Platelet Indications

When are Platelets Needed?

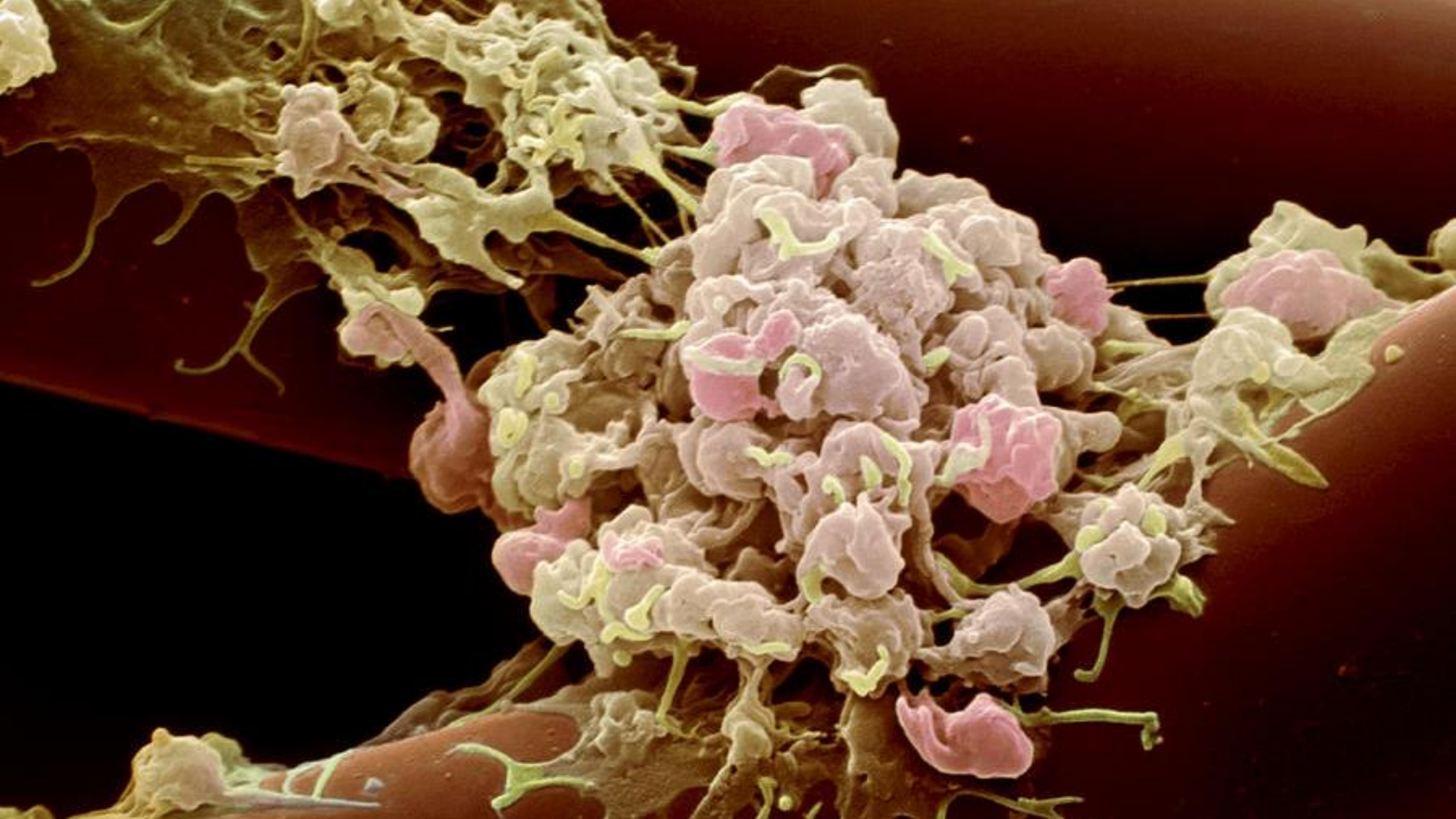
Paul Vulliamy MD PhD

Clinical Senior Lecturer, Centre for Trauma Sciences, Queen Mary University of London

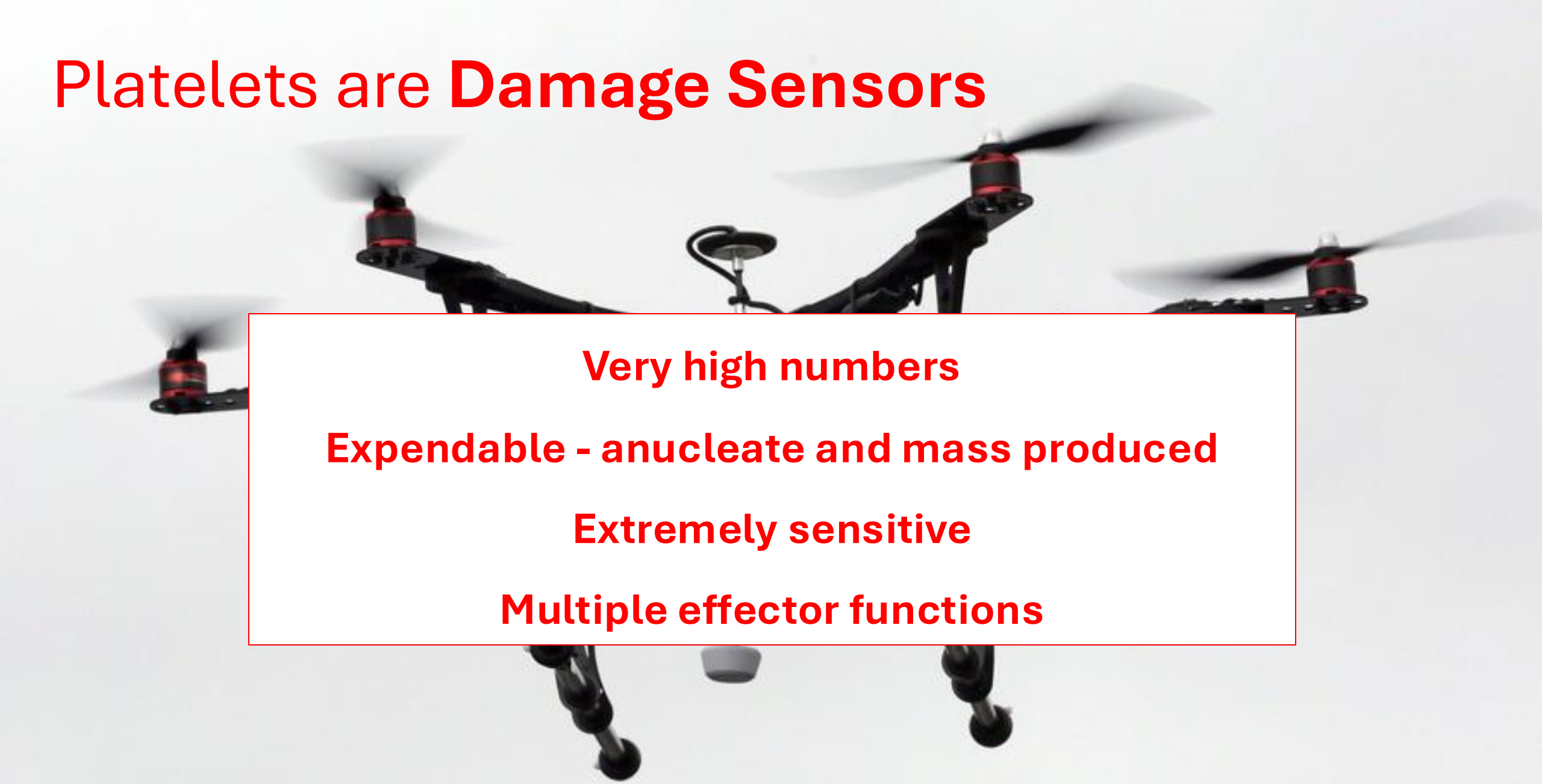
Consultant Trauma Surgeon, Royal London Hospital

What do we want platelets to do?

What do platelets do?



Platelets are **Damage Sensors**



Very high numbers

Expendable - anucleate and mass produced

Extremely sensitive

Multiple effector functions

Li, Zarbock, Hidalgo. Platelets as autonomous drones for hemostatic and immune surveillance. J Exp Med 2017

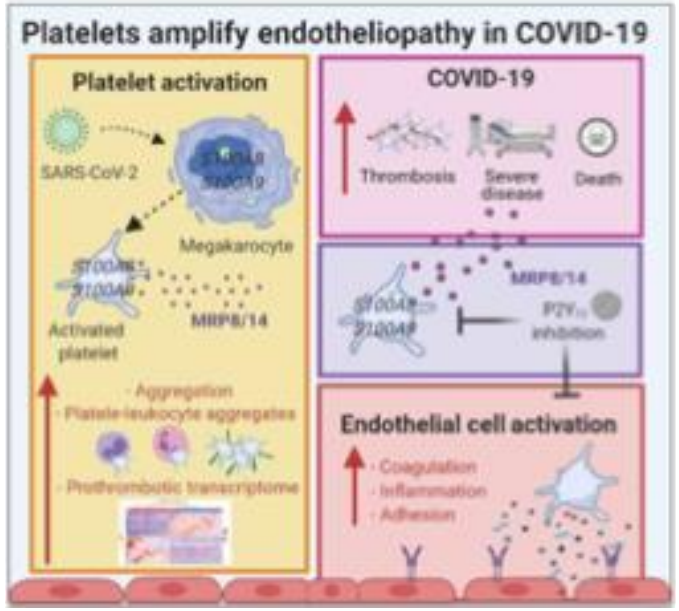
The diversity of platelet function

SCIENCE ADVANCES | RESEARCH ARTICLE

CORONAVIRUS

Platelets amplify endotheliopathy in COVID-19

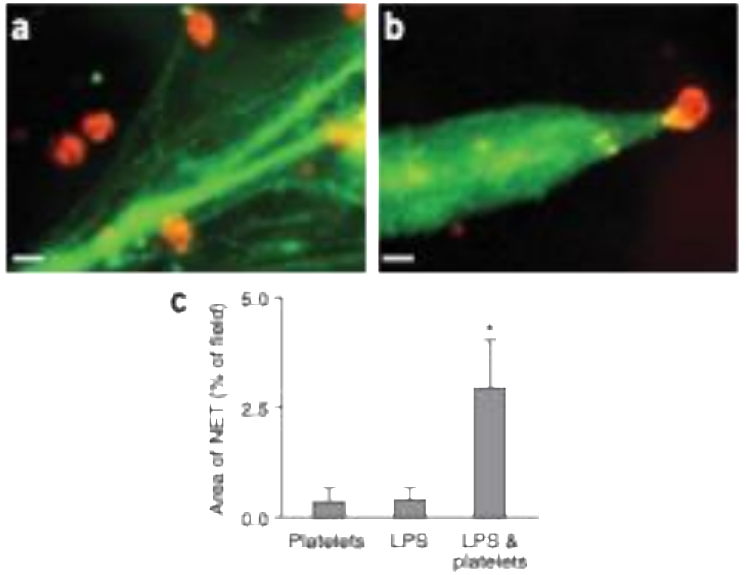
Tessa J. Barrett[1]*, MacIntosh Cornwell[1,2], Khrystyna Myndzar[1], Christina C. Rolling[1], Yuhe Xia[1], Kamelia Drenkova[1], Antoine Biebuyck[1], Alexander T. Fields[3], Michael Tawil[1], Elliot Luttrell-Williams[1], Eugene Yuriditsky[1], Grace Smith[4], Paolo Cotzia[5,6], Matthew D. Neal[7], Lucy Z. Kornblith[3], Stefania Pittaluga[3], Amy V. Rapkiewicz[8], Hannah M. Burgess[9], Ian Mohr[9], Kenneth A. Stapleford[9], Deepak Voora[10], Kelly Ruggles[2], Judith Hochman[1], Jeffrey S. Berger[1,11]*



nature medicine

Platelet TLR4 activates neutrophil extracellular traps to ensnare bacteria in septic blood

Stephen R Clark[1,6], Adrienne C Ma[1,6], Samantha A Tavener[1], Braedon McDonald[1], Zahra Goodarzi[1], Margaret M Kelly[1,2], Kamala D Patel[1,3], Subhadeep Chakrabarti[1,3], Erin McAvoy[1], Gary D Sinclair[2,3], Elizabeth M Keys[2], Emma Allen-Vercoe[4], Rebekah DeVinney[4], Christopher J Doig[5], Francis H Y Green[2] & Paul Kubes[1]



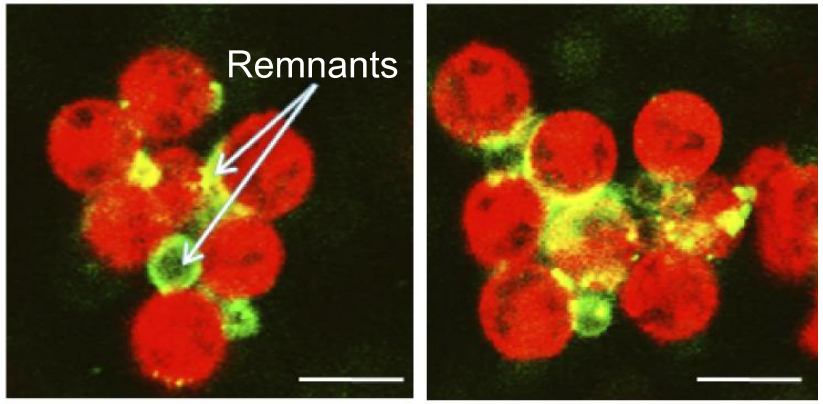
The diversity of platelet function

SCIENCE TRANSLATIONAL MEDICINE | RESEARCH ARTICLE

THROMBOSIS

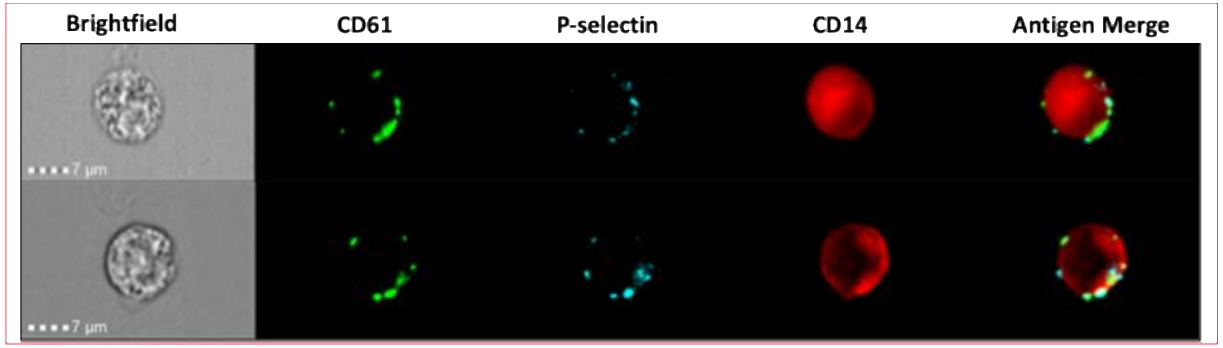
Neutrophil macroaggregates promote widespread pulmonary thrombosis after gut ischemia

Yuping Yuan,[1,2,3]* Imala Alwis,[1,2,3]* Mike C. L. Wu,[1,2,3]* Zane Kaplan,[1] Katrina Ashworth,[1] David Bark Jr.,[1] Alan Pham,[4] James Mcfadyen,[1] Simone M. Schoenwaelder,[1,2] Emma C. Josefsson,[5,6] Benjamin T. Kile,[5,6,7] Shaun P. Jackson[1,2,3,8†]

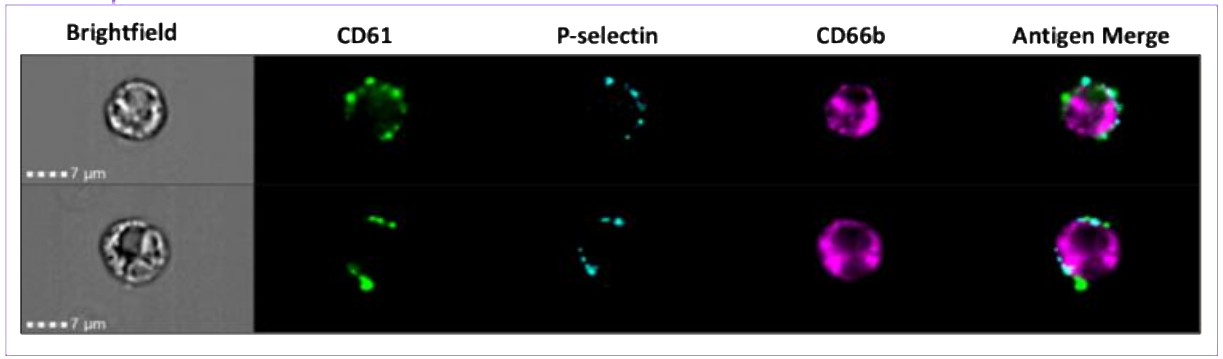


Neutrophils perfused over PS⁺ remnant platelets

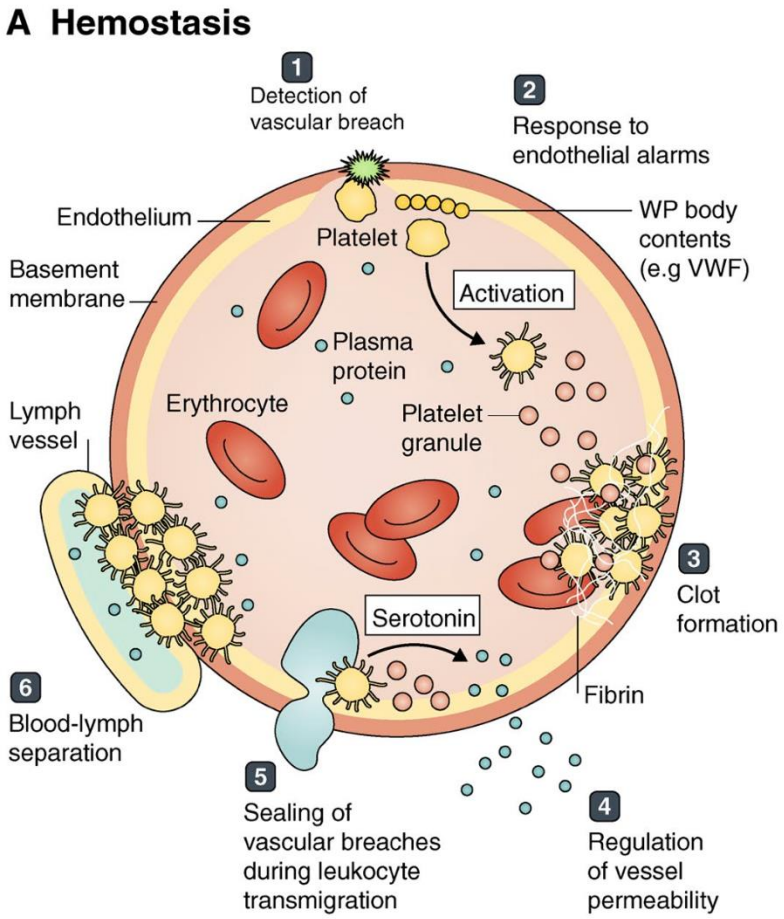
Monocytes



Neutrophils

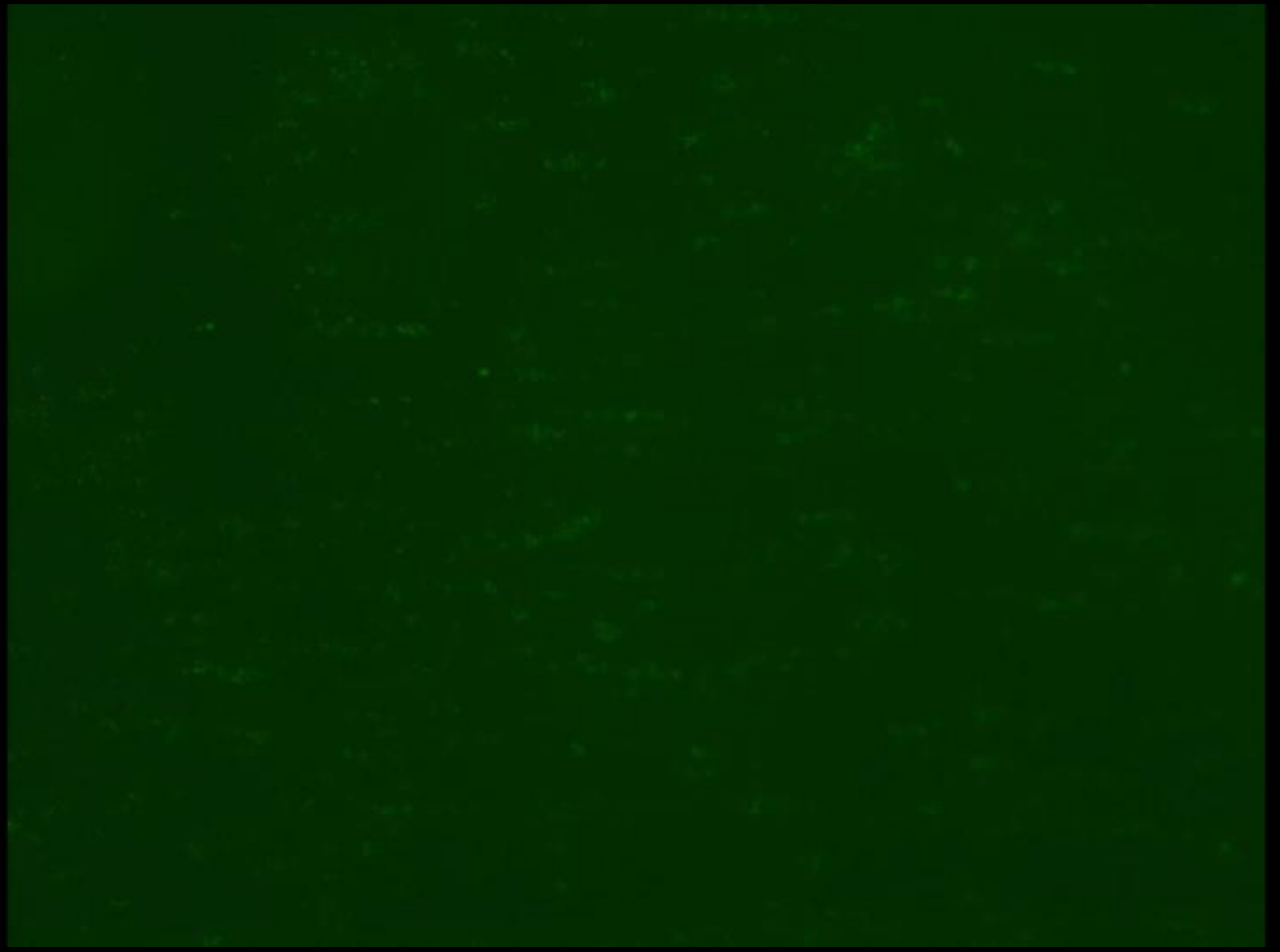


The diversity of platelet function



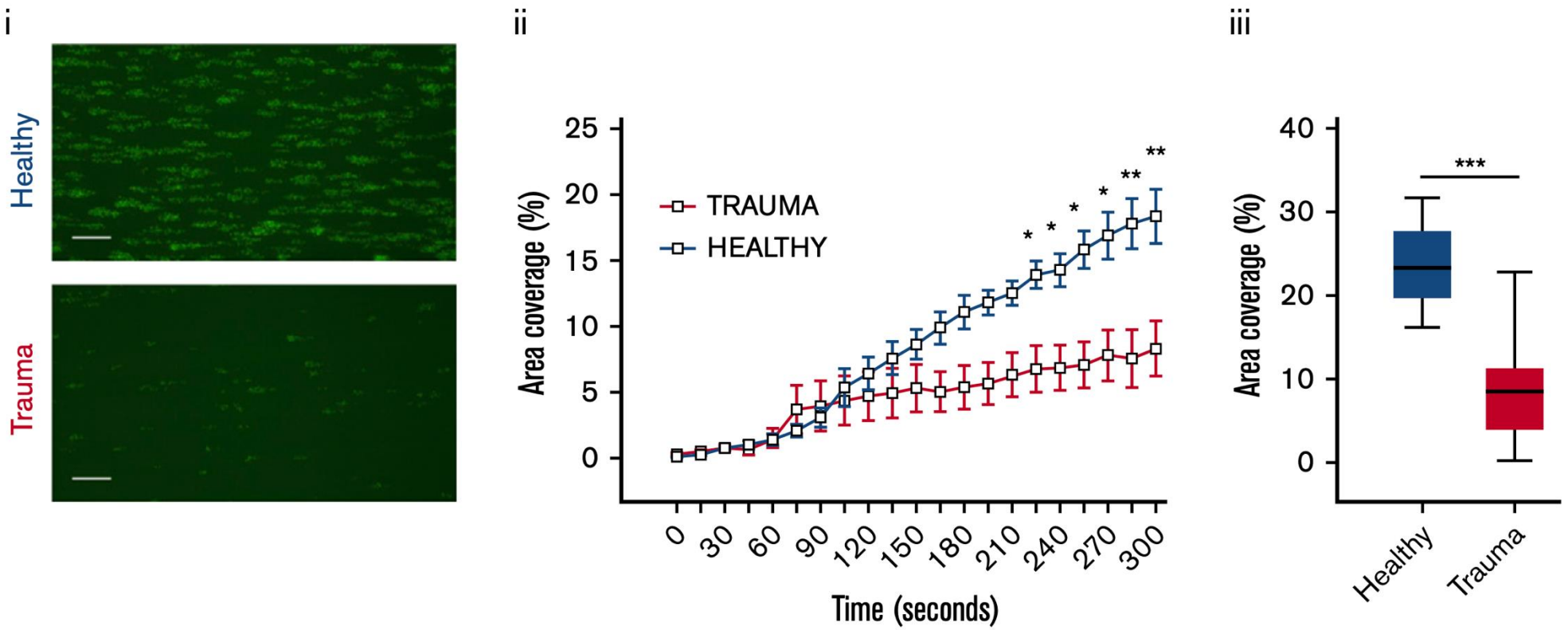

What do we want platelets to do?

Healthy Volunteer



Trauma Hemorrhage

Diminished platelet adhesion to collagen in trauma-induced coagulopathy

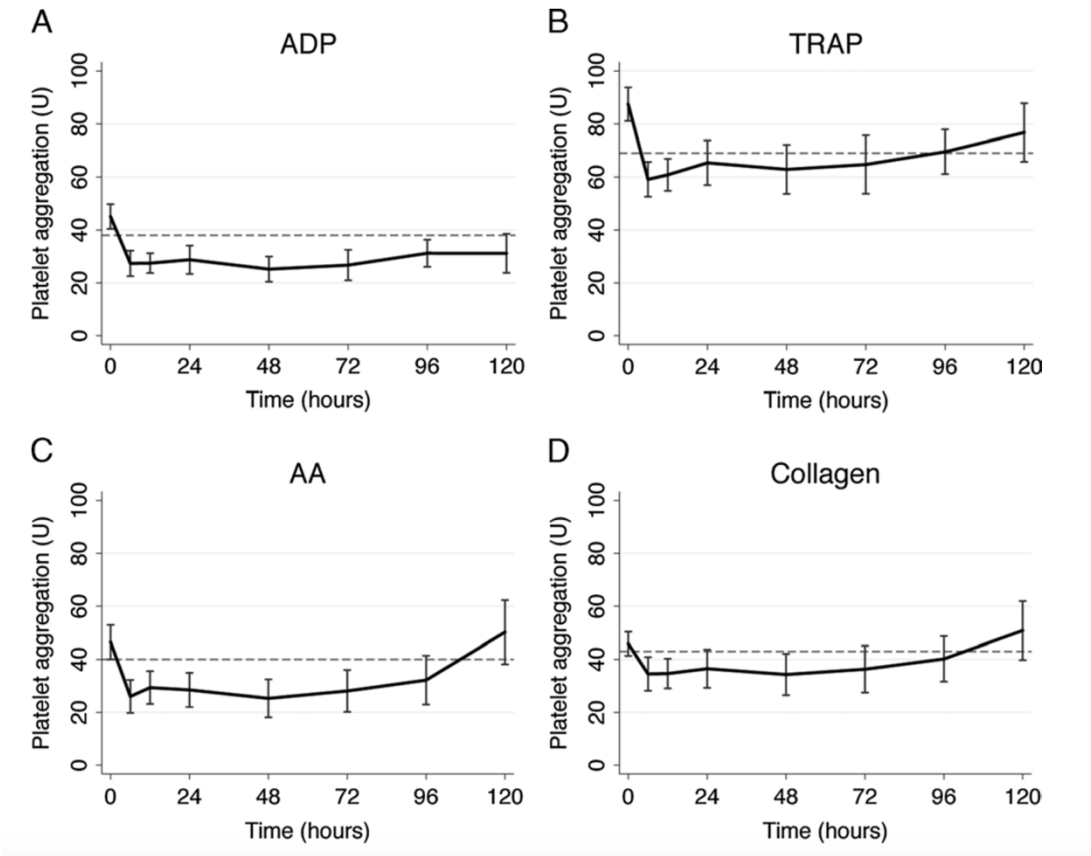


Vulliamy et al, Blood Advances 2020. DOI: 10.1182/bloodadvances.2020001776

Impaired platelet aggregation in response to *ex vivo* stimulation

Characterization of platelet dysfunction after trauma

Matthew E. Kutcher, MD, Brittney J. Redick, BA, Ryan C. McCreery, BS, Ian M. Crane, BS, Molly D. Greenberg, BS, Leslie M. Cachola, BA, Mary F. Nelson, RN, MPA, *and* **Mitchell Jay Cohen, MD,** *San Francisco, California*

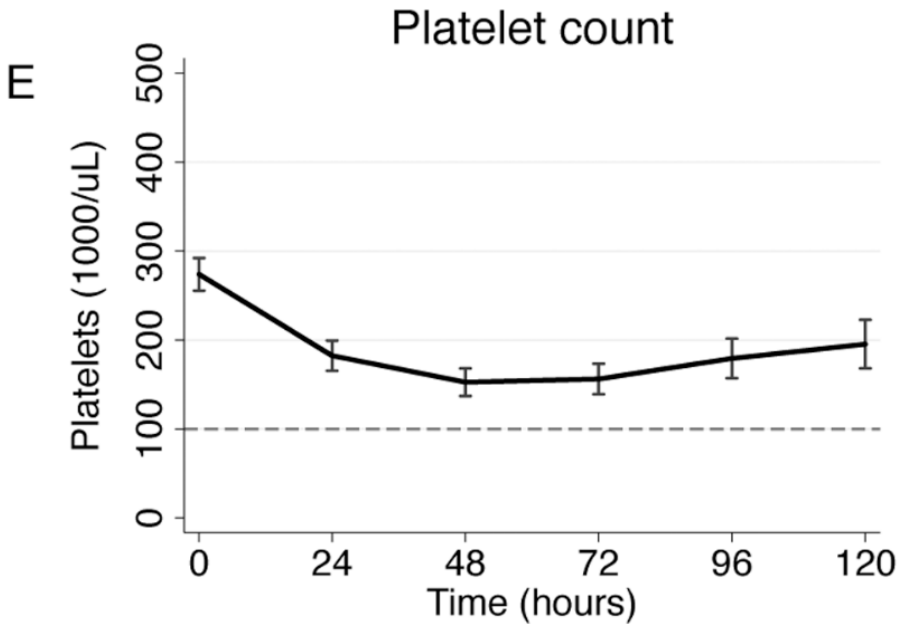


J Trauma 2012, DOI: 10.1097/TA.0b013e318256deab

Platelet numbers are preserved – but lower counts are prognostic

Characterization of platelet dysfunction after trauma

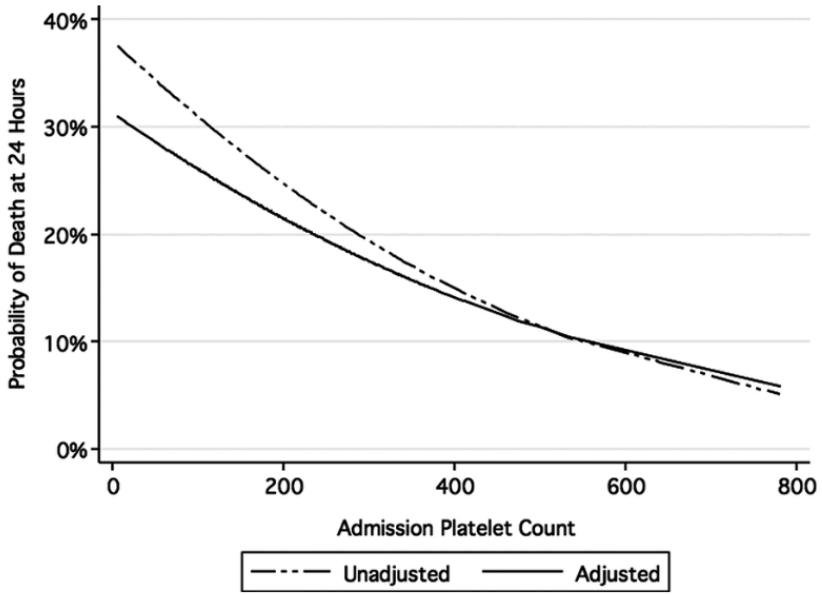
Matthew E. Kutcher, MD, Brittney J. Redick, BA, Ryan C. McCreery, BS, Ian M. Crane, BS, Molly D. Greenberg, BS, Leslie M. Cachola, BA, Mary F. Nelson, RN, MPA, *and* **Mitchell Jay Cohen, MD,** *San Francisco, California*



ORIGINAL ARTICLE

A Normal Platelet Count May Not Be Enough: The Impact of Admission Platelet Count on Mortality and Transfusion in Severely Injured Trauma Patients

Lisa M. Brown, MD, MAS, Mariah S. Call, BS, M. Margaret Knudson, MD, Mitchell J. Cohen, MD, and the Trauma Outcomes Group



J Trauma 2011, DOI: 10.1097/TA.0b013e318227f67c

Platelet transfusions do not support aggregation during active hemorrhage

J Trauma Acute Care Surg. 2017 Sep;83(3):388-397. doi: 10.1097/TA.0000000000001520.

Platelet transfusions reduce fibrinolysis but do not restore platelet function during trauma hemorrhage

Paul Vulliamy [1], Scarlett Gillespie, Lewis S Gall, La

Affiliations + expand

PMID: 28452886 DOI: 10.1097/TA.0000000000(

Observational Study J Surg Res. 2017 Jun 15:214:154-161. doi: 10.1016/j.jss.2017.02.037.

Epub 2017 Feb 28.

Impact of blood products on platelet function in patients with traumatic injuries: a translational study

Hanne Hee Henriksen [1], Alexandra G Gran
Bryan A Cotton [2], Nena Matijevic [2], Sisse
Tzu-An Chen [2], John B Holcomb [2], Pär I J

Affiliations + expand

PMID: 28624038 DOI: 10.1016/j.jss.2017.(

J Trauma Acute Care Surg. 2019 Nov;87(5):1042-1051. doi: 10.1097/TA.0000000000002459.

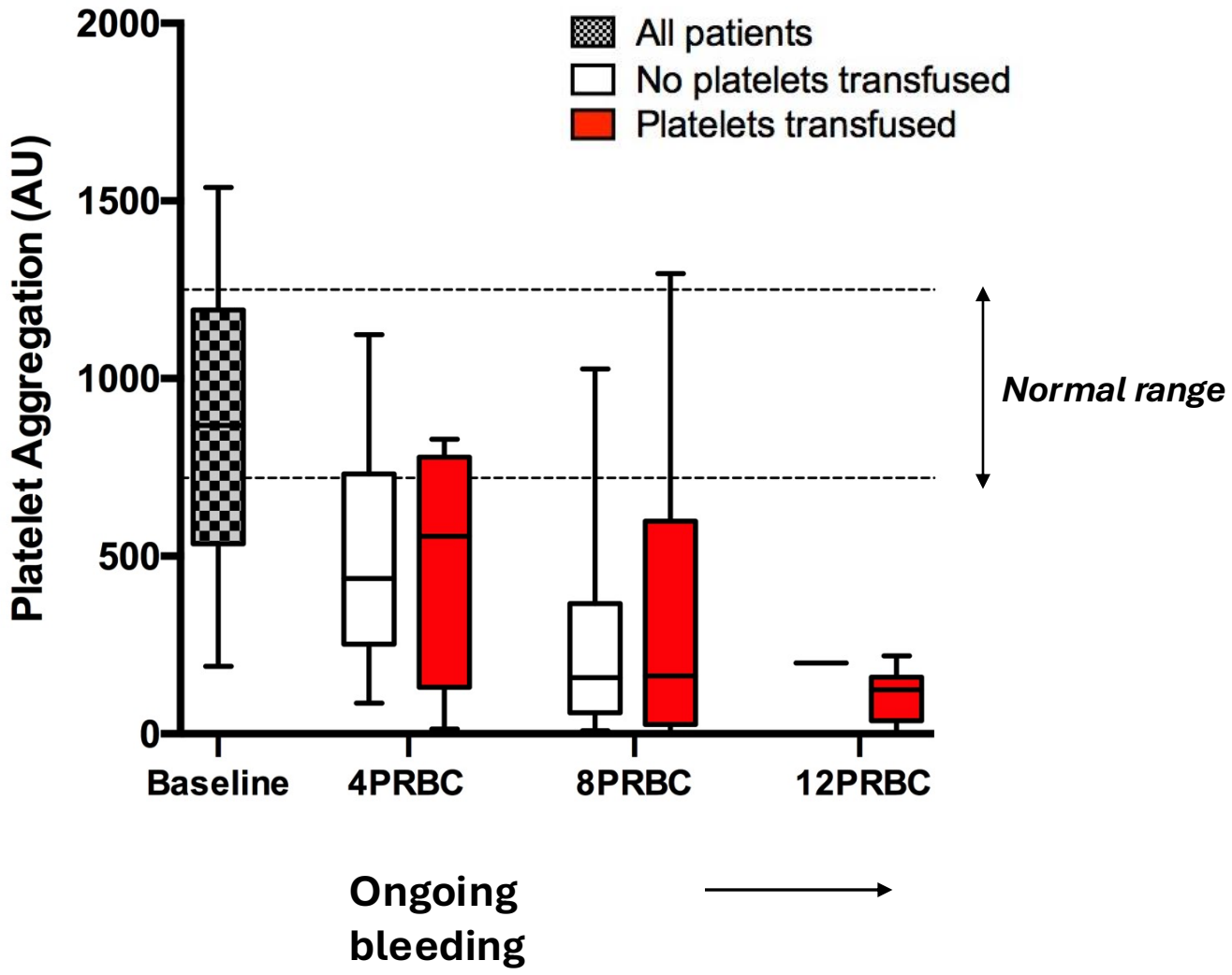
It's About Time: Transfusion effects on postinjury platelet aggregation over time

Lucy Z Kornblith [1], Anna Decker, Amanda S Conroy, Carolyn M Hendrickson, Alexander T Fields, Anamaria J Robles, Rachael A Callcut, Mitchell J Cohen

Affiliations + expand

PMID: 31389915 PMCID: PMC6814558 DOI: 10.1097/TA.0000000000002459

Platelet transfusions do not support aggregation during active hemorrhage



Why are platelet transfusions ‘ineffective’?

Is something in the blood ‘switching off’ platelets?

SHOCK, Vol. 55, No. 2, pp. 189–197, 2021

GOOD PLATELETS GONE BAD: THE EFFECTS OF TRAUMA PATIENT PLASMA ON HEALTHY PLATELET AGGREGATION

Alexander T. Fields,* Zachary A. Matthay,* Brenda Nunez-Garcia,* Ellicott C. Matthay,† Roland J. Bainton,‡ Rachael A. Callcut,* and Lucy Z. Kornblith*

**Department of Surgery, University of California, San Francisco; †Department of Epidemiology and Biostatistics, University of California, San Francisco; and ‡Department of Anesthesia and Perioperative Care, University of California, San Francisco*

Received: 25 June 2021 | Accepted: 9 May 2022

DOI: 10.1111/jth.15763

jth

ORIGINAL ARTICLE

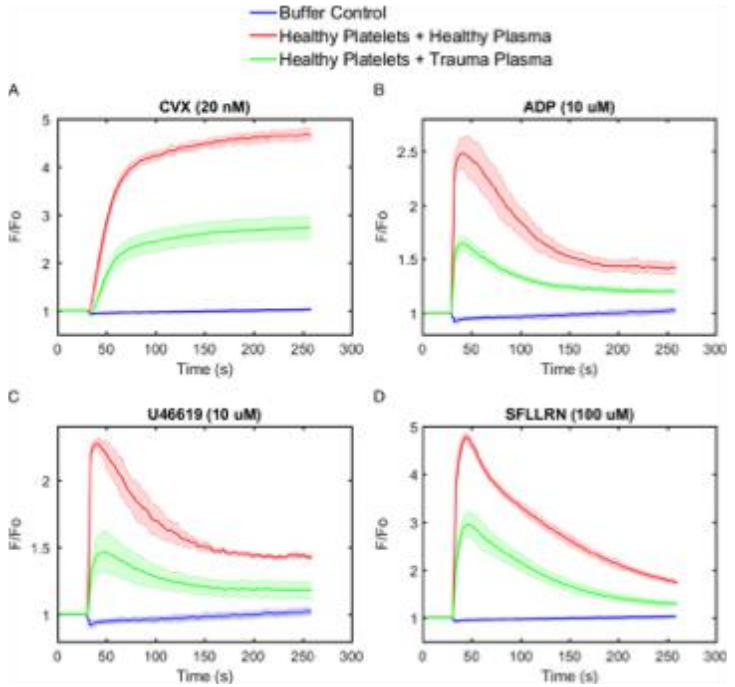
Importance of catecholamine signaling in the development of platelet exhaustion after traumatic injury

Zachary A. Matthay[1] | Alexander T. Fields[1] | Brenda Nunez-Garcia[1] | John J. Park[1] | Chayse Jones[2] | Aleksandra Leligdowicz[2] | Carolyn M. Hendrickson[2] | Rachael A. Callcut[3] | Michael A. Matthay[2] | Lucy Z. Kornblith[1]

ORIGINAL ARTICLE

Platelet dysfunction during trauma involves diverse signaling pathways and an inhibitory activity in patient-derived plasma

Christopher C. Verni, MS, Antonio Davila, Jr., PhD, Steve Balian, MD, Carrie A. Sims, MD, PhD, *and* **Scott L. Diamond, PhD**, *Philadelphia, Pennsylvania*



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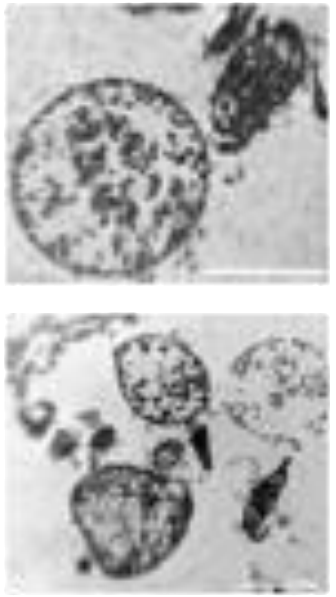
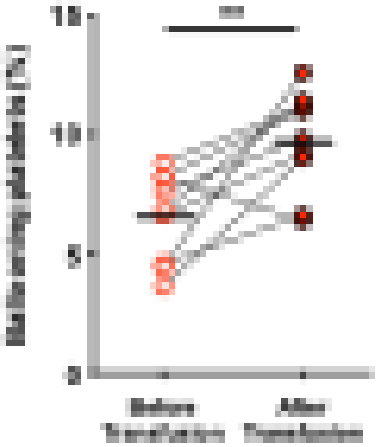
PNAS

Histone H4 induces platelet ballooning and microparticle release during trauma hemorrhage

Paul Vulliamy[a,1,2], Scarlett Gillespie[a,1], Paul C. Armstrong[b], Harriet E. Allan[b], Timothy D. Warner[b], and Karim Brohi[a,2]

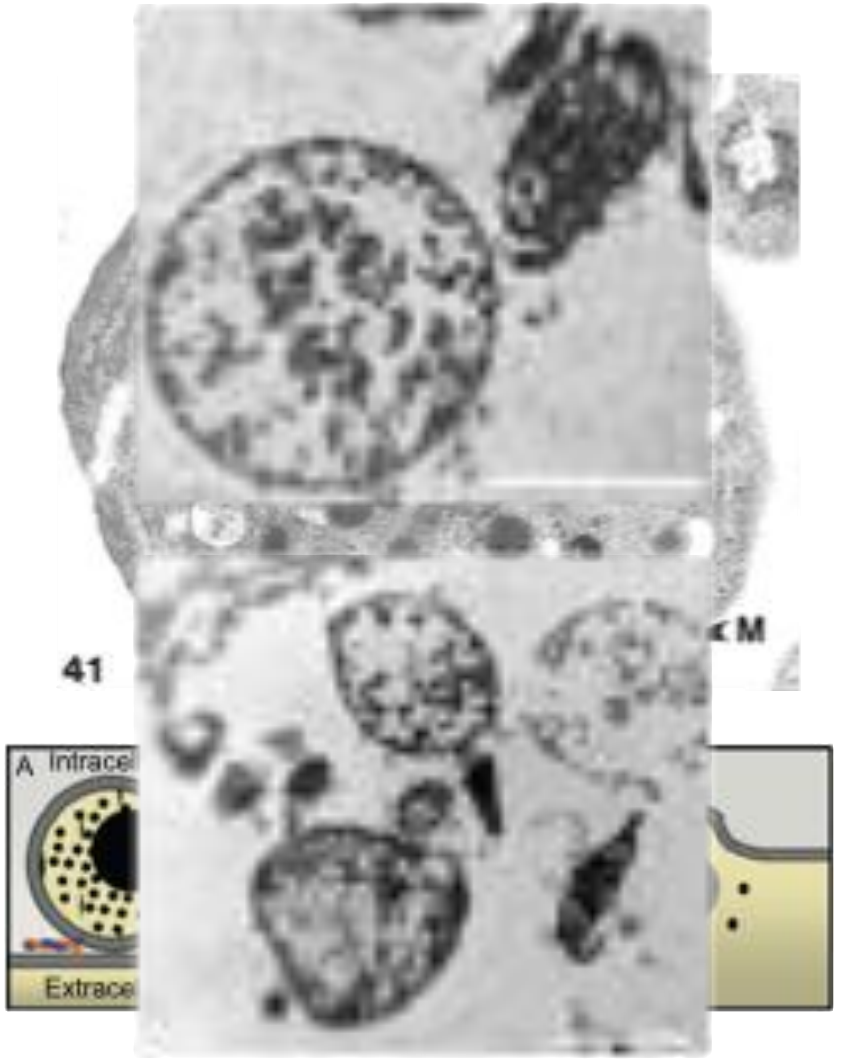
[a]Centre for Trauma Sciences, Blizard Institute, Barts and the London School of Medicine and Dentistry, Queen Mary University of London, E1 2AT, United Kingdom; and [b]Centre for Immunobiology, Blizard Institute, Barts and the London School of Medicine and Dentistry, Queen Mary University of London, E1 2AT, United Kingdom





Why are platelet transfusions ‘ineffective’?

Are transfused platelets doing something else??



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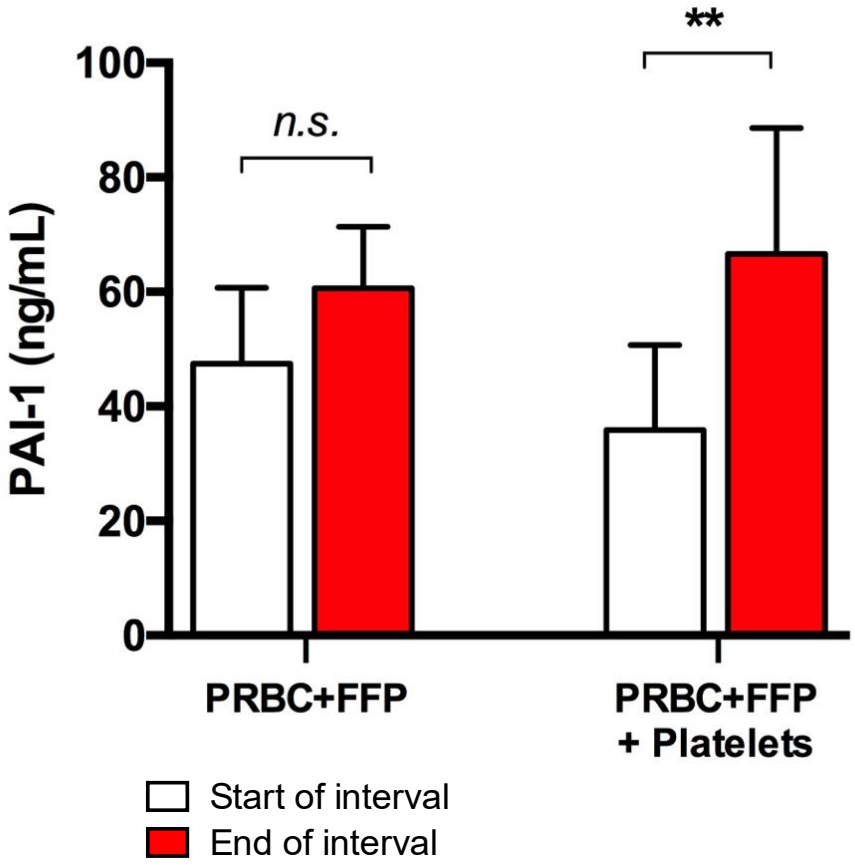


Why are platelet transfusions ‘ineffective’?

SCIENCE TRANSLATIONAL MEDICINE | RESEARCH ARTICLE

COAGULATION

Impaired hemostatic activity of healthy transfused platelets in inherited and acquired platelet disorders: Mechanisms and implications

Robert H. Lee[1,2]*, Raymond Piatt[1], Ankita Dhenge[1,2], María L. Lozano[3], Verónica Palma-Barqueros[3], José Rivera[3], Wolfgang Bergmeier[1,2]*

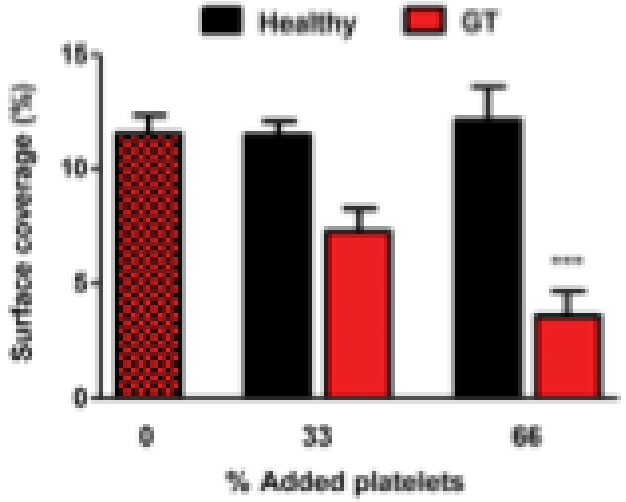
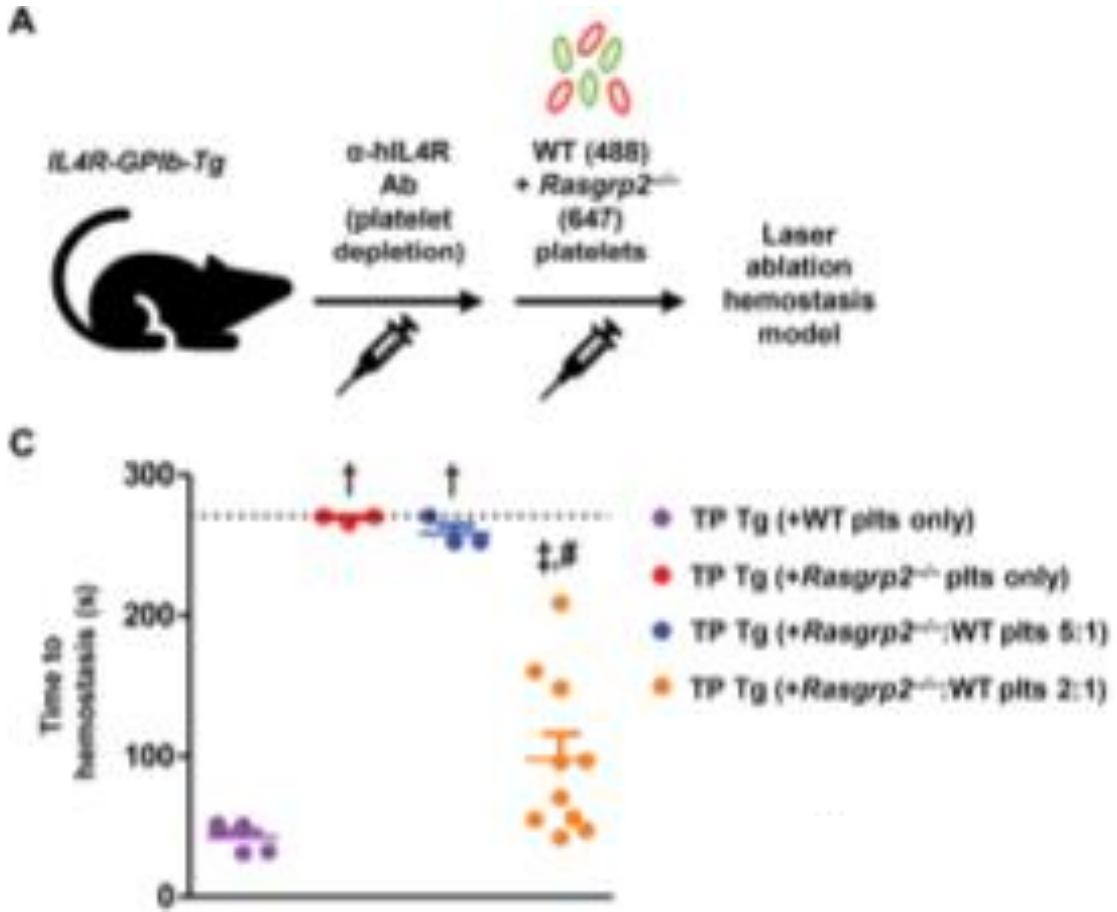


Fig. 5. GT patient platelets interfere with the function of healthy donor platelets.



Are platelets in whole blood different?

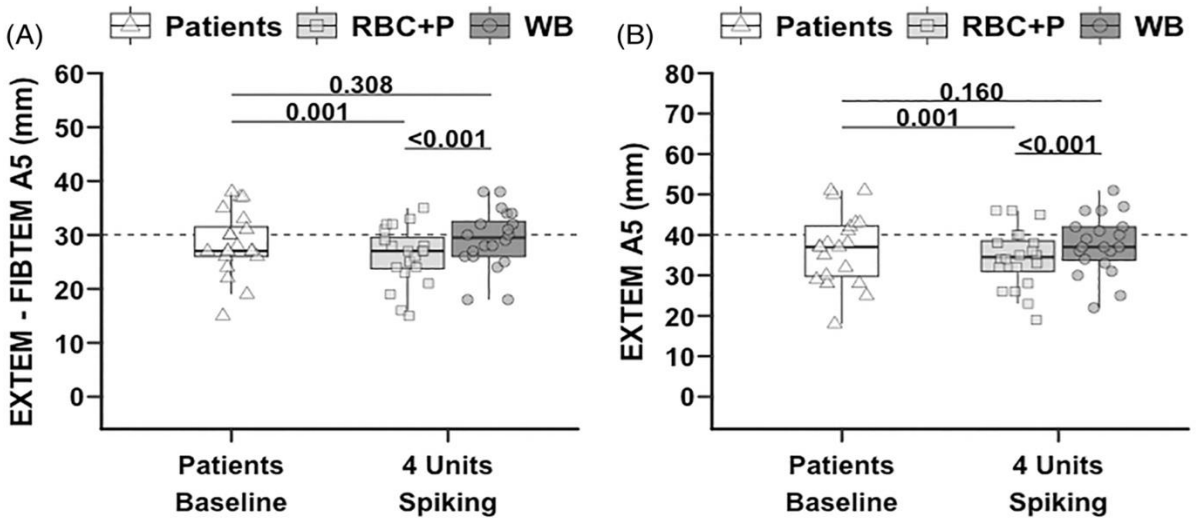
Comparative Study > Transfusion. 2025 Mar;65(3):624-636. doi: 10.1111/trf.18143.
Epub 2025 Feb 5.

Comparison of whole blood versus red blood cells and plasma to correct trauma-induced coagulopathy ex vivo

Andrea Rossetto [1 2], Paul Vulliamy [1 2], Sian Huish [3], Rebecca Cardigan [3 4], Laura Green [1 2 5], Ross Davenport [1 2]

Affiliations + expand

PMID: 39908221 PMCID: PMC11925139 DOI: 10.1111/trf.18143



Clinical Evidence

Research

Original Investigation

Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients With Severe Trauma
The PROPPR Randomized Clinical Trial

John B. Holcomb, MD; Barbara C. Tilley, PhD; Sarah Baraniuk, PhD; Erin E. Fox, PhD; Charles E. Wade, PhD; Jeanette M. Podbielski, RN; Deborah J. del Junco, PhD; Karen J. Brasel, MD, MPH; Eileen M. Bulger, MD; Rachael A. Callcut, MD, MSPH; Mitchell Jay Cohen, MD; Bryan A. Cotton, MD, MPH; Timothy C. Fabian, MD; Kenji Inaba, MD; Jeffrey D. Kerby, MD, PhD; Peter Muskat, MD; Terence O'Keeffe, MBChB, MSPH; Sandro Rizoli, MD, PhD; Bryce R. H. Robinson, MD; Thomas M. Scalea, MD; Martin A. Schreiber, MS; Deborah M. Stein, MD; Jordan A. Weinberg, MD; Jeannie L. Callum, MD; John R. Hess, MD, MPH; Nena Matijevic, PhD; Christopher N. Miller, MD; Jean-Francois Pittet, MD; David B. Hoyt, MD; Gail D. Pearson, MD, ScD; Brian Leroux, PhD; Gerald van Belle, PhD; for the PROPPR Study Group

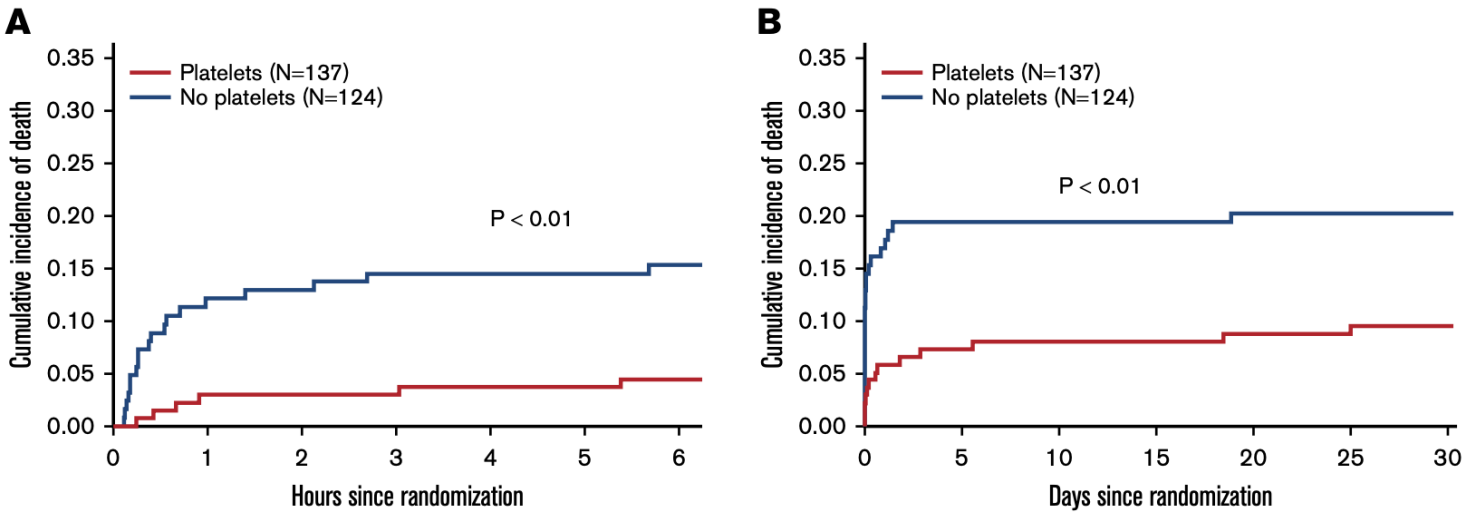
Clinical Evidence

REGULAR ARTICLE

blood advances™

Platelet transfusions improve hemostasis and survival in a substudy of the prospective, randomized PROPPR trial

Jessica C. Cardenas,[1,2] Xu Zhang,[3] Erin E. Fox,[1-3] Bryan A. Cotton,[1-3] John R. Hess,[4] Martin A. Schreiber,[5] Charles E. Wade,[1-3] and John B. Holcomb,[1-3] on behalf of the PROPPR Study Group



What do the guidelines say?

Rossaint *et al. Critical Care* (2023) 27:80
https://doi.org/10.1186/s13054-023-04327-7

Critical Care

GUIDELINES Open Access

The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition

Rolf Rossaint[1*], Arash Afshari[2], Bertil Bouillon[3], Vladimir Cerny[4,5], Diana Cimpoesu[6], Nicola Curry[7,8], Jacques Duranteau[9], Daniela Filipescu[10], Oliver Grottke[1], Lars Grønlykke[11], Anatole Harrois[9], Beverley J. Hunt[12], Alexander Kaserer[13], Radko Komadina[14], Mikkel Herold Madsen[2], Marc Maegele[15], Lidia Mora[16], Louis Riddez[17], Carolina S. Romero[18], Charles-Marc Samama[19], Jean-Louis Vincent[20], Sebastian Wiberg[11] and Donat R. Spahn[13]

Keep platelets >50x10^9/L (or >100x10^9/L if coexisting TBI) *(Grade 2B)*

Early and repeated monitoring of hemostasis *(Grade 1C)*

Avoid routine use of point-of-care platelet function testing *(Grade 1C)*

Give a high platelet:pRBC ratio *(Grade 2B)*

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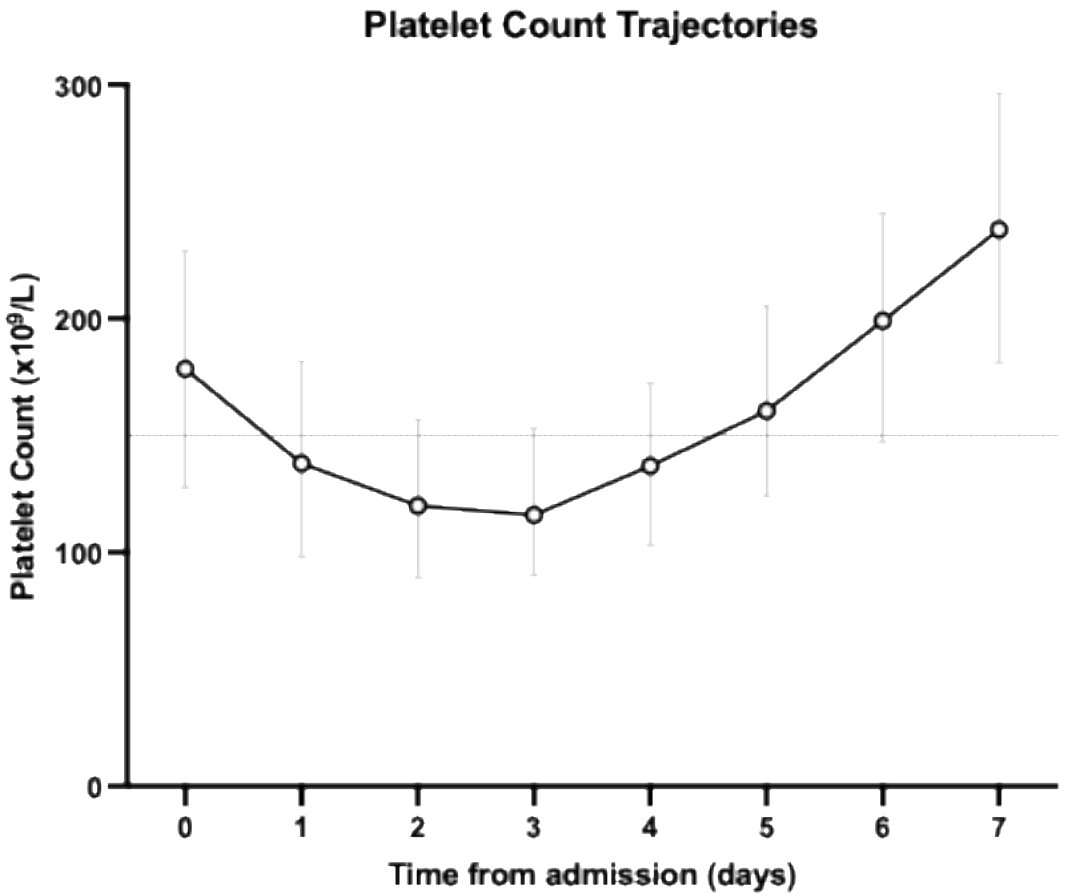
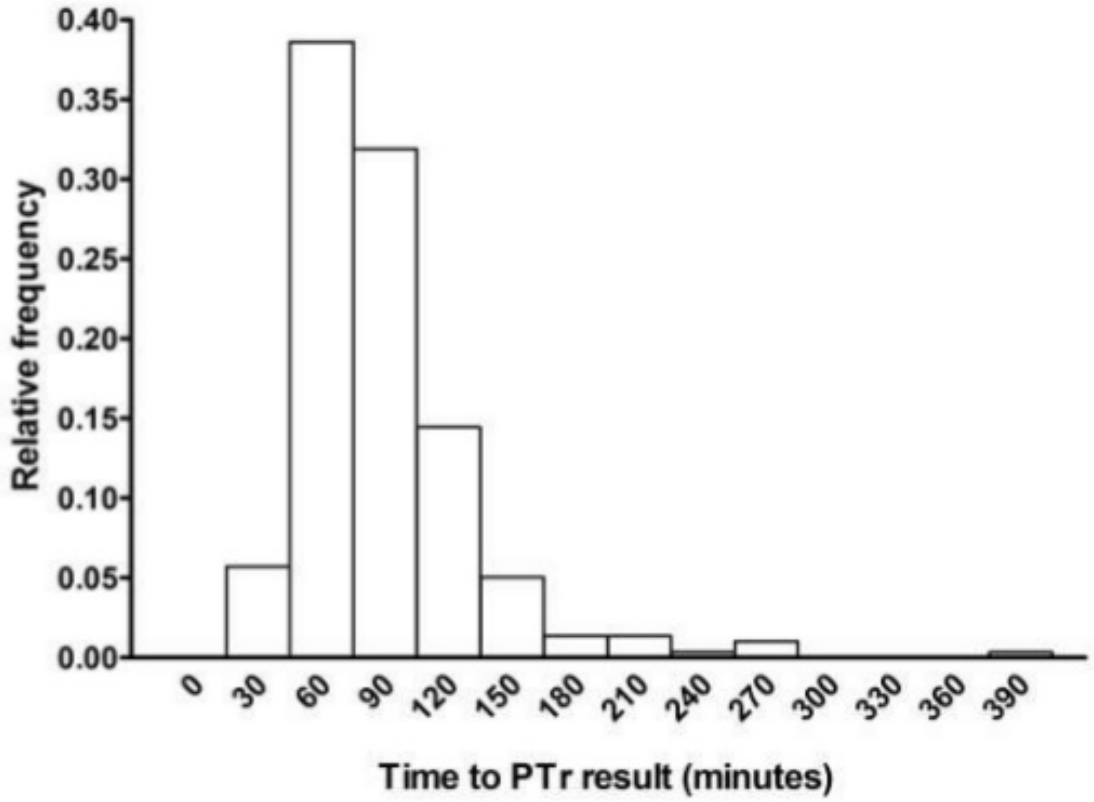
Early significant thrombocytopenia is rare



Platelet counts take time…



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Tools to guide platelet transfusion

a ROTEM	b TEG	c CCT
FIBRINOGEN If FIBTEM CA5 < 10 mm Give additional 4g equivalent of fibrinogen *(as cryoprecipitate or concentrate)*	**FIBRINOGEN** If FF TEG MA < 20 mm Give additional 4g equivalent of fibrinogen *(as cryoprecipitate or concentrate)*	**FIBRINOGEN** If Fibrinogen < 2 g/L Give additional 4g equivalent of fibrinogen *(as cryoprecipitate or concentrate)*
PLATELETS If (EXTEM CA5 – FIBTEM CA5) < 30 mm Give 1 additional pool of platelets	**PLATELETS** If (rTEG MA – FF TEG MA) < 45 mm Give 1 additional pool of platelets	**PLATELETS** If platelets < 100 x 10^9 /L Give 1 additional pool of platelets
If EXTEM CA5 ≥ 40 mm **AND** EXTEM CT > 80 s Give 4 additional units of plasma	If rTEG MA ≥ 65 mm **AND** rTEG ACT > 120 s Give 4 additional units of plasma	If INR > 1.2 **AND** Fibrinogen ≥ 2 g/L Give 4 additional units of plasma
TRANEXAMIC ACID If EXTEM LI30 < 85 % Give additional 1g tranexamic acid	**TRANEXAMIC ACID** If rTEG LY30 > 10 % Give additional 1g tranexamic acid	

Baksaas-Aasen K, Ann Surg 2019

What do the guidelines say?

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GUIDELINES Open Access

The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition

Rolf Rossaint[1*], Arash Afshari[2], Bertil Bouillon[3], Vladimir Cerny[4,5], Diana Cimpoesu[6], Nicola Curry[7,8], Jacques Duranteau[9], Daniela Filipescu[10], Oliver Grottke[1], Lars Grønlykke[11], Anatole Harrois[9], Beverley J. Hunt[12], Alexander Kaserer[13], Radko Komadina[14], Mikkel Herold Madsen[2], Marc Maegele[15], Lidia Mora[16], Louis Riddez[17], Carolina S. Romero[18], Charles-Marc Samama[19], Jean-Louis Vincent[20], Sebastian Wiberg[11] and Donat R. Spahn[13]

Keep platelets >50x10^9/L (or >100x10^9/L if coexisting TBI) *(Grade 2B)*

Early and repeated monitoring of hemostasis *(Grade 1C)*

Avoid routine use of point-of-care platelet function testing *(Grade 1C)*

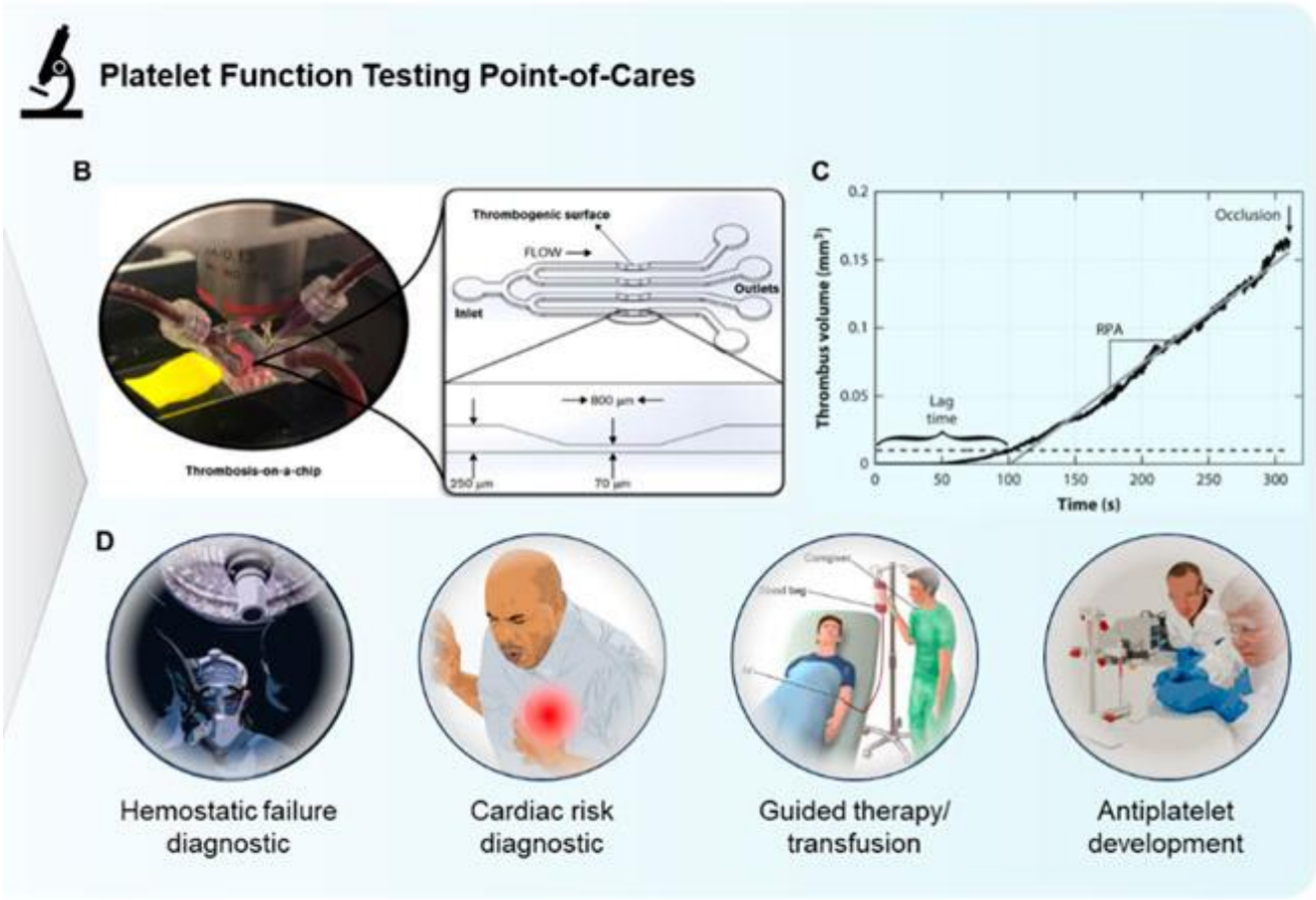
Give a high platelet:pRBC ratio *(Grade 2B)*

Novel tools - Microfluidics

Advancing microfluidic point-of-care platelet function tests: opportunities and challenges from bench to market

Minki Kang, Christopher A. Bresette and David N. Ku*

George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, United States



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Novel tools - Microfluidics

PLOS One

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RESEARCH ARTICLE

Trauma patients have reduced *ex vivo* flow-dependent platelet hemostatic capacity in a microfluidic model of vessel injury

Kimberly A. Thomas, Rassam M. G. Rassam, Ronit Kar, Devin M. Dishong, Katelin C. Rahn, Ricardo Fonseca, Melissa Canas, Jose Aldana, Hussain Afzal, Kelly Bochicchio, Matthew D. Neal, Grant V. Bochicchio, Philip C. Spinella, Susan M. Shea

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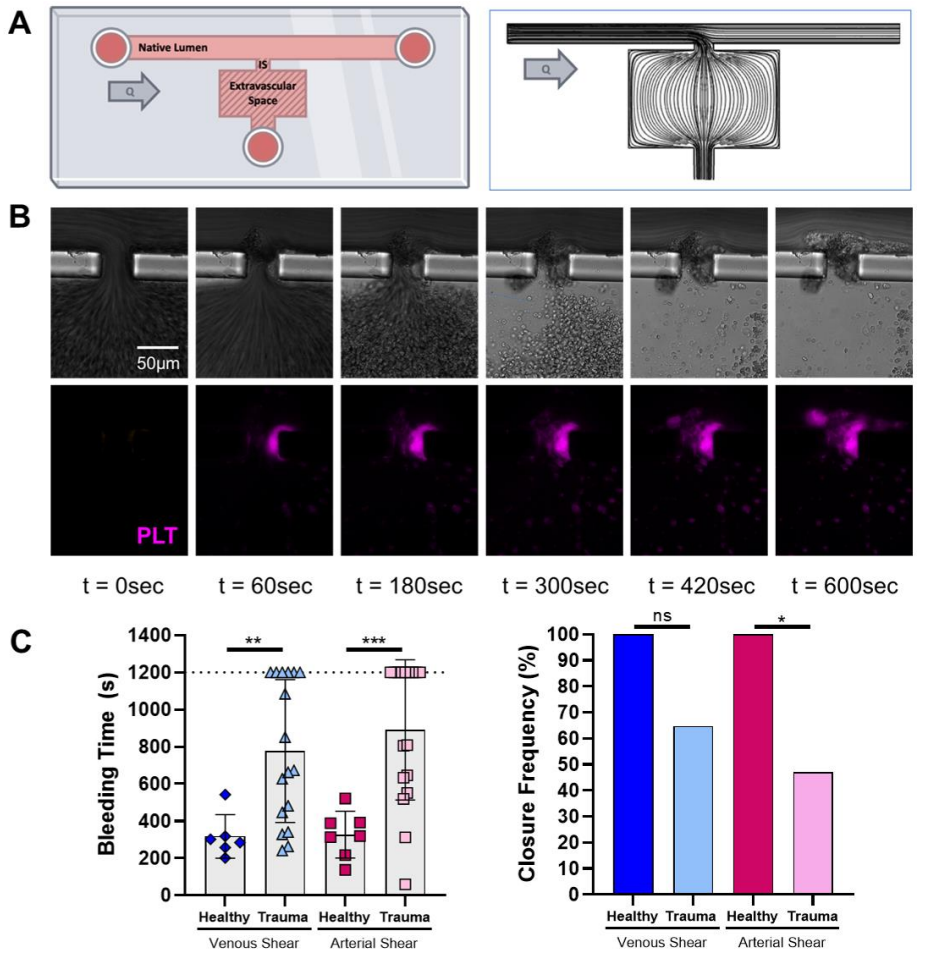

What do the guidelines say?

Rossaint *et al. Critical Care* (2023) 27:80
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Critical Care

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The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition

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When are platelets NOT indicated?

When are platelets NOT indicated?

The NEW ENGLAND JOURNAL of MEDICINE

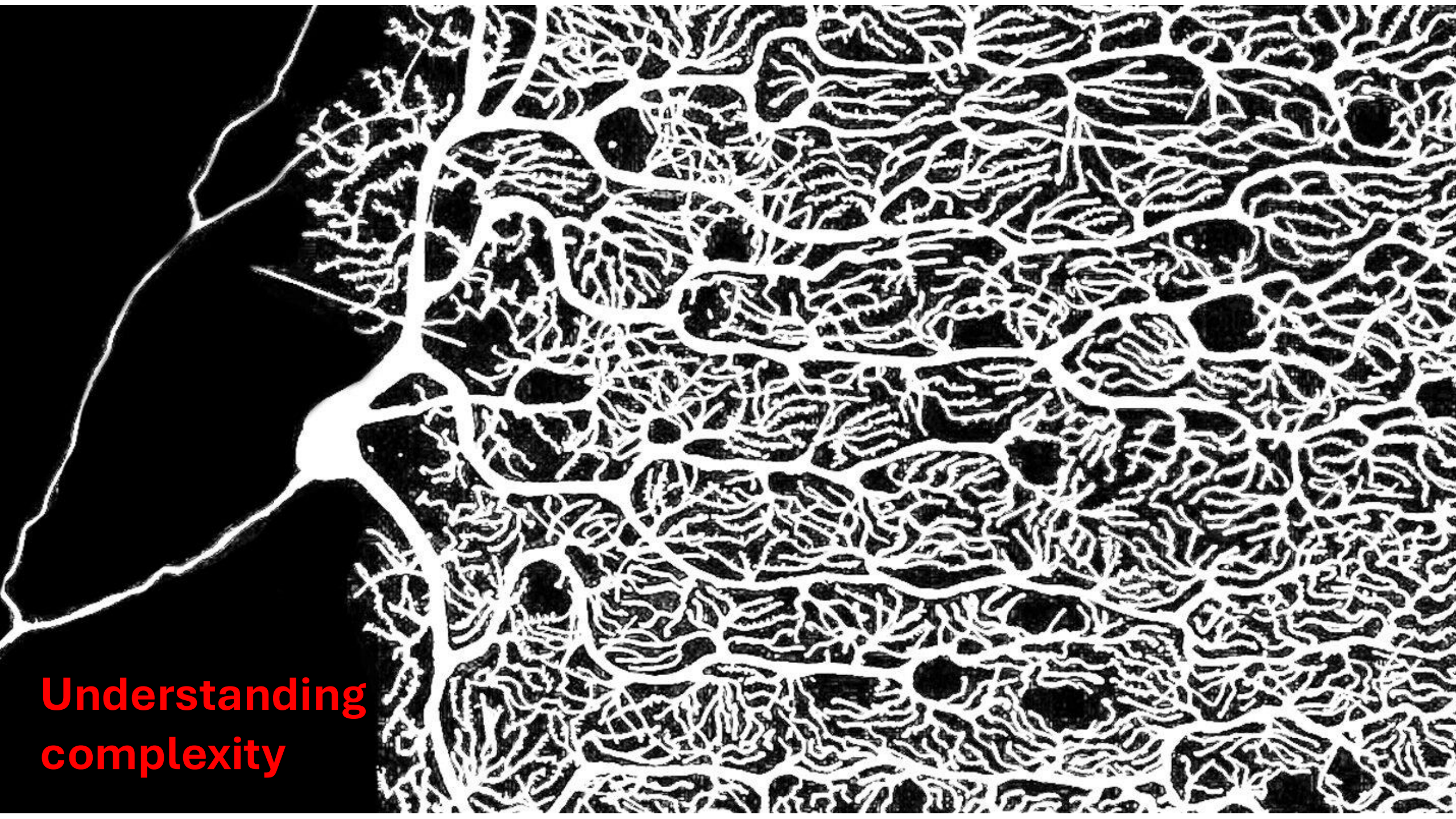
ORIGINAL ARTICLE

Randomized Trial of Platelet-Transfusion Thresholds in Neonates

Outcome	Low-Threshold Group (N=331)	High-Threshold Group (N=329)	Odds Ratio or Hazard Ratio (95% CI)*
Primary outcome			
Death or major bleeding episode through trial day 28 — no./total no. (%)	61/329 (19)	85/324 (26)	OR, 1.57 (1.06–2.32)†
Secondary outcomes‡			
Death through trial day 28 — no./total no. (%)	33/330 (10)	48/326 (15)	OR, 1.56 (0.95–2.55)
At least one major bleeding episode through trial day 28 — no./total no. (%)	35/330 (11)	45/328 (14)	HR, 1.32 (1.00–1.74)

When are platelets NOT indicated?

	Intention-to-treat population			As-treated population		
	Platelet transfusion group (n=97)	Standard care group (n=93)	Odds ratio (95% CI)	Platelet transfusion group (n=95)	Standard care group (n=95)	Odds ratio (95% CI)
Any SAE	41 (42%)	27 (29%)	1·79 (0·98–3·27)	40 (42%)	28 (29%)	1·74 (0·96–3·17)
Any fatal SAE	24 (25%)	15 (16%)	1·71 (0·83–3·51)	23 (24%)	16 (17%)	1·58 (0·77–3·22)
SAE due to ICH	24 (25%)	13 (14%)	2·02 (0·96–4·27)	24 (25%)	13 (14%)	2·13 (1·01–4·50)
ICH enlargement	15 (15%)	13 (14%)	1·13 (0·50–2·52)	15 (16%)	13 (14%)	1·18 (0·53–2·64)
Brain oedema	5 (5%)	0	11·12 (0·61–204·97)	5 (5%)	0	11·61 (0·63–212·94)
Brain herniation	2 (2%)	0	4·90 (0·23–103·33)	2 (2%)	0	5·11 (0·24–107·83)
Intraventricular extension	6 (6%)	0	13·28 (0·74–239·24)	6 (6%)	0	13·87 (0·77–249·82)
Hydrocephalus	3 (3%)	2 (2%)	1·45 (0·24–8·89)	4 (4%)	1 (1%)	4·13 (0·45–37·67)
SAE due to thromboembolism	4 (4%)	1 (1%)	3·96 (0·43–36·08)	4 (4%)	1 (1%)	4·13 (0·45–37·67)
Ischaemic stroke	1 (1%)	0	2·91 (0·12–72·26)	1 (1%)	0	3·03 (0·12–75·37)
Myocardial infarction	1 (1%)	1 (1%)	0·96 (0·06–15·55)	1 (1%)	1 (1%)	1·00 (0·06–16·23)
Extremity embolism	2 (2%)	0	4·90 (0·23–103·34)	2 (2%)	0	5·11 (0·24–107·81)
Pulmonary embolism	1 (1%)	0	2·91 (0·12–72·26)	1 (1%)	0	3·03 (0·12–75·37)


Understanding
complexity

Thank you

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