TEG and ROTEM in TRAUMA

CONCORD performance improvement

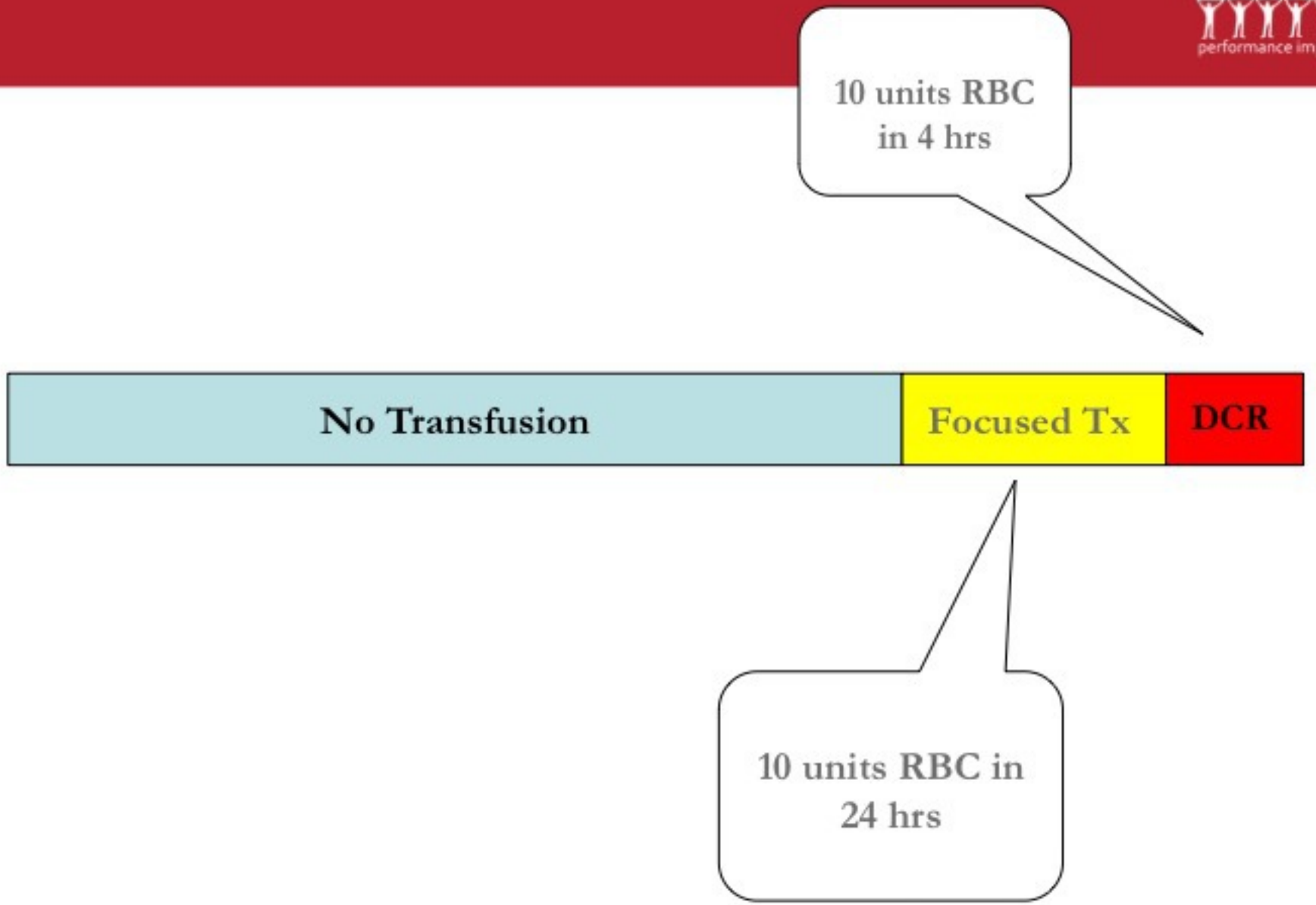
Kerry Gunn

Department of Anaesthesia and Perioperative Medicine

Auckland City Hospital

Summary

- A small proportion (4%) need an aggressive approach to transfusion
- Systems that include fibrinogen substrates *seem* to improve outcome
- The challenge is to develop systems that deliver fibrinogen rapidly enough to these patients
- TEG and ROTEM then can help us direct fibrinogen and drugs to the patients that need it
- Unless we include POC monitoring of coagulopathy we risk replacing exsanguination with thrombosis


10 units RBC
in 4 hrs
No Transfusion
Focused Tx
DCR
10 units RBC in
24 hrs

Traditional prerequisites before transfusion

Table 1. Investigations to be performed during massive transfusions

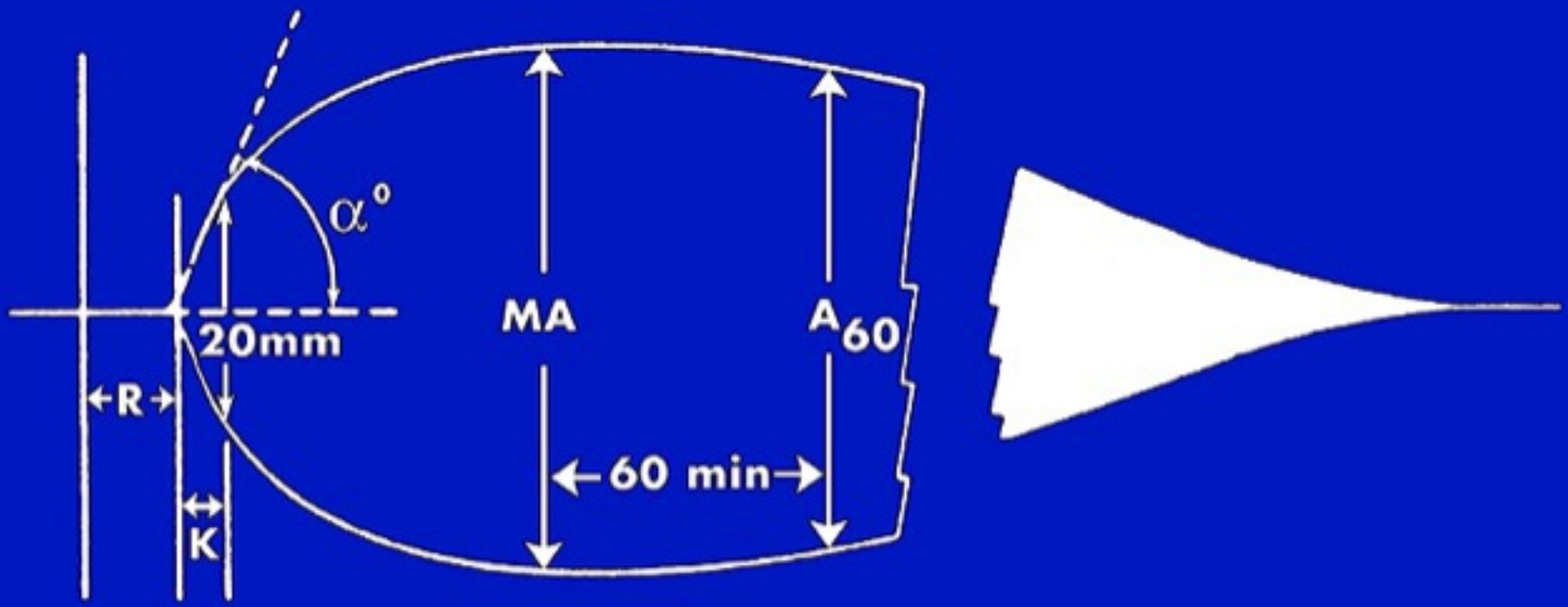
Investigation	Target value
Haemoglobin; haematocrit	10 g/dl; 0.32
Platelet count	$> 50 \times 10^9$/l
Prothrombin time	$< 1.5 \times$ control
Partial thromboplastin time	$< 1.5 \times$ control
Fibrinogen	> 0.8 g/l

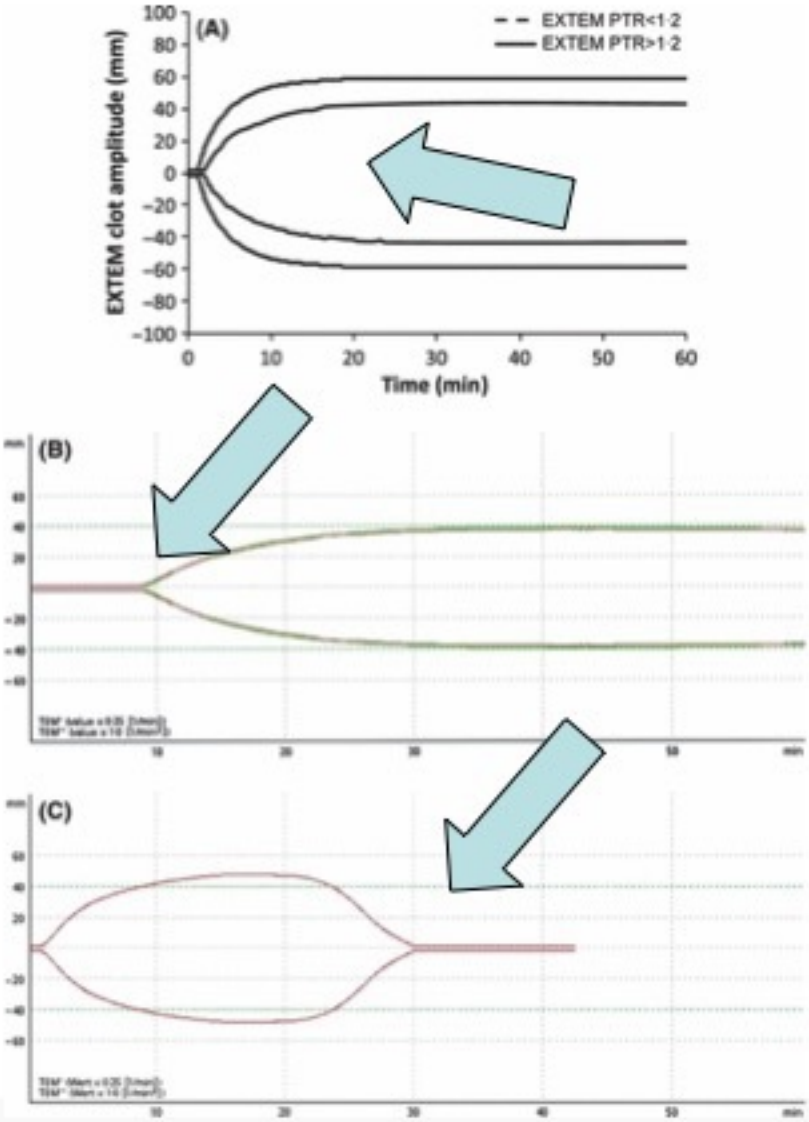
BSCH guidelines for massive transfusion 1998

Thromboelastography

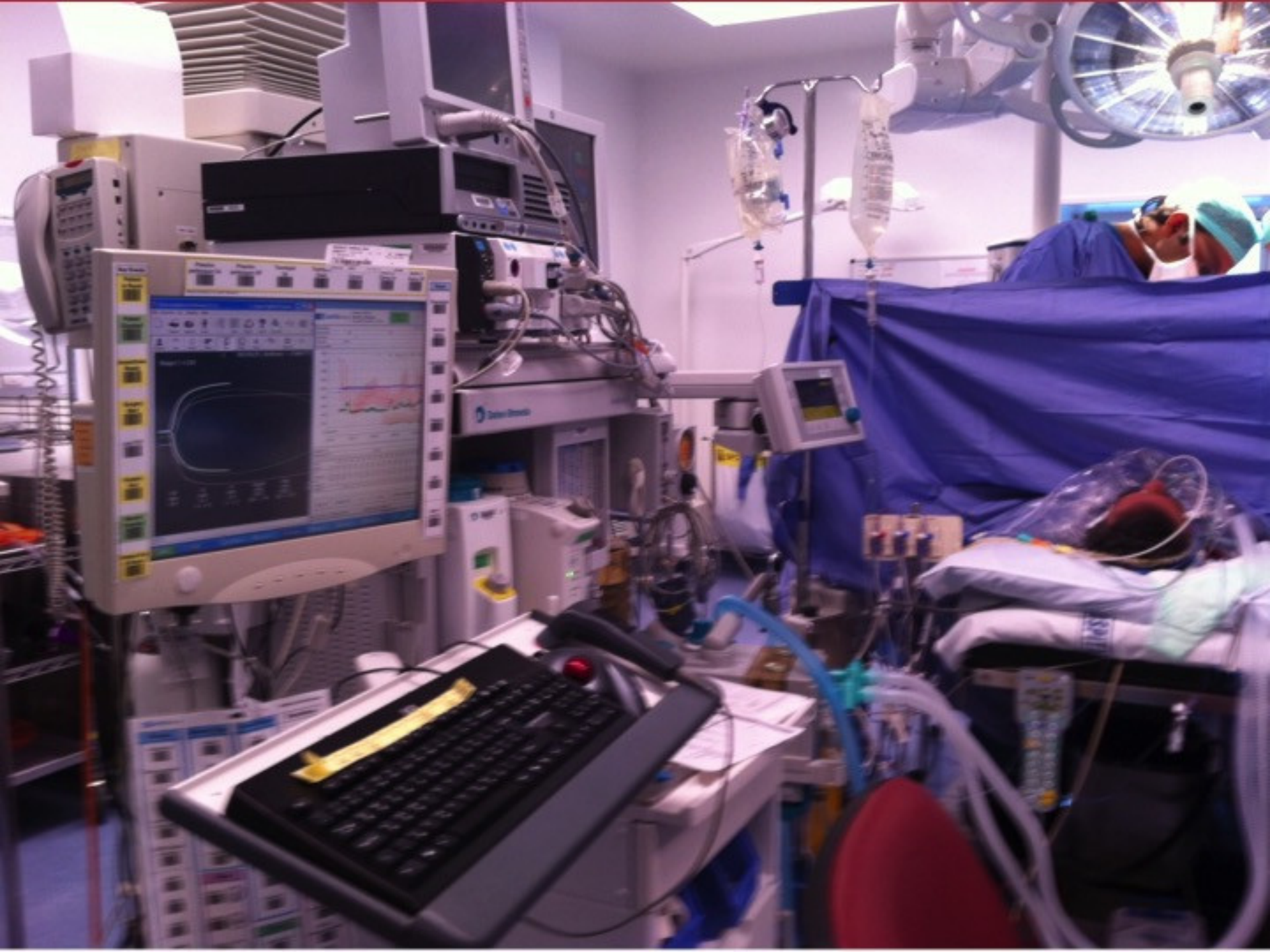
- measures viscoelastic properties
- incorporates input from clotting, platelets and fibrinolysis
- dynamic
- rapid results

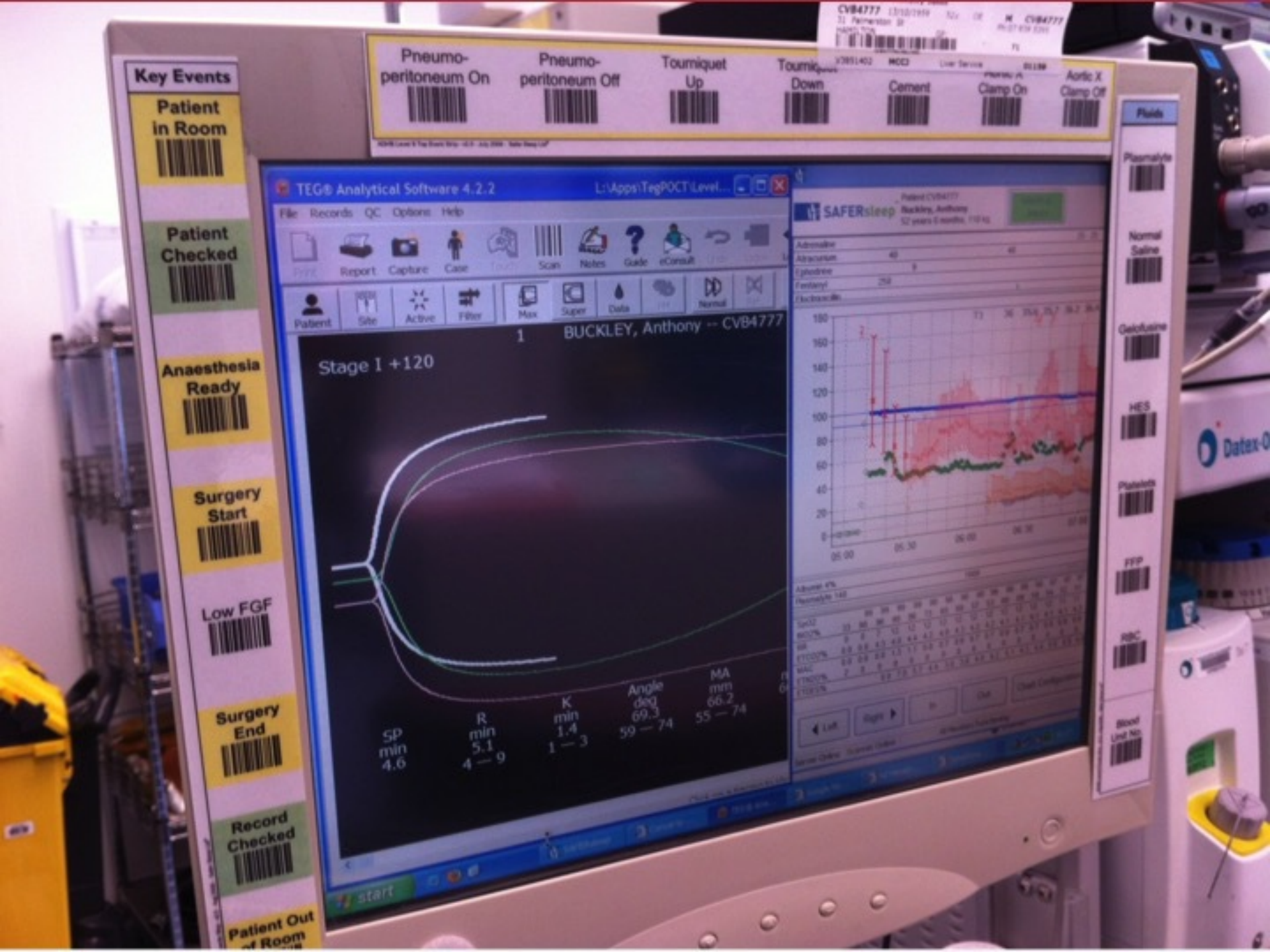
Schematic Diagram of Normal Thromboelastography Tracing




(A)
EXTEM PTR<1·2
EXTEM PTR>1·2
EXTEM clot amplitude (mm)
100
80
60
40
20
0
−20
−40
−60
−80
−100
0
10
20
30
40
50
60
Time (min)
(B)
(C)


ROTEM




Key Events
Patient in Room
Patient Checked
Anaesthesia Ready
Surgery Start
Low FGF
Surgery End
Record Checked
Patient Out
Pneumo-peritoneum On
Pneumo-peritoneum Off
Tourniquet Up
Tourniquet Down
Cement
Aortic X Clamp On
Aortic X Clamp Off
TEG® Analytical Software 4.2.2
File Records QC Options Help
Report Capture Case Scan Notes Guide eConsult
Patient Site Active Filter Max Super Data Normal
1 BUCKLEY, Anthony -- CVB4777
Stage I +120
SP min 4.6
R min 5.1 4 — 9
K min 1.4 1 — 3
Angle deg 69.3 59 — 74
MA mm 66.2 55 — 74
SAFERsleep
Fluids
Plasmalyte
Normal Saline
Gelofusine
HES
Platelets
FFP
RBC
Blood Unit No.
start

APPARATUS

Point-of-care testing Measurement of coagulation

CONCORD

Vox Sanguinis (2008) 95, 111–118

DOI: 10.1111/j.1423-0410.2008.01076.x

J. Hirsch,[1] T. Wendt,[1] P. Kuhly[2] and W. Schaffartzik[3]

1 Senior House Department of An the Free Universi

Can RapidTEG Accelerate the Search for Coagulopathies in the Patient With Multiple Injuries?

Victor Jeger, MS, Heinz Zimmermann, MD, and Aristomenis K. Exadaktylos, MD

Hypothesis: Early recognition of coagulopathy may improve the care of patients with multiple injuries. Rapid thrombelastography (RapidTEG) is a new variant of thromboelastography (TEG), in which coagulation is initiated by the addition of protein tissue factor. The kinetics of coagulation and the times of measurement were compared for two variants of TEG—RapidTEG and conventional TEG, in which coagulation was initiated with kaolin. The measurements were performed on blood samples from 20 patients with multiple injuries. The RapidTEG results were also compared with conventional measurements of blood coagulation. The mean time for the RapidTEG test was 19.2 ± 3.1 minutes (mean ± SD), in comparison with 28.9 ± 4.3 minutes for kaolin TEG and 34.1 ± 14.5 minutes for conventional coagulation tests. The mean time for the RapidTEG test was 30.8 ± 5.72 minutes, in comparison with 41.5 ± 5.66 minutes for kaolin TEG and 64.9 ± 18.8 for conventional coagulation tests—measured from admission of the patients to the resuscitation bay until the results were available. There were significant correlations between the RapidTEG results and those from kaolin TEG and conventional coagulation tests. RapidTEG is the most rapid available test for providing reliable information on coagulopathy in patients with multiple injuries. This has implications for improving patient care.

Key Words: Thrombelastography. Traumatic coagulopathy. Multiple injuries, tissue factor.

J Trauma. 2009;66:1253–1257.

trol Resuscitation on mortality
nts: a before and after study

t of Anaesthesia, Centre of Head and Orthopedics, Rigshospitalet, Copenhagen University

BJA

clopidogrel and
atients measured
pping™

tion, and Critical Care

aphy in the
ith

Holcomb, MD

Tl
Tr

Linda Shore-Lesser
Sanjeev Francis, BS*,

Departments of *Anesthes

T. C. Collyer[1*], D. J. Gray[2], R. Sandhu[2], J. Berridge[3] and G. Lyons[2]

[1]*Academic Unit of Anaesthesia, Royal Perth Hospital, Perth, Australia.* [2]*Department of Anaesthesia, St James's University Hospital, Leeds, UK.* [3]*Department of Anaesthesia, Leeds General Infirmary, Leeds, UK*

**Corresponding author. E-mail: tomcollyer@doctors.org.uk*

HEAD-TO-HEAD

The TEG® vs the ROTEM® th thromboelastometry systems

G. N. B. Jackson,[1] K. J. Ashpole[2] and S. M. Yentis[3]

1 Fellow, 2 Locum Consultant, 3 Consultant, Magill Department of Anaes Chelsea and Westminster Hospital, London, UK

Does Thromboelastography Predict Postoperative Thromboembolic Events? A Systematic Review of the Literature

Yue Dai, MB, MSc*
Anna Lee, PhD*
Lester A. H. Critchley, MD*
Paul F. White, PhD, MD†

BACKGROUND: Since thromboelastography (TEG) can detect hypercoagulable states, it is a potentially useful test for predicting postoperative thromboembolic complications. Therefore, we performed a systematic review of the literature to evaluate the accuracy of TEG in predicting postoperative thromboembolic events.
METHODS: PUBMED and EMBASE electronic databases were searched by two independent investigators to identify prospective studies involving adult patients undergoing operative procedures in which a TEG test was performed perioperatively and outcomes were measured by reference standards. The quality of included studies was assessed and measures of diagnostic test accuracy were

Does TEG predict these coagulation changes in haemorrhagic and shocked trauma patients?

YES……But so do other indices

Table 6: Prediction of transfusion by CCT, Rapid TEG*, and Kaolin TEG*.

		Cut-offs	Sensitivity	Specificity	PPV	NPV	AUC
Single indicator							
INR		>1.2	38%	88%	57%	77%	73%
INR		>1.5	19%	96%	67%	74%	73%
aPTT (sec)		>60.0	5%	98%	50%	69%	74%
Fibrinogen (g/L)		<3.0	90%	48%	43%	92%	74%
Thrombin time [sec]		>13.2	48%	73%	45%	75%	53%
Rapid K (min)		>1.8	68%	78%	61%	83%	79%
Kaolin K (min)		>1.7	68%	59%	46%	78%	67%
Rapid α-Angle (deg)		**<74.7**	**84%**	**57%**	**49%**	**88%**	**77%**
Kaolin α-Angle (deg)		<58.5	72%	61%	47%	82%	66%
Rapid MA (mm)		<59.6	68%	80%	63%	83%	75%
Kaolin MA (mm)		<58.4	56%	88%	70%	80%	70%
Rapid TMA (min)		>17.3	76%	57%	46%	83%	69%
Kaolin TMA (min)		>24.7	64%	63%	46%	78%	58%
Rapid G (d/sc)		<7374	68%	78%	61%	83%	73%
Kaolin G (d/sc)		<7073	56%	88%	70%	80%	70%
Combined indicators							
α-Angle + Heart Rate	Rapid α-Angle (deg) Heart Rate (bpm)	<75 >75	**84%**	**75%**	**62%**	**90%**	—
α-Angle + Hct	Rapid α-Angle (deg) Hct (%)	<75 <41	**88%**	**73%**	**61%**	**93%**	—

* Cut-offs determined by the data.

Jeger et al Scientific World Journal 2012 p 821794

Can the TEG explain the coagulation changes in haemorrhagic and shocked trauma patients?

Trauma Induced Coagulopathy

- Usually has an adequate Thrombin burst
- Fibrinogen levels are reduced
- Fibrin laydown and cross-bridging is impaired
- Fibrinolysis is increased

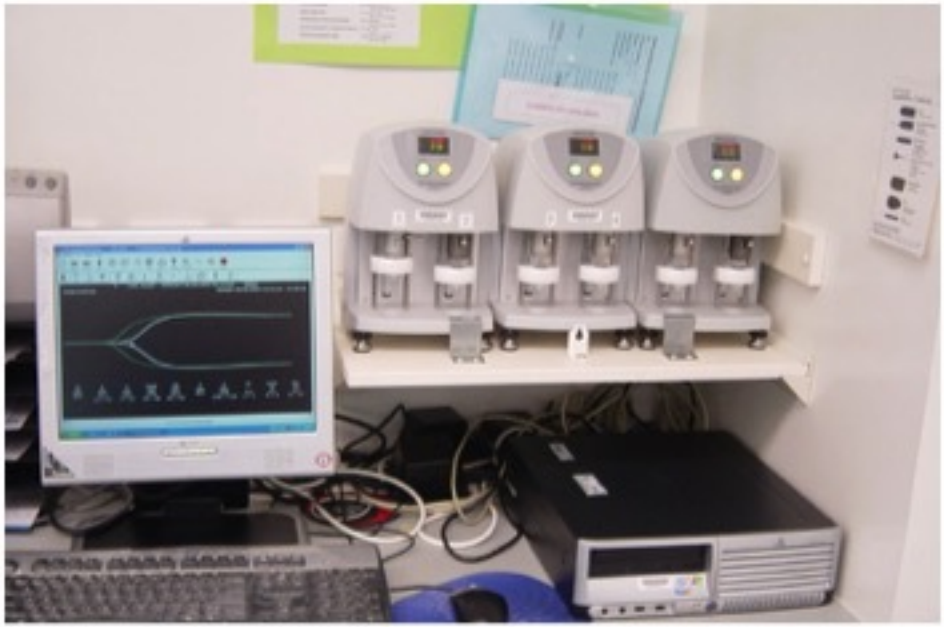
Can TEG direct product treatment in haemorrhagic and shocked trauma patients?

The place of TEG?

Appendix 1 Thrombelastography (TEG) treatment algorithm for patients with ongoing bleeding

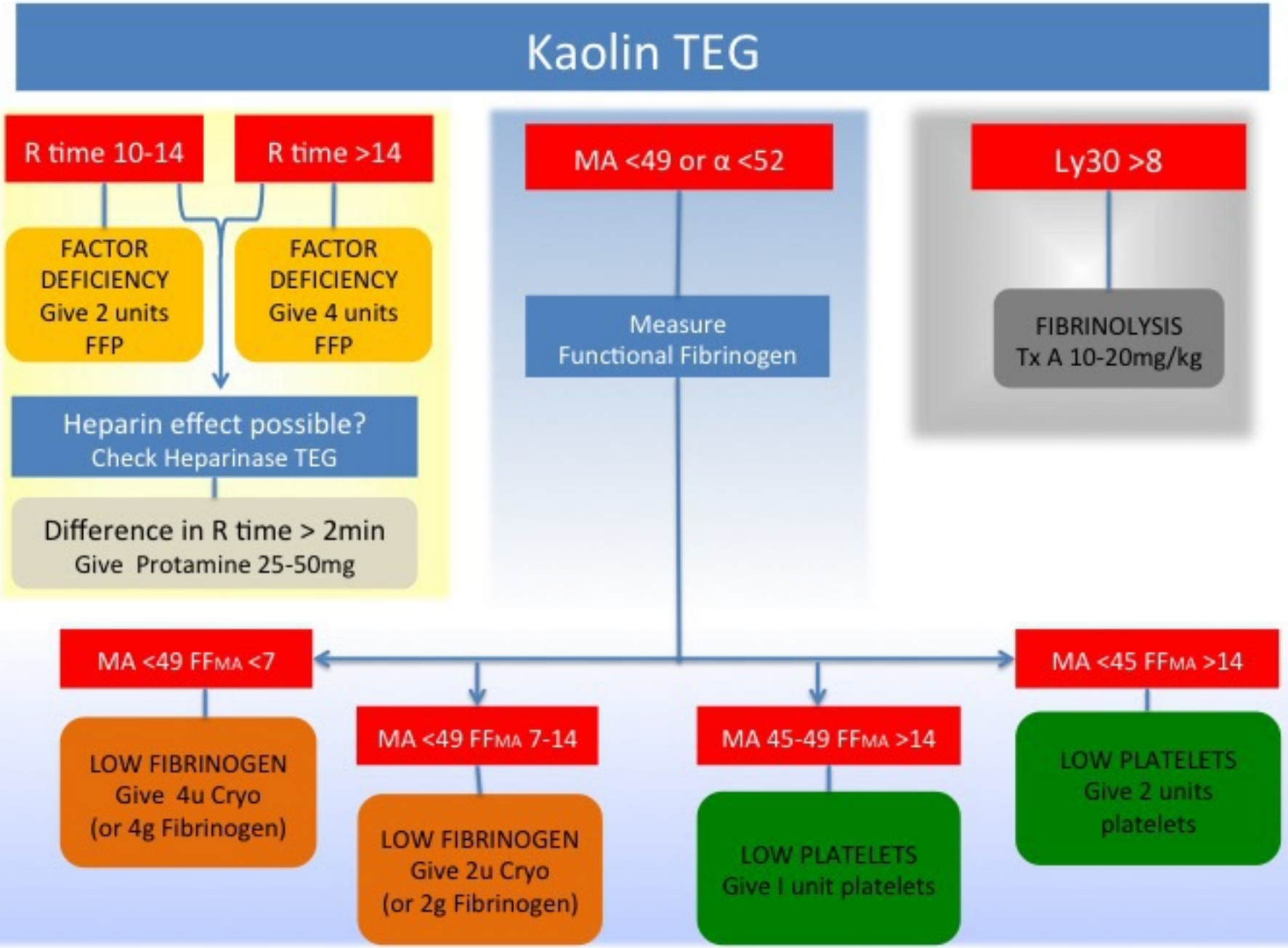
TEG Parameter	Treatment
R 11–14 min	2 × FFP or 10 ml/kg
R > 14 min	4 × FFP or 20 ml/kg
MA 46–50 mm	1 platelet concentrate
MA < 46 mm	2 platelet concentrates
Angle < 52	2 × FFP or fibrinogen
Ly30 > 8%	Antifibrinolytics

R, R-time, minutes; MA, maximum amplitude; Ly30, lysis in percent 30 min after MA is reached; FFP, fresh-frozen plasma.
One platelet concentrate pooled from the buffy-coat from four donors.



Johanson Vox Sanguinis 96 111-118

TEG ALGORITHM FOR MANAGEMENT OF BLEEDING PATIENTS



- Most of the benefit in TEG in improving blood management outside trauma is in
  - Stopping blood product use when it isn't required
  - Targeting specific product use when a defect exists (as opposed to a reduced conc of something)

ADHB Adult Code Crimson MTP

Team Leader Responsibilities

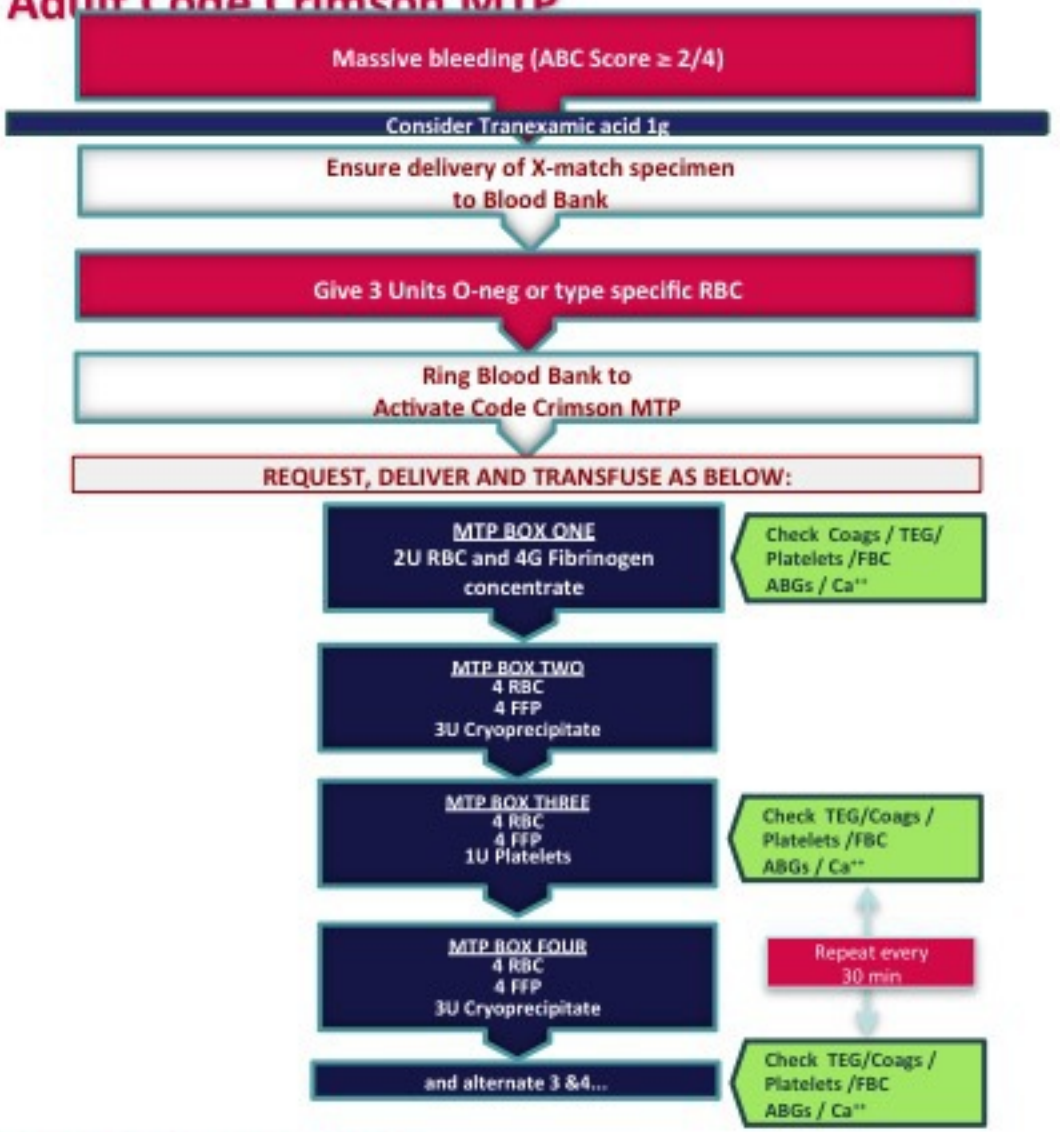
- Team leader should be a trauma team member
- Notify Coag Lab and send Coag requests on the Labplus Urgent form (orange border)
- Activate protocol by ringing Blood Bank (ext 24015) and say "I am activating the "Code Crimson MTP"
- Call for each box as required
- Make a decision to cease MTP and contact Blood Bank

Blood Bank Responsibilities

- Ensure X-match sample processed ASAP after O-neg release
- Notify NZBS Medical Officer after issuing MTP Box Four
- Thaw next box in advance and await request
- Ensure supply of platelets

Contacts

- Blood Bank - Ext 24015
- Coagulation Lab - Ext 22069
- Level 8 Anaesthetist - 021 496 374



Additional treatment thresholds

- if PR >1.5 or APTT >40 consider additional 4 units FFP
- if fibrinogen <1g/L consider additional 3U Cryoprecipitate
- if platelets <75 x10^9/L consider additional one pack platelets
- if ionized Ca++ <1mmol/L give 10mls Calcium

Salzburg

CONCORD performance improvement

Schöchl et al. Critical Care 2010, 14:R55
http://ccforum.com/content/14/2/R55

CRITICAL CARE

RESEARCH Open Access

Goal-directed coagulation management of major trauma patients using thromboelastometry (ROTEM®)-guided administration of fibrinogen concentrate and prothrombin complex concentrate

Herbert Schöchl[1,2], Ulrike Nienaber[1], Georg Hofer[1], Wolfgang Voelckel[1], Csilla Jambor[1], Gisela Scharbert[1], Sibylle Kozek-Langenecker[3] and Cristina Solomon[4,5]

Abstract

Introduction: The appropriate strategy for trauma-induced coagulopathy management is under debate. We report the treatment of major trauma using mainly coagulation factor concentrates.

Methods: This retrospective analysis included trauma patients who received ≥ 5 units of red blood cell concentrate within 24 hours. Coagulation management was guided by thromboelastometry (ROTEM®). Fibrinogen concentrate was given as first-line haemostatic therapy when maximum clot firmness (MCF) measured by FibTEM (fibrin-based test) was <10 mm. Prothrombin complex concentrate (PCC) was given in case of recent coumarin intake or clotting time measured by extrinsic activation test (EXTEM) >1.5 times normal. Lack of improvement in EXTEM MCF after fibrinogen concentrate administration was an indication for platelet concentrate. The observed mortality was compared with the mortality predicted by the trauma injury severity score (TRISS) and by the revised injury severity classification (RISC) score.

Results: Of 131 patients included, 128 received fibrinogen concentrate as first-line therapy, 98 additionally received PCC, while 3 patients with recent coumarin intake received only PCC. Twelve patients received FFP and 29 received platelet concentrate. The observed mortality was 24.4%, lower than the TRISS mortality of 33.7% (P = 0.032) and the RISC mortality of 28.7% (P > 0.05). After excluding 17 patients with traumatic brain injury, the difference in mortality was 14% observed versus 27.8% predicted by TRISS (P = 0.0018) and 24.3% predicted by RISC (P = 0.014).

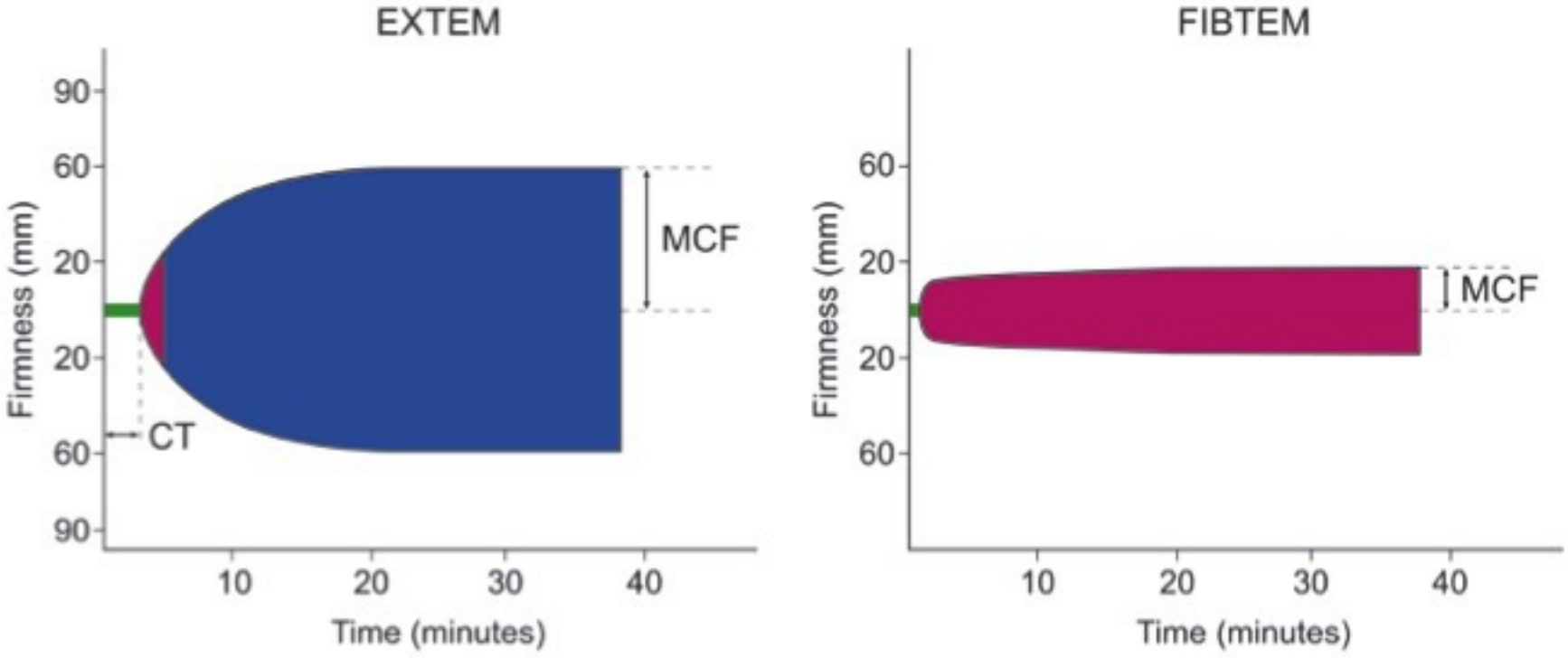
Conclusions: ROTEM®-guided haemostatic therapy, with fibrinogen concentrate as first-line haemostatic therapy and additional PCC, was goal-directed and fast. A favourable survival rate was observed. Prospective, randomized trials to investigate this therapeutic alternative further appear warranted.

Introduction

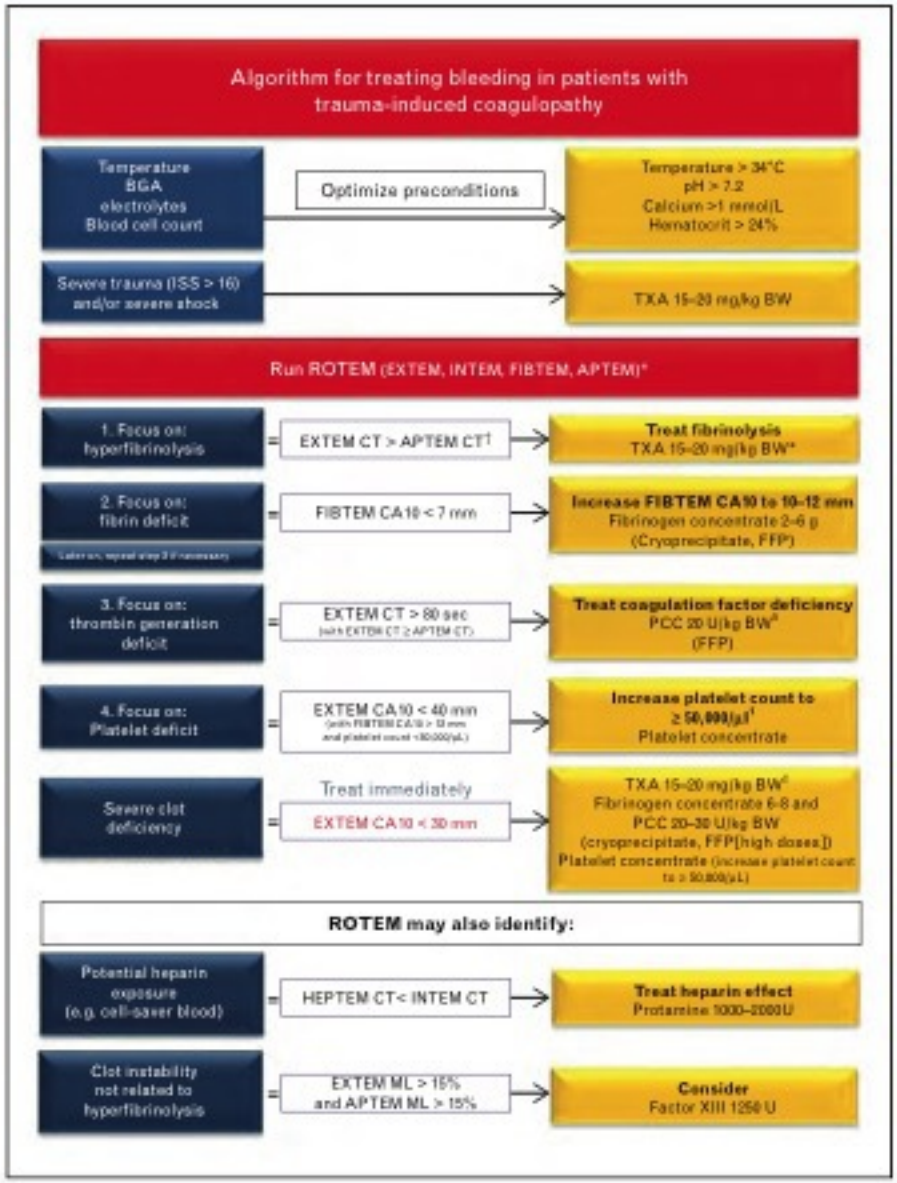
Coagulopathy has been shown to be present in approximately 25 to 35% of all trauma patients on admission to the emergency room (ER) [1,2]. This represents a serious problem for major trauma patients and accounts for 40% of all trauma-related deaths [3]. Coagulopathy forces a strategy of early and rapid haemostatic treatment to prevent exsanguination. Fresh frozen plasma (FFP) is part of the massive transfusion protocols in most trauma centres [3-5], although its efficacy is uncertain. Massive transfusion protocols that favour a red blood cell (RBC):FFP ratio of 1:1 have shown conflicting results [6-14]. In addition, there are well-recognised risks associated with FFP administration in the trauma setting, such as acute lung injury, volume overload, and nosocomial infection [12,15-17]. According to the Serious Hazards of Transfu-

*Correspondence: solomon.cristina@googlemail.com
[4]Department of Anaesthesiology and Intensive Care, Salzburger Landeskliniken SALK, 48 Müllner Hauptstrasse, 5020 Salzburg, Austria
Full list of author information is available at the end of the article


ROTEM
MULTIPLATE


EXTEM
90
60
20
20
60
90
Firmness (mm)
MCF
CT
10
20
30
40
Time (minutes)
FIBTEM
60
20
20
60
Firmness (mm)
MCF
10
20
30
40
Time (minutes)

Trauma flowsheet in Innsbruck



Auckland District Health Board

Fries, Innerhofer and Schobersberger. Curr Opin Anaesthesiol


RiaSTAP
Human Fibrinogen, Powder for Injection
Intravenous Injection Only
1 g
RiaSTAP
Human Fibrinogen, Powder for Injection
Intravenous Injection Only
1 g
Aquasonic
100

SOURCES OF FIBRINOGEN

	Fibrinogen Content	Thaw Time Delay	Factors Present	Implications
FFP	1:6G/L	30 min. + Transport	Fibrinogen (I) II, VII, IX, X, XII [V & VIII 65% (N)]	Weak TACO TRALI immunomodulation
Cryoprecipitate	2.5G/150ml	30 min. + Transport	Fibrinogen (I) vWF, VIII XIII fibronectin	Availability no viral inactivation
Fibrinogen Concentrate	1.0G/100ml	NIL	Fibrinogen (I)	Cost 20% greater than cryoprecipitate

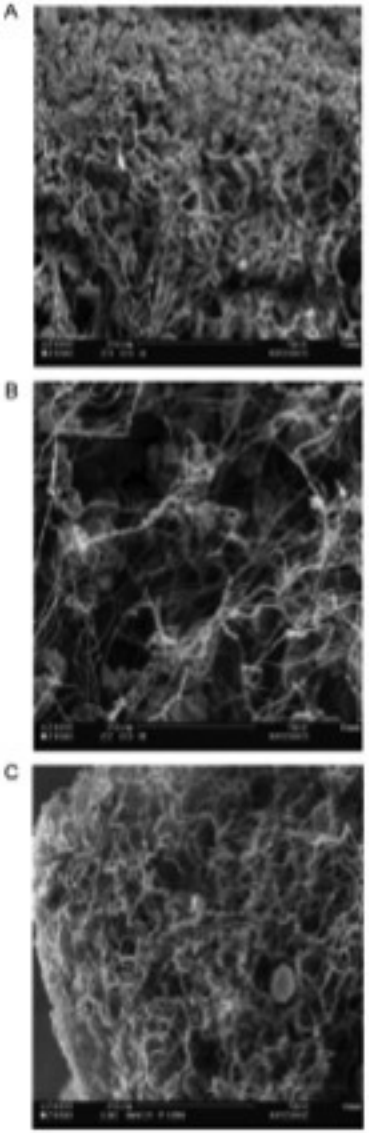
Electron microscopic scan of a ×2000 magnified blood clot

- fibTEM >10mm
- Fibrinogen > 1.5-2.0 g/L

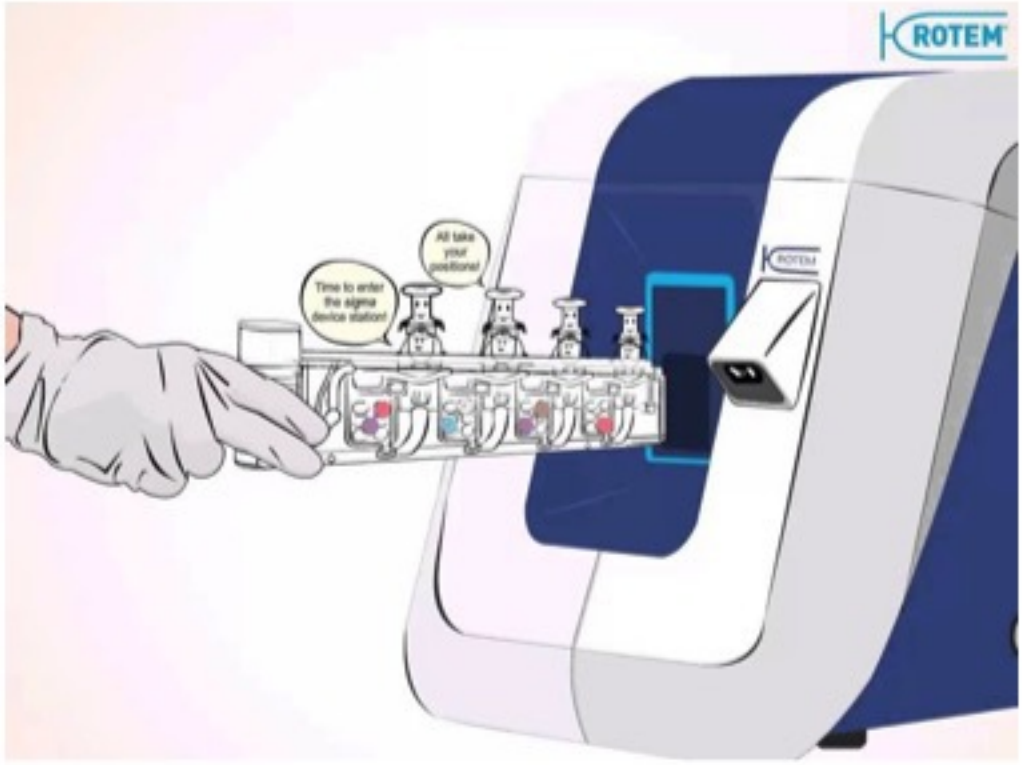
undiluted

65% haemodiluted

Post fibrinogen administration




HAEMONETICS
TEG6s


ROTEM
All take your positions!
Time to enter the sigma device station!

Summary

- TEG is a more intuitive coagulation test for replacement of factors in bleeding
- It has the potential to focus on better prediction of TIC
- It has the potential to increase our understanding of TIC
- It may be the tool to move us to MTP 2.0