The rationale for platelet transfusion during cardiopulmonary bypass: an observational study

Justification de la transfusion de plaquettes pendant la circulation extracorporelle: une étude observationnelle

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Abstract

Purpose Platelet transfusion in cardiac surgery is often empiric as no established point-of-care tests are available for clear guidance of blood product administration, and there are many variables that can potentially increase the risk of bleeding during cardiopulmonary bypass. The objectives of this study were to determine the factors that influenced physicians' decisions to transfuse platelets perioperatively and to determine whether these factors coincide with characteristics using chart abstraction.

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Methods This study was conducted at three university affiliated hospitals using focused physician questionnaires to assess factors influencing decisions to transfuse platelets and data abstraction to determine characteristics of patients receiving platelet transfusion during cardiac surgery.

Results Seventy-six physicians participated in the questionnaire; 41% identified bleeding and 22% identified both bleeding and the platelet count as the most significant factors influencing their decision to transfuse platelets. Of the 629 patients included in the study, 24.5% received a platelet transfusion intraoperatively and 4.5% received the transfusion postoperatively. The following factors were identified with the highest odds of receiving a platelet transfusion intraoperatively: combined bypass and valvular surgery (odds ratio [OR] 3.94; 95% confidence interval [CI] 1.94 to 8.00) and the presence of liver disease (OR 6.43; 95% CI 1.17 to 35.37).

Conclusion The use of focused physician questionnaires identified relevant aspects of patient care not apparent in the chart review that influenced the decision to transfuse platelets. The identification of bleeding, thrombocytopenia, more complex surgery, and the presence of liver disease

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highlights the requirement for standardized measures to assess the need for platelet transfusions in bleeding patients.

Résumé

Objectif En chirurgie cardiaque, la transfusion de plaquettes se fait souvent de façon empirique; en effet, aucun test reconnu n'est disponible au chevet du malade afin de guider clairement l'administration de produits sanguins. En outre, il existe de nombreuses variables qui peuvent potentiellement augmenter le risque de saignement pendant la circulation extracorporelle. Les objectifs de cette étude étaient de déterminer les facteurs influençant les décisions des médecins de transfuser des plaquettes en période périopératoire et de déterminer si ces facteurs concordent avec des caractéristiques tirées des dossiers des patients.

Méthode Cette étude a été réalisée dans trois hôpitaux universitaires à l'aide de questionnaires ciblés destinés aux médecins afin d'évaluer les facteurs influençant la décision de transfuser des plaquettes; de plus, nous avons tiré des données des dossiers des patients pour déterminer les caractéristiques des patients recevant des plaquettes en transfusion pendant une chirurgie cardiaque.

Résultats Soixante-seize médecins ont répondu au questionnaire; 41 % ont identifié les saignements et 22 % les saignements et la numération plaquettaire comme les facteurs les plus importants influençant leur décision de transfuser des plaquettes. Parmi les 629 patients inclus dans l'étude, 24,5 % ont reçu une transfusion de plaquettes pendant l'opération et 4,5 % en postopératoire. Les facteurs suivants ont été identifiés avec la probabilité la plus forte de recevoir une transfusion de plaquettes pendant l'opération: pontage et chirurgie valvulaire combinés (rapport de cotes [RC] 3,94; intervalle de confiance [IC] 95 % 1,94 à 8,00) et présence de maladie hépatique (RC 6,43; IC 95 % 1,17 à 35,37).

Conclusion L'utilisation de questionnaires ciblés auprès des médecins a permis d'identifier des aspects pertinents

des soins aux patients qui n'étaient pas apparents dans l'évaluation des dossiers et qui ont influencé la décision de transfuser des plaquettes. L'identification de saignements, de thrombocytopénie, de chirurgie complexe et la présence de maladie hépatique souligne le besoin de mesures standardisées pour évaluer le besoin de transfusions plaquettaires chez les patients qui saignent.

Patients undergoing cardiopulmonary bypass (CPB) often require perioperative platelet transfusion¹ since platelet-related defects are thought to be the most important hemostatic abnormality leading to impaired hemostasis and microvascular bleeding.² Thus, platelets are often transfused pre-emptively for bleeding, as clear indications for platelet transfusion have not been determined and the use of point-of-care testing to guide transfusion of hemostatic products is neither well established nor widely available.

Platelet use in cardiac surgery is high, variable, accounts for 20% of all platelet transfusions, and is second only to malignancy for total utilization rates.³ The rate of platelet transfusion in Canada ranges from 12-50% and internationally from 0-90%,⁴⁻⁸ reflecting the uncertainty of when to transfuse platelets.

Transfusion of platelets, like any other blood product, has been associated with significant morbidity and mortality.^{9,10} In addition, there has been conflicting evidence in the literature as to whether platelet transfusion in patients undergoing CPB is associated with additional morbidity aside from well-known transfusion risks. A retrospective analysis of randomized controlled trials of 1,700 patients treated with aprotinin suggests that platelet transfusion is associated with increased vasopressor use, stroke (odds ratio [OR] 2.56; 95% confidence interval [CI] 0.99 to 6.67), respiratory medication use, and death (OR: 4.7; 95% CI 1.65 to 13.73).¹¹ On the contrary, a study of 11,459 patients did not show that platelet transfusion is associated with increased adverse events.⁶

Several studies have attempted to identify factors associated with platelet transfusion in these patients. Variables consistently found to be associated with an increased rate of platelet transfusion include older age, previous cardiac surgery, bleeding, preoperative use of anti-platelet agents, and the platelet count.¹²⁻¹⁴ Other factors that have been found to be associated with a higher rate of transfusion include duration of CPB, the preoperative hemoglobin concentration, the preoperative creatinine level, and preoperative heart failure.¹² The indications for platelet transfusion during cardiac surgery need to be clarified as currently there are no definitive indications for platelet transfusion, and a high proportion of patients are being exposed to the adverse events of transfusion due to a high

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utilization of platelet transfusions in cardiac surgery. The objectives of this study were to determine the factors that influenced physicians' decisions to transfuse platelets perioperatively to patients undergoing cardiac surgery and to determine whether these factors coincide with characteristics found to be associated with platelet transfusion using chart abstraction.

Methods

This study involving 1) focused physician interviews using a semi-structured questionnaire and 2) chart abstraction was conducted at three university affiliated hospitals over a three-month period in 2010 and 2011. These three hospitals conduct approximately 4,000 cardiac surgeries each year. This study was approved in July 2010 by the University Health Network Research Ethics Board, the Research Ethics Board of Sunnybrook Health Sciences Centre, and St. Michael's Research Ethics Board. The research ethics boards at Sunnybrook Health Sciences Centre and the University Health Network waived the requirement for patient consent.

To determine the factors that influence physicians' decisions to transfuse platelets to patients undergoing CPB (for coronary artery bypass surgery [CABG], valvular surgery, combined bypass and valve surgery), we contacted a convenience sample of anesthesiologists and cardiac surgeons within 24 hr after they administered a platelet transfusion for any of these procedures. Consecutive patients who received a platelet transfusion preoperatively, intraoperatively, or postoperatively were identified by the Transfusion Medicine Laboratory at each site. To ensure accurate recall, each physician who transfused platelets was interviewed within 24 hr of ordering a platelet transfusion. Physicians were not interviewed when platelets were administered to patients with a platelet count less than $50 \times 10^9 \text{ L}^{-1}$ as platelet transfusions were considered appropriate for these patients. Physicians could be interviewed more than once if they transfused platelets to different patients or to the same patient but in a different setting (e.g., an intraoperative setting vs a postoperative setting).

We developed a questionnaire containing partially closed-ended questions (i.e., questions with preselected categories with an opportunity to select an "other" option) (Appendix). Four physicians who were not part of the investigational group assessed the questionnaire for face and content validity, comprehensibility, time to completion, ambiguity, and the range of responses. The questionnaire was subsequently piloted using another group of five physicians (two cardiac surgeons and three anesthesiologists), and their suggestions for modification were included in the final questionnaire. The questionnaire incorporated questions

about physician characteristics, the hospital setting for the platelet transfusion (preoperative, intraoperative, or postoperative), and factors that could potentially affect the physician's decision to transfuse platelets, i.e., the platelet count, bleeding (rate and volume), type of surgery, preoperative use of antiplatelet agents, hemodynamic instability, results of thromboelastography, renal function, and duration of CPB. The factors were selected from a literature search,¹¹⁻¹⁴ from consultation with experts in cardiac surgery, and from the pilot study. The physicians were asked to choose factors from this list that influenced their decision to transfuse platelets and to rank the factors in order of importance. Physicians also had the option of selecting a combination of factors.

During the three-month study period, we collected data on all patients undergoing CPB to determine the characteristics of patients who received a platelet transfusion. Patients undergoing CPB and included in the study were identified from the surgical lists in each hospital. The following characteristics were collected: age, sex, the type of surgery (primary CABG, combined bypass and valvular surgery, emergent/urgent or elective surgery, repeat surgery), preoperative use of anti-platelet agents (acetylsalicylic acid [ASA], thienopyridines, abciximab), whether or not a platelet transfusion was administered, the perioperative setting for platelet transfusion (preoperative, intraoperative, postoperative), the platelet count at which each unit was transfused, the presence of liver and renal insufficiency, the presence of bleeding (defined by volume of blood loss intraoperatively and from the drainage of the chest tube), and duration of CPB. Liver disease and renal disease were defined according to the modified Charlson comorbidity score.¹⁵ Liver disease was defined as severe (i.e., patients with cirrhosis, portal hypertension and a history of variceal bleeding), moderate (i.e., cirrhosis with portal hypertension without bleeding), or mild (i.e., cirrhosis without portal hypertension or chronic hepatitis). Renal insufficiency was defined as severe (i.e., dialysis) moderate (i.e., a serum creatinine $> 265 \mu\text{mol/L}$) or mild (i.e., a serum creatinine between 117 to $265 \mu\text{mol/L}$). The highest serum creatinine postoperatively was used to classify patients. Drainage from the chest tube was estimated from the time the chest tube was inserted to the time it was removed.

The factors selected to characterize patients who received a platelet transfusion were identified from the literature and by expert opinion.¹²⁻¹⁴ Five percent of the charts were re-abstracted for validation of data entry.

Statistical analysis

Continuous variables were described as mean (standard deviation) or medians (interquartile range) if the data were

heavily skewed. Categorical variables were described as numbers and percentages. To determine the characteristics associated with platelet transfusion, univariate analyses (Chi square or the Fisher's exact test for categorical variables and the Student's *t*-test, Wilcoxon rank-sum, or Kruskal-Wallis test for continuous variables) were performed. Multivariable logistic regression models were used to identify predictors of platelet transfusion for intraoperative and combined intraoperative and postoperative settings. Variables included in the models were analyzed as continuous (the platelet count, duration on CPB, blood loss, duration in the intensive care unit), categorical (type of surgery, renal failure, liver disease), or binary (use of ASA, use of thienopyridines, use of abciximab). The reference group for the surgical variable was elective CABG surgery. Due to an insufficient sample size, multivariable analysis was not performed to characterize patients who received postoperative platelet transfusion. There were only ten patients who had a reoperation; consequently, reoperation was not used as a covariate in the models. Those variables found to be significant ($P < 0.1$) on univariate analysis were included in the regression models. For ease of interpretation, odds ratios and 95% confidence intervals for platelet count, blood loss volume, CPB duration, and chest tube drainage were estimated considering change in units of $25 \times 10^9 \text{ L}^{-1}$, 500 mL, 30 min, and 500 mL, respectively. The c-statistic and the Hosmer-Lemeshow test were used to assess the discriminative ability of the logistic regression analysis. The significance level for the multivariable analysis was otherwise set at $P < 0.05$ for all other statistical analyses.

Results

Questionnaire

One hundred and thirteen platelet transfusion episodes occurred in the three-month study period for the questionnaire. Physicians were willing to be interviewed in 76 (67.2%) of these events, and the preponderance of respondents were anesthesiologists ($n = 71$). The mean (standard deviation) age of the physicians was 45.1 (8) yr. Physicians were in practice a mean of 16.5 (8) yr. Seventeen percent of physicians were in practice less than ten years, 43% were in practice 10–19 yr, and 33% were in practice 20–31 yr.

In 41% of the events, physicians identified bleeding as the most important factor in influencing their decision to transfuse platelets, and in 22% of the events, physicians identified bleeding in the presence of thrombocytopenia as being the most significant factor. Other highly ranked aspects were the type of surgical procedure and the preoperative use of anti-platelet agents. Thrombocytopenia was

never ranked as a factor influencing platelet transfusion in the absence of bleeding. During only one transfusion episode, a physician identified coagulopathy as influencing his/her decision to transfuse platelets. Thromboelastography results, available at two of the three hospitals, were not identified frequently or as a major reason to transfuse platelets.

Data abstraction

Fig. 1 depicts the flow diagram of the cohort of patients included in the data abstraction aspect of the study to analyze characteristics of patients who received a platelet transfusion. Of the 677 patients assessed for eligibility, 629 (92.9%) were included, and only 138 (21.9%) of those received a platelet transfusion intraoperatively. Twelve (1.9%) patients received a platelet transfusion in the postoperative setting, and 16 (2.5%) received both intra- and postoperative transfusions. Table 1 shows a comparison between the characteristics of patients who received a platelet transfusion and those who did not. The age of patients was similar between the groups as was the proportion of men undergoing CPB.

Patients who received a platelet transfusion had lower platelet counts ($P < 0.0001$), a higher prevalence of liver disease ($P = 0.025$), more valvular surgeries (primary and combined valvular and CABG surgery), and experienced more blood loss intraoperatively and postoperatively ($P < 0.0001$). Patients who received a transfusion did not receive ASA or thienopyridines more frequently than patients who did not receive a transfusion. Of 218 patients

Fig. 1 Flow diagram of patients with coronary artery bypass surgery assessed for eligibility

Table 1 Characteristics of patients undergoing coronary artery bypass surgery

Characteristics	Patients receiving platelet transfusion (<i>n</i> = 166)	Patients not receiving platelet transfusion (<i>n</i> = 463)	<i>P</i> -value
Age (yr), mean (SD)	64.7 (13.5)	64.6 (12.5)	0.92
Male sex, <i>n</i> (%)	114 (69)	347 (75)	0.12
Preoperative platelet count (10^9 L^{-1}), mean (SD)	202.0 (64.2)	228.2 (67.2)	<0.0001
Preoperative liver disease (mild/none), <i>n</i> (%)	6 (4)/160(96)	4(1)/459(99)	0.02
Preoperative renal failure (none/mild/moderate/severe), <i>n</i> (%)	143(86)/17(10)/2(1)/4(3)	415(90)/40(9)/2(0.4)/5(1)	0.30
Preoperative use of ASA, <i>n</i> (%)	78 (47)	265 (57)	0.02
Preoperative use of thienopyridines, <i>n</i> (%)	31 (19)	187 (40)	<0.0001
Preoperative use of abciximab, <i>n</i> (%)	1 (0.6)	8 (1.7)	0.46
Type of Surgery*			
Elective primary CABG, <i>n</i> (%)	36 (22)	210 (45)	<0.0001
Elective valvular surgery, <i>n</i> (%)	61 (37)	134 (29)	
Elective combined surgery, <i>n</i> (%)	36 (22)	31 (7)	
Emergent surgery <i>n</i> (%)	33 (20)	88 (19)	
Intraoperative blood loss (mL), mean (SD)	1,077.1 (985.7)	626.0 (498.3)	<0.0001
Duration of CPB (min), mean (SD)	146.5 (66.2)	98.0 (43.8)	<0.0001
Chest tube drainage (mL), mean (SD)	1,049.2 (717.9)	585.3 (433.6)	<0.0001
Days in the ICU, mean (SD)	5.96 (7.02)	3.04 (2.23)	<0.0001

SD = standard deviation; ASA = acetylsalicylic acid; CABG = coronary artery bypass surgery; CPB = cardiopulmonary bypass; ICU = intensive care unit. * Ten patients had reoperations

who had received thienopyridines, 55.1% had elective CABG surgery compared with 20.6% who had valvular surgery. Less than 2% of all patients received abciximab. There was no difference in the proportion of patients with renal insufficiency.

The mean CPB time for the 166 patients who received a platelet transfusion was 50 min longer than that of patients who did not receive a transfusion. The mean volume of blood loss as measured by intraoperative blood loss and mean chest tube drainage was approximately 500 mL more in patients who received platelet transfusion, and these patients spent an average of three days longer in the intensive care unit. Physicians in the two hospitals using thromboelastography administered 8% and 65% of the intraoperative platelet transfusions, whereas physicians in the hospital not using thromboelastography administered 27% of the intraoperative platelet transfusions.

Most preoperative platelet counts were above $100 \times 10^9 \text{ L}^{-1}$. Only four patients had a platelet count of $75\text{--}100 \times 10^9 \text{ L}^{-1}$, and no patient had a preoperative platelet count $< 50 \times 10^9 \text{ L}^{-1}$.

The platelet counts at which a platelet transfusion was administered are illustrated in Fig. 2. The platelet count immediately prior to the transfusion was considered the platelet trigger for that transfusion. Most of the platelet transfusions (40.3%) in the intraoperative setting were administered at a platelet count of $101\text{--}150 \times 10^9 \text{ L}^{-1}$.

Fig. 2 The proportion of platelet transfusions according to platelet count in the intraoperative setting

One of the four patients who had a preoperative platelet count of $\leq 100 \times 10^9 \text{ L}^{-1}$ preoperatively received an intraoperative platelet transfusion, while 45.7% of patients with a platelet count of $101\text{--}150 \times 10^9 \text{ L}^{-1}$ received a platelet transfusion intraoperatively (data not shown).

The association between the preoperative platelet count and intraoperative blood loss is described in Table 2. Patients with higher preoperative platelet counts had less intraoperative blood loss than patients with lower counts. There were only four patients who had a platelet count of $\leq 100 \times 10^9 \text{ L}^{-1}$, so there did not appear to be a

Table 2 The association between preoperative and intraoperative platelet count and intraoperative blood loss

Platelet count ($\times 10^9 \text{ L}^{-1}$)	Intraoperative blood loss (mL)	
	<i>n</i>	Median (interquartile range)
<i>Preoperative</i>		
0-100	4	575 [850]
101-150	73	700 [400]
151 or more*	516	500 [300]
<i>Intraoperative (n)</i>		
No platelet transfusion	448	500 [300]
0-100**	70	800 [650]
100-150**	59	800 [550]
151 or more***	16	950 [780]

* $P = 0.0099$ when compared with $101-150 \times 10^9 \text{ L}^{-1}$ preoperative platelet count; ** $P < 0.0001$ when compared with no platelet transfusion. *** $P = 0.05$ when compared with no platelet transfusion. All other comparisons were not statistically significant

difference in blood loss compared with patients with higher platelet counts. For patients who received a platelet transfusion intraoperatively, intraoperative blood loss was higher than that of patients who did not receive a platelet transfusion; however, the platelet count at the time of the platelet transfusion was not associated with the degree of intraoperative blood loss.

Multivariable analysis indicated that the odds of receiving platelets were highest for patients undergoing combined CABG/valvular surgery, for patients with mild preoperative liver disease, and for those undergoing emergent surgery (Table 3). On both univariate and

multivariable analysis, lower preoperative platelet counts were found to be associated with increased platelet transfusion, whereas the use of preoperative ASA and elective valvular surgery were no longer significant in multivariable analysis. The odds of receiving a platelet transfusion were somewhat increased in patients with longer duration of CPB and those with intraoperative blood loss. Thienopyridines were also not associated with an increased risk of platelet transfusion. Perioperative platelet transfusion was also associated with excess chest tube drainage (Table 3). Both models yielded excellent discrimination between patients receiving and not receiving transfusions (c-statistic > 0.80) and fit the data well (Hosmer-Lemeshow goodness-of-fit P -value > 0.05).

Discussion

By using focused physician interviews and analysis of patient and operative characteristics associated with platelet transfusion, this study aimed to direct future studies on determinants of the need for platelet transfusion during cardiac surgery. Concurrent with the results of our and other observational studies, physicians identified bleeding as the most important factor in influencing their decision to transfuse platelets, which coincides with the belief that microvascular bleeding is thought to be predominantly secondary to platelet dysfunction^{2,16} and consistent with recommendations regarding when to transfuse platelets.¹⁷ This finding supports the need for point-of-care tests to identify whether bleeding is mainly secondary to thrombocytopenia, particularly as physicians identified the

Table 3 Multivariable analysis of characteristics associated with platelet transfusion

Characteristics	Intraoperative platelet transfusion adjusted OR (95%CI)	Perioperative platelet transfusion adjusted OR (95%CI)
Preoperative platelet count (in units of $25 \times 10^9 \text{ L}^{-1}$)	0.89(0.82 to 0.98)	0.91(0.83 to 1.00)
Combined valvular/CABG*	3.94(1.94 to 8.00)	4.23(2.01 to 8.88)
Elective valvular surgery	1.32(0.73 to 2.39)	1.57(0.84 to 2.92)
Emergent surgery	1.92(1.01 to 3.65)	1.84(0.94 to 3.58)
Mild preoperative liver disease	6.43(1.17 to 35.37)	6.70(1.20 to 37.49)
Preoperative ASA	0.90(0.56 to 1.45)	0.86(0.53 to 1.41)
Preoperative thienopyridines	0.44(0.26 to 0.76)	0.51(0.29 to 0.88)
Intraoperative blood loss (in units of 500 mL)	1.35(1.11 to 1.64)	1.29(1.05 to 1.59)
Duration of CPB (in units of 30 min)	1.49(1.30 to 1.70)	1.43(1.24 to 1.65)
Postoperative chest tube drainage (in units of 500 mL)	-	2.14(1.62 to 2.82)

*The reference group is CABG. Intraoperative regression model: Wald test $P < 0.0001$, $C = 0.81$; Hosmer and Lemeshow goodness-of-fit test, $P = 0.32$. Perioperative regression model: Wald test $P < 0.0001$, $C = 0.86$; Hosmer and Lemeshow goodness-of-fit test, $P = 0.22$. OR = odds ratio; CI = confidence interval; CABG = coronary artery bypass surgery; ASA = acetylsalicylic acid; CPB = cardiopulmonary bypass

preoperative use of anti-platelet agents and the type of surgical procedure as influencing their decision to transfuse platelets. The selection of surgical procedure as influencing platelet transfusion decisions also coincides with results from our and other observational studies¹⁸ and was associated with a high odds of receiving a platelet transfusion (OR 4.65; 95% CI 2.10 to 9.45), second only to liver disease. As more complex procedures are being conducted, an increase in platelet utilization may occur as these procedures are associated with prolonged exposure of platelets to CPB resulting in platelet dysfunction.¹⁹

An interplay of factors influenced the decision to transfuse platelets as physicians did not identify that the platelet count alone influenced their decision to transfuse platelets; rather, they indicated that thrombocytopenia in the presence of bleeding influenced them to transfuse platelets. In addition, although the platelet count was also considered to be a factor in platelet transfusion, not all patients with a low platelet count received a platelet transfusion (i.e., 54% of patients with a platelet count of $100\text{--}150 \times 10^9 \text{ L}^{-1}$ received platelets), suggesting an interplay of factors influencing the decision to transfuse.

Though point-of-care testing is available in two of three centres used in this study, it was not used routinely as a guide to platelet transfusion. This may be because point-of-care testing is not well established for the assessment of bleeding in cardiac surgery as it has not been subjected to the same quality assessment measures as central laboratory-based testing and may not be undertaken by trained personnel.²⁰ The lack of routine use of thromboelastography may also be due to lack of adequate funding for routine use.

We did not find age or the use of thienopyridines to be associated with platelet transfusion rates (although physicians frequently identified the use of anti-platelet agents as a factor in their decision to transfuse platelets), which is discordant with previous studies.^{13,18} Age was similar in both patient populations; thus, the effect of older age could not be shown. As this was an observational study, the lack of significant effect of thienopyridines may be due to confounding variables that were not controlled or perhaps due to the fact that patients receiving thienopyridines had elective CABG surgery which is not associated with as high a risk of bleeding as, for example, valvular surgery.

There are some limitations to this study. We did not collect data on coagulation parameters or the hemoglobin concentration as coagulopathy may result in platelet transfusion, and anemia is thought to be associated with a higher risk of bleeding. Nevertheless, during the pilot study and the physicians' interviews, coagulopathy was identified by only one physician as affecting his/her decision to transfuse platelets, and anemia was not identified as a factor that influenced platelet transfusion. The

sample size was not predetermined to estimate significance of all the variables selected, and thus, some variables may not have been characterized as significant. Still, the c-statistic of our models, 0.81 and 0.86, represent excellent discrimination, and the Hosmer and Lemeshow test indicated that the models were well calibrated.²¹ A preponderance of responses to the questionnaire were from anesthesiologists and may not be considered reflective of a cardiac surgeon's decision to transfuse. Even so, bleeding was the primary factor that influenced the decision to transfuse platelets, which suggests that the decision to transfuse platelets was a shared decision between the anesthesiologist and cardiac surgeon. The 67% response rate to our questionnaire raises the possibility of non-response bias, i.e., the response from respondents may be different from the response from non-respondents. Nevertheless, the answers from the questionnaire were consistent, and the 67% response rate indicates that all estimates have a precision of plus or minus 10%.²²

The use of physician interviews enhanced the observational study by emphasizing relevant aspects of care that may not be easy to measure using observational study designs such as blood loss. Bleeding was cited by physicians as the most significant factor influencing their decision to transfuse platelets, yet the association between bleeding and platelet transfusion was not as significant in the chart abstraction aspect of the study. Bleeding, particularly during cardiac surgery, is difficult to measure. The use of physician interviews using non-simulated patients rather than case-based simulations also ensures that physician responses are indicative of physician behaviour. In addition, as observational studies in this patient population are particularly problematic due to the large number of confounding variables that cannot be overcome regardless of sophisticated analyses, i.e., more seriously ill patients receive more transfusions (confounding by indication bias),²³ the use of physician interviews corroborates the results of the observational study.

The two-step approach used in this study to determine the rationale for platelet transfusion in patients undergoing CPB is significant because the results show that observational studies may not be capturing the importance of specific factors (e.g., the extent that bleeding influences the rationale for platelet transfusion). Furthermore, the identification of bleeding as the major factor for platelet transfusion and the difference between the results of the questionnaire and the chart abstraction advocate for the development of validated standardized measures to assess perioperative bleeding, such as those used in previous studies,²⁴ and for point-of-care testing to ensure that the cause of bleeding is indeed secondary to platelet dysfunction so that the benefits of platelet transfusion balance the risks of transfusion.

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Conflicts of interest None declared.

Appendix: Questionnaire

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APPENDIX: The Questionnaire

Hospital

- ☐ St. Michael's
- ☐ Sunnybrook Health Sciences Centre
- ☐ Toronto General Hospital

When were platelets transfused (Check all that apply);

- ☐ Preoperatively
- ☐ Intraoperatively
- ☐ Postoperatively in the operating room
- ☐ Postoperatively in the intensive care unit

Demographics

Years in Practice

Specialty (check one)

- ☐ Anesthesia
- ☐ Cardiac Surgery
- ☐ Anesthesia resident
- ☐ Cardiac surgery resident
- ☐ Other: _____ (specify)

Age (years)

What are the most important factors that influenced you to transfuse this patient. RANK all that apply. The most important factor is ranked 1, the second most important factor is ranked 2, etc. If two factors were equivalent in influencing your decision, rank each the same number.

- ☐ Platelet count_____
- ☐ Bleeding: Specify if it was the rate or volume or both that affected your decision.
- ☐ Rapidity: State the rate_____mL/min
- ☐ Volume: State volume_____ mL
- ☐ Type of surgery if yes, what was the type of surgery
- ☐ Urgent
- ☐ Emergent
- ☐ Prior heart surgery
- ☐ Valve
- ☐ CABG
- ☐ Other
- ☐ Preoperative use of anti-platelet agent
- ☐ No
- ☐ Yes
- If yes, which anti-platelet was used.
- ☐ Aspirin
- ☐ Clopidogrel
- ☐ Abciximab (Rheopro)
- ☐ Other
- If yes, what was the dose of the antiplatelet agent_____
- If yes, when was it discontinued_____ (days before surgery)
- ☐ Hemodynamic instability
- ☐ TEG result
- ☐ Renal function
- ☐ Duration on bypass
- ☐ Other: Please specify_____

Any other comments

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