MODERN MANAGEMENT OF MAJOR HAEMORRHAGE

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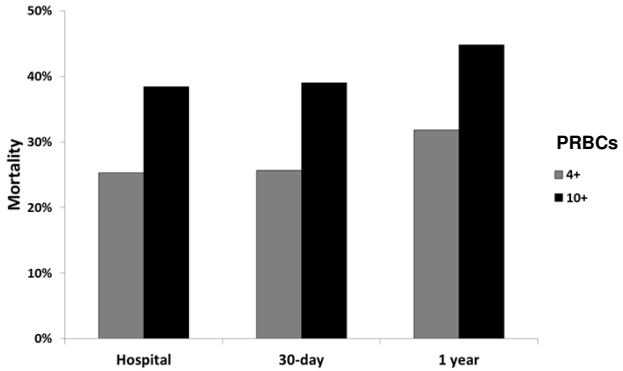
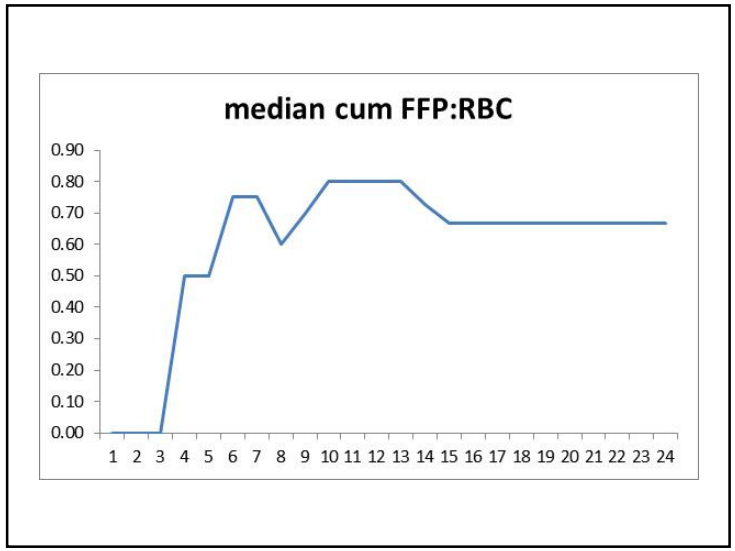
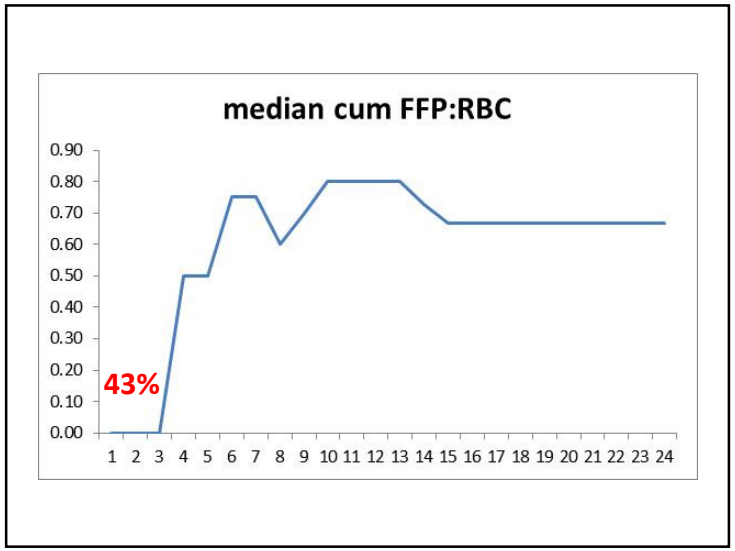
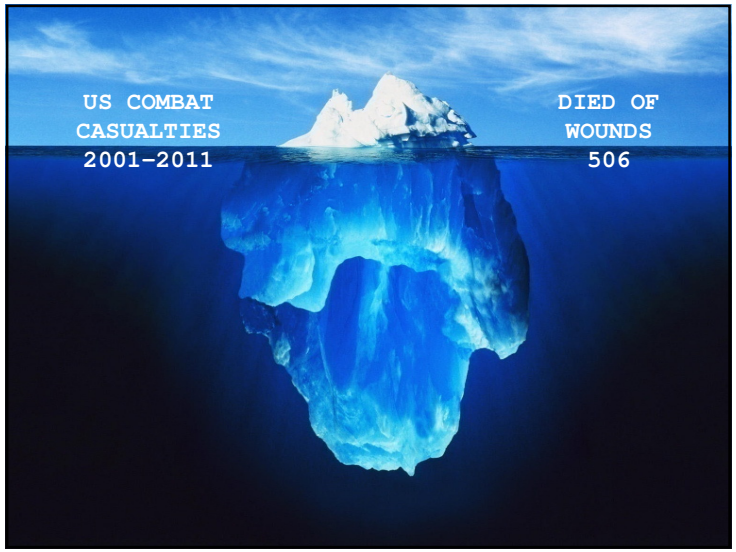
Royal London Major Trauma Centre
Barts Health NHS Trust

UK National Trauma Haemorrhage Mortality Rates




median cum FFP:RBC
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


median cum FFP:RBC
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
43%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


US COMBAT CASUALTIES 2001–2011
DIED OF WOUNDS 506


US COMBAT CASUALTIES 2001–2011
DIED OF WOUNDS 506
KILLED IN ACTION 4090
PREVENTABLE 1075
HEMORRHAGE 92%

HAEMOSTATIC Resuscitation

1. Early haemorrhage control
2. Permissive hypotension
3. Limit fluid infusions (dilution)
4. Target coagulopathy

HAEMOSTATIC Resuscitation

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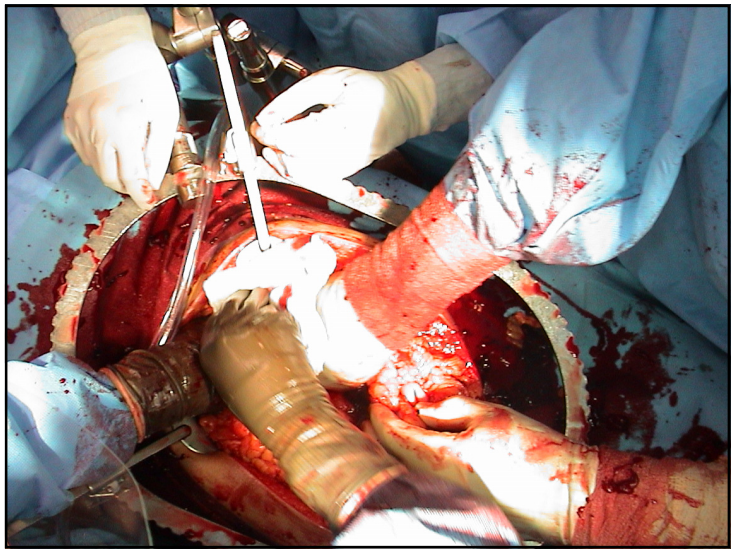
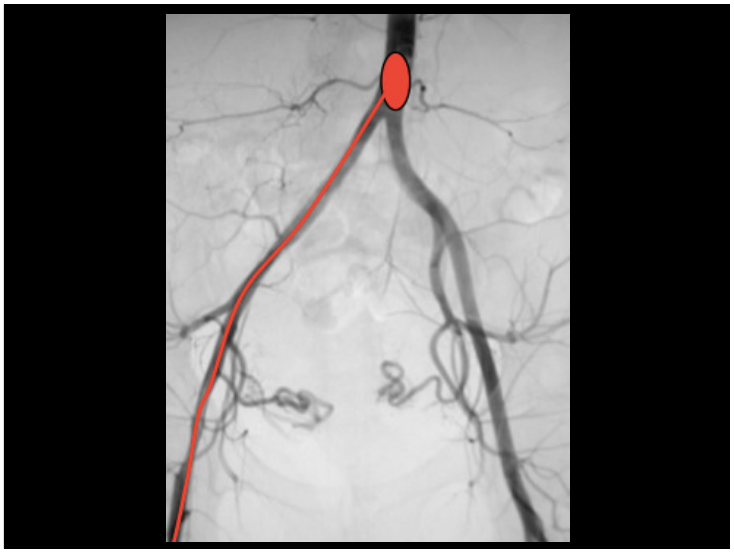
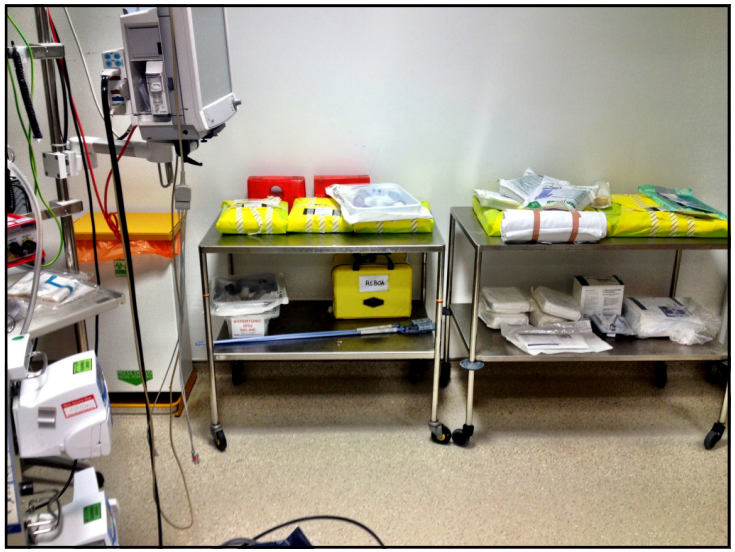



COMBAT
GAUZE

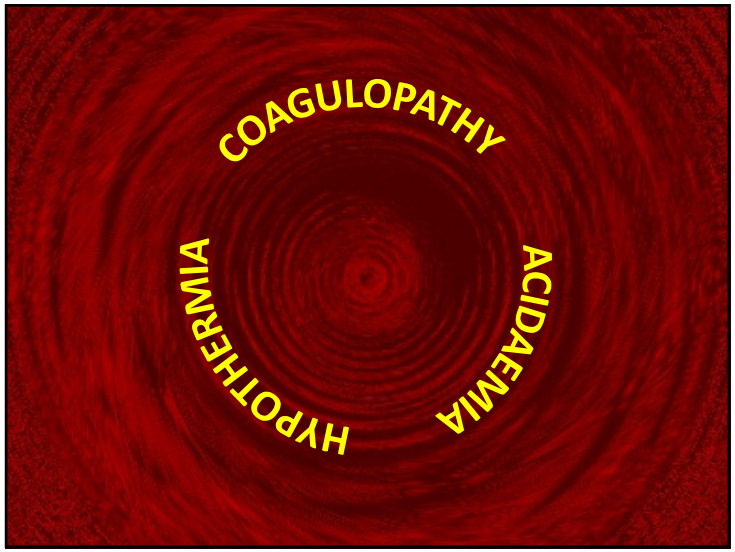

MED

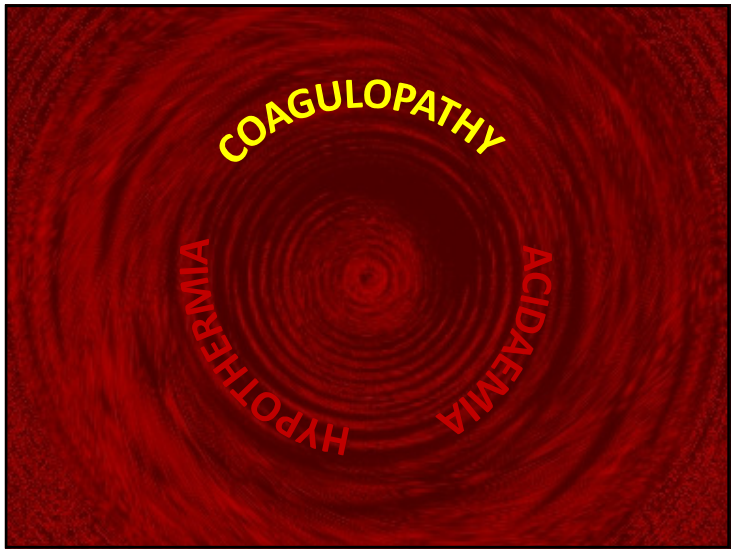


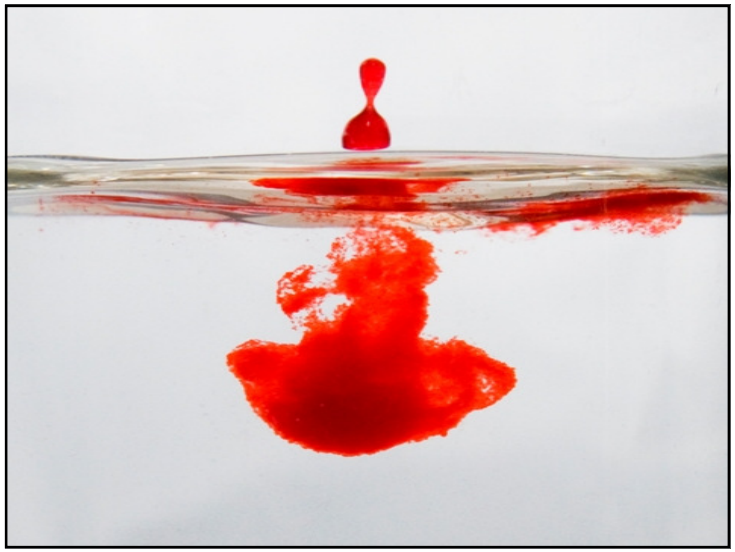


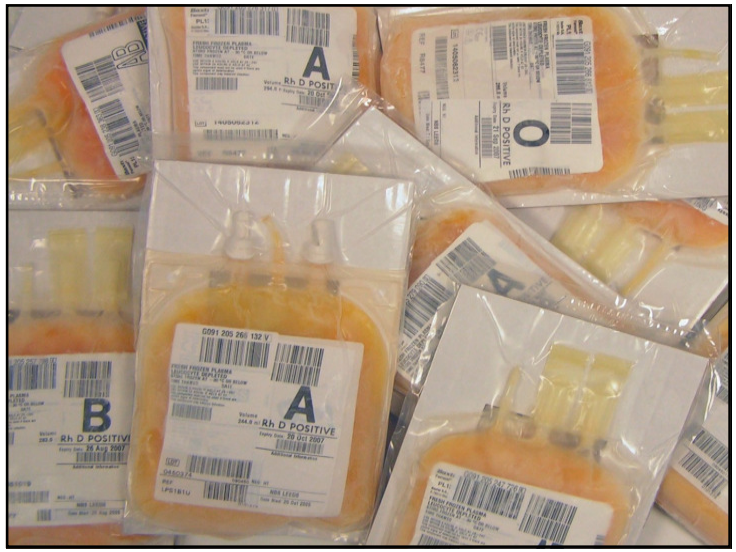
HAEMOSTATIC Resuscitation

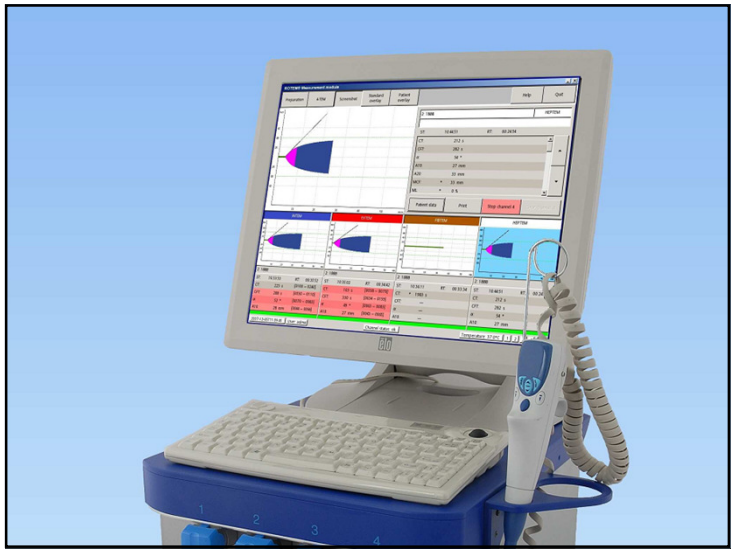
1. Early haemorrhage control (DCS)
2. Permissive hypotension
3. Limit fluid infusions (dilution)
4. Target coagulopathy



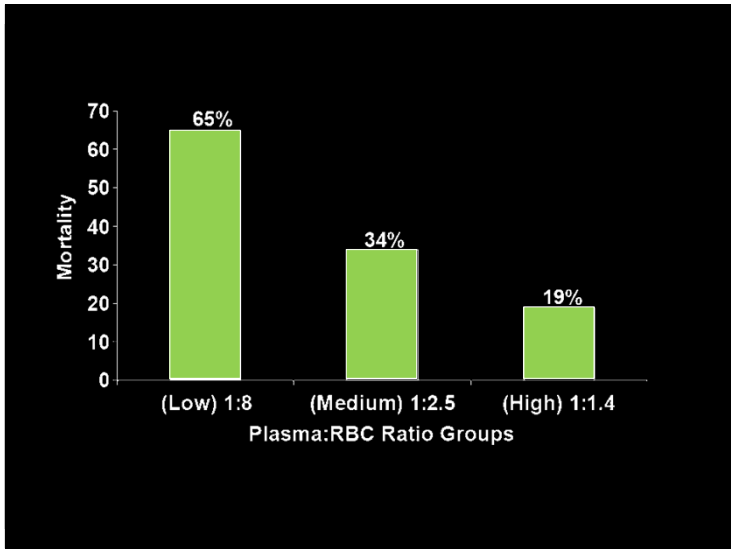





A
Rh D POSITIVE
O
Rh D POSITIVE
B
Rh D POSITIVE
A
Rh D POSITIVE




A
O
B
A


Mortality
70
60
50
40
30
20
10
0
65%
34%
19%
(Low) 1:8
(Medium) 1:2.5
(High) 1:1.4
Plasma:RBC Ratio Groups

Barts and The London NHS
NHS Trust

CODE RED TRAUMA - MAJOR HAEMORRHAGE

SENIOR MEMBER OF TRAUMA TEAM LEADER MUST DECLARE CODE RED if:
- Systolic BP < 90
- Poor response to initial fluid resuscitation
- Suspected active haemorrhage

↓

Take baseline blood samples prior to transfusion for:
- FBC, G&S, clotting screen and fibrinogen
- Near patient testing – ABG, FBC and ROTEM

↓

Nominate a member of team to call blood bank on 61108 to activate CODE RED
- State "patient unique identifier & CODE RED TRAUMA"
- Request:
  EITHER "CODE RED PACK A" (contains: 6 units RBC, 4 units FFP)
  OR
  "CODE RED PACK B" (contains: 6 units RBC, 4 units FFP, 1 unit platelets, 2 pools cryoprecipitate)
- Send porter to lab to collect pack immediately

Take Immediate Blood Transfusion (red cells) from RESUS fridge
- Use O NEG units in females or O POS units in males
- Use group specific blood as soon as available

Check Ca++ levels after 6 units of RBC

↓

Check if bolus dose of Tranexamic acid (TxA) has been given by HEMS team prior to arrival in ED
- Give bolus of 1g IV TxA over 10min (within 3 hrs of massive haemorrhage) followed by IV infusion of 1g over 8 hrs

↓

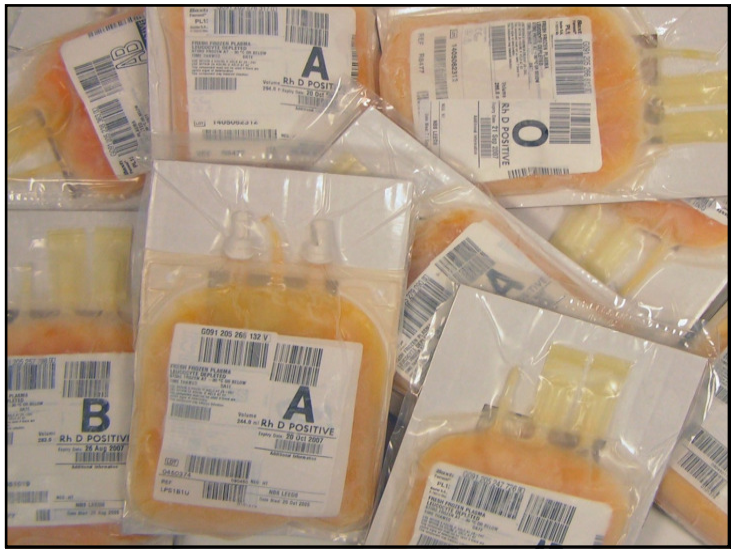
IF BLEEDING CONTINUES:
- Continue requesting one "CODE RED PACK B" until bleeding stops
- Use near patient testing to determine if Ca^{++} therapy is required ($CaCl_2$ 10 mls 10% IV)

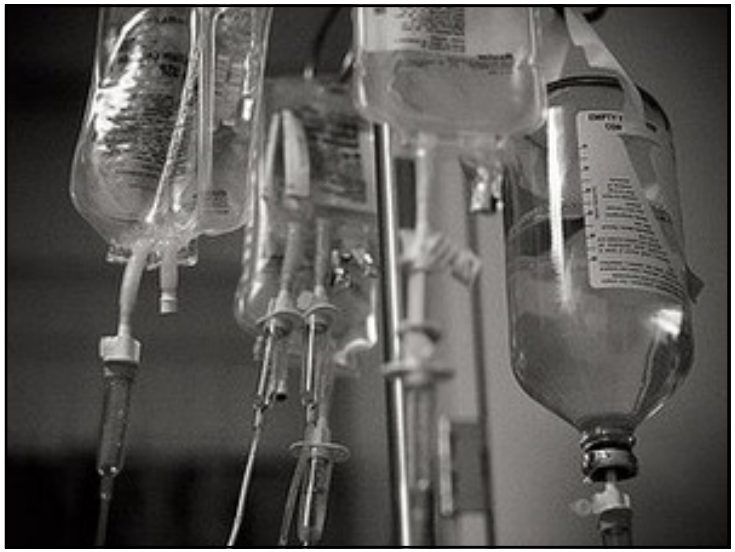
↓

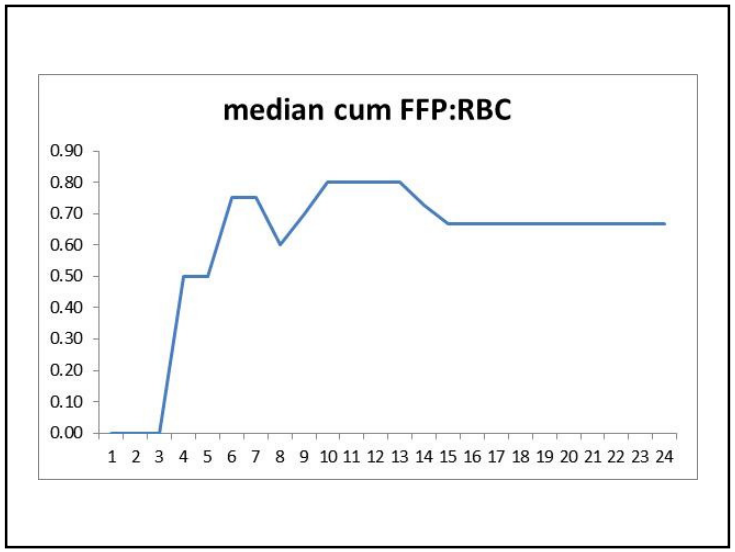
If bleeding persists after 2 x CODE RED PACK B
Transfusion Lab must contact the on call haemophilia SpR on bleep 1155 or via switchboard out of hours

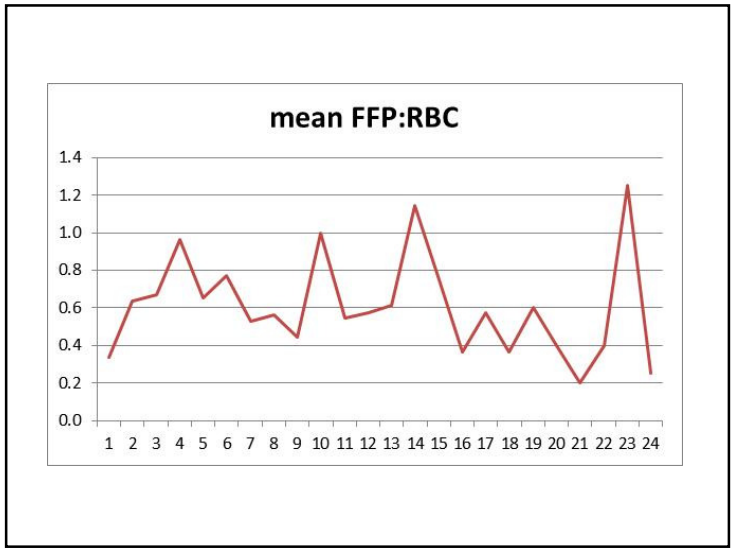
If bleeding is controlled REPEAT FBC AND CLOTTING SCREEN and administer:
- Platelets: if count <100x10⁹/l
- Cryoprecipitate: if Fibrinogen <1.5g/l
- FFP: to maintain PT/APTT ratio >1.2x normal
- Keep Temp >36°C and Ca++ >1.0

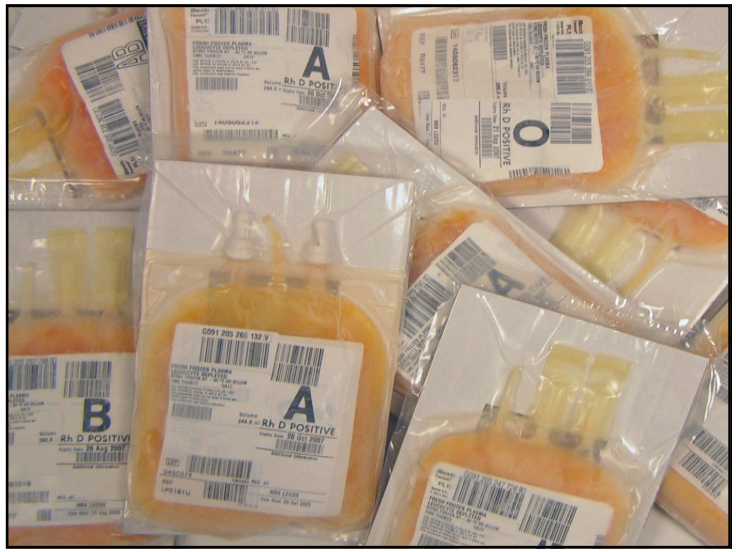
Revised in July 2011

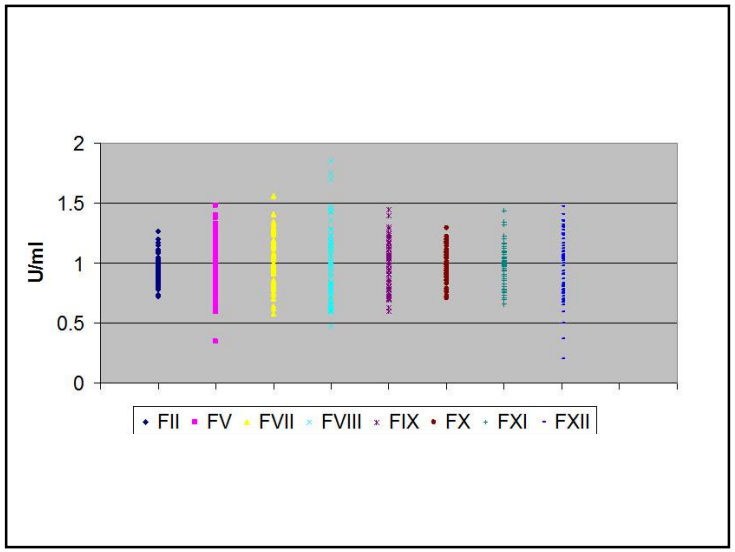


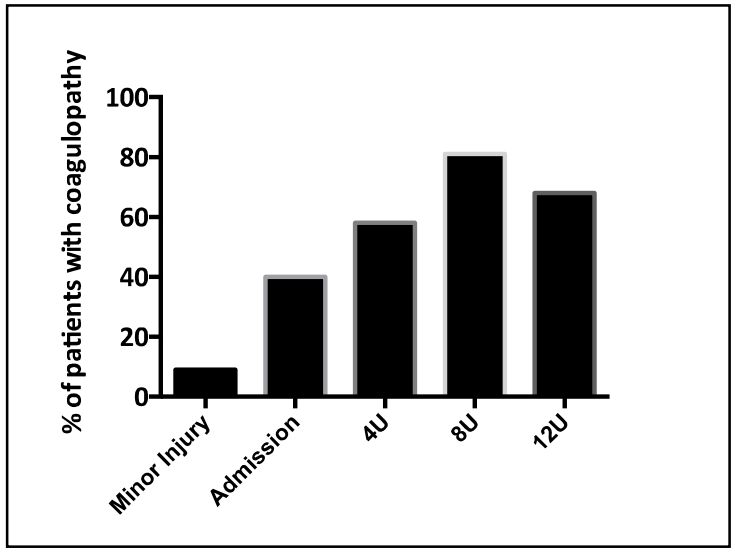


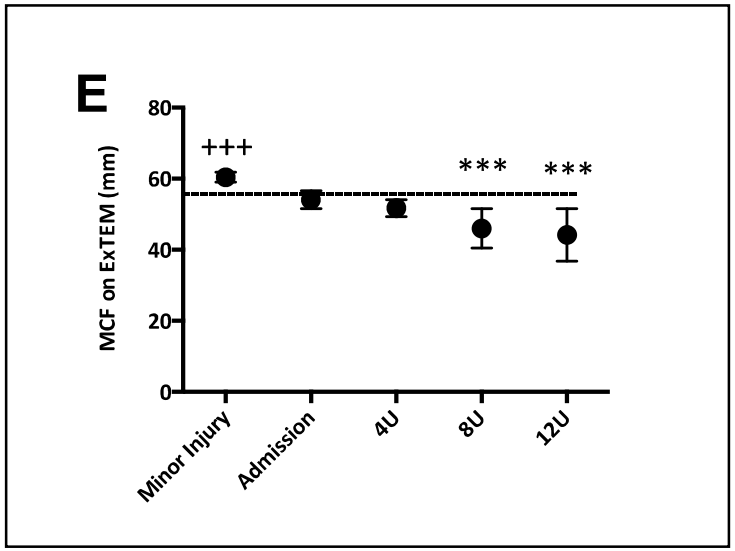


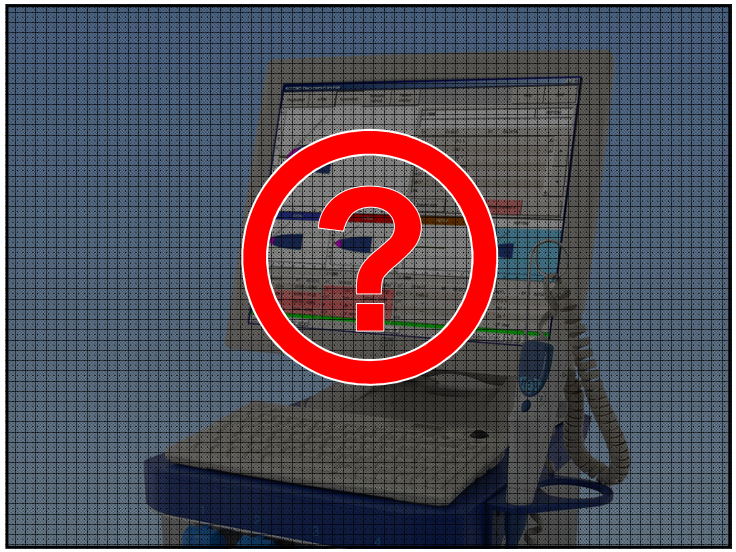

mean FFP:RBC
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

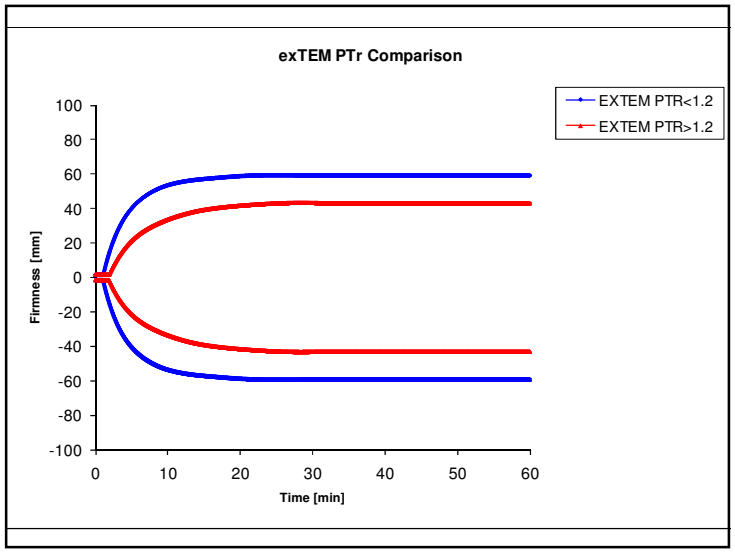

A
Rh D POSITIVE
O
Rh D POSITIVE
B
Rh D POSITIVE
A
Rh D POSITIVE

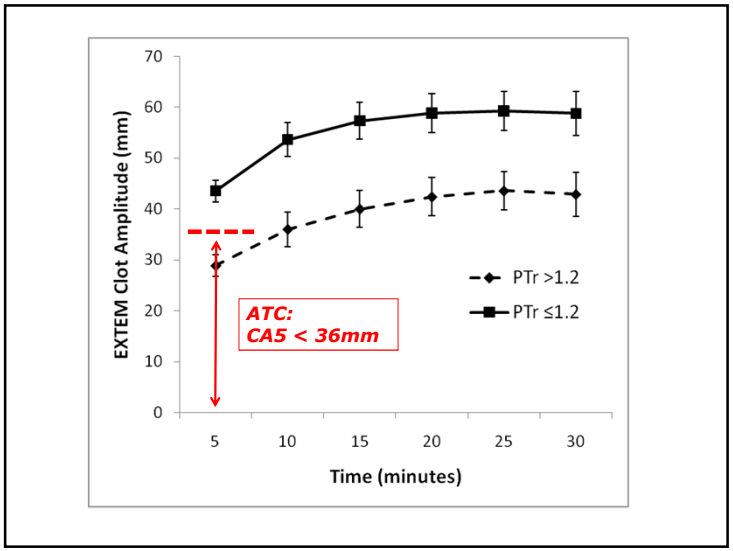

U/ml
2
1.5
1
0.5
0
FII FV FVII FVIII FIX FX FXI FXII

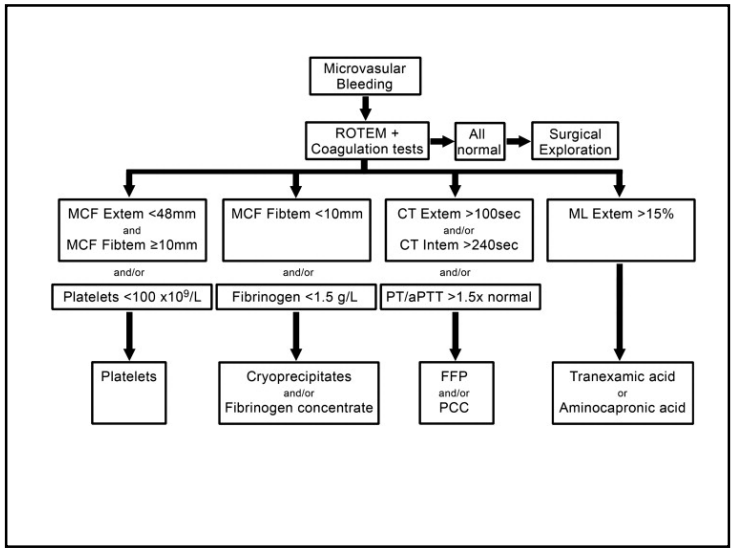

% of patients with coagulopathy
100
80
60
40
20
0
Minor Injury
Admission
4U
8U
12U

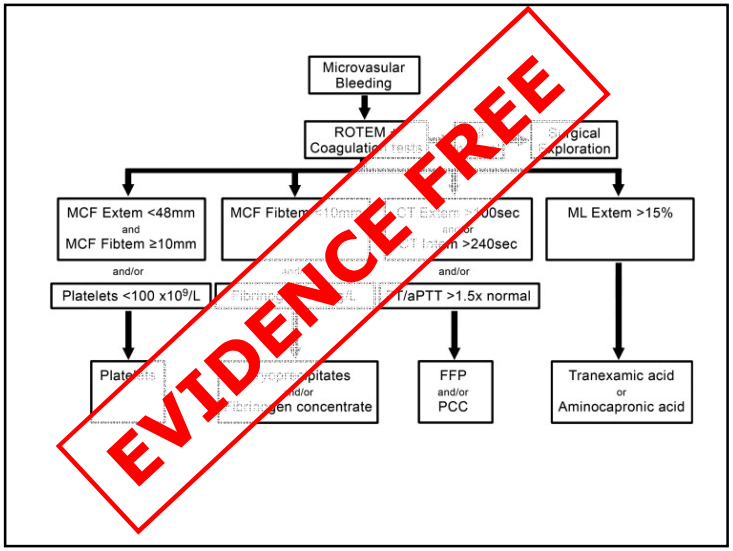

E
MCF on ExTEM (mm)
80
60
40
20
0
+++
***
***
Minor Injury
Admission
4U
8U
12U

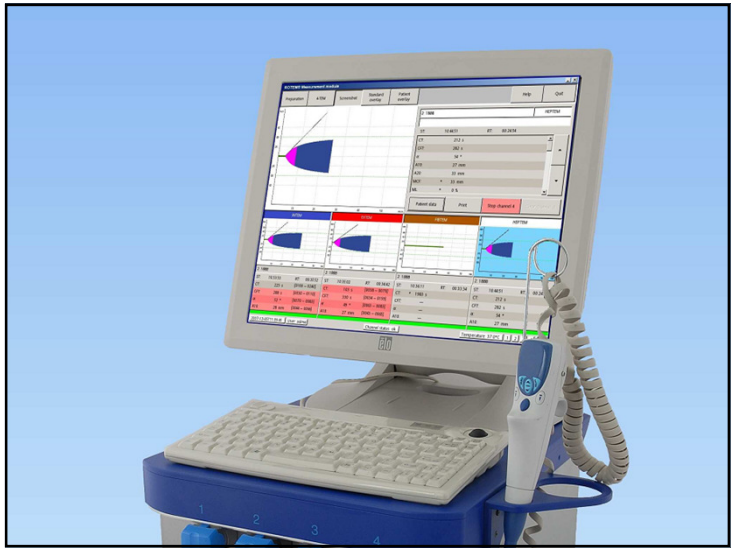


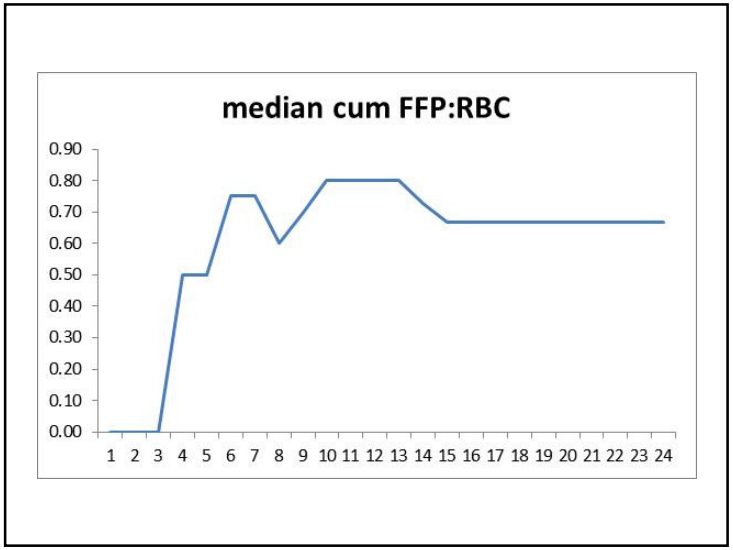

exTEM PTr Comparison
EXTEM PTR<1.2
EXTEM PTR>1.2
Firmness [mm]
100
80
60
40
20
0
-20
-40
-60
-80
-100
0
10
20
30
40
50
60
Time [min]

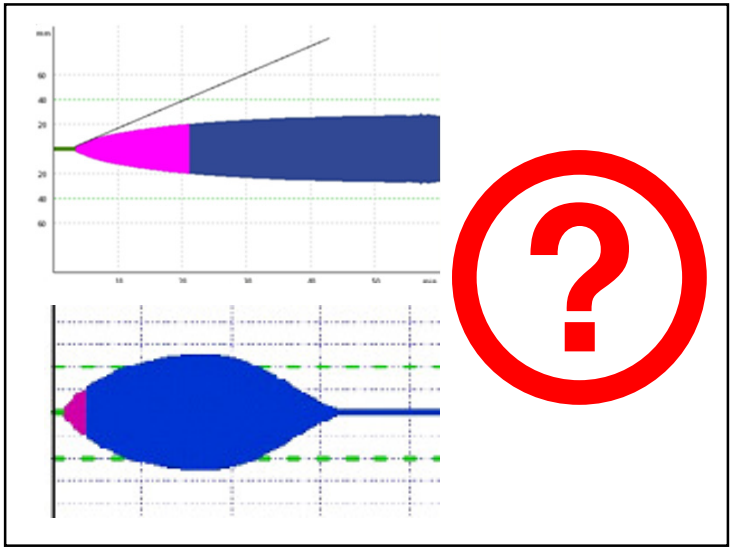

EXTEM Clot Amplitude (mm)
70
60
50
40
30
20
10
0
5
10
15
20
25
30
Time (minutes)
PTr >1.2
PTr ≤1.2
ATC:
CA5 < 36mm

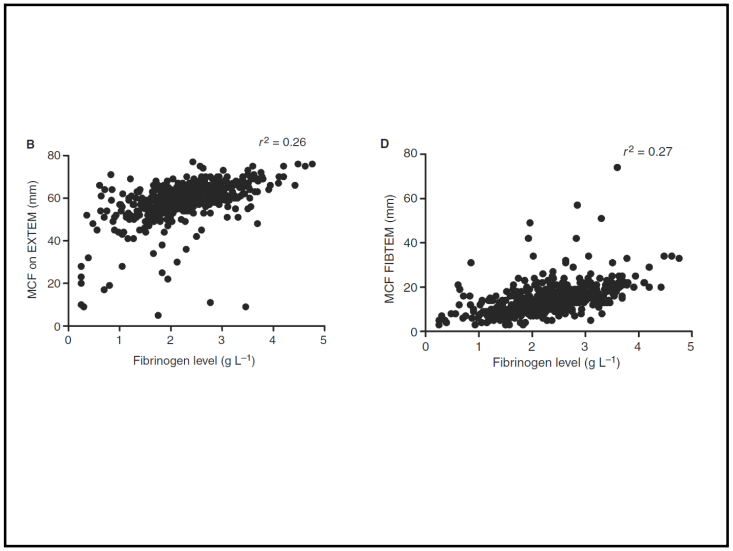

Microvasular Bleeding
ROTEM + Coagulation tests
All normal
Surgical Exploration
MCF Extem <48mm and MCF Fibtem ≥10mm
MCF Fibtem <10mm
CT Extem >100sec and/or CT Intem >240sec
ML Extem >15%
and/or
and/or
and/or
Platelets <100 x10⁹/L
Fibrinogen <1.5 g/L
PT/aPTT >1.5x normal
Platelets
Cryoprecipitates and/or Fibrinogen concentrate
FFP and/or PCC
Tranexamic acid or Aminocapronic acid

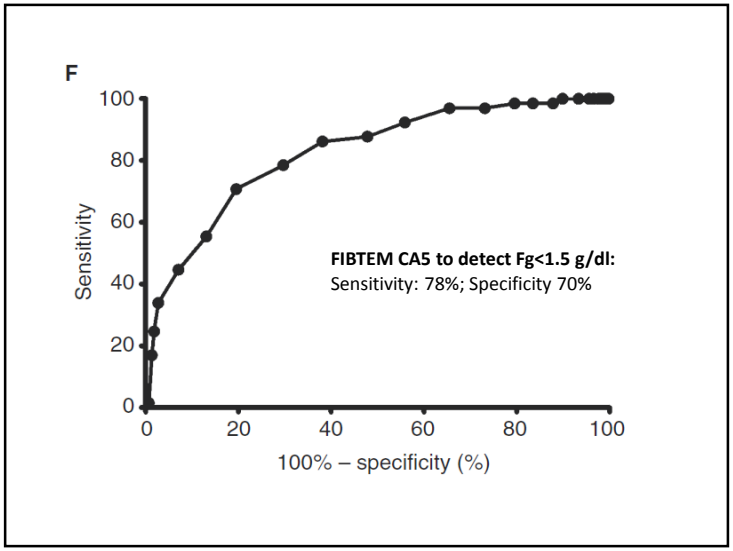

Microvasular Bleeding
MCF Extem <48mm and MCF Fibtem ≥10mm
ML Extem >15%
and/or
Platelets <100 x10⁹/L
FFP and/or PCC
Tranexamic acid or Aminocapronic acid
EVIDENCE FREE

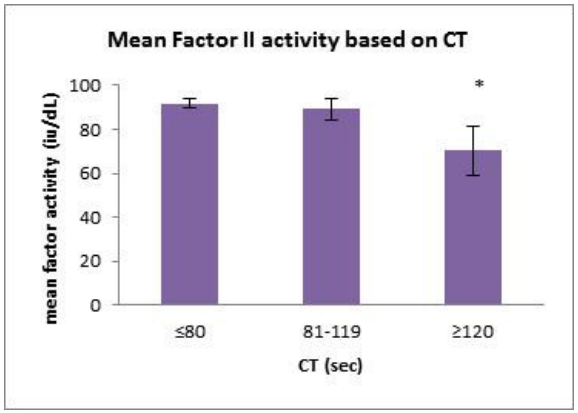


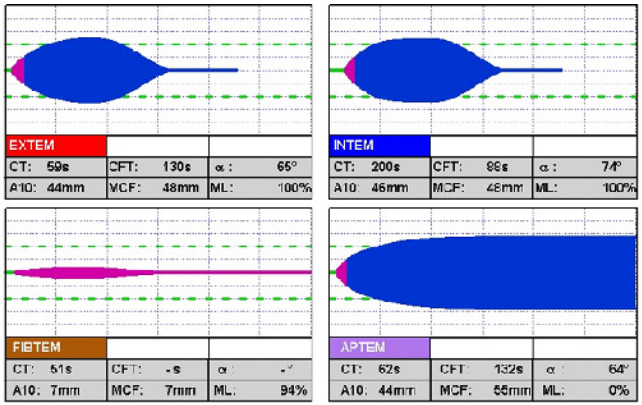

median cum FFP:RBC
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24




B
r^2 = 0.26
MCF on EXTEM (mm)
Fibrinogen level (g L^{-1})
D
r^2 = 0.27
MCF FIBTEM (mm)
Fibrinogen level (g L^{-1})


F
Sensitivity
100% – specificity (%)
FIBTEM CA5 to detect Fg<1.5 g/dl:
Sensitivity: 78%; Specificity 70%





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BJA

Evaluation of rotation thrombelastography for the diagnosis of hyperfibrinolysis in trauma patients

A. Levrat[2], A. Gros[2], L. Rugeri[3], K. Inaba[4], B. Floccard[2], C. Negrier[3] and J.-S. David[1]*

[1]*Department of Anesthesiology and Critical Care, Lyon-Sud Hospital, Hospices Civils de Lyon and*

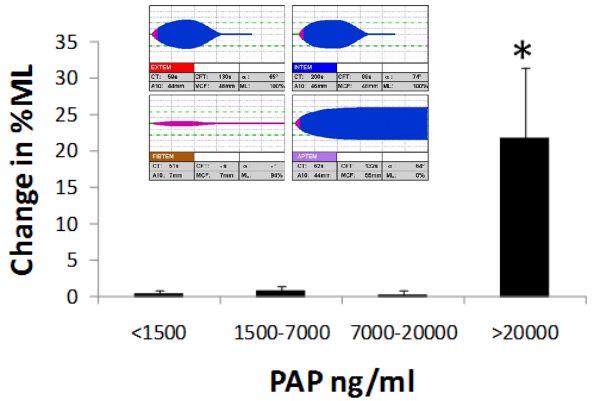
6% hyperfibrinolysis
100% mortality

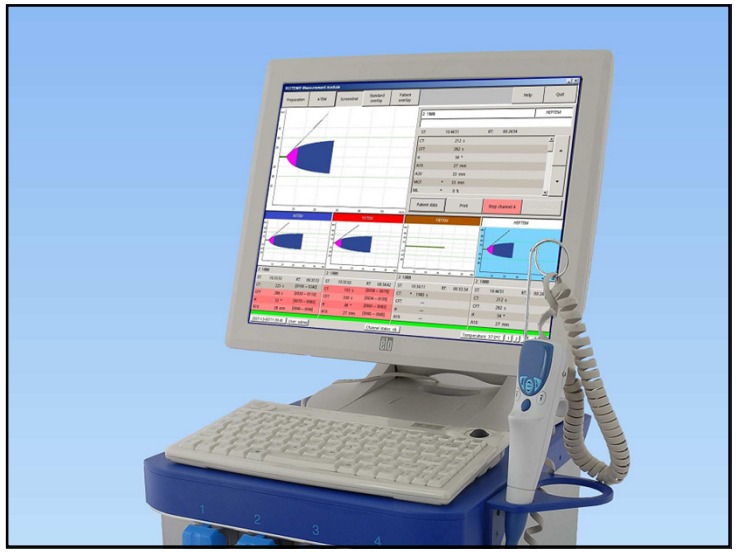
of hyperfibrinolysis with rotation thrombelastography (ROTEM®) may be beneficial.

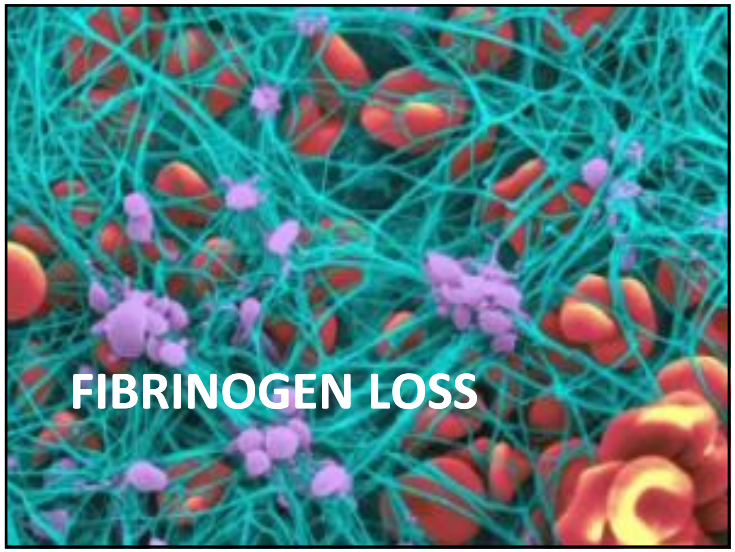
Methods. Eighty-seven trauma patients were included in this prospective observational study. Blood samples were collected at admission. After *in vitro* activation with tissue factor (EXTEM) and inhibition with aprotinin (APTEM), ROTEM® parameters including maximal clot firmness (MCF) and clot lysis index at 30 min (CLI_{30}) were determined. Hyperfibrinolysis was defined as a euglobulin lysis time (ELT) <90 min. Threshold for ROTEM® parameters were determined with receiver-operating characteristic curves (ROC) analysis according to the ELT results.

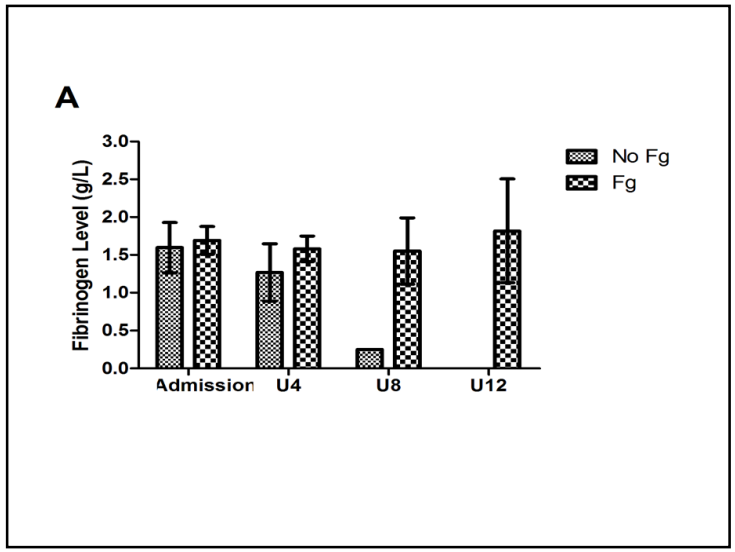
Results. ELT was determined in a subgroup of 23 patients. In this group of patients, ROC analysis showed that for a threshold of 18 mm (MCF-EXTEM), 71% (CLI_{30}) and 7% (increase of MCF-APTEM), sensitivity was, respectively, 100%, 75%, and 80% with a specificity of 100%. With the application of these thresholds to the whole trauma cohort, ROTEM® analysis detected hyperfibrinolysis in five patients [6%, 95% confidence interval (CI): 2–13%]. As expected, patients with hyperfibrinolysis were more severely injured (median Injury Severity Score: 75 *vs* 20, $P<0.05$), had greater coagulation abnormalities [international normalized ratio (INR): 8.2 *vs* 1.3, $P<0.05$; fibrinogen: 0.0 *vs* 2.2 g $litre^{-1}$, $P<0.05$], and a higher mortality rate (100%, CI: 48–100% *vs* 11% CI: 5–20%, $P<0.05$).

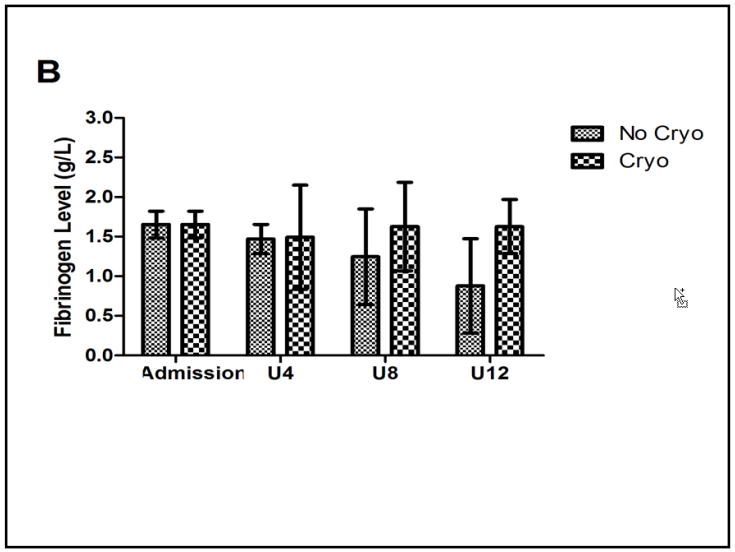
Conclusions. ROTEM® provided rapid and accurate detection of hyperfibrinolysis in severely injured trauma patients.

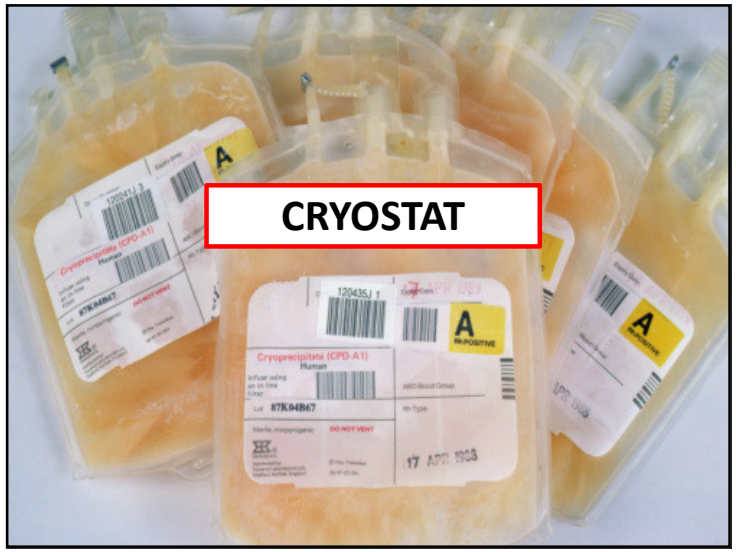


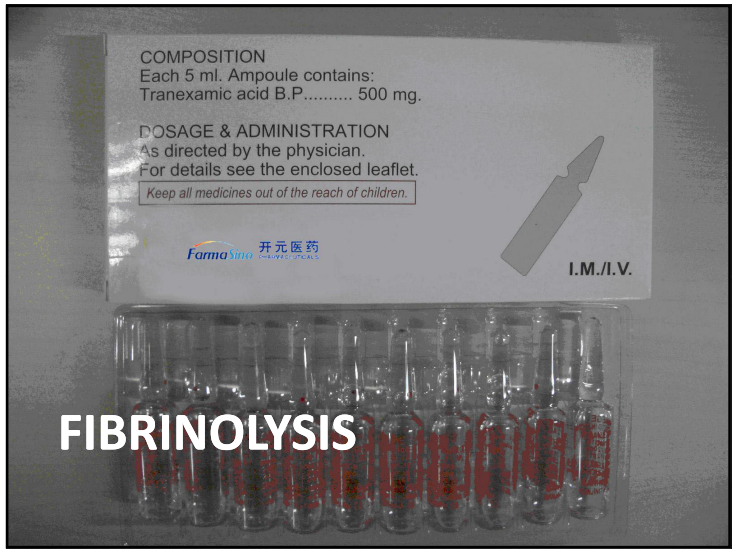


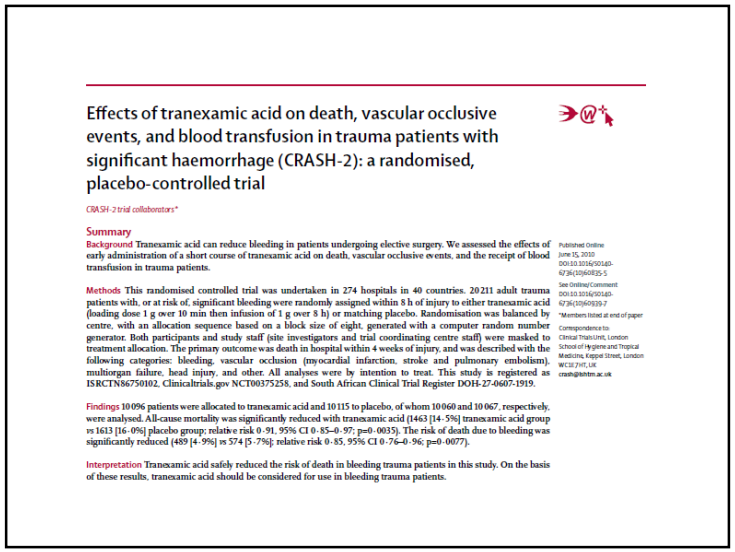

FIBRINOGEN LOSS


A
Fibrinogen Level (g/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Admission
U4
U8
U12
No Fg
Fg


B
Fibrinogen Level (g/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Admission
U4
U8
U12
No Cryo
Cryo







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

CRASH-2 trial collaborators*

Summary

Background Tranexamic acid can reduce bleeding in patients undergoing elective surgery. We assessed the effects of early administration of a short course of tranexamic acid on death, vascular occlusive events, and the receipt of blood transfusion in trauma patients.

Methods This randomised controlled trial was undertaken in 274 hospitals in 40 countries. 20 211 adult trauma patients with, or at risk of, significant bleeding were randomly assigned within 8 h of injury to either tranexamic acid (loading dose 1 g over 10 min then infusion of 1 g over 8 h) or matching placebo. Randomisation was balanced by centre, with an allocation sequence based on a block size of eight, generated with a computer random number generator. Both participants and study staff (site investigators and trial coordinating centre staff) were masked to treatment allocation. The primary outcome was death in hospital within 4 weeks of injury, and was described with the following categories: bleeding, vascular occlusion (myocardial infarction, stroke and pulmonary embolism), multiorgan failure, head injury, and other. All analyses were by intention to treat. This study is registered as ISRCTN86750102, Clinicaltrials.gov NCT00375258, and South African Clinical Trial Register DOH-27-0607-1919.

Findings 10 096 patients were allocated to tranexamic acid and 10 115 to placebo, of whom 10 060 and 10 067, respectively, were analysed. All-cause mortality was significantly reduced with tranexamic acid (1463 [14·5%] tranexamic acid group *vs* 1613 [16·0%] placebo group; relative risk 0·91, 95% CI 0·85–0·97; p=0·0035). The risk of death due to bleeding was significantly reduced (489 [4·9%] *vs* 574 [5·7%]; relative risk 0·85, 95% CI 0·76–0·96; p=0·0077).

Interpretation Tranexamic acid safely reduced the risk of death in bleeding trauma patients in this study. On the basis of these results, tranexamic acid should be considered for use in bleeding trauma patients.

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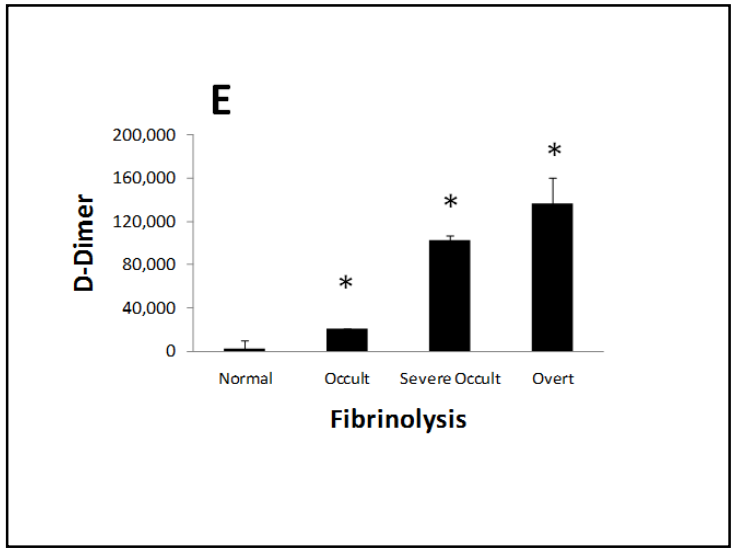

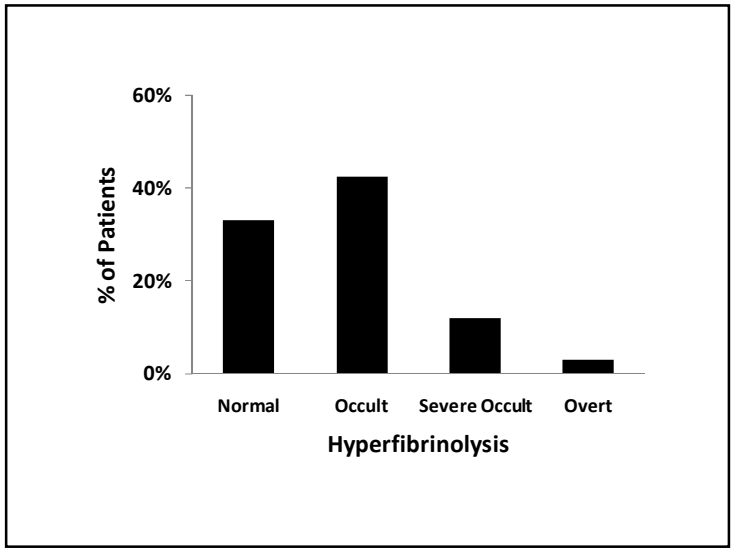

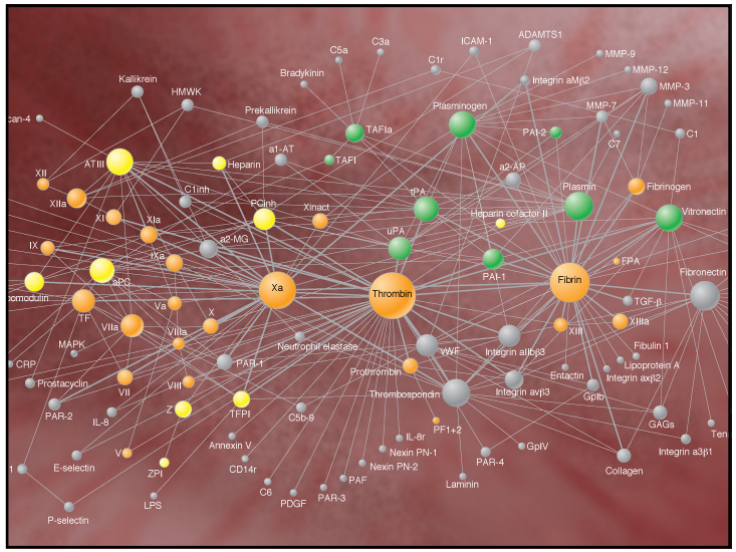

HAEMOSTATIC Resuscitation

1. Early haemorrhage control
2. Permissive hypotension
3. Limit fluid infusions (dilution)
4. Target coagulopathy

International Trauma Research Network

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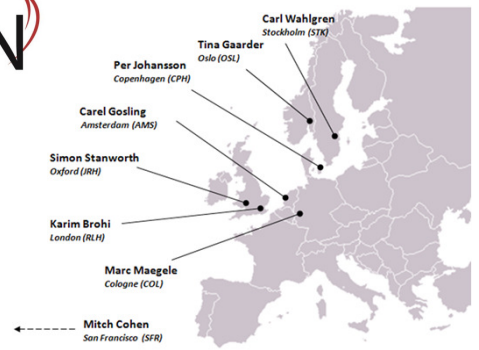

Targeted Action for Curing Trauma Induced Coagulopathy

TACTIC

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