Validation of the Rockall risk scoring system in upper gastrointestinal bleeding


Published in:
Gut

DOI:
10.1136/gut.44.3.331

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Validation of the Rockall risk scoring system in upper gastrointestinal bleeding

E M Vreeburg, C B Terwee, P Snel, E A J Rauws, J F W M Bartelsman, J H P vd Meulen and G N J Tytgat

Gut 1999;44:331-335

Updated information and services can be found at:
http://gut.bmjournals.com/cgi/content/full/44/3/331

These include:

References
This article cites 23 articles, 6 of which can be accessed free at:
http://gut.bmjournals.com/cgi/content/full/44/3/331#BIBL

5 online articles that cite this article can be accessed at:
http://gut.bmjournals.com/cgi/content/full/44/3/331#otherarticles

Email alerting service
Receive free email alerts when new articles cite this article - sign up in the box at the top right corner of the article

Topic collections
Articles on similar topics can be found in the following collections

Stomach and duodenum (580 articles)

Notes

To order reprints of this article go to:
http://www.bmjournals.com/cgi/reprintform

To subscribe to Gut go to:
http://www.bmjournals.com/subscriptions/
Validation of the Rockall risk scoring system in upper gastrointestinal bleeding

E M Vreeburg, C B Terwee, P Snel, E A J Rauws, J F W M Bartelsman, J H P vd Meulen, G N J Tytgat

Abstract

Background—Several scoring systems have been developed to predict the risk of rebleeding or death in patients with upper gastrointestinal bleeding (UGIB). These risk scoring systems have not been validated in a new patient population outside the clinical context of the original study.

Aims—To assess internal and external validity of a simple risk scoring system recently developed by Rockall and coworkers.

Methods—Calibration and discrimination were assessed as measures of validity of the scoring system. Internal validity was assessed using an independent, but similar patient sample studied by Rockall and coworkers, after developing the scoring system (Rockall’s validation sample). External validity was assessed using patients admitted to several hospitals in Amsterdam (Vreeburg’s validation sample). Calibration was evaluated by a Χ² goodness of fit test, and discrimination was evaluated by calculating the area under the receiver operating characteristic (ROC) curve.

Results—Calibration indicated a poor fit in both validation samples for the prediction of rebleeding (p<0.0001, Vreeburg; p=0.007, Rockall), but a better fit for the prediction of mortality in both validation samples (p=0.2, Vreeburg; p=0.3, Rockall). The areas under the ROC curves were rather low in both validation samples for the prediction of rebleeding (0.61, Vreeburg; 0.70, Rockall), but higher for the prediction of mortality (0.73, Vreeburg; 0.81, Rockall).

Conclusions—The risk scoring system developed by Rockall and coworkers is a clinically useful scoring system for stratifying patients who are included in clinical trials which study the effectiveness of endoscopic or other medical interventions. Unfortunately, the complexity and variability of these scoring systems limits their application in routine clinical practice.

More importantly however, the performance of most of these scoring systems has never been validated in a population of new patients. Validation refers to calibration, or the amount of agreement between predicted probabilities and observed percentages of rebleeders/deaths in different risk groups, and discrimination, or the ability of a scoring system to distinguish patients who rebleed/die from patients who do not rebleed/live.

Validity can be separated into internal and external validity: internal validity indicates whether the results of the analysis hold in future patients who are included according to the same criteria and within the same clinical context as the patients in the original study; external validity or generalisability refers to the performance of the scoring system in patients outside the study context, for example, patients in other hospitals. External validity is especially important when scoring systems are used to predict outcome in daily practice, because it is well known that scoring systems (or models in general) perform less well in patient samples outside the clinical context in which these models are developed.

Therefore, the aim of this study was to assess the external validity of a scoring system for predicting rebleeding and death after admis-

Abbreviations used in this paper: ROC curve, receiver operating characteristic curve; SRH, stigmata of recent haemorrhage; UGIB, upper gastrointestinal bleeding.
Table 1  The Rockall risk scoring system

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>&lt;60</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Shock</td>
<td>No shock: pulse &lt;100 + systolic BP &lt;100 mm Hg</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>No major comorbidity</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Mallory Weiss tear, no lesion identified and no SRH/blood</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Major SRH</td>
<td>None or dark spot only</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2  Distribution of patients in the risk score groups, calculated with the Rockall risk score, for the Rockall validation sample and for our own patient group

<table>
<thead>
<tr>
<th>Risk score</th>
<th>Predicted probabilities*</th>
<th>Rockall’s validation sample</th>
<th>Vreeburg’s validation sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rebleeding (%)</td>
<td>Mortality (%)</td>
<td>Number of patients</td>
</tr>
<tr>
<td>0</td>
<td>4.9</td>
<td>0</td>
<td>48</td>
</tr>
<tr>
<td>1</td>
<td>3.4</td>
<td>0</td>
<td>131</td>
</tr>
<tr>
<td>2</td>
<td>3.3</td>
<td>0</td>
<td>142</td>
</tr>
<tr>
<td>3</td>
<td>11.2</td>
<td>2.9</td>
<td>162</td>
</tr>
<tr>
<td>4</td>
<td>14.1</td>
<td>5.3</td>
<td>176</td>
</tr>
<tr>
<td>5</td>
<td>24.1</td>
<td>10.8</td>
<td>199</td>
</tr>
<tr>
<td>6</td>
<td>32.9</td>
<td>17.3</td>
<td>137</td>
</tr>
<tr>
<td>7</td>
<td>43.8</td>
<td>27.0</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>18.9</td>
<td>10.0</td>
<td>1180</td>
</tr>
</tbody>
</table>

*Predicted probabilities based on observed percentages in original patient sample (Rockall, table V(B)).
The Rockall risk scoring system in upper GI bleeding

333

The Rockall risk scoring system in upper GI bleeding

18 The area under the curve (AUC) is a measure of discrimination. The goodness of fit test evaluates the degree of correspondence between predicted probabilities and observed percentages of rebleeders/deaths. If the observed percentages of rebleeders/deaths are close to the predicted probabilities, the risk scoring system is considered to be well calibrated. The area under the ROC curve evaluates the ability of the risk scoring system to distinguish patients who rebled/died from those who did not. In the ROC curve, pairs of true positive and false positive rates are plotted, based on 2×2 classification tables of predicted and observed rebleeding/mortality, that can be constructed for each risk probability cut off point. The area under the curve (AUC) is a measure of the discriminative value of the risk scoring system. If this area is 0.50, the scoring system is performing no better than the toss of a coin. An area of 1.0 would reflect a perfect discriminative ability.

APPLICATION OF THE RISK SCORING SYSTEM

Table 1 shows the risk scoring system developed by Rockall et al.13 The scoring system represents a simplified summary of the results of a logistic regression analysis and includes three clinical variables (age, shock, and comorbidity) and two endoscopic variables (diagnosis and major SRH), each categorised and scored with 0–3 points, to give a maximum score of 11 points. We used this scoring system to assess the individual risk score for each patient in Vreeburg’s validation sample. Risk scores for Rockall’s validation sample were obtained from table V(B) of Rockall’s paper.13 Scores of ≤ 3 and scores of ≥ 8 were taken together as one category because of the low numbers in each of these outcome categories. We used the observed percentages of rebleeders/deaths in each risk category in the original patient sample of Rockall (presented in table IV(B) in Rockall’s paper13) as the predicted probabilities of rebleeding/mortality for both validation samples.

Because our classification of coexisting illnesses according to the ICED scale did not completely correspond to the classification of comorbidity used by Rockall, we scored the ICED classification as follows: none or mild coexisting illnesses received zero points, moderate illnesses received one point, severe illnesses received two points, and life threatening conditions received three points (table 1) (Rockall, personal communication).

VALIDATION OF THE RISK SCORING SYSTEM

Internal and external validity of the risk scoring system was assessed using a χ2 goodness of fit test as a measure of (model) calibration and the area under the ROC curve as a measure of (model) discrimination. The goodness of fit test evaluates the degree of correspondence between predicted probabilities and observed percentages of rebleeders/deaths. If the observed percentages of rebleeders/deaths are close to the predicted probabilities, the risk scoring system is considered to be well calibrated. The area under the ROC curve evaluates the ability of the risk scoring system to distinguish patients who rebled/died from those who did not. In the ROC curve, pairs of true positive and false positive rates are plotted, based on 2×2 classification tables of predicted and observed rebleeding/mortality, that can be constructed for each risk probability cut off point. The area under the curve (AUC) is a measure of the discriminative value of the risk scoring system. If this area is 0.50, the scoring system is performing no better than the toss of a coin. An area of 1.0 would reflect a perfect discriminative ability.
both validation samples ($\chi^2=17.6, \text{df}=6, p=0.007$ for Rockall’s validation sample, and $\chi^2=61.6, \text{df}=6, p<0.0001$ for Vreeburg’s validation sample).

In fig 2 the corresponding findings for the prediction of mortality are shown. Here the correspondence between predicted and observed rates was better for both validation samples ($\chi^2=7.08, \text{df}=6, p=0.3$ for Rockall’s validation sample, and $\chi^2=9.3, \text{df}=6, p=0.2$ for Vreeburg’s validation sample) indicating a better fit.

Overall, the predicted probabilities for rebleeding and mortality were closer to the observed rebleeding/mortality percentages of Rockall’s validation sample than of Vreeburg’s validation sample.

**Discussion**

The discriminative abilities of the risk scoring system for the prediction of rebleeding and mortality are given in figs 3 and 4 respectively.

For rebleeding, the AUCs were 0.70 (SE 0.02) for Rockall’s validation sample and 0.61 (SE 0.03) for Vreeburg’s validation sample. For mortality, the AUCs were 0.81 (SE 0.02) for Rockall’s validation sample and 0.73 (SE 0.02) for Vreeburg’s validation sample.

As with calibration, the discriminative ability of the scoring system was better for the prediction of mortality than for the prediction of rebleeding. Furthermore, the discriminative ability, for rebleeding as well as for mortality, was better for Rockall’s validation sample than for Vreeburg’s validation sample.

**Discussion**

Overall, the internal and external validity of the risk scoring system, as assessed by calibration and discrimination, could be considered satisfactory for the prediction of mortality but not for the prediction of rebleeding. For the prediction of rebleeding, we observed a lack of fit for both validation samples, and the AUCs were rather low (0.70 and 0.61). For the prediction of mortality, we observed a better fit and higher AUCs (0.81 and 0.73). As expected, the internal validity was higher than the external validity.

It is important that the performance of such a risk scoring system is shown in a sample of new patients outside the original study context, especially when a scoring system is used to predict outcome for future patients, because it is well recognised that a scoring system tends to perform better in the population in which it is developed. Although Rockall’s validation sample included new patients, who were not used in the development of the scoring system, these patients were included in the same hospitals using the same study protocol, and can be considered as the same type of patients. Therefore, the results in this patient sample indicate only the internal validation of the scoring system.

Our patient sample was slightly different from Rockall’s original patient sample because our classification of comorbidity according to the ICED scale was different. However, we tried to adjust as accurately as possible the ICED classification to the classification of Rockall. Secondly, and probably more important, we used hospital mortality while Rockall used 30 day mortality. This implies that we included patients who died after 30 days while hospitalised. For these patients, the prediction of mortality might be more difficult and the scoring system of Rockall might not be applicable for these patients. This might have led to an underestimation of the validity of the scoring system. On the other hand, we might have missed patients who died within 30 days but after discharge from the hospital. However, we assume that this latter group of patients will be rather small and will therefore not influence the results of the study.

The disappointing performance of the risk scoring system in the prediction of rebleeding might partly be explained by the fact that the risk scoring system was originally developed for the prediction of mortality and not for the prediction of rebleeding. Possibly, other risk factors are more important for the prediction
of rebleeding than for the prediction of mortality, or the risk factors should be weighted differently. Other scoring systems, specifically developed for the prediction of rebleeding, such as the Baylor bleeding score,24 are promising. Saeed et al25 applied this scoring system to an external patient group who presented with major ulcer haemorrhage, and found higher rates of rebleeding in high risk patients, compared with low risk patients. However, formal calibration or discrimination of this scoring system has not yet been assessed.

The aim of this study was to validate a simple risk scoring system proposed by Rockall et al. We did not assess the performance of the original logistic regression model, from which the scoring system was derived, in the prediction of rebleeding and mortality. An inadequate translation of the model into the risk scoring system could lead to a bad performance of the scoring system. For example, it was unclear to us why Rockall et al included rebleeding as a variable in the logistic regression model, but did not include rebleeding in the risk scoring system. This might have influenced the weighting of the variables in the scoring system. However, we agree that rebleeding should not be included in a scoring system, because at the time of admission with UGIB, rebleeding is an outcome event instead of a prognostic variable.

We showed that the Rockall risk scoring system has unsatisfactory validity for the prediction of rebleeding in patients admitted with acute UGIB. However, the system appears to be useful for the stratification of patients into high and low risk groups for mortality. In the highest risk category (at least eight points), mortality in our patient sample was 46.5% (40/86). This group of patients will probably benefit most from early intensive care treatment. In the lowest risk category (three points or less), mortality was still 4.2% (11/263) but in patients with two points or less, mortality was only 0.8% (1/118).

The mortality rate of patients with two points or less in a recent study of Jones et al also appeared to be low (1%). Therefore, one could consider the selection of patients with two points or less for early discharge, after the bleeding had settled. Therefore, for one fifth of the patients adequate management of care could be given. However, in the relatively large intermediate group, in which mortality varied from 9.7% to 24.3%, patient management is less clear and better discrimination is necessary. Part of this group might be treated optimally in specialised medium care units, especially for the first 72 hours, which has been recognised as the period in which rebleeding usually develops. However, more than 75% of these patients did not die and should be selected for early discharge. For these patients, the risk scoring system could possibly be improved by adding additional prognostic variables such as prior H$_2$ receptor antagonist therapy, smoking, or liver and renal function disturbances. These factors were found to be additional significant predictors of mortality in a multivariate logistic regression analysis based on our patient sample (data not shown). Better discrimination of high and low risk patients in this intermediate group would lead to better patient care and cost effective management.

We conclude that the risk scoring system developed by Rockall et al is a clinically useful scoring system for stratifying patients with acute UGIB into high and low risk categories for mortality, and in patient samples outside the original study context, but probably could be improved for the intermediate risk category. For the prediction of rebleeding, however, the performance of this scoring system was unsatisfactory.

1 Johnston SJ, Jones PF, Kyle J, et al. Epidemiology and course of gastrointestinal haemorrhage in north-east Scotland. 

2 Schiller KF, Trueove SC, Williams DG. Gaematemesis and melena, with special reference to factors influencing the outcome. 

3 Cutler JA, Mendeloff AI. Upper gastrointestinal bleeding. Nature and magnitude of the problem in the US. 


10 Braitman LE, Davido AV. Clinical factors in the diagnosis and clinical outcome. 


12 Saeed ZA, Ramirez FC, Hepps KS, et al. Prospective validation of the Baylor bleeding score for predicting the likelihood of rebleeding after endoscopic hemorrhage of peptic ulcers. 


15 Schein M, Gecelter G. APACHE II score in massive upper gastrointestinal haemorrhage. 

16 Pimpl W, Boeckl O, Waclawiczek HW. Use of the Rockall score to predict rebleeding from peptic ulcer: prognostic value and potential clinical applications. 

17 Clason AE, Macleod DAD, Elton RA. Clinical factors in the prediction of further hemorrhage or mortality in acute upper gastrointestinal haemorrhage. 


20 Braitman LE, Davidson F. Predicting clinical states in individual patients. 


23 Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. 

24 Saeed ZA, Winchester CB, Macheletza PA, et al. A scoring system to predict rebleeding from peptic ulcer: prognostic value and clinical applications. 