Patient Blood Management: Evidence-based Impact on Mortality Reduction

6th EEMEA Acute Care Experts Meeting, Vilnius, October 15-16, 2025

Klaus Görlinger, MD, Essen/Munich, Germany

Disclosures

- Senior Consultant for Anesthesiology, Emergency and Intensive Care Medicine, Hemostaseology, and Pain Therapy
- Dec 1986 - June 2012: Senior Consultant at the Department of Anesthesiology and Intensive Care Medicine, **University Hospital Essen, Germany** (Trauma, Liver Transplant and Cardiac Surgery)
- 2010 - 2012: Chair of the Section Clinical Hemotherapy and Hemostasis Management of the German Interdisciplinary Association of Critical Care and Emergency Medicine (**DIVI**)
- 2010 - 2012: Member of the European Society of Anesthesiology (**ESA**) Scientific Subcommittee Transfusion and Hemostasis and the Task Force / co-author of the **ESA Guidelines on the Management of Severe Perioperative Bleeding**
- Since July 2012, KG is the **Medical Director** of **Tem Innovations GmbH**, Munich, Germany, which belongs to **Werfen,** Barcelona, Spain since September 2016.

Obstetrics and PPH

Blood Transfus. 2019 Mar;17(2):112-136.

Patient Blood Management in Obstetrics: Prevention and Treatment of Postpartum Haemorrhage. A NATA Consensus Statement

Muñoz M, Stensballe J, Ducloy-Bouthors AS, Bonnet MP, De Robertis E, Fornet I, Goffinet F, Hofer S, Holzgreve W, Manrique S, Nizard J, Christory F, Samama CM, Hardy JF.

Recommendation 35. We recommend assessing haemostatic competence and risk of coagulopathy in severe ongoing PPH through laboratory tests (platelet count, PT, international normalised ratio [INR], aPTT, fibrinogen level) or **viscoelastic haemostatic tests to guide appropriate, goal-directed use of haemostatic blood components and pro-haemostatic agents (1B).**

Recommendation 36. **We recommend against pre-emptive fibrinogen supplementation (1B).** Instead, fibrinogen levels should be monitored early in severe ongoing PPH in order to **consider cryoprecipitate or fibrinogen concentrate substitution at a plasma level <2 g/L or FIBTEM A5 <12 mm (1C).**

Saudi J Anaesth. 2023 Jan-Mar;17(1):23-32.

The Role of Point of Care Thromboelastography (TEG) and Thromboelastometry (ROTEM) in Management of Primary Postpartum Haemorrhage: A Meta-Analysis and Systematic Review

Khanna P, Sinha C, Singh AK, Kumar A, Sarkar S.

RESULTS: We retrieved **five studies,** with a total of **1914 parturient with PPH.**

Patients receiving transfusion based upon **point of care viscoelastic tests** had lesser risk of having **emergency hysterectomy (OR = 0.55,** 95% CI 0.32-0.95, I2 = 7%), transfusion-associated circulatory overload **(TACO) (OR = 0.03,** 95% CI 0.00-0.50), reduced transfusion of **FFP (OR = 0.07,** 95% CI 0.04-0.14, I2 = 89%), **platelets (OR = 0.51,** 95% CI 0.28-0.91, I2 = 89%), **PRBC transfusion (OR = 0.70,** 95% CI 0.55-0.88, I2 = 89%), and had better **cost-effective treatment [Mean difference (MD) = -357.5,** 95% CI - 567.75 to -147.25, I2 = 93%] than patient received empirical transfusion.

No mortality was detected across the studies.

CONCLUSIONS: Point of care viscoelastic assessment guided transfusion in PPH confederates with **reduced morbidity.**

Patient Safety Award 2021

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soap.org

TRAUMA (TIC AND TBI)

J Trauma Acute Care Surg. 2020 Dec;89(6):999-1017.

2020 EAST PODIUM PAPER

Eastern Association for the Surgery of Trauma
Advancing Science, Fostering Relationships, and Building Careers

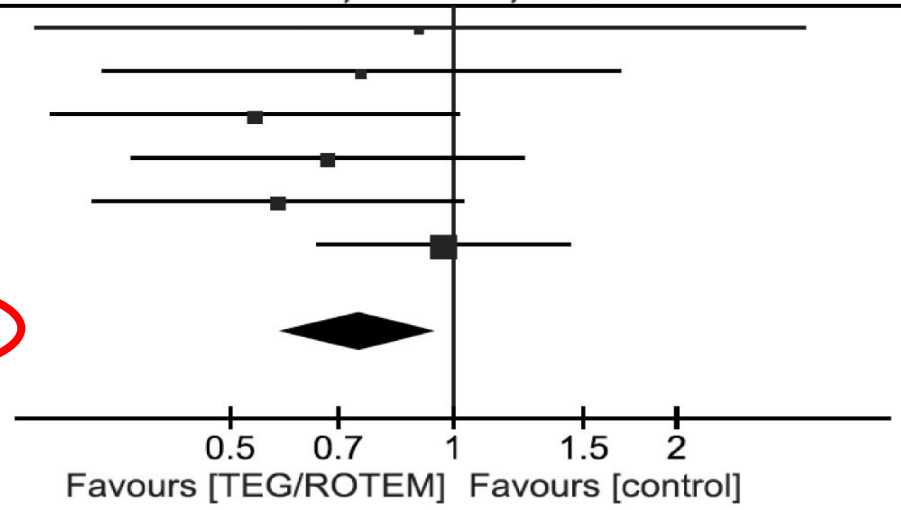
Thromboelastography and Rotational Thromboelastometry in Bleeding Patients with Coagulopathy: Practice Management Guideline from the Eastern Association for the Surgery of Trauma

Bugaev N, Como JJ, Golani G, Freeman JJ, Sawhney JS, Vatsaas CJ, Yorkgitis BK, Kreiner LA, Garcia NM, Aziz HA, Pappas PA, Mahoney EJ, Brown ZW, Kasotakis G.

F Mortality

Study or Subgroup	TEG/ROTEM Events	Total	Control Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Prat 2017	4	85	7	134	4.1%	0.90 [0.27, 2.99]
Schochl 2011	6	80	60	601	9.1%	0.75 [0.34, 1.68]
Gonzalez 2016	11	56	20	55	14.7%	0.54 [0.29, 1.02]
Nardi 2015	13	96	26	130	15.8%	0.68 [0.37, 1.25]
Unruh 2019	15	47	11	20	17.8%	0.58 [0.33, 1.03]
Guth 2019	33	102	34	102	38.4%	0.97 [0.66, 1.44]
Total (95% CI)		**466**		**1042**	**100.0%**	**0.75 [0.59, 0.95]**
Total events	82		158			

Heterogeneity: Tau² = 0.00; Chi² = 3.64, df = 5 (P = 0.60); I² = 0%
Test for overall effect: Z = 2.35 (P = 0.02)



J Trauma Acute Care Surg. 2020 Jul;89(1):145-152.

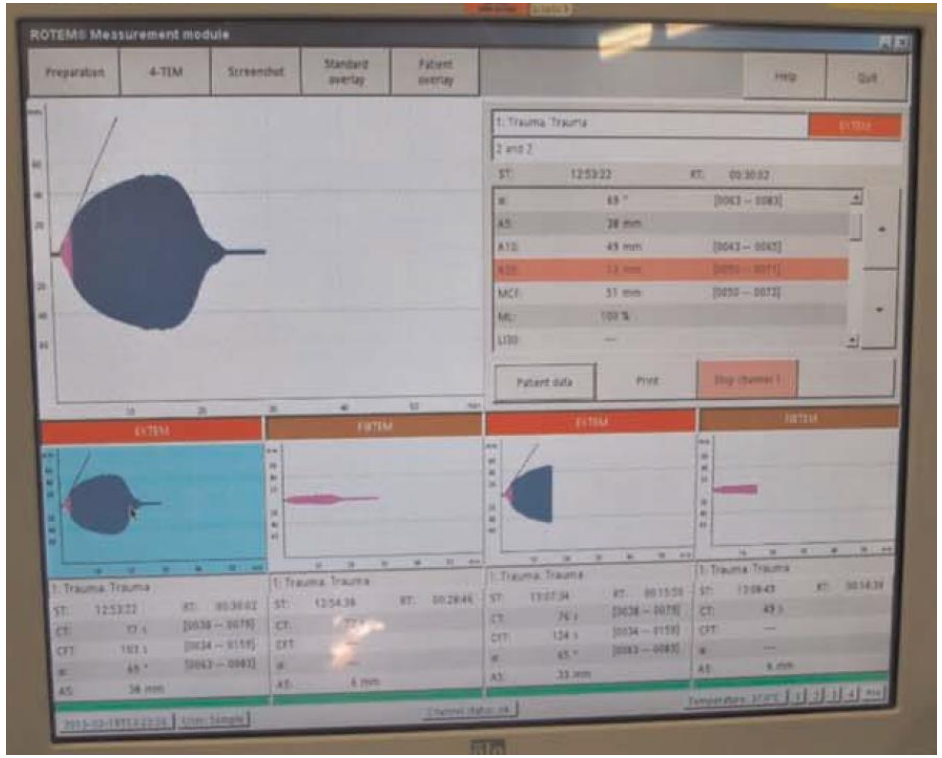
2020 EAST PODIUM PAPER

Viscoelastic Testing in Combat Resuscitation: Is it Time for a new Standard?

Lammers DT, Marenco CW, Morte KR, Bingham JR, Martin MJ, Eckert MJ.

RESULTS: There are **3,320 patients,** predominately male (98%), median age ranges from 25 years to 29 years, **Injury Severity Score of 18.8,** with a penetrating injury (84%) were studied. **Overall mortality was 9.7%.**

Five hundred ninety-four patients had VET during their initial resuscitation. After adjusting for confounders, **VET during initial resuscitation was independently associated with decreased mortality (OR, 0.63; *P = 0.04*; overall mortality after propensity analysis, 7.3% vs. 13.1%; *P = 0.001*).**

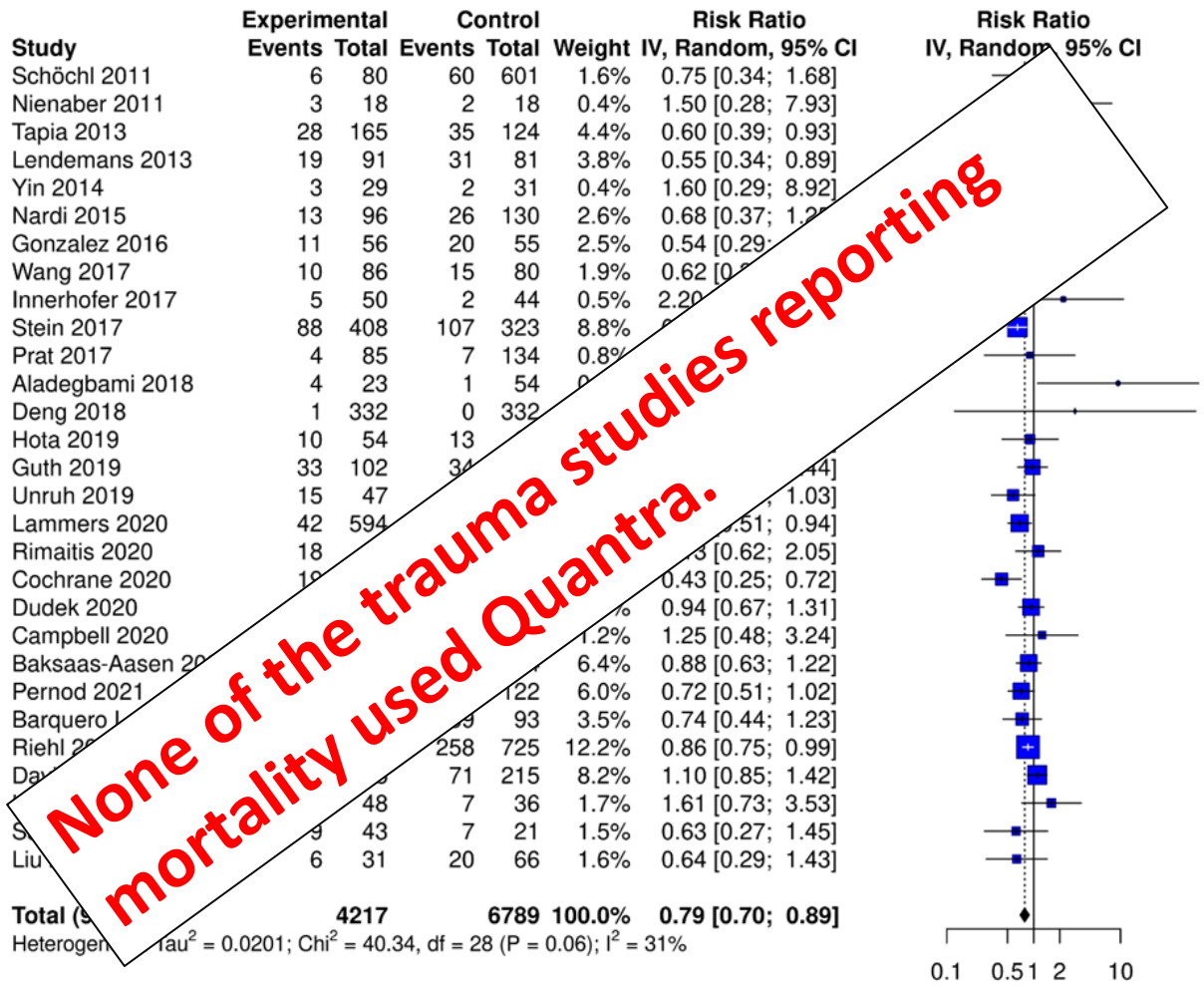


The Anesthesiology Annual Meeting; Oct 19, 2024, Philadelphia, USA. https://www.abstractsonline.com/pp8/#!/20301/presentation/31674.

Effect of Viscoelastic Testing on Mortality in Bleeding Patients with Severe Trauma: A Meta-Analysis

Goerlinger K, Maegele M, Lier H, Spahn DR.

SUMMARY: Our meta-analysis (random model) based on **29 studies** with **11,006 participants (overall mortality, 19%)** demonstrates a **significant reduction in mortality by viscoelastic testing (ROTEM/TEG)-guided bleeding management in bleeding patients with severe trauma (RR (95% CI), 0.7890 (0.7014; 0.8877); *P = 0.0003*).**

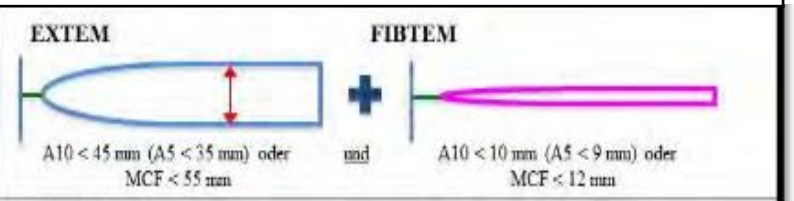
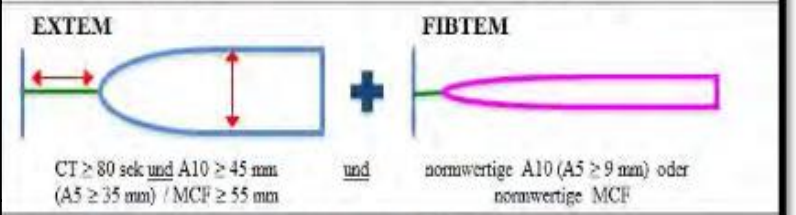
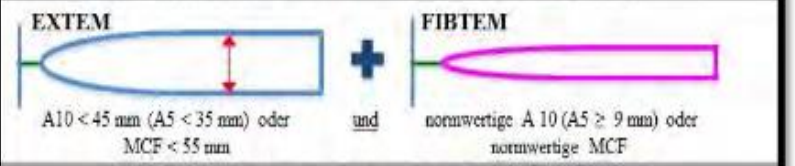


None of the trauma studies reporting mortality used Quantra.

German Level 3 Guideline on the Treatment of Patients with Severe/Multiple Injuries: AWMF Register-Nr. 187-023 (Version 4.1 from 2022-12-31; DGU)

2.4.14	Recommendation	New 2022
Recommendation Level A↑↑	Coagulation diagnostics and therapy should be guided by viscoelastic testing. **When available has been deleted!**	
2.4.15	Recommendation	New 2022
Recommendation Level B ↑	Coagulation diagnostics and therapy should be complemented by platelet function diagnostics.	
2.4.17	Recommendation	Modified 2022
Recommendation Level A↑↑	In patients with life-threatening bleeding and/or shock as well as in proven hyperfibrinolysis, 1 g tranexamic acid (TXA) should be given as soon as possible /prehospital over 10 minutes followed by an infusion of 1 g over 8 hours.	
2.4.20	Recommendation	New 2022
Recommendation Level A↑↑	In patients with life-threatening bleeding and/or shock, additional fibrinogen should be administered (initially 3-6 g or 30-60 mg/kg).	
2.4.21	Recommendation	New 2022
Recommendation Level B↑	In patients with life-threatening bleeding and/or shock, PCC administration should be considered in addition to fibrinogen.	

ROTEM-based Algorithm to guide the Administration of Hemostatic Drugs and Blood Products during Early Trauma Resuscitation (95)

Treatment Recommendation	Result Interpretation
Consider Fibrinogen Administration	
Consider Plasma Transfusion (or Prothrombin Complex Concentrate (PCC)) (Caveat: Low platelet count and low fibrinogen may prolong CT)	
Consider platelet transfusion	
Consider Antifibrinolytics	
Consider restrictive Transfusion/Therapy	

Liver Disease and Transplantation

Liver Int. 2022 Nov;42(11):2492-2500.

Rotational Thromboelastometry-Guided Blood Component Use in Cirrhotic Children Undergoing Invasive Procedures: Randomized Controlled Trial

Maria A, Lal BB, Khanna R, Sood V, Mukund A, Bajpai M, Alam S.

RESULTS: A total of **423 invasive procedures** were screened for inclusion of which **60 were randomized** (30 in each group with comparable baseline parameters).

The **volume of total blood components,** FFP and platelets transfused was **significantly lower in ROTEM** as compared to conventional group. Only **46.7%** of children in **ROTEM** group received a blood component compared to **100%** in **conventional group (*P < 0.001*).**

The requirement of **FFP (ROTEM: 43.3%, Conventional: 83.3%, *P = 0.001*)** was significantly **lower** in the patients receiving **ROTEM**-guided transfusions.

There was no difference in procedure-related bleed and transfusion-related complications between the two groups. **ROTEM was cost-effective** (median: ₹750; IQR: ₹750–3298 vs. (median: ₹3687; IQR: ₹1511–6293; *P = 0.002*) **despite the additional cost of the test.**

J Clin Exp Hepatol. 2025 Jan-Feb;15(1):102409.

Rotational Thromboelastometry Reduces the Need for Preemptive Transfusion in Cirrhosis: A Randomized Controlled Trial (NCT:05698134)

Kumar R, Ng LXL, Wong YJ, Tan CK, Wang LZ, Qiu TY, Wong B, Lin KW, Li JW, Kwek ABE, Ang TL, Gokhle RS, Sivanath TP.

RESULTS: From August 2021 to January 2023, a total of **40 patients** were recruited (ROTEM (n = 20) and SOC (n = 20)). The trial was terminated earlier during interim analyses due to compelling benefit in the ROTEM group after a scheduled interim analysis.

The **ROTEM group** required **substantially less blood transfusion** than the SOC group (**40%** [8/20] **vs 100%** [20/20], *P < 0.001*). The benefit was consistent across all types of blood product, including **fresh frozen plasma (*P < 0.001*)** and **pooled platelets (*P = 0.046*).**

No patients experienced clinically significant bleeding events.

Transfusion-associated adverse events occurred in one patient (5%) in the SOC group (allergic reaction) and none in the ROTEM group (*P = NS*). The **mortality in both groups at 30 and 90 days was similar.**

Hepatol Int. 2025 May 21. doi: 10.1007/s12072-025-10840-4. Online ahead of print.

Comparison of Relaxed verses Standard Cut-offs of Rotational Thromboelastometry for guiding Blood Product Use before Invasive Procedures in Advanced Cirrhosis: A Randomized Controlled Trial

Kumar M, Madke T, Mukund A, Patidar Y, Shasthry SM, Bihari C, Agarwal P, Jindal A, Bajpai M, Maiwall R, Choudhary A, Rajan V, Arora V, Thevathia HV, Meena BL, Singh SP, Maheshwari A, Bhardwaj A, Kumar G, Sarin SK.

RESULTS: The **proportion of patients transfused any blood product** (FFP, platelets or cryoprecipitate) was 287/524 (**54.8%**) in the **relaxed ROTEM group** versus 352/519 (**67.8%**) in the **standard ROTEM group** (*P < 0.001*).

Procedure-related bleeding and **non-bleeding complications** and **28-day mortality** were **similar in both the groups.**

CONCLUSIONS: **Relaxation of ROTEM cut-offs** leads to **lower prophylactic blood products transfusions without increased risk of bleeding** in patients with advanced cirrhosis undergoing invasive procedures.

Subgroup Analysis.

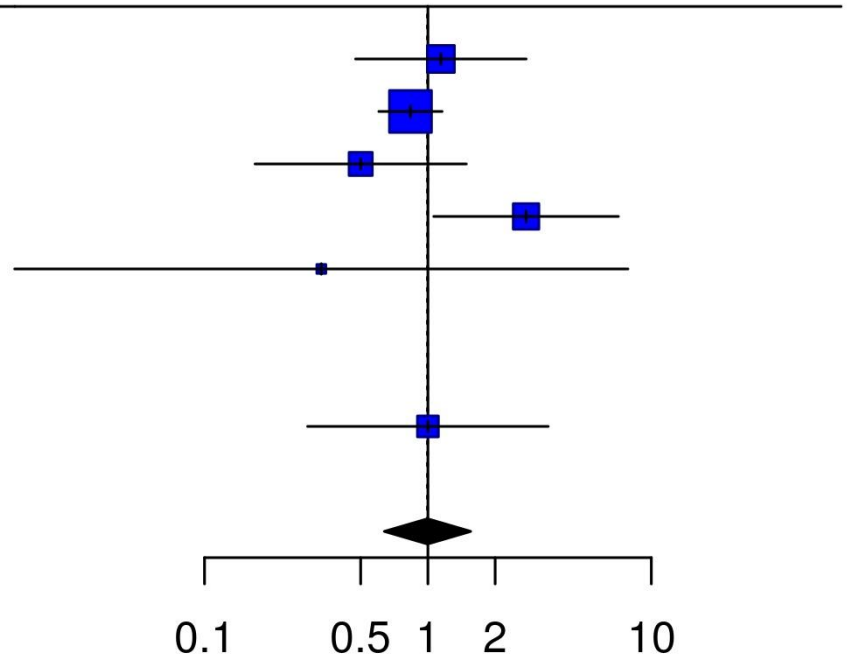
Effect of Viscoelastic Testing on Mortality in Cirrhotic Patients undergoing invasive Procedures: A Meta-Analysis

Görlinger K, Gandhi A, Perez-Calatayud AA, Yassen KA, Bezinover D, Saner FH.

Study	VET Events	VET Total	CON Events	CON Total	Weight	Risk Ratio MH, Random, 95% CI
De Pietri 2016	8	30	7	30	17.4%	1.14 [0.47; 2.75]
Kumar 2020	27	49	31	47	42.0%	0.84 [0.60; 1.16]
Rout 2020	4	30	8	30	12.8%	0.50 [0.17; 1.48]
Rocha 2020	11	19	4	19	15.6%	2.75 [1.06; 7.12]
Vuyyuru 2020	0	29	1	29	1.9%	0.33 [0.01; 7.85]
Maria 2022	0	30	0	30	0.0%	
Biswas 2024	0	29	0	29	0.0%	
Kumar 2025	4	20	4	20	10.4%	1.00 [0.29; 3.45]
Total (95% CI)		**236**		**234**	**100.0%**	**1.00 [0.64; 1.55]**

Heterogeneity: $Tau^2 = 0.0948$; $Chi^2 = 7.37$, df = 5 (P = 0.19); $I^2 = 32\%$

Test for overall effect: Z = -0.02 (P = 0.98)



Five studies used TEG, 3 studies used ROTEM, and no study used Quantra or ClotPro.

Subgroup Analysis.

Effect of Viscoelastic Testing on Mortality in Cirrhotic Patients undergoing invasive Procedures: A Meta-Analysis

Görlinger K, Gandhi A, Perez-Calatayud AA, Yassen KA, Bezinover D, Saner FH.

SUMMARY: Our meta-analysis (random model) based on **8 studies** with **470 participants (overall mortality, 23.2%)** demonstrates **no change in mortality by viscoelastic testing (ROTEM/ TEG)-guided bleeding management** in patients with liver cirrhosis underhgoing invasive procedures **(RR (95% CI), 1.00 (0.64; 1.55); *P* = 0.98487).**

We did not find notable variability, implying that the **effect sizes across studies were uniform in both size and direction.**

The funnel plot does not indicate a potential publication bias.

Based on the Z-score plot, **the total number of samples did not reach the optimal number (Actual Information Size (AIS) = 352/2337 = 15%),** and more research is needed to establish a conclusion.

Br J Anaesth. 2025 Sep 12:S0007-0912(25)00536-7. doi: 10.1016/j.bja.2025.07.079. Online ahead of print.

Use of Prothrombin Complex Concentrates in Liver Transplantation: A Systematic Review and Meta-Analysis

Kojundzic I, Alavi N, Lam A, Karkouti K, Callum J, Bieze M, Luzzi C, Shwaartz C, Englesakis M, Martin Carrier F, Boldingh JW, Vos JJ, van den Berg JP, Görlinger K, Harle C, Carr A, Lisman T, van Klei WA, McCluskey SA, Bartoszko J.

RESULTS: All studies were retrospective, with seven reporting the number of patients receiving PCC [392/1901 (21%)], and one grouping patients receiving different factor concentrates together [576/939 (61%)].

Patients receiving PCC had **worse preoperative coagulopathy, model for end-stage liver disease scores, and comorbidities.**

Patients exposed to PCC had a **comparable mean number of RBC, plasma, or platelet units transfused.**

Use of **viscoelastic testing-based algorithms incorporating PCC** compared with usual care was associated with **reduced odds of RBC exposure (OR: 0.53, 95% CI: 0.32-0.86, I^2=0%)** and **FP exposure (OR: 0.35, 95% CI: 0.13-0.92, I^2=50%),** but not platelets. Safety outcomes were driven by one large study using PCC as rescue therapy.

Br J Anaesth. 2025 Sep 12:S0007-0912(25)00536-7. doi: 10.1016/j.bja.2025.07.079. Online ahead of print.

Use of Prothrombin Complex Concentrates in Liver Transplantation: A Systematic Review and Meta-Analysis

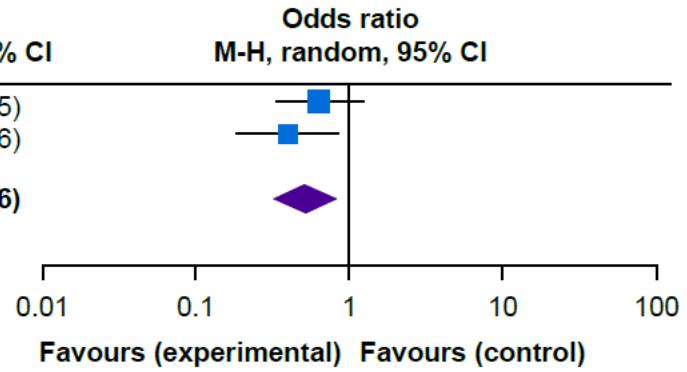
Kojundzic I, Alavi N, Lam A, Karkouti K, Callum J, Bieze M, Luzzi C, Shwaartz C, Englesakis M, Martin Carrier F, Boldingh JW, Vos JJ, van den Berg JP, Görlinger K, Harle C, Carr A, Lisman T, van Klei WA, McCluskey SA, Bartoszko J.

Both ROTEM Studies

Viscoelastic testing algorithms incorporating PCC: impact on RBC exposure

Study or subgroup	Viscoelastic algorithm Events	Total	Control Events	Total	Weight	Odds ratio M-H, random, 95% CI
Nascimento 2020	47	82	48	71	56.6%	0.64 (0.33–1.25)
Zamper 2018	14	45	47	89	43.4%	0.40 (0.19–0.86)
Total (95% CI)		**127**		**160**	**100.0%**	**0.53 (0.32–0.86)**
Total events	61		95			

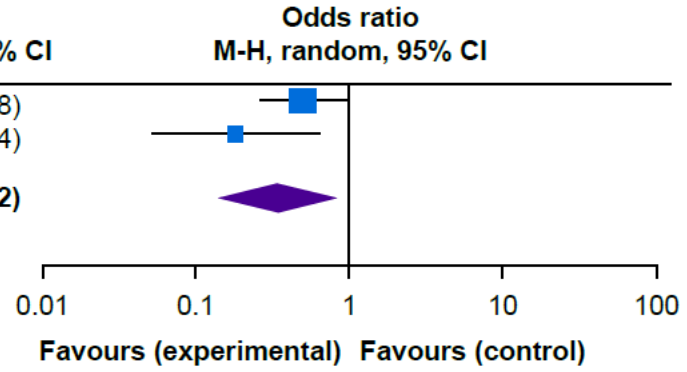
Heterogeneity: Tau^2=0.00; χ^2=0.83, df=1 (*P*=0.36); I^2=0%
Test for overall effect: Z=2.53 (*P*=0.01)



Viscoelastic testing algorithms incorporating PCC: impact on plasma exposure

Study or subgroup	Viscoelastic algorithm Events	Total	Control Events	Total	Weight	Odds ratio M-H, random, 95% CI
Nascimento 2019	25	82	33	71	64.1%	0.51 (0.26–0.98)
Zamper 2018	3	45	25	89	35.9%	0.18 (0.05–0.64)
Total (95% CI)		**127**		**160**	**100.0%**	**0.35 (0.13–0.92)**
Total events	28		58			

Heterogeneity: Tau^2=0.27; χ^2=2.01, df=1 (*P*=0.16); I^2=50%
Test for overall effect: Z=2.12 (*P*=0.03)



Transplant Rev (Orlando). 2025 Jul;39(3):100932.

Use of Decision Algorithms for Viscoelastic Tests and Use of Blood Products in Patients undergoing Liver Transplantation: A Systematic Review with Meta-Analysis

de Oliveira Júnior GL, Lins VMBC, Cavalcanti VMB, Tustumi F, Virgílio C, Andraus W.

RESULTS: Out of the 279 studies initially identified, **17 studies** were **included** in this review.

Algorithms for VETs reduced RBC transfusion (-0.44 (95 % CI -0.62; -0.25; *P < 0.01*), while there was **no significant difference with VETs without algorithms,** and the overall measure showed a smaller reduction (-0.33; 95 % CI -0.61 to -0.04; *P = 0.02*).

CONCLUSION: The results highlight the **potential of algorithms for VETs** to reduce the use of blood products in liver transplants.

Subgroup Analysis.

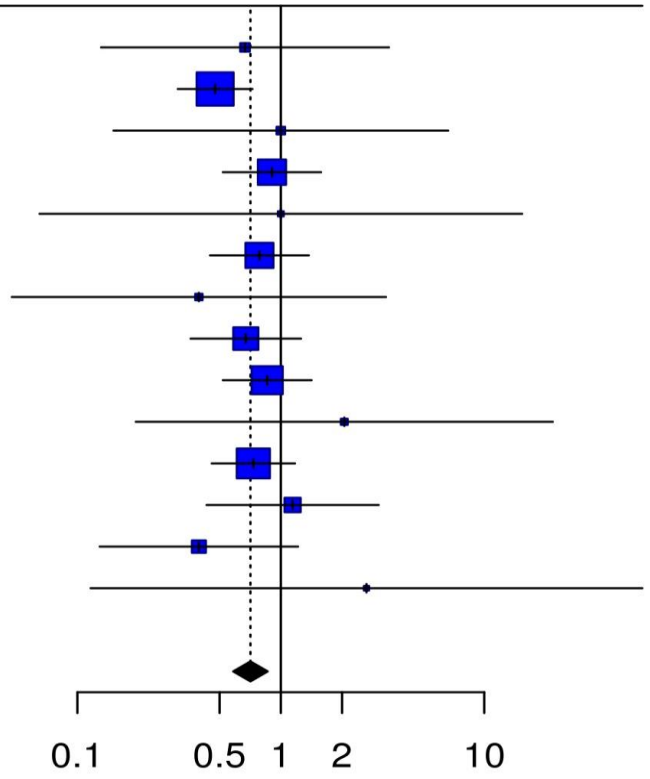
Effect of Viscoelastic Testing on Mortality in Liver Transplantation: A Meta-Analysis

Görlinger K, Gandhi A, Perez-Calatayud AA, Yassen KA, Bezinover D, Saner FH.

Study	VET Events	VET Total	CON Events	CON Total	Weight	Risk Ratio MH, Random, 95% CI
Wang 2010	2	14	3	14	1.4%	0.67 [0.13; 3.40]
Alamo 2013	20	89	69	146	21.4%	0.48 [0.31; 0.73]
Roullet 2015	2	30	2	30	1.1%	1.00 [0.15; 6.64]
Leon-Justel 2015	19	100	21	100	12.4%	0.90 [0.52; 1.58]
Smart 2017	1	34	1	34	0.5%	1.00 [0.07; 15.34]
Kandeel 2018	20	121	20	95	12.2%	0.79 [0.45; 1.37]
Zamper 2018	1	45	5	89	0.8%	0.40 [0.05; 3.29]
Schumacher 2019	10	82	60	331	9.8%	0.67 [0.36; 1.26]
Leon-Justel 2019	24	168	28	168	15.1%	0.86 [0.52; 1.42]
Bonnet 2019	2	39	1	40	0.7%	2.05 [0.19; 21.72]
Nascimento 2020	22	82	26	71	17.2%	0.73 [0.46; 1.17]
Scarlatescu 2021	8	94	7	94	4.0%	1.14 [0.43; 3.02]
Gaspari 2021	4	90	10	89	3.0%	0.40 [0.13; 1.21]
Sarmiento 2024	1	16	0	14	0.4%	2.64 [0.12; 59.82]
Total (95% CI)		**1004**		**1315**	**100.0%**	**0.71 [0.58; 0.86]**

Heterogeneity: $Tau^2 = 0$; $Chi^2 = 8.81$, df = 13 (P = 0.79); $I^2 = 0\%$

Test for overall effect: Z = -3.45 (P < 0.01)



Two studies used TEG, 12 studies used ROTEM, and no study used Quantra or ClotPro.

Subgroup Analysis.

Effect of Viscoelastic Testing on Mortality in Liver Transplantation: A Meta-Analysis

Görlinger K, Gandhi A, Perez-Calatayud AA, Yassen KA, Bezinover D, Saner FH.

SUMMARY: Our meta-analysis (random model) based on **14 studies** with **2319 participants (overall mortality, 16.8%)** demonstrates a **significant reduction in mortality by viscoelastic testing (ROTEM/TEG)-guided bleeding management** in patients undergoing liver transplantation **(RR (95% CI), 0.71 (0.58; 0.86); *P = 0.00055*).**

We did not find notable variability, implying that the **effect sizes across studies were uniform in both size and direction.**

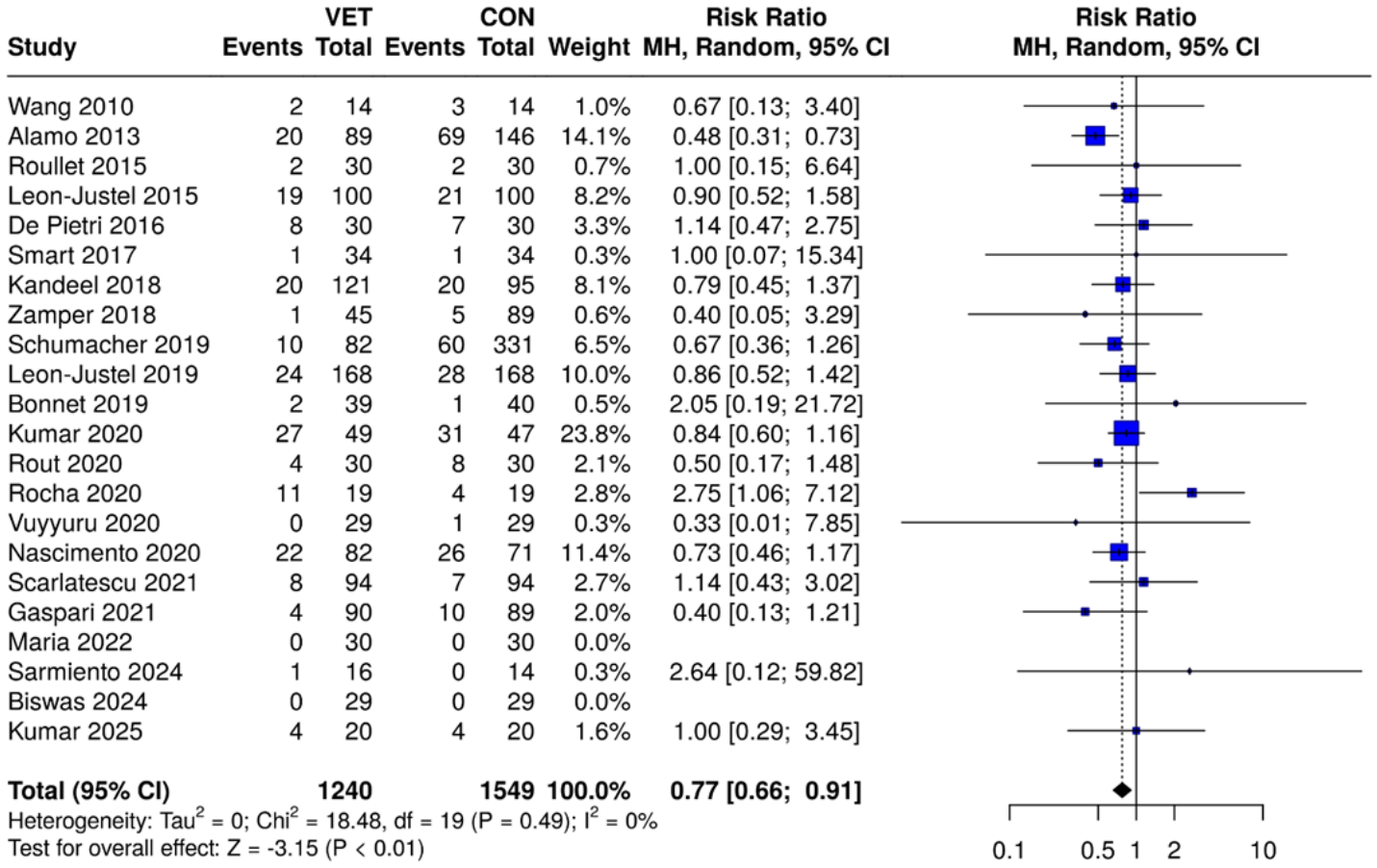
The funnel plot does not indicate a potential publication bias.

Based on the Z-score plot, **the total number of samples did not reach the optimal number (Actual Information Size (AIS) = 2319/3108 = 75%),** and more research is needed to establish a conclusion.

NATA25; April 24-26, 2025, Munich, Germany. https://nataonline.com/nata25-abstract-book/.

Effect of Viscoelastic Testing on Mortality in Liver Transplantation and Cirrhotic Patients undergoing invasive Procedures: A Meta-Analysis

Görlinger K, Gandhi A, Perez-Calatayud AA, Yassen KA, Bezinover D, Saner FH.



Seven studies used TEG, 15 studies used ROTEM, and no study used Quantra or ClotPro.

NATA25; April 24-26, 2025, Munich, Germany. https://nataonline.com/nata25-abstract-book/.

Effect of Viscoelastic Testing on Mortality in Liver Transplantation and Cirrhotic Patients undergoing invasive Procedures: A Meta-Analysis

Görlinger K, Gandhi A, Perez-Calatayud AA, Yassen KA, Bezinover D, Saner FH.

SUMMARY: Our meta-analysis (random model) based on **22 studies** with **2789 participants (overall mortality, 17.9%)** demonstrates a **significant reduction in mortality by viscoelastic testing (ROTEM/TEG)-guided bleeding management** in patients with liver cirrhosis undergoing invasive procedures or liver transplantation **(RR (95% CI), 0.77 (0.66; 0.91); *P = 0.00162*).**

We did not observe significant heterogeneity, suggesting that the **effect sizes across studies were consistent in both magnitude and direction.**

The funnel plot does not indicate a potential publication bias.

Based on the Z-score plot, **the total number of samples did not reach the optimal number (Actual Information Size (AIS) = 2671/2908 = 96%),** and more research is needed to establish a conclusion.

Blood Transfus. 2024 Mar;22(2):122-129.

Extract from the 2022 ESC Guidelines on Cardiovascular Assessment and Management of Patients undergoing Non-Cardiac Surgery - Patient Blood Management

Halvorsen S, Mehilli J, Choorapoikayil S, Zacharowski K.

Recommendation Table 17 – Recommendations for Intra- and Post-operative Complications Associated with Blood Loss

Recommendations	Class[a]	Level[b]
In patients undergoing surgery with expected blood loss of ≥ 500 mL, **use of washed cell salvage** is recommended.[377,378]	I	A
It is recommended to **use point-of-care diagnostics for guidance of blood component therapy,** when available.[370,379–383]	I	A

HERE, WE ARE!

Cardiovascular Surgery and Transplantation (HTX, LuTX)

Anaesthesia. 2019 Dec;74(12):1589-1600.

The Role of Fibrinogen and Fibrinogen Concentrate in Cardiac Surgery: An International Consensus Statement from the Haemostasis and Transfusion Scientific Subcommittee of the European Association of Cardiothoracic Anaesthesiology

Erdoes G, Koster A, Meesters MI, Ortmann E, Bolliger D, Baryshnikova E, Ahmed A, Lance MD, Ravn HB, Ranucci M, von Heymann C, Agarwal S.

Assessment of fibrinogen activity using **viscoelastic point-of-care testing** shortly before or after weaning from cardiopulmonary bypass in patients and procedures with a high risk of bleeding appears to be a **rational strategy.**

In contrast, the use of Clauss fibrinogen test for determination of plasma fibrinogen level can no longer be recommended without restrictions due to its **long turnaround time, high inter-assay variability** and **interference with high heparin levels** and fibrin degradation products.

Fibrinogen concentrate does not seem to increase adverse outcomes (i.e., thromboembolic events).

Anaesthesia. 2021 Mar;76(3):381-392.

A European Consensus Statement on the Use of Four-Factor Prothrombin Complex Concentrate for Cardiac and Non-Cardiac Surgical Patients

Erdoes G, Koster A, Ortmann E, Meesters MI, Bolliger D, Baryshnikova E, Martinez Lopez De Arroyabe B, Ahmed A, Lance MD, Ranucci M, von Heymann C, Agarwal S, Ravn HB.

In the **massively bleeding patient with coagulopathy,** our group recommends the administration of an **initial bolus of 25 IU.kg^{-1}.**

This applies for: the acute reversal of vitamin K antagonist therapy; haemostatic resuscitation, particularly in trauma; and the reversal of direct oral anticoagulants when no specific antidote is available.

In **patients with a high risk for thromboembolic complications, e.g. cardiac surgery,** the administration of an **initial half-dose bolus (12.5 IU.kg^{-1})** should be considered. A second bolus may be indicated if coagulopathy and microvascular bleeding persists and other reasons for bleeding are largely ruled out.

Tissue-factor-activated, factor VII-dependent and heparin insensitive point-of-care tests may be used for **peri-operative monitoring** and **guiding of prothrombin complex concentrate therapy.**

BMJ Open. 2024 Aug 21;14(8):e091381.

Protocol for a Phase 3, Randomised, Active-control Study of Four-Factor Prothrombin Complex Concentrate versus Frozen Plasma in Bleeding Adult Cardiac Surgery Patients requiring Coagulation Factor Replacement: The LEX-211 (FARES-II) Trial

Karkouti K, Callum J, Bartoszko J, Solomon C, Knaub S, Levy JH, Tanaka KA; FARES-II Study Group.

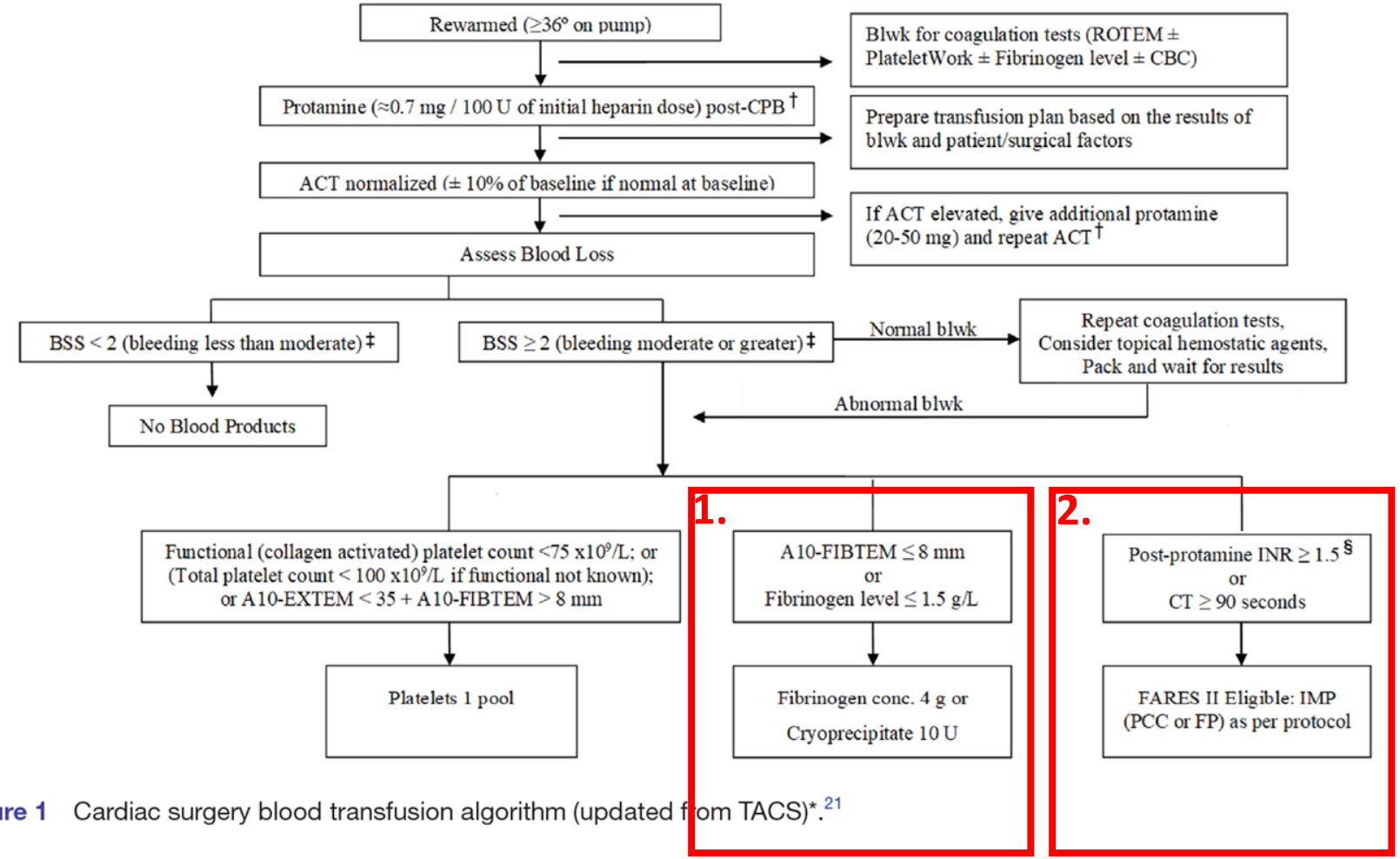


Figure 1 Cardiac surgery blood transfusion algorithm (updated from TACS)*.[21]

JAMA. 2025 Mar 29:e253501. doi: 10.1001/jama.2025.3501. Online ahead of print.

Prothrombin Complex Concentrate vs Frozen Plasma for Coagulopathic Bleeding in Cardiac Surgery: The FARES-II Multicenter Randomized Clinical Trial

Karkouti K, Callum JL, Bartoszko J, Tanaka KA, Knaub S, *et al.;* FARES-II Study Group.

RESULTS: Of 538 enrolled patients, **420 patients** (median age, 66 years [IQR, 57-73 years]; 74%, male; 10%, Asian; 1%, Black; and 65%, White) were included in the primary analysis; of those, 296 **(70%) underwent complex surgeries.**

Compared with the **207 patients in the frozen plasma group,** the **213 patients in the PCC group** had **higher hemostatic effectiveness (166 [77.9%] vs 125 [60.4%];** difference, 17.6%; 95% CI, 8.7%-26.4%; *P < 0.001* for noninferiority and superiority) and had received **fewer transfusions** including **red blood cells, platelets, and noninvestigational frozen plasma units** (mean, **6.6 units;** 95% CI, 5.7-7.7 **vs 9.3 units;** 95% CI, 8.0-10.8; difference, 2.7; 95% CI, 1.0-4.4; P = .002).

Seventy-seven patients (36.2%) in the PCC group vs 98 (47.3%) in the frozen plasma group experienced **serious adverse events (RR, 0.76;** 95% CI, 0.61-0.96; *P = 0.02*).

Twenty-two patients (10.3%) in the PCC group and 39 (18.8%) in the frozen plasma group had **acute kidney injury (RR, 0.55;** 95% CI, 0.34-0.89; *P = 0.02*).

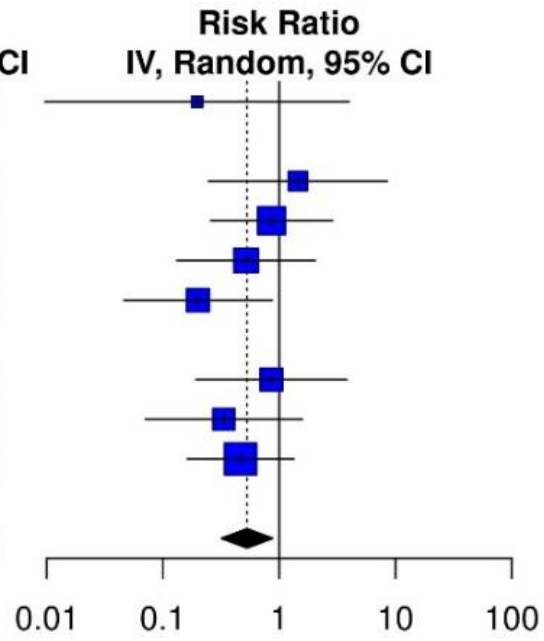
The Anesthesiology Annual Meeting; Oct 19, 2024, Philadelphia, USA. https://www.abstractsonline.com/pp8/#!/20301/presentation/31677.

Effect of Viscoelastic Testing on Mortality in Cardiovascular Surgery, Lung Transplant, and ECMO: A Meta-Analysis

Goerlinger K, Petricevic M, Lier H, Karkouti K.

Study	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio IV, Random, 95% CI
Shore-Lesserson 1999	0	53	2	52	2.8%	0.20 [0.01; 3.99]
Royston 2001	0	30	0	30	0.0%	
AK 2009	3	114	2	110	8.2%	1.45 [0.25; 8.50]
Girdauskas 2010	4	27	5	29	17.7%	0.86 [0.26; 2.87]
Paniagua 2011	3	26	4	18	13.7%	0.52 [0.13; 2.05]
Weber 2012	2	50	10	50	12.0%	0.20 [0.05; 0.87]
Nakayama 2015	0	50	0	50	0.0%	
Buscher 2017	2	7	3	9	11.6%	0.86 [0.19; 3.81]
Haensig 2019	2	52	6	52	10.7%	0.33 [0.07; 1.58]
Vajter 2023	4	31	10	36	23.2%	0.46 [0.16; 1.33]
Total (95% CI)		**440**		**436**	**100.0%**	**0.53 [0.32; 0.88]**

Heterogeneity: $Tau^2 = 0$; $Chi^2 = 4.77$, df = 7 (P = 0.69); $I^2 = 0\%$



SUMMARY: Our meta-analysis (random model) based on **10 RCTs** with **876 participants (overall mortality, 7.1%)** demonstrates a **significant reduction in mortality by viscoelastic testing (ROTEM/TEG)-guided bleeding management** in patients undergoing **cardiovascular surgery, lung transplant, or ECMO (RR (95% CI), 0.5280 (0.3183; 0.8756); *P = 0.0204*).**

The Anesthesiology Annual Meeting; Oct 19, 2024, Philadelphia, USA. https://www.abstractsonline.com/pp8/#!/20301/presentation/31677.

Effect of Viscoelastic Testing on Mortality in Cardiovascular Surgery, Lung Transplant, and ECMO: A Meta-Analysis

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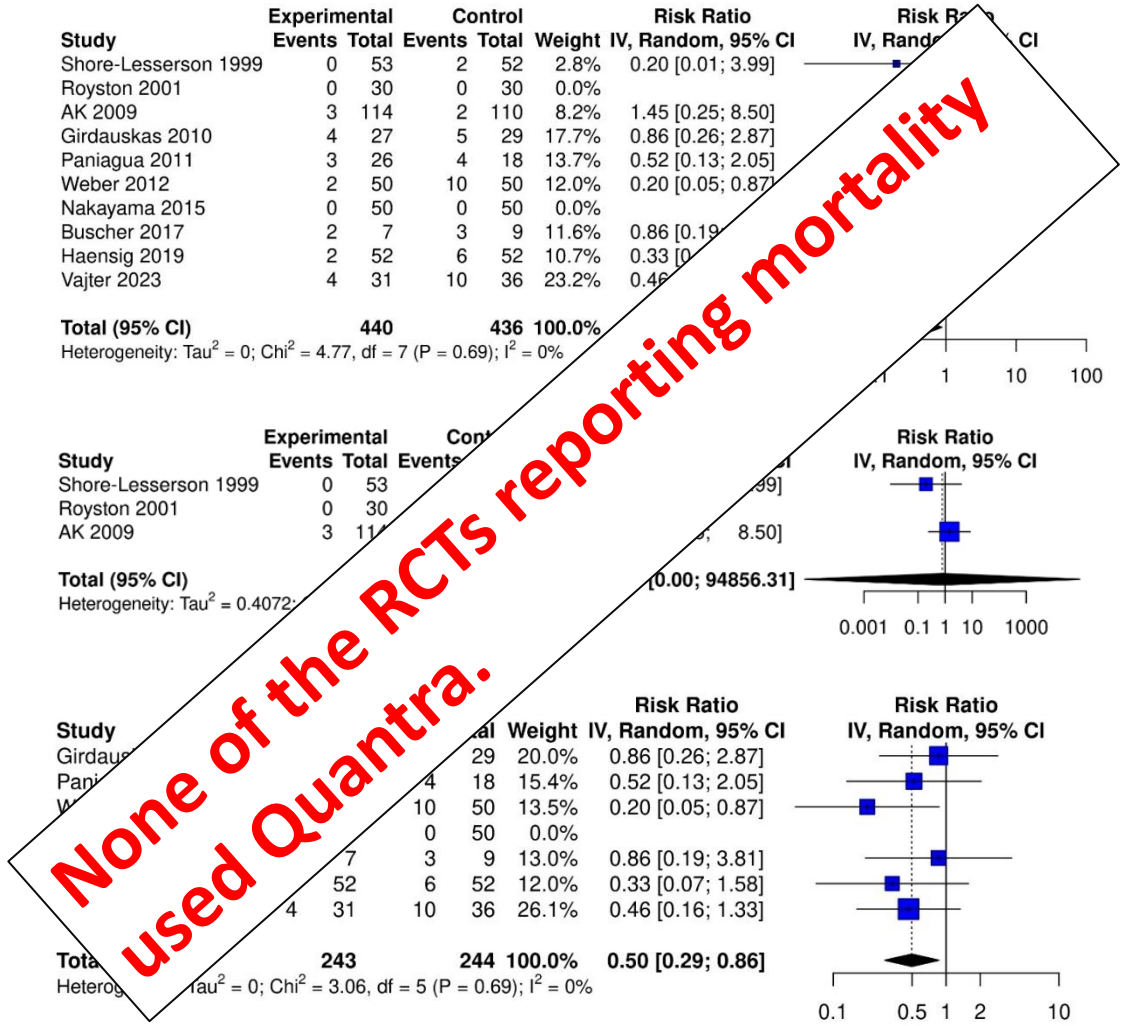


J Cardiothorac Vasc Anesth. 2025 Aug;39(8):1964-2018.
Eur J Cardiothorac Surg. 2025 May 6;67(5):ezae352. Interdiscip Cardiovasc Thorac Surg. 2025 May 6;40(5):ivae170.

2024 EACTS/EACTAIC Guidelines on Patient Blood Management in Adult Cardiac Surgery in Collaboration with EBCP

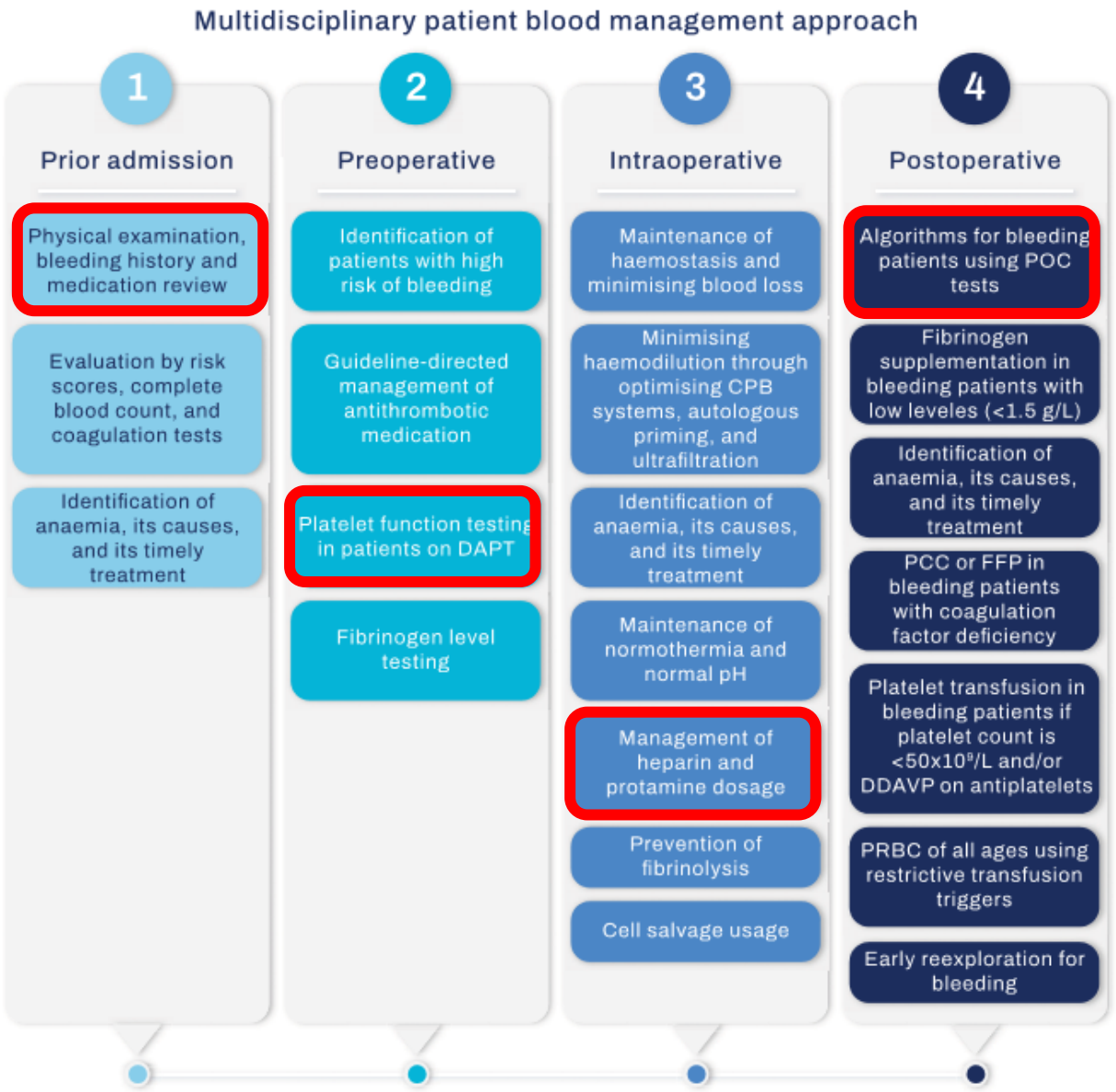
Casselman FPA, Lance MD, Ahmed A, Ascari A, Blanco-Morillo J, Bolliger D, Eid M, Erdoes G, Gerhardus Haumann R, Jeppsson A, van der Merwe HJ, Ortmann E, Petricevic M, Paolo Weltert L, Milojevic M; EACTS/EACTAIC/EBCP Scientific Document Group.

Recommendation Table 11: **Recommendations for transfusion strategies**

Recommendations	**Class[a]**	**Level[b]**	**Ref[c]**
Implementation of a patient blood management protocol for the bleeding patient is recommended.	I	B	[414-417]
Perioperative treatment algorithms for the bleeding patient based on viscoelastic POC testing is recommended to reduce the number of transfusions.	I	A	[42, 45, 47, 442]

In summary, previous and recent **evidence supports the use of perioperative POC testing in cardiac surgery** to potentially **reduce the requirements for blood transfusions,** enhance resource management and **improve clinical outcomes,** including bleeding rates, **ICU and hospital lengths of stay** and **overall all-cause mortality.**

J Cardiothorac Vasc Anesth. 2025 Aug;39(8):1964-2018.
Eur J Cardiothorac Surg. 2025 May 6;67(5):ezae352. Interdiscip Cardiovasc Thorac Surg. 2025 May 6;40(5):ivae170.



MULTIDISCIPLINARY PBM APPROACH:

1. Physical examination, bleeding history and medication review. **[I C]**
2. Platelet function testing in patients on DAPT. **[IIb B]**
3. Management of heparin and protamine dosage. **[I A]**
4. Algorithms for bleeding patients using POC tests. **[I A]**

eactaic European Association of Cardiothoracic Anaesthesiology and Intensive Care

EACTS EUROPEAN ASSOCIATION FOR CARDIO-THORACIC SURGERY

All Clinical Settings

Acta Anaesthesiol Scand. 2025 Jan;69(1):e14558.

Thromboelastography or Rotational Thromboelastometry Guided Algorithms in Bleeding Patients: An Updated Systematic Review with Meta-Analysis and Trial Sequential Analysis

Kvisselgaard AD, Wolthers SA, Wikkelsø A, Holst LB, Drivenes B, Afshari A.

RESULTS: This systematic review included **31 randomised tri** ... **36),** with **most patients undergoing elective cardiac surg** ... TEM-guided algorithms reduced the amount of transfuse ... **en plasma (RR 0.5,** 95% CI 0.32-0.72, I^2: 94%), **platelets (R** ... 0.55-0.91, I^2: 57%), the risk for **surgical reintervention (R** ... CI 0.47-0.94, I^2: 0%), and **bleeding** with a **standard mea** ... **-0.31** (95% CI -0.55 to -0.08, I^2: 75%).

No statisti ... **ant difference was demonstrated for mortality (RR 0.7** ... 37-1.00, I^2: 5%). **Trial sequential analysis of mortality analysis** i ... ed that **54% of the optimal information size** was reached with an alpha-boundary RR of 0.81 (95% CI 0.63-1.03).

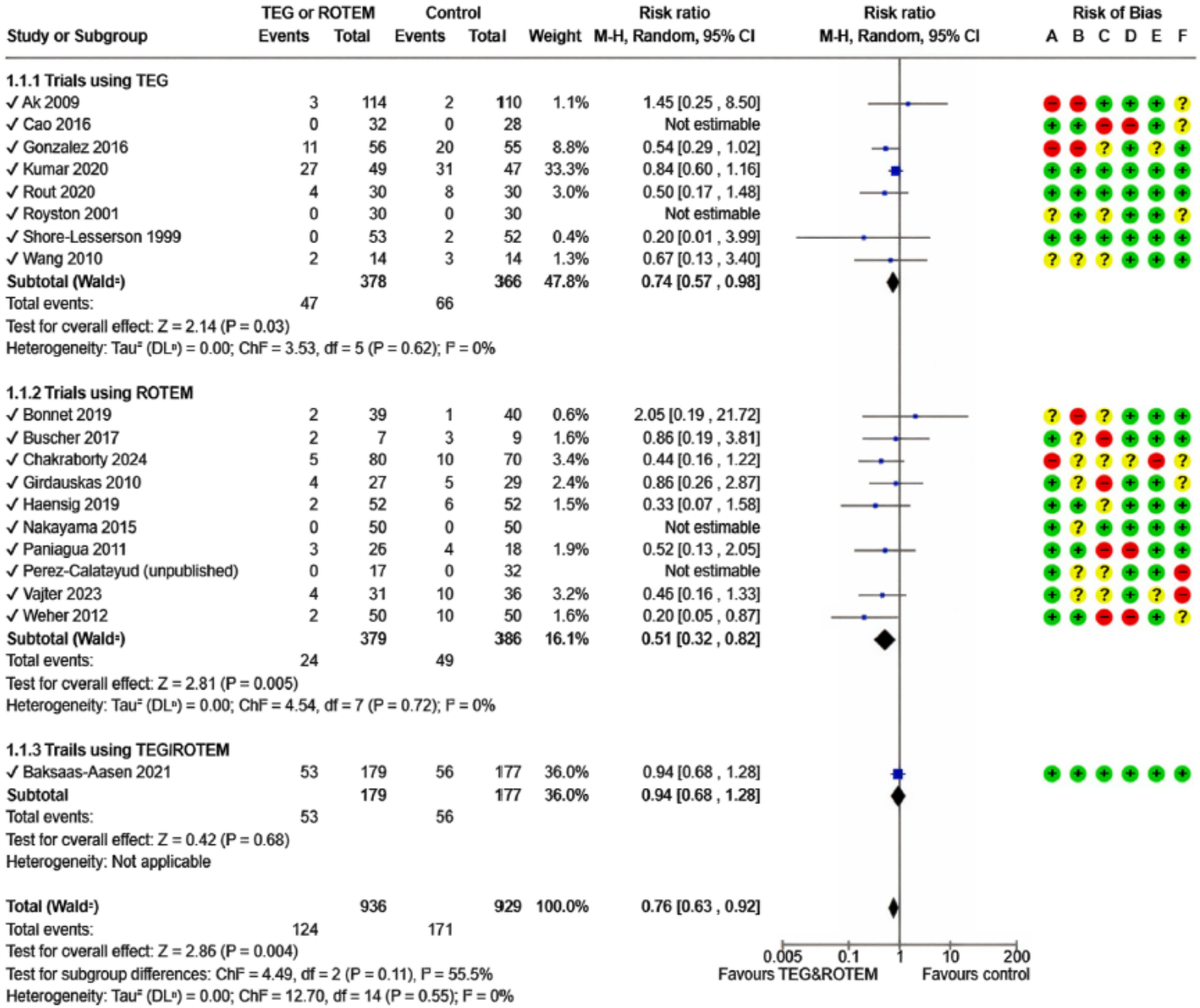
SOME WRONG AND MISSING DATA FOR MORTALITY!

Acta Anaesthesiol Scand. 2025 Nov;69(10):e70127.

Rapid Update and Revision of: Thromboelastography or Rotational Thromboelastometry Guided Algorithms in Bleeding Patients – An Updated Systematic Review With Meta-Analysis and Trial Sequential Analysis

Kvisselgaard AD, Wolthers SA, Wikkelsø A, Holst LB, Drivenes B, Afshari A.

RESULTS: This systematic review included **35 randomized trials (n = 3096), primarily elective cardiac surgery. TEG-/ROTEM-guided algorithms** led to a **statistically significant reduction in mortality (RR = 0.76, 95% CI 0.63-0.92) I^2: 0%.** Furthermore, a significant reduction in transfused fresh frozen plasma (RR = 0.52, 95% CI 0.35-0.76) I^2: 94%, platelets (RR = 0.69, 95% CI 0.55-0.87) I^2: 60%, the risk for surgical reintervention (RR = 0.63, 95% CI 0.45-0.88) I^2: 0%, and bleeding with a standard mean difference of -0.31 (95% CI, -0.51 to -0.11) I^2: 72% was found. **Trial sequential analysis of mortality analysis** indicated that **64% of the optimal information size** was reached with a crossed alpha-boundary.


Study or Subgroup
TEG or ROTEM Events Total
Control Events Total
Weight
Risk ratio M-H, Random, 95% CI
Risk ratio M-H, Random, 95% CI
Risk of Bias A B C D E F
1.1.1 Trials using TEG
✓ Ak 2009 3 114 2 110 1.1% 1.45 [0.25 , 8.50]
✓ Cao 2016 0 32 0 28 Not estimable
✓ Gonzalez 2016 11 56 20 55 8.8% 0.54 [0.29 , 1.02]
✓ Kumar 2020 27 49 31 47 33.3% 0.84 [0.60 , 1.16]
✓ Rout 2020 4 30 8 30 3.0% 0.50 [0.17 , 1.48]
✓ Royston 2001 0 30 0 30 Not estimable
✓ Shore-Lesserson 1999 0 53 2 52 0.4% 0.20 [0.01 , 3.99]
✓ Wang 2010 2 14 3 14 1.3% 0.67 [0.13 , 3.40]
Subtotal (Wald²) 378 366 47.8% 0.74 [0.57 , 0.98]
Total events: 47 66
Test for cverall effect: Z = 2.14 (P = 0.03)
Heterogeneity: Tau² (DL¤) = 0.00; ChF = 3.53, df = 5 (P = 0.62); F = 0%
1.1.2 Trials using ROTEM
✓ Bonnet 2019 2 39 1 40 0.6% 2.05 [0.19 , 21.72]
✓ Buscher 2017 2 7 3 9 1.6% 0.86 [0.19 , 3.81]
✓ Chakraborty 2024 5 80 10 70 3.4% 0.44 [0.16 , 1.22]
✓ Girdauskas 2010 4 27 5 29 2.4% 0.86 [0.26 , 2.87]
✓ Haensig 2019 2 52 6 52 1.5% 0.33 [0.07 , 1.58]
✓ Nakayama 2015 0 50 0 50 Not estimable
✓ Paniagua 2011 3 26 4 18 1.9% 0.52 [0.13 , 2.05]
✓ Perez-Calatayud (unpublished) 0 17 0 32 Not estimable
✓ Vajter 2023 4 31 10 36 3.2% 0.46 [0.16 , 1.33]
✓ Weher 2012 2 50 10 50 1.6% 0.20 [0.05 , 0.87]
Subtotal (Wald²) 379 386 16.1% 0.51 [0.32 , 0.82]
Total events: 24 49
Test for cverall effect: Z = 2.81 (P = 0.005)
Heterogeneity: Tau² (DL¤) = 0.00; ChF = 4.54, df = 7 (P = 0.72); F = 0%
1.1.3 Trails using TEGiROTEM
✓ Baksaas-Aasen 2021 53 179 56 177 36.0% 0.94 [0.68 , 1.28]
Subtotal 179 177 36.0% 0.94 [0.68 , 1.28]
Total events: 53 56
Test for cverall effect: Z = 0.42 (P = 0.68)
Heterogeneity: Not applicable
Total (Wald²) 936 929 100.0% 0.76 [0.63 , 0.92]
Total events: 124 171
Test for cverall effect: Z = 2.86 (P = 0.004)
Test for subgroup differences: ChF = 4.49, df = 2 (P = 0.11), F = 55.5%
Heterogeneity: Tau² (DL¤) = 0.00; ChF = 12.70, df = 14 (P = 0.55); F = 0%
0.005 0.1 1 10 200
Favours TEG&ROTEM
Favours control

KJA
Korean Journal of Anesthesiology

Editorial

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From evidence-based medicine to patient-centered care

Woong Mo Kim

Department of Anesthesiology and Pain Medicine, Chonnam National University Medical School & Hospital, Gwangju, Korea

Ideal healthcare decision making therefore requires that **patients receive proper education using evidence-based data.** To meet this end, patient decision aids have been utilized in various fields of medicine, including cardiology, urology, gynecology, endocrinology, oncology, and **anesthesiology** [3].

Cultivating trust in the anesthesiologists effort to provide supportive care during the procedure for the patient, in addition to the **decision aids,** may be the **key to effectively incorporating PCC in EBM.**

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