Rotational thromboelastometry for perioperative blood conservation? It is all in the bloody details

Rodolfo V. Rocha, MD, Derrick Y. Tam, MD, and Stephen E. Fremes, MD, MSc

From the Division of Cardiac Surgery, Schulich Heart Centre, Department of Surgery, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada.

Disclosures: Authors have nothing to disclose with regard to commercial support.

Received for publication July 26, 2018; accepted for publication July 27, 2018; available ahead of print Sept 1, 2018.

Address for reprints: Stephen E. Fremes, MD, MSc, FRCSC, Schulich Heart Centre, Sunnybrook Health Sciences Centre, 2075 Bayview Ave, Rm H4 05, Toronto, Ontario, Canada M4N 3M5 (E-mail: stephen.fremes@sunnybrook.ca).

J Thorac Cardiovasc Surg 2019;157:1055-7

0022-5223/\$36.00

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<https://doi.org/10.1016/j.jtcvs.2018.07.080>

Blood transfusion is associated with various complications, but is also likely an independent risk factor of mortality following cardiac surgery. Long-term risk-adjusted mortality has been consistently associated with transfusion. Engoren and colleagues^{1,2} reported a 5-year mortality risk ratio of 1.7 (95% confidence interval [CI], 1.4-2.0). Likewise, von Heymann and colleagues³ associated transfusion with a mortality hazard ratio of 1.340 (95% CI, 1.109-1.620) and Koch and colleagues⁴ observed an association of transfusion with a risk-adjusted reduction in survival (0.074 ± 0.016 ; $P < .0001$). Furthermore, the production cost of a unit of packed red blood cells (RBCs) is high, about CAN\$450 in Ontario,⁵ with the true cost of RBC transfusion in the United States ranging from \$522 to \$1183 after the incorporation of administration, labor, material, and overhead costs.⁶ On the other hand, transfusion can be a life-saving therapeutic measure, especially during procedures associated with major blood loss and coagulopathy, such as aortic surgery.

Several isolated strategies have been previously examined. Intraoperative topical hemostatic agents have been showed to reduce blood transfusion from 47.1% to 29.2% ($P < .01$).⁷ Antifibrinolytic agents, such as epsilon-aminocaproic or tranexamic acid, have been associated with a reduction in transfusions.⁸⁻¹⁰ Use of cell savers have also been associated with a decrease in blood transfusions (relative risk, 0.77; 95% CI, 0.69-0.86)¹¹ as has a restrictive strategy of postoperative red cell transfusion (odds ratio, 0.41; 95% CI, 0.37-0.47).¹² Ad and colleagues¹³ described a reduction in blood products transfused from 54% to 25% following propensity score matching, with no difference in outcomes, using a multidisciplinary approach involving multiple strategies (ie, widespread use of cell salvage, acute normovolemic hemodilution, retrograde autologous priming, and intra- and postoperative restrictive red cell transfusion) to decrease transfusions. Nevertheless, the rate of blood

Rotational thromboelastometry device.

Central Message

The use of rotational thromboelastometry to assess hemostasis may minimize blood transfusion in cardiac surgery.

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product transfusion after cardiac surgery varies substantially amongst institutions. The risk-adjusted rates of blood transfusion during coronary artery bypass grafting ranges from 18.1% to 68.1% in Ontario.¹⁴ Thus, strategies to reduce blood transfusions and variability in transfusion remain relevant to contemporary cardiac surgery. Recently, a point-of-care assessment for hemostasis using rotational thromboelastometry (ROTEM) has emerged as an adjunct to better determine the need for blood transfusion intraoperatively.¹⁵

ROTEM relies on viscoelastic principles to assess hemostasis in whole blood, through the use of multiple tests: INTEM, which activates the contact phase of hemostasis, evaluates the intrinsic coagulation pathway; EXTEM activates hemostasis via physiologic activator tissue factor, being a screening test for extrinsic coagulation pathway abnormalities; HEPTTEM, performed in the presence of heparinase, detects residual heparin; and FIBTEM, which is an assay to evaluate the fibrin part of the clot. The use of ROTEM has been associated with a reduction in the proportion of patients transfused with RBCs (relative risk, 0.86; 95% CI, 0.79-0.94) in a recent meta-analysis involving mostly cardiac surgery patients.¹⁶

St Onge and colleagues¹⁷ report their single-center experience in using ROTEM during aortic surgery and compare their results with aortic cases performed without ROTEM. The primary objective was to assess the influence of a point-of-care ROTEM-based algorithm in aortic surgery,

an operative group typically with high blood transfusion requirements. The primary outcome was RBC transfusion. Two different propensity-score matching models were used, yielding slightly different conclusions. In the primary analysis, using a parsimonious propensity score model, there was a trend toward reducing RBC transfusion in the ROTEM group (58% vs 47%; $P = .08$), which was also associated with transfusion of fewer units of RBCs (median, 1.0 units; interquartile range [IQR], 0.0-4.0 units vs median, 0.0 units; IQR, 0.0-2.0 units; $P = .03$), fresh frozen plasma (median, 0.0 units; IQR, 0.0-4.0 units vs mean, 0.0 units; IQR, 0.0-2.0 units; $P = .04$), and a decrease in recombinant factor VII (11% vs 4%; $P = .04$), whereas desmopressin use was increased (6% vs 16%; $P = .02$). There was no difference in perioperative mortality (4% vs 3%; $P = .99$) or re-exploration for bleeding (12% vs 10%; $P = .68$), whereas massive transfusion was reduced (21% vs 11%; $P = .04$).

However, in a sensitivity analysis using a semisaturated propensity score and including all preoperative variables, none of the transfusion results were statistically different between the control and ROTEM cohorts, although directionally similar to the findings using the parsimonious match. Recombinant factor VII was identical in the 2 groups. Desmopressin use was increased in the ROTEM patients (5% vs 18%; $P < .01$) and a trend toward more prothrombin complex concentrate requirement was observed when using ROTEM (5% vs 11%; $P = .07$). Again we saw no differences in death or re-exploration, but in these patients massive transfusion was no different as well (13% vs 15%; $P = .67$).

The conflicting results between the primary and sensitivity analyses suggest that the study findings are not robust; the findings are suggestive rather than definitive regarding the benefits of ROTEM in this population. The study compared the experimental group (ie, ROTEM use) with historical controls; the before-after study design can be associated with temporal biases, despite propensity score matching. A large proportion of the ROTEM population was lost after adjustment in both the initial (40% [from 188 to 112]) and the latter analysis (49% [from 188 to 95]). This suggests that there may be important confounders even within the relatively short period of 3 years. In addition, there were several variables after propensity score matching with standardized mean differences $> 10\%$. Moreover, the retrospective nature of the study cannot adjust for unmeasured confounders, which only a randomized controlled trial can address.¹⁸

St Onge and colleagues¹⁷ must be congratulated for their important contribution. Their implementation of the point-of-care ROTEM hemostasis assessment in a patient group at increased risk of bleeding and transfusion is notable. It is also important to emphasize that successful blood conservation requires a multidisciplinary approach, as recommended

by the Society of Thoracic Surgeons blood conservation clinical practice guidelines.¹⁹ Successful multidisciplinary patient blood management programs have provided improved results in Australia and Canada.^{20,21} These programs involve pre-, peri-, and postoperative measurements to safely reduce transfusion, integrating and educating patients, family physicians, cardiologists, surgeons, anesthesiologists, intensivists, hematologists, nurses, and nutritionists.

This study demonstrates the safety of ROTEM in aortic surgery, but also leads us to focus on stricter adoption of evidence-based protocols and guidelines by physicians, as well as to understand that blood transfusion should be addressed in a multidisciplinary fashion, integrating different health care professionals and addressing both prevention and treatment.

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