The ACTA **PORT**-Score for predicting the **P**eri**o**perative **R**isk of blood **T**ransfusion for adult patients undergoing cardiac surgery

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ABSTRACT

Objective: To derive a simple and accurate scoring system to predict risk of transfusion for patients undergoing cardiac surgery

Design: Retrospective analysis of data collected from the ACTA National Audit; for the derivation dataset, we included data from 20,036 patients, which we then externally validated using a further group of 1,047 patients.

Methods: We identified independent risk factors associated with transfusion by performing univariate analysis, followed by logistic regression. We then simplified the score to an integer-based system and tested it using AUC characteristic statistic. A Hosmer-Lemeshow goodness-of-fit test was applied. Finally, the scoring system was applied to the external validation dataset and the same statistical methods applied to test the accuracy of the ACTA-PORT score.

Results: Several factors were shown to be independently associated with risk of transfusion. These included age, gender, body surface area, logistic EuroSCORE, preoperative haemoglobin and creatinine, and type of surgery. In our primary dataset, the score accurately predicted risk of perioperative transfusion in cardiac patients with an AUC of 0.76. The external validation confirmed the accuracy of the scoring method with an AUC of 0.84 and good agreement across all scores with a minor tendency to under-estimate transfusion risk in very high-risk patients.

Conclusion: The ACTA-PORT score is a reliable, validated tool for predicting the risk of transfusion for patients undergoing cardiac surgery. This score will allow clinicians to easily identify patients at increased risk for transfusion and apply patient blood management strategies appropriately, with the potential to reduce perioperative morbidity and mortality.

INTRODUCTION

Cardiac surgery has long been associated with comparatively high rates of blood product transfusion. Blood products are a limited resource and are both expensive and resource-intensive; cardiac surgery consumes a significant proportion of these global blood resources. There is conflicting evidence supporting the relative merits of restrictive[1] or liberal[2] transfusion triggers, but there is a significant body of evidence that *any* perioperative transfusion is associated with higher risk of mortality in both the short-[3] and long-term.[4]

Several factors have been shown to be independently associated with transfusion in cardiac surgery patients. These include age,[5] gender, pre-operative haemoglobin concentration (Hb), elevated plasma creatinine[3] and low body weight.[3] Various attempts have been made to synthesise these predisposing factors into a predictive scoring system,[6-8] but as yet none have become widely established.

Patient blood management (PBM) is an increasingly important concept in perioperative medicine and as with any risk-reduction strategy, the first step is to predict individual risk, followed by targeted strategies to mitigate this risk.[9] This allows for appropriate and focussed use of PBM strategies, which may include medication and techniques that can be expensive, or may result in harmful side-effects, and should be therefore be reserved for those at higher risk of transfusion. Scoring systems to predict general mortality and morbidity are widely used in cardiac surgery and critical care, such as the EuroSCORE[10] and the recently published ARCTIC score[11]. A similar scoring system to guide effective perioperative PBM could have a major impact on resource allocation and

potentially on perioperative morbidity. We therefore decided to design the Association of Cardiothoracic Anaesthetists (ACTA) perioperative risk of blood transfusion score – the ACTA-PORT score, using a large national database collected by members of ACTA.

METHODS

This study comprises a national service audit of NHS cardiac surgery centres that collected relevant patient data as part of routine institutional practice. The Research and Ethics Committee of the London School of Hygiene and Tropical Medicine approved the study, and individual patient consent was not required. Between 1st January 2010 and 31st July 2013, data were collected from 10 cardiac surgery centres in the UK during the first ACTA national audit; an analysis of the effect of anaemia has already been published.[11] After the analysis was complete, a further centre provided data from the same study period – this was analysed as the external validation dataset.

Baseline data collected included age, gender, pre-operative haemoglobin (Hb) creatinine, weight, height, logistic EuroSCORE, diabetes, hypertension, type of surgery proposed and previous cardiac surgery. Body mass index (BMI) and body surface area (BSA) were derived from weight and height. These variables were chosen because we a priori expected them to be associated with outcome. Outcomes recorded included number of units of blood transfused, duration of ICU and hospital stay, and death.

As our goal was to produce a simple-to-use integer risk score, the continuous variables age, preoperative haemoglobin, creatinine, logistic EuroSCORE, BMI and BSA were all categorised using clinical judgement where available or otherwise following graphical inspections and taking into account the distribution of the outcome. We used logistic

EuroSCORE as EuroSCORE-2 was not in routine use in the NHS during the study period. Although EuroSCORE was designed to calculate the risk of mortality (as opposed to transfusion), we included it as a separate variable to aid in the calculation of risk of transfusion. Operation type was grouped into three categories; isolated CABG or valve surgery, combination surgeries (CABG and valve, or valve and valve), and other (including operations on the aorta).

The univariate association between each of the baseline variables and the outcome of blood transfusion was assessed using logistic regression. Forward and backward stepwise model building approaches were used in developing a final multivariable logistic regression model using a threshold for inclusion or exclusion of $P < 0.05$. Both approaches yielded identical final models. A restricted set of pre-specified potential interactions were investigated using likelihood ratio tests.

As our goal was to produce a risk score that is generalisable beyond the centres involved in this audit, centre was not included as a fixed effect in the model. We compared multivariable logistic regression models omitting centre completely and multivariable mixed effects logistic regression models including centre as a random effect. These two approaches produced almost identical results in terms of the estimate odds ratios and the overall model performance and we therefore decided to proceed with the former.

Adjusted odds ratios and 95% confidence intervals for the final multivariable model are presented along with p-values from a likelihood ratio test. For each variable in the model, we set the lowest risk category as the reference group so that the risk score would only involve the addition of points. The logistic odds ratio for each category was converted into an integer by dividing by 0.2 and rounding to nearest the nearest whole number. The total integer risk

score for each patient was then calculated by summing the points associated with their combination of baseline risk factors.

The discriminatory performance of the risk score before and after simplification was assessed using the area under the receiver operating characteristic curve (AUC) statistic. The goodness of fit of the models i.e. how closely predicted risk matched observed risk, was assessed using the Hosmer-Lemeshow goodness-of-fit test.

The predicted risk of transfusion associated with each value of the total integer risk score was calculated and presented in a table and figure. We grouped the risk score into six equally spaced categories (0-4, 5-9, 10-14, 15-19, 20-24 and 25-30) and plotted the observed versus predicted proportion of patients transfused in each category.

We assessed the sensitivity of our results to the influence of missing data using multiple imputation. Multiple imputation with chained equations was used to generate 20 completed datasets. The selected model was then fitted to each of the 20 completed datasets and the estimated coefficients were combined according to Rubin's rules.

An external validation of the integer risk score was carried out using data from a further cardiac surgical centre. The integer risk score was calculated for each patient in the external dataset and the performance of the risk score was assessed using the AUC and the Hosmer-Lemeshow goodness-of-fit test. We grouped the risk score for the validation patients into the same categories as described above for the derivation data and plotted the observed versus predicted risk of transfusion. We also used our validation dataset to compute the TRACK score and compared our model with TRACK using the DeLong method. We were unable to calculate any other published risk scores as we did not collect the required variables.

The analysis was carried out using Stata 14 (StataCorp, College Station, TX).

Patient involvement.

Patients/service users/lay people were not involved in the design of this study.

RESULTS

We analysed data from 20,036 patients, whose baseline characteristics are shown in Table 1. A total of 8,635 (43%) patients were transfused.

Table 1 shows the baseline characteristics of the patients overall and by the outcome of blood transfusion. The mean age of the patients in this audit was 67 years [range 18, 111] and 71% were male. Mean pre-operative haemoglobin was 132 g/L with 31% of patients being anaemic ($< 130/< 120$ g/L for males/females respectively). Haemoglobin was not available for 16% of patients in this audit. Of the 20,036 patients 8,635 (43%) received a blood transfusion perioperatively.

With the exception of a known history of hypertension, all the baseline variables were strongly associated with the risk of blood transfusion (all $P < 0.001$) in the univariate analysis. Age, EuroSCORE, female gender, diabetes and elevated creatinine were positively associated with the risk of transfusion. Haemoglobin, BMI and BSA were negatively associated with the risk of transfusion. Patients undergoing combination surgery were more likely to be transfused. There were marked differences in transfusion rates among the 10 centres, which ranged from 31% to 56% (Table 2).

Table 3 shows the adjusted odds ratios, 95% CIs and p-values for the 7 variables included in the final multivariable risk score. During the model building process, it was found that BSA was a stronger predictor of transfusion than BMI. Neither history of hypertension nor diabetes were found to be independently associated with risk of transfusion. Table 2 also shows the log-odds ratio, their standard errors and the integer points associated with each category. Other than age ($p = 0.02$), all the variables in the multivariable risk score were

strongly associated with the outcome (p < 0.001). No statistically significant interactions were found. The strongest predictor of transfusion was baseline Hb, followed by BSA and EuroSCORE. The AUC for the integer risk score model was 0.760 (95% CI 0.752, 0.768) and the Hosmer-Lemeshow goodness-of-fit test provided no evidence of a poor fit (p=0.23). The AUC from the non-integer risk model (i.e. using the log-odds ratios) was 0.762 indicating that little predictive power had been lost through the simplification process.

The risk score for any patient is simply calculated by adding the points associated with their baseline characteristics.

For example, a 65 year old (+0 points) male (+0 points), with baseline Hb of 135 g/L (+3 points), BSA of 2.0 (+2 points), logistic EuroScore of 1.5 (+2 points), creatinine of 1.5 (+1 point) and undergoing CABG surgery (+2 points) would have a total risk score of 10 points. A 75 year old (+1 point) female (+1 point), with baseline Hb of 125 g/L (+6 points), BSA of 1.8 (+4 points), logistic EuroScore of 2 (+3 points), creatinine of 2.5 (+3 points) and undergoing valve surgery (+2 points) would have a total risk score of 20 points.

Table 4 and Figure 1 show the predicted risk of transfusion associated with each value of the risk score. Figure 1 additionally shows the distribution of the risk score among the patients in the audit. The risk score can in theory take values ranging from 0 to 30 with a higher score being associated with a higher risk. For example, the risk of transfusion for the patient described above with a risk score of 10 is estimated to be 26.9% compared to an estimated risk of transfusion of 73.1% for patient with a risk score of 20. Figure 1 shows that the risk score is fairly normally distributed in this sample of patients with very few patients having a risk score below 5 (1.9%) or above 24 (1.8%). The median risk score was 14, for which the estimated risk of transfusion is 45%.

Figure 2 shows the observed versus predicted risk of transfusion across categories of the risk score. It can be seen that the score performs well in stratifying the risk of transfusion. Among patients with a score below 10, less than 20% were transfused compared with close to 80% of patients with a score of 20 or above. There is good agreement between the predicted and observed probability of transfusion.

The observed transfusion risk was more than 4 times higher among patients with a risk score of 20 or above compared to those with a score below 10. The AUC for the risk score in the external validation dataset is 0.835 (95% CI 0.810, 0.859). However, it can also be seen that the score tends to underestimate the risk of transfusion, particularly at higher levels of the score e.g. 73% and 89% observed versus 60% and 79% predicted in the $15-19$ and $20-24$ categories respectively.

The score was not designed to predict number of units of blood transfused. However, increasing ACTA-PORT score was associated with increased number of units of blood transfused peri-operatively: risk score 0-14, median units of blood transfused 0; score 15-19, median 1 unit; score 20-24, median 2 units; and score 25-30, median 3 units.

The results from the sensitivity analysis using multiple imputation did not make substantial changes to the risk score. We also calculated the performance of the ACTA-PORT score at various integer risk score cut-points; the optimum cut-point was 15, with a positive predictive value of 69.5% and a negative predictive value of 70.9%, with 70.3% of values correctly predicted.

DISCUSSION

We have developed a simple, integer-based scoring system that is highly accurate at predicting the likelihood of transfusion and is the first scoring system of its kind to be externally validated, demonstrating its applicability in a real-world scenario. Furthermore, this scoring system demonstrates improved accuracy when compared with previous attempts to quantify perioperative transfusion risk

The concept of a scoring system designed to predict the risk of bleeding or transfusion during cardiac surgery is not new. One of the first efforts in this area was from Papworth Hospital.[6] This system aimed to measure blood loss exceeding $2mL.kg^{-1}.hr^{-1}$, requirement for fresh frozen plasma, platelets or cryoprecipitate, or return to theatre after arrival in the ICU. Whilst the negative predictive value of this score was high, only 27% of patients who the score placed in the highest risk category subsequently demonstrated major bleeding. This low positive predictive value was confirmed by a subsequent external validation.[7]

Whilst the Papworth Bleeding Risk Score sought to identify those patients at risk of excessive blood loss in the ICU after cardiac surgery, subsequent scoring systems have sought to predict the risk of transfusion. A relatively recent example of this is the Transfusion Risk and Clinical Knowledge (TRACK) score, described in 2009.[8] TRACK aimed to create a simple, easily applied system, based on five predictors of transfusion risk, assigning each variable a proportional risk score based on the clinical condition of the patient. This scoring system was subsequently validated against an external cohort, and proved to be superior to three earlier systems[13-15] with an area under the receiver-operator curve (AUC) of 0.70. Like the ACTA-PORT score, TRACK aimed to improve the utility of the scoring

system for clinical practice due to its relative simplicity, whist at the same time remaining sensitive and specific for predicting transfusion risk

Recently, Goudie and colleagues published their contribution to this field.[16] This impressive dataset produced two risk prediction models: one for any red cell transfusion, and another predicting a requirement for massive transfusion. This is considerably more complex than the simpler TRACK and ACTA-PORT prediction models. When the Goudie model was published, it represented an advance on many existing scoring systems,[10, 12, 15] with an AUC of 0.77 for any red blood cell transfusion. ACTA-PORT represents an improvement on Goudie et al, retaining the simplicity and accessibility of TRACK combined with a greater predictive accuracy for red cell transfusion; our validation cohort demonstrating an AUC of 0.84. We used our validation dataset to compute the TRACK score; the AUC of TRACK was 0.781 (ACTA-PORT vs. TRACK p<0.001 using the DeLong method for comparing risk scores), therefore we conclude that the ACTA-PORT score performs significantly better than TRACK.

Thus, ACTA-PORT represents the latest step in the evolution of pre-operative prediction of transfusion requirement. Correctly applied, ACTA-PORT has the potential to enable the clinician to quantify this risk before surgery, thereby allowing modification of important risk factors during pre-operative optimisation. It will also help surgeons and anaesthetists plan which interventions to apply during the perioperative period. For example, cell salvage may be reserved for patients with increased risk of transfusion e.g. ACTA-PORT score >15. The risk of transfusion may also be helpful for planning blood supply in the nearest (hospital) blood bank, and for aiding decisions about reserving blood specifically, which can again reduce costs associated with surgery, e.g. no need to cross match blood if ACTA-PORT score <15.

Blood transfusion during cardiac surgery is known to place additional physiological stress on the individual patient, and a further economic burden on health services. This recognition comes at a time when there is increasing debate regarding the appropriate target Hb during cardiac surgery, with some authors suggesting a liberal transfusion strategy is equivalent,[2] if not superior[17] to a restrictive strategy. This has the potential to increase the demand for blood products in the cardiac surgery setting if effective Patient Blood Management (PBM) strategies are not introduced. The short- and long-term costs of blood transfusion during cardiac surgery are well documented,[18] but as recent reports have suggested, the costs of developing a PBM program designed to offset such costs are not small.[19] ACTA-PORT and similar scores, as part of an effective program of perioperative optimisation, have the ability to predict the requirement of patients for transfusion in the surgical setting, allowing more effective targeting of limited resources such as cell salvage, for example.

Quite separate from the economic arguments for such a score, the avoidance of transfusion has substantial clinical benefits for the individual patient. Transfusion has been shown to be associated with increased morbidity related to ischaemia,[20] infection, [21-24] renal impairment,[25] post-CABG graft occlusion[26] and acute lung injury.[27] With respect to longer term outcomes, Engoren and colleagues found that blood transfusion during cardiac surgery was associated with a doubling of the risk of death at 5 years.[27] Yet this clinical intervention, with appropriate preoperative warning and preparation, can potentially be avoided.

In our study, the only realistically modifiable risk factor associated with requirement for blood transfusion was Hb. Patients with an Hb <130 g/L accounted for nearly 50% of all transfusions, despite making up only one-third of the total cohort. Using the risk profile of those patients included in the ACTA-PORT cohort, a PBM program that was able to increase a patient's haemoglobin from 120 to 130 g/L would theoretically decrease their risk of

requiring a transfusion during the perioperative period by 40%, with an implied reduction in perioperative morbidity and mortality.

Similar to previous studies that have used the retrospective analysis of large databases to generate a risk score, our study suffers from some limitations. First, the preoperative management of patients presenting for cardiac surgery at the centres involved in the study was not standardised. The possibility that patients at certain centres were exposed to different PBM strategies therefore cannot be excluded, and may potentially confound any subsequent analysis. Such strategies may include differences in the cessation of anti-platelet therapies and the use of cell salvage, as well as the transfusion preferences of individual surgeons and centres. All the centres administered tranexamic acid routinely, but at different doses depending on institutional preference.

Secondly, despite demonstrating overall reliability in predicting the risk of transfusion, the score does slightly underestimate the transfusion risk in higher risk categories of patients. Patients with an integer risk score of greater than 20 had a roughly 10% higher observed rate of transfusion relative to the predicted risk. This may reflect the nature of the validation cohort, being from a single centre, as opposed to the multi-centre model derivation dataset. Consequently, the transfusion practices in the specific centre may not accurately reflect general transfusion practice. This may be due to regional variation in anaemia incidence as described by Klein et al,[12] or a higher incidence of complex cardiac surgery being undertaken at this specific centre. The decision by the authors to not specifically correct for regional variation was made in order to retain generalisation, enabling the scoring system to be used at centres outside those who participated in the initial cohort. Consequently, if a centre has policies or surgeons that mean transfusions are more likely (compared with the average in the audit) the score will underestimate risk, as evidenced by the results of the validation cohort. Whilst ACTA-PORT will still be useful to stratify the risk

of transfusion in any presenting for surgery, the system will need to be recalibrated if centres outside of the control cohort wish to use it to predict absolute risk. We plan to design a simple App/online calculator to calculate the ACTA-PORT score when planning surgery or discussing risk with patients.

Finally, the system makes use of the EuroSCORE[10] as an overall marker of patient mortality. This may limit the applicability of the scoring system beyond health systems that routinely collect this information, particularly centres in China[29] and Australia.[30] Furthermore, risk prediction models are subject to constant revision,[31] potentially further limiting the applicability of derived models that make use of them.

In summary, using a large, multicenter cohort of patients collected from multiple cardiac centres, our group has derived a robust, simple and accurate system for predicting the risk of transfusion for patients undergoing cardiac surgery. ACTA-PORT is the most accurate system of its kind to date, and may be used as part of a selection process for participation in a perioperative PBM program reducing the clinical and economic burden of transfusion. Future research in this area will ideally include independent validation against a further external cohort, comparing ACTA-PORT with other bleeding/transfusion risk scores, as well as trialling incorporation of our score into a PBM program to enable stratification of transfusion risk and targeting interventions to mitigate this.

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CONTRIBUTORSHIP STATEMENT

AAK conceived and designed the study, coordinated data collection and revised the manuscript. TC performed all statistical analysis and participated in the writing and revision of the manuscript. JY wrote and revised the manuscript. LFM wrote and revised the manuscript. NF and CE coordinated data collection and assisted in the revision of the manuscript. TR assisted in the conception of the study and the revision of the manuscript. Appendix 1 lists the collaborators in this study.

CONFLICT OF INTEREST STATEMENT

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FIGURE LEGENDS

Figure 1: The distribution of risk scores in our population; shows that the distribution follows a relatively normal curve and superimposed is a line showing the increasing risk of transfusion associated with higher scores.
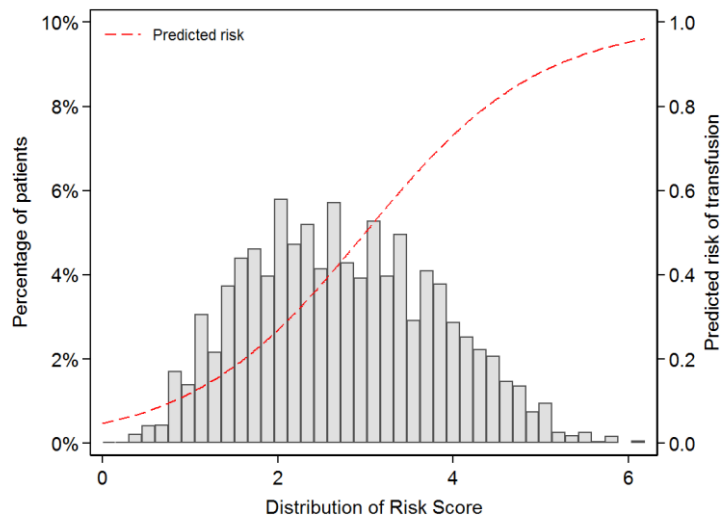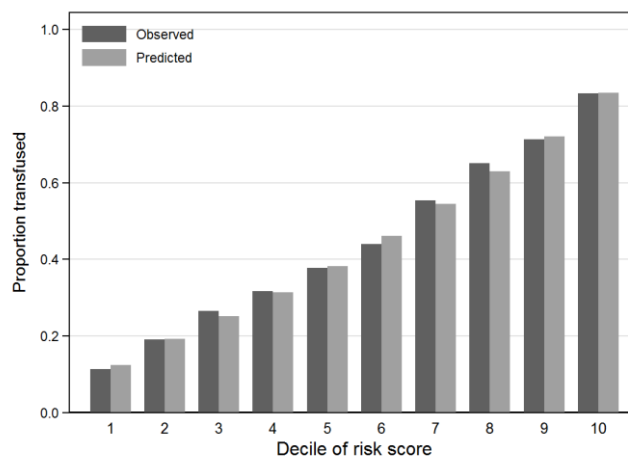

Figure 2: Observed vs. predicted transfusion rates in the derivation dataset, demonstrates the close correlation between predicted and observed rates of transfusion using our score across the range of scores in our derivation dataset.

TABLES

	All n=20,036	Not transfused n=11,041	Transfused n=8,638	p-value
Age; years	67.1 (11.9)	65.2 (12.0)	69.7 (11.3)	<0.001
Sex; men	14,303 (71.4%)	9,093 (79.8%)	5210 (60.3%)	<0.001
Pre-operative Hb; g/L Missing data	132 (17) 3237 (16.2%)	138 (15) 2077 (18.2%)	125 (17) 1160 (13.4%)	<0.001
Body surface area; m2	1.9 (0.2)	2.0 (0.2)	1.9 (0.2)	<0.001
Body mass index; kg/m2	28.4 (5.1)	29.0 (5.0)	27.6 (5.0)	<0.001
EuroSCORE Missing data	4.3 (2.1-8.7 (0.4-98.4)) 393 (2%)	3.2 (1.7-6.6 (0.4-98.4)) 238 (2.1%)	6.0 (3.1-11.7 (0.4-97.9)) 155 (1.8%)	
Creatinine; µmol/L Missing data	88 (71-106 (9-1547)) 2172 (10.8%)	88 (71-97 (9-1547)) 1254 (11%)	88 (71-106 (9-1450)) 918 (10.6%)	<0.001
Diabetes Missing data	3916 (22.0%) 2267 (11.3%)	2114 (20.7%) 1208 (10.6%)	1802 (23.8%) 1059 (12.3%)	<0.001
Hypertension Missing data	13,325 (67.8%) 384 (1.9%)	7,511 (67.2%) 224 (2.0%)	5814 (68.6%) 160 (1.9%)	0.04
Operation type				
CABG or valve*	14,575 (73%)	8,778 (77%)	5,797 (67%)	
Double procedure	2,858 (14%)	1,008 (9%)	1,850 (21%)	
Other Missing data	2,594 (13%) 9 (<0.1%)	1608 (14%) 7 (0.1%)	986 (11%) 2 (<0.1%)	<0.001

Table 1: Baseline characteristics. Values are mean (SD), number (proportion or median (IQR (range)).

* Indicates isolated CABG or single valve surgery.

Centre	All n=20,036	Not transfused n=11,401	Transfused n=8,638	Transfusion rate
A	2559 (13%)	1268 (11%)	1291 (15%)	50%
B	732 (3%)	425 (4%)	307 (4%)	42%
C	2058 (10%)	1410 (12%)	648 (8%)	31%
D	2371 (12%)	1233 (11%)	1138 (13%)	48%
E	5371 (27%)	3283 (29%)	2088 (24%)	39%
F	500 (3%)	292 (3%)	208 (2%)	42%
G	960 (5%)	423 (4%)	537 (6%)	56%
H	1986 (10%)	1029 (9%)	957 (11%)	49%
I	1099 (6%)	618 (5%)	481 (6%)	44%
J	2400 (12%)	1420 (12.5%)	980 (11%)	41%

Table 2: Anonymised centres. The difference in transfusion rates between centres was statistically significant ($p < 0.001$).

Characteristic	Category	Odds ratio (95%)		p-value	Log odds ratio (SE)		Points
Age; years	**<70**	Ref.					+0
	70+	1.11	(1.01, 1.21)	0.02	0.10	(0.04)	+1
Sex	**Male**	Ref.					+0
	Female	1.27	(1.15, 1.40)	<0.001	0.24	(0.05)	+1
Haemoglobin	**<110**	6.36	(5.38, 7.52)		1.85	(0.09)	+9
g/L	**110-**	4.60	(3.93, 5.38)		1.53	(0.08)	+8
	120-	3.19	(2.79, 3.65)		1.16	(0.07)	+6
	130-	1.93	(1.70, 2.20)		0.66	(0.07)	+3
	140-	1.55	(1.37, 1.77)		0.44	(0.07)	+2
	150+	Ref.		<0.001			+0
Body surface area	**<1.7**	3.62	(2.97, 4.42)		1.29	(0.10)	+6
m²	**1.7-**	2.21	(1.85, 2.64)		0.79	(0.09)	+4
	1.9-	1.56	(1.31, 1.85)		0.44	(0.09)	+2
	2.1-	1.24	(1.04, 1.49)		0.22	(0.09)	+1
	2.3+	Ref.		<0.001			+0
EuroSCORE	**<1**	Ref.					+0
	1-	1.36	(1.10, 1.70)		0.31	(0.11)	+2
	2-	1.73	(1.39, 2.15)		0.55	(0.11)	+3
	3-	2.16	(1.75, 2.68)		0.77	(0.11)	+4
	9+	2.76	(2.20, 3.46)	<0.001	1.01	(0.12)	+5
Creatinine	**<88**	Ref.					+0
µmol/L	**88-**	1.33	(1.23, 1.44)		0.29	(0.04)	+1
	177-	1.93	(1.54, 2.42)	<0.001	0.66	(0.12)	+3
Type of Operation	**CABG/Valve**	1.38	(1.22, 1.55)		0.32	(0.06)	+2
	Combination	2.84	(2.46, 3.29)		1.05	(0.07)	+5
	Other	Ref.		<0.001			+0
Intercept		NA			-3.00	(0.15)	

Table 3: Multivariable Risk Score outlining corresponding odds ratios, log odds ratios and how ACTA-PORT score was constructed, showing the number of score-points that were attributed to each group.

Integer risk score	Predicted risk of transfusion	Integer risk score	Predicted risk of transfusion
0	0.0470	15	0.500
1	0.0570	16	0.550
2	0.0690	17	0.599
3	0.0830	18	0.646
4	0.1000	19	0.690
5	0.1190	20	0.731
6	0.1420	21	0.769
7	0.1680	22	0.802
8	0.1980	23	0.832
9	0.2310	24	0.858
10	0.2690	25	0.881
11	0.3100	26	0.900
12	0.3540	27	0.917
13	0.4010	28	0.931
14	0.4500	29	0.943
15	0.5000	30	0.953

Table 4: Integer risk score totals and associated predicted risk of transfusion. It demonstrates that low scores attract a very low risk of transfusion (i.e. a score of 1 gives a risk of transfusion as less than 5%) whereas a patient with a score of 30 would have more than a 95% risk of requiring a transfusion.