

Thromboelastography-Based Transfusion Algorithm Reduces Blood Product Use after Elective CABG: A Prospective Randomized Study

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ABSTRACT ***Objective:*** **Bleeding and allogeneic transfusion remain constant problems in cardiac surgical procedures. In this study, we aimed to test the role of a routine thromboelastography (TEG)-based algorithm on bleeding and transfusions in patients undergoing elective coronary artery bypass grafting (CABG).** ***Methods:*** **Patients (n = 224) undergoing elective CABG with cardiopulmonary bypass were prospectively randomized into two groups according to transfusion strategy: in group 1 (clinician-directed transfusion, n = 110) need for blood transfusion was based on clinician's discretion and standard coagulation tests and in group 2 (TEG algorithm group, n = 114) kaolin-activated (k) TEG-based algorithm-guided perioperative transfusion management. Transfusion, blood loss, and outcome data were recorded.** ***Results:*** **There were no differences in consumption of packed cell units, blood loss, re-exploration for bleeding, and early clinical outcome between the groups. Patients in the TEG group had significantly lower median units of fresh frozen plasma and platelets compared with the other group (p = 0.001). The median number of total allogeneic units transfused (packed cells and blood products) was significantly reduced in the TEG group compared with the other group (median 2, range 1–3 units vs. median 3, range 2–4 units, respectively, p = 0.001). The need for tranexamic acid was significantly diminished in the TEG group compared with the other group (10.3% vs. 19%, respectively, p = 0.007).** ***Conclusion:*** **Our results show that routine use of a kTEG-guided algorithm reduces the consumption of blood products in patients undergoing elective CABG. Adopting such an algorithm into routine management of these patients may help to improve clinical outcome and reduce the potential risks of transfusion-related complications and total costs after CABG.**
doi: 10.1111/j.1540-8191.2009.00840.x *(J Card Surg 2009;24:404-410)*

Cardiac surgery with cardiopulmonary bypass (CPB) causes severe derangements in hemostatic system, which in turn put the patient at risk for microvascular bleeding (MVB). It has been reported that 11% of patients have excessive bleeding after CPB, and the reason in most of these cases was found to be nonsurgical.[1,2] Excessive transfusion and re-exploration are potentially associated with a number of adverse outcomes such as blood-borne infections, transfusion reactions, respiratory dysfunction, increased cost, renal failure, and mortality after cardiac surgery.[1,3-5]

Thrombelastography (TEG), as a point-of-care testing, evaluates the hemostatic system globally and enables one to interrogate different components of hemostatic system individually.[6] Current evidence suggests that incorporation of TEG analysis into perioperative management has further refined the efficacy of blood conservative strategies to higher levels in terms of transfusions and total costs, especially in patients at higher risk for bleeding after cardiac surgery.[7-10] Currently, routine use of transfusion algorithms has not been extensively accepted in cardiac surgical practice, and their application is mostly reserved for patients undergoing high-risk surgical procedures for bleeding.[7,8] However, it is now well known that even patients undergoing elective routine coronary artery bypass grafting (CABG) consume a considerable amount of blood and blood products.[11] In this prospective study, we hypothesized that simple and routinely used kaolin-activated TEG (kTEG)-based transfusion algorithm would decrease the need for allogeneic blood exposure and blood loss in patients undergoing conventional CABG. We investigated the effect

Disclosure statement: All authors declare that there is no conflict of interest to be disclosed.

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TABLE 1
Modified Version of the TEG-Based Transfusion Algorithm Proposed by Royston and Kier[8]

TEG Parameter		Treatment
$14 < r < 21$ (mm)	Mild deficiency in coagulation factors*	1 unit FFP
$21 \leq r < 28$ (mm)	Moderate deficiency in coagulation factors*	2 units FFP
$r \geq 28$ (mm)	Severe deficiency in coagulation factors*	4 units FFP
$40 \leq MA < 48$ (mm)	Moderate deficiency in the number/function of platelets	1 unit¥ platelets
$MA < 40$ (mm)	Severe deficiency in the number/function of platelets	2 units platelets
$LY30 > 7.5$ (%)	Exaggerated fibrinolysis	TA

FFP = fresh frozen plasma; TA = tranexamic acid.
*If the r time on the h-kTEG was less than one-half of the nonheparinase r time on the kTEG; ¥ represents single-donor platelets obtained by apheresis are the equivalent of approximately six platelet concentrates.

of the algorithm on the amount of blood and blood products consumed perioperatively, mediastinal chest tube drainage (MCTD), and clinical outcome after CABG with CPB.

PATIENTS AND METHODS

After obtaining approval to conduct the study from the local ethics committee and written informed consent from each patient, 224 consecutive patients undergoing elective first-time CABG were enrolled into the study. A power analysis revealed that a sample size of 80 patients in each group has an 80% power to detect a risk reduction of 50% in the proportion of patients receiving packed red blood cells (PRBCs) and blood products including fresh frozen plasma (FFP) and platelets with a significance level (alpha) of 0.05 (two-tailed). Exclusion criteria for the study were preoperative hemodynamic instability, malignancies, history of bleeding diathesis, use of low-molecular-weight heparin molecules until the day of operation, and recent treatment (<5 days) with a glycoprotein IIb/IIIa antagonist or clopidogrel. Also, patients with impaired renal function (creatinine >2 mg/dL) and any liver disease resulting in elevated liver function tests were excluded. According to transfusion strategy, patients were prospectively randomized to either clinician-directed transfusion group (group 1, CDT, n = 110) or TEG-based algorithm group (group 2, TEG, n = 114).

In the CDT group, the decision for blood product (platelet suspension and/or FFP) was determined by using the criteria obtained from abnormal conventional laboratory tests, absence of visible clots, and presence of generalized oozing-type bleeding in the surgical field. Platelet suspension was ordered if the platelet count was less than 100,000/μL. FFP was given if the prothrombin time (PT) was over 14 seconds or activated partial thromboplastin time (APTT) was >1.5× normal. After complete neutralization of systemic heparin, an additional dose of protamine sulfate was given according to the control activated clotting time (ACT) values (25 mg if the ACT was between 120 and 150 seconds or 50 mg if it was over 150 seconds). In this group, the appropriate amount of blood products was judged according to the clinical discretion of the anesthesiologist responsible for the postoperative care of the patient. In the TEG group, we used the modified version of the transfusion algorithm previously proposed by Royston and Kier[8] in which tranexamic acid (TA) is used instead of aprotinin as an antifibrinolytic agent (Table 1).

The decision for TA requirement in the CDT group was determined by absence of visible clots and presence of generalized oozing-type bleeding in the surgical field. In the TEG group, a prolonged lysis rate-30 (LY30) value that stands for exaggerated fibrinolysis (Table 1) was used as a criterion for TA treatment.

Laboratory tests including PT, APTT, and platelet count in group 1 and kTEG and h-kTEG analyses in group 2 were studied at the same time points (t_1, before induction of general anesthesia; t_2, after institution of CPB; t_3, 15 minutes after administration of protamine sulfate; t_4, on admission to the intensive care unit (ICU); t_5, 6 hours after CPB; and lastly t_6, 24 hours after CPB. The h-kTEGs were studied to eliminate the effect of systemic heparin concomitantly. An additional dose of protamine sulfate (25 mg) was given if the r time on the h-kTEG was less than one-half of the nonheparinase r time on the kTEG. TA (Transamine® 10%, Fako AS, Istanbul, Turkey) was started at an initial dose of 10 mg/kg given over 20 minutes followed by an infusion of 1 mg/(kg · h). Transfusions were performed by the anesthesiologist who was blinded to the patient's group assignment. PRBCs were transfused when hematocrit (Htc) level was less than 25%. An Hct value of 18% was accepted during CPB. In the presence of intolerance to anemia or older age, the threshold for blood transfusion was adjusted to higher Htc levels.

To determine the degree of platelet dysfunction, adenosine diphosphate (ADP)-induced platelet aggregation analysis was performed preoperatively in both groups. Excessive bleeding was defined as mediastinal blood loss over 400 mL in the first hour after surgery or over 100 mL/hour for 4 consecutive hours. Postoperative acute renal dysfunction (ARD) was defined as postoperative serum creatinine greater than 2 mg/dL or need for dialysis therapy or hemofiltration before hospital discharge. In the TEG group, normal TEG analyses in the presence of excessive bleeding dictated re-exploration for bleeding. Early mortality was defined as any dearth occurring within 30 days after operation. Data were collected prospectively and entered into the institutional database. Twelve-hour MCTD was measured at 1-hour intervals, and transfusion

requirements were recorded until discharge from hospital.

Anesthesia and surgical procedure

After general anesthesia and median sternotomy, standard aortocaval cannulation was performed to establish CPB. When preoperative Htc was less than 30%, one unit of PRBC was added to the pump prime. Moderate (28–32 °C) hypothermia and pulsatile flow of 2.2–2.4 L/m^2 were maintained throughout the CPB in all cases. Non-heparin-coated circuits were utilized for CPB. During CPB, Htc was maintained between 18% and 22%. Left internal mammary artery (LIMA) and saphenous vein were utilized as bypass conduits in all patients. The rest of the operation was completed in a standard fashion. Perioperative anticoagulation was performed with standard heparin (Nevparin®, Mustafa Nevzat, Istanbul, Turkey) (300 units/kg) and monitored with repeated ACT analyses, which were kept over 450 seconds during CPB. Anticoagulation was reversed with the use of protamine sulfate (Protamin®, ICN Pharmaceuticals, Birsfelden, Switzerland) (1 mg of which per 100 units of heparin).

Blood measurements, platelet aggregation, and TEG

Perioperative Htc values were analyzed by GEM Premier 3000 blood gas/electrolyte analyzer model 5700 (Instrumentation Laboratory, Lexington, MA, USA). Complete blood count was determined by the use of the Coulter system (Coulter HMX-AL system hematology analyzer; Beckman Coulter Corporation, Miami, FL, USA). PT, international normalized ratio, and APTT were studied by Diagnostica Stago STA compact (Diagnostica Stago S.A.S., Asnières sur Seine Cedex, France). ACT and ADP-induced platelet aggregation analyses were made on ACT II analyzer (Medtronic, Minneapolis, MN, USA) and ChronoLog Lumi aggregometer (ChronoLog Corp., Havertown, PA, USA). Blood for these analyses was withdrawn from a radial artery catheter. For platelet aggregation, citrated blood samples withdrawn from a peripheral venous catheter were evaluated by optical aggregometry in platelet-rich plasma.[12] The final platelet count was adjusted to 300 $\times$ 10^9/L with autologous platelet-poor plasma. ADP (final concentration 10 μmol/L) was added and aggregation was recorded for 5 minutes. Maximum amplitude of primary and secondary aggregation curves was measured in centimeters. Percent inhibition of aggregation (A_{max}) was calculated by comparing the amplitudes of platelet aggregation of each group. TEG measures the kinetics of clot formation and growth as well as the strength and stability of the formed clot. The kinetics of clot formation stands for the adequacy of quantitative factors for clot formation and the strength and stability of the formed clot stand for the ability of the clot to do the work of the hemostatic system. kTEG and hTEG analyses (TEG® 5000 Thromboelastograph® Analyzer, Haemoscope Corporation, Niles, IL, USA) were performed after quality control procedures as described[6] and the following kTEG and h-kTEG parameters were recorded: r time (r; normal range 10–19 minutes) represents the time to initiation of clot formation; the maximum amplitude (MA; normal range 54.5–72.5 mm) represents the maximum clot strength; and the lysis rate-30 (LY30; normal range 0% to 7.5%) represents the rate of cloth lysis 30 minutes after MA. All TEG measurements were performed when nasopharyngeal temperature was over 35 °C. ACT was used to monitor the effect of heparin during CPB in both groups. Prolonged r values were assessed concurrently by ACT (less than 120 sec) and h-kTEG analysis and then it was judged as a defect in coagulation factors.

TABLE 2
Perioperative Variables of the Patients

	CDT (N = 110)	TEG (N = 114)	P Value
Age (years)	65.9 ± 22.1	63.2 ± 19.2	0.329
Male	87	86	0.379
Diabetes mellitus	39	33	0.258
Hypertension	14	37	**0.000**
COPD	22	25	0.773
Preoperative EF (%)	59.8 ± 22.5	57.1 ± 17.9	0.321
Preoperative aspirin	71 (64.5)	67 (58.7)	0.295
Euroscore	3.01 ± 1.7	2.8 ± 0.6	0.082
ACC time (minute)	36.7 ± 7.6	39.1 ± 12.1	0.074
CPB time (minute)	58.7 ± 3.8	60.2 ± 7.7	0.062
Number of grafts	2.9 ± 1.3	3.2 ± 1.6	0.122
Ventilation (hour)	7.9 ± 4.7	8.2 ± 2.1	0.540
Re-thoracotomy for bleeding	4 (3.6)	6 (5.2)	0.574
ICU stay (hour)	25.3 ± 11.2	23.3 ± 5.7	0.099
Hospital stay (day)	6.3 ± 1.4	6.2 ± 1.1	0.552

CDT = clinician-directed transfusion; TEG = thromboelastography; EF = ejection fraction; COPD = chronic obstructive pulmonary disease; ACC = aortic cross-clamping; CPB = cardiopulmonary bypass; ICU = intensive care unit.
Boldface stands for statistical significance and number in parenthesis represents percentages.

Statistical analysis

Statistical analysis was performed with the SPSS for Windows 14.0 version (SPSS, Inc., Chicago, IL, USA). Data were defined as continuous and categorical variables. Continuous variables were expressed as mean ± standard deviation (SD) or median and interquartile ranges (25% to 75%) and compared by means of Student's *t*-test or Wilcoxon sum-of-ranks test. Categorical data were expressed as frequencies and percentages. Chi-square test was used to analyze relationships between categorical data. Significance was established when p value was less than 0.05.

RESULTS

Demographics and perioperative variables were shown in Table 2. There were no differences in demographics and perioperative variables between the groups except hypertension that was found to be significantly higher in the TEG group (p = 0.000). Seventy-one (64.5%) and 67 (58.7%) patients were on aspirin therapy until the day before the operation in the CDT

TABLE 3
Perioperative Data Related to MCTD, Allogeneic Blood Product Exposure, and Hematological Parameters.

	CDT (N = 110)	TEG (N = 114)	P Value
Twelve-hour MCTD (mL)	591.4 ± 339.2	480.5 ± 351	0.087
Need for additional protamine (n)*	47 (42.7)	62 (54.3)	0.080
Risk of transfusion (n)*			
PRBC	60 (54.5)	52 (45.6)	0.181
FFP	31 (28.1)	19 (16.6)	**0.038**
Platelets	29 (26.3)	17 (14.9)	**0.033**
PRBCs exposure (unit) €			
Intraop	0 (0–1)	1 (0–1)	0.581
Postop	1 (0–1)	1 (0–1)	0.741
Total	1 (1–2)	1 (0–1)	0.599
FFP exposure (unit) €			
Intraop	1 (0–1)	0 (0–1)	**0.008**
Postop	1 (0–1)	1 (0–1)	**0.034**
Total	1 (1–2)	1 (1–1)	**0.001**
Platelet exposure (unit) €			
Intraop	1 (0–1)	0 (0–1)	**0.004**
Postop	1 (0–1)	1 (0–1)	**0.028**
Total	1 (1–2)	1 (1–1)	**0.001**
Total allogeneic exposure (unit) €	3 (2–4)	2 (1–3)	**0.001**
Htc (%)			
Preoperative	38.9 ± 5.8	40.2 ± 6.2	0.104
Termination of CPB	25.4 ± 2.3	26.1 ± 4	0.103
Postoperative day 1	29.9 ± 3.1	30.5 ± 4.1	0.214
Discharge	30.5 ± 3.6	30.3 ± 3.2	0.659
Platelets ×1000 (μL)			
Preoperative	265.4 ± 73.8	270.1 ± 34.2	0.543
Postoperative day 1	179.3 ± 67.3	193.2 ± 45.2	0.070
Discharge	207.3 ± 73.6	199.1 ± 34.1	0.288

The data are presented as the mean ± standard deviation (SD), the median with 25th and 75th quartiles and percentages.

Numbers in parentheses represent 25th and 75th quartiles of the median value€ or percentages*.
n = number of patients; MCTD = mediastinal chest tube drainage; Htc = hematocrit; PRBC, patients receiving packed red blood cells; CPB = cardiopulmonary bypass; CDT = clinician-directed transfusion; TEG = thromboelastography; FFP: fresh frozen plasma.
Boldface stands for statistical significance.

and the TEG groups, respectively. Early mortality was seen in three patients (2.7%) in the TEG group (due to low cardiac output in two patients and multiple organ failure in one patient) and two patients (1.7%) in the CDT group (due to mediastinitis in one and respiratory insufficiency in the other patient). One patient in the TEG group had superficial soft-tissue infection of the sternal incision that was successfully treated with the appropriate antibiotic therapy. Postoperative ARD was detected in the nine patients (8.1%) and seven patients (6%) in the CDT and the TEG groups, respectively ($p = 0.553$). None of the patients had major respiratory complication or hemodialysis.

Perioperative MCTD, allogeneic blood exposure, and hematological variables were seen in Table 3. Twelve-hour MCTD was slightly increased in the CDT group compared to the TEG group, but the difference was not significant ($p = 0.087$). Preoperative aspirin use did not create a difference in MCTD in each group (589.4 ± 330.2 mL in the aspirin users vs. 575.3 ± 273.7 mL in the nonusers, $p = 0.791$ in the CDT, and 503.2 ± 247.7 mL in the aspirin users vs. 472.3 ± 227.2 mL in the nonusers, $p = 0.466$ in the TEG group). All patients had normal preoperative standard coagulation tests including platelet count, PT, APTT, and ACT. History of aspirin use resulted in a significant reduction in A_{max} values in both groups (for the CDT group 63.1 ± 27.4% in the aspirin users vs. 79.2 ± 17.4% in the nonusers, $p = 0.000$, and for the TEG group 63.7 ± 21.9% vs. 75.4 ± 13.6%, $p = 0.000$, respectively). There was no difference between the groups. In the TEG group, baseline TEG analyses (t_1) were in normal ranges in aspirin nonusers except three patients in whom there was a hypercoagulable pattern. There was no significant difference in baseline mean MA values between the aspirin users and the nonusers. Hemodilution during CPB was standardized by intraoperative Htc measurements at the termination of CPB and equivalent levels of which was detected between the groups. Excessive bleeding was detected in 8.1% (n = 9) and 9.4% (n = 11) of the patients in the CDT and the TEG groups, respectively ($p = 0.700$), of which five of the nine patients in the CDT group and six of the nine patients in the TEG group underwent reexploration for bleeding. The causes for bleeding were surgical in two patients in the CDT (from the saphenous vein side branch) and in all patients in the TEG group (one from the LIMA side branch and three from left thoracic wall and two from the saphenous vein side branch). Three patients, out of five (60%), in the CDT

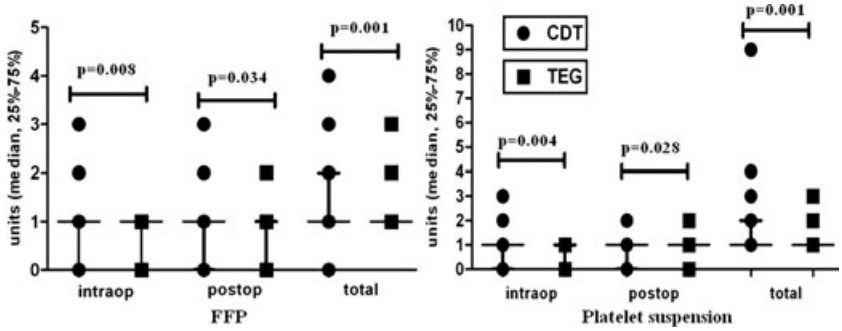

Figure 1. *Perioperative FFP and platelet suspension exposure. The data are presented as the median with 25th and 75th quartiles, the upper and the lower most points represent maximum and minimum values. CDT = clinician-directed transfusion; TEG = thromboelastography; FFP = fresh frozen plasma.*

group and none in the TEG group had an inappropriate surgical intervention for bleeding.

The median units of blood products transfused perioperatively in both groups were given in Figure 1. In comparison, while the risk of PRBCs exposure was similar between two groups, the incidence of FFP and TS transfusions was significantly reduced in the TEG group compared with the other group (Table 3). Patients in the TEG group had significantly lower median amounts of FFP and platelets (both intraoperatively and postoperatively) compared with the other group. Also, the median number of total allogeneic units transfused was also significantly lower in the TEG group compared with the other group. In the TEG group 10 patients (10.3%) required TA infusion, while 21 patients (19%) in the CDT group received TA ($p = 0.007$). The timing to start TA was before induction of anesthesia in only one patient in the TEG group, during CPB in six patients in the TEG and 11 patients in the CDT groups, and during early postoperative period in three patients in the TEG and 10 patients in the CDT groups. Preoperative aspirin use did not create a difference in the rate of blood product transfusion in or between the groups.

DISCUSSION

Our results demonstrated that a simple kTEG-based algorithm causes a significant reduction in the risk for allogeneic blood product (FFP and platelet suspension) exposure and diminished the amount of allogeneic blood products transfused after elective CABG. The use of algorithm decreased the amount of 12 hours MCDT slightly. Moreover, the need for TA was significantly reduced in the TEG group compared with the CDT group. We did not find a difference in the incidence of excessive bleeding, re-exploration for bleeding, and early clinical outcome between two groups. Normal TEG measurements in the presence of excessive MCTD certainly implied a surgical origin for bleeding and, therefore, dictated re-exploration. The use of aspirin did not create a difference in the MCTD and transfusion requirements.

Despite recent advance in blood conservative strategies, cardiac surgical procedures still consume almost 20% of allogeneic blood products in the United States.[13] It has been shown that that 27% of all blood units consumed in elective CABG patients are unnecessarily transfused and this would result in 24% increase in the costs spent for all blood products.[14] With this regard, routine use of a TEG-based algorithm in cardiac surgery would seem to help in finding a target patient population in whom the decision for transfusion is given inadvertently.

Nowadays, incorporation of particular TEG parameters like MA and alpha angle into a transfusion algorithm has been shown to be more effective in deciding perioperative transfusion requirements, especially in patients at higher risk for bleeding.[7,15] Royston and Kier[8] demonstrated significantly less blood and blood component usage in the TEG-based algorithm compared to the conventional "clinician-directed" group with no excessive MCTD in patients at risk for bleeding and transfusions. We used the modified version of a transfusion algorithm proposed by Royston and Kier[8] and three parameters (r time, MA, and LY30) were used to assess hemostatic system. In accordance with the results from the literature, the algorithm resulted in a significant reduction in the consumption of allogeneic blood exposure in our patient cohort. MCTD in the TEG group was slightly reduced. Also, TA usage was significantly reduced in the TEG group compared with the other group.

Data related to the profit of a routinely used TEG-based transfusion algorithm in patients at lower risk for bleeding, such as elective CABG patients, are limited. Nuttall et al.[16] showed that use of a TEG-based transfusion algorithm in patients with abnormal bleeding decreased both the rate of intraoperative nonerythrocyte allogeneic blood products and early postoperative blood loss after standard CABG. Helm et al.[17] revealed that transfusions can be avoided in lower risk patients using a comprehensive blood strategy utilizing preoperative optimization and routine intraoperative use of aprotinin and cell selvage system. However, increasing the number of coagulation tests and blood conservative methods limits the practicability and increases the complexity and the costs of the algorithm. Instead, an algorithm including simple kTEG measurements at multiple time points reduced the perioperative exposure of allogeneic blood products in our study. To facilitate the applicability of the algorithm, we tested the feasibility of a pretty simple kTEG-guided

transfusion algorithm without including any complex blood activators. For a kTEG analysis, it takes almost 30–45 minutes to obtain the result that was comparable to those with the standard coagulation tests. Moreover, TEG can be performed at the patient's bedside by nontechnical personnel and interpreted rapidly.

Taking the patients undergoing re-exploration for bleeding into consideration, 60% of the patients (three out of five patients) in the CDT group had an inappropriate re-exploration. In contrast, the negative predictive value of the kTEG for excessive bleeding was found to be 100% in the algorithm group. Thus, we think that routine TEG application would help to minimize inappropriate re-explorations and, therefore, morbidity and mortality after CABG. In our patients we could not reveal a difference in early clinical outcome between the groups. However, adverse outcome related to increased transfusion is expected to be higher in patients with severe preoperative comorbid conditions and limited organ reserves. Our patient cohort was relatively without severe comorbidities, which may explain why we could not demonstrate a difference in clinical outcome. We did not look for cost analysis in this study. It has been clearly stated that a bedside TEG-guided transfusion management causes a saving of 44% in the costs spent for blood and blood products.[10] Therefore, reduction in the amount of blood products in lower risk patients for bleeding seems to be important, at least to reduce the expenses for allogeneic blood products.

Nowadays, the number of patients using antiplatelet agents, aspirin or clopidogrel or both, until the day of operation is increasing owing to their antithrombotic benefits. Current dogma suggests that preoperative aspirin ingestion is not a considerable determinant of allogeneic blood transfusion or mediastinal blood loss after CABG. In agreement with these results, although preoperative platelet function was found to be depressed in the aspirin users when compared with the nonusers in both groups, it did not create a difference in perioperative blood loss and transfusion requirements in our patient cohort. Therefore, aspirin therapy until the day of operation would be beneficial due to its antithrombotic effects without increasing the risk of perioperative blood loss.

Prophylactic use of the antifibrinolytic drugs such as aprotinin and TA is regarded to reduce the incidence of hemostatic defects seen after CPB. Recent evidence suggests that liberal use of these agents, particularly aprotinin, results in serous end-organ damage like renal failure and early graft thrombosis after cardiac surgery.[18] Therefore, limitation of the use of an antifibrinolytic agent by a TEG-guided transfusion algorithm would help to prevent their inappropriate use and related unwanted effects.[7] In a study by Andreasen and Nielsen,[19] it was found that prophylactic use of TA in patients undergoing CABG with a low risk of postoperative bleeding does not result in any significant decrease in either postoperative bleeding or allogeneic transfusions compared to a placebo group. With this regard, TEG helps to find the target patient population that would really benefit from an antifibrinolytic therapy after CABG. Restriction of TA use to a particular group of patients determined by using TEG would cause its inappropriate consumption and a reduction in total hospital costs.

Our study has some apparent limitations. First, it has been shown that coagulation profile laboratory tests including bleeding time, PT, APTT, fibrinogen, fibrin split products, platelet count, and mean platelet volume could reliably predict MVB after CPB.[11,20] Although both groups had the same number of draws at the same time points in our study, it was possible that the TEG group might have been better equipped to treat coagulation defects than the CDT group. The lack of matching conventional laboratory values in the CDT group might have created bias for the TEG to be shown to be more effective in reducing transfusion requirements. Second, it has been accepted that the benefit of antifibrinolytic drugs as a blood conservation tool must begin prior to the start of fibrinolysis. However, in a randomized trial by Brown et al.,[21] it has been shown that TA exerts similar antifibrinolytic action when administered before and during operation. Its effect remains minimal when applied after operation. In our study, TA was started whenever excessive fibrinolysis had been suspected or detected. TA was administrated during the operation in the majority of the cases. Third, although the evidence that an r time of 14–21 mm represents a mild deficiency of coagulation factors that can be reversed by giving one unit of FFP based on the results of the study by Royston and Kier,[8] this needs to be standardized. Last, absence of total arterial revascularization with only LIMA usage in this patient cohort may not reflect the real profile of CABG patients.

In conclusion, this study reveals that evaluation of hemostatic alterations related to CPB by routinely used kTEG analyses and performing perioperative transfusion therapy according to the kTEG-guided transfusion algorithm decreases the requirement for blood products and antifibrinolytic agents in a patient cohort at low risk for bleeding after conventional CABG. Furthermore, TEG-guided approach also has a high capability to differentiate surgical bleeding from the nonsurgical one in patients with excessive MCTD. Adopting of a kTEG containing transfusion management to the perioperative care of cardiac surgical patients, either at low or high risk for transfusion, may further decrease the morbidity and hospital costs related to perioperative transfusion and MVB.

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