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ORIGINAL

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Point of care management of heparin administration after heart surgery

A randomized, controlled trial

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Abstract *Objectives:* Determination of activated partial thromboplastin time (aPTT) is used in coagulation management after heart surgery. Results from the central laboratory take long to be obtained. We sought to shorten the time to obtain coagulation results and the desired coagulation state and to reduce blood loss and transfusions using point of care (POC) aPTT determination. *Design:* Randomized, controlled trial. *Setting:* University-affiliated 20-bed surgical ICU. *Patients and participants:* Forty-two patients planned for valve surgery (*Valves*) and 84 for coronary artery bypass grafting (*CABG*) with cardiopulmonary bypass. *Interventions:* Valves and CABG were randomized to postoperative coagulation management monitored either by central laboratory aPTT (Lab group) or by POC aPTT (POC group). Heparin was administered according to guidelines. *Measurements and results:* POC aPTT results were available earlier than Lab aPTT after venipuncture in *Valves* (3 ± 2 vs. 125 ± 68 min) and in *CABG* (3 ± 4 vs. 114 ± 62 min). Heparin was introduced earlier in the POC group in *Valves* (7 ± 23 vs. 13 ± 78 h, $p = 0.01$). *Valves* of the POC group bled significantly less than *Valves* in the Lab group (647 ± 362 ml vs. 992 ± 647ml, $p < 0.04$), especially during the first 8 h after ICU admission. There was no difference in bleeding in *CABG* (1074 ± 869 ml vs. 1102 ± 620, $p =$ NS). In *Valves*, fewer patients in the POC group than in the Lab group needed blood transfusions (1/21 vs. 8/21; $p = 0.03$). No difference was detected in *CABG*. *Conclusions:* In *Valves* in the POC group the time to the desired coagulation state was reduced, as was the thoracic blood loss, reducing the number of patients transfused. This improvement was not observed in *CABG*. Side effects were similar in the two groups.

Keywords Quality · Cardiac surgery · Intensive care unit · Coagulation

Introduction

Severe bleeding occurs occasionally after heart surgery with cardiopulmonary bypass (CPB) [1]. Rapid assessment of the coagulation state is required to identify the causes of hemorrhages, such as platelet dysfunction, residual heparin, coagulation factor depletion, hyperfibrinolysis and bleeding from surgical causes [1]. In addition, patients after valve replacement surgery need early onset and monitoring of therapeutic heparin treatment without increasing bleeding.

The activated partial thromboplastin time (aPTT), measured in the central laboratory (Lab aPTT), is routinely used to guide the management of postoperative coagulation treatment. The time from venipuncture to availability of the laboratory results can be as much as 2 h [2]. A pilot study in our surgical intensive care unit (SICU) showed similar results (136 ± 126 min). Besides, there is no evidence that Lab aPTT is the most reliable test to assess the bleeding risk and the coagulation state after CPB [1].

Point of care (POC) tests provide aPTT within 3 min and have shown their accuracy in coronary care patients [3, 4, 5] and during CPB [6]. POC aPTT correlated poorly with Lab aPTT in our context [7]. One author suggested that POC aPTT could be a better predictor of post-CPB bleeding risk [8].

We hypothesized that the management of heparin administration by POC aPTT after CPB would decrease the time to achieve the desired (anti-)coagulation state and lead to a reduced blood loss and need for transfusions.

We compared, in a prospective, randomized, open controlled trial, heparin treatment and anticoagulation monitoring managed by POC aPTT and by Lab aPTT in patients after heart surgery. Patients after coronary artery bypass grafting (*CABG*) needing prophylactic heparin, and patients after valve replacement surgery (*Valve*) needing therapeutic heparin were analyzed separately. Preliminary results of this study were presented at an international meeting [9].

Materials and methods

The study was approved by the institutional ethics committee. Written informed consent was obtained from every patient before surgery. The study was performed in the 20-bed SICU, of a tertiary university teaching hospital.

Patients

Adult patients planned for elective CABG or valve surgery with cardiopulmonary bypass were included. Patients with bleeding disorders, hepatic dysfunction, chronic renal insufficiency or on extracorporeal cardiac assistance or with intra-aortic balloon pump were excluded (for details see ESM).

Study design

We compared two different postoperative coagulation management strategies guided either by Lab aPTT (Lab group) or by POC aPTT (POC group) in *Valves* and *CABG*. After randomization stratified by the type of surgery, we assessed Lab aPTT in the Lab group, while we measured both the POC aPTT and the Lab aPTT in the POC group. The medical and nursing teams in charge of patients in the POC group were blinded to the Lab aPTT results.

Endpoints

The primary endpoints were postoperative thoracic blood loss, the number of patients needing postoperative transfusions during their ICU stay and hemoglobin levels at ICU discharge.

The secondary endpoints were the time from the ICU admission to the onset of heparin treatment, the percentage of Lab aPTT and POC aPTT results within the desired anticoagulation range, the amount of heparin/24 h administered per patient during ICU stay and the number of other major bleedings, or thromboembolic events.

Laboratory and point of care coagulation assessment

Measurement of aPTT was performed at ICU admission and then every 6 h, or 4 h after initiation of heparin and after each dosage modification. aPTT was assessed within the following hour in the case of administration of protamine, fibrinogen, fresh frozen plasma or platelet transfusions, or in the presence of important thoracic blood losses (> 250 ml/h for more than 1 h).

Lab aPTT, heparin activity, fibrinogen and prothrombin time were tested by standard methods in the central laboratory (for details see ESM). The central laboratory is accredited in accordance with the ISO/IEC 17025 Standard (type C: methods development allowed) by the Swiss Federal Office of Metrology and Accreditation (METAS, Bern).

The three POC devices (CoaguChek® Pro; Roche Diagnostics, Switzerland) were used according to the manufacturer's recommendations. Inter-operator, inter-instrument and inter-cartridge variability were satisfactory [7].

The anesthesia procedure, the intra-operative and the postoperative coagulation/anticoagulation management protocol and details of data collection are provided in the ESM.

Indication for red blood cell transfusion

Red blood cells (RBCs) were transfused when the hematocrit level was below 22% in patients after valve surgery and below 24% after CABG. In the presence of myocardial

ischemia or cardiogenic shock, the threshold was a hematocrit value of 28%.

Power calculation, randomization and statistical analysis

The study was designed to detect a clinically significant reduction in the total thoracic blood loss at ICU discharge i.e., of at least 350 ml (equivalent to one RBC). The standard deviation (SD) estimates of ± 400 ml for *Valves* and ± 570 ml for *CABG* were derived from the pilot study. With an $\alpha = 0.05$ and a power of 80%, the calculation resulted in 21 patients in each group in *Valves* and 42 in *CABG*. A total of 126 patients were randomized by a computer-generated randomization table with concealed, opaque envelopes stratified according to the operation type (*Valves*, *CABG*). For the statistical analysis, StatView for Windows version 5.0.1® (SAS Institute Inc., Cary, NC, USA) was used. All analyses were performed following intention to treat. *Valves* and *CABG* were analyzed and are presented separately.

The agreement between Lab aPTT and POC aPTT and the bleeding risk assessment was analyzed in patients in which POC aPTT was performed (POC group) considering Valves and CABG together (63 patients). Further details on the statistical analysis are provided in the ESM.

Results

The flow diagram of patients included between July 2000 and February 2002 is summarized in Fig. E1 of the ESM.

Agreement between Lab aPTT and POC aPTT in *Valves* and *CABG*

The overall agreement between Lab aPTT and POC aPTT, assessed according to Bland and Altman, was

Table 1 Outcome data

	Valves			*CABG*		
	Lab group ($n = 21$)	**POC group** ($n = 21$)	p value[a]	**Lab group** ($n = 42$)	**POC group** ($n = 42$)	p value[a]
Blood loss, Hb and transfusions at ICU discharge						
Cumulative thoracic blood loss (mean ± SD, ml)	992 ± 647	647 ± 362	**0.04**	1102 ± 620	1074 ± 869	0.86
Hemoglobin (mean ± SD, g/l)	9.3 ± 1.4	9.8 ± 1.2	0.27	9.7 ± 1.0	9.7 ± 1.3	0.79
Patients transfused with RBC during ICU, *n* (%)	8 (38)	1 (5)	**0.02**	8 (19)	5 (12)	0.55
Patients transfused with FFP during ICU, *n* (%)	2 (10)	0 (0)	0.48	3 (7)	5 (12)	0.71
Patients transfused with platelets during ICU, *n* (%)	0 (0)	0 (0)	–	1 (2)	1 (2)	> 0.99
Patients treated with protamine sulfate during ICU, *n* (%)	1 (5)	0 (0)	> 0.99	1 (2)	1 (2)	> 0.99
Surgical hemostasis, *n* (%)	0 (0)	0 (0)	–	1 (2)	1 (2)	> 0.99
Complications at hospital discharge						
Non mediastinal hemorrhage / blood loss, *n* (%)	0 (0)	0 (0)	–	0 (0)	0 (0)	–
Thromboembolic event, *n* (%)	0 (0)	0 (0)	–	0 (0)	1 (2)	> 0.99
CABG occlusion, *n* (%)	0 (0)	0 (0)	–	0 (0)	1 (2)	> 0.99
Length of:						
ICU stay, [median (range), days]	2 (1–7)	2 (1–18)	0.66	2 (1–9)	2 (1–12)	0.34
Hospital stay, [median (range), days]	13 (8–24)	11 (8–62)	0.73	9 (2–24)	11 (5–34)	0.63
Death during:						
ICU, *n* (%)	0 (0)	1 (5)	> 0.99	2 (5)	0 (0)	> 0.99
Hospital stay, *n* (%)	0 (0)	2 (10)	0.49	2 (5)	1 (2)	> 0.99

RBC, red blood cells; FFP, fresh frozen plasma; [a] Calculated using ANOVA with Bonferroni correction, Fisher's exact test or Mann–Whitney *U* test as appropriate

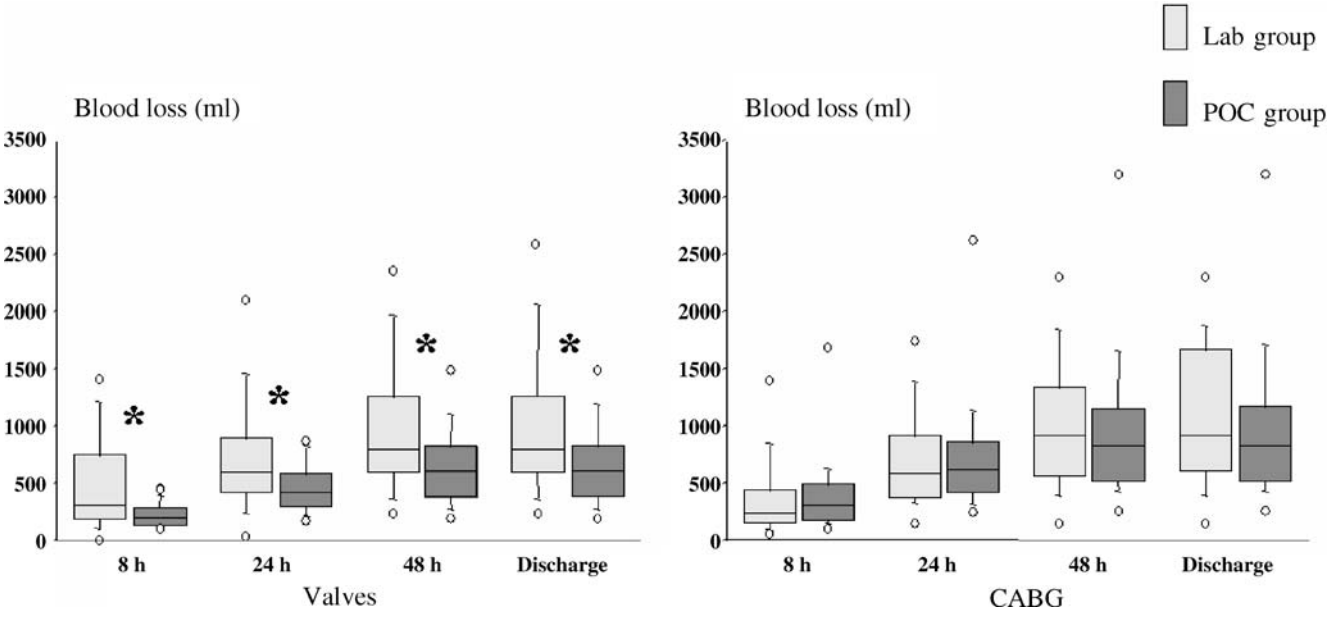

Fig. 1 Cumulative thoracic blood loss (box plots) at 8, 24, and 48 h after ICU admission and at ICU discharge in patients that underwent valvular surgery (*Valves*) or coronary artery bypass grafting (*CABG*) with coagulation management guided by central laboratory aPTT (Lab group; *light gray*) or by point of care aPTT (POC group; *dark gray*). In the box plots, the *middle horizontal bars* represent median values, the *squares* represent the 25th and 75th percentiles, the *lower and upper bars* represent the 10th and 90th percentiles, and the *circles* represent minimum and maximal values. $^{*}p<0.05$ by ANOVA with Bonferroni correction

poor (–15.5 ± 30.6 s). The agreement between samples drawn at ICU admission was worse (–27.0 ± 56.8 s) than between those drawn thereafter (–14.2 ± 25.8 s).

Patient population

Patients' characteristics before surgery and at ICU admission and data regarding surgery and cardio-pulmonary bypass did not differ between the Lab and POC groups (Tables E1 and E2 of the ESM) in *Valves* or *CABG*. The *Valves* patients had the tendency to be younger ($p = 0.07$), were less frequently males ($p = 0.02$), had undergone heart surgery in the past more often ($p = 0.001$) and took less frequently aspirin prior to the operation ($p < 0.001$). In *Valves* CPB was shorter ($p < 0.02$), heparin and protamine doses given during CPB were lower ($p < 0.001$ and $p < 0.004$ respectively) and *valves* had less frequently pleural drains ($p < 0.001$). In *Valves* the mean Lab aPTT was higher ($p < 0.04$) and more heparin was delivered during their ICU stay ($p = 0.004$).

Endpoints

Valves

The cumulative thoracic blood loss was significantly lower in the POC group at each time during the ICU stay and at discharge than in the Lab group ($p < 0.05$) (Fig. 1). This difference became apparent during the first 8 h and persisted until ICU discharge. The hemoglobin at ICU discharge was similar in the Lab and POC groups. Significantly fewer patients in the POC group required RBC transfusions during their ICU stay (Table 1). The number needed to treat (NNT) to avoid one patient to be transfused was 3. All transfused patients, except one (Lab group), received their first transfusion within the first 12 h. The number of other blood products transfused was similar in the Lab and POC groups (Table 1). The number of surgical procedures needed for hemostasis did not differ between the Lab and POC groups (Table 1).

No patient showed an extrathoracic blood loss, other hemorrhages or thromboembolic events related to heparin therapy (Table 1).

None of the outcome measures considered differed between the Lab and POC groups (Table 1). The duration of endotracheal intubation did not differ between the two groups [median (range): Lab group 9 h (0–17), POC group 8 h (0–264); $p = 0.33$].

The characteristics of the coagulation assessment during the ICU stay of both groups are detailed in Table 2. There were significant differences between the POC and the Lab group regarding the coagulation assessments and the heparin treatment during the ICU stay (Table 2). During the first 8 h, 6/21 patients in the Lab group and 15/21 in the POC group ($p = 0.01$) were put on heparin. Within 24 h, 19/21 patients in the Lab group and 21/21 patients in

Table 2 Coagulation

	Valves			*CABG*		
	Lab group ($n = 21$)	**POC group** ($n = 21$)	p value[a]	**Lab group** ($n = 42$)	**POC group** ($n = 42$)	p value[a]
Coagulation assessments during ICU stay						
Number of Lab aPTT / POC aPTT assessments, n	177 / –	255 / 272		293 / –	373 / 376	
Lab aPTT (mean ± SD, s)	42 ± 13	47 ± 25	**0.02**	40 ± 14	37 ± 12	**0.003**
POC aPTT (mean ± SD, s)	–	64 ± 36		–	53 ± 34	
Lab aPTT in target range, n (%)	60 (34)	120 (47)[b]	**0.007**	125 (43)	176 (47)[c]	0.27
POC aPTT in target range, n (%)	–	193 (71)[b]		–	283 (74)[c]	
Time, venipuncture to availability of result (mean ± SD, min)	125 ± 68	3 ± 2	**< 0.0001**	114 ± 62	3 ± 4	**< 0.0001**
Time, venipuncture to corrective action (mean ± SD, min)	201 ± 114	48 ± 84	**< 0.0001**	222 ± 185	102 ± 110	**< 0.0001**
Heparin treatment during ICU stay						
ICU admission-first heparin administration (mean ± SD, h)	12.8 ± 8.8	6.8 ± 4.8	**0.01**	13.6 ± 10.1	10.9 ± 7.5	0.15
Dose /24 h ICU stay (mean ± SD, 10^3 IU)	9.2 ± 6.1	15.3 ± 8.3	**0.01**	8.0 ± 6.6	9.1 ± 6.4	0.42
Coagulation parameters at ICU discharge						
Platelets (mean ± SD, g/l)	158 ± 69	160 ± 68	0.92	145 ± 42	193 ± 61	**0.008**
Prothrombin time (mean ± SD, %)	84 ± 10	89 ± 10	0.31	88 ± 14	87 ± 16	0.89
Lab aPTT (mean ± SD, s)	46 ± 17	45 ± 12	0.79	38 ± 8	40 ± 17	0.38
POC aPTT (mean ± SD, s)	–	72 ± 50	–	–	58 ± 43	–
Fibrinogen (mean ± SD, g/l)	5.9 ± 1.9	4.7 ± 1.9	0.20	6.4±1.5	6.4 ± 1.8	0.97

[a] Calculated using Student's t-test, Fisher's exact test or Mann–Whitney U test as appropriate [b] Lab aPTT in target vs. POC aPTT in target in the POC group in Valves ($p < 0.0001$) [c] Lab aPTT in target vs. POC aPTT in target in the POC group in CABG ($p < 0.0001$)

the POC group were put on heparin (p = NS). In patients in whom heparinization was postponed (at any moment), this was due to results (Lab or POC aPTT) outside the protocol range in all cases. In those patients, aPTT was repeated following the anticoagulation protocol (see ESM).

The thoracic blood loss during the first 8 h was less in patients in whom heparin was started compared with patients in whom it was not started (239 ± 123 ml vs. 442 ± 430 ml, $p = 0.04$). The thoracic blood loss in the first 8 h in patients receiving heparin was in the POC group 210 ± 102 ml ($n = 15$) and 314 ± 147 ml ($n = 6$) in the Lab group ($p = 0.078$). The thoracic blood loss in the first 8 h of patients not receiving heparin was almost identical in the POC and Lab group.

CABG

The cumulative thoracic blood loss did not differ between the two groups (Fig. 1), nor did the thoracic blood loss in the different time intervals. No outcome measure differed between the two groups (Table 1).

No patient showed extrathoracic blood loss or other hemorrhages. Two patients in the POC group showed a transient myocardial ischemic event that resolved totally in less than 24 h.

There were significant differences between the POC group and the Lab group regarding the coagulation assessments and the heparin treatment during the ICU stay, and coagulation parameters at ICU discharge (Table 2).

Bleeding risk assessment

In a multiple regression model, the thoracic blood loss at ICU discharge of all groups correlated positively only with the maximal activated clotting time during the CPB, the total dose of protamine administered at the end of the CPB, and the POC aPTT at ICU admission (Table 3). Lab aPTT was not considered in the multiple regression model

Table 3 Uni- and multivariate correlations for bleeding during the ICU stay

	Univariate analysis			Multivariate analysis		
	Coefficient	95% CI	*p*	Coefficient	95% CI	*p*
Cardio-pulmonary bypass data						
Cardio-pulmonary bypass time (min)	3.15	1.54–4.75	0.05	–	–	NS
Aortic cross-clamp time (min)	4.90	2.84–6.97	0.02	–	–	NS
Max. activated clotting time during CPB (s)	0.61	0.34–0.88	0.03	1.08	0.67–1.49	0.01
Total protamine dose (IU)	0.17	0.16–0.18	0.02	0.39	0.38–0.40	0.0002
ICU admission data						
Platelet count at ICU admission (g/l)	–2.47	–3.69– –1.25	0.05	–	–	NS
Prothrombin time at ICU admission (%)	–10.47	–15.67– –5.27	0.05	–	–	NS
POC aPTT at ICU admission (s)	3.45	1.65–5.25	0.06	4.27	2.68–5.86	0.009
ICU stay data						
Total heparin dosage during ICU stay (IU)	0.002	0.001–0.003	0.05	–	–	NS

CPB: cardio-pulmonary bypass. ICU: intensive care unit. POC aPTT: point of care activated partial thromboplastin time. CI: confidence interval

because it showed a $p > 0.1$ in the simple regression (coefficient 95 CI: –2.26 to 3.24, $p = 0.86$). However, even if added in the final multiple regression model it was not significantly correlated (coefficient 95 CI: –5.97 to 2.39, $p = 0.67$) and the other variables remained almost identical. All variables analyzed are available in the ESM (Table E3).

Discussion

The cause of abnormal or excessive bleeding after CPB is multifactorial [1]. Several interventions were performed to manage excessive perioperative blood loss, focusing on identification and correction of coagulation anomalies, on guidelines or on medications [1]. Most interventions used a set of POC or laboratory tests to analyze and reduce excessive bleeding [10, 11, 12, 13, 14]. We extended our intervention to all patients, including those "bleeding normally".

The reduction in thoracic blood loss is not due to shorter POC turnaround times. The differences in blood loss occurred in the initial 8 h after ICU admission, during which time no intervention (protamine administration, surgical reexploration) was attempted. Our findings suggest that the reduced thoracic blood loss is due to the ability of the POC aPTT to better predict the bleeding tendency and therefore to identify patients in whom heparin may be introduced without increasing blood loss. Indeed, in our study the POC aPTT at ICU admission was a good and independent predictor of the subsequent bleeding tendency, whereas the Lab aPTT was not. This seems to confirm previous reports suggesting that POC and Lab aPTT are measuring different aspects of hemostasis and that a whole-blood coagulation test, such as the POC aPTT, could be a better predictor of the bleeding tendency than Lab aPTT [7, 8]. Lab aPTT is already known to be a poor predictor of the bleeding tendency [15, 16]. Moreover, the difference between the POC group and the Lab group in the thoracic blood loss in the first 8 h tended (small sample size) to be significant only in patients who received heparin. POC therefore permitted correct identification of patients (*Valves*) in whom anticoagulation could be introduced early without increasing their thoracic blood loss and allowed withholding of anticoagulation in those in whom it would have increased the blood loss during the first 8 h after surgery. The same decision taken on the basis of the Lab aPTT assessment resulted in early anticoagulation with increased bleeding. Several patients in whom anticoagulation was withheld in the Lab group could probably have been put on heparin without any bleeding risk. The Lab aPTT determination seems accurate but cannot be considered as a reference measure to decide whether or not to start heparin in the immediate postoperative period. POC aPTT is not accurate in cardiac surgery patients for measurement of "the" aPTT, but it seems to have greater validity in deciding whether or not to start heparin in the first postoperative hours.

In *CABG* we did not find a difference in thoracic blood loss and transfusions. In *CABG*, heparin was introduced at prophylactic doses and later after normalization of coagulation parameters. The ability to better identify patients in whom heparin may be introduced without increasing blood loss seems less important in this situation.

The reduced time to initiation of heparin and the delivery of more heparin may be related to the other property of the POC device, i.e. the short time to obtain results. This permitted a shorter interval from the decision to measure aPTT to the introduction of heparin.

The fact that earlier heparinization did not reduce thromboembolic events could question its usefulness. International guidelines [17, 18] recommend introduction

of heparin after valvular surgery as soon as possible if patients are not bleeding. Postoperatively the valves are not epithelialized [17], and patients are in a hypercoagulable state [19]. In patients who have undergone valvular surgery more than 3 months previously, the risk in stopping anticoagulation is very low (4–10 thromboembolic episodes for 100 patient-years) [20, 21]. In contrast, in the early phase after heart surgery, strokes are, even in the presence of anticoagulation, quite frequent (2% of patients in the first 10 days after cardiac surgery) [22]. Patients with prosthetic valves may have subclinical cerebral microembolization [21]. In our study, thromboembolic events were very rare . However, for all the reasons above, in patients not bleeding, heparin should be administered as soon as possible.

We planned to study and we analyzed separately *Valves* and *CABG*. This was due to the fact that patients characteristics, surgical procedures and medication during CBP are different. These differences are not irrelevant, since they affect the tendency to bleed postoperatively, as shown in the multivariate model of the postoperative bleeding tendency. Most importantly, however, the postoperative management is different. Indeed in Valves the anticoagulation is much more aggressive, targeting and achieving higher (therapeutic) anticoagulation values, beginning earlier anticoagulation and delivering more heparin during the ICU stay, as described in the heparin treatment protocol (ESM). Regarding the effects of the POC, it is obvious that the outcomes depending on the reduced time to get the results, outcomes are improved by the POC in *Valves* and in *CABG*. It is also clear that the outcomes, depending on the ability to identify patients in whom heparin can be safely initiated early, can be improved mainly in *Valves* rather than in *CABG*.

After this study, we implemented the use of the POC device in our unit for Valves in the first 24 h. The translation from research into clinical routine can be difficult. We have now two reference values for anticoagulation (for the POC aPTT and for the Lab aPTT). All the quality control measures (internal and external) require time and personnel. Whether the benefits of our research will be translated into everyday clinical life remains to be demonstrated.

Whether other POC measures such as the activated coagulation time (ACT), the thromboelastogram (TEG) [1] or the thrombolytic assessment systems (TAS), or systems analyzing the number of platelets, such as the Coulter T540 or M16 [12], or platelet function, such as the PFA-100 and the hemoSTATUS with short turnaround times will help to decrease the perioperative blood loss has to be further studied.

Our study has several limitations. First, blinding the study groups was obviously impossible. However, it seems improbable that the bleeding could have been intentionally influenced. This is supported by the fact that interventions against bleeding were absent in both groups. Second, we did not perform POC aPTT in the Lab group. POC tests have to be performed at the bedside with whole blood only a few seconds after venipuncture. Blinding of the team in charge of the patient would have been almost impossible. The different time intervals to get the results between the Lab aPTT and POC aPTT with this design could not have been taken in account. As a consequence, we performed more coagulation assessments in the POC group. This could have biased the results in favor of the POC group. However, the main difference in blood loss was observed during the first 8 h, when only one coagulation assessment was performed in most patients, which should minimize the possible bias. Third, the power calculation for CABG was based on a SD of the thoracic blood loss smaller than finally measured. This could have resulted in an underpowered study. However, the thoracic blood loss and the hemoglobin at ICU discharge, as well as the number of patients needing transfusions, were almost identical in both groups. We would have had to include more than 8,000 patients for the blood loss and almost 1,000 patients for the number of transfused patients to confirm potential clinically insignificant differences between the two groups. Fourth, we cannot rule out the possibility that rare events, such as major extrathoracic hemorrhages or thromboembolic events were not increased. We would have needed approximately 2,500 patients to exclude an increase from 2% to 4% of these events. Fifth, we did not further analyze the differences between the Lab aPTT and the POC aPTT. This question was specifically addressed in a previous paper [7].

In conclusion, in this randomized, open, controlled trial, in *Valves* but not in *CABG*, coagulation management guided by POC aPTT results allowed the introduction of heparin earlier and higher and more appropriate doses could be administered. Furthermore POC aPTT seems to better predict the postoperative bleeding tendency than Lab aPTT. This allowed identification of patients that underwent valvular surgery in whom heparin could be initiated or withheld in a more appropriate way, hereby reducing postoperative thoracic blood loss and transfusions. Every third patient managed following the POC aPTT results could avoid requiring transfusions.

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