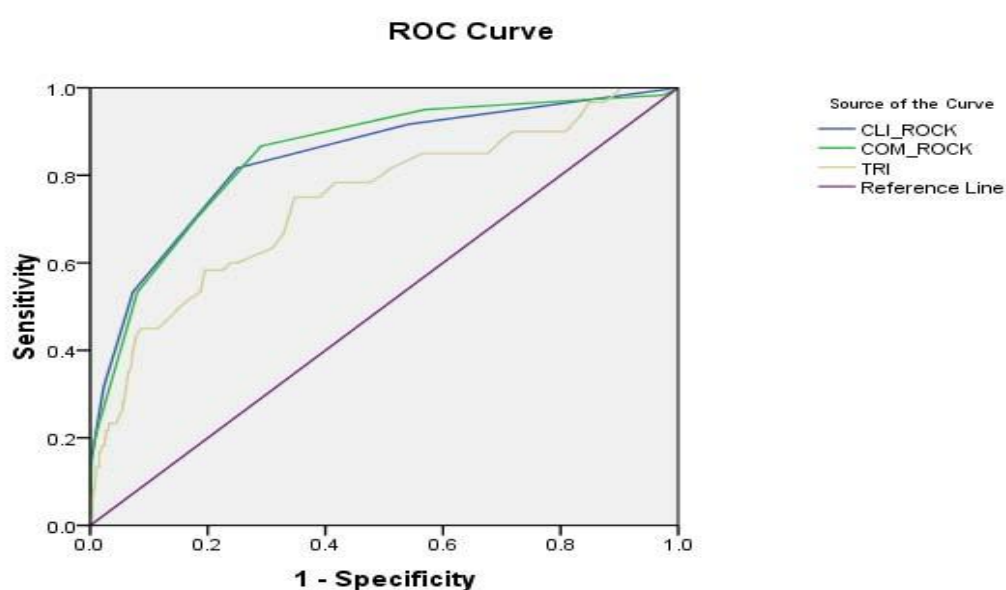


Figure 2. Receiver operating curves of Rockall scores and TRI in mortality prediction

Comparing Predictive Value of TRI Model and Rockall Scores

Figure 1 and figure 2 shows the ROCs(receiver operating curves) of TRI and Rockall scores for rebleeding and death, and their analyzed data were shown in table 2 and 3. AUC(area under curve) of TRI for rebleeding is 0.599(95% CI: 0.528-0.671, $P<0.001$) that was lower than Rockall scores-0.655(95% CI: 0.603-0.727, $P<0.001$), 0.696(95% CI: 0.634-0.758), respectively.(Table 2, Figure 1) AUC of TRI for death was 0.741(95% CI: 0.670-0.813, $P<0.001$) that was also lower than Rockall scores-0.838(95% CI: 0.779-0.896, $P<0.001$), 0.846(95% CI: 0.792-0.900, $P<0.001$), respectively.(Table 3, Figure 2)

Distribution of Rebleeding and Mortality Events Graded by TRI

As shown in table 4, rebleeding rate did not tend to increase when TRI grade promoted through lowest(0-<10), low(10-<30), moderate(30-60), high(>60-80) and highest(>80) risk group. Mortality rates in every grades of TRI were 2.9%, 6.3%, 17.2%, 46.7% and 57.1%, respectively, tending to increase with risk grade promotion, however, there were significant differences between mortality rates of low and moderate risk groups($P=0.00017$), and between moderate and high risk groups($P=0.01763$), but not between lowest and low risk groups($P=0.41$), and between high and highest risk group(P =not applicable).

Table 4. Distribution of rebleeding and mortality events by classic TRI events.

TRI risk grade	Cases	Rebleeding cases	Rebleeding rates(%)	Dead cases	Mortality rates(%)	P
0-<10(lowest)	68	10	14.7	2	2.9	-
10-<30(low)	348	35	10.0	22	6.3	0.41
30-60(moderate)	145	32	22.1	25	17.2	0.00017
>60-80(high)	15	2	13.3	7	46.7	0.01763
>80(highest)	7	2	28.6	4	57.1	NA

P: P-value between mortalities of neighboring TRI grades, NA: not applicable.

DISCUSSION

Acute upper gastrointestinal bleeding is one of the most common gastrointestinal emergencies, the prevalence of which is one hundred per million every year, so that it has high mortality rate and wastes much medical costs.[9] Therefore, early and correct prediction of its prognosis is an important problem for saving lives and medical costs. Though well-established scoring systems as Rockall score, Glasgow-Blatchford score and AIMS65 score were developed and their efficacies were globally validated, differences between viewpoints of the researchers on some qualitative indices in those scores is followed by the differences in clinical applications and efficacies of scores. Since quantitative indices do not make variation by subjective viewpoints

of researchers, the quantitative models may be more believable, though they have lower predictive values.

TRI, or TIMI(thrombolysis in myocardial infarction) risk index is a widely used linear model to predict the outcomes of STEMI, which has a high correlation with in-hospital mortality.[5,6] What we interested in this model is that this score contains systolic blood pressure, heart rate and age, which has been validated as the risk factors of UGIB.[7] TRI is very similar to clinical Rockall score, containing age, systolic blood pressure and heart rates, which are the highest risk factors of Rockall scores. Although Rockall scores contain more risk indices that its expected predictive value may be higher, TRI model has an advantage of being simpler and quick to

calculate. And TRI do not involve any qualitative indices like in Rockall scores (comorbidity, endoscopic diagnosis, presence of stigmata of recent bleeding), so that it may not make differences by subjective viewpoints of researchers.

We compared TRI model and Rockall scores.[Figure 1-2, table 2-3] Many trials denied the predictive value of Rockall scores for rebleeding in UGIB.[10-15] Our trial also demonstrated that Rockall scores had low predictive values for rebleeding, with low AUCs as 0.655(95% CI: 0.603-0.727, $P<0.001$), 0.696(95% CI: 0.634-0.758), which were similar to other studies.[15] AUC of TRI for rebleeding was 0.599(95% CI: 0.528-0.671, $P<0.001$), which was much lower than Rockall scores, indicating indirectly that the qualitative indices of Rockall scores (comorbidity, endoscopic diagnosis, presence of stigmata of recent bleeding) correlated to rebleeding events. High accuracy of Rockall scores for mortality prediction were reported several times, as same as in our trial.[16-24] AUCs of Rockall scores for mortality were very high, 0.838(95% CI: 0.779-0.896, $P<0.001$) and 0.846(95% CI: 0.792-0.900, $P<0.001$), respectively. AUC of TRI was 0.741(95% CI: 0.670-0.813, $P<0.001$), which was lower than Rockall scores as we expected.

We calculated the rebleeding rate and mortality rate in every risk group of TRI in order to validate the utility of this model for UGIB prediction.[Table 4] As a result, rebleeding rates were 14.7%, 10.0%, 22.1%, 13.3% and 28.6%, respectively in lowest(0-10), low(10-30), moderate(30-60), high(>60-80) and highest(>80) risk group, not tended to increase with risk grade promotion, indicating TRI model was not useful for rebleeding prediction. Mortality rates in every grades were 2.9%, 6.3%, 17.2%, 46.7% and 57.1%, respectively, tending to increase with risk grade promotion, however, there were significant differences between mortality rates

of low and moderate risk groups($P=0.00017$), and between moderate and high risk groups($P=0.01763$), but not between lowest and low risk groups($P=0.41$), and between high and highest risk group($P=\text{not applicable}$). This showed that lowest and highest risk group of TRI were not so meaningful in UGIB risk stratification that it would be logical to categorize TRI into low(0-30), moderate(30-60) and high risk group(>60) for UGIB.

Enough utility of TRI for mortality prediction of UGIB supplies with various possibilities in clinical application. First of all, TRI is too fast to calculate that it can be used as the risk score to classify the patients in very early hours of emergency medicine. Another possibility is that TRI was already validated for acute myocardial infarction, so it may operate more accurately for the prediction of gastrointestinal bleeding which may be complicated after fibrinolytic therapy for myocardial infarction. Finally, all the parameters of TRI are dynamic indices allowing real-time observation of UGIB by TRI.

There are several limitations in our study. First, we haven't validated the predictive value of TRI for the prognosis of some interventions(transfusion, surgery). Second, we haven't taken enough cohort to compare the mortality for high and highest risk group. We hope world-wide trials on this score, expecting new interesting results.

CONCLUSION

Predictive value of TRI to forecast the outcomes of acute upper gastrointestinal bleeding is lower than Rockall scores. However, TRI is useful to predict UGIB mortality quickly, since this score shows significant risk stratification for mortality rate when divided into 3 risk groups-low(<30), moderate(30-60), and high risk group(>60).

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Conflict of Interest

Authors declare that there is no conflict of interest.

Author Contributions

Jong Sin-Hyok: study concept and design, acquisition of data, analysis and interpretation of data, drafting of manuscript, and statistical analysis, **Kim Song-Hwan:** study concept and design, acquisition of data, analysis and interpretation of data, drafting of manuscript, and statistical analysis, **Jong Nam-Hun:** study concept and design, acquisition of data, analysis and interpretation of data, **Pak Hyo-Guk:** acquisition and analysis of data, **Kim Hye-Song:** study concept and design, acquisition and interpretation of data, **Yu Nam:** acquisition and analysis of data, , and statistical analysis, **Jo Dong-Hui:** critical revision of the manuscript for important intellectual content, **Kang Jong-Chol:** acquisition and analysis of data.

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