The Papworth Bleeding Risk Score: a stratification scheme for identifying cardiac surgery patients at risk of excessive early postoperative bleeding

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Objective: We have developed a risk stratification score to identify cardiac surgical patients at higher risk of severe postoperative bleeding to aid a decision on whether to use a specific intervention preoperatively. Methods: We prospectively created a database of 11,592 consecutive patients, who underwent cardiac surgery with cardiopulmonary bypass. An adverse outcome was formally defined as a mean blood loss exceeding 2 ml kg$^{-1}$ h$^{-1}$ measured between arrival in the intensive care unit (ICU) and the earliest of the elapse of 3 h; the start of transfusion of any one of fresh-frozen plasma, platelets or cryoprecipitate; return to theatre or death. Univariate and multivariate associations of severe postoperative bleeding with patient characteristics, clinical features and procedure details were analysed on a development set. The final risk stratification scheme was then evaluated on a test set. Results: Severe postoperative bleeding was associated with urgent or emergency surgery, surgery that was not coronary artery bypass grafting or single valve surgery, presence of aortic valve disease, low body mass index and older age. A risk stratification score was constructed from the above variables to define preoperative categories that demonstrated high, medium and low risk of severe postoperative bleeding. Patients deemed to be at high, medium and low risk by our preoperative scoring had a 21% (95% confidence interval: 18–24%), 8% (7–10%) and 3% (2–4%) rate of severe postoperative bleeding, respectively, within the test set. Conclusion: We have developed a simple risk stratification score that can separate, preoperatively, patients into risk groups with markedly different rates of severe postoperative bleeding.

Keywords: Haemorrhage; Surgery; Cardiopulmonary bypass; Predictive scoring

1. Introduction

It is well established that severe postoperative bleeding leads to increased morbidity and mortality for cardiac surgery patients [1–3], and is a relatively common complication of cardiac surgery [4–7]. It is associated with renal failure, sepsis, neurological impairment, acute respiratory distress syndrome and death.

A large number of therapies are available to clinicians to decrease the amount of blood loss. Such therapies include drugs that can be administered prophylactically. However, some of these drugs may be hazardous [8–10], and are usually expensive. For this reason, it can be difficult to make a clinical or health economic case for the administration of such agents to all cardiac surgical patients. Consequently, it would be desirable to be able to identify groups of patients, who are at the highest risk of severe postoperative bleeding, both to inform decisions as to whether to administer prophylactic interventions or to identify a higher-risk cohort of patients when planning the evaluation of new interventions. This would also support clinical decision when informed consent is sought from the patient.

We sought to develop a simple model that would allow straightforward preoperative stratification of patients into different risk categories to aid in such identification. We took the view that such a model should be based on variables routinely available to the clinical team before the operation.
monary bypass at Papworth Hospital — a tertiary referral and teaching hospital — from October 2000 to October 2008, were obtained from two prospectively collected databases — one of which is dedicated to blood loss and blood transfusion data. Fields within the database contained data pertaining to

- patient characteristics: age at operation, sex, height and weight;
- clinical features: aortic valve disease, mitral valve disease, previous myocardial infarction, left ventricular function, European System for Cardiac Operative Risk Evaluation (EuroSCORE), neurological dysfunction, chronic lung disease, preoperative renal function and blood tests and blood pressure;
- medical management: use of aspirin and other anticoagulants and use of tranexamic acid and aprotinin;
- administrative details: date and time of operation and time of admission to intensive care unit (ICU);
- details of procedure: broad category of operation, exact procedure performed, priority, pseudo-anonymised surgeon and anaesthetist IDs, cross-clamp time, bypass time and transfusion prior to transfer to ICU;
- outcome: vital status at discharge, cumulative blood loss on ICU, at 20 min, 40 min, 1 h and hourly thereafter for 12 h, final blood loss and time of and reason for any return to theatre; and
- interventions in ICU: start time, date and product transfused after arrival to ICU.

This database is maintained by a full-time clinical information analyst (CG), who is solely responsible for continuous prospective data collection daily at the bedside as part of a continuous audit process in the hospital. Data are audited regularly and information fed back to all staff to ensure effective use of blood and blood products. The second database consisted of data entered at the time of surgery by the surgical team and records the details of the procedures performed [11]. These data are systematically verified for accuracy and completeness by an independent audit team.

Both databases were reviewed by an external statistical team (ACP, BR and MU) and were deemed of excellent quality in terms of completeness, consistency of coding and other features.

2.2. Patient management

All patients underwent cardiac surgery with cardiopulmonary bypass in a single institution with a standard, but not rigid, perioperative protocol. The use of tranexamic acid is encouraged, and administration of aprotinin (until the drug was withdrawn) was at the discretion of the clinical team, and was usually reserved for active endocarditis and transplantations.

Anticoagulation for cardiopulmonary bypass is achieved with heparin to maintain an activated coagulation time above 400 s. The non-heparin-coated cardiopulmonary bypass circuit is usually primed with 1.5 L of Ringer’s lactate and 50 ml of 20% mannitol. The administration of intravenous fluid (Hartmann and Gelofusine), choice of cardioplegic solution, and the regulation of other clinical parameters, such as temperature and perfusion pressure, are at the discretion of the clinical team. Anticoagulation is reversed at the end of cardiopulmonary bypass by administering protamine to achieve an activated coagulation time within 10% of the initial time.

Perioperative transfusion is guided by an institutional algorithm (Fig. 1), and adherence by each individual clinician is consistently monitored and reported at quarterly meetings and through regular written updates.

2.3. Dependent and predictor variables

Prior studies concerning postoperative bleeding have often defined it as transfusion of more than 5 units of blood products and/or the return of the patient to theatre due to excessive bleeding [2,4,6]. One problem with this approach is that protocols concerning the use of transfusion vary between institutions and adherence to (or interpretation of) such protocols may vary amongst surgical teams within an institution. There may also be a level of subjectivity in determining what level of postoperative bleeding warrants a return to theatre.

The primary objective of this model was to identify patients at increased risk of an adverse postoperative bleeding outcome. This adverse outcome was formally defined as a mean blood loss exceeding 2 ml kg$^{-1}$ h$^{-1}$ measured between arrival in ICU and the earliest of the following events: the elapse of 3 h; the start of transfusion of any one of fresh-frozen plasma, platelets or cryoprecipitate; return to theatre or death. These different events took account of patients for whom measurements over the full 3 h were either unavailable (return to theatre or death) or likely to be influenced by medical interventions made in response to bleeding (for instance, where platelets were administered within the 3-h period).

We note that transfusion of blood products prior to transfer to the critical care unit was considered to be part of standard surgical practice and did not constitute an end point in our analysis.

2.4. Use of antifibrinolytics

The non-uniform use of aprotinin and tranexamic acid on patients in the database was recognised at the outset to present a problem.

Fig. 1. Papworth hospital perioperative transfusion algorithm.
If patients who received aprotinin were to be included in model development, these patients received an effective intervention (no longer available for use) intended to reduce the chance of significant postoperative bleeding. Consequently, the early postoperative blood loss amongst these patients would inevitably underestimate the level of significant bleeding amongst a prospective cohort of patients. However, to assume that every patient given aprotinin would have bled to excess in the absence of the drug would result in overestimation of the level of significant bleeding amongst this patient cohort. To remove records where aprotinin was used would be to remove a group of patients deemed at sufficient risk of significant postoperative bleeding to warrant the use of a prophylactic treatment, potentially the very type of patient that the risk model would be used to identify.

The variability and time-dependence in the reported use of tranexamic acid presented a similar difficulty. If the use of tranexamic acid was universal amongst the patients who formed the development set, and if the intention was to apply the risk model to patients certain to receive tranexamic acid, there would not be any problem. However, there was an increasing reported use of tranexamic acid over the period of data collection.

Such considerations were taken account of in the development of the stratification model.

2.5. Statistical analysis

Before performing any analysis, 60% of the records were selected at random to form the model development dataset. The remaining 40% of records were set aside for use as a validation set for evaluating the final scheme. All analysis was performed in Statistical Package for Social Sciences (SPSS) version 12.0.1 (SPSS 12.0.1 for Windows, SPSS Inc., Chicago, IL, USA).

Each of the variables in the dataset was formally tested for univariate association with severe postoperative bleeding. Categorical variables were tested by comparing the mean blood loss between categories using a T-test. Continuous variables were tested for association using univariate linear regression and checking the resulting significance of the fit. Variables found significant ($p < 0.05$ under both equal and unequal variance assumptions) or borderline significant ($<0.05$ under one of unequal or equal variance assumptions) at univariate level were considered as candidate variables for multivariate analysis.

Multivariable logistic regression was used to select the final risk variables included in the model. To ensure that any model was robust, we conducted multivariate analyses in nine ‘scenarios’ with a view to using in further model development only those variables that appeared frequently enough over the scenarios. The scenarios considered were defined by the inclusion of different groups of patients according to use of tranexamic acid and by different ways of incorporating data concerning patients who received aprotinin. We chose a forward stepwise method to identify independent predictors of severe postoperative bleeding, with $p = 0.05$ chosen as the threshold level selected to indicate statistical significance for variables to be entered into and retained in the final model for each of the nine scenarios. We additionally performed the multivariate analyses including surgeon and anaesthetist IDs as potential risk factors. However, our intention was to develop a robust risk stratification tool for potential use in any cardiothoracic institution and, hence, these factors were not included in the final model.

Variables identified across several of the scenarios were transformed into binary variables and all combinations of these different risk factors were considered as an initial stratification scheme. The scheme was then simplified by combining combinations with similar bleeding outcomes.

3. Results

There were records on 11 592 patients who had cardiac surgery between 30th October 2000 and 17th October 2008, and 60% (6906 records) were used for the development of the model. The remaining 40% (4686 records) were used as a test set. Within the development set, there were 12 cases where the weight was not recorded and, in 81 cases, an end point was reached prior to the first measurement of blood loss being made (i.e., these patients received a transfusion within 20 min of arrival). The outcome measure of severe early blood loss could thus be calculated in 6813 of 6906 records (99%). There were no significant differences between the development and test datasets in terms of patient demographics.

Results of the logistic regression analyses across the nine scenarios identified a core group of factors consistently associated with severe postoperative bleeding. Different surgery types were flagged in each scenario, with coronary artery bypass grafting (CABG) surgery and single valve surgery consistently being associated with a lower risk of excessive bleeding. The other core variables identified were age, body mass index (BMI), the presence of aortic valve disease and the priority of the surgery. Five surgeons and no anaesthetists were identified as being associated with greater early postoperative blood loss. The surgeon ID was not included in the final model.

The continuous variables of age and BMI were converted to dichotomous variables to allow for a simple stratification scheme. The 75th centile for age over the entire dataset was 75 years. The median BMI was 27.2 kg m$^{-2}$ and the 25th centile was 24.5. To make stratification easy to implement, we chose a BMI cut-off value of 25 kg m$^{-2}$, corresponding to the threshold between people classified as ‘overweight’ and those classified as ‘normal’ weight [12]. The final risk factor table, along with the ‘score’ allocated to each variable considered in the final risk stratification, is shown in Table 1.

We examined the association between different combinations of risk factors and excessive blood loss, and found that

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Value 0</th>
<th>Value 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery priority</td>
<td>Elective</td>
<td>Urgent or emergency</td>
</tr>
<tr>
<td>Surgery type</td>
<td>CABG or single valve</td>
<td>All other surgery types</td>
</tr>
<tr>
<td>Aortic valve disease</td>
<td>None</td>
<td>Stenosis, regurgitation, both</td>
</tr>
<tr>
<td>BMI</td>
<td>BMI greater/equal to 25</td>
<td>BMI less than 25</td>
</tr>
<tr>
<td>Age</td>
<td>Younger than 75</td>
<td>75 years or older</td>
</tr>
</tbody>
</table>

Table 1. The Papworth Bleeding Risk Stratification Score table.
the number of risk factors present was more important than the precise combination of risk factors. The ordering in terms of the individual risk factors was not sufficient to warrant weighing them differently. Thus, we decided to allocate patients in the development set a score based simply on the number of risk factors they had (the right-hand column of Table 1). Consequently, each patient can score between 0 and 5. The proportion of patients exceeding the predetermined threshold of 2 ml kg⁻¹ h⁻¹ of blood loss can be calculated for each of the six different risk scores (Table 2).

In our development set, 7.5% (512/6813) of patients had severe postoperative bleeding as defined by our end point. There was an increased incidence of severe, early postoperative bleeding in patients with higher risk scores. Relatively few patients scored 4 or above on the risk score, with a clear difference in the proportion of patients bleeding excessively between the group scoring ≥3 and the group scoring ≤2. Consequently, a further division was made into ‘risk groups’, with those patients scoring ≥3 labelled as ‘high risk’, those scoring 1 or 2 as ‘medium risk’ and those scoring 0 labelled as ‘low risk’ of early postoperative bleeding (Table 3).

Our risk stratification model was then tested amongst the 4686 records set aside as a test set. In this set, 45 records were excluded as the patient had received a transfusion of cryoprecipitate, fresh-frozen plasma or cryoprecipitate before the initial measure of blood loss could be recorded, or because the patient’s weight was not available. Consequently, 4641 records remained for testing. Our risk stratification model was tested across the same nine scenarios used in the development of the initial model. The model performed extremely well, with clear and consistent stratification between the risk groups (Table 4 and Fig. 2). The larger confidence intervals in the right-hand-most group are due to the relatively small number of patients, who received neither aprotinin nor tranexamic acid.

4. Discussion

We have developed a simple, additive, easy to use, clinical stratification model, the Bleeding Risk Score (BRiSc) that enables preoperative stratification of patients into a low-, medium- or high-risk category of immediate postoperative bleeding. Its use could help inform the clinical decision of whether to administer a prophylactic drug or use a specific intervention in cardiac surgical patients or to identify a higher-risk cohort of patients for future evaluation of new prophylactic interventions.

4.1. The risks of transfusion and of therapies to reduce blood loss

Severe postoperative blood loss and red-blood-cell transfusion in patients undergoing cardiac surgery are strongly associated with increased morbidity and mortality. There is increased morbidity, increased hospital stay and higher hospital costs [3,13,14]. Severe postoperative bleeding has been shown to have a strong independent association with both early and late mortality [1—3,15,16]. Massive postoperative blood loss post-cardiac surgery has been associated with an eightfold increase in the odds of death [2]. The practice of red-blood-cell transfusion is itself associated with risks, including incompatibility immunosuppression, febrile reactions, transmission of blood-borne infections, sepsis and transfusion-related lung injury [14].

Table 2. Showing the groups by risk score, ranked according to proportion of patients in each group who exceed the blood loss threshold.

<table>
<thead>
<tr>
<th>Risk score</th>
<th>Proportion of patients exceeding the threshold of 2 ml⁻¹ kg⁻¹ h⁻¹ blood loss</th>
<th>Total number in group</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>27%</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>26%</td>
<td>282</td>
</tr>
<tr>
<td>3</td>
<td>19%</td>
<td>756</td>
</tr>
<tr>
<td>2</td>
<td>10%</td>
<td>1514</td>
</tr>
<tr>
<td>1</td>
<td>6%</td>
<td>2073</td>
</tr>
<tr>
<td>0</td>
<td>3%</td>
<td>2143</td>
</tr>
<tr>
<td>All groups</td>
<td>8%</td>
<td>6813</td>
</tr>
</tbody>
</table>

Table 3. Stratification of patients into three groups and summary statistics for each risk group for all patients in the development dataset.

<table>
<thead>
<tr>
<th>Risk group</th>
<th>Proportion of patients exceeding threshold of 2 ml⁻¹ kg⁻¹ h⁻¹ blood loss (95% confidence intervals)</th>
<th>Absolute numbers</th>
<th>Median (IQR) blood loss (ml⁻¹ kg⁻¹ h⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk</td>
<td>21% (18–23%)</td>
<td>226 (1083)</td>
<td>0.81 (0.43–1.60)</td>
</tr>
<tr>
<td>Medium risk</td>
<td>8% (7–9%)</td>
<td>287 (3587)</td>
<td>0.58 (0.32–0.95)</td>
</tr>
<tr>
<td>Low risk</td>
<td>3% (2–4%)</td>
<td>60 (2143)</td>
<td>0.46 (0.30–0.73)</td>
</tr>
<tr>
<td>All groups</td>
<td>8.5% (8–9%)</td>
<td>573 (6813)</td>
<td>0.54 (0.32–0.94)</td>
</tr>
</tbody>
</table>

IQR: interquartile range.

Table 4. Summary statistics for each risk group for all patients in the test dataset.

<table>
<thead>
<tr>
<th>Risk group</th>
<th>Proportion of patients exceeding threshold of 2 ml⁻¹ kg⁻¹ h⁻¹ blood loss (95% confidence intervals)</th>
<th>Absolute numbers</th>
<th>Median (IQR) blood loss (ml⁻¹ kg⁻¹ h⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk</td>
<td>21% (18–24%)</td>
<td>151 (729)</td>
<td>0.82 (0.42–1.67)</td>
</tr>
<tr>
<td>Medium risk</td>
<td>8% (7–10%)</td>
<td>209 (2480)</td>
<td>0.55 (0.33–0.92)</td>
</tr>
<tr>
<td>Low risk</td>
<td>3% (2–4%)</td>
<td>46 (1432)</td>
<td>0.47 (0.30–0.71)</td>
</tr>
<tr>
<td>All groups</td>
<td>9% (8–10%)</td>
<td>406 (4641)</td>
<td>0.54 (0.32–0.92)</td>
</tr>
</tbody>
</table>

IQR: interquartile range.
It has been shown in many settings that patients receiving more red-blood-cell transfusions have increased rates of sepsis and transfusion-related lung injury [3,13]. Therapies aiming at reducing blood loss may be expensive and may introduce a new risk [8—10,17,18], and should therefore only be targeted towards patients at the highest risk of severe postoperative bleeding. In other words, patients in the lower-risk category should not be exposed to unnecessary and potentially harmful interventions. For example, therapies such as recombinant factor VIIa have been shown to be effective in reducing severe postoperative blood loss [17], but their use in cardiac surgery remains 'off-label', they are very expensive compared with more conventional therapies and have been shown to have a significant risk of adverse thrombo-embolic events [17,18]. During the period of data collection for this study, evidence emerged that aprotinin, a therapy that had been widely employed to reduce severe postoperative bleeding, was associated with increased risk of renal failure, myocardial infarction and stroke [9,10]. Due to the association between aprotinin and serious end-organ damage, its continued use in the bleeding cardiac surgical patient was not felt to be prudent, and our institution adjusted its protocol accordingly.

Causes of postoperative bleeding may be surgical factors such as the quality of surgical haemostasis at sites of anastomoses [19] or non-surgical factors such as coagulopathy [14,20,21]. Studies have shown that surgical causes for bleeding may be found in up to 66% of patients re-explored for bleeding [22]. The morbidity and mortality associated with severe postoperative bleeding have been shown to be worse in patients where no surgical cause can be found for excessive postoperative blood loss [22].

4.2. The assessment of bleeding risk in the cardiac surgical patient

Previous authors have attempted to develop preoperative scoring of patients undergoing cardiac surgery to determine the risk of severe postoperative bleeding [4—7], but, thus far, no preoperative risk scoring system has been widely accepted and implemented. Many studies have used information available only postoperatively or genetic tests that are not widely available for all patients [7]. Although these studies may inform us of the reasons why patients bleed in the postoperative period, they fail to guide the clinician in the preoperative assessment of the bleeding risk.

Factors including old age, high preoperative creatinine, low preoperative haemoglobin, urgent surgery, low BMI, long cardiopulmonary bypass time, low intra-operative core temperature, large volumes of intra-operative salvaged cells transfused and multiple coronary anastomases have all previously been associated with an increased risk of severe postoperative bleeding [4—7,14,16,24].

The definition of what constitutes severe postoperative bleeding has also varied between studies, with several different markers being used as end points to define severe postoperative bleeding. These have included the volume of blood lost [4], number of units of red blood cells transfused [7] and need for surgical re-exploration [3,5]. The inherent subjectivity of such measures has always hindered the universal application of the scoring systems that they have produced. Previous studies have varied widely in their estimations of the risk of severe postoperative bleeding in cardiac surgical patients, with figures ranging from 2.7% to 29% [1—3,5—7,14,16,24]. Much of this variation may be due to variation in the definitions and end points used to represent severe postoperative bleeding.

4.3. Volume of blood transfused as a marker of severe postoperative bleeding

The number of units of red blood cells transfused in a set period has been extensively used as a marker of severe postoperative bleeding [2,6,7,16]. While a simple and easily available outcome measure, the practice of transfusion in the bleeding patient varies greatly between centres, with the rate of blood transfusion after cardiac surgery varying from 27% to 92% [14,25]. There remains no universally agreed haematocrit at which the benefit of transfusion outweighs the risk, with different protocols in place in different centres [25]. The decision to transfuse is observer dependent, with studies suggesting that 18% of decisions to transfuse may be inappropriate [13].

4.4. Re-exploration as a marker of severe postoperative bleeding

The need for surgical re-exploration has been used in several studies as a marker of severe postoperative bleeding [3—6,15]. Re-exploration is associated with increased morbidity and mortality [15], and its rate has been estimated at 3.1—4.5% [3—6,15]. The decision to return to theatre for re-exploration is also highly observer dependent and may be made for reasons other than blood loss. Indeed, previous studies have estimated that only 50% of surgical re-exploration is undertaken to investigate excessive surgical bleeding [23].

4.5. Volume of blood lost as marker of severe postoperative bleeding

Both total volume of blood lost and the rate of blood loss have been used to represent end points in assessing the risk of
severe postoperative bleeding [13]. Previous studies have used various measures of gross drainage to represent severe postoperative bleeding. We believe that by selecting the rate of bleeding per kilogram of bodyweight over the first 3 h of admission to the recovery area (cardiothoracic ICU), as a measure of early postoperative bleeding, reduces observer-dependent error, and is more applicable to the variable population undergoing cardiac surgery.

4.6. BRiSc Score

Our work identified 512 out of 6813 (7.5%) patients who reached the pre-decided end point that represents severe postoperative bleeding before 3 h had elapsed on the critical care unit. This is consistent with previous work, which has identified the risk of severe postoperative bleeding as being between 2.7% and 29% of cardiac surgical patients, dependent on study design and definitions of severe bleeding [1–3, 5–7, 16, 24]. Although the use of the rate of blood loss per kilogram of bodyweight reduces observer-dependent error, clinical estimates of blood loss are inherently unreliable even under closely controlled conditions [14]. However, we believe the outcome measure employed here is less subjective than others.

Our study looked at the rate of blood loss per kilogram of bodyweight over the initial 3 h following admission to the ICU. This involved assessment of the blood volume collected by mediastinal drains, and, consequently, was not able to capture and include patients who bled excessively in the operating theatre upon cessation of cardiopulmonary bypass. The ability to include intra-operative blood loss could potentially strengthen our model, but these data are not included in our database, and the precise estimation of intra-operative blood loss is problematic [19].

The operating surgeon had an impact on the rate of postoperative bleeding, but as the intention of our study was to develop a risk score that could be used preoperatively to assess the risk of severe postoperative blood loss in any centre, we did not augment our tool to account for the performance of individual surgeons.

Our model performs well in relation to the two main features that should be used to assess risk model strengths: calibration and discrimination [11]. Calibration is the accuracy of the model for predicting risk in a group of patients, in other words, if the model says that the risk of severe postoperative bleeding is likely to be 10%, and the actual rate of bleeding is 10% or close to it, then the model is well calibrated. Discrimination refers to the model’s ability to separate low-risk and high-risk groups of patients. In other words, if most of the severe bleeding occurs in patients that the model identifies as high risk, then the model discriminates well. When applying our model to the test dataset, there was a clear and consistent difference in the rates of postoperative blood loss between the different risk groups. Consequently, our model can be deemed to show good discriminative ability.

The BRiSc Score has been shown to accurately stratify patients into three groups with different risk of severe postoperative bleeding. While we feel our population of patients undergoing cardiac surgery is typical of that encountered in many specialist cardiac centres, institutional variation in clinical practice and transfusion guidelines may impact on the use of the scoring system. Further work and testing of our risk stratification score in different institutions is needed to confirm its external applicability and clinical utility.

5. Limitations

We have identified three main limitations to our work that may weaken the strength of our observation: (1) the cohort of patients in the historic dataset is not the same as the future cohort because of the change in the use of aprotinin and tranexamic acid; (2) we used data from only one hospital, and this score could perform differently in other settings; and (3) by its nature, the score excludes other intra-operative factors that may have a greater impact on bleeding. Despite these, we believe we have developed a simple and robust scheme.

6. Conclusion

The risk stratification score we have devised, BRiSc, is simple and effective, using readily available information to identify at an early stage a group of cardiac surgical patients at higher risk of severe postoperative bleeding. Evaluation of expensive and potentially high-risk therapies designed to reduce postoperative blood loss can then be targeted at a patient group more likely to receive benefit from the intervention. This score could also inform clinical protocols on the use of current prophylactic interventions.

References

The problem to predict which patient is going to present with severe bleeding after cardiac surgery has been intriguing surgeons and anaesthetists for several decades. It is a difficult task since different factors, both surgical and non-surgical, contribute to postoperative bleeding. Numerous studies have attempted to identify patient characteristics and biomarkers associated with excessive blood loss; however, so far, the value of a single factor and/or laboratory test to predict excessive bleeding in individual patients has not been proven. There have also been previous attempts to construct risk scores based on combinations of patient preoperative characteristics but none of the scoring systems has gained widespread use. It is important to underline that there is a huge discrepancy between different studies trying to identify patients with increased bleeding risk regarding, for example, study populations, definitions of blood loss, end points, sampling time points, local routine in surgical and anaesthetic procedures and statistical analysis, which makes comparisons and meta-analyses troublesome.

In the present edition of European Journal of Cardio-Thoracic Surgery, Vuylsteke and associates present a new stratification system for identifying cardiac surgery patients at risk of excessive early postoperative bleeding, the Papworth Bleeding Risk Score (BrISc) [1]. Based on the results from over 6800 patients, an additive score was constructed where points were given for surgery priority, surgery type, aortic valve disease, body mass index (BMI) and age. The patients were then divided into three groups: a low-risk group (0 points), a medium-risk group (1—2 points) and a high-risk group (3—5 points). The score was tested in nearly 5000 patients and the results clearly demonstrate that the BrISc score was able to separate groups of patients with different bleeding risks. The prevalence of bleeding complications was 3% in the low-risk group, 8% in the medium-risk group and 21% in the high-risk group.

However, while the negative predictive value was high (3% in the low-risk group developed severe postoperative bleeding), the positive predictive value was low. Only 21% of the patients who were rated high risk did in fact bleed severely. It is thus doubtful if the score can be used to guide prophylactic treatment in individual patients. Instead, the potential of the score lies most likely in identifying groups of patients with increased bleeding risk to be included in forthcoming studies with new hemostatic drugs or methods. By including only high-risk patients in the studies, the necessary number of patients can be markedly diminished which increases the chance to demonstrate group differences and reduces study costs.

The authors should be commended for their effort to construct a new score. The BrISc score’s risk factors are easy to understand and interpret, and the calculation of the score is simple and straightforward.

Keywords: Cardiac surgery; Bleeding; Risk stratification