



Lithuanian University of Health Sciences

Optimizing Patient Safety Through Comprehensive Bleeding Management In Cardiac Surgery

YERLAN ORAZYMBETOV



WHY BLEEDING MATTERS?

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①

More than 1 million open heart surgery

②

Approximately 1 in 5 patients experiences excessive bleeding

③

20–40% patients receive a transfusion



BLEEDING INCREASES



1

The rate of re-exploration

2

Blood transfusion

3

The length of hospital stay

4

Costs

5

Prolonged mechanical
ventilation

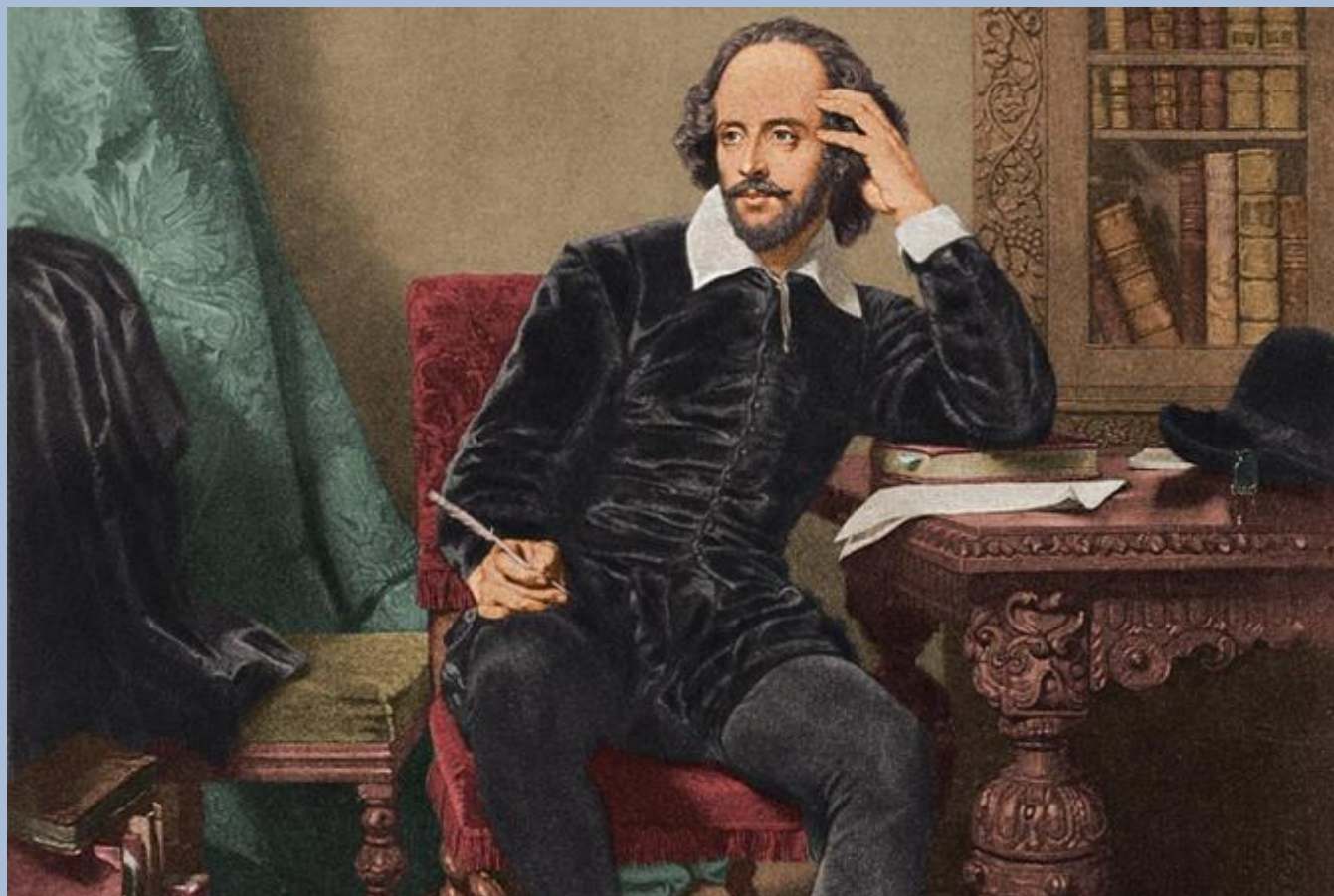
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Acute respiratory distress
syndrome and atrial arrhythmias

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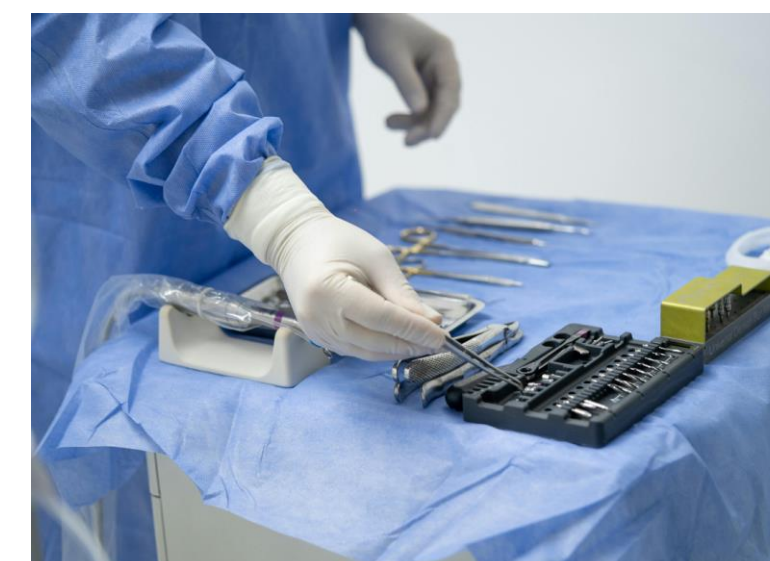
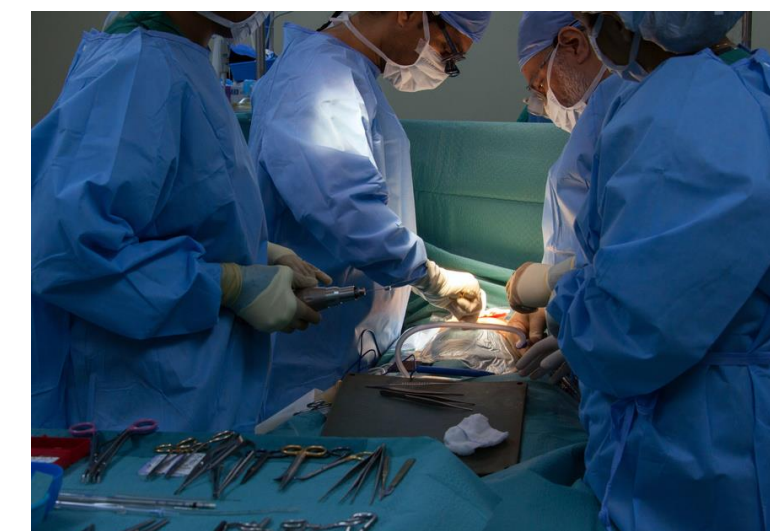
Morbidity and mortality

**To BLEED
or Not to
BLEED?**





LITUOVOS SVEIKATOS MOKSLŲ
UNIVERSITETO LIGONINĖ
KAUNO
KLINIKOS



**THE AVERAGE BLOOD VOLUME LOSS AFTER HEART SURGERY IS
300 ML, WHICH IS SIGNIFICANTLY HIGHER IN 10% OF CASES**

**THE REOPERATION RATE DUE TO BLEEDING IS BETWEEN 2.3 AND
8%.**

Reoperation for Bleeding in Patients Undergoing Coronary Artery Bypass Surgery

Incidence, Risk Factors, Time Trends, and Outcomes

Rajendra H. Mehta, Shubin Sheng, Sean M. O'Brien, Frederick L. Grover, James S. Gammie, T. Bruce Ferguson, Eric D. Peterson and
and on behalf of the Society of Thoracic Surgeons National Cardiac Surgery Database Investigators

Originally published 6 Oct 2009 | <https://doi.org/10.1161/CIRCOUTCOMES.109.858811> | Circulation: Cardiovascular Quality and Outcomes. 2009;2:583-590

[Other version\(s\) of this article](#) ▼

Etiology of Bleeding

Surgical factors

50–67%

Coagulation disorders

33%

MECHANISMS OF BLEEDING

General

- Anemia
- Coagulopathy
- The effect of medications

CPB-related causes

- Platelet dysfunction
- Hemodilution
- Hypothermia (Enzyme Slowdown)
- Hyperfibrinolysis
- Heparin/protamine imbalance

The influence of cardiopulmonary bypass on coagulation



Increase

PT and INR 33%
aPTT 20%

Fibrinogen
concentration 36%
The absolute platelet
count 45%
Platelet function 65%
Plasma coagulation
factors 30-50%

Decrease

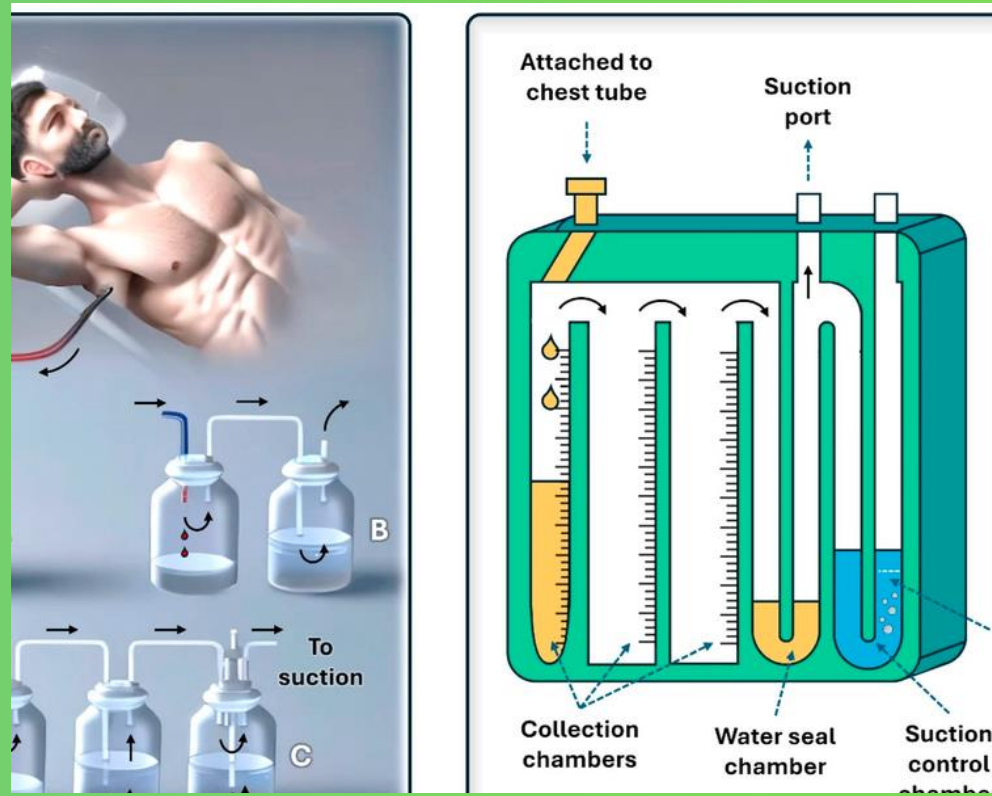
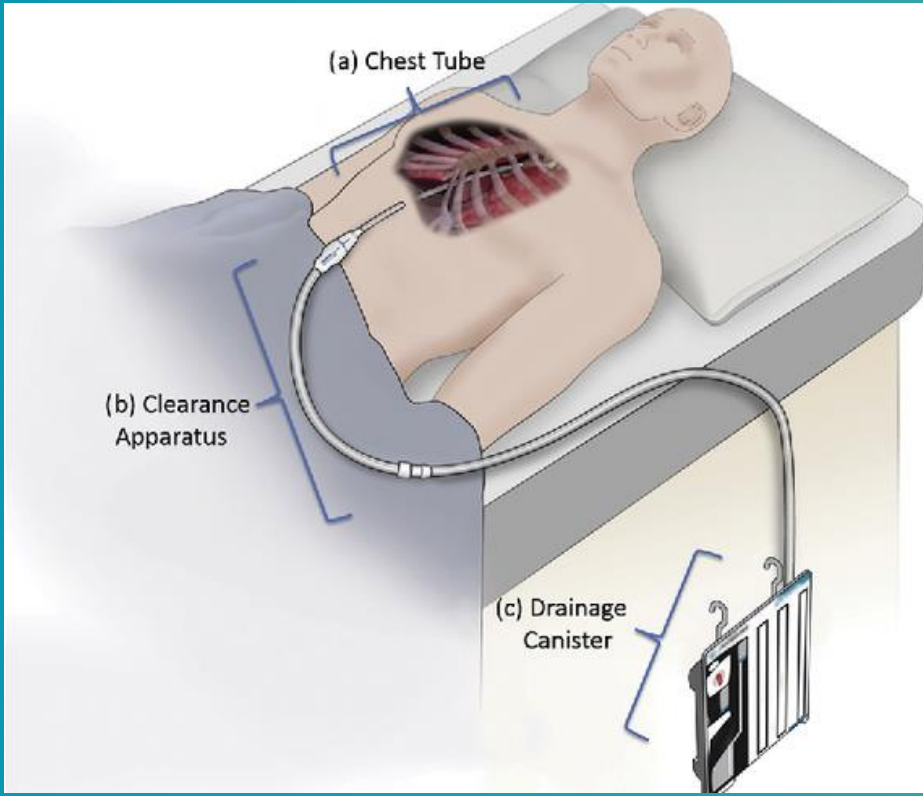
Definition and Grading of Bleeding



TABLE 1 Characteristics of Common Bleeding Scales Used in Cardiac Surgery

Bleeding Scale	Main Components	Advantages	Disadvantages
E-CABG ²²	• Amount of blood components transfused • Need for reexploration for excessive bleeding	– Relatively simple definition of bleeding – Accounts for postoperative bleeding – Incorporates an additive score	– Based on surrogate outcomes of bleeding
UDPB ⁹	• Delay in sternal closure • Postoperative chest tube blood loss within 12 hours • Amount of blood components transfused • Prothrombotic drugs administered • Need for reexploration or tamponade	– Widely used – Incorporates measurement of blood loss volume	– Complex grading system – Partially based on surrogate outcomes of bleeding
BARC ¹⁰	• Overt signs of bleeding • Hemoglobin level • Need for reexploration or tamponade • Requirement for IV vasoactive agents • Intracranial hemorrhage • Transfusion of whole blood or pRBCs within 48 hours • Chest tube output within a 24-hour period	– Combines both laboratory and clinical assessments – Specifically includes assessment of CABG-related bleeding – Validated in acute coronary syndrome²³ – Incorporates measurement of blood loss volume	– Minor grades potentially not clinically relevant – Complex grading system – Partially based on surrogate outcomes of bleeding – Designed based on consensus
WHO ¹⁵	• Visual assessment of hemorrhage	– Widely used – Relatively simple definition of bleeding – Does not require laboratory assessment	– Subjective – Associated with high interobserver variability²⁴ – Minor grades potentially not clinically relevant
SPOT GRADE ¹⁷	• Visual assessment of hemorrhage • Expected interventions • Rate of blood flow	– Clinically validated²⁵ – Meets US FDA requirements for use in determining the degree of bleeding in a surgical wound – Based on quantitative determination of blood flow	– Some subjective elements – Limited to intraoperative assessment
VIBe ¹⁶	• Visual presentation • Anatomic appearance • Estimated rate of blood loss	– Designed based on US FDA criteria for clinician-reported scales – Validated in multiple surgical disciplines – Includes an assessment of blood loss	– Some subjective elements – Limited to intraoperative assessment

BARC, Bleeding Academic Research Consortium; E-CABG, European registry of Coronary Artery Bypass Grafting; IV, intravenous; pRBCs, packed red blood cells; UDPB, Universal Definition of Perioperative Bleeding; US FDA, United States Food and Drug Administration; VIBe, Validated Intraoperative Bleeding; WHO, World Health Organization.



50 kg



120 kg

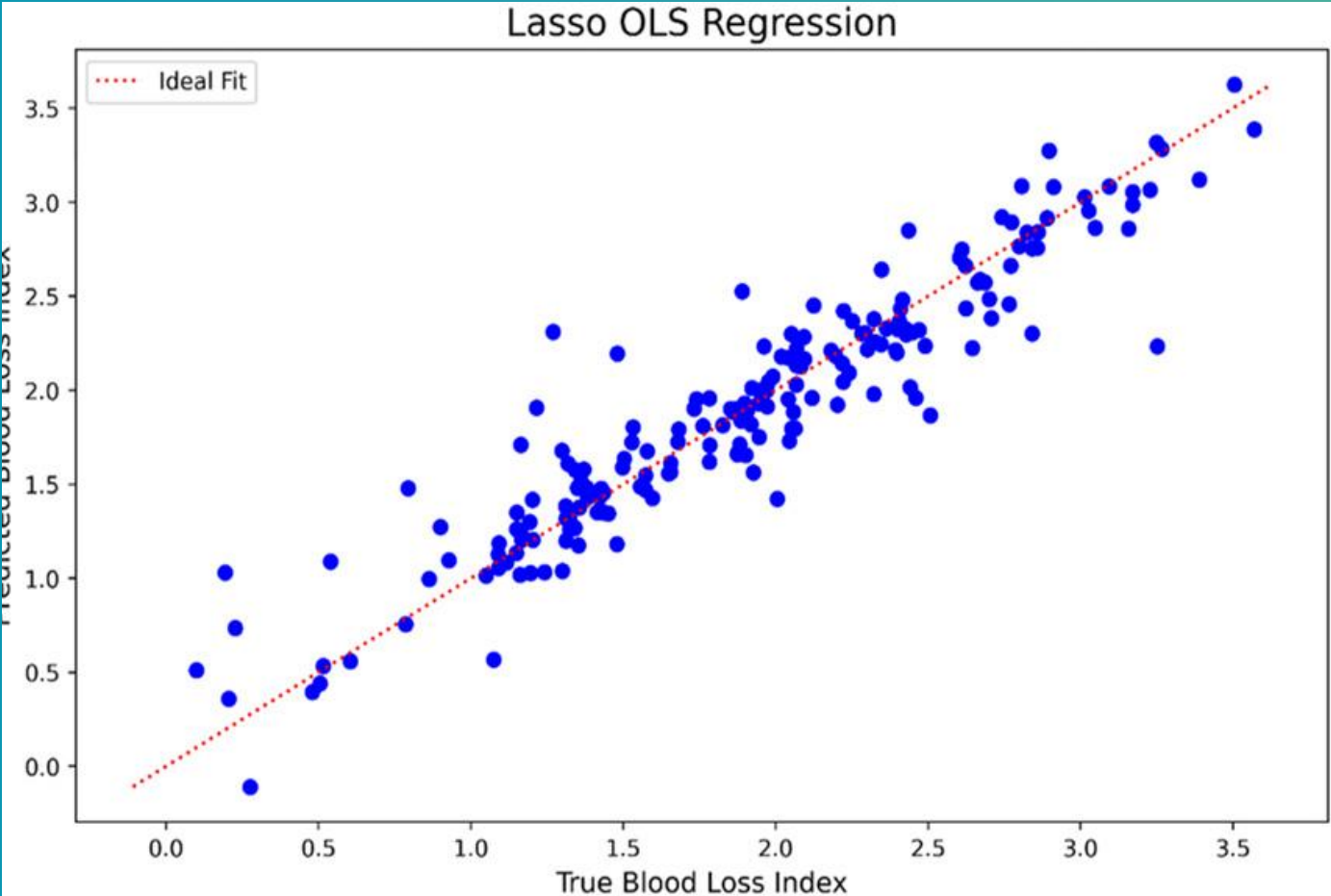


Calculation of blood loss in cardiac surgery: How should we monitor?

Yerlan Orazymbetov,^{1,2} Serik Aitaliyev,^{1,3} Povilas Jakuška,¹ Audronė Veikutienė,⁴ Tadas Lenkutis,⁵ Rassul Zhumagaliyev,¹ Aušra Saudargienė⁶ and Rimantas Benetis¹

Perfusion
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$$Hb/kg\ index = \frac{Hb\ loss\ (intra-op) + Hb\ loss\ (CTD) - Hb\ transfusion\ (PRBC)}{Body\ weight\ (kg)}$$



Model	MSE Mean ±	MAPE Mean	Corr Mean ±	R2 ± SD
LR	0.12 ± 0.13	0.20 ± 0.11	0.90 ± 0.08	0.77 ± 0.17
Lasso	0.15 ± 0.07	0.31 ± 0.17	0.91 ± 0.06	0.68 ± 0.07
Lasso-OLS	0.08 ± 0.04	0.18 ± 0.10	0.92 ± 0.06	0.82 ± 0.13
SVM	0.17 ± 0.08	0.31 ± 0.19	0.83 ± 0.09	0.64 ± 0.15
kNN	0.35 ± 0.14	0.48 ± 0.29	0.58 ± 0.09	0.26 ± 0.12
DT	0.30 ± 0.09	0.33 ± 0.17	0.65 ± 0.19	0.24 ± 0.44
XGBoost	0.15 ± 0.05	0.27 ± 0.12	0.84 ± 0.11	0.65 ± 0.21
DNN	0.34 ± 0.36	0.42 ± 0.35	0.75 ± 0.20	0.42 ± 0.21

Patient Outcomes Related to Excessive Bleeding and Reexploration



Control of bleeding throughout the cardiac surgical procedure should be a high priority.



Excessive intraoperative and postoperative bleeding in cardiac surgery significantly increases the likelihood of the need for reexploration.



Excessive perioperative bleeding in cardiac surgery is associated with an increased risk of adverse outcomes.



Prompt reexploration for bleeding reduces the risk of adverse outcomes.



What is **ROTEM**?

-  **Viscoelastic Hemostatic Assays (VHAs)**
-  **Measures: initiation, strength, fibrinogen role, lysis**
-  **Faster than PT/aPTT/INR**
-  **•Point-of-care, bedside use**
-  **Applications: pre-op, intra-op, post-op**

ROTEM

01

Basics

- Viscoelastic Hemostatic Assays (VHAs)
- Measures clot initiation, strength, fibrinogen role, lysis
- Faster than PT/aPTT/INR
- Point-of-care, bedside use

02

Parameters Explained

- CT: Clotting Time - initiation
- CFT: Clot Formation Time - kinetics
- MCF: Maximum Clot Firmness - stability
- LI/ML: Lysis Index/Maximum Lysis - fibrinolysis

03

Advantages

- Point-of-care, bedside testing
- Rapid results: minutes vs hours
- Guides targeted therapy
- ↓ Blood product consumption

NEW



Rotational Thromboelastometry for Assessing Bleeding Complications and Factor XIII Deficiency in Cardiac Surgery Patients

Christoph Raspé, PhD¹, Maximilian Besch, MD¹, Efstratios I. Charitos, PhD, MD², Lilit Flöther, MD¹, Michael Bucher, PhD¹, Florian Rückert¹, and Hendrik Treede, PhD²

Clinical and Applied
Thrombosis/Hemostasis
2018, Vol. 24(9S) 136S-144S
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 CARDIOTHORACIC ANESTHESIOLOGY:
The *Annals of Thoracic Surgery* CME Program is located online at <http://www.annalsthoracicsurgery.org/cme/home>. To take the CME activity related to this article, you must have either an STS member or an individual non-member subscription to the journal.

Thromboelastography-Directed Transfusion in Cardiac Surgery: Impact on Postoperative Outcomes

Roberta E. Redfern, PhD, Kevin Fleming, CCP, Rebekah L. March, MPH, Nathan Bobulski, CCP, Michael Kuehne, PhD, PA-C, John T. Chen, PhD, and Michael Moront, MD

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AHA/ASA Journals

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Circulation

RESEARCH ARTICLE

Originally Published 21 September 2016

Check for updates

Point-of-Care Hemostatic Testing in Cardiac Surgery: A Stepped-Wedge Clustered Randomized Controlled Trial

Keyvan Karkouti, MD, Jeannie Callum, MD, Duminda N. Wijeyesundera, MD, PhD, Vivek Rao, MD, PhD, Mark Crowther, MD, Hilary P. Grocott, MD, Ruxandra Pinto, PhD, and Damon C. Scales, MD, PhD TACS Investigators

AUTHOR INFO & AFFILIATIONS

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BLOOD TRANSFUSION

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Blood Transfusion - 3 2018 (May - June)

Introduction of thromboelastometry-guided administration of fresh-frozen...

Original article

Blood Transfusion - 3 2018 (May - June)

Introduction of thromboelastometry-guided administration of fresh-frozen plasma is associated with decreased allogeneic blood transfusions and post-operative blood loss in cardiopulmonary-bypass surgery

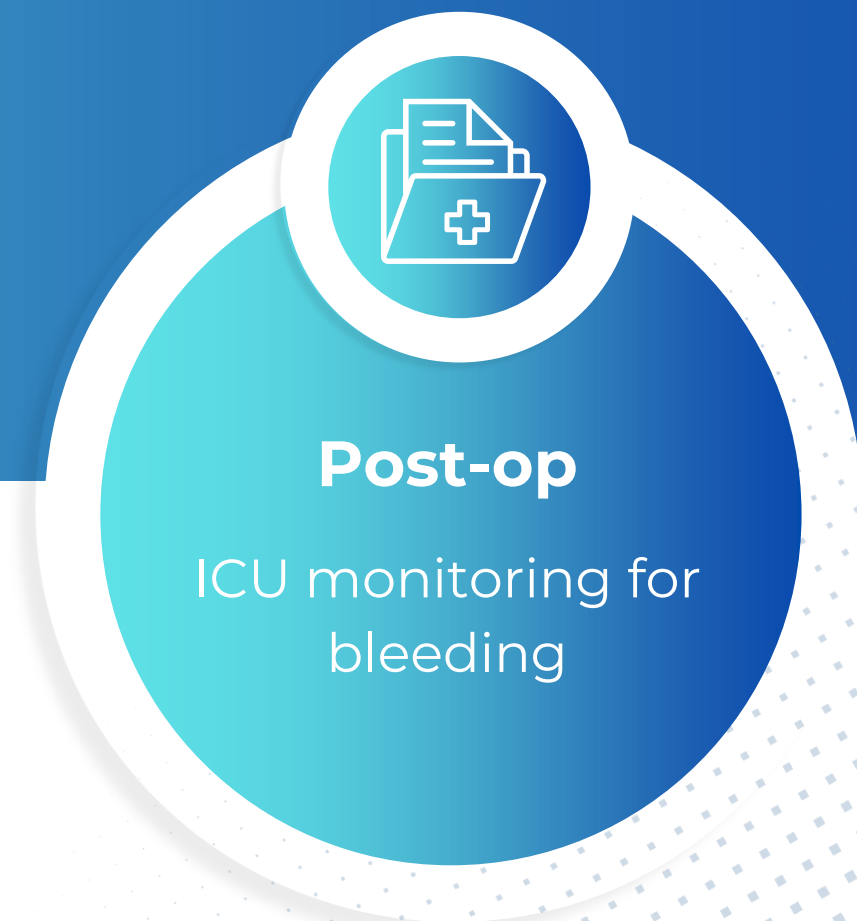
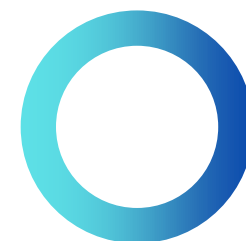
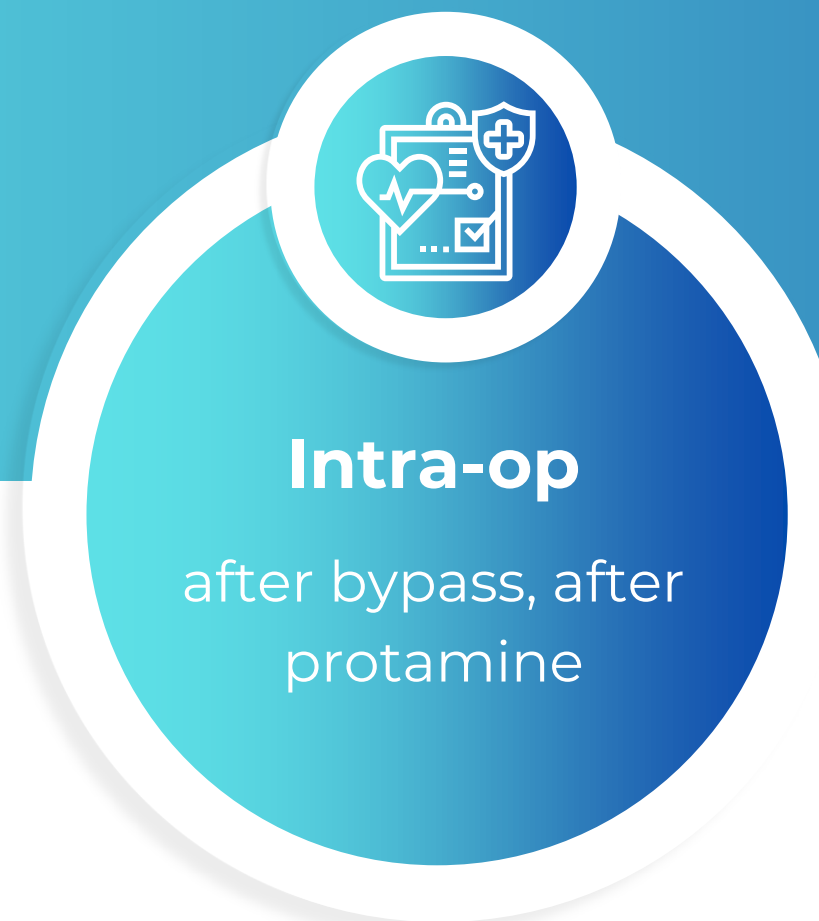
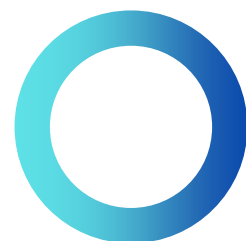
[Junko Ichikawa](#), [Takahito Marubuchi](#), [Keiko Nishiyama](#), [Mitsuharu Kodaka](#), [Klaus Görlinger](#), [Makoto Ozaki](#), [Makiko Komori](#)

Key words: blood coagulation, rotational thromboelastometry, cardiopulmonary bypass, fresh-frozen plasma, transfusion

DOI: 10.1182/2017-03-0000000000000000

CLINICAL APPLICATION – TIMING

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LATEST EVIDENCE & GUIDELINES



EACTS/EACTAIC 2024

Support ROTEM-guided algorithms



Karrar et al. 2024:

↓ Allogenic transfusions



Noteboom et al. 2025

Interpretation reliable, training needed



Ihtasham et al. 2025

Integration with anemia correction, anticoagulation, fibrinogen prophylaxis

Patient Blood Management



01

RBC transfusion should not be used empirically

02

**An evidence-based hemoglobin threshold and defined clinical criteria
7.5 g/dL**

03

Standardization is needed to reduce unwanted variability in transfusions

04

Intraoperative RBC recovery

05

Acute normovolemic hemodilution

06

Retrograde autologous priming

THE USE OF ANTITHROMBOTIC AGENTS

The risks of stopping anticoagulant and anti-platelet therapy must be individualized and balanced against the benefits of continuing therapy.

Prior to elective surgery, in the absence of coronary artery disease (CAD) or a strong antithrombotic indication, aspirin should be discontinued to reduce the risk of bleeding.

MANAGING CATASTROPHIC BLEEDING – 5 P'S

Outcome: This structured approach = fewer re-explorations, optimized transfusion, and improved patient outcomes (Karkouti & Ho 2018).



Thank You

