Financial disclosure:

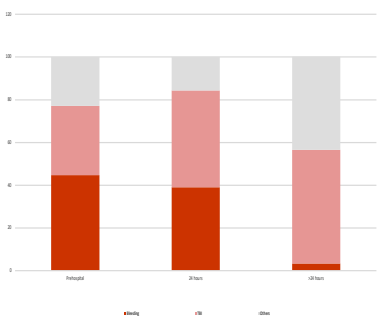
Grants/support/lecture fee

Astra Zeneca, Baxter, BBraun, Cytosorb, CSL Behring, Deutsche Bundeswehr, Haemoscope, LFB-France, Ministerium für Landesverteidigung und Sport, Mitsubishi Pharma, Octapharm, Pfizer, Portola, US Army, US Department of Defense, Werfen.

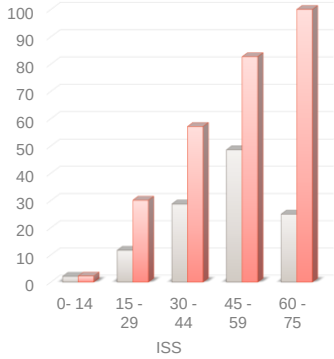
Why & How trauma patients die ...

% Mortaliity

Bleeding/TBI



Coagulopathy



Cerny V, Fries D et al. Variations and obstacles in the use of coagulation factor concentrates for major trauma bleeding across Europe: outcomes from a European expert meeting. Eur J Trauma Emerg Surg. 2021 Jan 5.
Callcut RA et al. The why and how our trauma patients die. J Trauma Acute Care Surg. 2019 May;86(5):864-70.

Prehospital *bleeding* management in trauma

hypothermia & coagulation


mechanical bleeding control


invasive procedures

pharmaceutical haemostatics


transfusion & infusion


„The lethal triad of hypothermia, acidosis and coagulopathy …“

„1 ^{0}C of decreased temperature decreases clotting factor activity by 10 %.“

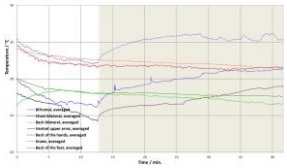
Stage 1: 35 – 32 ^{0}C:
shivering, pain, tachycardia, hypertension.
mild coagulopathy

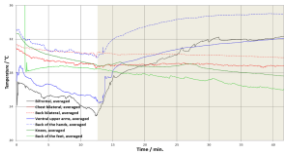
Stage 2: 32 – 28 ^{0}C:
exhausted, centralisation, hypotension, bradycardia, decreased pain perception
clinically manifest coagulopathy

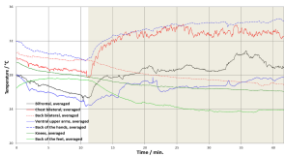
Stage 3: 28 – 24 ^{0}C: coma, mydriasis, arrythmia, circulatory arrest.
severe coagulopathy

Stage 4: < 24 ^{0}C: apnoa, ventricular fibrillation
severe coagulopathy

Efficacy of an Infrared Radiator for Hypothermia Prevention in a Simulated Setup of Entrapped Vehicle Accident Victims








- In a healthy (dressed and immobilised) subject, the skin surface **cooled by several degrees within 12 minutes** at a mean outside temperature of 5 C.
- The use of a CWB, FAW or IRR are in principle **all suitable** for reducing or compensating for heat loss.

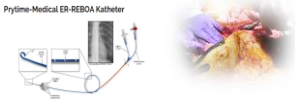
Stroop R et al. Injury 52; 2021: 1491-2501

Prehospital *bleeding* management in trauma

hypothermia & coagulation

mechanical bleeding control

invasive procedures



pharmaceutical haemostatics

transfusion & infusion

Torniquet

Empfehlungen zum Tourniquet Einsatz

Task Force for Advanced Bleeding Care in Trauma

Spahn et al. Critical Care 2013, 17:R76
http://ccforum.com/content/17/2/R76

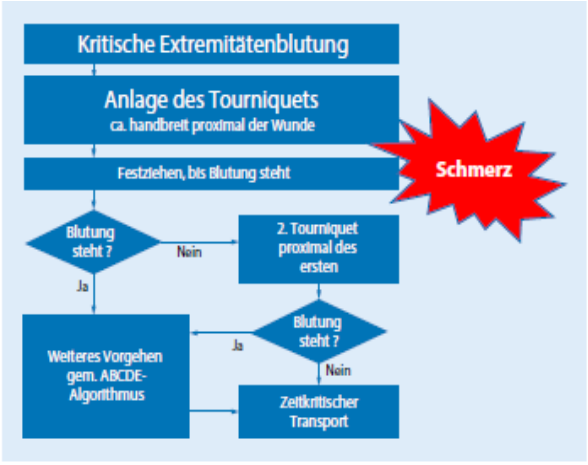
CRITICAL CARE

RESEARCH Open Access

Management of bleeding and coagulopathy following major trauma: an updated European guideline

„we recommend adjunct tourniquet use to stop bleeding from open extremity injuries in the pre-surgical setting

Prähospitale Anwendung von Tourniquets bei lebensbedrohlichen Extremitätenblutungen …



Hossfeld B et al. Unfallchirurg 2018 · 121:516–529

AWMF online
Das Portal der wissenschaftlichen Medizin

S3 Leitlinie zum Tourniquet Einsatz

Aktive Blutungen an den Extremitäten sollten gemäß eines Stufenschemas behandelt werden (Grad B)

1. Manuelle Kompression
2. Hochlagerung
3. Tourniquet

Indikationen für den sofortigen Gebrauch des Tourniquets

1. Lebensgefährliche Blutungen/multiple Blutungsquellen
2. Keine Erreichbarkeit der Verletzung
3. Massenanfall von Verletzten

Tourniquet Drücke

- Möglichst geringer Abbindedruck (70-100 mmHg über syst RR)
- Bei adipösen PatientInnen höher
- Blutungsstop entscheidet
- Bei Ineffektivität Neuanlage mit höherem Druck oder 2. Tourniquet proximal des ersten

Maximale Anlagedauer

- 60 – 90 min, max. 120 min
- Reduziert bei älteren PatientInnen/vaskulären Erkrankungen

The medical response to multisite terrorist attacks in *Paris*

... Among those without lethal wounds, damage control consists of maintaining the blood pressure at the lowest level ensuring consciousness (mean arterial pressure 60 mm Hg) using ***tourniquets****, vasoconstrictors, tranexamic acid, and prevention of temperature lowering (the demand for tourniquets was so high that the mobile teams came back without their belts).*

Hirsch M et al. Lancet 2015; 386: 2535-8

Beckenschlinge

S3-Leitlinie Polytrauma/Schwerverletzten-Behandlung empfiehlt bei instabilem Beckenring und hämodynamischer Instabilität eine mechanische Notfallstabilisierung (Grad A)

Update S3 Leitlinie
Polytrauma /
Schwerverletztenversorgung
für Kliniken des TraumaNetzwerks, Rettungsdienst, Notärzte, Notaufnahmen

ERC-Leitlinien von 2015 empfehlen ebenfalls bei traumatisch induziertem Kreislaufstillstand mit nicht komprimierbarer Blutung unter anderem die Verwendung von Beckenschlingen zur Therapie des hypovolämischen Schocks.

erc

KISS-SCHEMA

K – Hier begründen bereits Auffälligkeiten in der Beurteilung der **Kinematik** des Traumas,

I – bei der **Inspektion** des Beckens (Fehlstellungen – auch Beinlängendifferenz, Blutungen – auch urethral, vaginal oder perianal, Ekchymosen/Hämatome, Prellmarken und äußerliche Haut-/Weichteilverletzungen, Amputationsverletzungen der unteren Extremität) sowie

S – Schmerzen im Beckenbereich den Verdacht auf eine instabile Beckenfraktur und

S – indizieren so eine präklinische **Stabilisierung** des Beckens mittels Beckenschlinge.

1. Die Beine werden oberhalb der Knie und/oder auf Knöchelhöhe in Innenrotation fixiert.
2. Die Beckenschlinge wird auf Höhe der Trochanteren positioniert.
   Fixierte Beckenschlinge SAM® Pelvic Sling II™.
   Fixierte Beckenschline T-POD™.
   Behelfsmäßige Schienung mit Rettungsdecke.

Prehospital *bleeding* management in trauma

hypothermia & coagulation

mechanical bleeding control

invasive procedures

pharmaceutical haemostatics

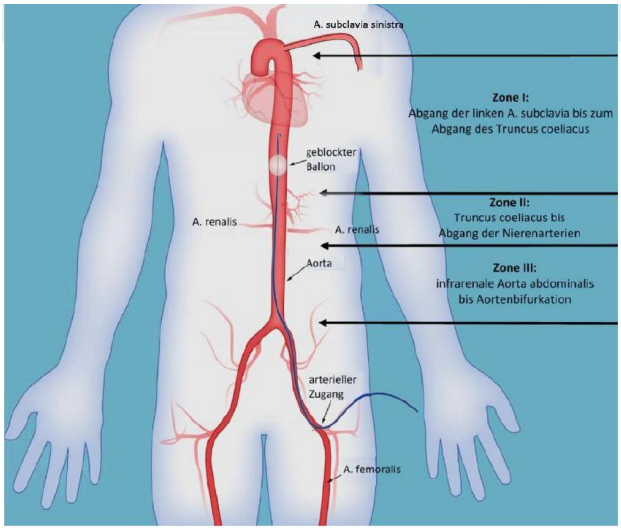
transfusion & infusion

Resuscitative Endovascular Balloon Occlusion of Aorta (REBOA)

Verletzungen mit raschem Blutverlust aus:

- Leber
- Milz
- Niere
- Mesenterium
- Becken
- Geburtswege

Resuscitative Endovascular Balloon Occlusion of Aorta (REBOA)



REBOA (Resuscitative Endovascular Balloon Occlusion of the Aorta):

Brauchen wir das wirklich?

Aufgrund der möglichen Komplikationen während und nach der REBOA-Prozedur ist eine gefäßchirurgische Expertise unabdingbar. Zudem sind wegen der geringen Fallzahlen sowohl anfängliche Schulungen als auch regelmäßige Übungen notwendig. Dennoch stellt REBOA eine potenziell lebensrettende Sofortmaßnahme dar, die als solche im **Portfolio von Traumazentren** vorgehalten werden sollte.

Wortmann M et al. Notfall & Rettungsmed; 02.01.2018

Akut Thorakotomie („Clamshell“)

Komplette Eröffnung des Thorax im 5. ICR

Als Indikation
Kreislaufstillstand bei penetrierender Thorax- bzw. Oberbauchverletzung, sofern keine externe Herzdruckmassage möglich ist.

Kontraindikation:
- stumpfes Bauchtrauma
- mehr als 10 Minuten keine kardiale Auswurfleistung
- messbarer Puls

Abgeraten:
- massiven Schädelverletzungen
- nicht speziell dafür qualifiziertem Personal
- mangelnder Ausrüstung

Das Verfahren sollte generell nur durchgeführt werden, wenn der Patient nicht innerhalb von 10 Minuten nach Eintreten des Herz-Kreislauf-Stillstandes operativ versorgt werden kann.

Wise D. et al. Emerg Med J 2005;22:22-24

A systematic review of 3251 emergency department thoracotomies: is it time for a national database?

Edward John Nevins[1] · Nicholas Thomas Edward Bird[1] · Hassan Zakria Malik[2,3] · Simon Jude Mercer[2,4] · Khalid Shahzad[1,2] · Raimundas Lunevicius[1,2] · John Vincent Taylor[1,2] · Nikhil Misra[1,2]

Thirty-seven articles, containing 3.251 patients who underwent EDT, were identified. There were 277 (8.5%) survivors.

improved survival for:

- penetrating vs blunt trauma (OR 2.10; *p* 0.0028)
- stab vs gun-shot (OR 5.45;*p* < 0.0001)
- signs of life (SOL) on admission vs no SOL (OR 5.36; *p* < 0.0001)
- and SOL in the field vs no SOL (OR 19.39; *p* < 0.0001)

Penetrating injury remains a robust indication for EDT. *Non cardiothoracic cause of cardiac arrest should not preclude EDT*. In the absence of on scene SOL, survival following EDT is extremely unlikely.

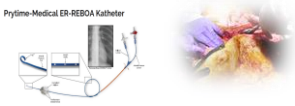
Nevins EJ et al. Eur J Trauma Emerg Surg 2019, Jul 14

Prehospital *bleeding* management in trauma

hypothermia & coagulation

mechanical bleeding control

invasive procedures



pharmaceutical haemostatics

transfusion & infusion

CRASH-2
Clinical Randomisation of an Antifibrinolytic in Significant Haemorrhage

CRITICAL CARE

Recommendation 22

We recommend that TXA be administered to the trauma patient who is bleeding or at risk of significant haemorrhage as soon as possible and **within 3 h after injury at a loading dose of 1 g infused over 10 min, followed by an i.v. infusion of 1 g over 8 h.**

(Grade 1A)

We recommend that protocols for the management of bleeding patients consider administration of the **first dose of TXA en route to the hospital**.

(Grade 1C)

We recommend that the administration of TXA **not await results from a viscoelastic assessment**.

(Grade 1B)

Management of bleeding and coagulopathy following major trauma: an updated European guideline.
Spahn D et al. Spahn et al. Critical Care 2019/xxx

CRITICAL CARE

Recommendation 22

We recommend that TXA be administered to the trauma patient who is bleeding or at risk of significant haemorrhage as soon as possible and within 3 h after injury at a loading dose of 1 g infused over 10 min, followed by an i.v. infusion of 1 g over 8 h.

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We recommend that protocols for the management of bleeding patients consider administration of the **first dose of TXA *en* route to the hospital**.

(Grade 1C)

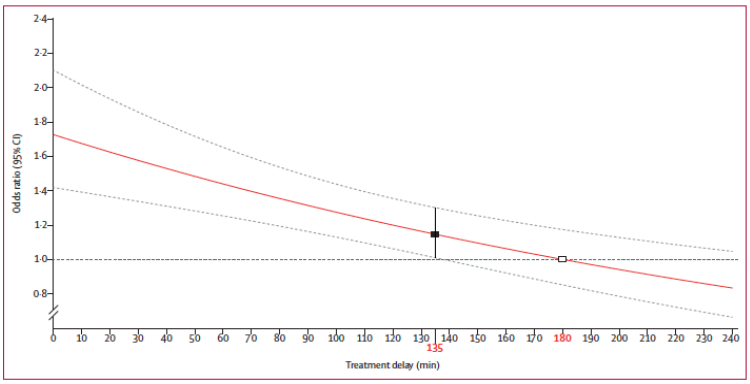
We recommend that the administration of TXA **not await results from a viscoelastic assessment**.

(Grade 1B)

Management of bleeding and coagulopathy following major trauma: an updated European guideline.
Spahn D et al. Spahn et al. Critical Care 2019/xxx

Effect of treatment delay on the effectiveness and safety of antifibrinolytics in acute severe haemorrhage: a meta-analysis of individual patient-level data from 40 138 bleeding patients

*Angèle Gayet-Ageron, David Prieto-Merino, Katharine Ker, Haleema Shakur, François-Xavier Ageron, Ian Roberts, for the Antifibrinolytic Trials Collaboration**



OR for NOT dying from bleeding

local hemostatics for prehospital use

tradename	agent	application
QuickClot®	zeolithe	granule
QuickClot ACS+®	zeolithe	teabag
QuickClot Combat Gauze®	kaolin	gauze
Celox Gauze®	chitosan	gauze
WoundStat®	silicate	granule
Kerlix®	cotton	gauze

Spahn et al. Critical Care 2013, 17:R76
http://ccforum.com/content/17/2/R76

CRITICAL CARE

RESEARCH Open Access

Management of bleeding and coagulopathy following major trauma: an updated European guideline

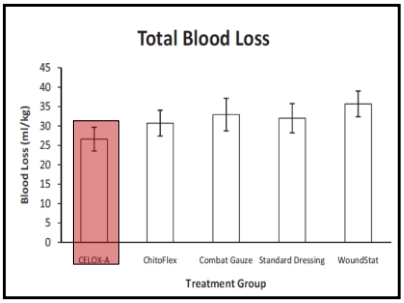
„We recommend the use of **topical haemostatic agents** in **combination** with other **surgical measures or with packing** for venous or moderate arterial bleeding associated with parenchymal injuries“ **(Grade 1B)**

Spahn D et al. Spahn et al. Critical Care 2019/2023

Comparison of Celox-A, ChitoFlex, WoundStat, and Combat Gauze Hemostatic Agents Versus Standard Gauze Dressing in Control of Hemorrhage in a Swine Model of Penetrating Trauma

		Initial Hemostasis		Rebleed		Survival	
Group	*n*	Yes	%	Yes	%	Yes	%
CA	16	16	100	4	25	14	88
CF	16	13	81	9	56	13	81
CG	16	15	94	4	25	12	75
SG	16	13	81	5	31	13	81
WS	16	11	69	4	25	9	56
Total	80	68	85	26	33	61	76

CA = Celox-A, CF = ChitoFlex, CG = combat gauze, SG = standard gauze, WS = WoundStat.



Littlejohn LF et al. Acad Emerg Med 2011; 18:4:340-350

Prehospital *bleeding* management in trauma

hypothermia & coagulation

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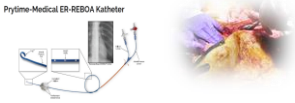
invasive procedures



pharmaceutical haemostatics

transfusion & infusion

Whole blood transfusion

Study	Patients	Type of study	Description	Results
Ho and Leonard	77	Retrospective cohort study	Unrefrigerated young WB in a civilian setting	No benefit
Cotton et al.	55	RCT	SRCT comparing WB and component therapy	No difference in 30-d mortality
Zielinski et al.	119	Retrospective observational study	Describes the THOR network pre- hospital WB program	Observation only Overall mortality 31%
Leeper et al.	18	Retrospective descriptive analysis	Pediatric uncrossmatched LTOWB transfusion for hemorrhagic shock	ISS: 34 Mortality 44%
Seheult et al.	135	Retrospective case–control analysis	Matched LTOWB patients within 24 hours to component therapy patients	No mortality difference, similar clinical outcomes across groups
Zhu et al.	30	Retrospective descriptive analysis	Descriptive study of prehospital WB transfusion	Mortality in adult: 36%; mean ISS: 29 in pediatric patients: 20%; ISS: 29
Condron et al.	1	Case study	Case report	N/A
Hazelton et al.	107	Dual-center case-match study	Matching analysis for patients who received CSWB vs. BCT for hemodynamic parameters,	No difference in 30-d mortality be- tween the two groups
Williams et al.	350	prospective therapeutic study	Comparison of low titer Type O- WB versus BCT in prehospital and emergency department	equivocally mortality benefit.
Gallaher et al.	125	Retrospective Cohort Analysis	Comparison of whole blood in combination with BCT versus BCT	No difference in 24-hour and 30-day mortality. Whole blood/BCT group received significantly more component-equivalent units.

Walsh M and Fries D et al. Semin Thromb Hemost. 2020 Mar;46(2):221-234

Prehospital blood/-component transfusion …

Moore E, et al. Plasma First in the Field for Postinjury Hemorrhagic Shock. *Shock 2014*

Effect of Prehospital Red Blood Cell Transfusion on Mortality and Time of Death in Civilian Trauma Patients

Retrospective trauma database study comparing mortality before-implementation with after-implementation of phRTx:

- no significant improvement in **overall survival** (p=0.554)
- **Prehospital mortality:** 42,2% versus 27.6% (p<0.001)

Rehn M et al. Shock. 2019 Mar;51(3):284-288.

Effect of Prehospital Red Blood Cell Transfusion on Mortality and Time of Death in Civilian Trauma Patients

Neither survival benefits nor a decreased incidence of shock on admission were observed after prehospital helicopter emergency medical service URBC transfusions.

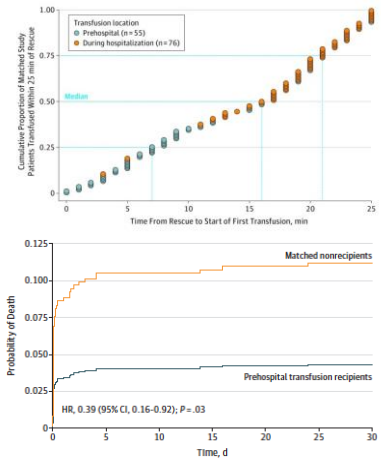
Rehn M et al. Shock. 2019 Mar;51(3):284-288.

Are on-scene blood transfusions by a helicopter emergency medical service useful and safe? - A multicentre case-control study.

Parameter	URBC	Control	P-value
ISS	34	35	0,242
Transportation time (min)	84	71	0,118
Hb	**8,0**	**6,5**	**0,01**
BE	9,9	6,2	0,628
Survival (%)	55	60	0,547
Shock at admission (%)	70	58	0,243

Peters JH et al. Eur J Emerg Med. 2019 Apr;26(2):128-132

Association of Prehospital Blood Product Transfusion During Medical Evacuation of Combat Casualties in Afganistan



Transfusion prehospital or within minutes of injury was associated **with greater 24-hour and 30-day survival** than delayed transfusion.

Shackelford SA et al. JAMA. 2017; 318:1581-1591

Association of Prehospital Blood Product Transfusion During Medical Evacuation of Combat Casualties in Afganistan

Characteristics	Prehospital transfusion (n=55)	Matched non-reciepients (n=345)	P value
Hb (G/dl)	12,4	12,8	0.24
pH	7,28	7,29	0.65
INR	1,4	1,2	0.08
RBC/24h	15	11	0.02

Shackelford SA et al. JAMA. 2017; 318:1581-1591

Prehospital Transfusion of Plasma and Red Blood Cells in Trauma Patients

Prehospital plasma and RBC transfusion was associated with:

- improved early outcomes
- negligible blood products wastage
- not an overall survival advantage

"… Similar to the data published from the ongoing war, improved early outcomes are associated with placing blood products prehospital, allowing earlier infusion of life-saving products to critically injured patients."*

***ISS = 24 and mortality = 26%**

Holcomb J et al. Prehosp Emerg Care 2015;19(1):1-9

Prehospital Transfusion of Plasma and Red Blood Cells in Trauma Patients

Arrival physiology and laboratory data

median arrival Hgb	**13.5**	**vs**	**13.0**	***p 0.206***

Outcome and resuscitation data

30-day mortality, %	**22**	**vs**	**21**	***p 0.626***
24-hour mortality, %	**14**	**vs**	**13**	***p 0.529***

Holcomb J et al. Prehosp Emerg Care 2015;19(1):1-9

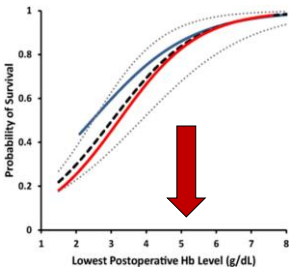
Prehospital Transfusion of Plasma and Red Blood Cells in Trauma Patients

Parameter	GT	LF	p-value	OA	p-value
Median scene SBP	120	124	0.258	120	0.760
Median scene HR	100	99	0.402	101	0.114
Scene hypotension, %	16	14	0.845	15	0.855
Median ISS	14	22	<0.001	22	0.998
Median prehosp fluids	**325**	**300**	**0.143**	**500**	**<0.001**
Median prehosp RBC	**0**	**1**	**0.028**	**0**	**0.208**
Median prehosp plasma	**0**	**1**	**0.001**	**0**	**0.005**

Holcomb J et al. Prehosp Emerg Care 2015;19(1):1-9

Author	Design	Target	Result
Rehn M et al. Shock. 2019	Retrospective/before-after	?	overall survival (p=0.554) Prehospital mortality: 42,2% versus 27.6% (p<0,01)
Peters JH et al. Eur J Emerg Med. 2019	Kohortenstudie/ matched control	?	no survival benefits nor a decreased incidence of shock on admission
Shackelford SA et al. JAMA. 2017	Retrospective cohort analysis	?	improved 24-hour and 30-day survival
Holcomb J et al. Prehosp Emerg Care 2015	Retrospective cohort analysis	?	**improved early outcomes???** negligible blood products wastage no survival benefit

CRITICAL CARE



Shander A et al. Transfusion. 2014 Oct;54(10 Pt 2):2688-95

Management of bleeding and coagulopathy following major trauma: an updated European guideline.
Spahn D et al. Spahn et al. Critical Care 2019/2023

Recommendation 17:
We recommend a target Hb of 7 to 9 g/dl. (Grade 1C)

Prehospital Plasmatransfusion

Moore E, et al. Plasma First in the Field for Postinjury Hemorrhagic Shock. Shock 2014

Einzelspenderplasma (FFP)

(Fraktionierung von Vollblut, innerhalb von 24 Stunden Schockgefroren, 4-6 Monate Quarantäne)

Poolplasma (SDP)

(Plasmapool von > 100 Einzelspendern; Vorteil: Dilutionseffekt und neutralisierende AK anderer Spender, lipidumhüllte Viren werden mit TNBP und Triton 100 inaktiviert, 5-15 % niedrigere Konzentration an Gerinnungsfaktoren als FFP)

Lyoplasma

(Leukozyten- und zelldepletiertes Trockenpulver mit einer Haltbarkeit von 15 Monaten, das bei Raumtemperatur gelagert werden kann und vor der Transfusion mit Wasser zu Injektionszwecken aufgelöst und verflüssigt wird)

READY TO USE

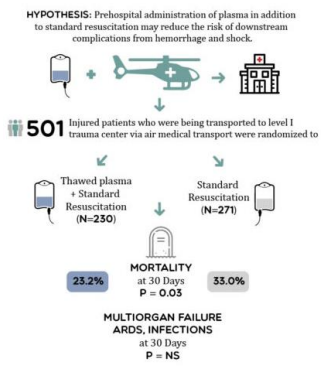
study	intervention	
PUPTH: Prehospital use of plasma in traumatic hemorrhage (The PUPTH Trial): study protocol for a randomised controlled trial	effect of **2 units of plasma** vs saline	
PAMPer: PreHospital Air Medical Plasma Trial	effect of **2 units of plasma** vs saline	
COMBAT: Initial experience with a randomized clinical trial of plasma-based resuscitation in the field for traumatic hemorrhagic shock	effect of **2 units of plasma** vs saline	
RePHILL: Resuscitation with Pre-Hospital Blood Products)	up to two units of packed red blood cells and **two units** of LyoPlas	

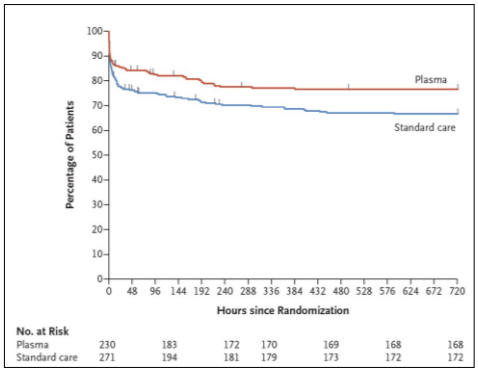
The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JULY 26, 2018 VOL. 379 NO. 4

Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock

J.L. Sperry, F.X. Guyette, J.B. Brown, M.H. Yazer, D.J. Triulzi, B.J. Early-Young, P.W. Adams, B.J. Daley, R.S. Miller,

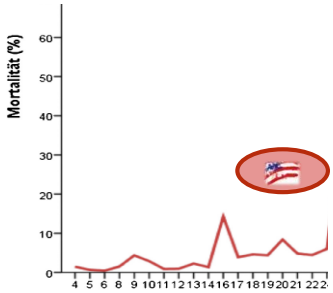




Risk stratification in trauma and haemorrhagic shock: Scoring systems derived from the TraumaRegister DGU®☆

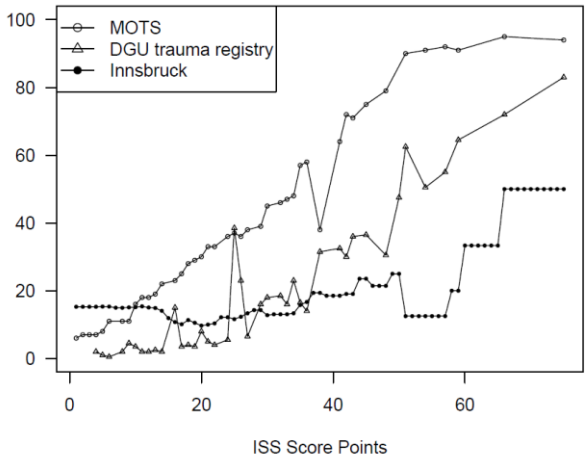
Sebastian Wutzler [a,*], Marc Maegele [b,c], Arasch Wafaisade [b,c], Hendrik Wyen [a], Ingo Marzi [a], Rolf Lefering [b] the TraumaRegister DGU[1]

[a] Department of Trauma, Hand and Reconstructive Surgery, Hospital of the Johann Wolfgang Goethe-University, Frankfurt, Germany
[b] Institute for Research in Operative Medicine, Cologne Merheim Medical Center (CMMC), University of Witten/Herdecke, Cologne, Germany
[c] Department of Orthopedics, Trauma and Sports Medicine, Cologne Merheim Medical Center (CMMC), University of Witten/Herdecke, Cologne, Germany



Variable	Standard-Care Group (N=271)	Plasma Group (N=230)
Prehospital red-cell transfusion — no. (%)¶	114 (42.1)	60 (26.1)
Initial Glasgow Coma Scale score <8 — no. (%)‖	129 (47.6)	103 (44.8)
Median prehospital systolic blood pressure (IQR) — mm Hg**	69 (61–81)	71 (64–81)
Median prehospital heart rate (IQR) — beats/min	115 (96–126)	117 (104–128)
Prehospital intubation — no. (%)	141 (52.0)	115 (50.0)
Prehospital cardiopulmonary resuscitation — no. (%)	18 (6.6)	13 (5.7)
Median prehospital transport time (IQR) — min	40 (33–51)	42 (34–53)
Median Injury Severity Score (IQR)††	21 (12–29)	22 (14–33)

trauma & mortality…



Plasma-first resuscitation to treat haemorrhagic shock during emergency ground transportation in an urban area: a randomised trial

	plasma group	control group
FI baseline	253 (224 - 310	278 (250 – 331)
FI at admission	195 (157 – 275)	222 (154 – 282)
mortality 24h	15% (10)	10% (6)
mortality 28d	12% (8)	10% (6)
MOF	6% (4)	2% (1)
MOF+death	21% (14)	12% (7)

Moore H et al. Lancet 2018; 392:283-291

Resuscitation with blood products in patients with trauma related haemorrhagic shock receiving prehospital care (RePHILL)

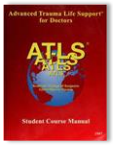
n = 432 (209 PRBC + Lyoplas, 223 sodium chloride)

Neither ***morbidity, mortality nor lactate clearance or coagulation***

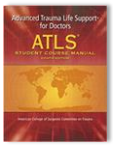
improved with prehospital transfusion of blood products

	Lyoplas + RBC	NaCL 0.9%	P value
Hgb g/dL	13,8 (19)	11,8 (23)	0.0001
ExTEM CT sec	78 (73)	78 (69)	0.81
ExTEM MCF mm	55.7 (12,4)	54,9 (6,1)	0.64
Lactate	5,42 (4,45)	5,78 (4,68)	O,42

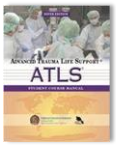

TRAUMA
MANAGEMENT
Fluid Resuscitation &
Permissive Hypotension



1997: **8l colloids & crystalloids** (= 4,8l volume effect)



2004: **4l colloids & crystalloids** (= 2,4l volume effect)

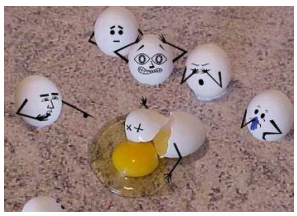


2013: **2l crystalloids** (= 400 ml volume effect)

2019: **1l crystalloids** (= 200 ml volume effect)

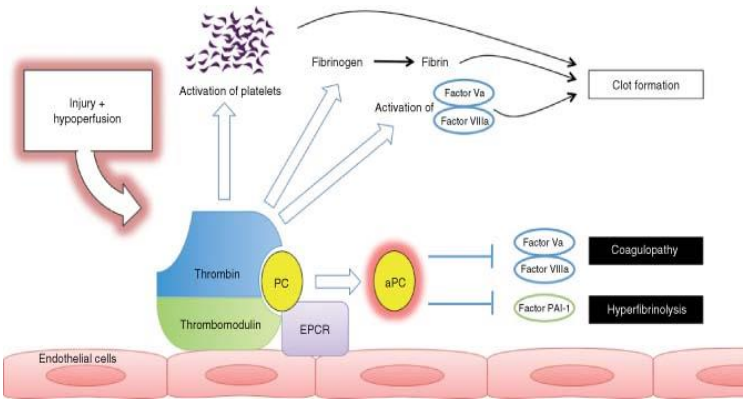
Side effects of fluid replacement therapy in trauma hemorhage

- Dilution
- Coagulopathy
- Volume overload
- Pulmonary dysfunction
- (Abdominal compartment) syndrome
- Increase in blood pressure → increases blood loss
- Hypothermia due to cold infusion solutions



„The lethal triad of hypothermia, acidosis and coagulopathy …“

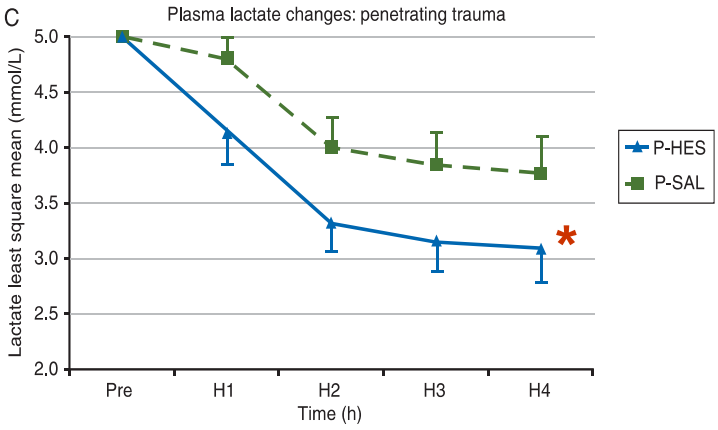
Hypovolemia/inadequate resuscitation → Protein C activation → Coagulopathy



Thorsen K et al. 2011; British J of Surgery 98(7):894-907

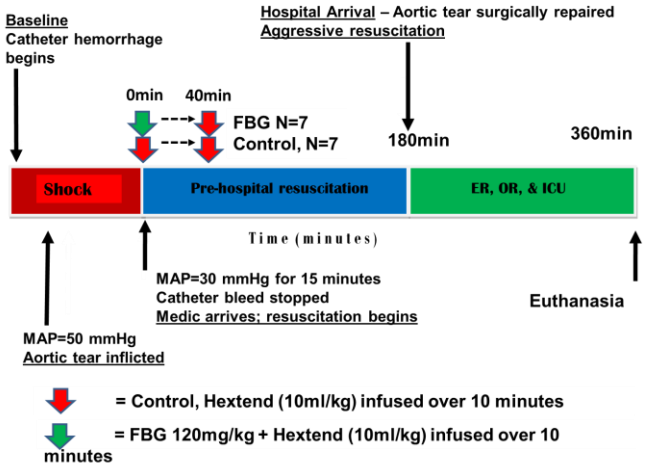
The FIRST Study:

Lactate/Lactate clearance in penetrating trauma



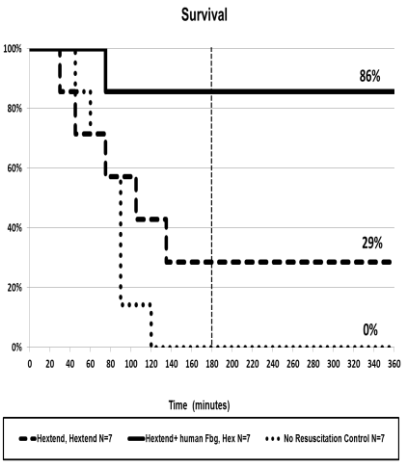
Fibrinogen concentrate improves survival during limited resuscitation of uncontrolled hemorrhagic shock in a Swine model

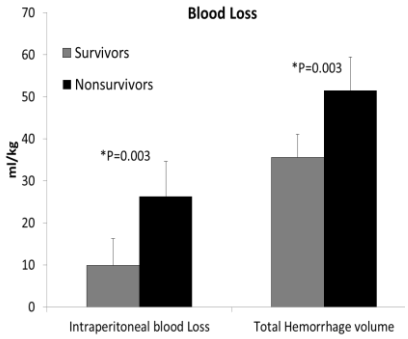
Experimental Protocol



White N et al. 2014 Nov;42(5):456-63.

Fibrinogen concentrate improves survival during limited resuscitation of uncontrolled hemorrhagic shock in a Swine model

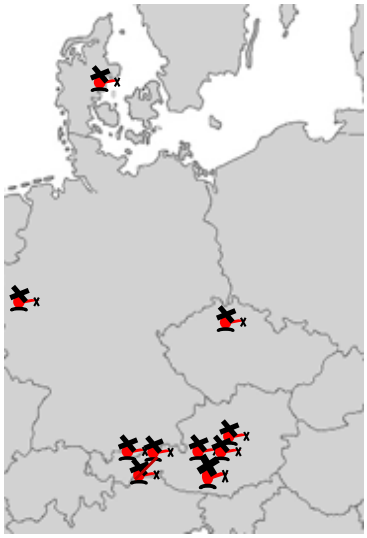




White N et al. 2014 Nov;42(5):456-63.

Sequence of critical of clotting factor concentrations in severe trauma :

1. **Fibrinogen (Factor I)**
2. **Factor XIII**
3. **Prothrombin (Factor II)**
4. **Factor V**
5. **Factor VII**
6. **Platelets**



FIBTIC

Fibrinogen in Trauma induced coagulopathy

- Prospective, randomized placebo controlled multicenter, multinational prehospital trial
- 12 study centers in 3 European countries

European Journal of Anaesthesiology; April 2021, Vol.:38,4: 348-357

... feasability???

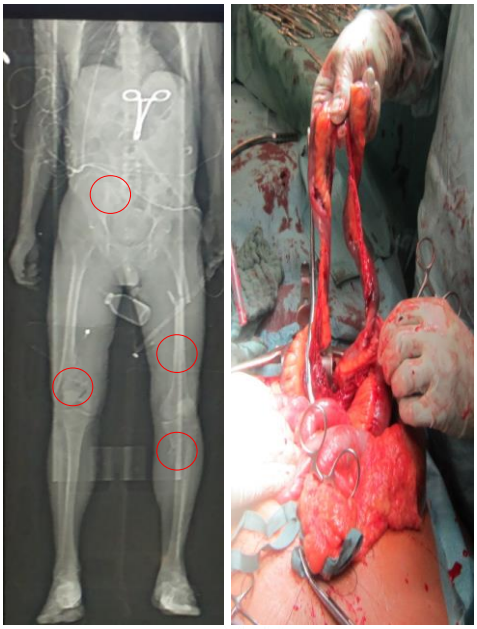
ISS 43, Injuries

CCT:
- Orbita fracture

Thorax:
- Serial rip fracture
- Pneumothorax right
- Vertebral Fractures TH III/IV

Abdomen:
- Positive FAST
- Rupt. of the spleen
- Rupt. of the mesenterium reg lieum

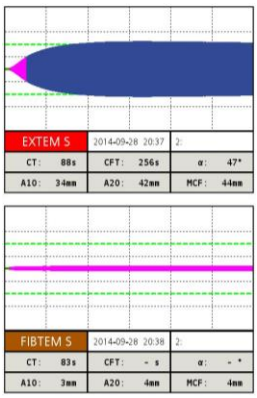
Fractures:
- Femur fracture left
- Supra-diacondyl femur fracture
- Tibia fracture



European Journal of Anaesthesiology; April 2021, Vol.:38,4: 348-357

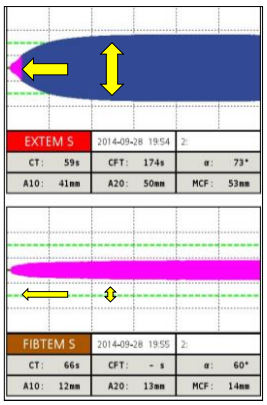
Lab results in the field

Hb:	10.8g/dL
Plt:	91.000/µL
PT:	31%
aPTT:	50.2sec
Fbg:	58 mg/dL

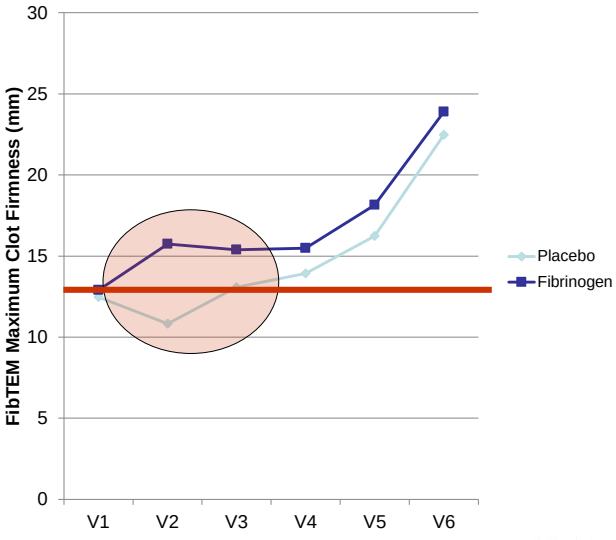


Lab results on admission

Hb:	**6.6g/dL**
Plt:	**73.000/µL**
PT:	**46%**
aPTT:	**45.2 sec**
Fbg:	**151 mg/dL**

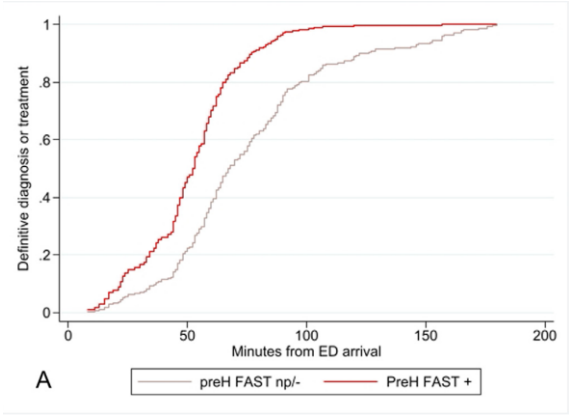


European Journal of Anaesthesiology; April 2021, Vol.:38,4: 348-357



European Journal of Anaesthesiology; April 2021, Vol.:38,4: 348-357

„prehospital ultrasound in reducing time to definitive care in abdominal trauma“



Gamberini L et al. Injury 53 (2022) 1587–1595

- ✓ **temperature management**
- ✓ **targeted use of TXA**
- ✓ **Tourniquet, hemostyptic woundbandages and pelvic sling**
- ✓ **critical view on prehospital transfusion**

Future perspectives:

… blood components registry and coordination

… prehospital ultrasound

… rational volume therapy

… coagulation factors pre-hospital – on the route