

# REBOA, ECPR, And Cryo... Oh My!

---

Kim Boswell, MD  
University of Maryland School of Medicine  
Critical Care Symposium 2024

1

## No Disclosures...

2

# Objectives

---

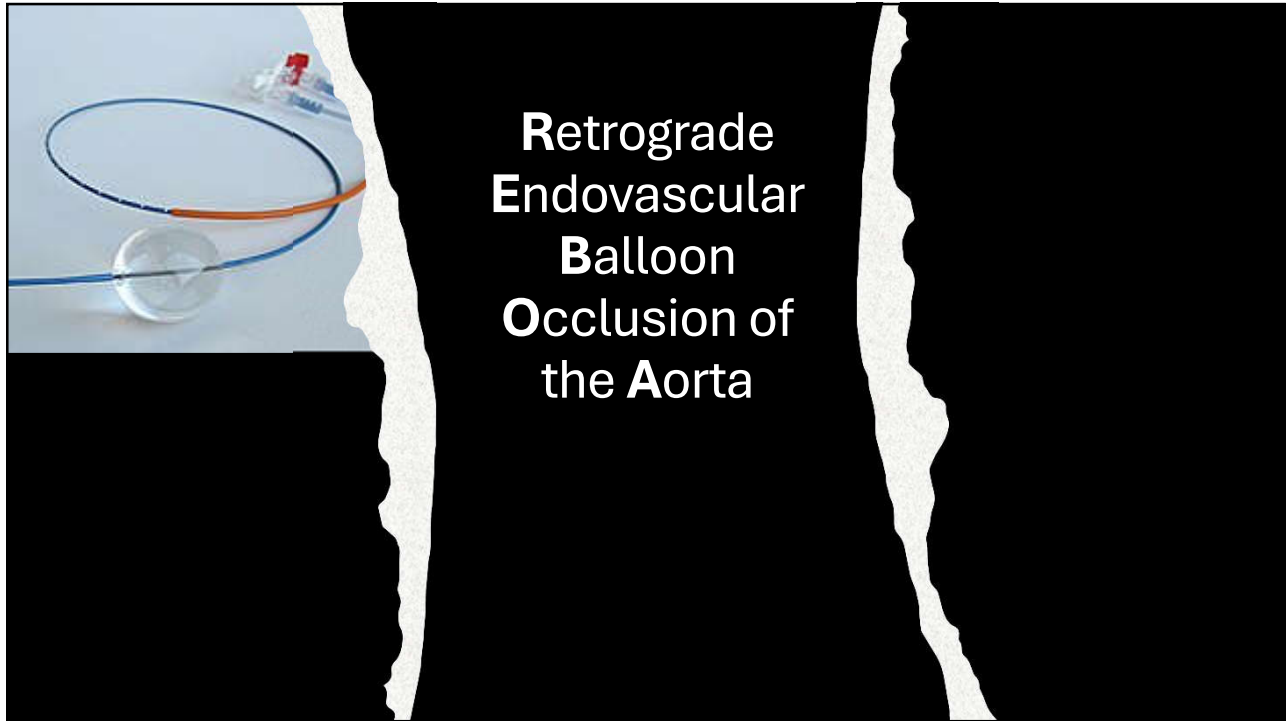
- Know current recommendations and contraindications for the use of REBOA in the Emergency Department
- Understand current literature surrounding ECPR and what population might benefit from ECPR
- Review the literature on trauma induced coagulopathy
- Understand the role of fibrinogen concentrate and cryoprecipitate in the hemorrhaging trauma patient

3

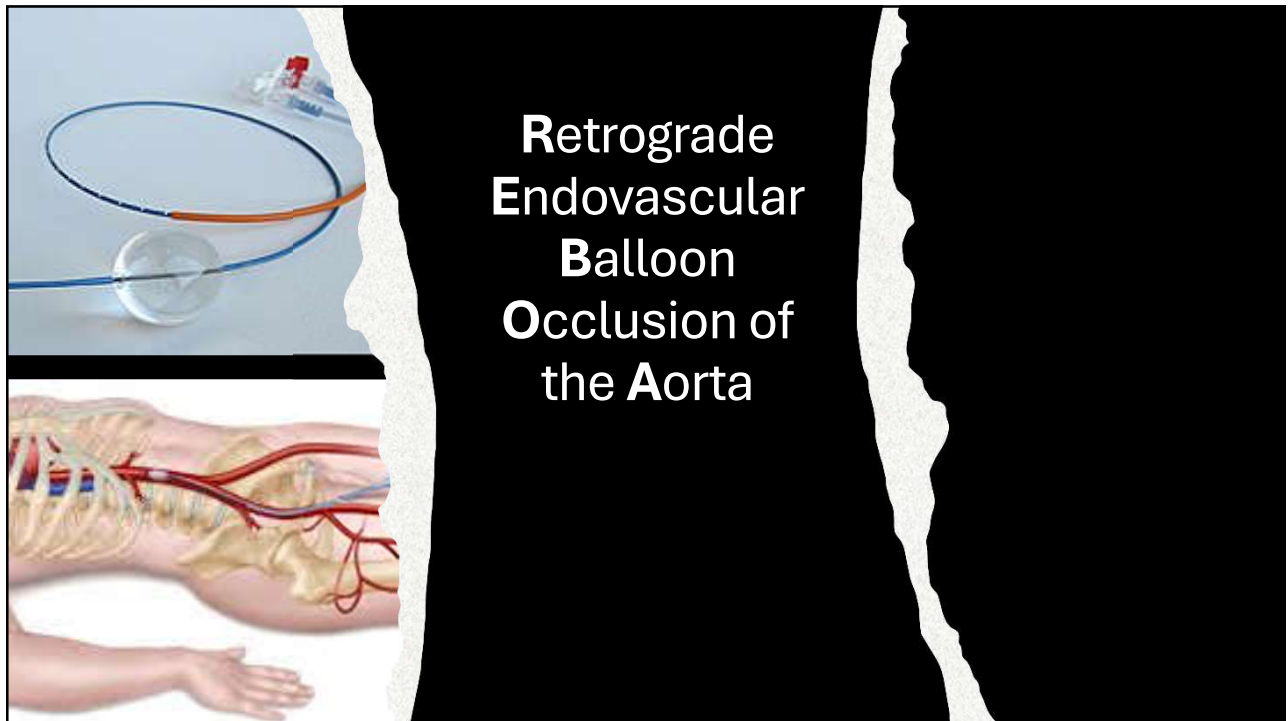
# REBOA

---

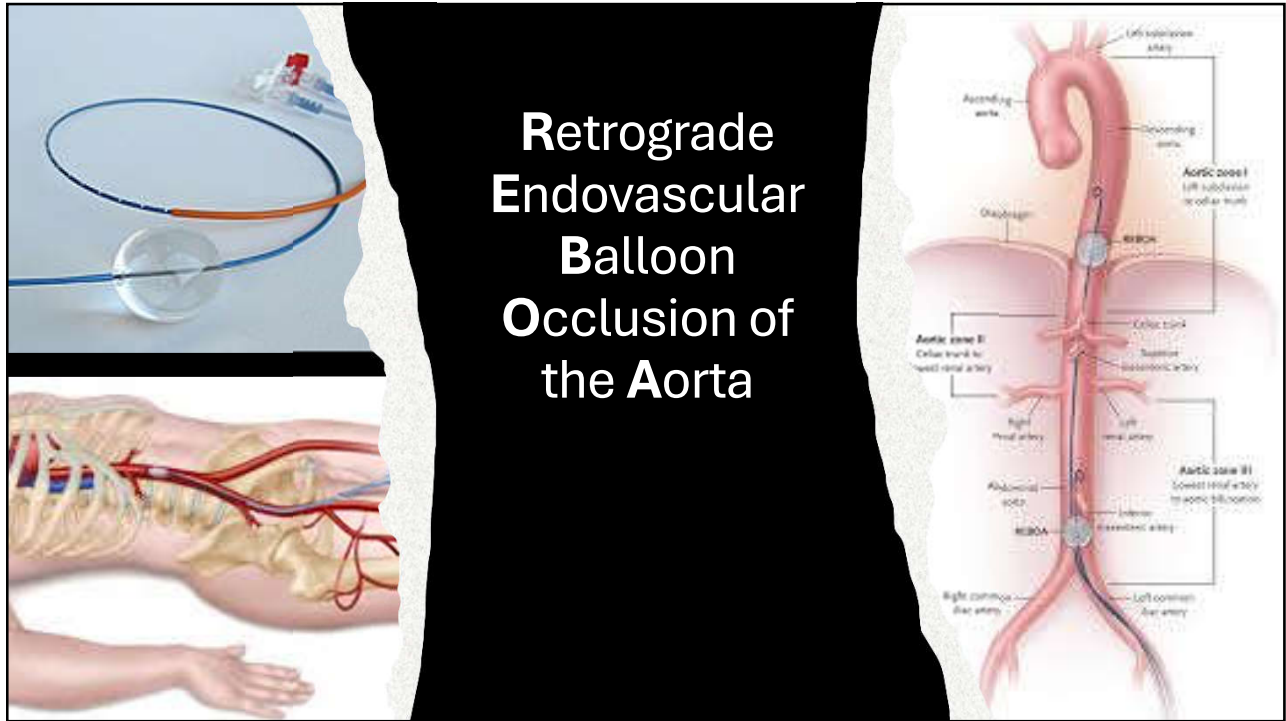
4



5



6



7



# Early Experience

8

# Current Literature

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

## Emergency Department Resuscitative Endovascular Balloon Occlusion of the Aorta in Trauma Patients With Exsanguinating Hemorrhage: The UK-REBOA Randomized Clinical Trial

Jan O. Jansen, PhD; Jemma Hudson, PhD; Claire Cochran, MSc; Graeme MacLennan, MSc; Robbie Lendrum, MBChB; Sam Sadek, MBBS; Katie Gillies, PhD; Seonaidh Cotton, PhD; Charlotte Kennedy, MSc; Dwayne Boyers, PhD; Gillian Ferry, MSc; Louisa Lawrie, PhD; Mintu Nath, PhD; Samantha Wileman, PhD; Mark Forrest, BSc; Karim Brohi, MBBS; Tim Harris, MBBS; Fiona Lecky, PhD; Chris Moran, MD; Jonathan J. Morrison, PhD; John Norrie, MSc; Alan Paterson, DPhil; Nigel Tai, MS; Nick Welch; Marion K. Campbell, PhD; and the UK-REBOA Study Group

Mark Forrest, BSc; Karim Brohi, MBBS; Tim Harris, MBBS; Fiona Lecky, PhD; Chris Moran, MD; Jonathan J. Morrison, PhD; John Norrie, MSc; Alan Paterson, DPhil; Nigel Tai, MS; Nick Welch; Marion K. Campbell, PhD; and the UK-REBOA Study Group

9

# Current Literature

- No current, high-grade evidence clearly demonstrates REBOA improves outcomes or survival compared to standard treatment of severe hemorrhage
- REBOA is less invasive than resuscitative thoracotomy and in skilled hands may be more rapidly applied as compared with resuscitative thoracotomy.

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

## Emergency Department Resuscitative Endovascular Balloon Occlusion of the Aorta in Trauma Patients With Exsanguinating Hemorrhage: The UK-REBOA Randomized Clinical Trial

Jan O. Jansen, PhD; Jemma Hudson, PhD; Claire Cochran, MSc; Graeme MacLennan, MSc; Robbie Lendrum, MBChB; Sam Sadek, MBBS; Katie Gillies, PhD; Seonaidh Cotton, PhD; Charlotte Kennedy, MSc; Dwayne Boyers, PhD; Gillian Ferry, MSc; Louisa Lawrie, PhD; Mintu Nath, PhD; Samantha Wileman, PhD; Mark Forrest, BSc; Karim Brohi, MBBS; Tim Harris, MBBS; Fiona Lecky, PhD; Chris Moran, MD; Jonathan J. Morrison, PhD; John Norrie, MSc; Alan Paterson, DPhil; Nigel Tai, MS; Nick Welch; Marion K. Campbell, PhD; and the UK-REBOA Study Group

Mark Forrest, BSc; Karim Brohi, MBBS; Tim Harris, MBBS; Fiona Lecky, PhD; Chris Moran, MD; Jonathan J. Morrison, PhD; John Norrie, MSc; Alan Paterson, DPhil; Nigel Tai, MS; Nick Welch; Marion K. Campbell, PhD; and the UK-REBOA Study Group


Open Access  
Trauma Surgery  
& Acute Care Open

Guidelines/Algorithms

Joint statement from the American College of Surgeons Committee on Trauma (ACS COT) and the American College of Emergency Physicians (ACEP) regarding the clinical use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)

Megan Brenner,<sup>1</sup> Eileen M Bulger,<sup>2</sup> Debra G Perina,<sup>3</sup> Sharon Henry,<sup>1</sup> Christopher S Kang,<sup>4</sup> Michael F Rotondo,<sup>3</sup> Michael C Chang,<sup>6</sup> Leonard J Weireter,<sup>7</sup> Michael Coburn,<sup>8</sup> Robert J Winchell,<sup>9</sup> Ronald M Stewart<sup>10</sup>

10



Who,  
Where, &  
What Future  
Directions...

---

11

**ECPR**

---

12





# ECMO for OHCA

13



The Lancet  
Volume 396, Issue 10265, 5–11 December 2020, Pages 1807–1816

February 22, 2022

## Effect of Intra-arrest Transport, Extracorporeal Cardiopulmonary Resuscitation, and Immediate Invasive Assessment and Treatment on Functional Neurologic Outcome in Refractory Out-of-Hospital Cardiac Arrest A Randomized Clinical Trial

Jan Belohlavek, MD, PhD<sup>1</sup>; Jana Smalцова, MD<sup>1,2</sup>; Daniel Rob, MD<sup>1</sup>; et al.

Author Affiliations | Article Information

JAMA. 2022;327(8):737-747. doi:10.1001/jama.2022.1025

---

Articles

### Advanced reperfusion strategies for patients with out-of-hospital cardiac arrest and refractory ventricular fibrillation (ARREST): a phase 2, single centre, open-label, randomised controlled trial

Prof Demetris Yannopoulos MD,<sup>a,b</sup> Jason Bortos MD,<sup>a,b</sup> Ganesh Raveendran MD,<sup>a,b</sup>, Emilv Walser BSN,<sup>a,b</sup> Prof John Connett PhD,<sup>a</sup> Thomas A Murray PhD,<sup>a</sup> Gary Collins MS,<sup>a</sup>, Lin Zhang PhD,<sup>a</sup> Rajat Kalra MBChB,<sup>a,b</sup> Marinos Kosmopoulos MD,<sup>a,b</sup>, Prof Ranjit John MD,<sup>a</sup>, Andrew Shaffer MD,<sup>c</sup> Prof R I Froscone MD,<sup>a</sup>, Keith Weslev MD,<sup>d</sup> Marc Conterato MD,<sup>a</sup>, Prof Michelle Birros MD,<sup>b</sup>, Prof Jakub Tolar MD,<sup>a</sup>, Prof Tom P Aufderheide MD.<sup>1</sup>

**The NEW ENGLAND  
JOURNAL of MEDICINE**

ESTABLISHED IN 1812      JANUARY 26, 2023      VOL. 388 NO. 4

### Early Extracorporeal CPR for Refractory Out-of-Hospital Cardiac Arrest

M.M. Suverein, T.S.R. Delnoij, R. Lorusso, G.J. Brandon Bravo Bruinsma, L. Otterspoor, C.V. Elzo Kraemer, A.P.J. Vlaar, J.J. van der Heijden, E. Scholten, C. den Uil, T. Jansen, B. van den Bogaard, M. Kuijpers, K.Y. Lam, J.M. Montero Cabezas, A.H.G. Driessen, S.Z.H. Rittersma, B.G. Heijnen, D. Dos Reis Miranda, G. Bleeker, J. de Metz, R.S. Hermanides, J. Lopez Matta, S. Eberl, D.W. Donker, R.J. van Thiel, S. Akin, O. van Meer, J. Henriques, K.C. Bokhoven, L. Mandigers, J.J.H. Bunge, M.E. Bol, B. Winkens, B. Essers, P.W. Weerwind, J.G. Maessen, and M.C.G. van de Poll

14

## Where does this leave us?

---

- No definitive answers



15

## Where does this leave us?

---

- No definitive answers
- Current literature limited in its generalizability



16



## Where does this leave us?

- No definitive answers
- Current literature limited in its generalizability
- Standardized protocols are necessary

PROTOCOL



17

## Where does this leave us?

- No definitive answers
- Current literature limited in its generalizability
- Standardized protocols are necessary
- ECPR may offer benefit in specific populations & systems

PROTOCOL



18

# Cryo....

---

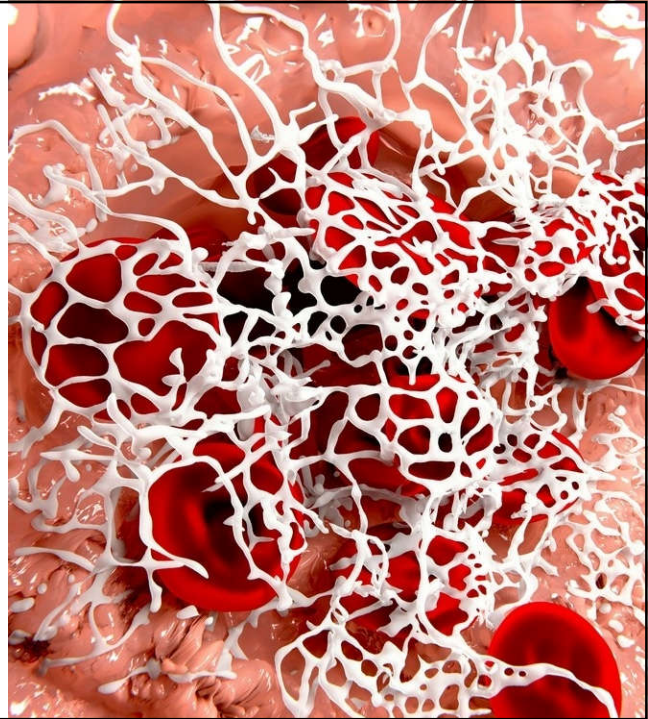
19

The collage features several key elements: a blood bag labeled 'WHOLE BLOOD 0', a vial of 'Tranexamic Acid Injection, USP 1000 mg/10 mL (100 mg/mL)', a vial of 'ANDEXXA', a sample of cryoprecipitate, and a triangle diagram with the vertices labeled 'HYPOTHERMIA', 'COAGULOPATHY', and 'ACIDOSIS'. The text 'Treatment of hemorrhage' is centered, and 'PCC' is written in large blue letters on the right.

20

## But what about cryo?

- CRYOSTAT2
  - Does early administration of high dose cryoprecipitate in traumatic hemorrhage improve survival?



21

## And what about fibrinogen concentrate?

---

- FiiRST & E-Fit 1
- FEISTY
  - Does using fibrinogen concentrate vs. cryo result in a shorter time to administration in the trauma patient with major hemorrhage?

22

## Points to take home...

- Advanced therapies like REBOA & ECPR are still new in the world of medicine
- Data is lacking and inconclusive, but suggestions are they could be beneficial especially at high volume centers
- Use of early, high dose cryoprecipitate to treat hypofibrinogenemia in hemorrhaging trauma does not appear to improve survival
- Fibrinogen concentrate can be administered more quickly than cryo, but doesn't appear to alter outcomes
- As with everything in medicine... more, high quality studies are needed

23

## References

- Jansen JO, Hudson J, Cochran C, MacLennan G, Lendrum R, Sadek S, Gillies K, Cotton S, Kennedy C, Boyers D, Ferry G, Lawrie L, Nath M, Wileman S, Forrest M, Brohi K, Harris T, Lecky F, Moran C, Morrison JJ, Norrie J, Paterson A, Tai N, Welch N, Campbell MK; UK-REBOA Study Group; Aylwin C, Bew D, Brooks A, Chinery J, Cowlam T, Frith D, George A, Hudson A, Johnstone P, Mahmood A, Novak A, O'Meara M, Reid S, Sattout A, Smith C, Stansfield T, Thompson J. Emergency Department Resuscitative Endovascular Balloon Occlusion of the Aorta in Trauma Patients With Exsanguinating Hemorrhage: The UK-REBOA Randomized Clinical Trial. *JAMA*. 2023 Nov 21;330(19):1862-1871. doi: 10.1001/jama.2023.20850. PMID: 37824132; PMCID: PMC10570916.
- Yannopoulos D, Bartos J, Raveendran G, Walsler E, Connett J, Murray TA, Collins G, Zhang L, Kalra R, Kosmopoulos M, John R, Shaffer A, Frascone RJ, Wesley K, Conterato M, Biros M, Tolar J, Aufderheide TP. Advanced reperfusion strategies for patients with out-of-hospital cardiac arrest and refractory ventricular fibrillation (ARREST): a phase 2, single centre, open-label, randomised controlled trial. *Lancet*. 2020 Dec 5;396(10265):1807-1816. doi: 10.1016/S0140-6736(20)32338-2. Epub 2020 Nov 13. PMID: 33197396; PMCID: PMC7856571.
- Suverein MM, Delnoij TSR, Lorusso R, Brandon Bravo Bruinsma GJ, Otterspoor L, Elzo Kraemer CV, Vlaar APJ, van der Heijden JJ, Scholten E, den Uil C, Jansen T, van den Bogaard B, Kuijpers M, Lam KY, Montero Cabezas JM, Driessen AHG, Rittersma SZH, Heijnen BG, Dos Reis Miranda D, Bleeker G, de Metz J, Hermanides RS, Lopez Matta J, Eberl S, Donker DW, van Thiel RJ, Akin S, van Meer O, Henriques J, Bokhoven KC, Mandigers L, Bunge JH, Boi ME, Winkens B, Essers B, Weerwind PW, Maessen JG, van de Poll MCG. Early Extracorporeal CPR for Refractory Out-of-Hospital Cardiac Arrest. *N Engl J Med*. 2023 Jan 26;388(4):299-309. doi: 10.1056/NEJMoa2204511. PMID: 36720132.
- Cralley AL, Vigneshwar N, Moore EE, Dubose J, Brenner ML, Sauaia A; AAST AORTA Study Group. Zone 1 Endovascular Balloon Occlusion of the Aorta vs Resuscitative Thoracotomy for Patient Resuscitation After Severe Hemorrhagic Shock. *JAMA Surg*. 2023 Feb 1;158(2):140-150. doi: 10.1001/jamasurg.2022.6393. PMID: 36542395; PMCID: PMC9856952.
- Godbole M, Olafson S, Cohen RB, Ward CL, Sailes S, Sharlin M, Parsikia A, Moran BJ, Leung PSP. Eastern Association for the Surgery of Trauma (EAST) vs Western Trauma Association (WTA): How a Level 1 Trauma Center Splits the Difference in Resuscitative Thoracotomy. *Cureus*. 2024 Mar 20;16(3):e56521. doi: 10.7759/cureus.56521. PMID: 38646323; PMCID: PMC11026983.
- Davenport R, Curry N, Fox EE, et al. Early and Empirical High-Dose Cryoprecipitate for Hemorrhage After Traumatic Injury: The CRYOSTAT-2 Randomized Clinical Trial. *JAMA*. 2023;330(19):1882-1891. doi:10.1001/jama.2023.21019
- Winearts J, Wultschleger M, Wake E, McQuilten Z, Reade M, Hurn C, Ryan G, Trout M, Walsham J, Holley A, George S, Dyer W, McCullough J, Keijzers G, Fraser J, Presneil J, Campbell D. Fibrinogen Early In Severe Trauma study (FEISTY): results from an Australian multicentre randomised controlled pilot trial. *Crit Care Resusc*. 2023 Oct 18;23(1):32-46. doi: 10.51893/2021.1.OA3. PMID: 38046391; PMCID: PMC10692540.

24