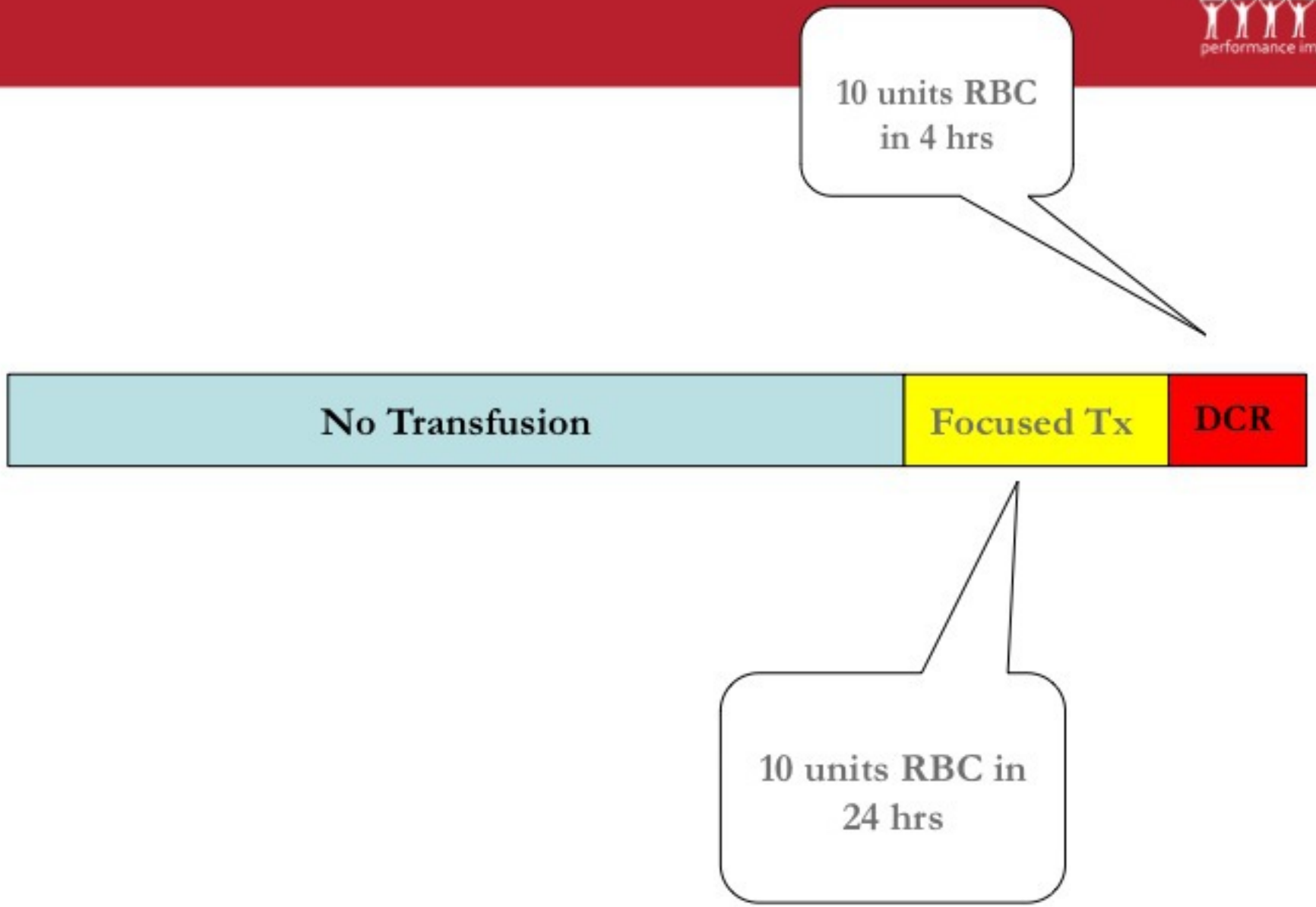
TEG in TRAUMA

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 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

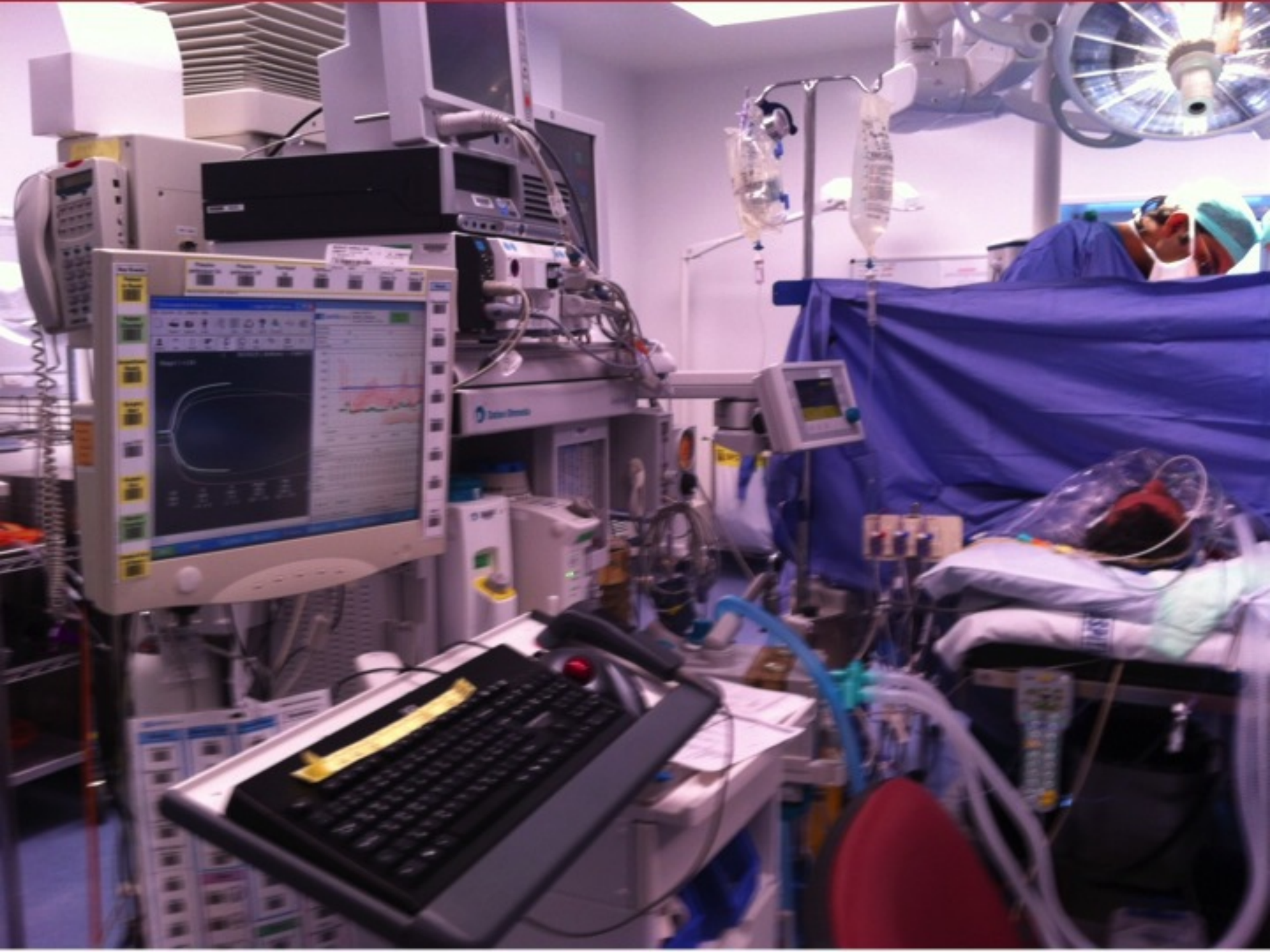
Investigation	Target value
Haemoglobin; haematocrit	10 g/dl; 0.32
Platelet count	$> 50 \times 10^9$/l
Prothrombin time	$< 1.5 \times$ control
Partial thromboplastin time	$< 1.5 \times$ control
Fibrinogen	> 0.8 g/l

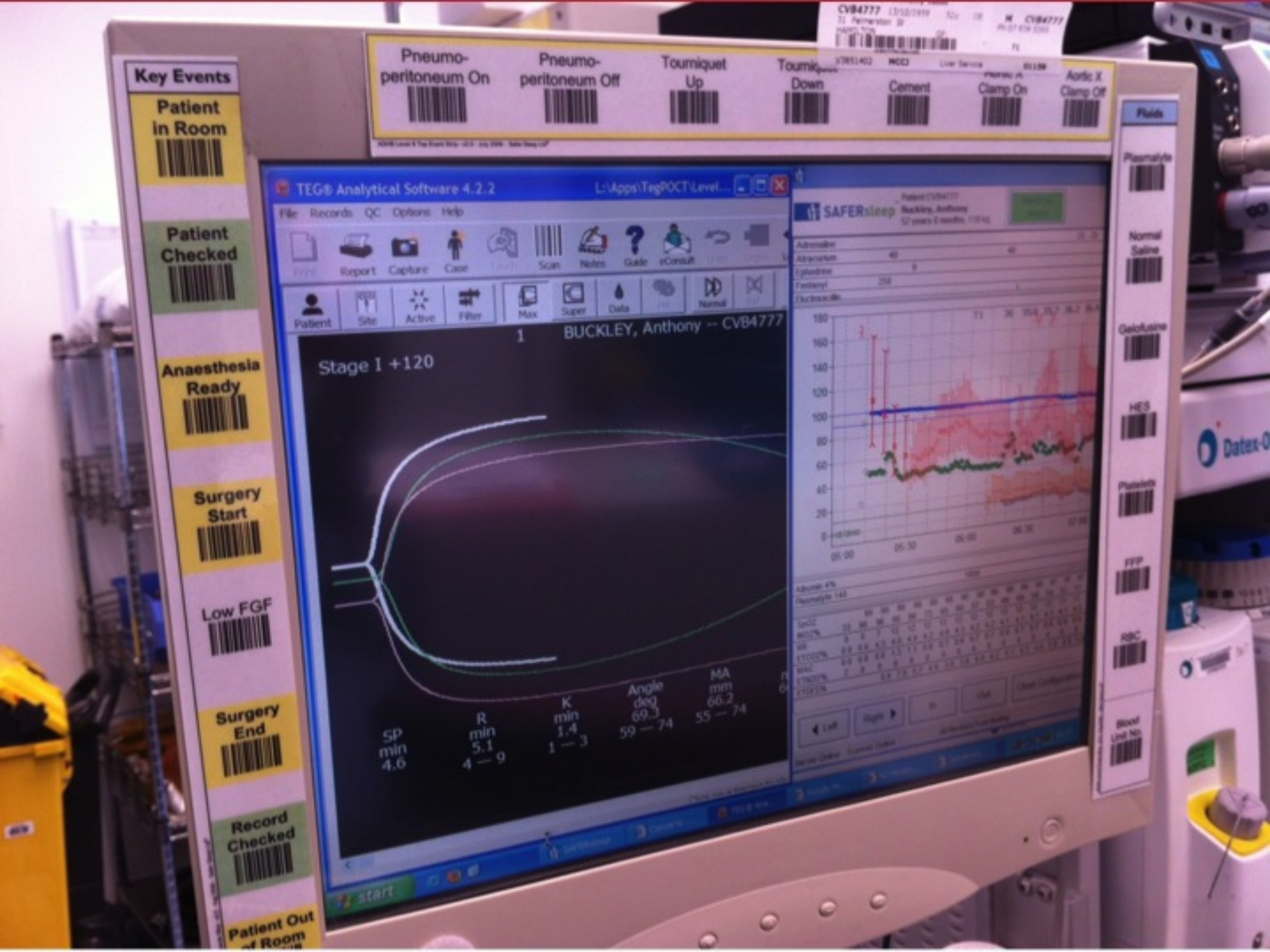
BSCH guidelines for massive transfusion 1998

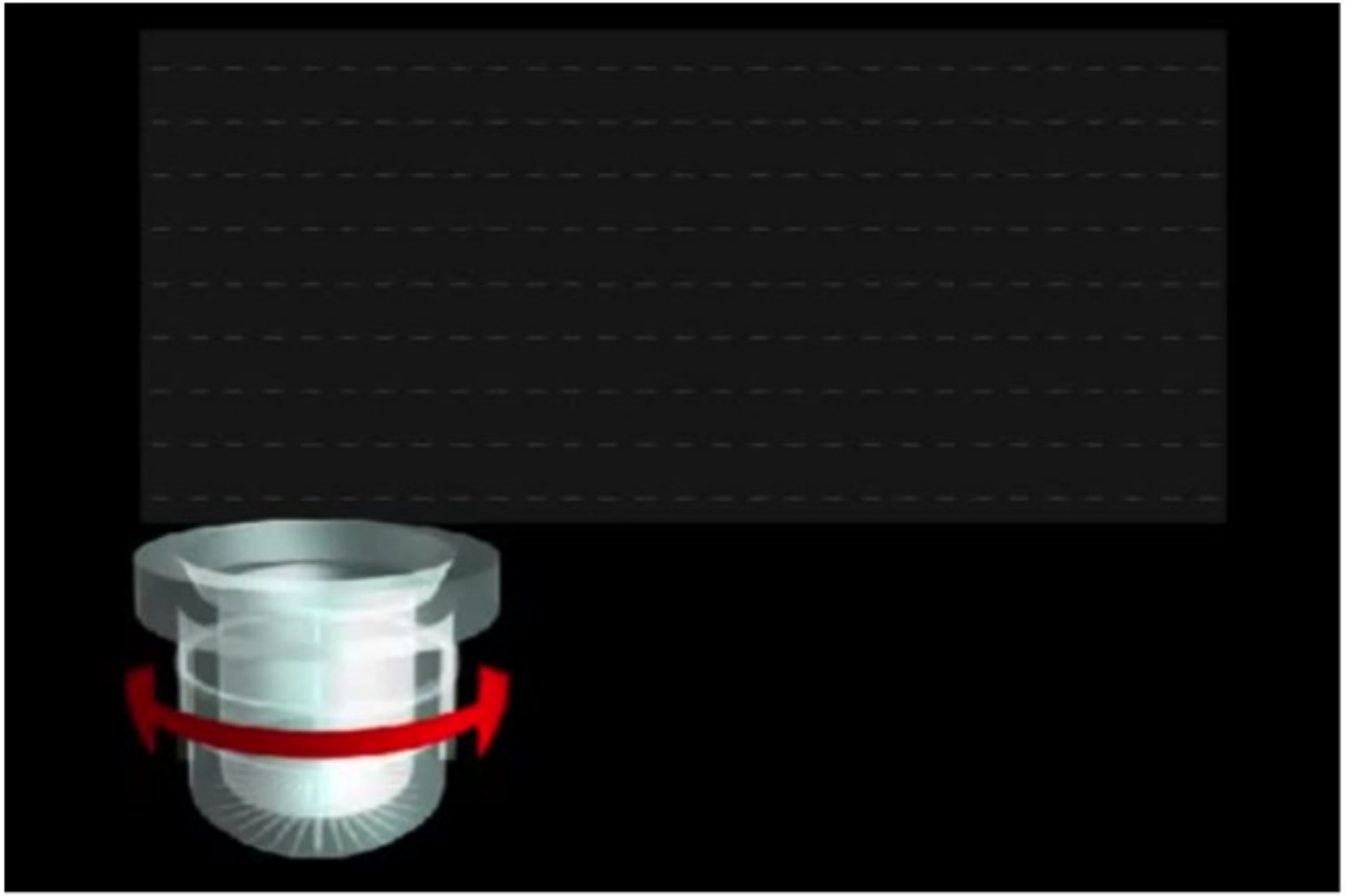
Thromboelastography

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

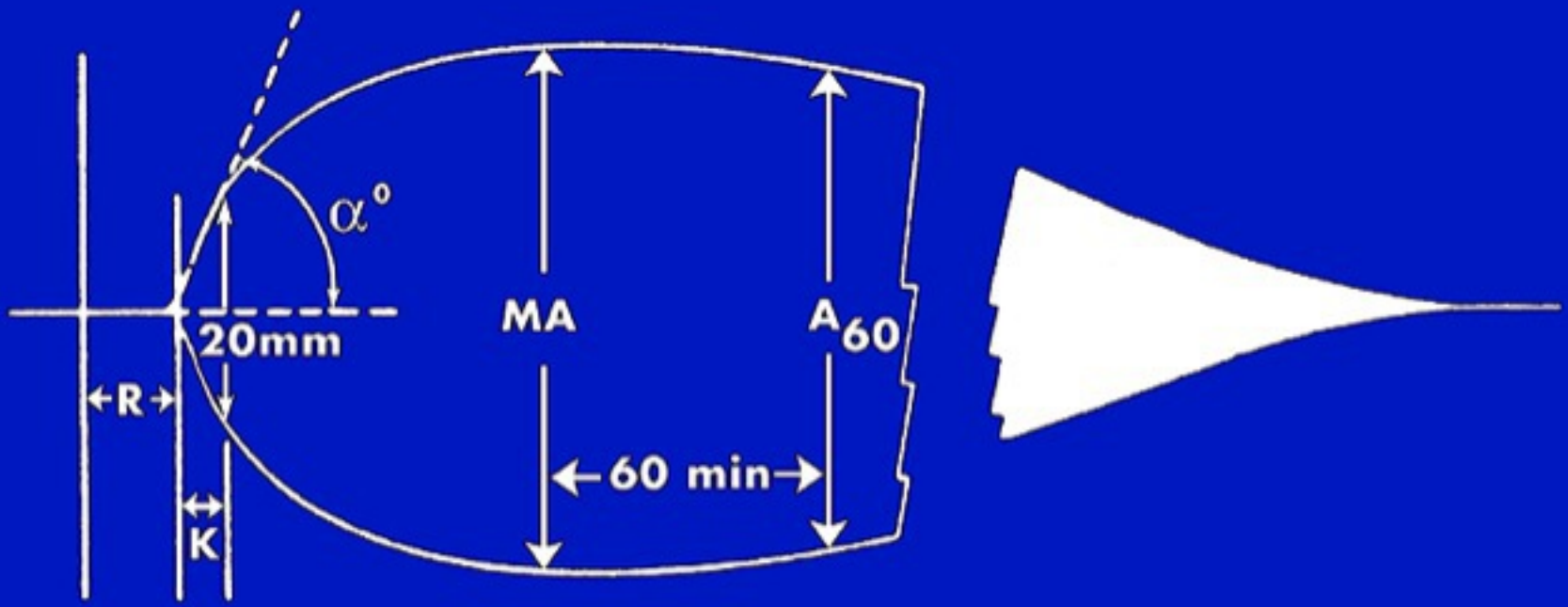

ROTEM



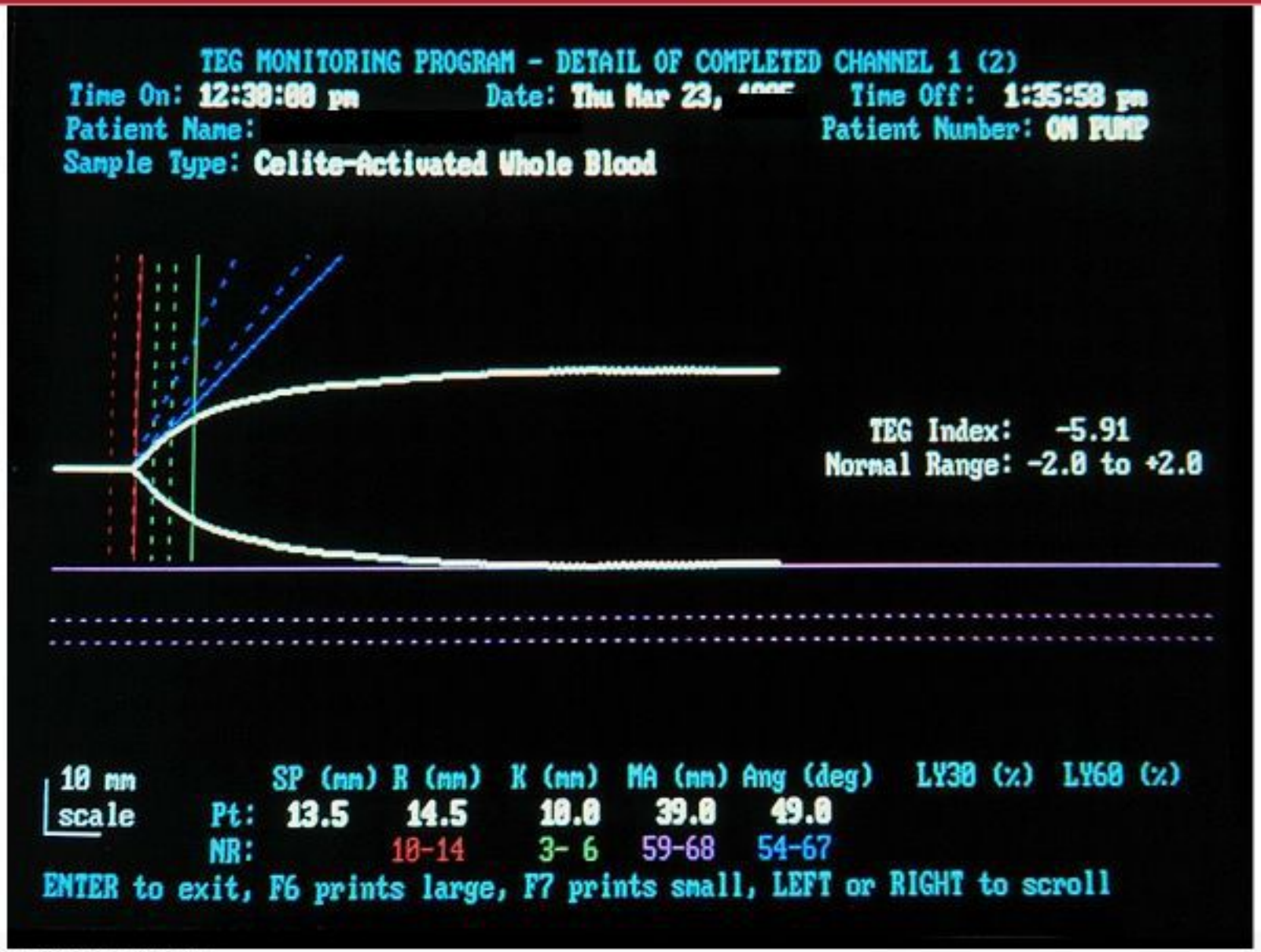

Key Events
Patient in Room
Patient Checked
Anaesthesia Ready
Surgery Start
Low FGF
Surgery End
Record Checked
Patient Out
Pneumo-peritoneum On
Pneumo-peritoneum Off
Tourniquet Up
Tourniquet Down
Cement
Aortic X Clamp On
Aortic X Clamp Off
TEG® Analytical Software 4.2.2
File Records QC Options Help
Report 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



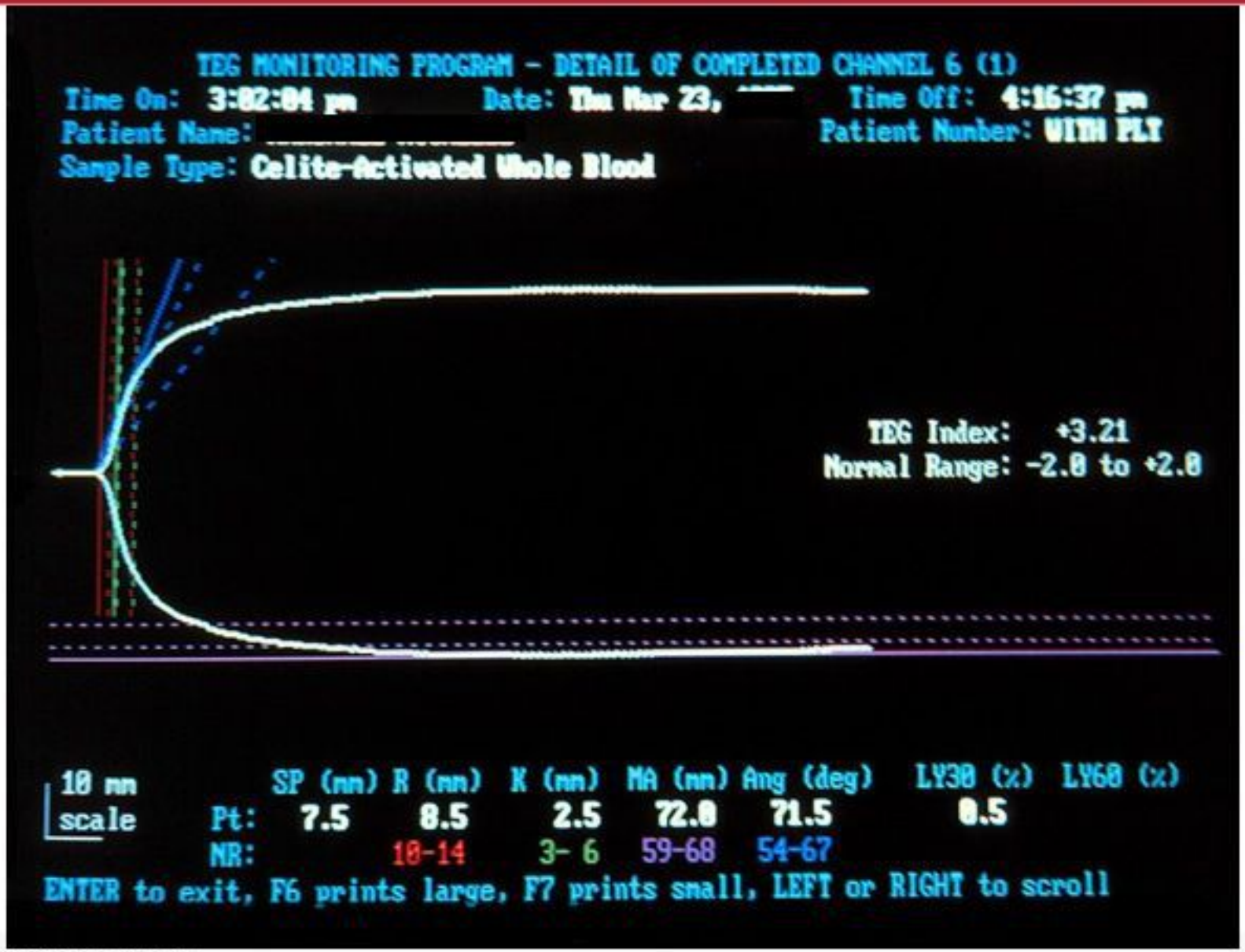
Schematic Diagram of Normal Thromboelastography Tracing



Platelet Dysfunction



After Platelet Transfusion



APPARATUS

Point-of-care testing Measurement of coagulation

CONCORD

Vox Sanguinis (2008) 95, 111–118

DOI: 10.1111/j.1423-0410.2008.01083.x

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

1 Senior House
Department of An
the Free Universi

trol Resuscitation on mortality
nts: a before and after study

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

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 thrombelastography (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 56.1 ± 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.

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 Anaest 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%**	—

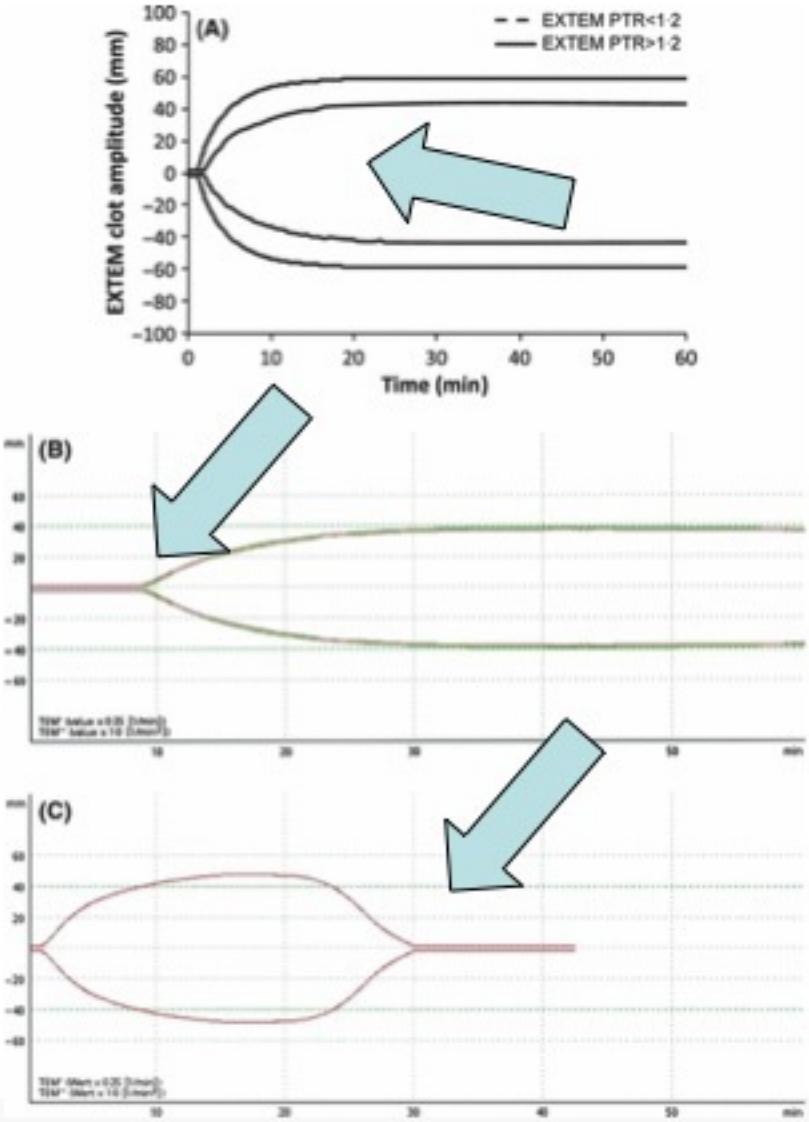
* Cut-offs determined by the data.

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

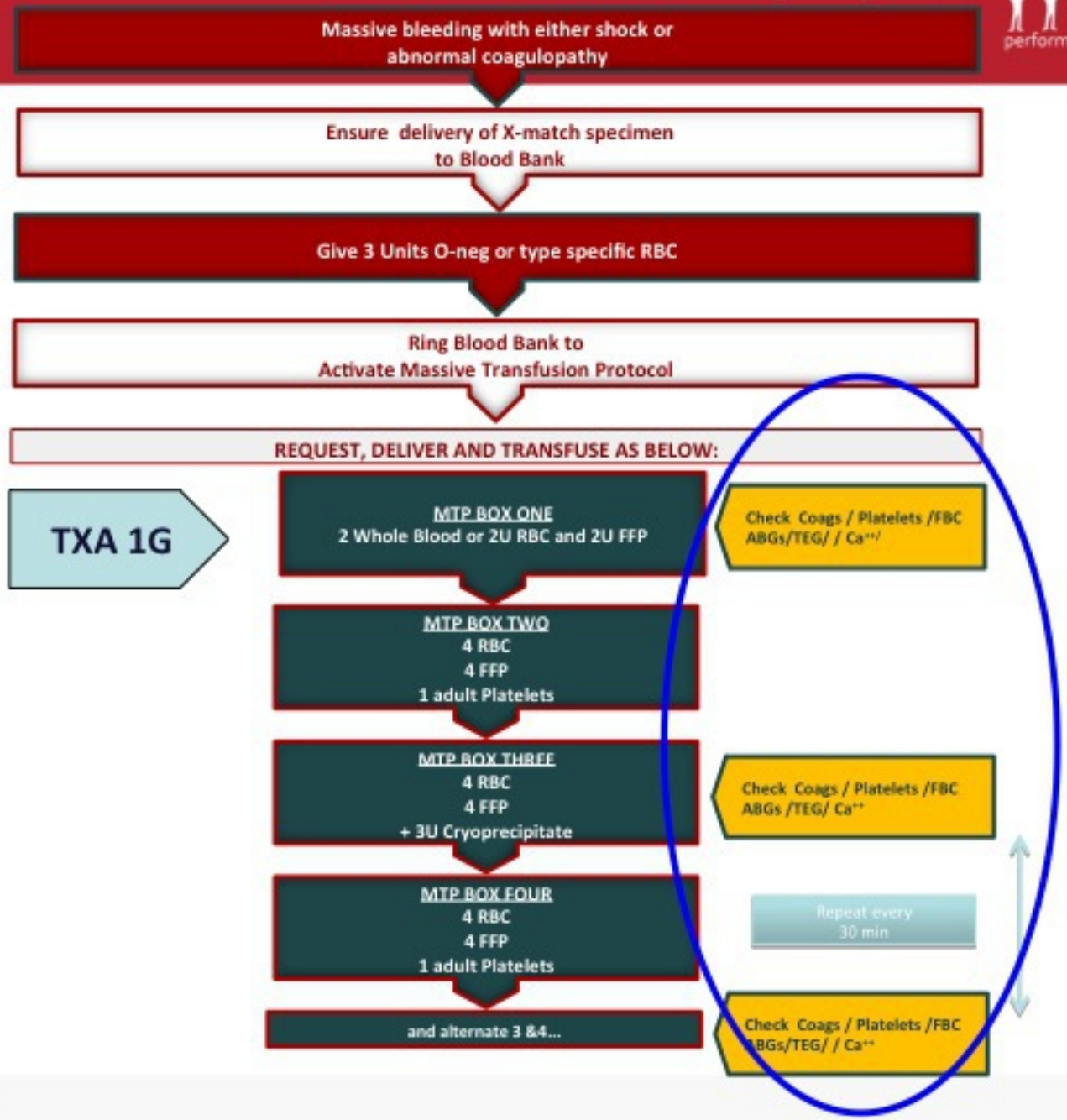

(A)
EXTEM PTR<1·2
EXTEM PTR>1·2
EXTEM clot amplitude (mm)
100
80
60
40
20
0
−20
−40
−60
−80
−100
0
10
20
30
40
50
60
Time (min)
(B)
(C)

Can TEG direct product treatment in haemorrhagic and shocked trauma 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 Massive Transfusion Protocol (MTP)

CONCORD performance improvement



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

Table 1 Recommended TEG algorithm for goal-directed therapy of bleeding patients in the Capital Region of Denmark

TEG parameter*	Coagulopathy	Intervention
R >10 min	Coagulation factors ↓	FFP 10–20 ml/kg (if FFP is without clinical efficacy, consider cryoprecipitate 3–5 ml/kg)
Angle <52 °	Hypofibrinogenemia?	→ Functional Fibrinogen (FF) analysis
MA <49 mm and		
MA_{FF} <14 mm	Fibrinogen ↓	FFP 20–30 ml/kg /
Fibrinogen konc. 25–50 mg/kg /		
Cryoprecipitate 5 ml/kg		
MA <49 mm and		
MA_{FF} >14 mm	Platelets ↓	Platelets 5–10 ml/kg
Ly30 >8%	Primary hyperfibrinolysis	Tranexamic acid 1–2 g IV (adults)
Children 10–20 mg/kg IV		
Ly30 >8% and		
Angle and/or MA ↑↑	Reactive hyperfibrinolysis	Tranexamic acid contraindicated
Difference in R >2 min between st-TEG and hep-TEG	Heparinization	Protamine sulphate or FFP 20–30 ml/kg

R, Reaction time; Angle, α-angle; MA, Maximum amplitude; MA_{FF}, Maximum amplitude by Functional Fibrinogen® analysis; Ly30, Lysis after 30 min; st-TEG, standard TEG; hep-TEG, heparinase TEG.
*Reference values (Haemonetics Corp.): R 3–8 min, Angle 55–78 °, MA 51–69 mm, Ly30 0-8%, MA_{FF}=14-24 mm.

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

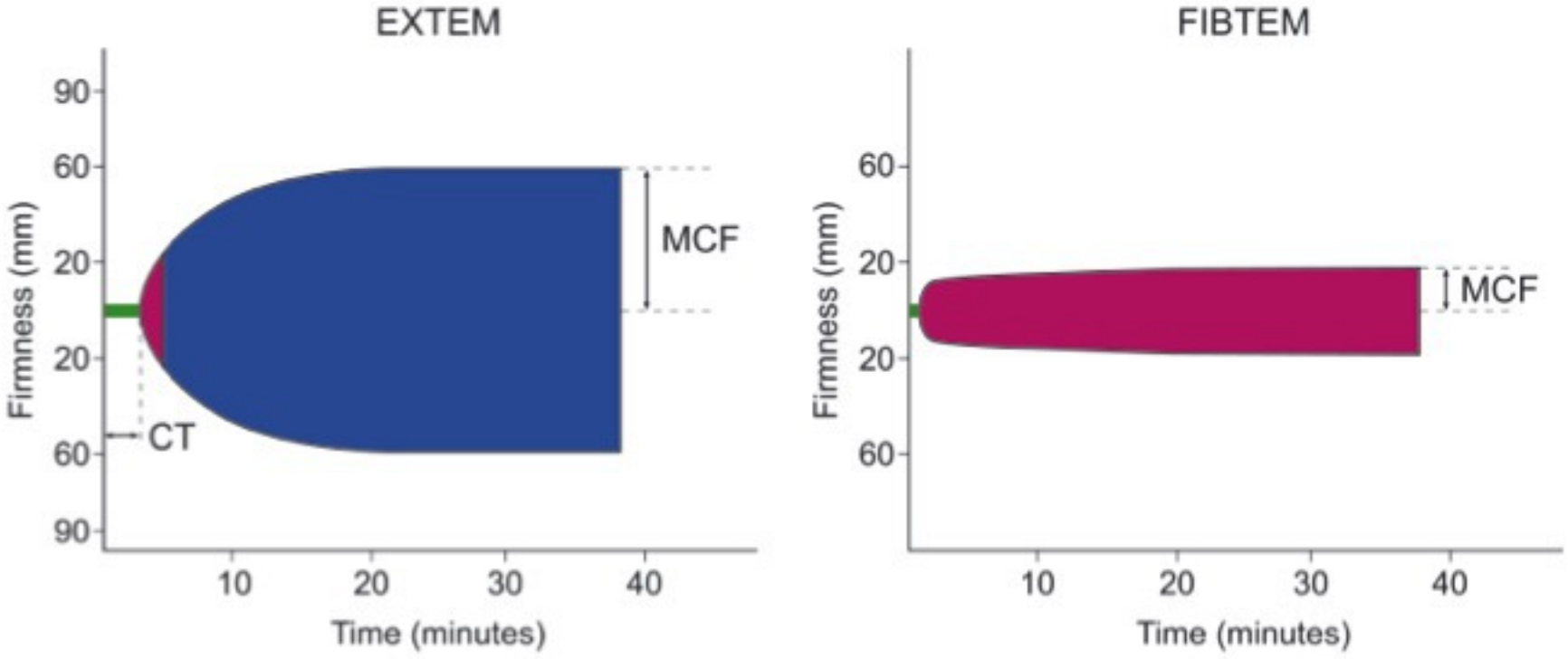
CRITICAL CARE

RESEARCH Open Access

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

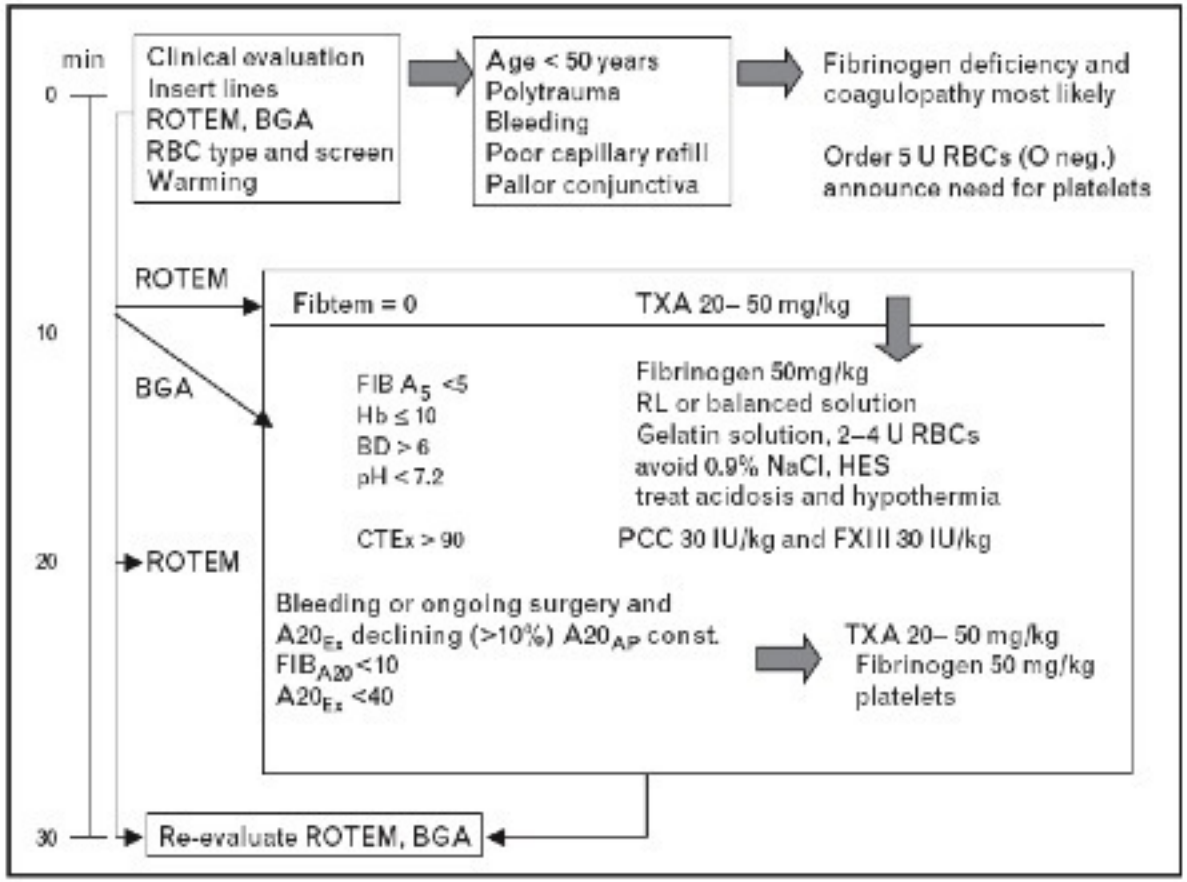
Herbert Schöchl[1,2], Ulrike Nienaber[3], Georg Hofer[1], Wolfgang Voelckel[1], Csilla Jambor[4], Gisela Scharbert[5], Sibylle Kozek-Langenecker[5] and Cristina Solomon*[6]

- Trauma patients receiving >5 units RBCs
- fibTEM guided therapy if <10mm
- 131 patients
- 128 received fibrinogen, 98 patient received PCC


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

Figure 1 Algorithm for immediate effective therapy of trauma-induced coagulopathy as advocated by the authors and implemented at the University Hospital Innsbruck, Austria



HES, hydroxyethyl starch solutions; RBC, red blood cell.

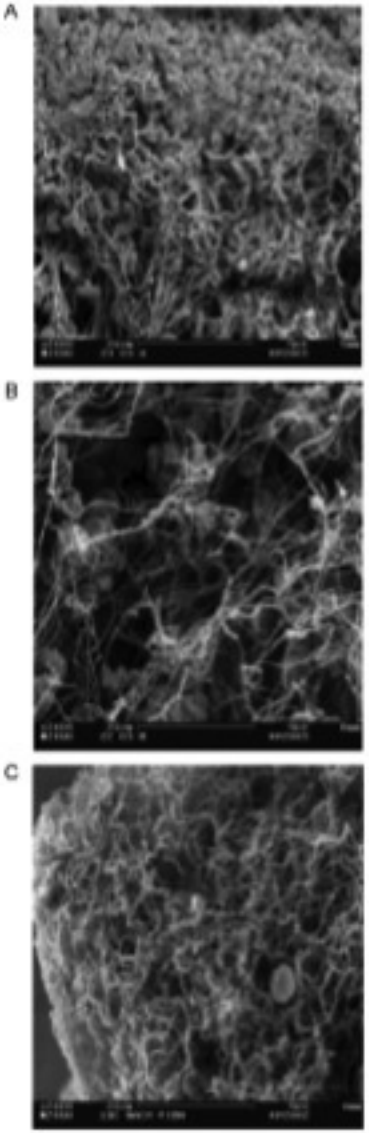
Electron microscopic scan of a ×2000 magnified blood clot

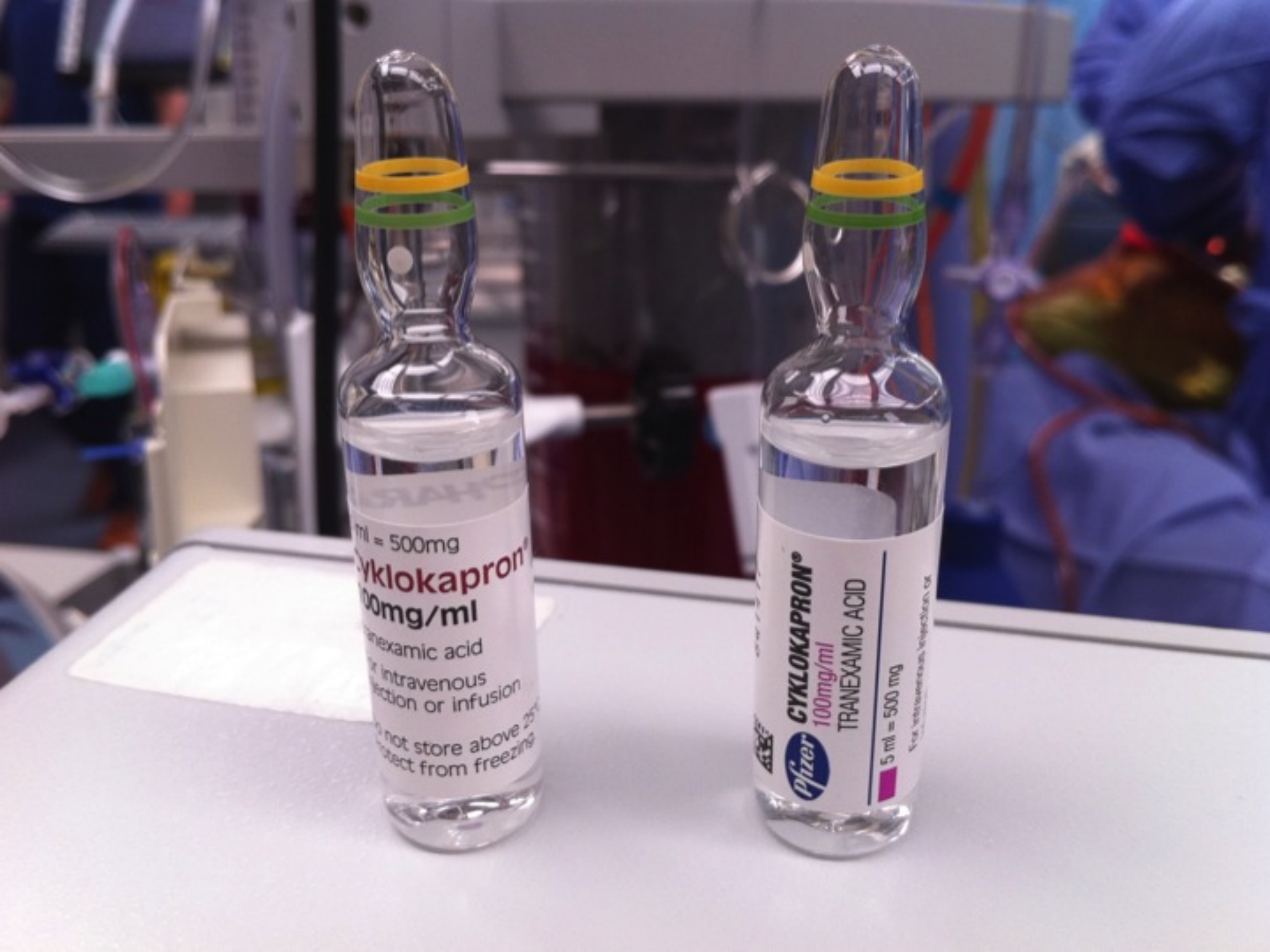
- fibTEM >10mm
- Fibrinogen > 1.5-2.0 g/L

undiluted

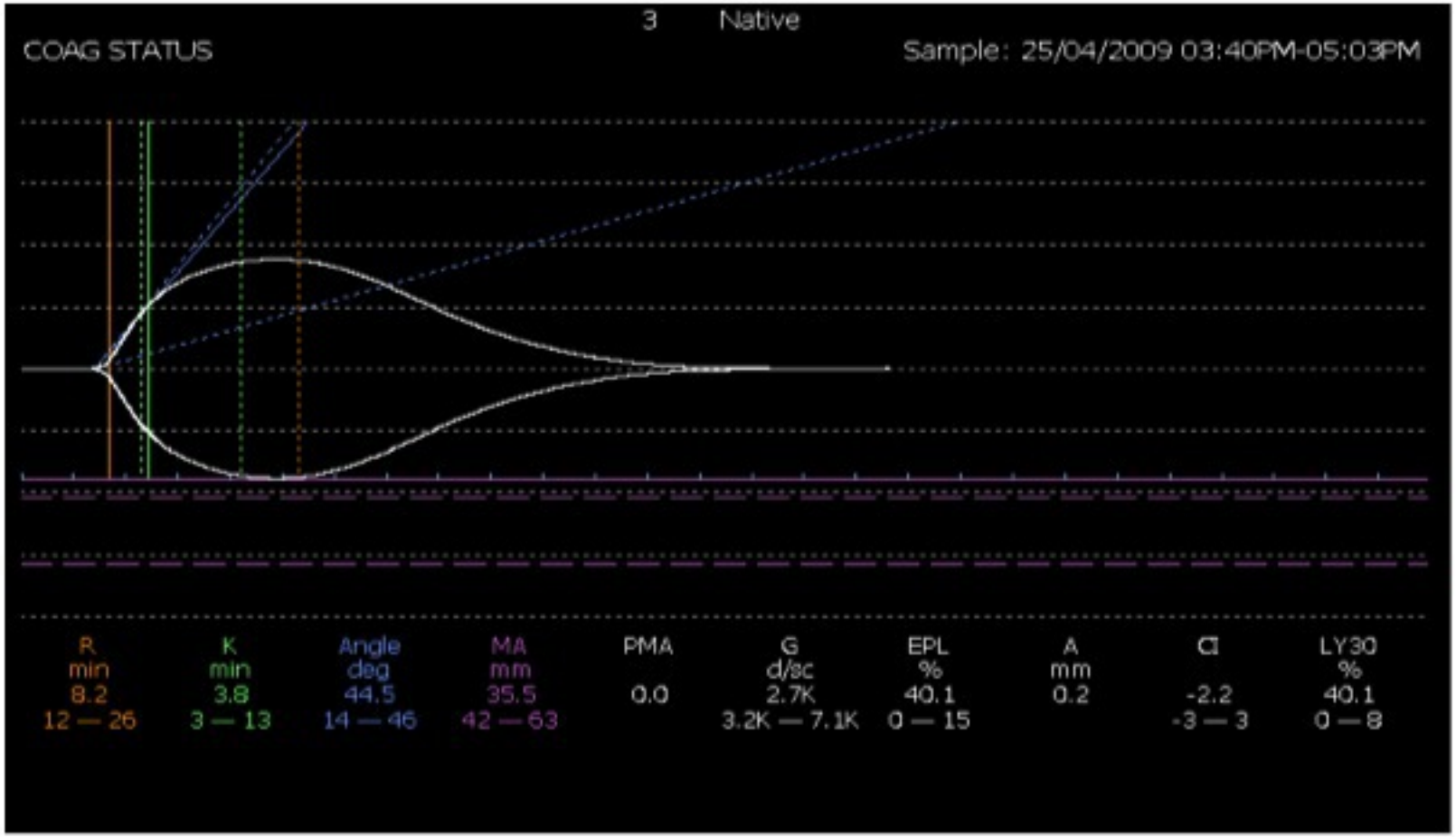
65% haemodiluted

Post fibrinogen administration

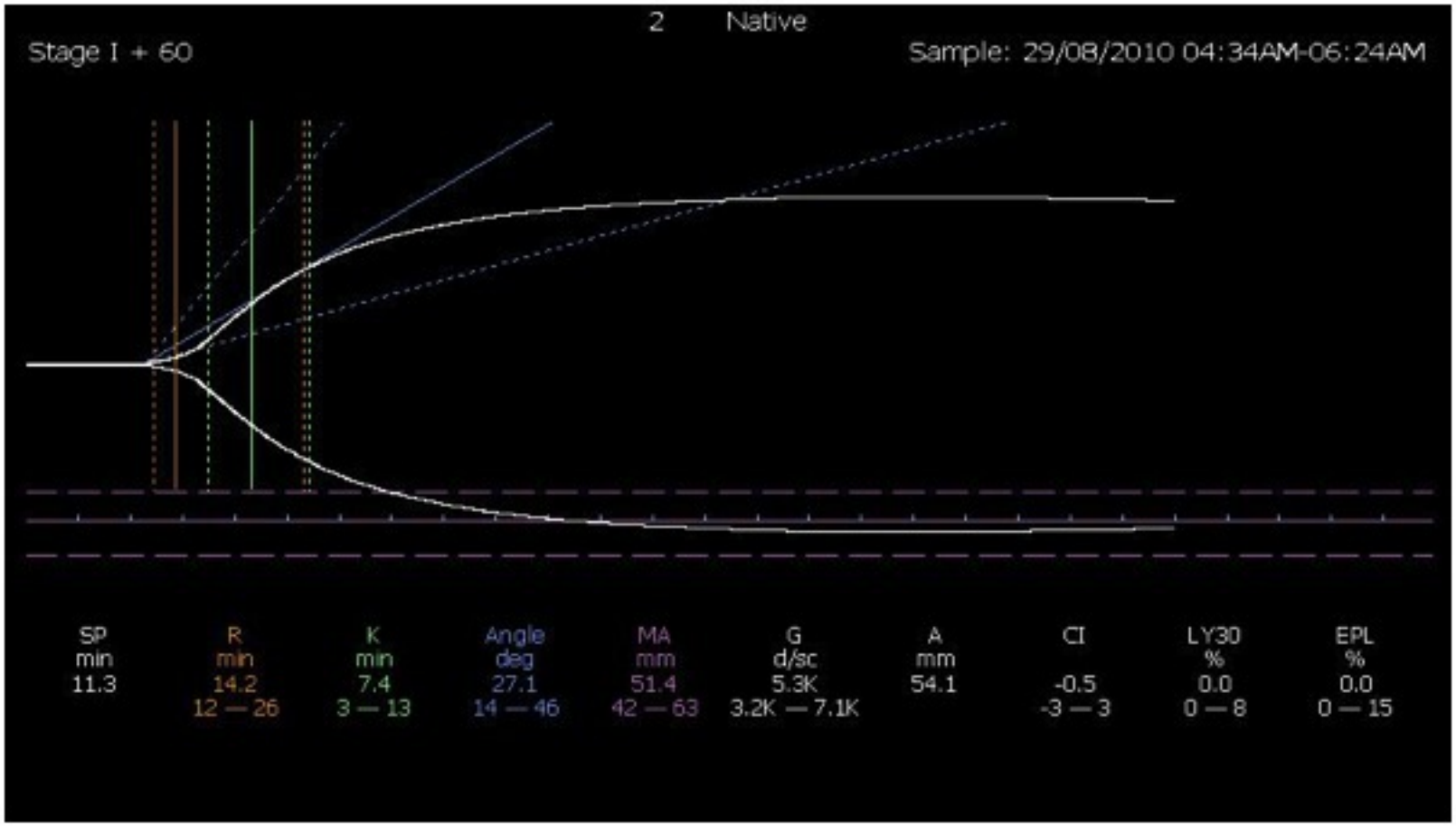



ml = 500mg
yklokapron
00mg/ml
anexamic acid
r intravenous
ection or infusion
not store above 25
otect from freezing
Pfizer
CYKLOKAPRON®
100mg/ml
TRANEXAMIC ACID
5 ml = 500 mg

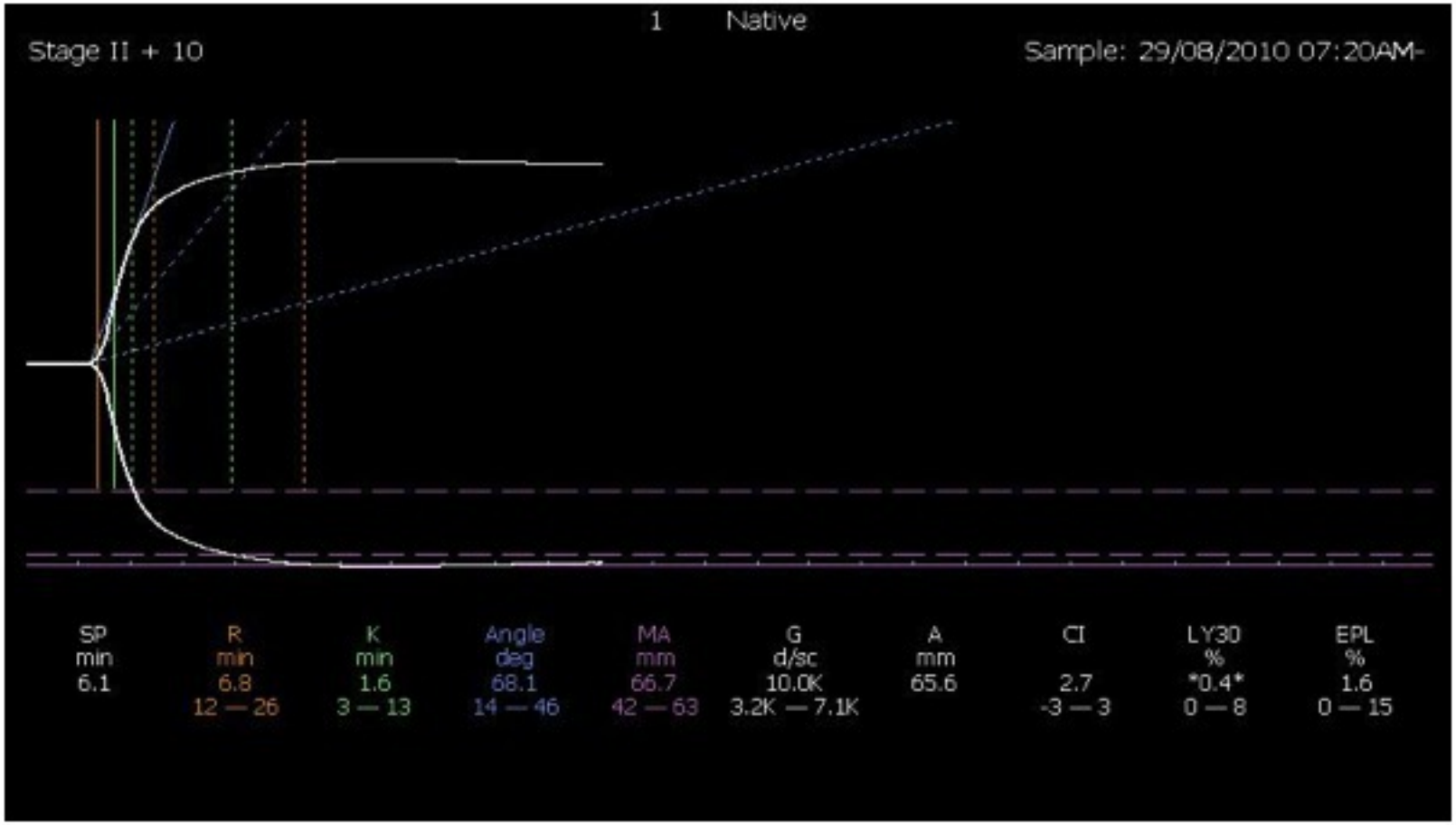
Fibrinolysis on a TEG?



TEG before TXA



TEG 30 mins after TXA 1G



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