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Risk assessment after acute upper gastrointestinal haemorrhage

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Abstract

The aim of this study was to establish the relative importance of risk factors for mortality after acute upper gastrointestinal haemorrhage, and to formulate a simple numerical scoring system that categorises patients by risk. A prospective, unselected, multicentre, population based study was undertaken using standardised questionnaires in two phases one year apart. A total of 4185 cases of acute upper gastrointestinal haemorrhage over the age of 16 identified over a four month period in 1993 and 1625 cases identified subsequently over a three month period in 1994 were included in the study. It was found that age, shock, comorbidity, diagnosis, major stigmata of recent haemorrhage, and rebleeding are all independent predictors of mortality when assessed using multiple logistic regression. A numerical score using these parameters has been developed that closely follows the predictions generated by logistical regression equations. Haemoglobin, sex, presentation (other than shock), and drug therapy (non-steroidal anti-inflammatory drugs and anticoagulants) are not represented in the final model. When tested for general applicability in a second population, the scoring system was found to reproducibly predict mortality in each risk category. In conclusion, a simple numerical score can be used to categorise patients presenting with acute upper gastrointestinal haemorrhage by risk of death. This score can be used to determine case mix when comparing outcomes in audit and research and to calculate risk standardised mortality. In addition, this risk score can identify 15% of all cases with acute upper gastrointestinal haemorrhage at the time of presentation and 26% of cases after endoscopy who are at low risk of rebleeding and negligible risk of death and who might therefore be considered for early discharge or outpatient treatment with consequent resource savings.

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Acute upper gastrointestinal haemorrhage is a common medical emergency with an incidence in England of approximately 100 per 100 000 adults per year and a mortality among unselected cases in the region of 14%.[1] The important factors influencing the outcome of acute upper gastrointestinal haemorrhage have been the focus of much research and debate since the 1940s but, although the risk factors associated with both rebleeding and death are well known, different researchers have put a different emphasis on each of these according to their experiences.[2–16] Age, comorbidity, shock, diagnosis, admission haemoglobin values, presentation, ulcer size, stigmata of recent haemorrhage, and blood transfusion requirements have all been described as significant risk factors for further haemorrhage and death. Further haemorrhage has been consistently described as the most important risk factor for mortality. It is generally accepted that the risk of rebleeding and death is related to many factors, which are not entirely independent of each other.

While previous studies have served to indicate which variables are important in determining the risk of rebleeding and death, few attempts have been made to devise a simple and therefore clinically useful risk scoring system that makes use of readily available clinical information to categorise patients by risk. We have used a large uniform database to analyse the risk factors for mortality and we have used the analysis to construct a simple numerical risk scoring system. The primary purpose of this score is to allow case mix assessment for comparative audit. An understanding of the risk associated with any particular patient is an important initial step in the management process. Most cases of acute upper gastrointestinal haemorrhage are treated by junior staff in the setting of busy casualty departments and a simple scoring system may be a useful aid to the clinical judgement of risk, especially as there is evidence of considerable disagreement as to what the important prognostic factors are, even within the British Society of Gastroenterology.[17] The development of treatment protocols and the selection of patients for clinical trials are other areas where a risk index might be of benefit.

Methods

The data presented were collected as part of a national audit of the management and outcome of acute upper gastrointestinal haemorrhage. Four health regions in England (North West Thames, South West Thames, Trent, and the West Midlands) were recruited to this prospective study, undertaken under the auspices of the British Society of Gastroenterology, the Royal College of Surgeons of England, the Royal College of Physicians of

TABLE I *Factors analysed in relation to rebleeding and mortality with odds ratios and 95% confidence intervals*

Variable	*Type of data*	*Categorisation*	*Cases*	*Rebleed*		*Dead*		*Odds*	*95% CI*
				No	*%*	*No*	*%*		
All cases			4185	643/4119 (66 missing)	15·6	585/4142 (43 missing)	14·1		
Age	Continuous	<60		151/1290	11·7	74/1294	5·7	Reference	
		60–79		291/1741	16·7	255/1754	14·5	2·80	2·14 to 3·67
		>=80		201/1088	18·5	256/1094	23·4	5·04	3·83 to 6·62
Sex (4 missing)	Categorical	Male	2376	379/2366	16·0	313/2376	13·2	Reference	
		Female	1762	263/1749	15·0	272/1762	15·4	1·20	1·01 to 1·43
Shock (74 missing)	Ordinal	No shock	2897	330	11·4	288	9·9	Reference	
		Tachycardia	687	164	23·9	134	19·3	2·17	1·73 to 2·71
		BP<100	347	94	27·1	95	27·1	3·37	2·58 to 4·39
		BP<70	60	30	50·0	28	45·9	7·70	4·59 to 12·9
		BP<50	34	15	44·0	27	71·1	22·3	10·9 to 45·4
Haemoglobin	Continuous	Hb>=10	2554	299	11·7	275/2554	10·8	Reference	
		Hb<10	1362	314	23·3	258/1362	18·9	1·94	1·61 to 2·33
NSAID	Categorical	No		423/2820	15·0	417/2834	14·7	Reference	
		Yes		220/1299	16·9	168/1308	12·8	0·85	0·71 to 1·04
Anticoagulants	Categorical	No	3864	595/3841	15·5	536/3864	13·9	Reference	
		Yes	278	48/278	17·3	49/278	17·6	1·33	0·96 to 1·83
SRH (all cases)	Categorical n=3047	None	1976	178	9·0	103	5·2	Reference	
		Present	1078	298	27·8	193	17·9	3·97	3·08 to 5·10
Further haemorrhage (62 missing)	Categorical	No	3387	–		293	8·7	Reference	
		Yes	730	–		272	37·3	6·24	5·15 to 7·56
SRH (peptic ulcer group only) n=1300	Categorical	None		66/674	9·8	25/674	3·7	Reference	
		Blood in UGIT		103/316	32·6	68/321	21·2	6·98	4·31 to 11·3
		Adherent clot		79/238	33·2	39/240	16·3	5·04	2·98 to 8·53
		Visible vessel		22/97	22·7	12/97	12·3	3·66	1·78 to 7·56
		Spurting vessel		9/34	26·5	6/35	17·1	5·37	2·05 to 14·1
		Dark spot		17/115	14·8	11/117	9·4	2·69	1·29 to 5·64
Diagnosis	Categorical	None made	1014	125	12·5	200	19·7	1·75	1·45 to 2·11
		Peptic ulcer	1450	267	18·5	170	11·7	0·73	0·60 to 0·88
		Malignancy	155	47	29·7	58	37·4	3·93	2·80 to 5·50
		Varices	180	67	37·0	41	22·8	1·85	1·29 to 2·66
		Mallory-Weiss	214	8	3·7	6	2·8	0·17	0·07 to 0·38
		Erosive disease	447	36	8·1	29	6·5	0·39	0·27 to 0·58
		Oesophagitis	429	37	8·6	35	8·2	0·51	0·36 to 0·73
		Other	253	56	22·8	46	18·2	1·38	0·99 to 1·93
Comorbidity	Categorical	None	1653	184	11·2	73	4·4	Reference	
		Cardiac failure	378	84	22·6	129	34·1	7·73	5·68 to 10·5
		Ischaemic heart disease	659	107	16·5	125	19·0	4·30	3·17 to 5·81
		Asthma	136	18	13·3	19	14·0	3·16	1·85 to 5·40
		COAD	280	48	17·6	67	23·9	5·42	3·80 to 7·73
		Diabetes mellitus	277	43	15·9	62	22·4	5·07	3·53 to 7·28
		Rheumatoid arthritis	168	32	19·0	33	19·6	4·45	2·86 to 6·91
		Liver failure	178	61	35·5	68	38·2	8·65	6·01 to 12·5
		Renal failure	123	29	24·4	56	45·5	10·3	6·96 to 15·3
		Disseminated malignancy	172	53	30·0	89	51·7	11·7	8·28 to 16·6
		Other	463	83	18·0	78	16·8	3·81	2·73 to 5·33
		Pneumonia	88	12	14·1	30	34·1	7·72	4·80 to 12·4
		Dementia	176	22	12·5	28	15·9	3·60	2·27 to 5·72
		Recent major operation	120	24	20·5	27	22·5	5·09	3·16 to 8·22
		Malignancy	119	27	23·7	33	27·7	6·28	4·0 to 9·86
		CVA/TIA	253	32	13·1	54	21·3	4·83	3·30 to 7·04
		Haematological malignancy	109	28	25·7	30	27·5	6·23	3·91 to 9·94
		Hypertension	179	18	10·2	19	10·6	2·40	1·42 to 4·07
		Trauma/burns	62	4	6·9	17	27·4	6·21	3·46 to 11·2
		Other cardiac disease	141	20	14·5	20	14·2	3·21	1·9 to 5·42
		Major sepsis	42	6	14·6	13	31·0	7·01	3·61 to 13·6
		Other liver disease	69	14	23·3	5	7·2	1·64	0·64 to 4·19

SRH=stigmata of recent haemorrhage, UGIT=upper gastrointestinal tract, COAD=chronic obstructive airway disease, CVA/TIA=cerebrovascular accident/transient ischaemic attack.

London, and the Association of Surgeons of Great Britain and Ireland. Seventy four 'acute' hospitals participated in the initial audit.

A lead consultant at each site (usually a member of the British Society of Gastroenterology) represented the project locally. The identification of subjects and administration of the questionnaire was undertaken by an audit coordinator at each hospital. Patients were identified daily in the accident and emergency department, the wards, the endoscopy unit, the operating theatre, and from blood transfusion records and admission data. The questionnaire was generally completed by medical staff and the audit coordinator was then responsible for checking and returning a completed questionnaire for each patient correctly identified. The data collected incorporated patient details including known risk factors, treatment including the use of endoscopy, endoscopic findings, details of surgical involvement, diagnosis, complications, and mortality. Data were entered into a computer database using a validated optical scanning device.[18 19]

The risk scoring system was validated using data collected during the second phase of the national audit in 1994, which used an identical methodology at 45 'acute' hospitals from three health regions over a period of three months.

Statistical methods

Multiple logistic regression analysis[20] was undertaken using SPSS computer software.[21] Continuous variables were categorised to avoid multiplicative errors and variables with more than two categories were recorded using an appropriate indicator variable coding scheme. Variables were entered into the initial models if the crude odds ratios were significantly different from 1. The models were developed using a forward stepwise selection procedure. A variable was included at each step if the score statistics was less than 0·05 and was removed if

TABLE II *Significant predictor variables for mortality*

	Initial model				*Complete model*			
Variable	*b*	*SE*	*Significance*	*Exp(B)*	*b*	*SE*	*Significance*	*Exp(B)*
Age								
<60	Reference		<0·0001				<0·0001	
60–79	0·92	0·17	<0·0001	2·5	0·85	0·22	0·0001	2·34
80+	1·53	0·18	<0·0001	4·6	1·49	0·24	<0·0001	4·43
Shock – none	Reference		<0·0001				0·0363	
Tachycardia (p>=100)	0·76	0·13	<0·0001	2·15	0·34	0·18	0·0570	1·40
BP<100	0·89	0·16	<0·0001	2·43	0·50	0·21	0·0199	1·65
BP<70	1·75	0·30	<0·0001	5·60	0·77	0·39	0·0517	2·15
BP<50	2·75	0·43	<0·0001	15·69	0·83	0·61	0·1759	2·28
Comorbidity								
None	−1·04	0·16	<0·0001	0·35	−1·06	0·20	<0·0001	0·35
Cardiac failure	0·72	0·15	<0·0001	2·06	0·59	0·21	0·0051	1·81
Renal failure	1·55	0·21	<0·0001	4·72	1·68	0·29	<0·0001	5·40
Liver failure	1·04	0·22	<0·0001	2·84			NS	
Disseminated malignancy	1·83	0·19	<0·0001	6·22	1·43	0·28	<0·0001	4·18
Pneumonia	0·92	0·29	0·0017	2·50			NS	
Malignancy	0·59	0·28	0·0370	1·80			NS	
Haematological malignancy	0·76	0·28	0·0061	2·13	0·77	0·35	0·0292	2·15
Diagnosis								
No lesion identified, no SRH					Reference		0·0005	
No lesion identified, SRH present					−0·16	0·38	0·6710	0·85
Peptic ulcer					−0·16	0·14	0·2549	0·85
Malignancy					1·14	0·25	<0·0001	3·14
Varices					−0·40	0·28	0·1419	0·67
Mallory-Weiss					−0·33	0·47	0·4792	0·71
Erosive disease					−0·24	0·25	0·3225	0·78
Oesophagitis					0·29	0·21	0·1685	1·34
Other					−0·09	0·28	0·7589	0·91
Major SRH					1·05	0·17	<0·0001	2·87
Rebleeding					1·71	0·15	<0·0001	5·57
Constant (B_0)	−1·22	0·13	<0·0001		−2·98	0·24	<0·0001	

B represents the variable coefficient in the logistic regression equation and B_0 represents a constant. SE is the standard error of the coefficient B. Significance is the statistical significance for the hypothesis that the coefficient is different from zero. Exp(B) represents the factor change in the odds that death will occur. For the categorised variables the value should only be interpreted within each variable. The prediction of mortality is calculated using the equation $p = \frac{1}{1+e^{-(B_0+B_1X_1+B_2X_2+B_3X_3+\ldots\ldots B_pX_p)}}$ where p is the probability of death and X represents the variable, where X=0 if absent and 1 if present. SRH=stigmata of recent haemorrhage, NS=not significant.

the log likelihood ratio test statistic was greater than 0·1. Confidence interval analysis was undertaken using CIA software.[22]

Results

Utilisation of all the principal risk factors that determine outcome necessitates the development of two related models. Important predictive variables such as diagnosis and the presence of stigmata of recent haemorrhage are usually only available once endoscopy has been performed. An initial predictive model has been developed based upon the information derived from the history, examination, and simple blood tests. A second more complete model includes, in addition, risk factors derived from endoscopic information and further haemorrhage.

Data were drawn from 4185 cases presenting with an acute upper gastrointestinal haemorrhage. Overall mortality was 14% (585 of 4142*). Further haemorrhage (continued bleeding necessitating operation or rebleeding) occurred in 18% (736) and was associated with a 37% (272 of 730*) mortality. The initial model was based upon 3981 cases for whom all investigated variables were recorded. The second complete model was based upon 2956 cases that had, in addition, undergone diagnostic endoscopy or emergency surgery.

*Mortality data were missing in a total of 43 cases and in six cases in the group sustaining further haemorrhage.

Table I lists the factors considered in this study with crude odds ratios and 95% confidence intervals. Continuous variables have been categorised.

Age, sex, comorbidity, shock, and haemoglobin had a crude odds ratio significantly different form 1 and were entered into a logistic regression analysis with death as the dependant variable. After forward stepwise analysis, 'sex' and 'haemoglobin <10 g/dl' were excluded from the model.

Diagnosis, stigmata of recent haemorrhage, and rebleeding were then entered into a second analysis together with the significant variables from the first analysis.

Table II gives the B coefficients for both models with the standard error and significance. Age, shock, comorbidity, diagnosis,

TABLE III *Numerical risk scoring system*

	Score			
Variable	*0*	*1*	*2*	*3*
Age	<60 Years	60–79 Years	>=80 Years	
Shock	'No shock', systolic BP >=100, pulse <100	'Tachycardia', systolic BP >=100, pulse >=100	'Hypotension', systolic BP <100	
Comorbidity	No major comorbidity		Cardiac failure, ischaemic heart disease, any major comorbidity	Renal failure, liver failure, disseminated malignancy
Diagnosis	Mallory-Weiss tear, no lesion identified and no SRH	All other diagnoses	Malignancy of upper GI tract	
Major SRH	None or dark spot only		Blood in upper GI tract, adherent clot, visible or spurting vessel	

Maximum additive score prior to diagnosis=7. Maximum additive score following diagnosis=11.

stigmata of recent haemorrhage, and rebleeding are all independently significant factors in the prediction of mortality in these models.

A simple risk score has been devised using only these significant variables. An integer score was attributed to each category of each variable according to its relative contribution in the logistic regression model (as determined by its regression coefficient). The score was then adapted so that the outcome in each category most closely fitted the predictions of the logistic regression model.

Age and degree of shock were categorised and each attributed a score of 0, 1, or 2. Comorbidity was categorised and attributed a score of 0, 2, or 3. This gives a maximum additive score of 7 before diagnosis.

A score of 0, 1, or 2 for diagnosis and 0 or 2 for stigmata of recent haemorrhage was then added to give a maximum score of 11. Scores of 8 or more are considered as one category as there are very few cases in these very high risk categories. Table III shows the derived scoring system.

The population experiencing further haemorrhage is considered separately from the population without further haemorrhage in the complete model.

Table IV shows the observed mortality and rebleeding rate in each category for both models. Figure 1 shows these data for the complete model. Mortality increases in a stepwise fashion as the risk score increases. The rate of rebleeding also increases as the risk score increases. There were no deaths in categories 0 and 1 of the full model and only one death (0·3%) in category 2. Twenty six per cent of the sample were in these lowest three categories. The population that rebled experienced a fivefold increase in mortality in risk group 3, which decreased to a twofold increase for risk group 8.

TABLE IV(A) *Observed mortality by initial risk score*

Score		*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
	No	595	505	641	890	859	326	141	24
	%	14·9	12·7	16·1	22·4	21·6	8·2	3·5	0·6
Deaths	No	1	12	36	98	211	129	69	12
	%	0·2	2·4	5·6	11·0	24·6	39·6	48·9	50·0

TABLE IV(B) *Observed rebleeding and mortality by complete risk score*

Score		*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8+*
	No	144	281	337	444	528	453	312	267	190
	%	4·9	9·5	11·4	15·0	17·9	15·3	10·6	9·0	6·4
Rebleed	No	7	9	18	50	76	83	102	113	101
	%	4·9	3·4	5·3	11·2	14·1	24·1	32·9	43·8	41·8
Deaths	No	0	0	1	8	16	30	20	23	25
(no rebleed)	%	0	0	0·3	2·0	3·5	8·1	9·5	14·9	28·1
Deaths	No	0	0	0	5	12	19	34	49	53
(rebleed)	%	0	0	0	10·0	15·8	22·9	33·3	43·4	52·5
Deaths	No	0	0	1	13	28	49	54	72	78
(total)	%	0	0	0·2	2·9	5·3	10·8	17·3	27·0	41·1

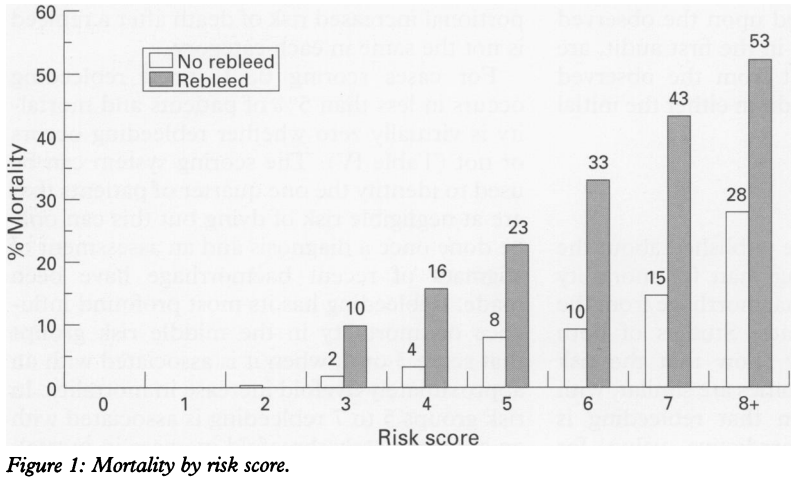

Figure 1: Mortality by risk score.

Validation

Figure 2 shows the degree of association between the predictions of the full logistical regression model and the observed mortality in each category of the risk score. The box plots represent the distribution of predicted

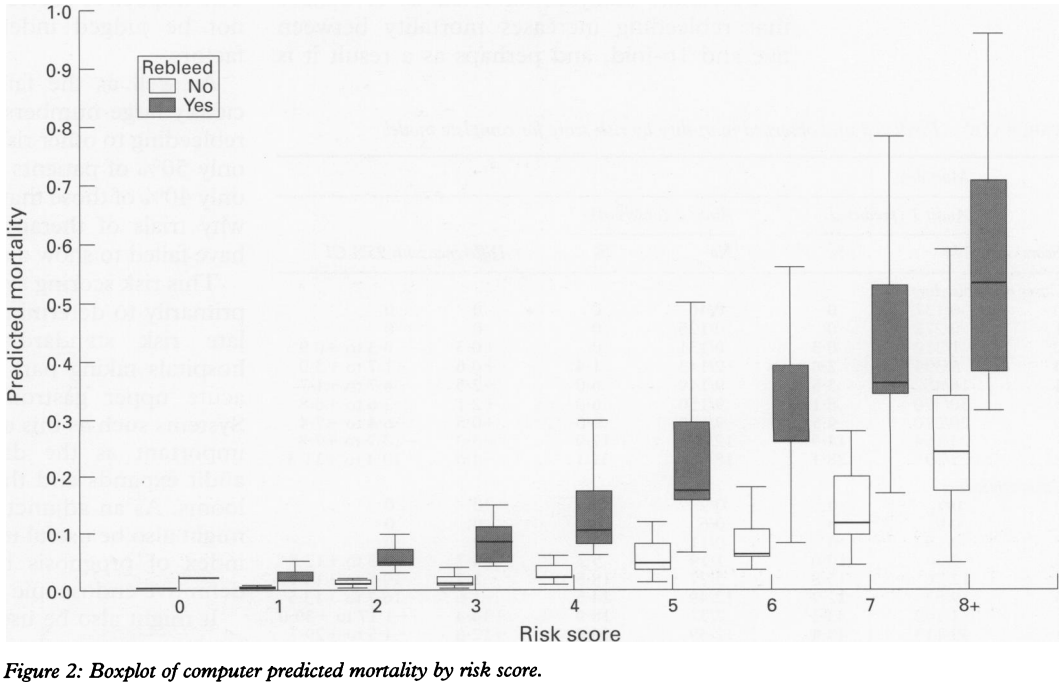

Figure 2: Boxplot of computer predicted mortality by risk score.

TABLE V(A) *Predicted and observed mortality by risk score for initial model*

	Mortality					
	Audit 1 (predicted)		*Audit 2 (observed)*			
Score	*No*	*%*	*No*	*%*	*Difference with 95% CI*	
0	1/595	0·2	0/246	0·0	+0·2	−0·2 to +0·5
1	12/505	2·4	6/201	3·0	−0·6	−3·3 to +2·1
2	36/641	5·6	14/249	6·1	0·0	−3·9 to +2·9
3	98/890	11·0	38/311	12·1	−1·2	−5·4 to +3·0
4	211/859	24·6	77/364	21·0	+3·4	−1·8 to +8·5
5	129/326	39·6	47/134	35·1	+4·5	−5·2 to +14·2
6	72/141	51·1	42/68	61·8	−10·7	−24·9 to +3·5
7	12/24	50·0	6/8	75·0	−25·0	−61·1 to +11·1
Total	568/3981	14·3	230/1584	14·5		

mortalities (using the logistic regression equation) for cases within each risk score category. It can be seen that there is a high degree of association between the predictions of the logistic regression model and the greatly simplified numerical score.

The risk score has been validated in a second population of 1625 cases collected using an identical methodology as part of the second phase of the National Audit. All the necessary variables were recorded in 1584 cases. In 1190 cases, variables for endoscopic diagnosis and stigmata of recent haemorrhage were also recorded. It can be seen in Table V that the predicted outcomes, based upon the observed outcome by risk category in the first audit, are not significantly different from the observed outcome in the second audit in either the initial or complete models.

Discussion

There is a great deal more published about the risk factors for rebleeding than for mortality after an acute episode of haemorrhage from the upper gastrointestinal tract. Studies of both rebleeding and mortality show that the risk factors for these two outcomes are similar, with the additional conclusion that rebleeding is itself of independent predictive value for mortality.

Univariate analyses have led us to believe that rebleeding increases mortality between five and 16-fold, and perhaps as a result it is often regarded as the harbinger of death. Indeed the thrust of modern treatment is specifically targeted at preventing rebleeding by physical means in those lesions amenable to endoscopic haemostatic therapy in the belief that a reduction in mortality should follow. Although several clinical trials have shown a significant reduction in rebleeding with these methods, however, the reduction in mortality has been much more elusive and only two trials using lasers have shown a significant reduction in mortality.[23] Meta-analysis has suggested a 30% improvement in mortality in the peptic ulcer group with visible vessels.[24] Although rebleeding is a very important sign to detect and act upon, either endoscopically or surgically, there are many other factors that determine the final outcome.

Our scoring system has been developed with a view to simplicity and ease of variable acquisition. We have shown how it can be used to broadly categorise patients by risk and there are several important conclusions for the model: firstly, that the risk of rebleeding as well as the risk of death increases as the risk score increases; secondly, that patients who rebleed have an increased mortality compared with those who do not rebleed; thirdly, that the proportional increased risk of death after a rebleed is not the same in each category.

For cases scoring 0, 1, or 2 rebleeding occurs in less than 5% of patients and mortality is virtually zero whether rebleeding occurs or not (Table IV). The scoring system can be used to identify the one quarter of patients that are at negligible risk of dying but this can only be done once a diagnosis and an assessment of stigmata of recent haemorrhage have been made. Rebleeding has its most profound influence on mortality in the middle risk groups that score 3 or 4, when it is associated with an approximately fivefold increase in mortality. In risk groups 5 to 7 rebleeding is associated with an approximately threefold increase in mortality and for risk group 8, a twofold increase. The impact of rebleeding on outcome should not be judged independently of other risk factors.

As well as the failure to investigate sufficiently large numbers of cases, the relation of rebleeding to other risk factors and the fact that only 50% of patients that die have rebled and only 40% of those that rebleed die, may explain why trials of therapy that reduce rebleeding have failed to show a reduction in mortality.

This risk scoring system has been developed primarily to determine case mix and to calculate risk standardised mortality for the hospitals taking part in the national audit of acute upper gastrointestinal haemorrhage.[25] Systems such as this are likely to become more important as the discipline of comparative audit expands and the threat of league tables looms. As an adjunct to clinical judgement, it might also be useful in the clinical setting as an index of prognosis both before and after a definitive endoscopic diagnosis.

It might also be used in the development of treatment protocols. The full array of management tools for optimal care of patients with

TABLE V(B) *Predicted and observed mortality by risk score for complete model*

	Mortality					
	Audit 1 (predicted)		*Audit 2 (observed)*			
Score	*No*	*%*	*No*	*%*	*Difference with 95% CI*	
Cases not rebleeding						
0	0/137	0	0/46	0	0	0
1	0/272	0	0/125	0	0	0
2	1/319	0·3	0/131	0	+0·3	−0·3 to +0·9
3	8/394	2·0	2/143	1·4	+0·6	−1·7 to +3·0
4	16/452	3·5	9/149	6·0	−2·5	−6·7 to +1·7
5	30/370	8·1	9/150	6·0	+2·1	−2·6 to +6·8
6	20/210	9·5	9/100	9·0	+0·5	−6·4 to +7·4
7	23/154	14·9	12/67	17·9	−3·0	−13·7 to +7·8
8+	25/89	28·1	18/56	32·1	−4·0	−19·4 to +11·3
Cases rebleeding						
0	0/7	0	0/2	0	0	0
1	0/9	0	0/6	0	0	0
2	0/18	0	0/11	0	0	0
3	5/50	10·0	1/19	5·3	+4·7	−8·3 to +17·8
4	12/76	15·8	5/27	18·5	−2·7	−19·5 to +14·1
5	19/83	22·9	12/49	24·5	−1·6	−16·7 to +13·5
6	34/102	33·3	7/37	18·9	+14·4	−1·17 to +30·0
7	49/113	43·4	12/39	30·8	+12·6	−4·5 to +29·7
8+	53/101	52·5	18/33	54·5	+2·07	−21·7 to +17·5

upper gastrointestinal haemorrhage is expensive. Rapid endoscopy by experienced endoscopists on call 24 hours per day, high dependency units, medicosurgical collaboration, and on call endoscopy staff all have considerable financial implications. Being able to select patients that will benefit the most from intensive treatment is one important step in the rationalisation of resources. Early discharge or even outpatient treatment of very low risk groups or the transfer to intensive care facilities of very high risk cases for whom a determined effort to save life is being made, might easily be incorporated into a treatment protocol, however, the use of such a system in selecting patients for surgery could only be promoted after evidence from clinical trials.

It is important to understand that this system, like most predictive methods cannot predict the outcome of any individual patient, except perhaps those in categories 0 and 1 in whom no deaths occurred. The risk of death is simply a measurement of the number of deaths that might be expected in a large population of cases with those risk factors. The testing of the model in a second large population has, however, allowed us to confirm the general applicability of the model based upon current standards of treatment.

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