How can ROTEM® testing help you in cardiac surgery?

Complicated bleeding situations can appear intra and post operatively. They can be life-threatening and always require immediate action. A fast differential diagnosis is the basis of targeted therapy.
1. What are the guidelines?
2. Does the ROTEM® analysis give quicker results than conventional lab tests?
3. What are the advantages of using a therapy algorithm guided by ROTEM® (and other POC tests)?
4. Can ROTEM® be used to monitor fibrinogen and fibrinogen substitution?
5. Can ROTEM® be used to monitor protamine reversal?
6. Can ROTEM® be used in pediatric cardiac surgery?
7. Can ROTEM® guided bleeding management reduce costs?
8. Which ROTEM® tests should be measured and when during CPB?
What are the guidelines?

**Management of severe perioperative bleeding**

Guidelines from the European Society of Anaesthesiology


“We recommend the application of transfusion algorithms incorporating predefined intervention triggers based on POC coagulation monitoring assays to guide haemostatic intervention during cardiovascular surgery.” 1C

“We recommend the use of perioperative coagulation monitoring using ROTEM/TEG for targeted management of coagulopathy.” 1C

“We recommend that fibrinogen concentrate infusion guided by point-of-care viscoelastic coagulation monitoring should be used to reduce perioperative blood loss in complex cardiovascular surgery.” 1B

“We recommend that a plasma fibrinogen concentration <1.5–2.0 g l_1 or ROTEM/TEG signs of functional fibrinogen deficit should be triggers for fibrinogen substitution.” 1C

“We suggest that fibrinogen concentrate (30–50 mg kg_1) or cryoprecipitate (5 ml kg_1) may be used to increase plasma fibrinogen concentrations above trigger values of 1.5–2.0 g l_1 or FIBTEM MCF > 7mm in bleeding children.” 2C

“We suggest the use of perioperative coagulation analysis using viscoelastic point-of-care monitoring (ROTEM/TEG) for timely detection of coagulation defects including dilutional coagulopathy and hyperfibrinolysis.” 2C

“Implementation of transfusion and coagulation management algorithms (based on ROTEM/TEG) can reduce transfusion-associated costs in trauma, cardiac surgery and liver transplantation.” B

“Targeted therapy with fibrinogen and/or PCC guided by ROTEM/TEG is not associated with an increased incidence of thromboembolic events.” C
Does ROTEM® analysis give quicker results than conventional lab tests?

A comparative evaluation of rotation thromboelastometry and standard coagulation tests in hemodilution-induced coagulation changes after cardiac surgery


“ROTEM variables demonstrated clinically relevant correlations with PLT counts and fibrinogen levels.... Decreasing levels of fibrinogen can be quickly determined (<15-20 min) using FIBTEM”

Early thromboelastometric variables reliably predict maximum clot firmness in patients undergoing cardiac surgery: a step towards earlier decision making

Dirkmann et al.; Acta Anaesthesiol Scand. 2013 May;57(5)

“We recommend the use of Clot Firmness after 5 or 10 min to allow earlier assessment and potential therapeutic action”

Using reagent-supported thromboelastometry (ROTEM) to monitor haemostatic changes in congenital heart surgery employing deep hypothermic circulatory arrest.


“ROTEM® results were available within 15 min and therefore much faster than standard tests”
What are the advantages of using a therapy algorithm guided by ROTEM®? (and other POC tests)

Hemostatic therapy algorithms in conjunction with POC testing reduced the number of transfused units of packed erythrocytes when compared with conventional laboratory coagulation testing.

POC-guided therapy was associated with lower FFP and PC usage and costs as well as an improved clinical outcome.

6-month mortality was lower in the POC group.

...the use of a ROTEM-guided transfusion algorithm... was associated with a significant decrease in the cumulative number of transfused allogeneic blood units.

ROTEM usage was...associated with a reduced risk of massive perioperative transfusion.

Implementation of a coagulation management algorithm based on early, first-line therapy with fibrinogen concentrate and/or PCCs combined with POC testing using thromboelastometry and impedance aggregometry was associated with a marked decrease in the incidence of allogeneic blood transfusion and of transfusion requirements when compared with temporal controls.

The incidence of massive transfusion, reexploration, and of thrombotic/thromboembolic adverse events also decreased.
What are the advantages of using a therapy algorithm guided by ROTEM®? (and other POC tests)

Potential value of transfusion protocols in cardiac surgery.


“Implementation of POC algorithms including a comprehensive bundle of POC diagnostics (thromboelastometry and whole blood impedance aggregometry) … seems to be complex but most effective in reducing perioperative transfusion requirements and has been shown to be associated with a decreased incidence of thrombotic/thromboembolic events, transfusion-related adverse events, as well as with improved patients’ outcomes including 6-month mortality.”
(review 16 studies, 8507 cardiovascular surgical patients)

Can ROTEM® be used to monitor fibrinogen and fibrinogen substitution?

Fibrinogen Concentration Significantly Decreases After On-Pump Versus Off-Pump Coronary Artery Bypass Surgery: A Systematic Point-of-Care ROTEM® Analysis


“A comparative evaluation of rotation thromboelastometry and standard coagulation tests in hemodilution-induced coagulation changes after cardiac surgery


“Fibrinogen concentration significantly decreases after cardiopulmonary bypass. ROTEM helps in its fast detection”

“Decreasing levels of fibrinogen can be quickly determined (<15-20 min) using FIBTEM”
Use of fibrin-based thromboelastometry for cryoprecipitate transfusion in cardiac surgery involving deep hypothermic circulatory arrest during cardiopulmonary bypass

Sang Hyun Lee et al.; Blood Coagul Fibrinolysis. 2010 Oct;21(7):687-91

"The fibrinogen level reflected in FIBTEM values during pump can be used to estimate FIBTEM after Protamin reversal..."

"...the amount of cryoprecipitate needed for replacing mainly the fibrinogen could be predicted with high sensitivity and specificity":

Fibrinogen concentrate reduces intraoperative bleeding when used as first-line hemostatic therapy during major aortic replacement surgery: results from a randomized, placebo-controlled trial.


"That FIBTEM-guided fibrinogen concentrate as first-line hemostatic therapy led to a significant reduction in the rate of bleeding explains why patients who received fibrinogen concentrate required fewer transfusions with allogeneic blood products than patients who received placebo".

"Our findings demonstrate the benefit of using a target FIBTEM maximum clot firmness value to guide appropriate dosing of fibrinogen concentrate".

Bleeding management with fibrinogen concentrate targeting a high-normal plasma fibrinogen level: a pilot study.


"The FIBTEM MCF was an appropriate parameter for dosing fibrinogen concentrate":

Reduction of Fresh Frozen Plasma Requirements by Perioperative Point-of-Care Coagulation Management with Early Calculated Goal-Directed Therapy.


“...the amount of cryoprecipitate needed for replacing mainly the fibrinogen could be predicted with high sensitivity and specificity".
Effects of protamine and heparin can be detected and easily differentiated by modified thrombelastography (Rotem): an in vitro study.

Mittermayr et al.; Br J Anaesth. 2005 Sep;95(3):310-6

“Effects of protamine and heparin can be detected and easily differentiated”

Can ROTEM® be used in pediatric cardiac surgery?

Can ROTEM® analysis be applied for haemostatic monitoring in paediatric congenital heart surgery?

Andreasen et al.; Cardiol Young. 2011 Dec;21(6):684-91

Intraoperative Thromboelastometry Is Associated with Reduced Transfusion Prevalence in Pediatric Cardiac Surgery

Romlin et al.; Anesth Analg 2011; 112:30–6

“ROTEM® can detect haemostatic impairments in children undergoing cardiac surgery”

“...routine use of intraoperative TEM to guide transfusions in pediatric cardiac surgery reduces the overall proportion of patients receiving transfusions...”
Can ROTEM® be used in pediatric cardiac surgery?

Earlier detection of coagulopathy with thromboelastometry during pediatric cardiac surgery: a prospective observational study

Birgitta et al.; Paediatr Anaesth. 2013 Mar;23(3):222-7

“Intraoperative TEM analyses can be accelerated ... by analyzing clot firmness already after 10 minutes”

Thromboelastometry (ROTEM®) in children: age-related reference ranges and correlations with standard coagulation tests.


Can ROTEM® guided bleeding management reduce costs?

Reference ranges for children are available

HTA Programme: Health Technology Assessment Report 11
The clinical and cost effectiveness of thromboelastography/thromboelastometry

Craig et al.; NHS Quality Improvement Scotland 2008.

“Financial savings for the NHS by use of TE (primarily hospitalization and cost of blood products) is calculated as > 0.34 Mio £ for cardiac surgery“ (UK, Scotland)
Can ROTEM® guided bleeding management reduce costs?

Point-of-Care Testing A Prospective, Randomized Clinical Trial of Efficacy in Coagulopathic Cardiac Surgery Patients

Weber et al.; Anesthesiology 2012; 117:531–47

“Conventional coagulation management was nearly twice as expensive as POC-guided coagulation management”

Thromboelastometry Based Early Goal-Directed Coagulation Management Reduces Blood Transfusion Requirements, Adverse Events, and Costs in Acute Type A Aortic Dissection: A Pilot Study


“Postoperative plasma transfusion (p = 0.038), recognized incidents (p = 0.048), and resulting costs on coagulation treatment (p = 0.049) were significantly reduced”.

First-line Therapy with Coagulation Factor Concentrates Combined with Point-of-Care Coagulation Testing is Associated with Decreased Allogeneic Blood Transfusion in Cardiovascular Surgery: A Retrospective, Single-center Cohort Study

Görlinger et al.; Anesthesiology. 2011 Dec;115(6):1179-91

“Overall costs for allogeneic blood products and coagulation factor concentrates per patient decreased by 6.5%, corresponding to a cost-saving of about 50,000 euros per year”.

Cost reduction of perioperative coagulation management in cardiac surgery: value of "bedside" thrombelastography (ROTEM).

Spalding et al.;

"Saved costs for blood- and coagulation products clearly outweighed the expenses of ROTEM® (Germany)

An audit of red cell and blood product use after the institution of thromboelastometry in a cardiac intensive care unit.

Anderson et al.;

"Introduction of thromboelastometry has significantly decreased our use of red cells and blood products" (UK)
Which ROTEM® tests should be measured and when during CPB?

Published information and recommendations are available from expert ROTEM® users. e.g. in the ROTEM® delta HELP menu

**Sample times**

1. **Anaesthesia**
   - Optional
   - Either INTEM or EXTEM

2. **CPB**
   - 30 min before coming off bypass
   - FIBTEM, INTEM, EXTEM

3. **Protamine**
   - 10 min after protamine
   - INTEM, HEPTEM, EXTEM, FIBTEM

**Note:**
- This recommendation is based on liquid ROTEM® reagents
- The heparin sensitive single use reagents fib-tem® S, ex-tem® S and ap-tem® S are not used for testing during CPB.