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Trauma Induced Coagulopathy

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Trauma Induced Coagulopathy

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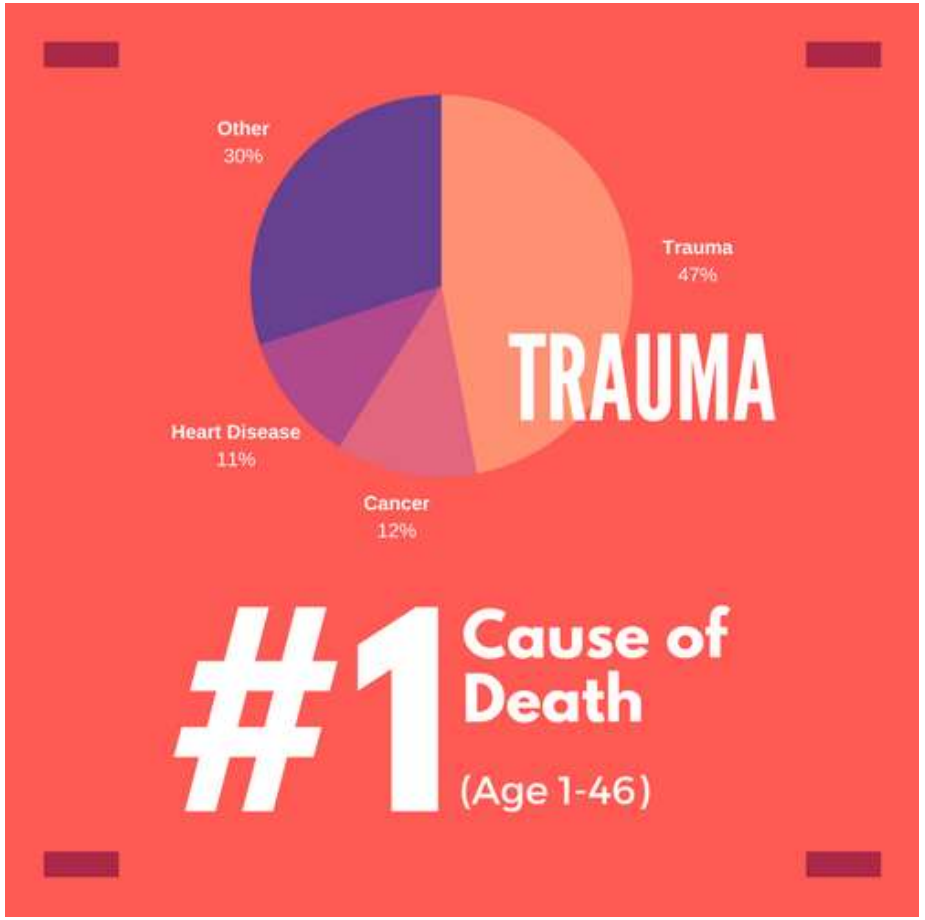
Disclosures

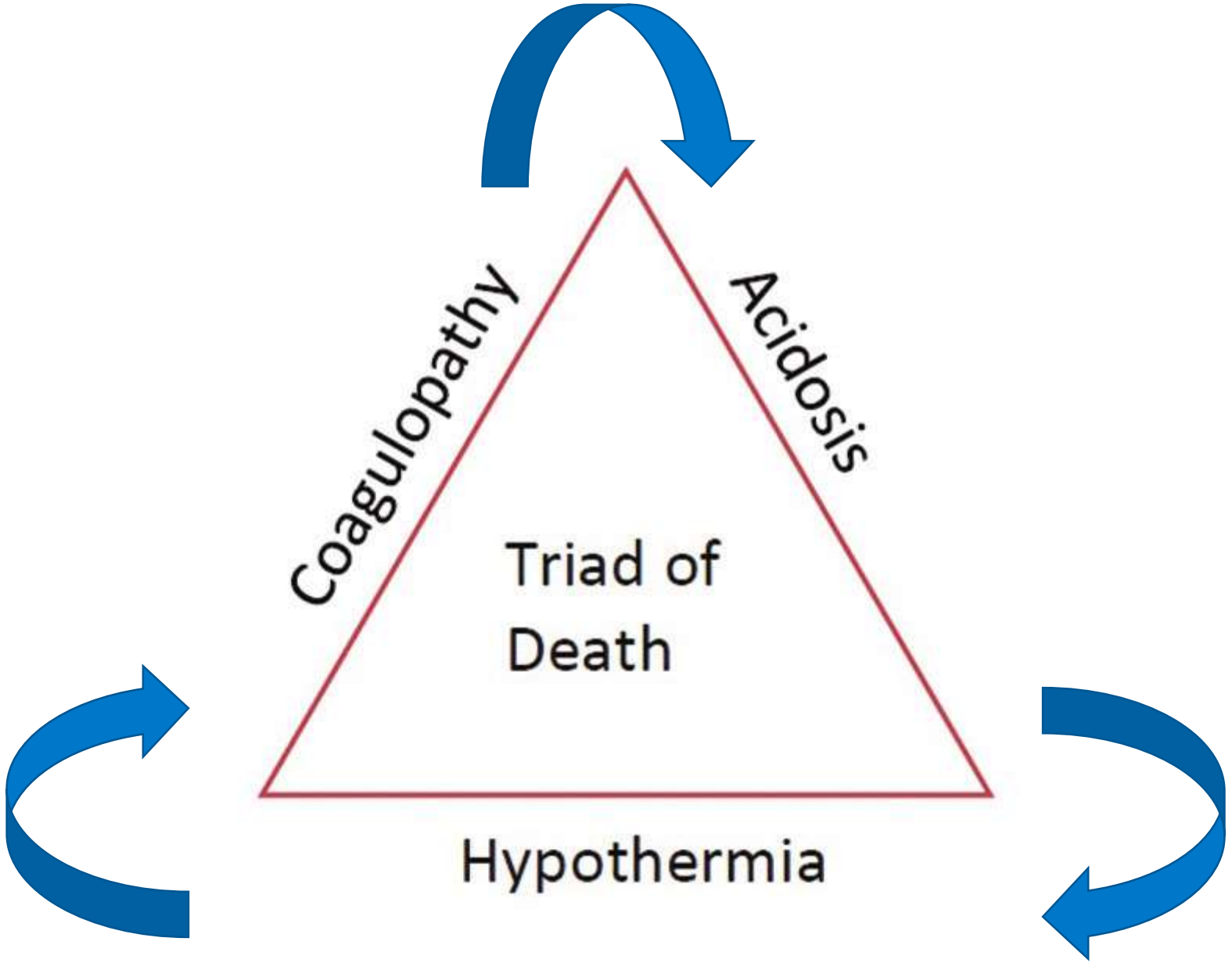
Goals

- Discuss how traumatic events affect coagulation of patient
- Steps ED doctor can take to prevent and treat coagulopathy
- New technology and how can help guide trauma care

Trauma

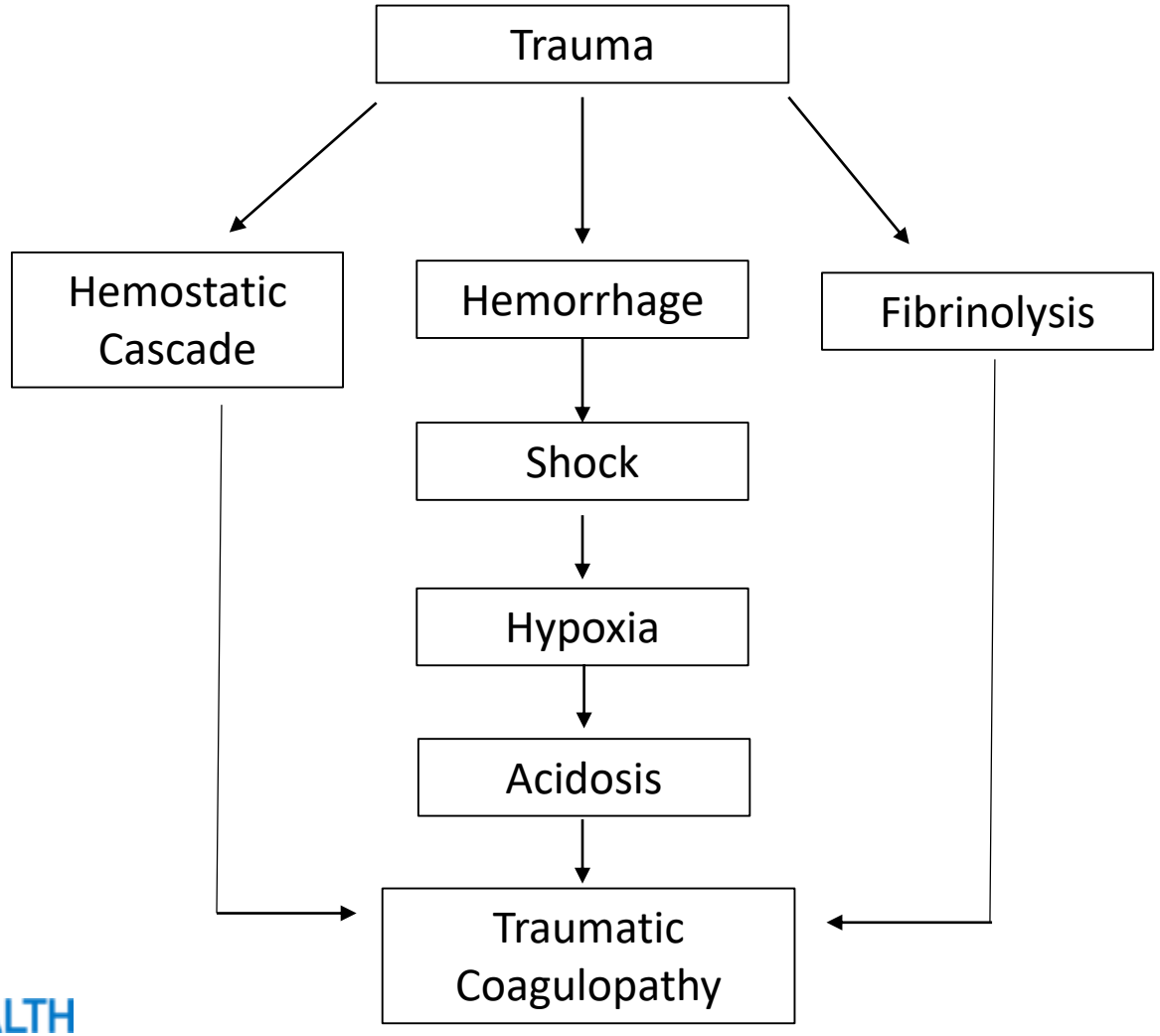


- Massive hemorrhage: 50% if trauma deaths
- Coagulopathy: 7x increase in mortality


Coagulopathy
Acidosis
Triad of
Death
Hypothermia

Coagulopathy

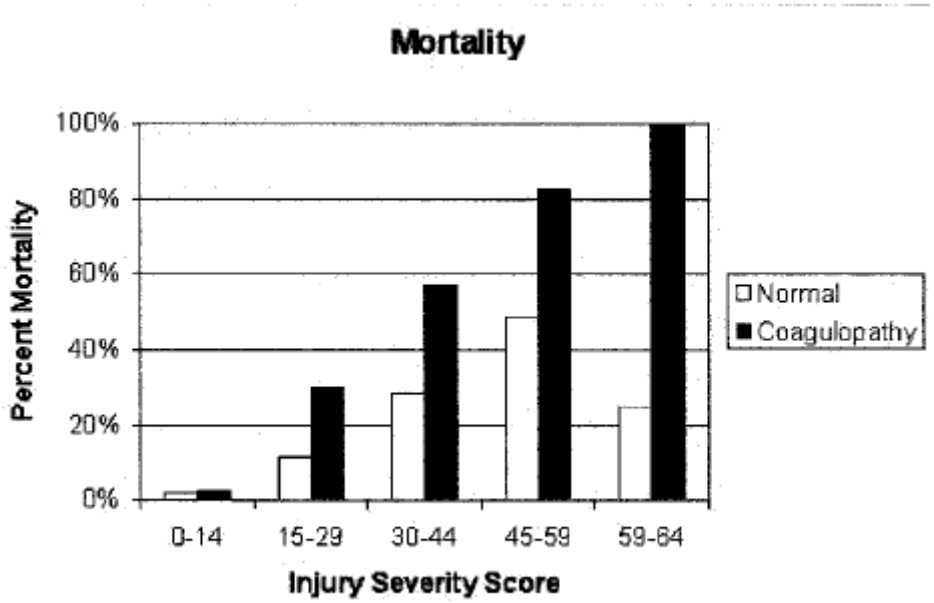
Acute Endogenous Coagulopathy



Acute Traumatic Coagulopathy[1]

- Brohi, J Trauma, 2003

- 25% of patients arrived to ED COAGULOPATHIC



Acute Traumatic Coagulopathy[1]

- No correlation between fluid and coagulopathy

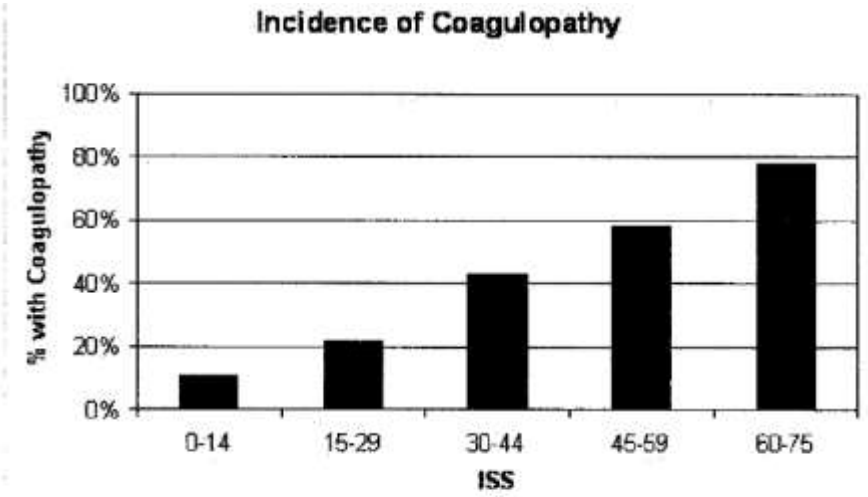
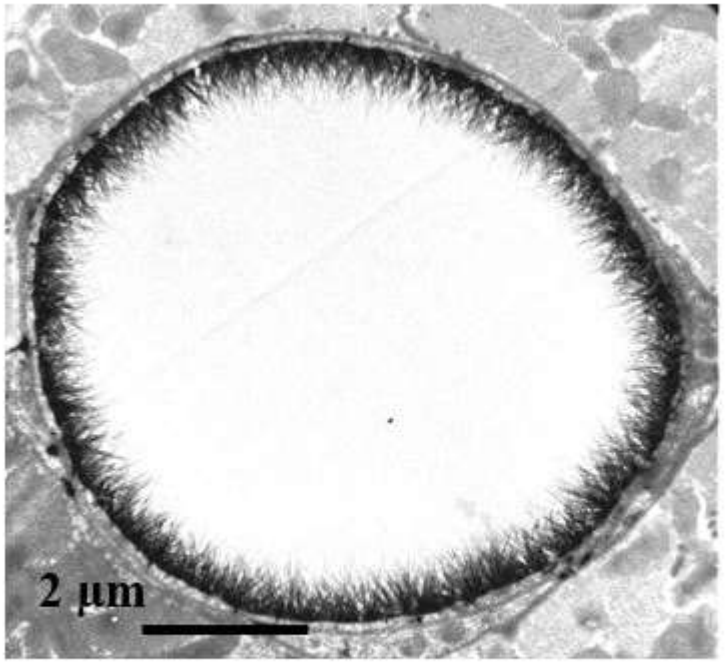
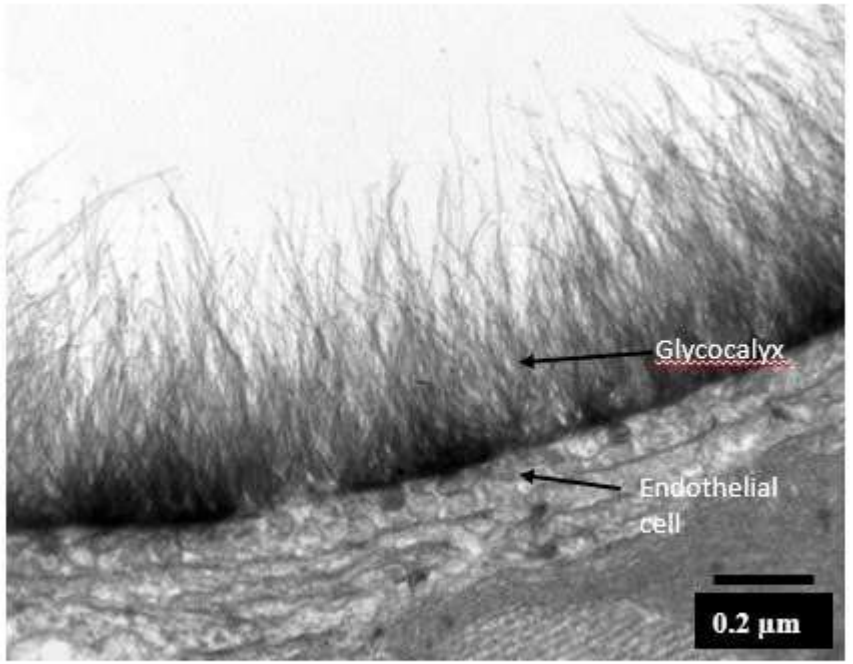


Fig. 1. *Incidence of coagulopathy. ISS, Injury Severity Score.*

Endothelial Glycocalyx

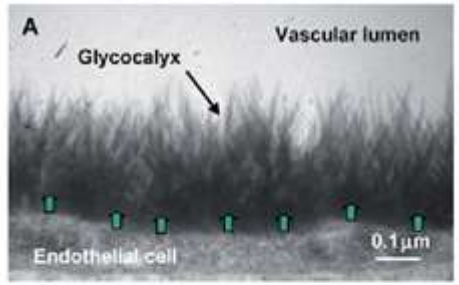




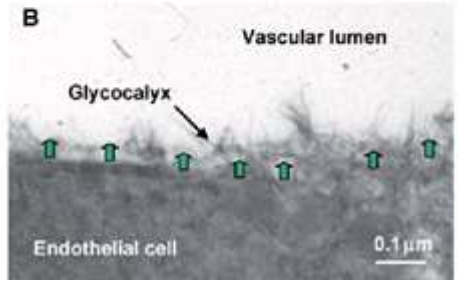
van den Berg, Vink & Spaan, Circulation Research 2003, 92: 592-594

Trauma and Endothelium

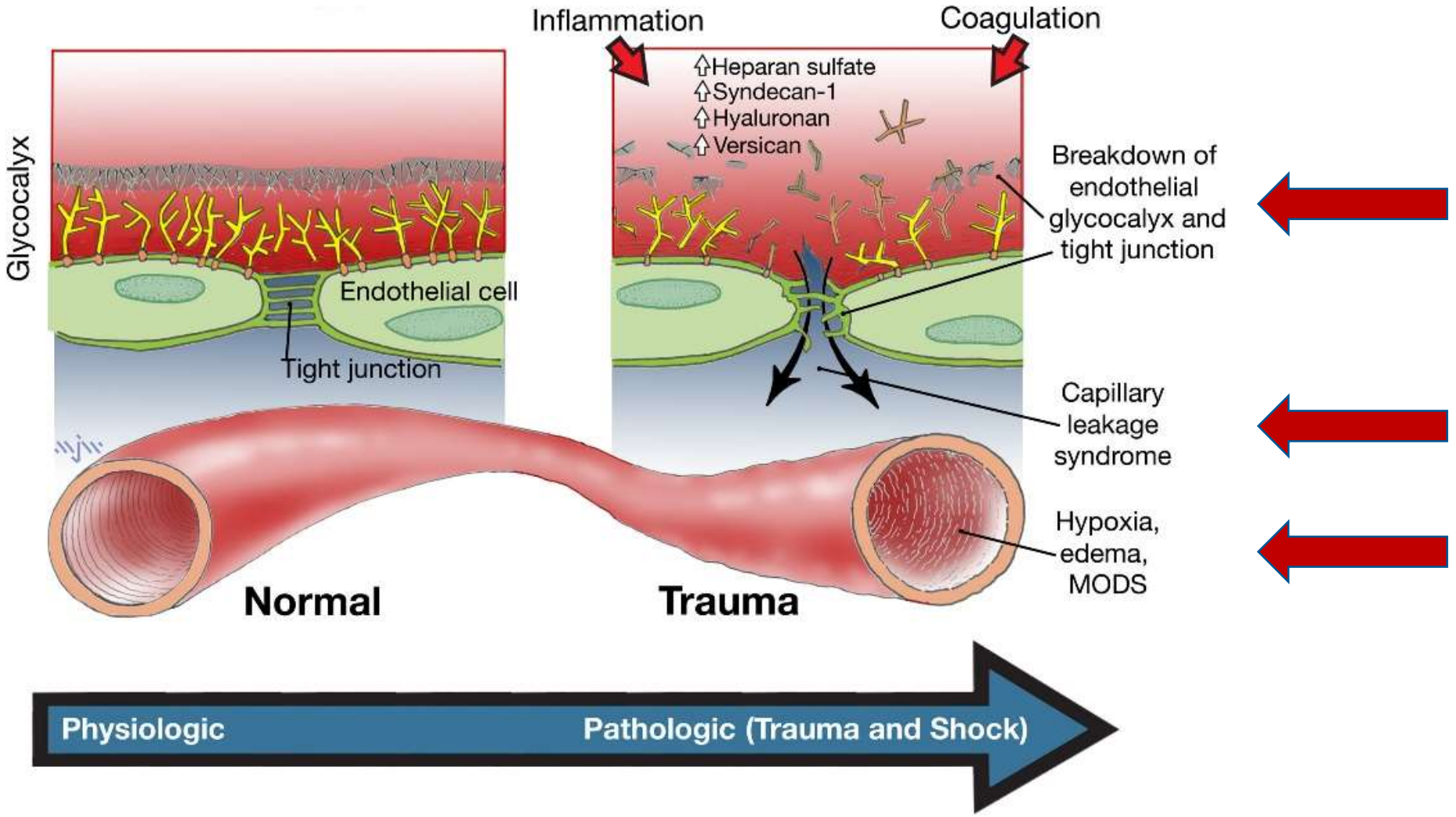
Normal



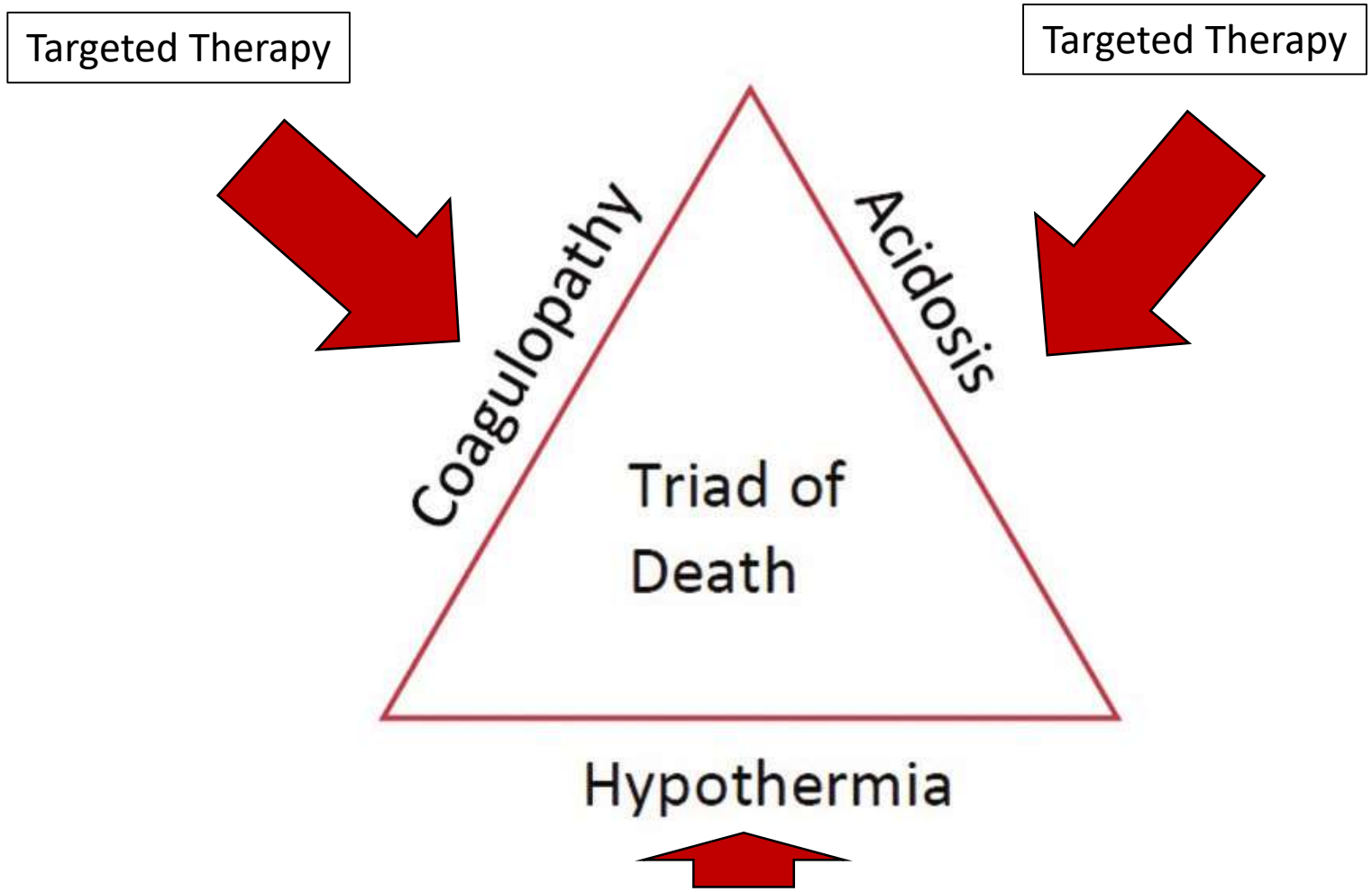
Ischemia



Endothelial Breakdown



Prevent the “Lethal Triad”



Damage Control Resuscitation(DCR)[2]

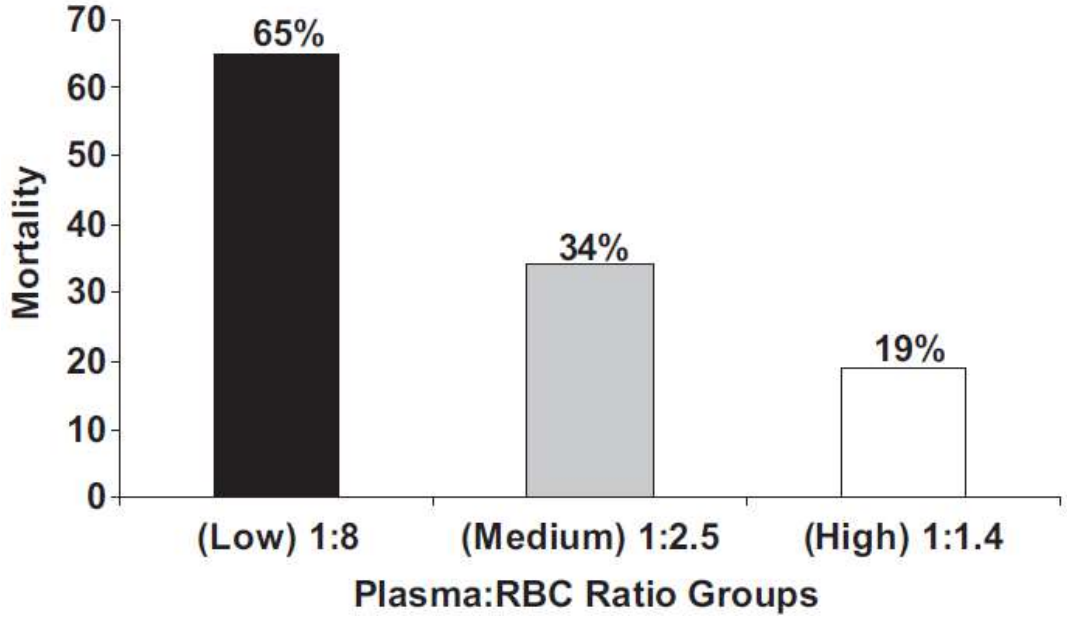
- Prevent Hypothermia
  - Warm the patient
  - Blood products through fluid warmer
- Massive Transfusion
  - Early transfusion of blood products
  - Minimize IVF
- Permissive Hypotension
  - Don’t ‘pop the clot’
- Administration of TXA

DCR – Preventing Hypothermia

- Hypothermia:
  - Increased heat loss
  - Decreased heat generation
- ↑coagulation times
- Maintaining normothermia shown to improve survival[13]

DCR - Massive Transfusion

- Military Conflict: whole blood
- Borgman, J Trauma 2007[3]



PROMMTT[10]

- Holcomb, JAMA Surgery, 2013

- Early use of plasma/platelets -> Improved survival

PROPPR[11]

- Consistent transfusion rations
  - 1:1:1 vs 1:1:2

- No mortality difference

Start within minutes

Balanced Ratio

Who Gets MTP?

- Nunez, J Trauma, 2010[12]

- Predictors:
  - Penetrating Mechanism
  - SBP ≤ 90
  - HR ≥ 120
  - Positive FAST

≥ 2 → 85% sensitive, 86% specific

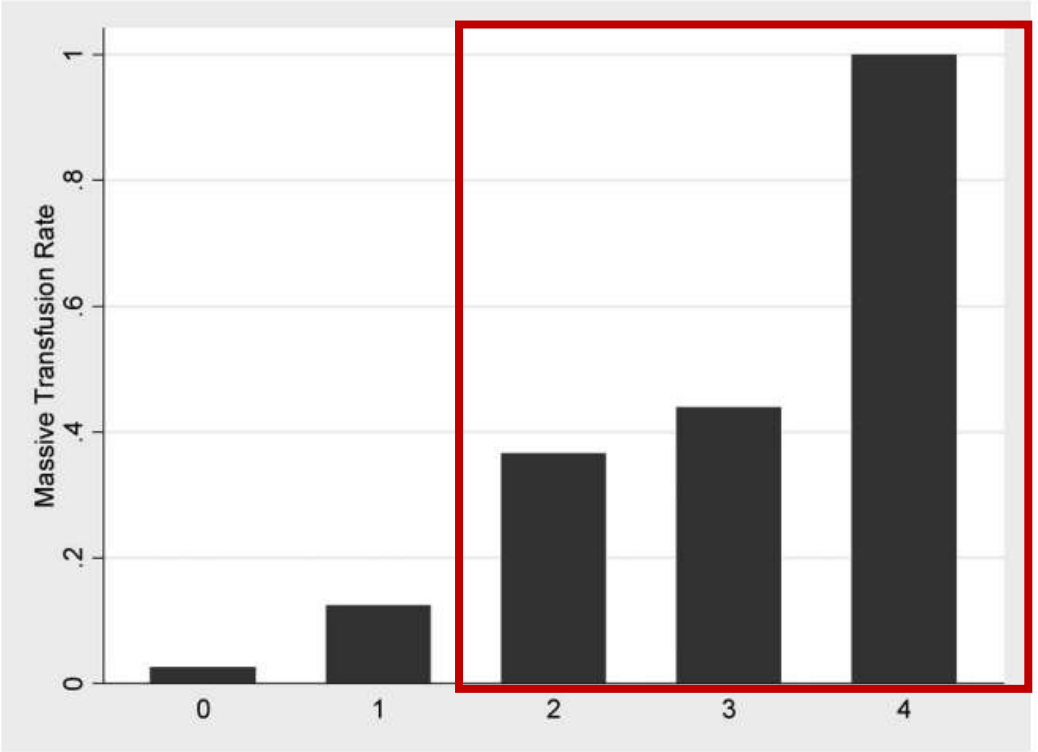
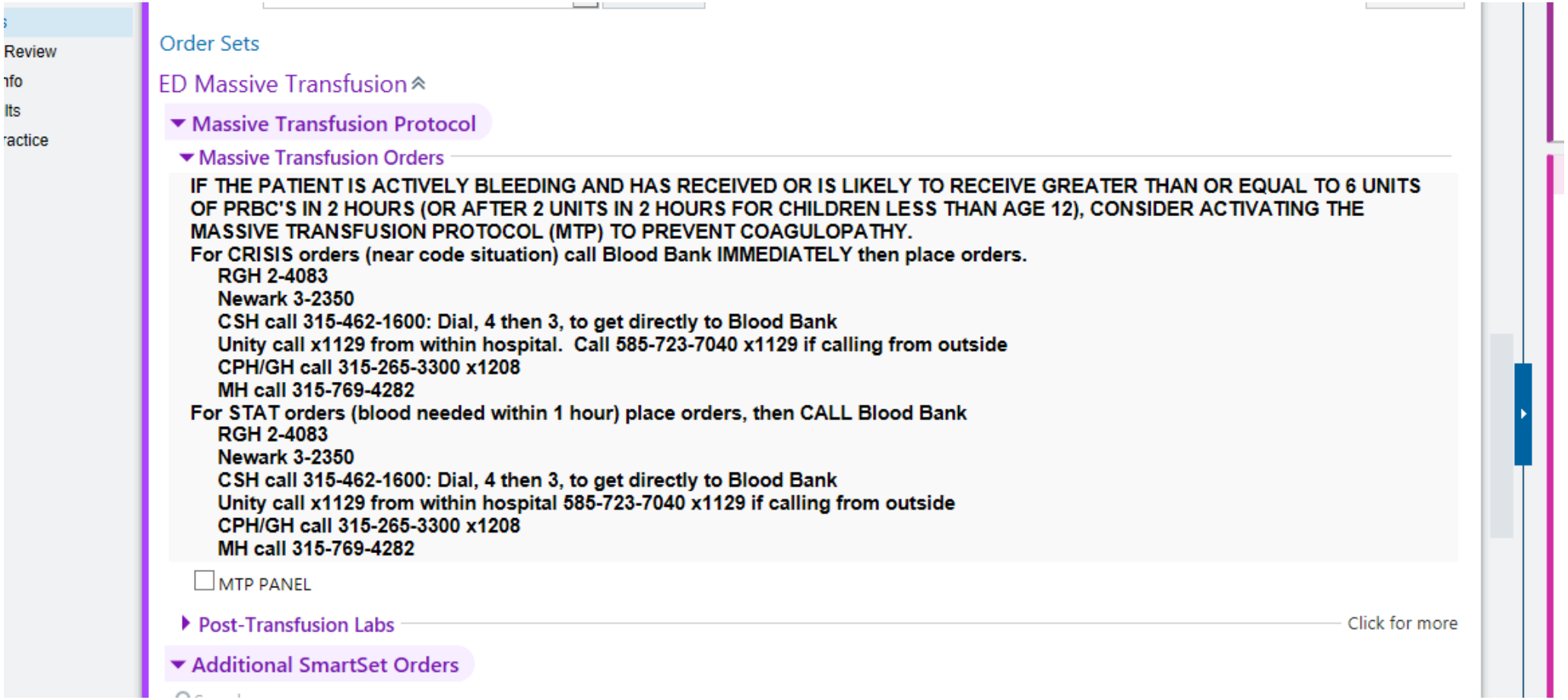


Fig. 1. *Rate of massive transfusion by ABC score.*

MTP at RGH


Review
nfo
lts
ractice
Order Sets
ED Massive Transfusion
Massive Transfusion Protocol
Massive Transfusion Orders
IF THE PATIENT IS ACTIVELY BLEEDING AND HAS RECEIVED OR IS LIKELY TO RECEIVE GREATER THAN OR EQUAL TO 6 UNITS OF PRBC'S IN 2 HOURS (OR AFTER 2 UNITS IN 2 HOURS FOR CHILDREN LESS THAN AGE 12), CONSIDER ACTIVATING THE MASSIVE TRANSFUSION PROTOCOL (MTP) TO PREVENT COAGULOPATHY.
For CRISIS orders (near code situation) call Blood Bank IMMEDIATELY then place orders.
RGH 2-4083
Newark 3-2350
CSH call 315-462-1600: Dial, 4 then 3, to get directly to Blood Bank
Unity call x1129 from within hospital. Call 585-723-7040 x1129 if calling from outside
CPH/GH call 315-265-3300 x1208
MH call 315-769-4282
For STAT orders (blood needed within 1 hour) place orders, then CALL Blood Bank
RGH 2-4083
Newark 3-2350
CSH call 315-462-1600: Dial, 4 then 3, to get directly to Blood Bank
Unity call x1129 from within hospital 585-723-7040 x1129 if calling from outside
CPH/GH call 315-265-3300 x1208
MH call 315-769-4282
MTP PANEL
Post-Transfusion Labs
Click for more
Additional SmartSet Orders

DCR - Permissive Hypotension

- Sterns, Academic Emergency, 1995[4]
  - Resuscitated to MAPs of 40, 60, 80

TABLE 2 Survival Time and Mortality

	Survival Time (min)	Mortality (%)
Group I	58 ± 7	11
Group II	57 ± 8	11
Group III	44 ± 12*	78*

MAP 40
↓
MAP 80

Bickell – NEJM[5]

Table 5. Outcome of Patients with Penetrating Torso Injuries, According to Treatment Group.

Variable	Immediate Resuscitation	Delayed Resuscitation	P Value
Survival to discharge — no. of patients/total patients (%)	193/309 (62)*	203/289 (70)†	0.04
Estimated intraoperative blood loss — ml‡	3127±4937	2555±3546	0.11
Length of hospital stay — days§	14±24	11±19	0.006
Length of ICU stay — days§	8±16	7±11	0.30

- Immediate IVF
  - Promoted ongoing hemorrhage
  - Hydraulic disruption of thrombus
  - **Dilution of coagulation factors**

DCR - TXA for Trauma Patients

Figure 2: Mortality by days from randomisation

	Tranexamic acid (n=10 060)	Placebo (n=10 067)	RR (95% CI)	p value (two-sided)
Any cause of death	1463 (14·5%)	1613 (16·0%)	0·91 (0·85–0·97)	0·0035
Bleeding	489 (4·9%)	574 (5·7%)	0·85 (0·76–0·96)	0·0077
Vascular occlusion*	33 (0·3%)	48 (0·5%)	0·69 (0·44–1·07)	0·096
Multiorgan failure	209 (2·1%)	233 (2·3%)	0·90 (0·75–1·08)	0·25
Head injury	603 (6·0%)	621 (6·2%)	0·97 (0·87–1·08)	0·60
Other causes	129 (1·3%)	137 (1·4%)	0·94 (0·74–1·20)	0·63

Data are number (%), unless otherwise indicated. RR=relative risk. *Includes myocardial infarction, stroke, and pulmonary embolism.

Table 2: Death by cause

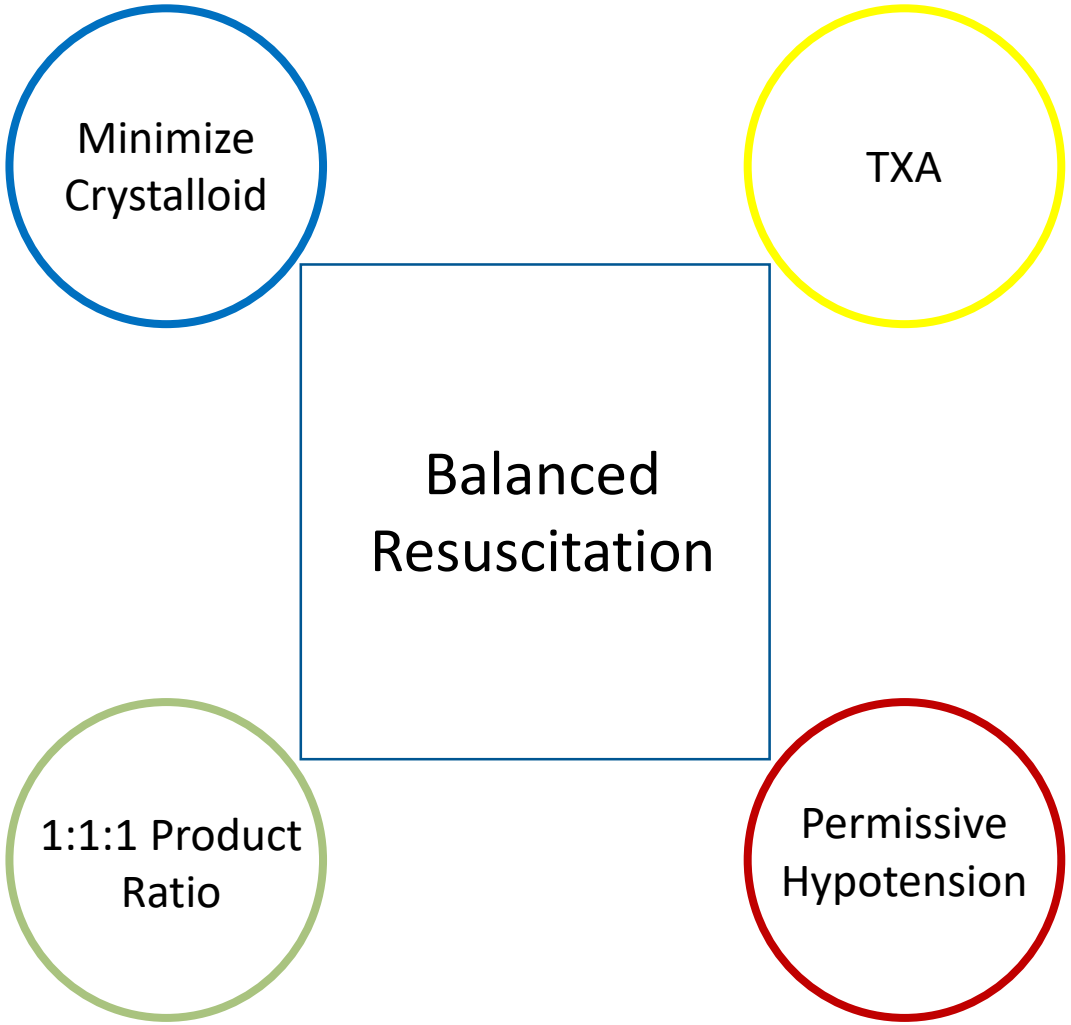
DCR - TXA

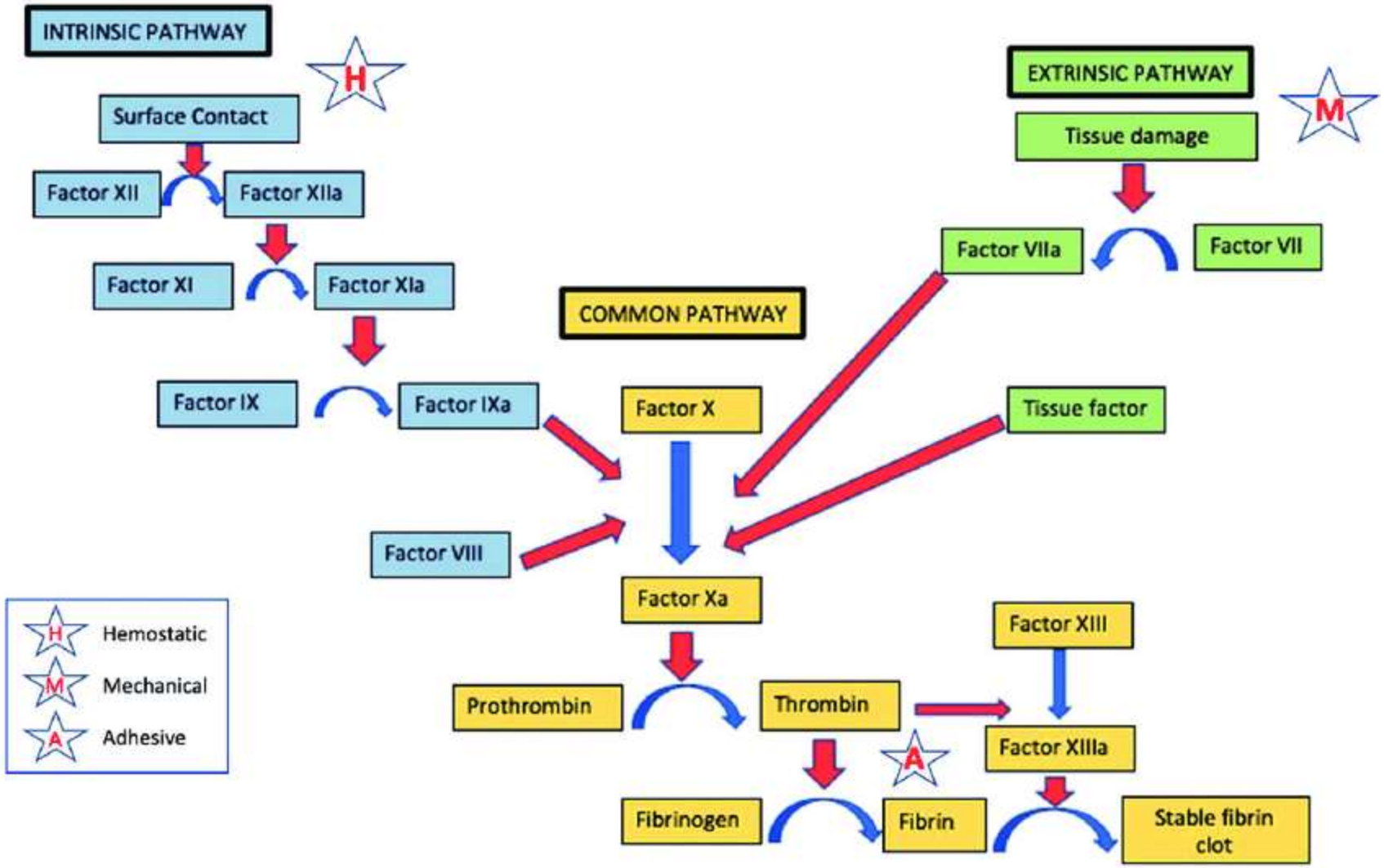
	Tranexamic acid (n=10 060)	Placebo (n=10 067)	RR (95% CI)	p value
Vascular occlusive events*				
Any vascular occlusive event	168 (1·7%)	201 (2·0%)	0·84 (0·68–1·02)	0·084
Myocardial infarction	35 (0·3%)	55 (0·5%)	0·64 (0·42–0·97)	0·035
Stroke	57 (0·6%)	66 (0·7%)	0·86 (0·61–1·23)	0·42
Pulmonary embolism	72 (0·7%)	71 (0·7%)	1·01 (0·73–1·41)	0·93
Deep vein thrombosis	40 (0·4%)	41 (0·4%)	0·98 (0·63–1·51)	0·91
Need for transfusion and surgery				
Blood product transfused	5067 (50·4%)	5160 (51·3%)	0·98 (0·96–1·01)	0·21
Any surgery	4814 (47·9%)	4836 (48·0%)	1·00 (0·97–1·03)	0·79
Neurosurgery	1040 (10·3%)	1059 (10·5%)	0·98 (0·91–1·07)	0·67
Chest surgery	1518 (15·1%)	1525 (15·1%)	1·00 (0·93–1·06)	0·91
Abdominal surgery	2487 (24·7%)	2555 (25·4%)	0·97 (0·93–1·02)	0·28
Pelvic surgery	683 (6·8%)	648 (6·4%)	1·05 (0·95–1·17)	0·31
Median (IQR) units of blood product transfused†	3 (2–6)	3 (2–6)	..	0·59‡
Dependency				
No symptoms	1483 (14·7%)	1334 (13·3%)	1·11 (1·04–1·19)	0·0023
Minor symptoms	3054 (30·4%)	3061 (30·4%)	1·00 (0·96–1·04)	0·94
Some restriction	2016 (20·0%)	2069 (20·6%)	0·97 (0·92–1·03)	0·36
Dependent (not requiring constant attention)	1294 (12·9%)	1273 (12·6%)	1·02 (0·95–1·09)	0·63
Fully dependent	696 (6·9%)	676 (6·7%)	1·03 (0·93–1·14)	0·57
Alive (disability status not known)	54 (0·5%)	41 (0·4%)	..	..
Dead	1463 (14·5%)	1613 (16·0%)	0·91 (0·85–0·97)	0·0035

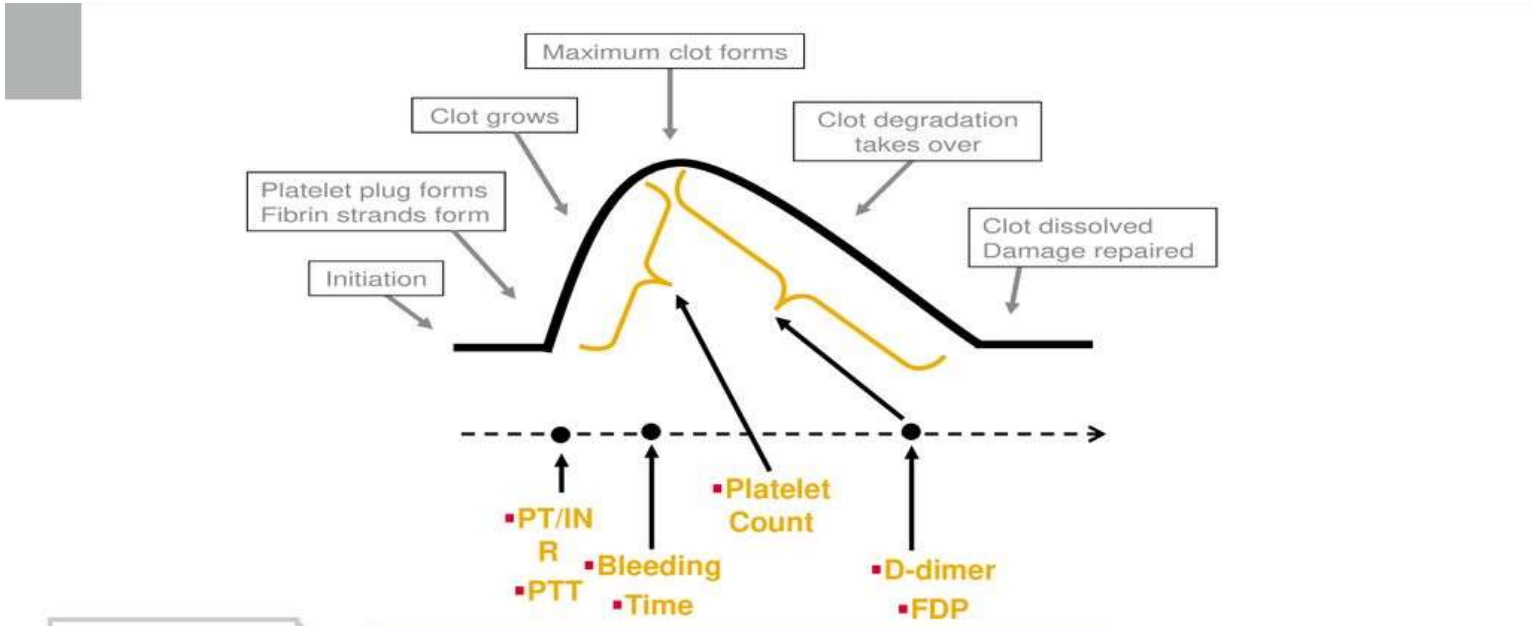
Data are number (%), unless otherwise indicated. Counts are for numbers of patients with at least one such event. RR=relative risk. *Includes both fatal and non-fatal events. †Transfused patients only. ‡Analysis used logarithmic transformation of mean units of blood products transfused.

***Table 3*: Vascular occlusive events, need for transfusion and surgery, and level of dependency**

Balanced Resuscitation




INTRINSIC PATHWAY
H
Surface Contact
Factor XII
Factor XIIa
Factor XI
Factor XIa
Factor IX
Factor IXa
EXTRINSIC PATHWAY
M
Tissue damage
Factor VIIa
Factor VII
COMMON PATHWAY
Factor X
Tissue factor
Factor VIII
Factor Xa
Factor XIII
Prothrombin
Thrombin
Factor XIIIa
A
Fibrinogen
Fibrin
Stable fibrin clot
H Hemostatic
M Mechanical
A Adhesive


Maximum clot forms
Clot grows
Clot degradation takes over
Platelet plug forms
Fibrin strands form
Clot dissolved
Damage repaired
Initiation
▪PT/INR
▪PTT
▪Bleeding Time
▪Platelet Count
▪D-dimer
▪FDP
▪Traditional Hemostasis Tests
Do not define the overall process, just provide pieces of the process!
7
© 2011 Haemonetics Corp
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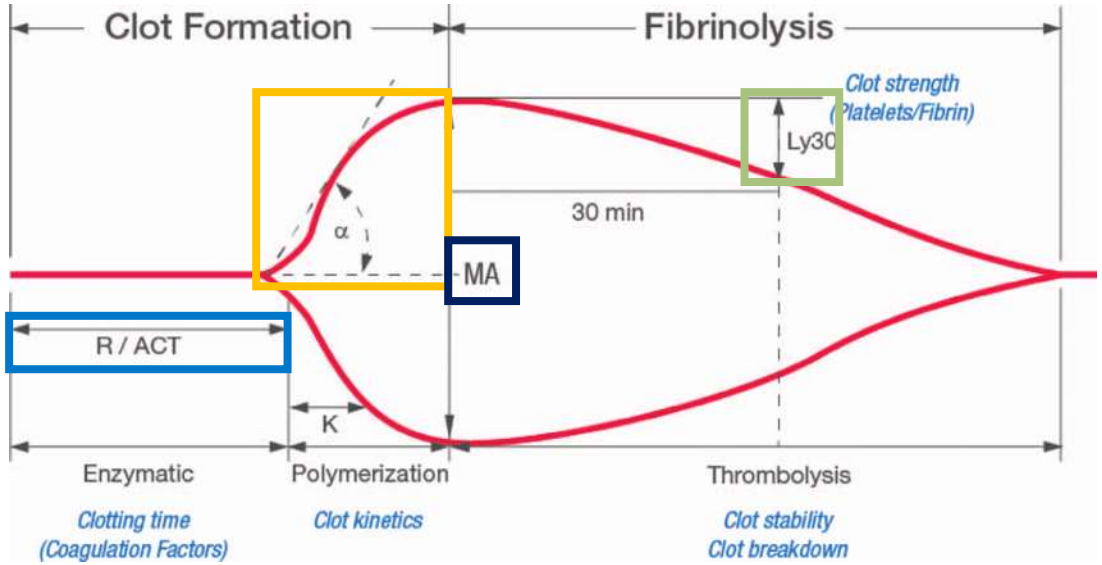
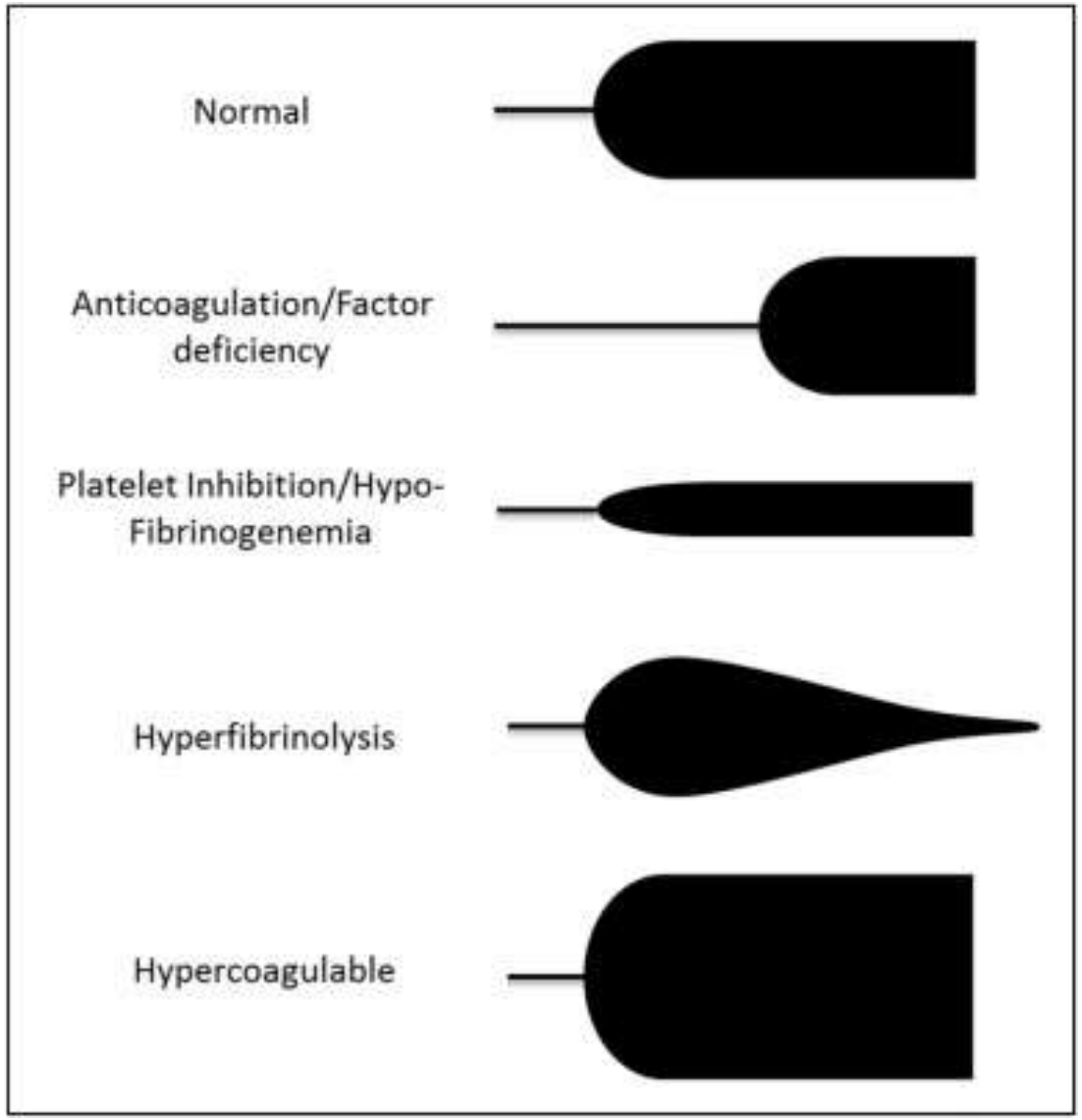
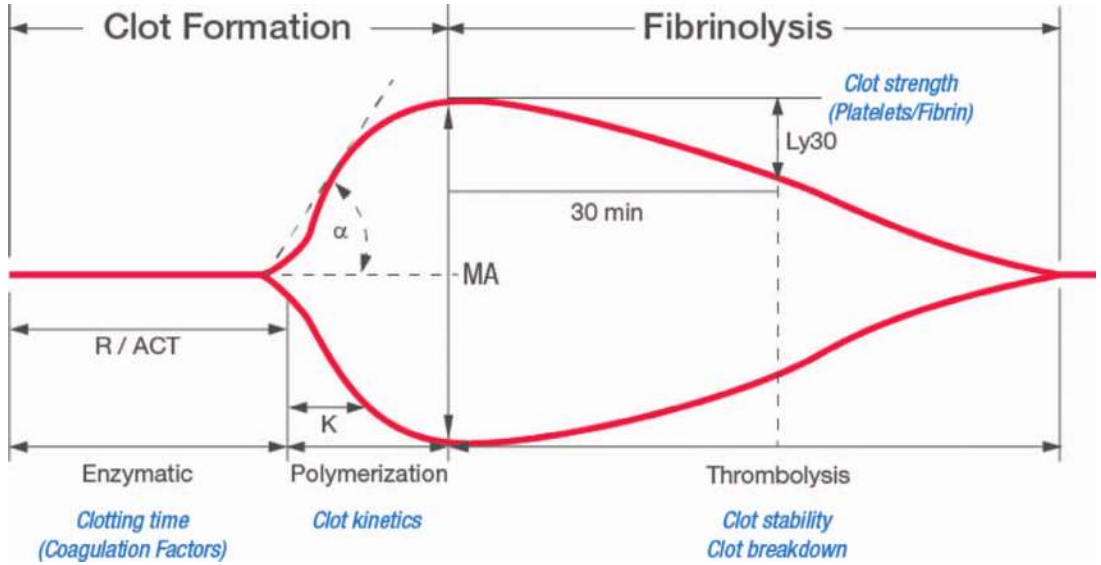
Thrombelastography (TEG)

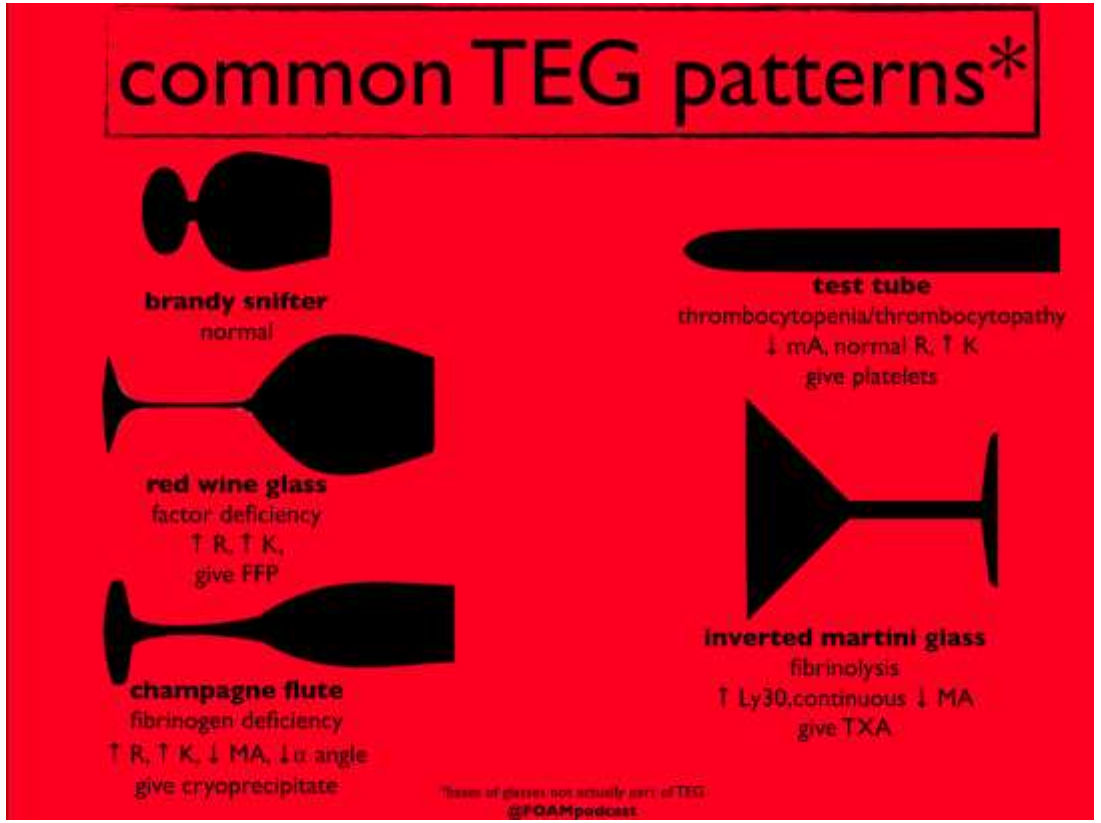


- R: Reaction Time = Thrombin Generation
- α: Clot Formation Time = Fibrinogen
- MA: Maximum Amplitude = Platelets
- Ly30: Lysis at 30min = Fibrinolysis


Normal
Anticoagulation/Factor deficiency
Platelet Inhibition/Hypo-Fibrinogenemia
Hyperfibrinolysis
Hypercoagulable

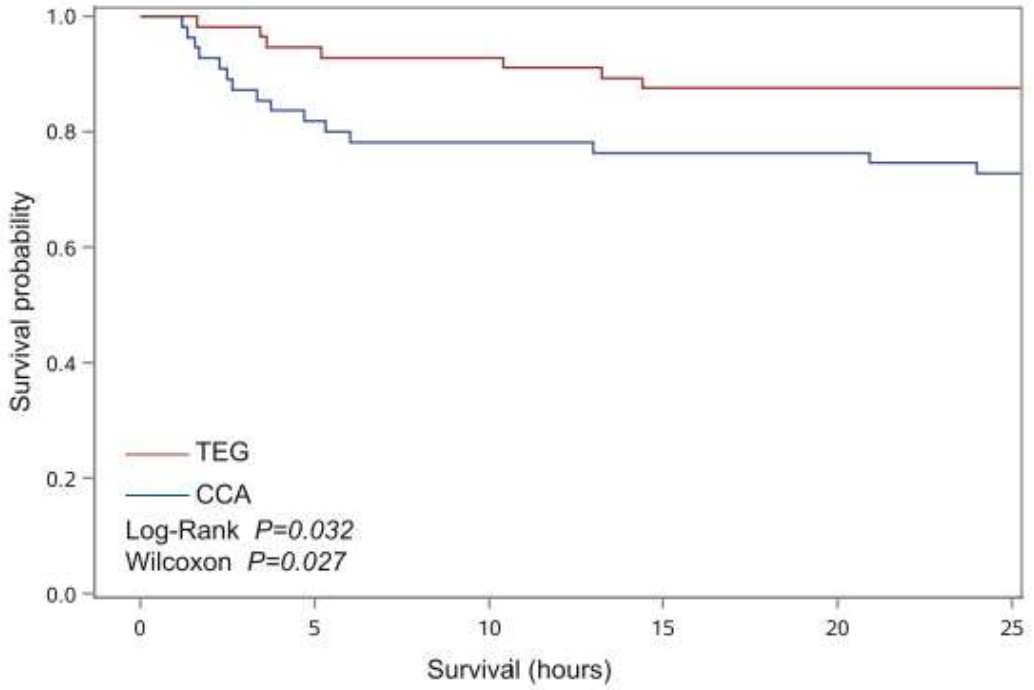
Fancy Glasses





Does it Work?

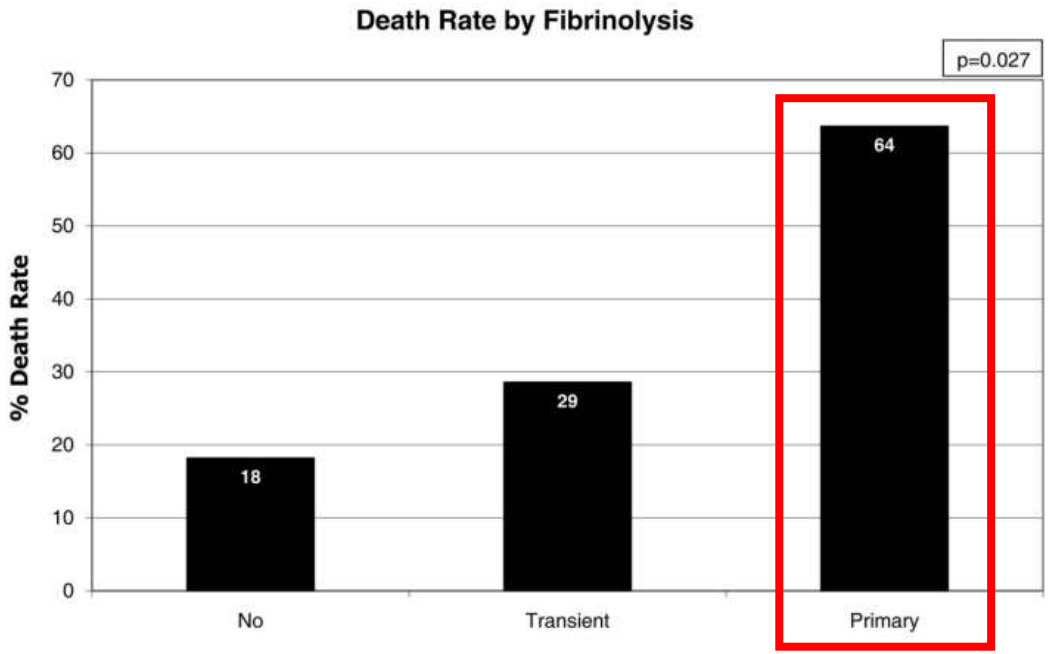
- Goal-directed Hemostatic Resuscitation of Trauma-induced Coagulopathy[5]



50% reduced mortality

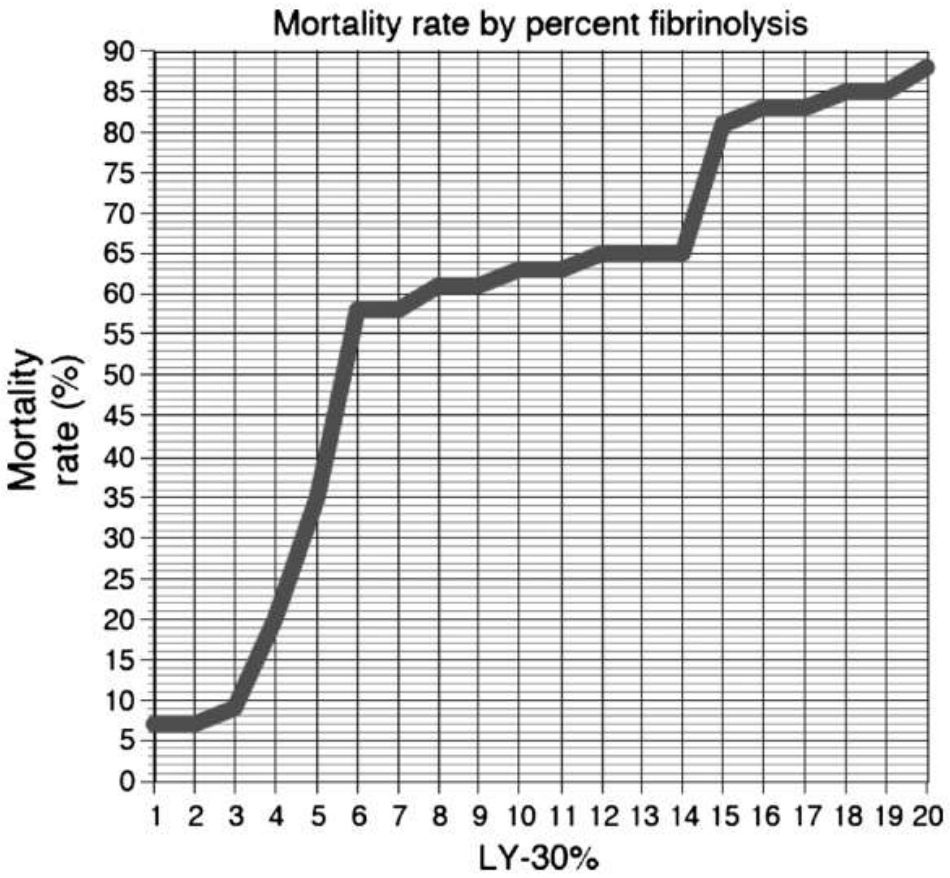
Primary Fibrinolysis in Trauma

- Kashuk, et al, Annals of Surg, 2010[6]
- Primary Fibrinolysis – 34% of patients who required MTP

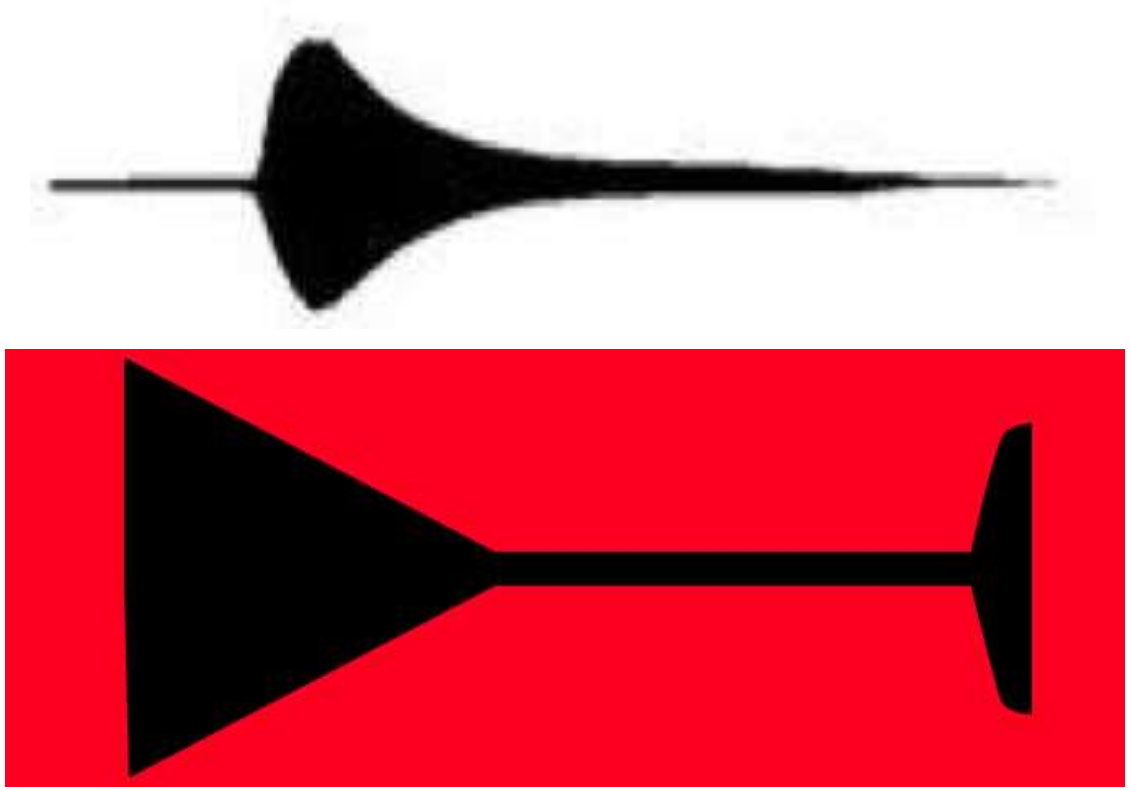


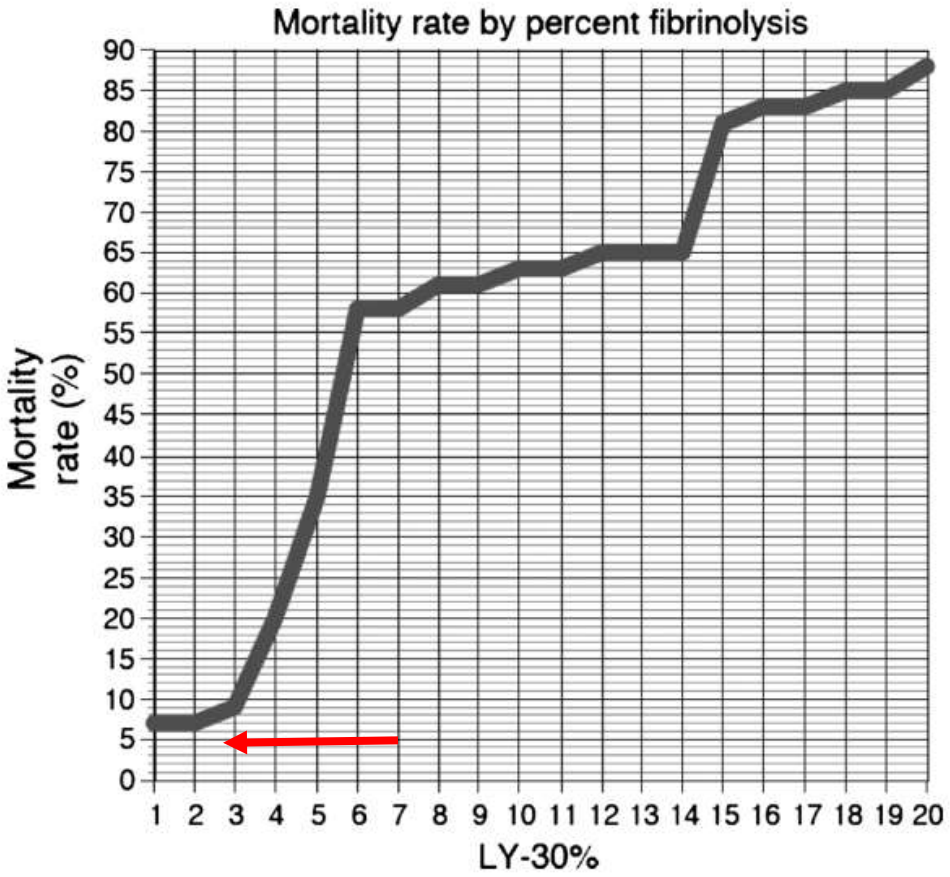
Hyperfibrinolysis

- Cotton, J Trauma Acute Care Surg[7]
- Hyperfibrinolysis = ~2%
- Each 1L of crystalloid – 15% increased odds of hyperfibrinolysis

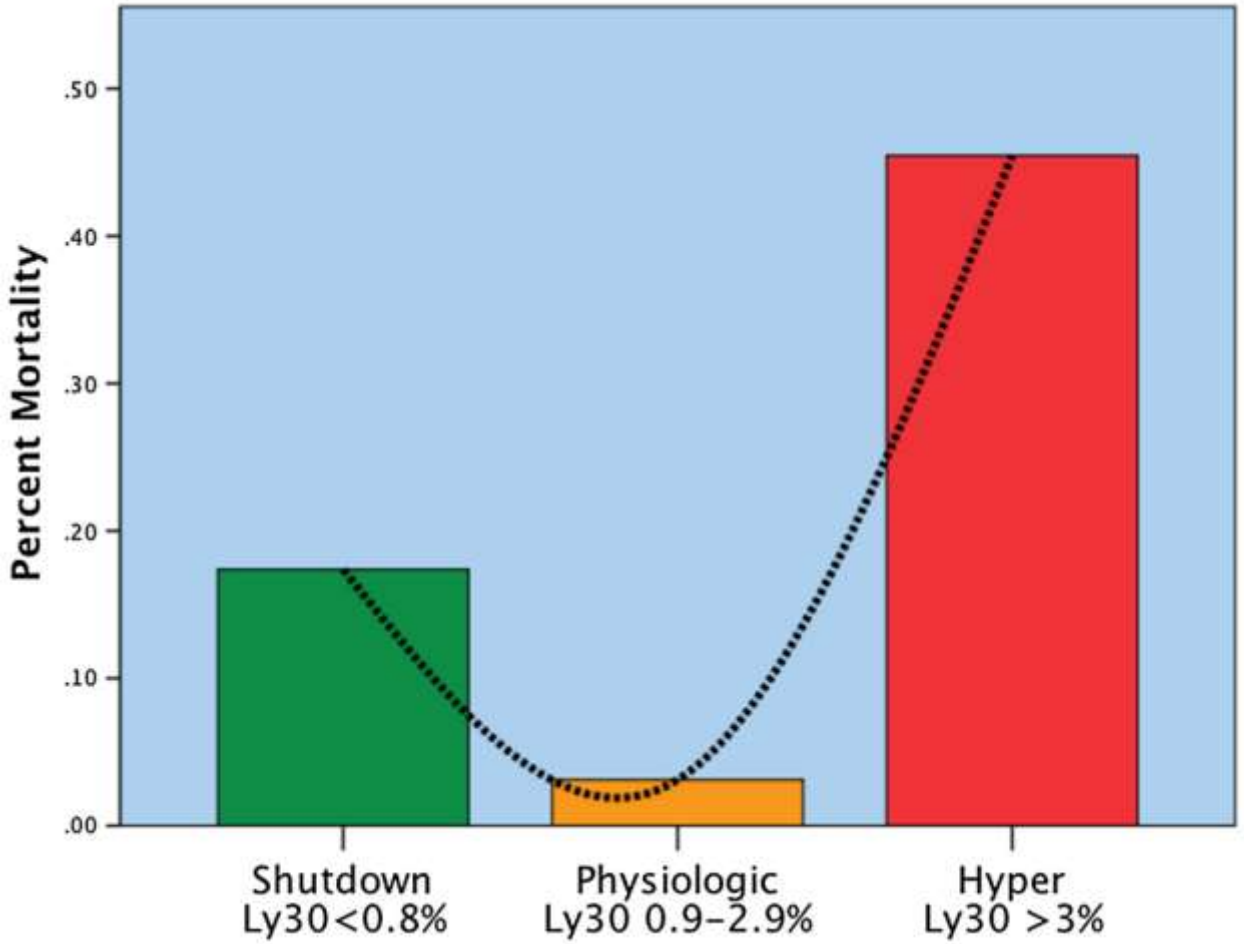


Hyperfibrinolysis



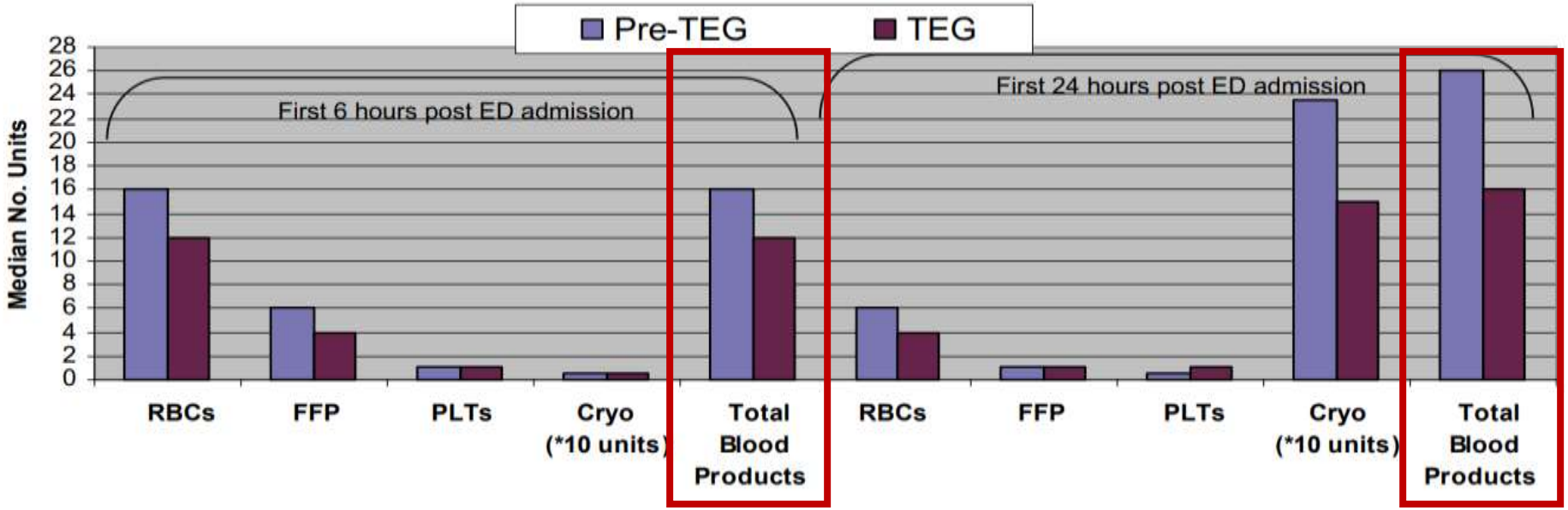


Fibrinolysis and Mortality



Improved Blood Product Use

- Kashuk, Transfusion, 2011[9]
- More efficient transfusion management?



What Have We Learned?

- Many trauma patients ARRIVE to the ED coagulopathic
- Damage Control Resuscitation
- Thromboelastography: bedside application for better trauma care

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