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Prehospital treatment of haemorrhagic shock

Ed Barnard


ROYAL NAVY
BARNARD

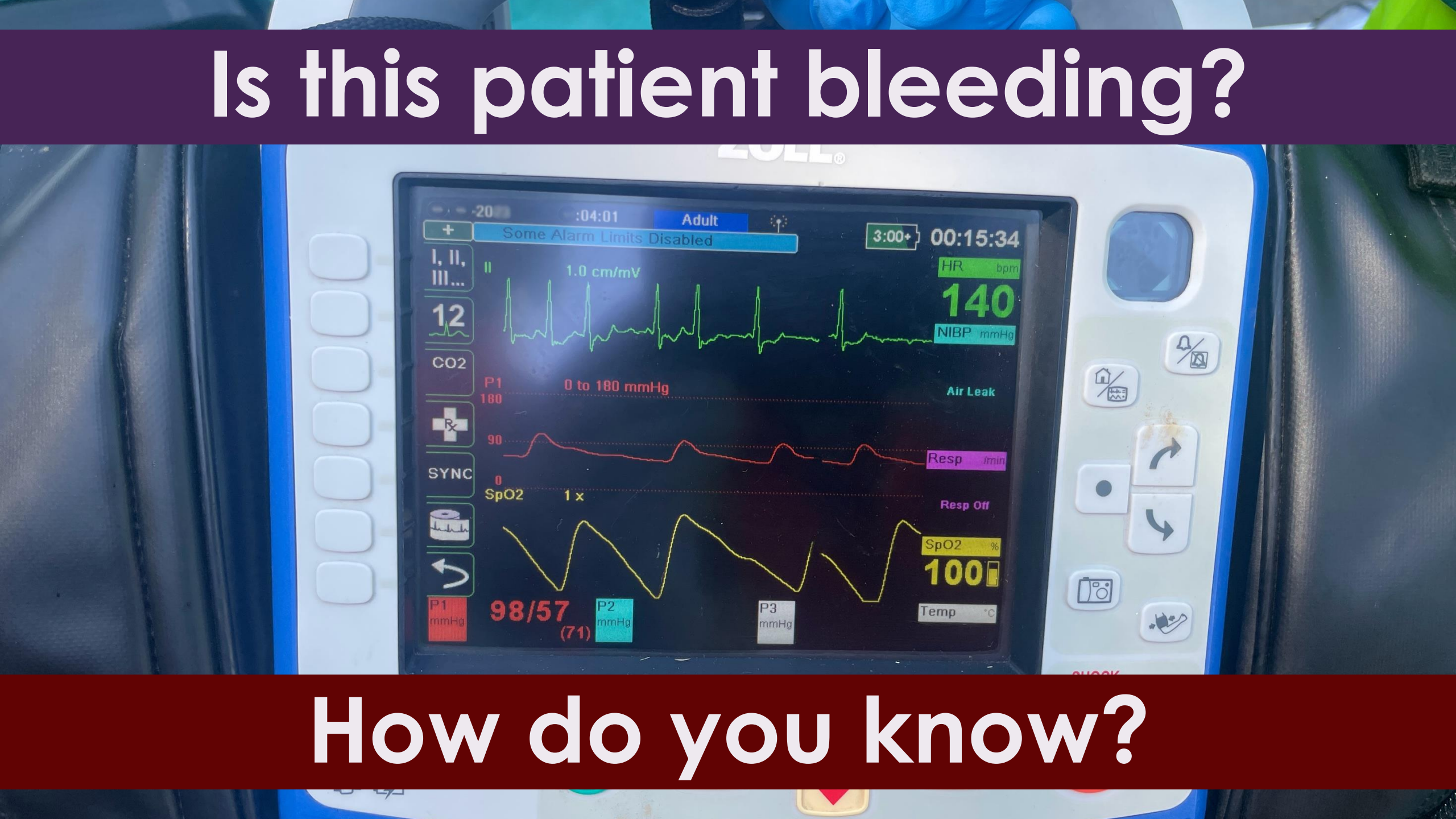

EMERGENCY A BULANCE
NHS
QUICKLY
SAVE
PSIS


East Anglian
Air Ambulance
G-RESU


FIRE
AMBULANCE


AMBULANCE

Is this patient bleeding?



How do you know?

The Hateful Eight

Pale

Clammy

Air Hunger

Venous collapse

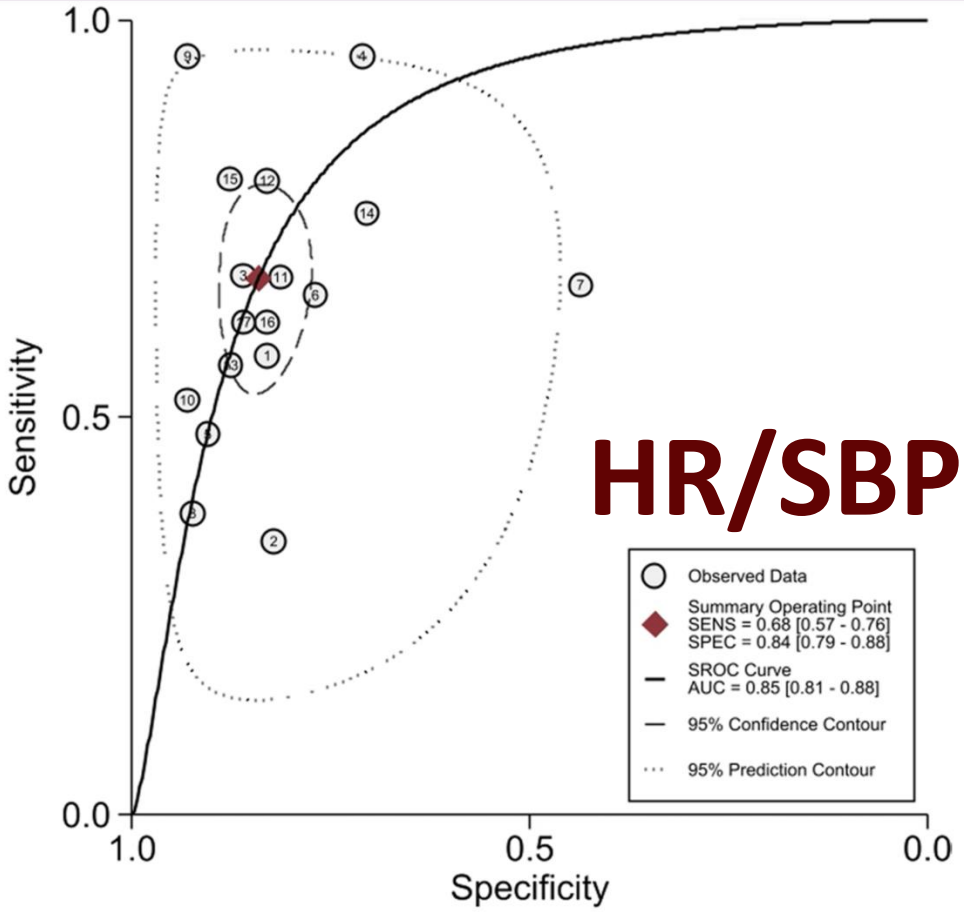
Hypotension

Low/falling $ETCO_2$

Tachy or bradycardia

Altered mentation

Shock index



35 papers

N=670k patients

Sensitivity 68% (95%CI 57-76)
Specificity 84% (95%CI 79-88)
AUC 0.85 (95%CI 0.81-0.88)

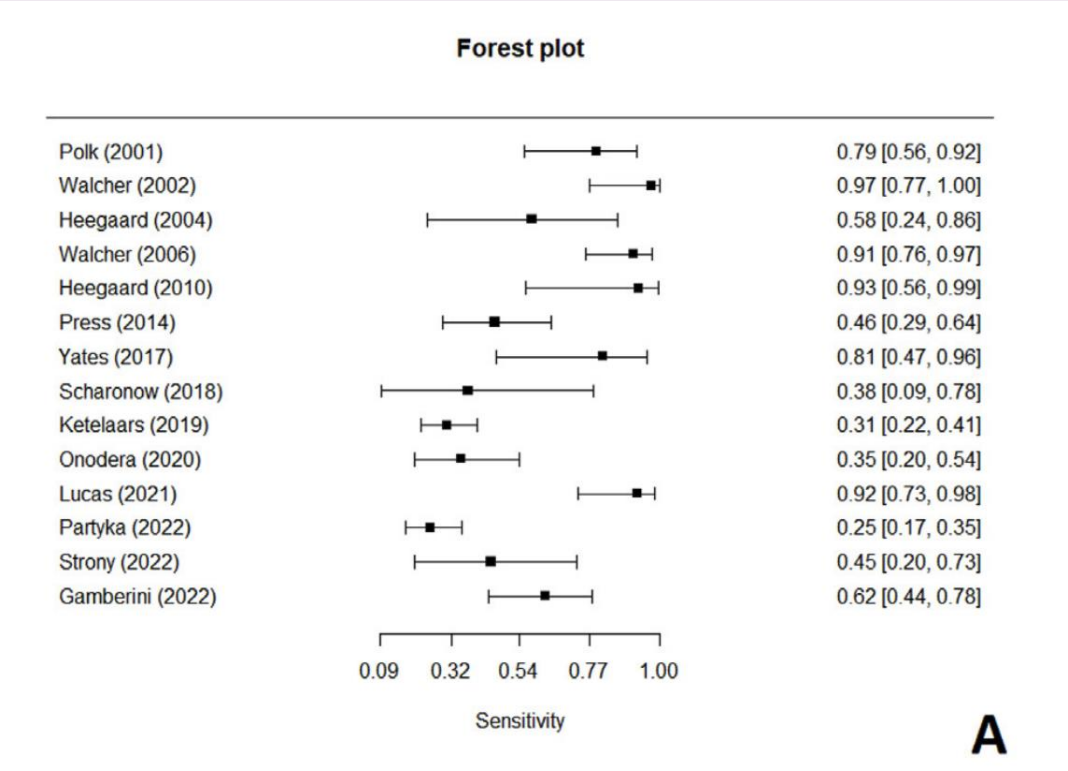
Prehospital data had similar results

* Carsetti A, et al. Shock index as predictor of massive transfusion and mortality in patients with trauma: a systematic review and meta-analysis. Crit Care. 2023 Mar 5;27(1):85. doi: 10.1186/s13054-023-04386-w.

Compensatory Reserve Index

* Johnson MC, et al. Compensatory Reserve Index: Performance of A Novel Monitoring Technology to Identify the Bleeding Trauma Patient. Shock. 2018 Mar;49(3):295-300. doi: 10.1097/SHK.0000000000000959.
* Convertino V, et al. J Trauma Acute Care Surg. 2023 May 17. doi: 10.1097/TA.0000000000004029.

Prehospital ultrasound (E-FAST)



21 papers

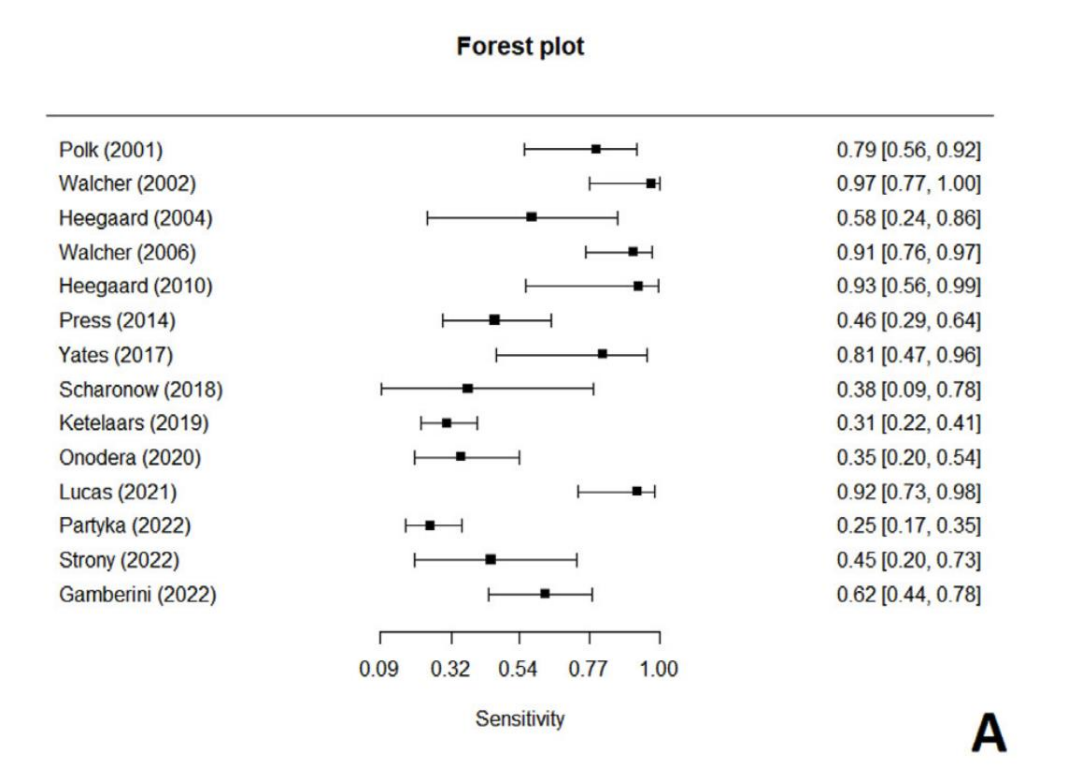
N=5790 patients

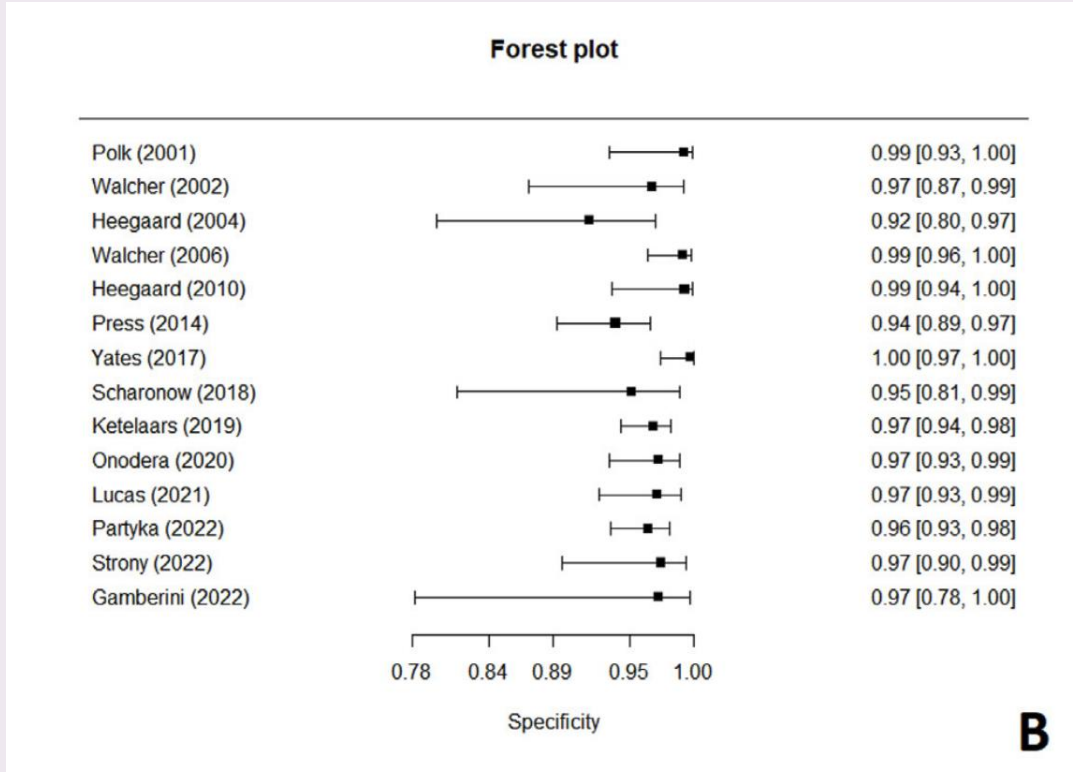
Sensitivity 63% (95%CI 45-78)
Specificity 97% (95%CI 96-98)
AUC 0.97

Time - 2.7 (2.1-3.3) minutes

* Gamberini L, et al. Diagnostic accuracy for hemoperitoneum, influence on prehospital times and time-to-definitive treatment of prehospital FAST: A systematic review and individual participant data meta-analysis. Injury. 2023 Mar 20:S0020-1383(23)00280-2. doi: 10.1016/j.injury.2023.03.024.

Prehospital ultrasound (E-FAST)





* Gamberini L, et al. Diagnostic accuracy for hemoperitoneum, influence on prehospital times and time-to-definitive treatment of prehospital FAST: A systematic review and individual participant data meta-analysis. Injury. 2023 Mar 20:S0020-1383(23)00280-2. doi: 10.1016/j.injury.2023.03.024.

Prehospital ultrasound (E-FAST)

Improving the governance of Prehospital Point of Care Ultrasound (POCUS) using a novel cloud-based system

Jon Barratt [2,1,3,*], Toby Edmunds [4,1,5], Rob Major [4,1], Andrew Downes [1]

Background

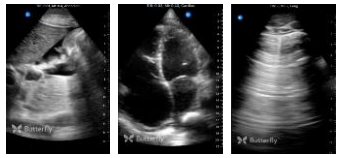
The use of **prehospital point of care ultrasound (POCUS)** has increased recently due to improved accessibility and portability of devices. Availability of **robust governance** remains a challenge for emergency medical systems using POCUS and a barrier to some clinicians from using prehospital POCUS [1].

East Anglian Air Ambulance (EAAA) is a mixed urban/rural helicopter emergency medical system (HEMS) that attends 1,800 patients per annum; since December 2020 they have utilised a **novel cloud-based** solution to improve their provision of **governance for POCUS.**

Methods

EAAA utilises a system of remote review and reporting of on scene POCUS studies. This is performed by **Senior HEMS** clinicians working **remotely** using cloud-based software. A service level agreement specifies reporting within 24 hours of a study being undertaken.

During the first 24 months, a qualitative reporting system was used. This changed in December 2022 to a more **robust quantitative system** that allows for individual clinician **accuracy** to be measured and system-wide **specificity** and **sensitivity** to be reported.



Baseline data

- **716** POCUS studies during the reporting period.
- **19%** of EAAA missions had POCUS performed.
- Diagnostic modality breakdown:
  - Echocardiography – **54%**
  - eFAST/abdomen – **30%**
  - Lung – **14%**

Results

117 studies analysed using quantitative reporting:

- **Sensitivity – 93%**
- **Specificity – 100%**

Gold standard: CT findings from hospital follow up if available or expert clinical review of POCUS images

Conclusion

Use of a remote, cloud-based system has **improved** the **governance of POCUS** at EAAA. Further research is required to understand whether wider implementation can lead to **better patient outcomes** across a broader population.

Reference

[1] National Survey of Prehospital Care Services of United Kingdom for Use, Governance and Perception of Prehospital Point of Care Ultrasound. Salman Naeem et al. POCUS, 2022, *https://doi.org/10.24908/pocus.v7i2.15739*

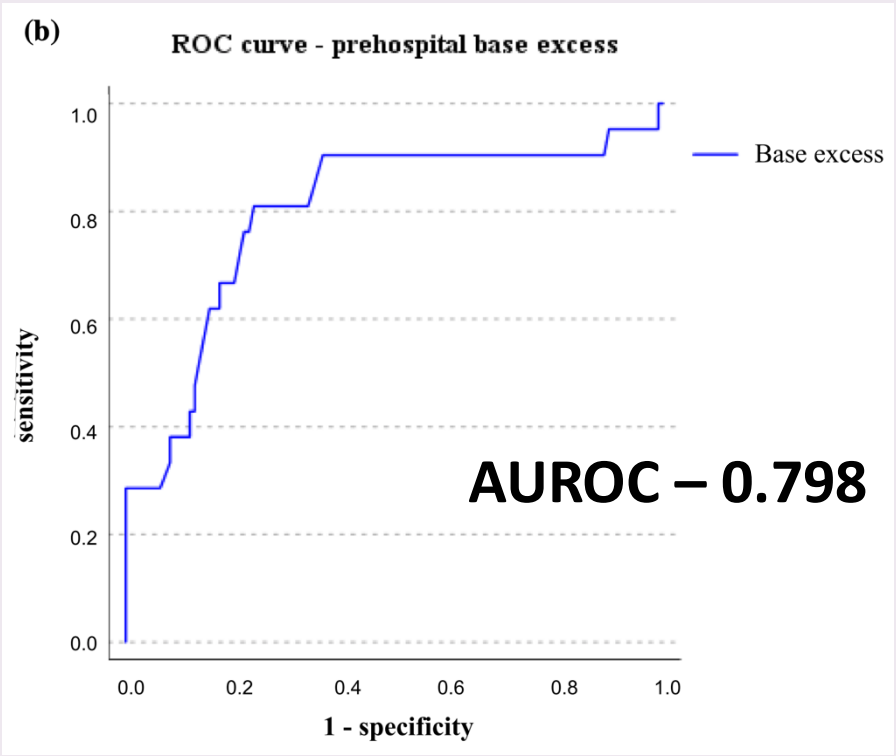
Affiliations

[1] Department of Research, Audit, Innovation and Development, East Anglian Air Ambulance, Norwich
[2] Academic Department of Military Emergency Medicine , Birmingham
[3] University Hospitals of the North Midlands, Stoke-on-Trent
[4] University of East Anglia, Norwich
[5] North West Anglia NHS Foundation Trust, Peterborough

East Anglian Air Ambulance

Contact:
Jon.Barratt@eaaa.org.uk

Biomarkers

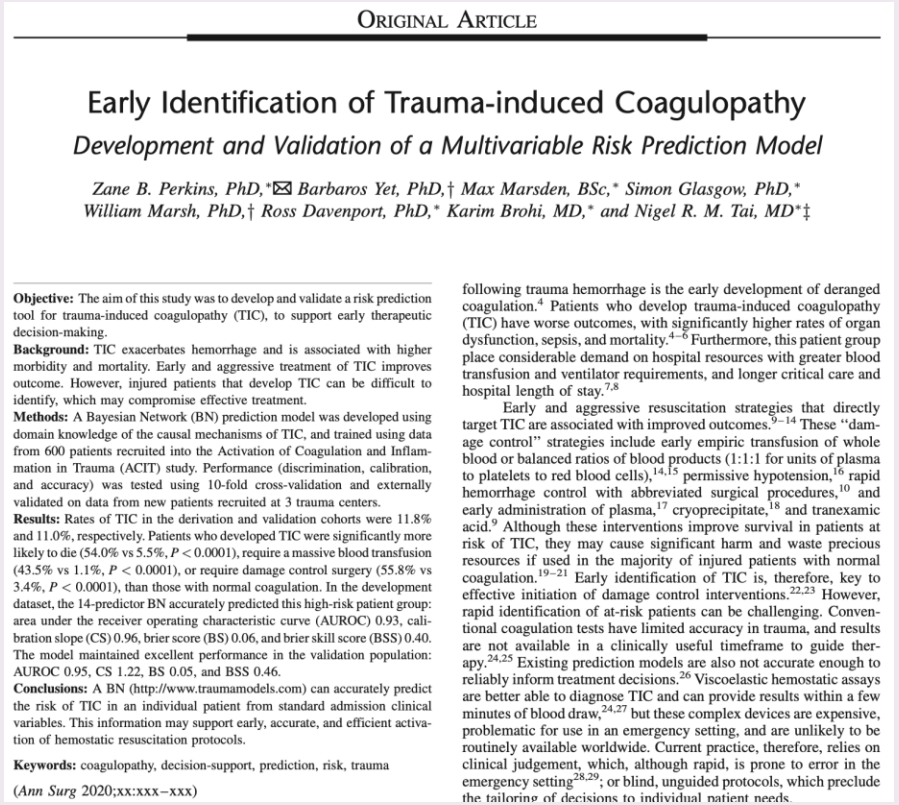


When SBP <100mmHg and clinician suspicion of torso haemorrhage:

Lac AUROC – 0.87
BE AUROC – 0.87

* Gaessler H, et al. Prehospital predictors of the need for transfusion in patients with major trauma. Eur J Trauma Emerg Surg. 2023 Apr;49(2):803-812. doi: 10.1007/s00068-022-02132-5.

Modelling



ORIGINAL ARTICLE

Early Identification of Trauma-induced Coagulopathy

Development and Validation of a Multivariable Risk Prediction Model

Zane B. Perkins, PhD,✉ Barbaros Yet, PhD,† Max Marsden, BSc,* Simon Glasgow, PhD,* William Marsh, PhD,† Ross Davenport, PhD,* Karim Brohi, MD,* and Nigel R. M. Tai, MD*‡*

Objective: The aim of this study was to develop and validate a risk prediction tool for trauma-induced coagulopathy (TIC), to support early therapeutic decision-making.

Background: TIC exacerbates hemorrhage and is associated with higher morbidity and mortality. Early and aggressive treatment of TIC improves outcome. However, injured patients that develop TIC can be difficult to identify, which may compromise effective treatment.

Methods: A Bayesian Network (BN) prediction model was developed using domain knowledge of the causal mechanisms of TIC, and trained using data from 600 patients recruited into the Activation of Coagulation and Inflammation in Trauma (ACIT) study. Performance (discrimination, calibration, and accuracy) was tested using 10-fold cross-validation and externally validated on data from new patients recruited at 3 trauma centers.

Results: Rates of TIC in the derivation and validation cohorts were 11.8% and 11.0%, respectively. Patients who developed TIC were significantly more likely to die (54.0% vs 5.5%, $P < 0.0001$), require a massive blood transfusion (43.5% vs 1.1%, $P < 0.0001$), or require damage control surgery (55.8% vs 3.4%, $P < 0.0001$), than those with normal coagulation. In the development dataset, the 14-predictor BN accurately predicted this high-risk patient group: area under the receiver operating characteristic curve (AUROC) 0.93, calibration slope (CS) 0.96, brier score (BS) 0.06, and brier skill score (BSS) 0.40. The model maintained excellent performance in the validation population: AUROC 0.95, CS 1.22, BS 0.05, and BSS 0.46.

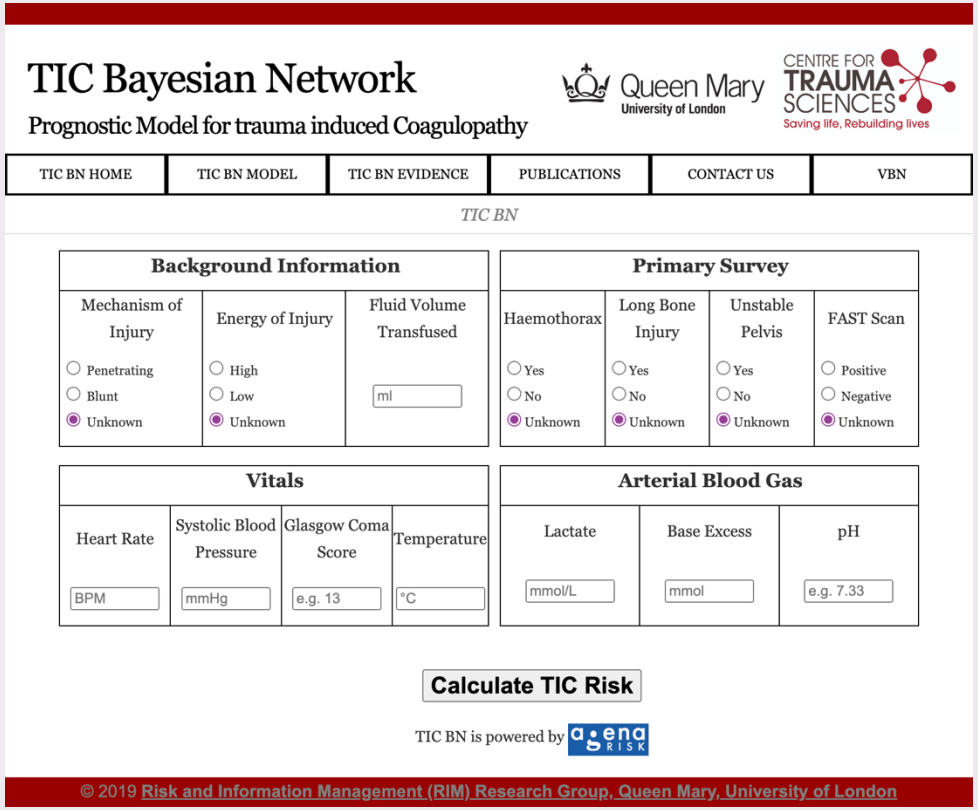
Conclusions: A BN (http://www.traumamodels.com) can accurately predict the risk of TIC in an individual patient from standard admission clinical variables. This information may support early, accurate, and efficient activation of hemostatic resuscitation protocols.

Keywords: coagulopathy, decision-support, prediction, risk, trauma

(*Ann Surg* 2020;xx:xxx–xxx)

following trauma hemorrhage is the early development of deranged coagulation.[4] Patients who develop trauma-induced coagulopathy (TIC) have worse outcomes, with significantly higher rates of organ dysfunction, sepsis, and mortality.[4–6] Furthermore, this patient group place considerable demand on hospital resources with greater blood transfusion and ventilator requirements, and longer critical care and hospital length of stay.[7,8]

Early and aggressive resuscitation strategies that directly target TIC are associated with improved outcomes.[9–14] These "damage control" strategies include early empiric transfusion of whole blood or balanced ratios of blood products (1:1:1 for units of plasma to platelets to red blood cells),[14,15] permissive hypotension,[16] rapid hemorrhage control with abbreviated surgical procedures,[10] and early administration of plasma,[17] cryoprecipitate,[18] and tranexamic acid.[9] Although these interventions improve survival in patients at risk of TIC, they may cause significant harm and waste precious resources if used in the majority of injured patients with normal coagulation.[19–21] Early identification of TIC is, therefore, key to effective initiation of damage control interventions.[22,23] However, rapid identification of at-risk patients can be challenging. Conventional coagulation tests have limited accuracy in trauma, and results are not available in a clinically useful timeframe to guide therapy.[24,25] Existing prediction models are also not accurate enough to reliably inform treatment decisions.[26] Viscoelastic hemostatic assays are better able to diagnose TIC and can provide results within a few minutes of blood draw,[24,27] but these complex devices are expensive, problematic for use in an emergency setting, and are unlikely to be routinely available worldwide. Current practice, therefore, relies on clinical judgement, which, although rapid, is prone to error in the emergency setting[28,29]; or blind, unguided protocols, which preclude the tailoring of decisions to individual patient needs.



traumamodels.com

* Perkins ZB, Yet B, Marsden M, Glasgow S, Marsh W, Davenport R, Brohi K, Tai NRM. Early Identification of Trauma-induced Coagulopathy: Development and Validation of a Multivariable Risk Prediction Model. Ann Surg. 2021 Dec 1;274(6):e1119-e1128. doi: 10.1097/SLA.0000000000003771.

How will I assess this patient..

1. **Mechanism**

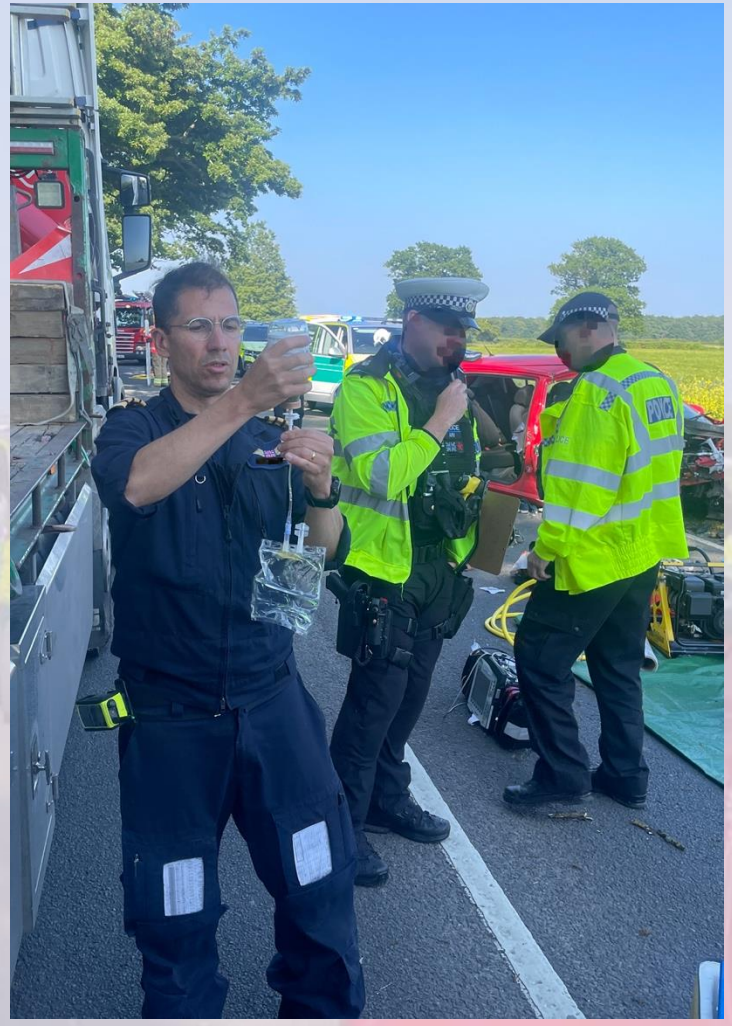
2. **How the patient looks** (incl. Hateful Eight)

3. **Standard physiological variables** – with time..

4. **POCUS**
   - Lines: venous for volume; arterial for BP / ABG
   - E-FAST: bleeding / lungs-up / tamponade

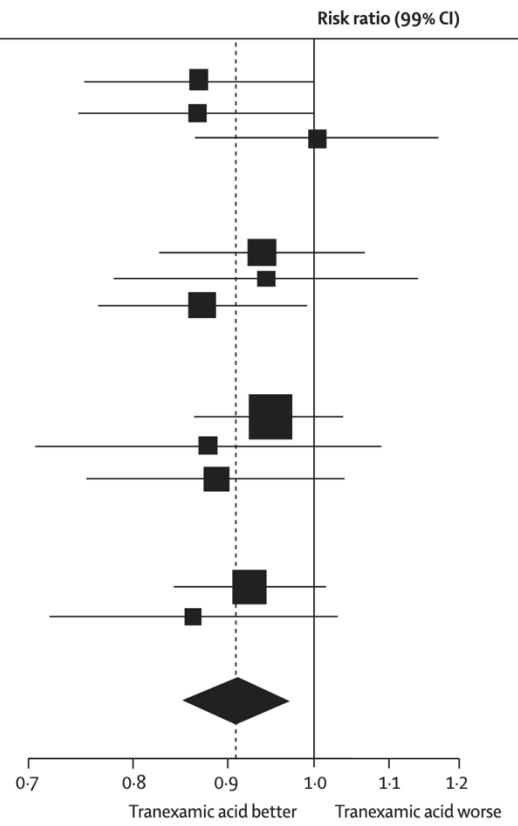
5. **Markers of tissue perfusion** - lactate / base

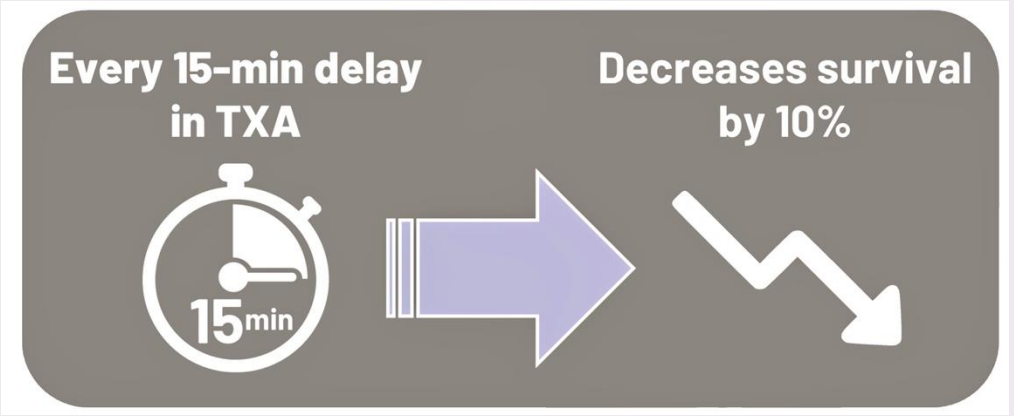
6. **Time** / response to intervention



TXA

	Tranexamic acid allocated	Placebo allocated	Risk ratio (99% CI)
Time from injury (h)			
≤1	509/3747 (13·6%)	581/3704 (15·7%)	0·87 (0·75–1·00)
>1–≤3	463/3037 (15·2%)	528/2996 (17·6%)	0·87 (0·75–1·00)
>3	491/3272 (15·0%)	502/3362 (14·9%)	1·00 (0·86–1·17)
χ^2_2=4·411; p=0·11			
Systolic blood pressure (mm Hg)			
≥90	702/6878 (10·2%)	736/6761 (10·9%)	0·94 (0·82–1·07)
76–89	280/1609 (17·5%)	313/1689 (18·5%)	0·94 (0·78–1·14)
≤75	478/1562 (30·6%)	562/1599 (35·1%)	0·87 (0·76–0·99)
χ^2_2=1·345; p=0·51			
GCS			
Severe (3–8)	796/1789 (44·5%)	860/1830 (47·0%)	0·95 (0·86–1·04)
Moderate (9–12)	219/1349 (16·2%)	249/1344 (18·5%)	0·88 (0·70–1·09)
Mild (13–15)	447/6915 (6·5%)	502/6877 (7·3%)	0·88 (0·75–1·04)
χ^2_2=1·387; p=0·50			
Injury type			
Blunt	1134/6788 (16·7%)	1233/6817 (18·1%)	0·92 (0·83–1·02)
Penetrating	329/3272 (10·1%)	380/3250 (11·7%)	0·86 (0·72–1·03)
χ^2_1=0·791; p=0·37			
All patients	**1463/10060 (14·5%)**	**1613/10067 (16·0%)**	**0·91 (0·85–0·97)***
Two-sided p=0·0035			





* CRASH-2 trial collaborators. Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial. Lancet. 2010 Jul 3;376(9734):23-32. doi: 10.1016/S0140-6736(10)60835-5

LTOWB

Plasma

* Moore HB, et al. Plasma-first resuscitation to treat haemorrhagic shock during emergency ground transportation in an urban area: a randomised trial. Lancet. 2018 Jul 28;392(10144):283-291. doi: 10.1016/S0140-6736(18)31553-8.
* Sperry JL, et al. Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock. N Engl J Med. 2018 Jul 26;379(4):315-326. doi: 10.1056/NEJMoa1802345.

ABTS WWII transfusion data

Period	Campaign	Wounded	Blood (pints)	Plasma (pints)	Blood (pints / 100 casualties)	Plasma (pints / 100 casualties)
1940-43	**Middle East**	63,190	10,359	41,383	16	65
1944-45	**NW Europe**	144,649	90,975	88,653	63	61
1943-45	**SE Asia**	38,678	3,325	30,224	8.5	88.5

Data from Prof. Rod Bailey, University of Oxford – reproduced with permission.

Red cells +/- plasma

Tucker *et al. Critical Care* (2023) 27:25
https://doi.org/10.1186/s13054-022-04279-4

Critical Care

RESEARCH Open Access

Association of red blood cells and plasma transfusion versus red blood cell transfusion only with survival for treatment of major traumatic hemorrhage in prehospital setting in England: a multicenter study

Harriet Tucker[1], Karim Brohi[1,2], Joachim Tan[3], Christopher Aylwin[4], Roger Bloomer[5], Rebecca Cardigan[6], Ross Davenport[1,2], Edward D. Davies[7], Phillip Godfrey[8], Rachel Hawes[9,10], Richard Lyon[11], Josephine McCullagh[2], Simon Stanworth[6,12], Julian Thompson[13,14], James Uprichard[15], Simon Walsh[4,16], Anne Weaver[2] and Laura Green[1,2,6*]

Abstract

Background In-hospital acute resuscitation in trauma has evolved toward early and balanced transfusion resuscitation with red blood cells (RBC) and plasma being transfused in equal ratios. Being able to deliver this ratio in prehospital environments is a challenge. A combined component, like leukocyte-depleted red cell and plasma (RCP), could facilitate early prehospital resuscitation with RBC and plasma, while at the same time improving logistics for the team. However, there is limited evidence on the clinical benefits of RCP.

Objective To compare prehospital transfusion of combined RCP versus RBC alone or RBC and plasma separately (RBC + P) on mortality in trauma bleeding patients.

Methods Data were collected prospectively on patients who received prehospital transfusion (RBC + thawed plasma/Lyoplas or RCP) for traumatic hemorrhage from six prehospital services in England (2018–2020). Retrospective data on patients who transfused RBC from 2015 to 2018 were included for comparison. The association between transfusion arms and 24-h and 30-day mortality, adjusting for age, injury mechanism, age, prehospital heart rate and blood pressure, was evaluated using generalized estimating equations.

Results Out of 970 recruited patients, 909 fulfilled the study criteria (RBC + P = 391, RCP = 295, RBC = 223). RBC + P patients were older (mean age 42 vs 35 years for RCP and RBC), and 80% had a blunt injury (RCP = 52%, RBC = 56%). RCP and RBC + P were associated with lower odds of death at 24-h, compared to RBC alone (adjusted odds ratio [aOR] 0.69 [95%CI: 0.52; 0.92] and 0.60 [95%CI: 0.32; 1.13], respectively). The lower odds of death for RBC + P and RCP vs RBC were driven by penetrating injury (aOR 0.22 [95%CI: 0.10; 0.53] and 0.39 [95%CI: 0.20; 0.76], respectively). There was no association between RCP or RBC + P with 30-day survival vs RBC.

Red cells
Red cells + plasma (R+P)
Red cells in plasma (RCP)

N=909 patients / six HEMS

No difference in 30-d mortality

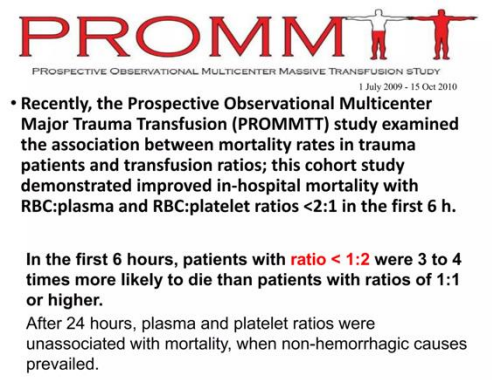
24-hr mortality:

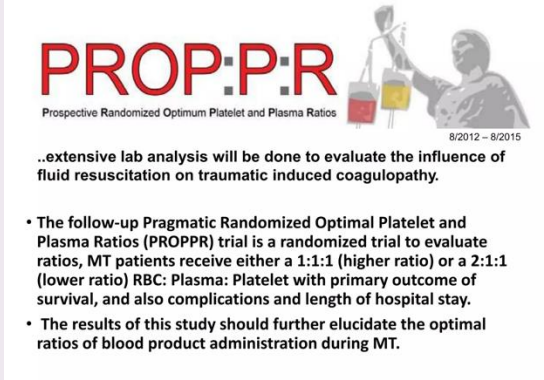
RCP aOR 0.69 (0.52-0.92)
R+P aOR 0.60 (0.32-1.13)

} Red cells (no plasma)

RePHILL trial

Death	PRBC/plasma	0.9% saline	Adjusted average difference	*P*-value
≤3-hours	32/197 (16%)	46/208 (22%)	-7% (-15% to 1%)	***p*=0.08**
≤30-days	86/204 (42%)	99/219 (45%)	-4% (-13% to 6%)	*p*=0.44





Are we interested in early survival?

* Crombie N, et al. Resuscitation with blood products in patients with trauma-related haemorrhagic shock receiving prehospital care (RePHILL): a multicentre, open-label, randomised, controlled, phase 3 trial. Lancet Haematol. 2022 Apr;9(4):e250-e261. doi: 10.1016/S2352-3026(22)00040-0

A survey to define the prehospital blood resuscitation practices of UK Air Ambulances

Ed Barnard, Laura Green, Tom Woolley
Simon Stanworth, Rebecca Cardigan, Jason Smith

NHS Blood and Transplant

SWIFT Study of Whole blood In Frontline Trauma

2019

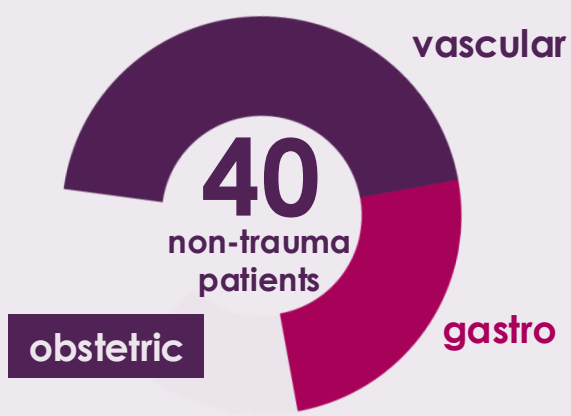
n=12k

92 mins

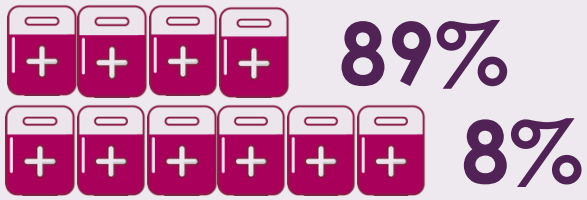
n=18

n=709

Blood component combinations	Air Ambulances / *n* (%)
Red cells + FDP	**7** (36.8%)
Red cells + plasma*	**6** (31.6%)
Red cells only	**3** (15.8%)
FDP only	**1** (5.3%)
Red cells in plasma**	**1** (5.3%)
No products	**1** (5.3%)



+24



15 (79.0%) UK AAs interested to take part in whole blood research

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Ed Barnard, Laura Green, Tom Woolley
Simon Stanworth, Rel

NHS Blood and Transplant

SWIFT Study of Whole blood In Frontline Trauma

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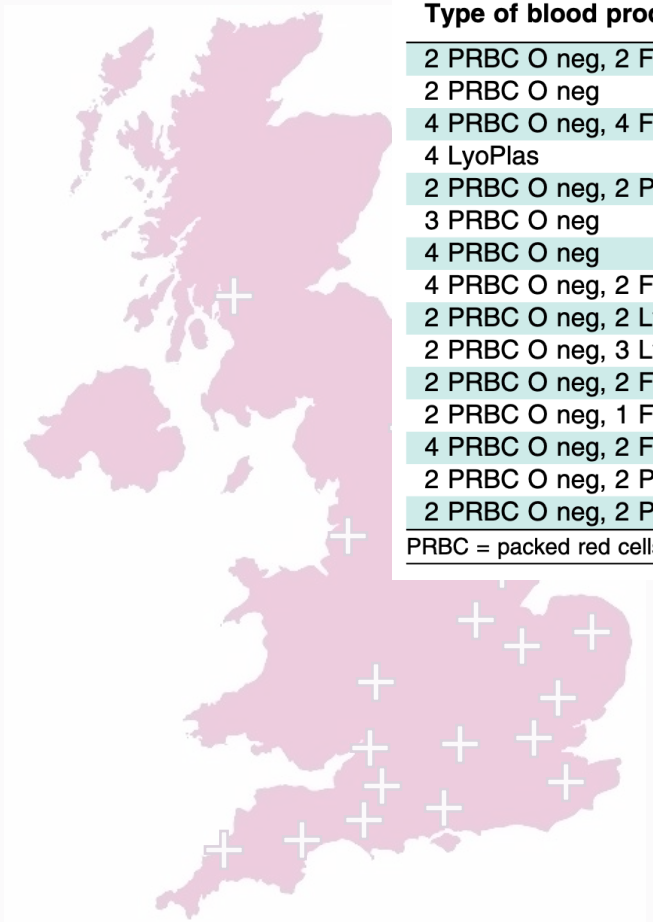
	3 (15.8%)
	1 (5.3%)
	1 (5.3%)
	1 (5.3%)

Table 1 – Type of blood products carried by UK prehospital critical care services.

Type of blood product	Number (n = 25)
2 PRBC O neg, 2 FFP	5
2 PRBC O neg	3
4 PRBC O neg, 4 FFP	3
4 LyoPlas	2
2 PRBC O neg, 2 PRBC O pos, 4 FFP	2
3 PRBC O neg	1
4 PRBC O neg	1
4 PRBC O neg, 2 FFP	1
2 PRBC O neg, 2 LyoPlas	1
2 PRBC O neg, 3 LyoPlas	1
2 PRBC O neg, 2 FFP, 2 LyoPlas	1
2 PRBC O neg, 1 FFP, 4 LyoPlas	1
4 PRBC O neg, 2 FFP, 4 LyoPlas	1
2 PRBC O neg, 2 PRBC O pos, 4 LyoPlas, 6 g fibrinogen, 3000iu Beriplex	1
2 PRBC O neg, 2 PRBC O pos, 4 FFP, 4 LyoPlas, 4 g fibrinogen	1

PRBC = packed red cells, O neg = O negative, O pos = O positive, FFP = fresh frozen plasma.



n=18

n=709

24

89%

8%

15 (79.0%) UK AAs interested to take part in whole blood research

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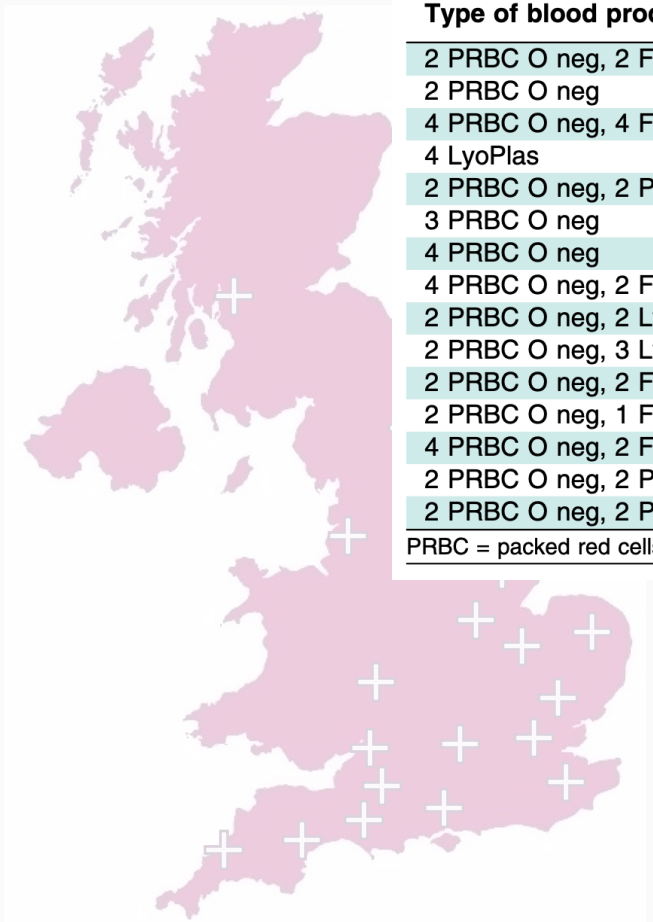
2 PRBC O neg, 2 LyoPlas	1
2 PRBC O neg, 3 LyoPlas	1
2 PRBC O neg, 2 FFP, 2 LyoPlas	1
2 PRBC O neg, 1 FFP, 4 LyoPlas	1
4 PRBC O neg, 2 FFP, 4 LyoPlas	1
2 PRBC O neg, 2 PRBC O pos, 4 LyoPlas, 6 g fibrinogen, 3000iu Beriplex	1
2 PRBC O neg, 2 PRBC O pos, 4 FFP, 4 LyoPlas, 4 g fibrinogen	1

PRBC = packed red cells, O neg = O negative, O pos = O positive, FFP = fresh frozen plasma.



n=18

n=709

24

15 (79.0%) UK AAs interested to take part in whole blood research

In the cases of severe primary haemorrhage accompanied by shock, blood transfusion frequently produces an immediate and almost incredible improvement.

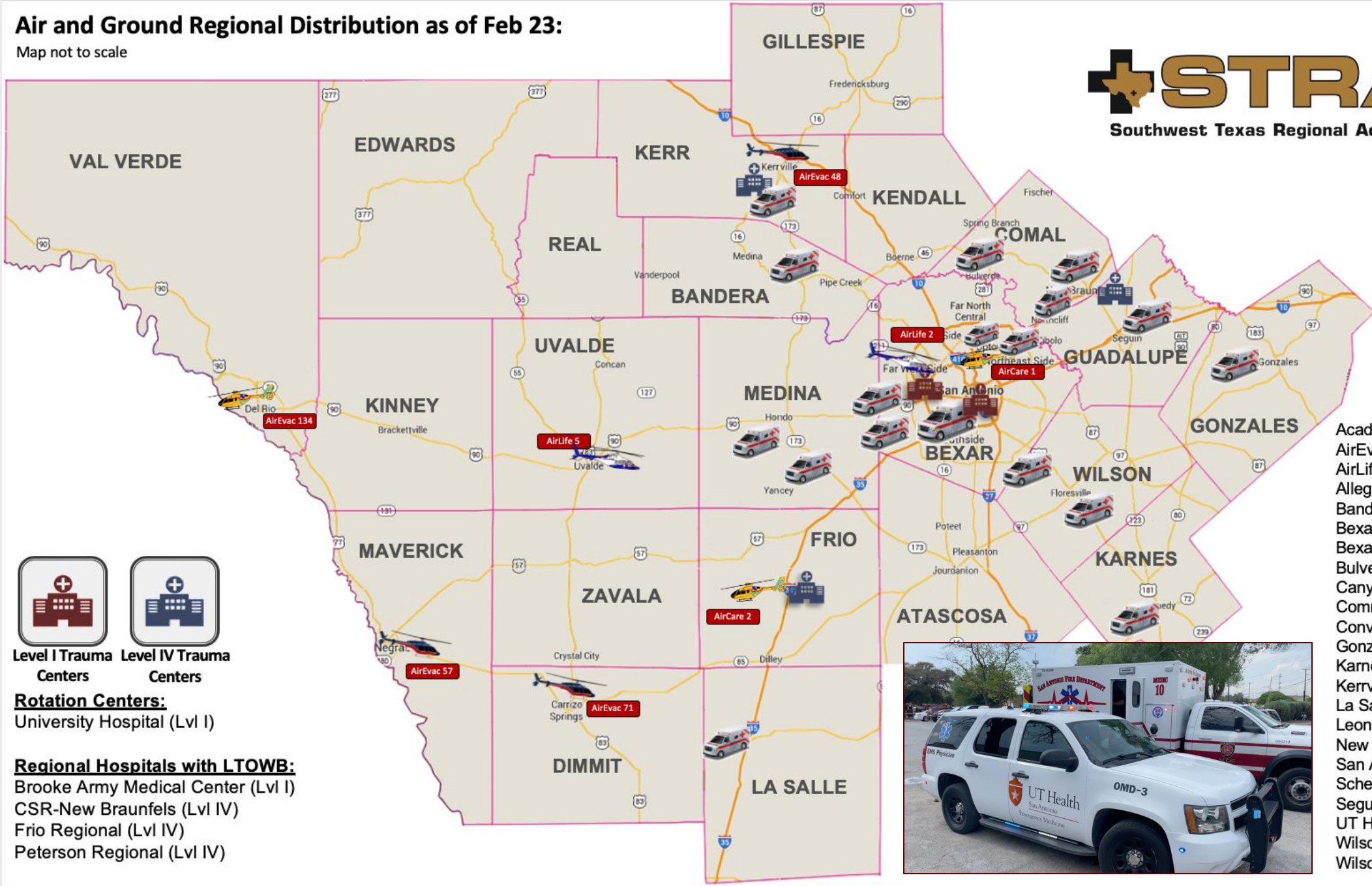
In the cases of severe primary haemorrhage accompanied by shock, blood transfusion frequently produces an immediate and almost incredible improvement.

The change from a pallid, sometimes semi-conscious patient with a rapid flickering pulse to a comparatively healthy looking conscious and comfortable patient with a slower and fuller pulse is dramatic evidence of the value of the transfused blood.

Air and Ground Regional Distribution as of Feb 23:

Map not to scale

STRAC
Southwest Texas Regional Advisory Council



Level I Trauma Centers

Level IV Trauma Centers

Rotation Centers:
University Hospital (Lvl I)

Regional Hospitals with LTOWB:
Brooke Army Medical Center (Lvl I)
CSR-New Braunfels (Lvl IV)
Frio Regional (Lvl IV)
Peterson Regional (Lvl IV)

Rotation Sites:
Acadian Ambulance (x2)
AirEvac/MAC (x11)
AirLife (x4)
Allegiance EMS
Bandera EMS
Bexar Co ESD2 EMS (x2)
Bexar Co ESD 7 EMS
Bulverde-Spring Branch EMS
Canyon Lake EMS
Community EMS
Converse EMS
Gonzales ESD 1 EMS
Karnes Co EMS
Kerrville Fire/EMS
La Salle Co EMS (x2)
Leon Valley EMS
New Braunfels EMS (x2)
San Antonio Fire Dept EMS (x8)
Schertz EMS
Seguin EMS
UT Health-SA Fellows
Wilson Co ESD 2 EMS
Wilson Co ESD 3 EMS

Author, country, year	N studies / patients & inclusions	Primary outcome	Main results	Secondary outcomes
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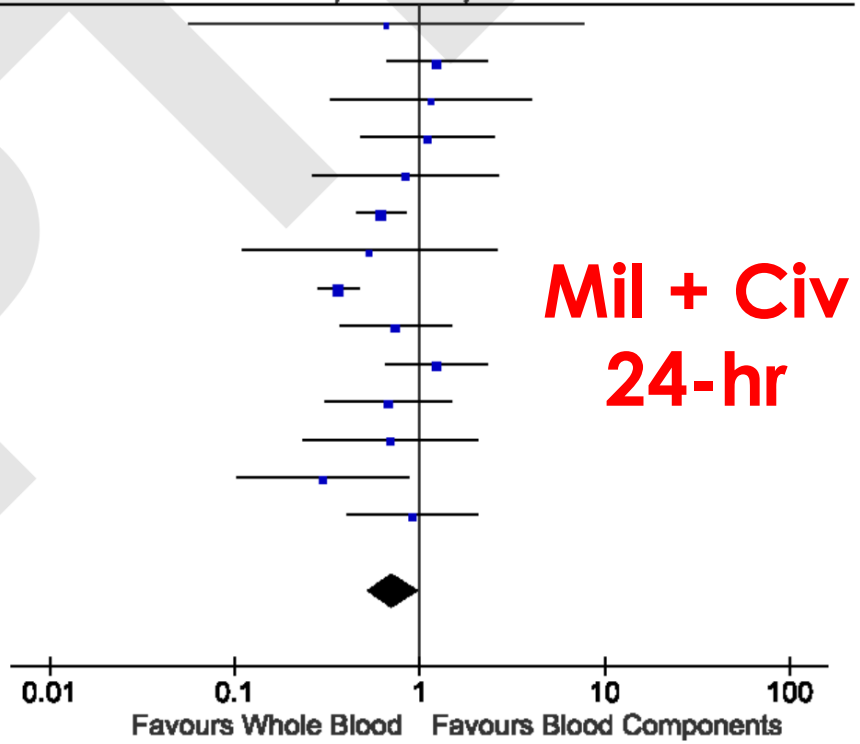
Whole blood – latest SR/MA

Study or Subgroup	Whole blood Events	Total	Blood components Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Auten 2015	1	26	2	35	1.4%	0.66 [0.06, 7.69]
Bohan 2021	33	121	22	95	9.4%	1.24 [0.67, 2.32]
Cotton 2014	6	55	5	52	4.2%	1.15 [0.33, 4.03]
Gallahar 2020	12	42	22	83	7.1%	1.11 [0.48, 2.54]
Guyette 2022	6	40	8	46	4.7%	0.84 [0.26, 2.66]
Hanna 2020	48	280	2054	8214	13.4%	0.62 [0.45, 0.85]
Hazelton 2019	2	52	8	115	2.9%	0.54 [0.11, 2.61]
Hazelton 2022	167	1180	138	443	14.1%	0.36 [0.28, 0.47]
Lee 2021	18	169	18	130	8.5%	0.74 [0.37, 1.49]
Perkins 2011	16	85	45	284	9.3%	1.23 [0.66, 2.31]
Seheult 2018	12	135	17	135	7.6%	0.68 [0.31, 1.48]
Shea 2020	7	44	9	42	5.1%	0.69 [0.23, 2.07]
Spinella 2009	4	100	31	254	5.2%	0.30 [0.10, 0.87]
Yazer 2021	13	92	14	92	7.2%	0.92 [0.40, 2.08]
Total (95% CI)		**2421**		**10020**	**100.0%**	**0.72 [0.53, 0.97]**
Total events	345		2393			

Heterogeneity: $Tau^2 = 0.15$; $Chi^2 = 31.12$, df = 13 (P = 0.003); $I^2 = 58\%$

Test for overall effect: Z = 2.14 (P = 0.03)



Mil + Civ
24-hr

* van der Horst RA, et al. Whole blood transfusion in the treatment of acute hemorrhage, a systematic review and meta-analysis. J Trauma Acute Care Surg. 2023 May 1. doi: 10.1097/TA.0000000000004000.

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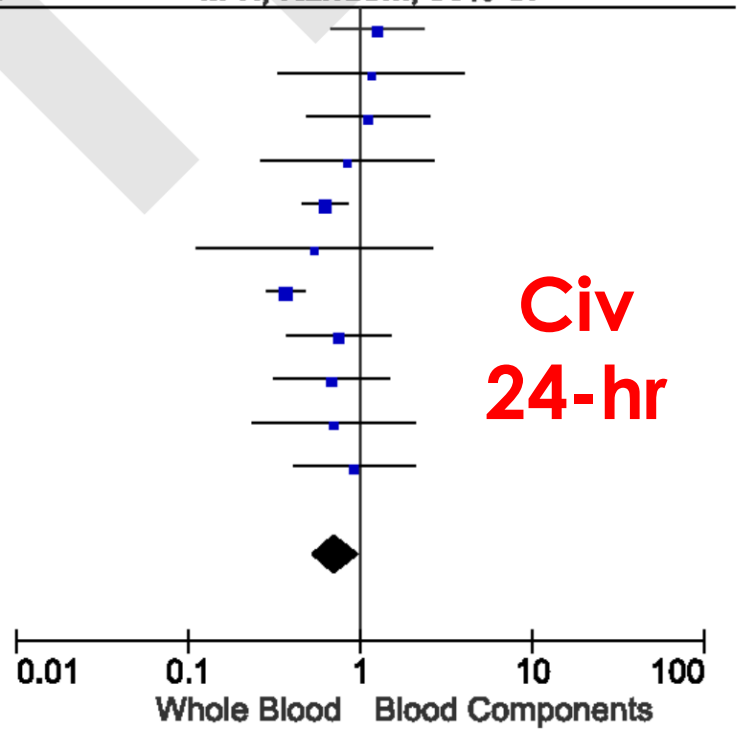
Yazer 2021	13	92	14	92	8.5%	0.92 [0.40, 2.08]
Total (95% CI)		**2210**		**9447**	**100.0%**	**0.71 [0.52, 0.98]**
Total events	324		2315			

Heterogeneity: $Tau^2 = 0.13$; $Chi^2 = 24.09$, df = 10 (P = 0.007); $I^2 = 58\%$

Test for overall effect: Z = 2.09 (P = 0.04)



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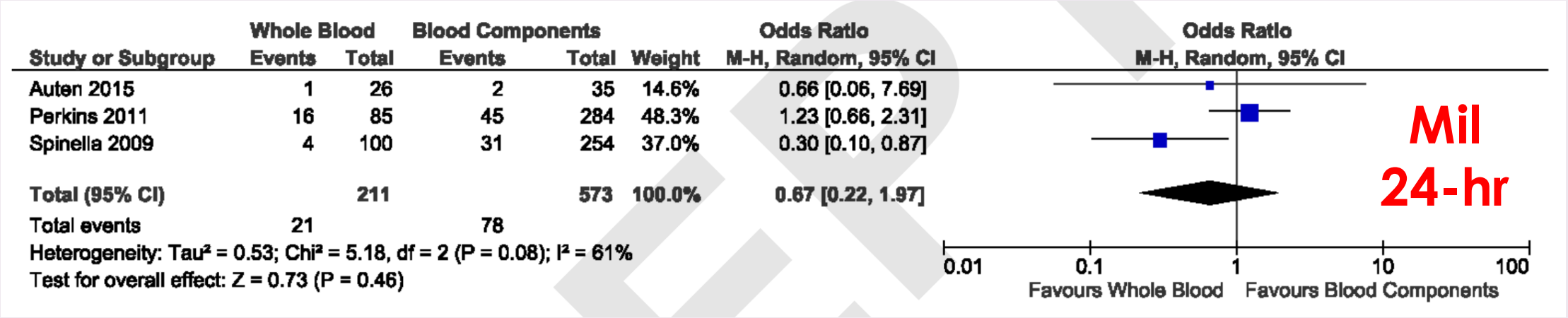

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Spinella 2009	4	100	31	254	37.0%	0.30 [0.10, 0.87]
Total (95% CI)		**211**		**573**	**100.0%**	**0.67 [0.22, 1.97]**
Total events	21		78			

Heterogeneity: Tau² = 0.53; Chi² = 5.18, df = 2 (P = 0.08); I² = 61%
Test for overall effect: Z = 0.73 (P = 0.46)

No signal of survival benefit at 30-d in combined or separate cohorts

* van der Horst RA, et al. Whole blood transfusion in the treatment of acute hemorrhage, a systematic review and meta-analysis. J Trauma Acute Care Surg. 2023 May 1. doi: 10.1097/TA.0000000000004000.

Calcium

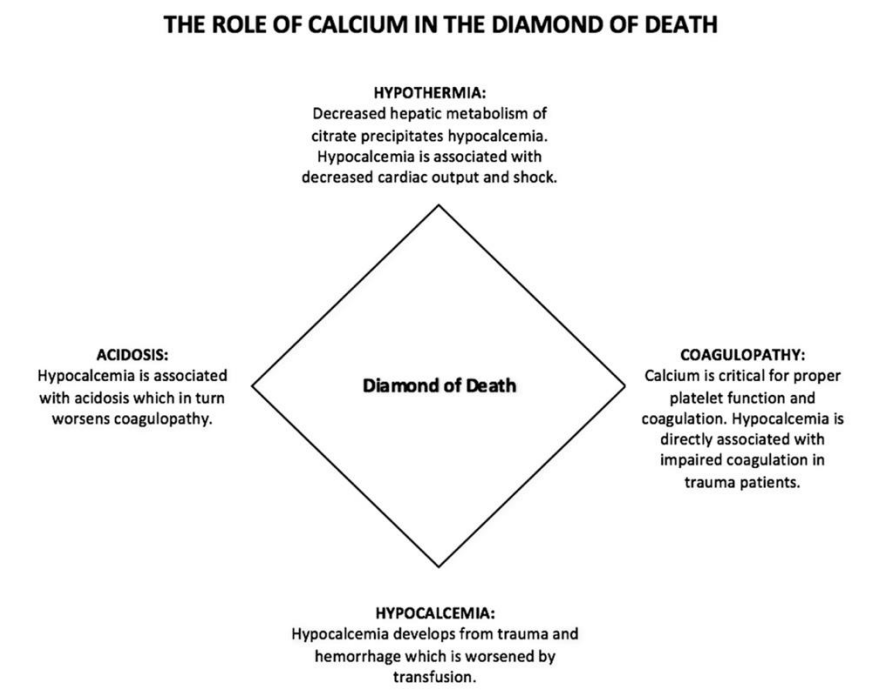


Table 2 – Guidelines for calcium replacement during PHBP administration.

Timing of calcium replacement	Number of organisations (n = 25)
Before any PHBP	5
After 2 PRBC + 2 FFP	5
After 1 PRBC	3
No SOP	2
After 1 PRBC + 1 FFP	2
After 1 PRBC + 1 LyoPlas	2
During 1st PRBC	1
After 1 FFP	1
After 2 PRBC	1
After 2 FFP	1
After 2 LyoPlas	1
After 2 PRBC + 2 LyoPlas	1

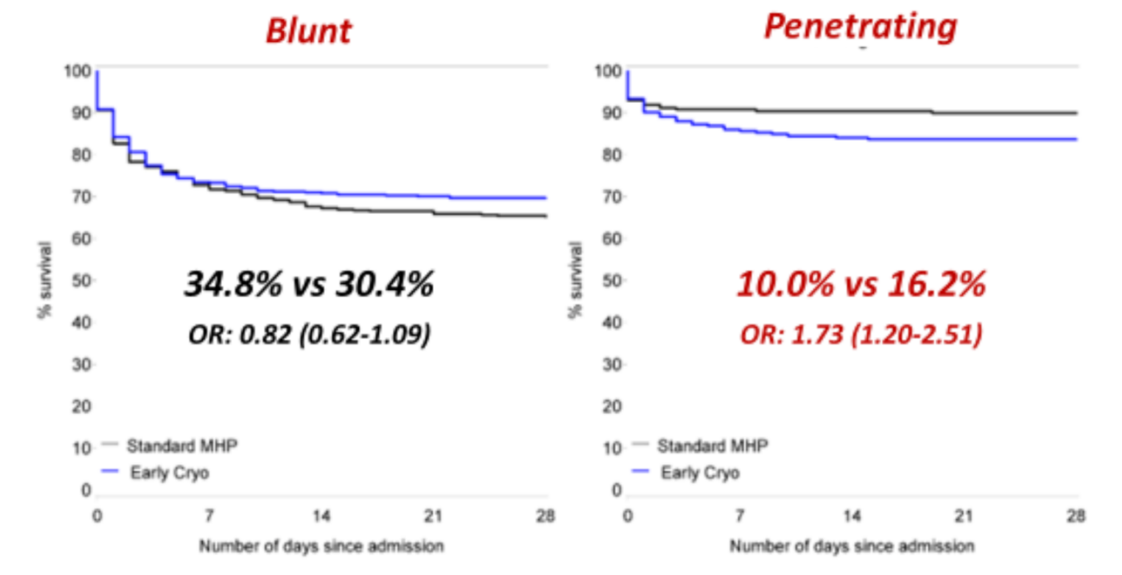
SOP = Standard Operating Procedure, PRBC = packed red cells, O neg = O negative, O pos = O positive, FFP = fresh frozen plasma.

* Wray JP, Bridwell RE, Schauer SG, Shackelford SA, Bebarta VS, Wright FL, Bynum J, Long B. The diamond of death: Hypocalcemia in trauma and resuscitation. Am J Emerg Med. 2021 Mar;41:104-109. doi: 10.1016/j.ajem.2020.12.065.
* Leech C, et al. Pre-hospital blood products and calcium replacement protocols in UK critical care services: A survey of current practice. Resusc Plus. 2022 Aug 5;11:100282. doi: 10.1016/j.resplu.2022.100282.

Fibrinogen

CRYOSTAT-2
EARLY CRYOPRECIPITATE IN TRAUMA

	Standard MHP	+ Early cryo	OR 0.96 (0.75-1.23)
28-d mortality	26.1%	25.3%	



Karim Brohi @karimbrohi · Jun 16

In the meantime some @CRYOSTAT_2 data from our #ccr23 presentation. Wait for the paper ofc, but I'd suggest:

- If you're thinking about giving concentrated fibrinogen (in any form) up front to trauma patients, don't.

- Prioritise getting fibrinogen (FIBTEM/FF) levels back asap

Karim Brohi Retweeted

Tim Coats @TJCoats · Jun 16

Interesting discussion from @CRYOSTAT_2 results presentation. Trial primary result = no difference.
Major trauma with bleeding is not one disease so looking for one treatment protocol may be an incorrect approach. We would not research to find a treatment that works for 'cancer'.

Prothrombin complex concentrate

Observational data only

Signal from *n*=4 trauma studies:

- PCC inferred mortality benefit; OR 0.64 (0.46-0.88)
- PCC group required fewer units of red cells: -3.0 (-1.9,-4.1)

4F-PCC: single retrospective propensity-matched study

- Improved survival and reduced transfusion

* van den Brink DP, et al. Effectiveness of prothrombin complex concentrate for the treatment of bleeding: A systematic review and meta-analysis. J Thromb Haemost. 2020 Oct;18(10):2457-2467. doi: 10.1111/jth.14991.

How will I treat this patient..

1. **TXA** – 2g bolus ASAP
2. **Early calcium**
3. **Still bleeding** / dying -> WB
4. **Has bled / sick OR remote / no WB** -> plasma initially (any kind)
5. **RCP + cold-stored platelets** – maybe
6. **Fibrinogen** – no
7. **Prothrombin complex concentrate** – no (wait for TAP)


ROBOTS
DONT
BLEED

twitter
@edbarn

Prehospital treatment of haemorrhagic shock

Ed Barnard

twitter
@edbarn

Prehospital treatment of haemorrhagic shock

Ed Barnard

Whole blood

J Trauma Acute Care Surg. 2020 Jan;88(1):87-93. doi: 10.1097/TA.0000000000002498.

Safety profile and impact of low-titer group O whole blood for emergency use in trauma

James Williams [1], Nicholas Merutka, David Meyer, Yu Bai, Samuel Prater, Rodolfo Cabrera, John B Holcomb, Charles E Wade, Joseph D Love, Bryan A Cotton

Affiliations + expand

PMID: 31464874 DOI: 10.1097/TA.0000000000002498

N=198 WB / *n*=152 COMP

Controlled for: age, severity, prehosp vitals

WB – 53% reduction in post-ED blood transfusion

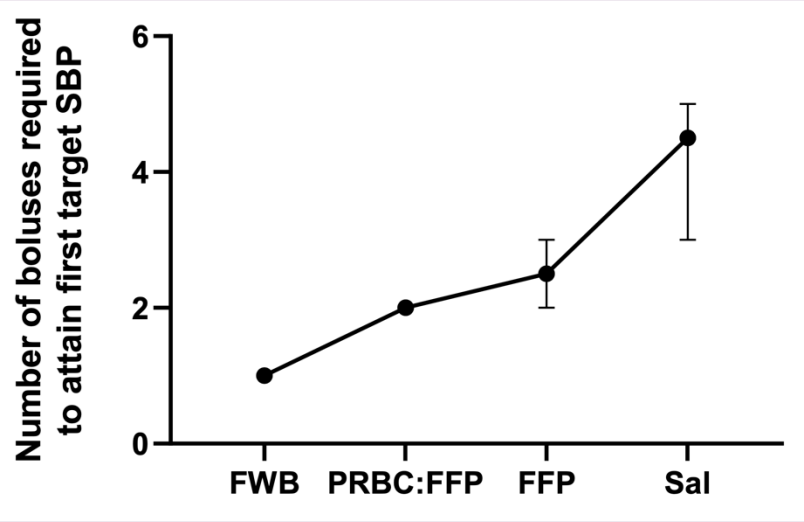
Survival OR 2.2 (1.0-4.8)

ORIGINAL ARTICLE

Resuscitation with whole blood or blood components improves survival and lessens the pathophysiological burden of trauma and haemorrhagic shock in a pre-clinical porcine model

Sarah Ann Watts[1] · Jason Edward Smith[2] · Thomas Woolley[2] · Rory Frederick Rickard[2] · Robert Gwyther[1] · Emrys Kirkman[1]

Received: 23 February 2022 / Accepted: 30 June 2022



A

TREATISE

OF THE

SCURVY.

IN THREE PARTS.

CONTAINING

An inquiry into the Nature, Cauſes, and Cure, of that Diſeaſe.

Together with

A Critical and Chronological View of what has been publiſhed on the ſubject.

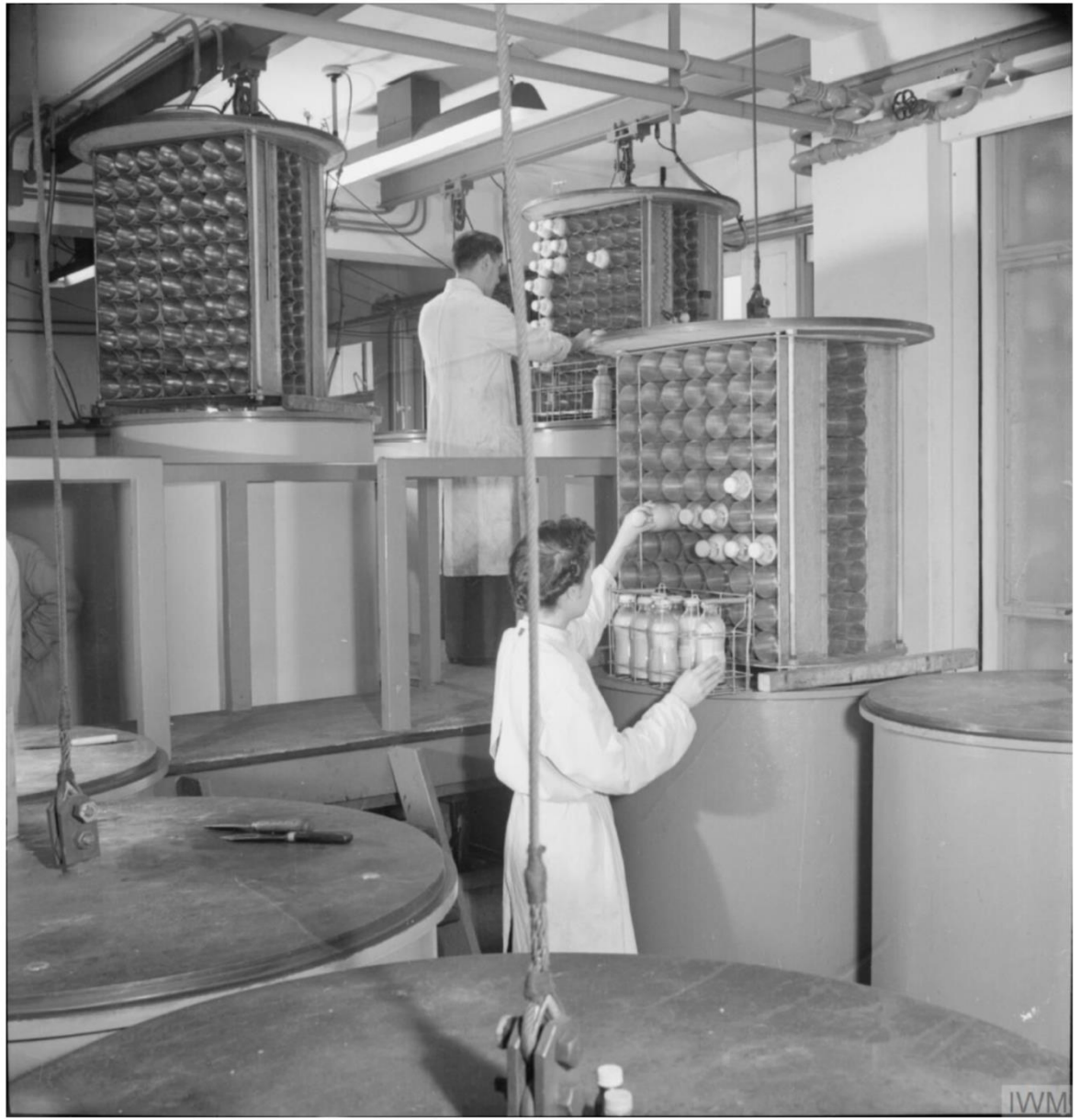
By *JAMES LIND*, M. D.

Fellow of the Royal College of Phyſicians in *Edinburgh*.

EDINBURGH:

Printed by SANDS, MURRAY, and COCHRAN.
For A. KINCAID & A. DONALDSON.
MDCCLIII.

© IWM D16749. A worker at the MRC Drying Unit in Cambridge passes crude plasma through a filter of paper pulp, prior to the freeze-drying process.



© IWM D16746. Workers at the MRC Drying Unit in Cambridge remove bottles of dried plasma from the vacuum drying chamber in which they have remained for three days. As a small amount of moisture remains, the bottles will then be placed in a secondary vacuum chamber for another two days, along with a drying agent, Phosphorous Pentoxide.

Research question

In patients with life-threatening haemorrhage, is prehospital WB transfusion better than standard care in improving survival and reducing the overall transfusion requirement at 24 hours?

Secondary questions

- Mortality and morbidity up to 30-days
- Hospital and ICU LOS
- Safety
- Health-related quality-of-life at 3 months
- Cost-effectiveness

SWIFT

Study of Whole blood In Frontline Trauma

Primary outcome

24-hour mortality or massive transfusion

(total products ≥10 units ≤24-hours)

	Blood product transfusion ≥10 units in 24 hours	
24-hour survival	**No**	**Yes**
Alive	**214 (32%)**	**204 (30%)**
Dead	**194 (29%)**	**61 (9%)**

Baseline (from RCP) – composite outcome of 68%

Powered for **12% difference**

Eligibility

Inclusion

- Patient (any age) requiring prehospital blood to treat traumatic life-threatening bleeding.
- Attended by a participating HEMS.

Exclusion

- No IV/IO access.
- Knowledge that the patient will object.

Trial design

Randomised controlled trial (RCT); 1:1

Intervention – two units of whole blood.

Control – two units of red cells and two units of plasma.

Unblinded

N of patients required: 848 / two years

Author, country, year	N studies / patients & inclusions	Primary outcome	Main results	Secondary outcomes
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