# Feasibility of use of Rotational Thromboelastometry (ROTEM) to Manage the Coagulopathy of Military Trauma in a Deployed Setting.

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# Background – Coagulopathy in Trauma

- Coagulopathy in trauma is common
- Up to 38% are coagulopathic on presentation to the Emergency Department
- Associated with a 5-fold increase in mortality
- Massive transfusions (MT) are higher in military patients and have up to 50% risk of mortality

# Addressing Coagulopathy

Special Commentary

The Journal of TRAUMA® Injury, Infection, and Critical Care

## Damage Control Resuscitation: Directly Addressing the Early Coagulopathy of Trauma

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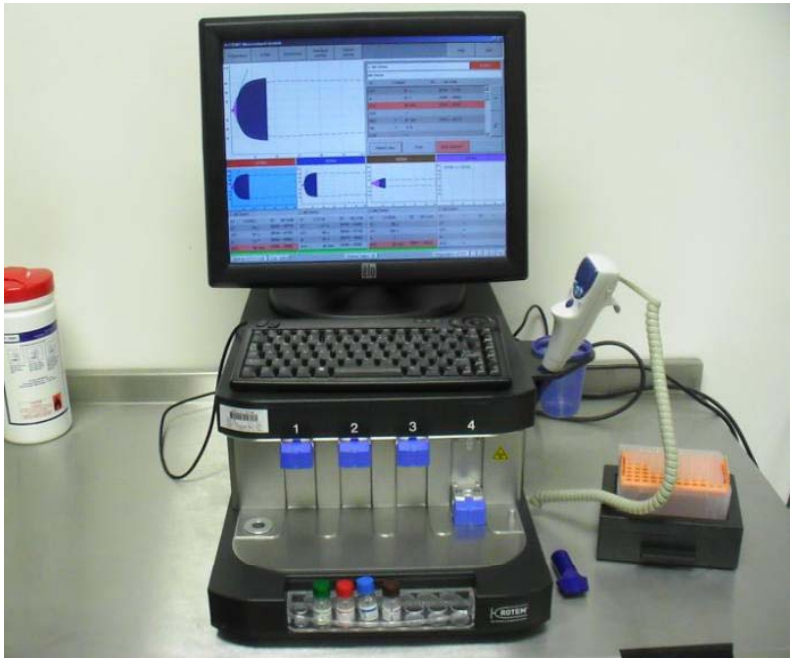
*J Trauma.* 2007;62:307–310.

# Testing for Coagulopathy

- Definition of Coagulopathy:
  - Prothrombin Time – PT:  > 18s
  - Activated Partial Thromboplastin Time – APTT: >60s
- Can take up to 60mins for these results to be available to clinician
- Thromboelastometry (TEM) offers a timely point of care that is used in elective cardiac and liver surgery

# Thromboelastography

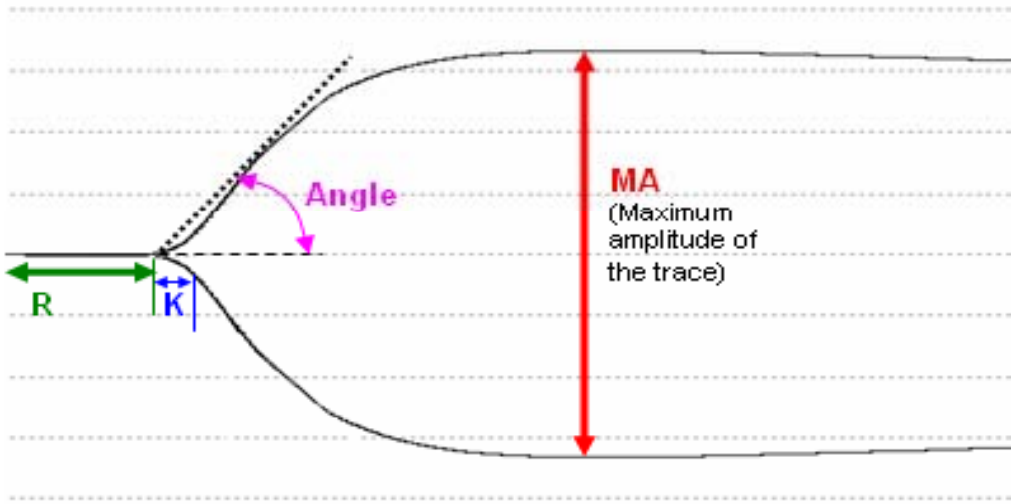
Whole blood test - global coagulation profile



Thromboelastometry
ROTEM

Thromboelastography
TEG

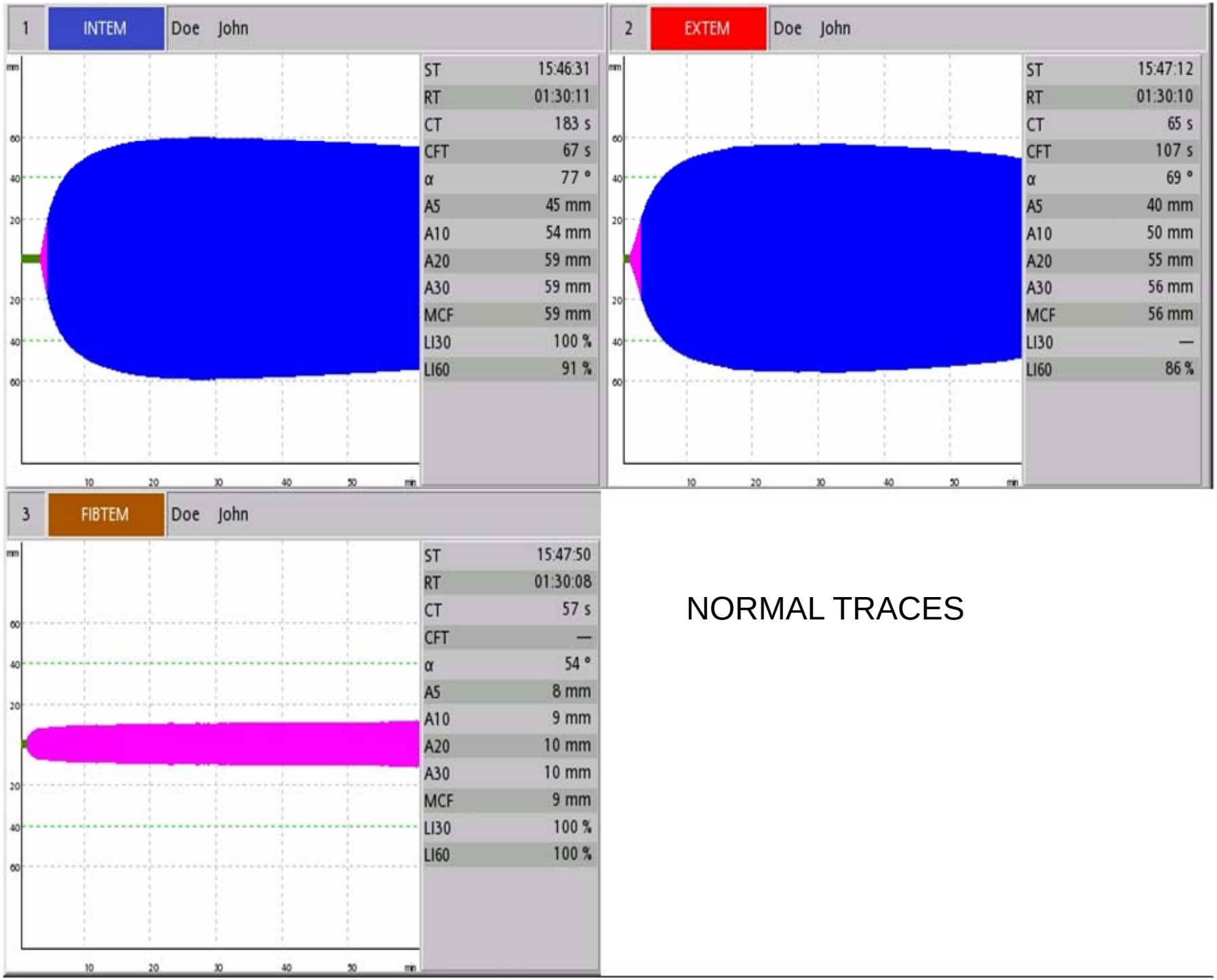
# Translation of Curve




**R= CT = initiation of clot**

**K= CFT = time from initiation to clot firmness of 20mm**

**MA= MCF = Firmness of clot**




NORMAL TRACES

# Aim of the Study

1. Observational field study to assess the feasibility of using ROTEM in a deployed setting.

2. To determine if the results from ROTEM could be used to assess the coagulation in the military trauma patient with the future potential to guide resuscitation therapies in MT patients.

# Study Outline

- Study period: 7 week from Jan – Mar 2009
- Assessed coagulation status of patients on admission to Role 3 facility in Camp Bastion
- Concentrating on those who received massive transfusions
    - UK Surgeon General's Operational Policy Letter
- Citrated blood samples were taken along with sample for standard laboratory tests and ABGs

# TEM measurement

- The ROTEM was placed in the operating room, next to ED and clinicians
- As ROTEM results were not yet incorporated into MT algorithms; results were not used to direct therapy but was available to clinicians
- All samples were run at 37°C

# Results – Patient Numbers

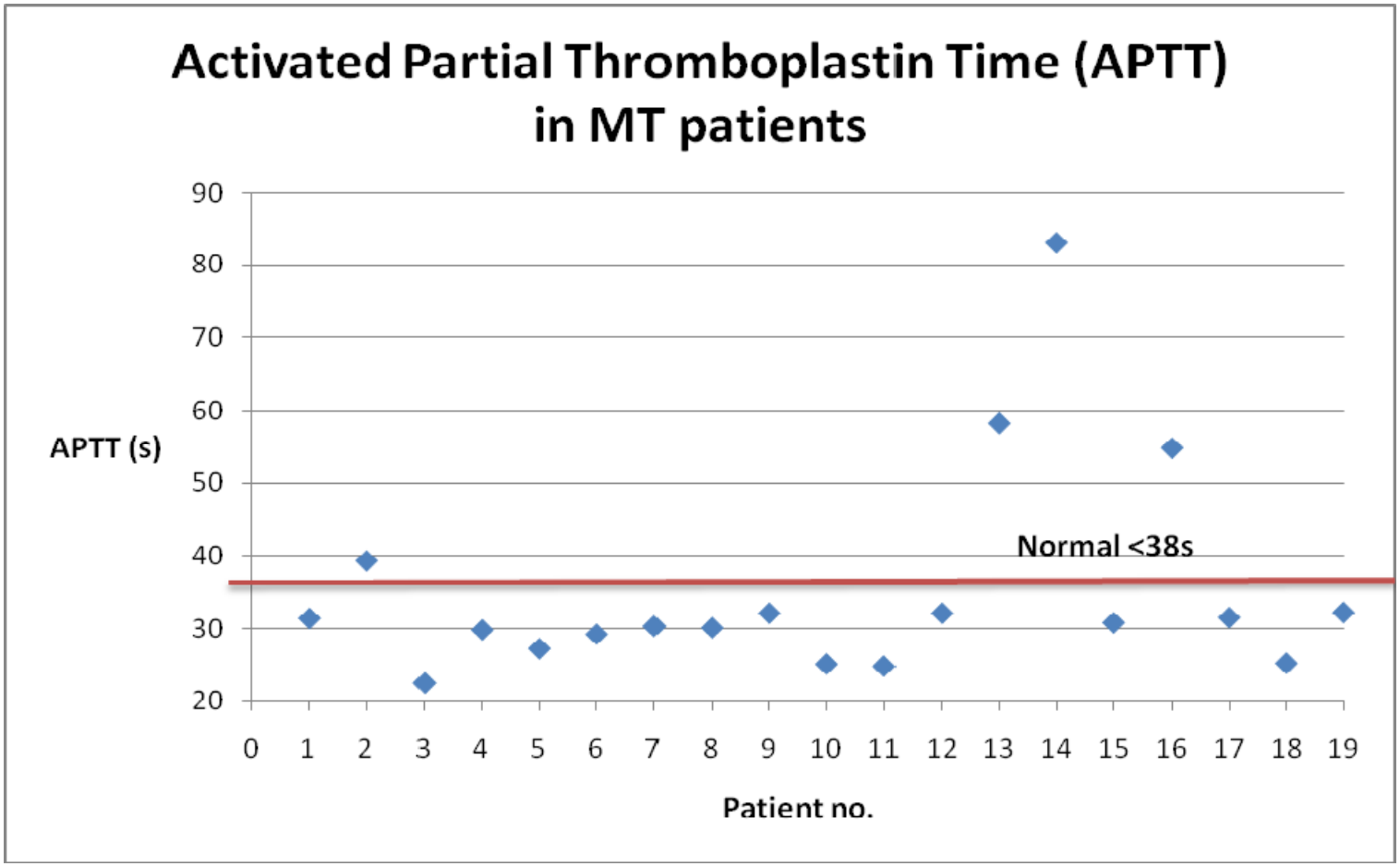
- 31 patients were tested
- 20 were enrolled into MTP
  - 1 had blood products prior to Role 3 ∴ excluded
- 11 non-MTP: 4 in-patients / 7 new admissions
  - 1 new admission was medical ∴ excluded
- 25 patients were analysed – all male
  - 19 MTP
  - 6 non- MTP

# Blood Transfusions

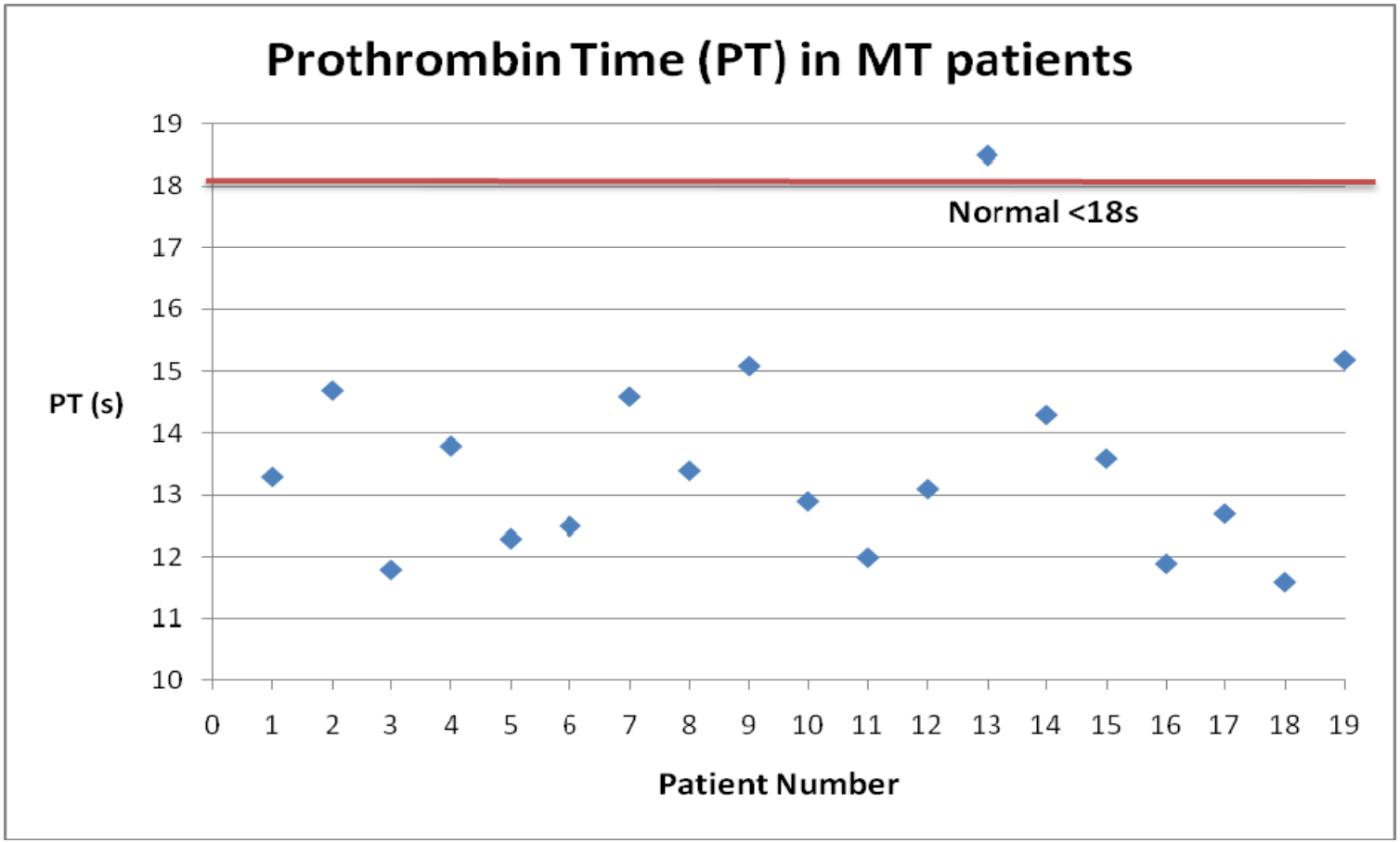
| | MTP (19) | | | | Non-MTP (6) | | | |
|---|---|---|---|---|---|---|---|---|
| Product | **P.RBC** | **FFP** | **Plt** | **Cryo** | **P.RBC** | **FFP** | **Plt** | **Cryo** |
| Total Products given | **164** | **116** | **15** | **13** | 5.5 | 3 | 0 | 0 |
| Average units per patient | **8.6** | **6** | **1** | **1** | 0.92 | 0.5 | 0 | 0 |
| Range | **4-16** | **2-12** | **0-5** | **0-2** | 0-2 | 0-2 | 0 | 0 |

Ratio 1.4 RBC : 1 FFP

# Laboratory Results - APTT



# Laboratory Results - PT



# ROTEM Results

- Looking at all patients (MT & non-MT):
  - **64%** (16/25) had abnormal results in all traces
  - Comparing to standard lab tests, ROTEM detects significantly more abnormalities

    p = 0.0005 (McNemar's test)
- In the two groups:
  - MT – **63.2%** (12/19) had abnormal results
  - Non-MT – **67.7%** (4/6) had abnormal results

# EXTEM Results

- Taking a MCF of 45mm or less as a level when the patient is at risk of bleeding

  *Lang et al.* 2005

- In the MT group – 31.6%  (6/19) were coagulopathic
- In the non-MT group – all patients are within normal limits

# Analysis of traces

- All patients with an abnormal INTEM had an abnormal EXTEM.
  - ∴ only need do 2 traces on each patient

- A10 is clot firmness at 10mins
  - Of the 9 abnormal EXTEM traces – 7 had low A10
  - No low A10 had a MCF above 50mm
  - Abnormal A10 is associated with Abnormal MCF

(p = 1.0)

# Case 1

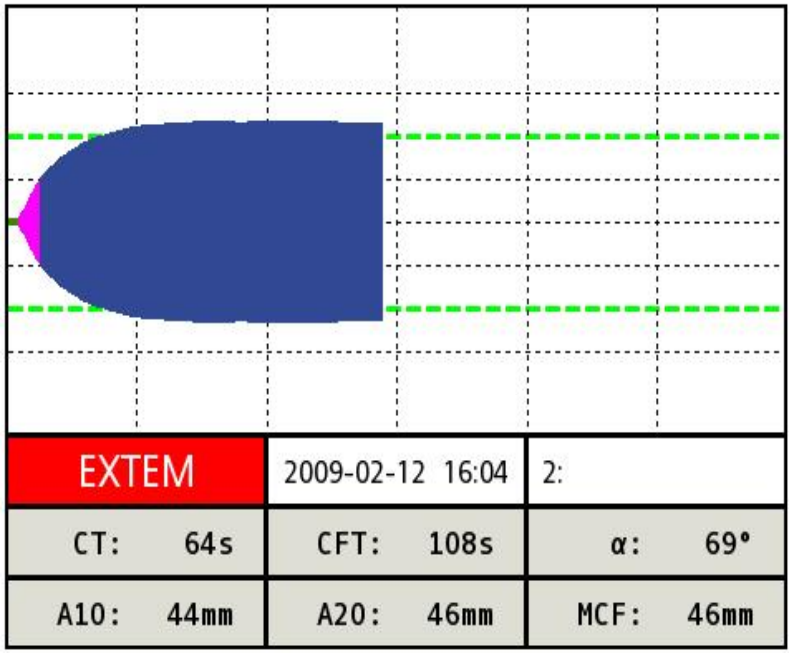
- 30kg Male
- 2hr post explosive incident

- Temp 32°c, BP -70/30
- pH = 7.01, BE = -18
- Hb - 5.6 / Plt – 236
- PT 18.5 / PTT 58.2

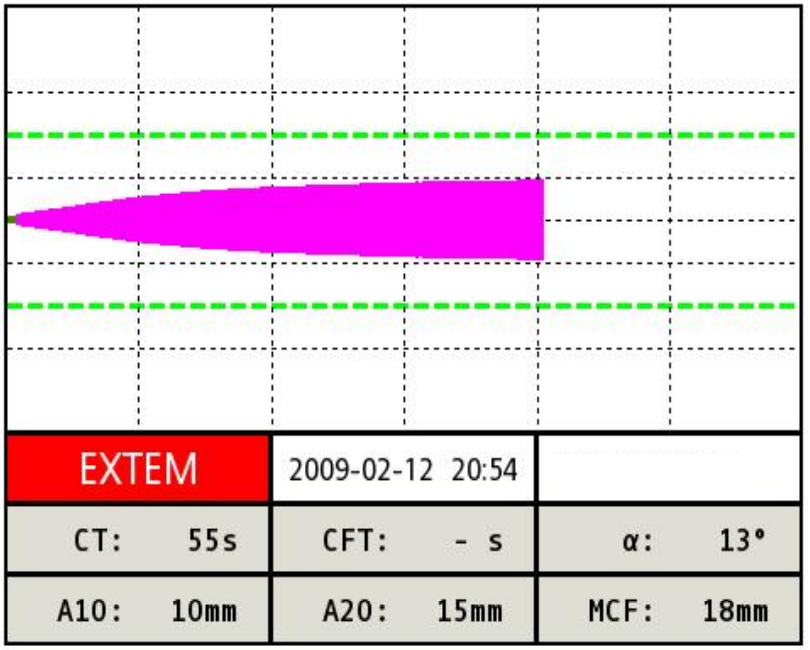
- Over next 18hrs –

  16 P.RBC, 10 FFP, 5Plts, 1Cryo

# EXTEM Traces

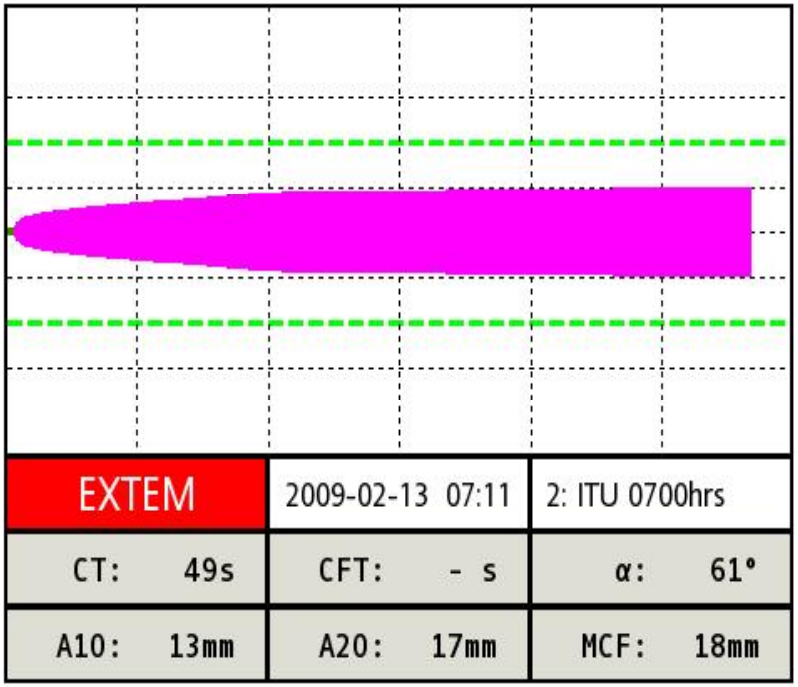



Initial ED trace

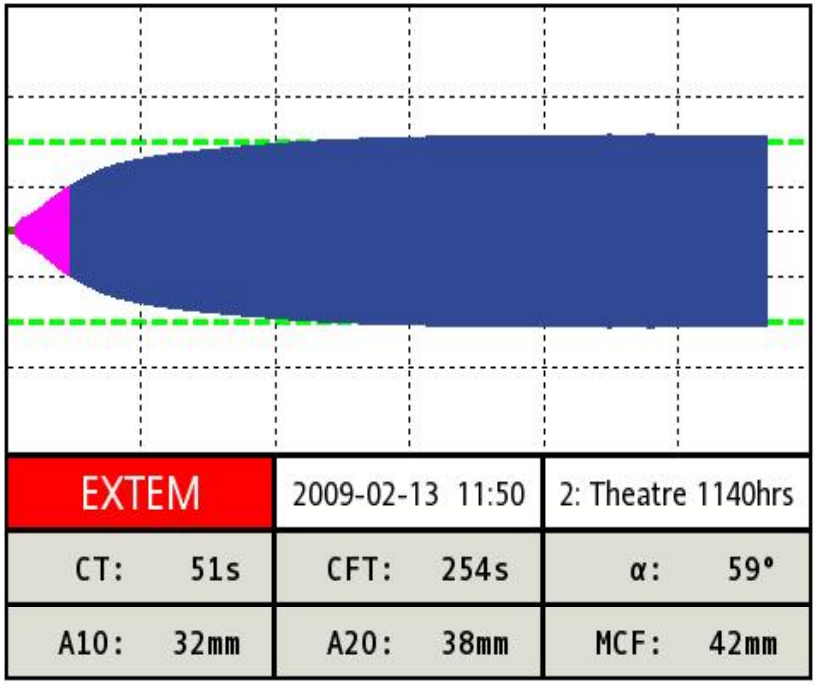



After admission to ITU

# Ongoing Resuscitation




After 15hrs – 15P.RBC/10FFP/ 4Plts/1Cryo

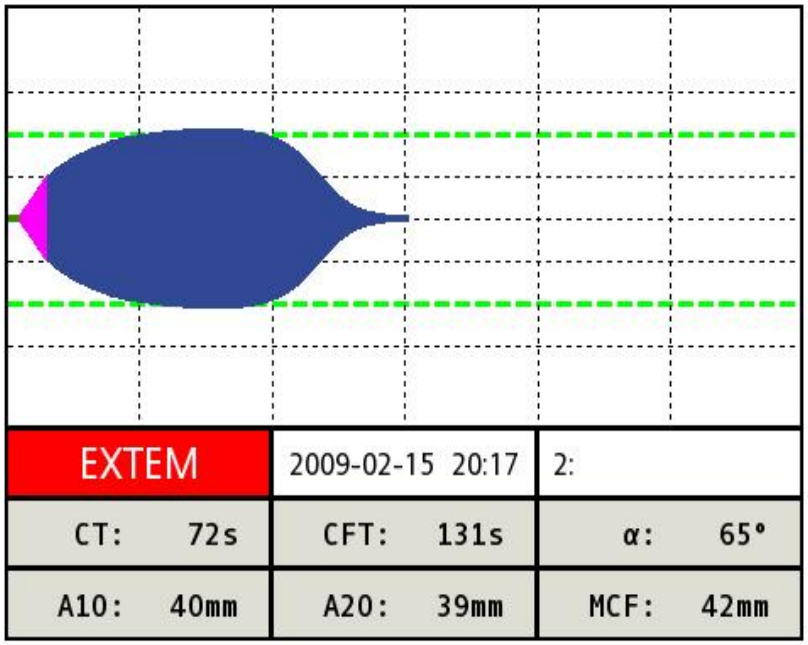



After 1 unit of apherised platelets

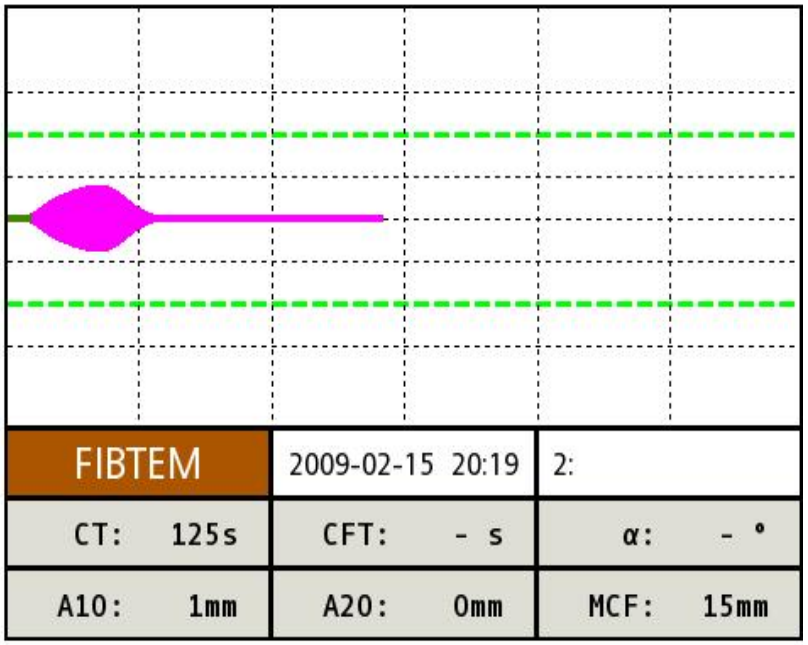
# Case 2

- 65 yr old man
- Unknown time after GSW to right flank
- Initial observations:
  - Systolic BP -110mmHg / pulse 94 bpm
  - Tympanic temperature -34.9°C
  - pH = 7.01 / base excess = -17
  - Hb = 8.4g/dL / plts = 182 x$10^9$cells/L
  - PT = 14.3s / APTT = 83.1s

# Initial Trace



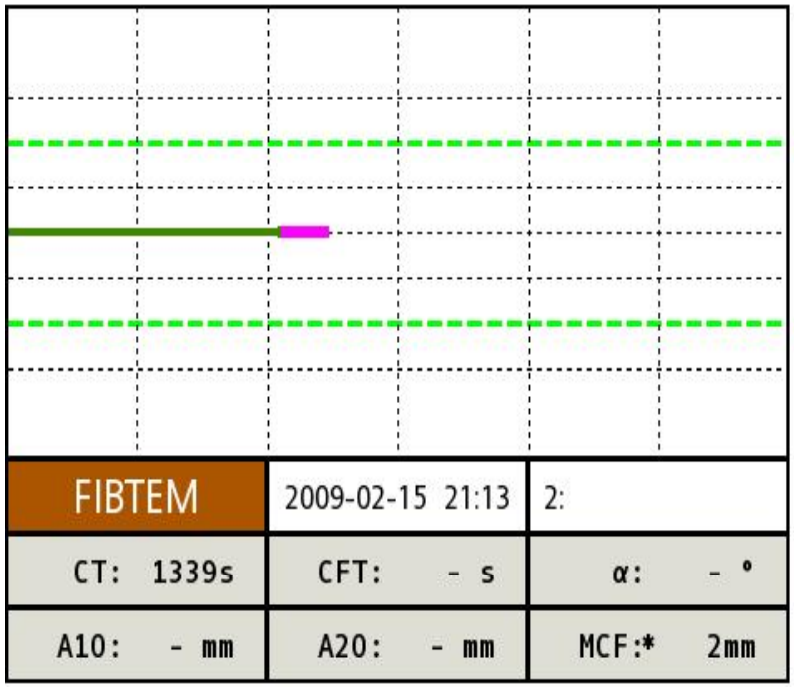
| EXTEM | 2009-02-15 20:17 | 2: |
|---|---|---|
| CT: 72s | CFT: 131s | α: 65° |
| A10: 40mm | A20: 39mm | MCF: 42mm |



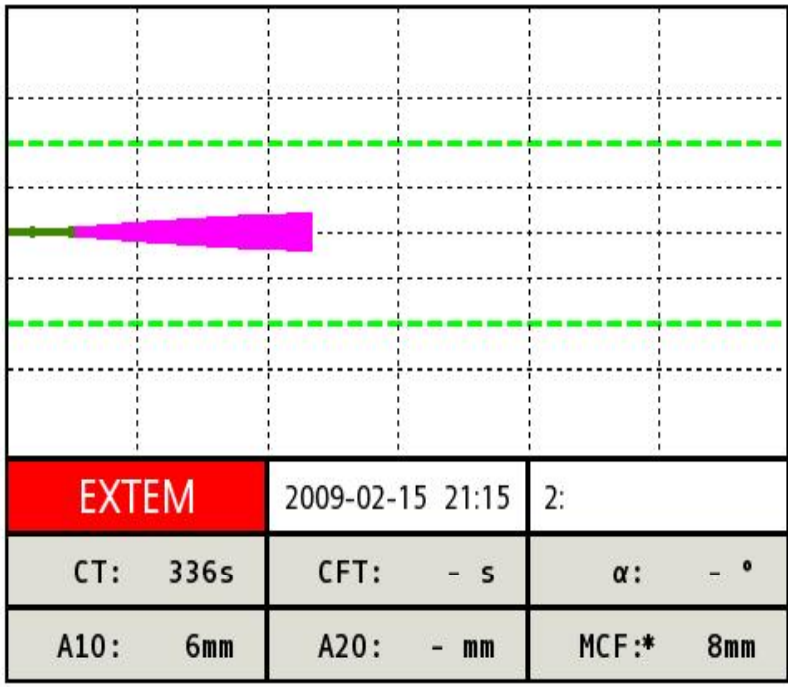
| FIBTEM | 2009-02-15 20:19 | 2: |
|---|---|---|
| CT: 125s | CFT: - s | α: - ° |
| A10: 1mm | A20: 0mm | MCF: 15mm |

HYPERFIBRINOLYSIS

# After 1 hr



| FIBTEM | 2009-02-15 21:13 | 2: |
|---|---|---|
| CT: 1339s | CFT: - s | α: - ° |
| A10: - mm | A20: - mm | MCF:* 2mm |



| EXTEM | 2009-02-15 21:15 | 2: |
|---|---|---|
| CT: 336s | CFT: - s | α: - ° |
| A10: 6mm | A20: - mm | MCF:* 8mm |

Completely hypocoagulable state

# Summary of Findings

- It is feasible to use ROTEM in a deployed military setting
- Statistically more patients with abnormal coagulation results were detected using ROTEM than standard laboratory measures
- It provides a convenient and timely method to measure coagulation state
- The exemplar cases show ROTEM allows individualisation of management

# Discussion

- Preliminary observational case study
- Data collection is ongoing
- Continuing clinical evaluation of TEM data in a deployed setting will allow its incorporation into future protocols

# Acknowledgements


- Surgeon General's Research Strategy Group
- Stratos funding
- Combat Casualty Care Team at Defence Science Technology Laboratory, Porton Down, UK

R

C

D

M

# Thank you

# Results - Admission Physiology

| Massive Transfusion Patients MTP (19) | Non- Massive Transfusion Patients non-MTP (6) |
|---|---|
| **ISS** = **35** (25-50) | **ISS** = **20** (19-20) |
| **Systolic BP** = **111**mmHg (95-134) | **Systolic BP** = **141**mmHg (130-165) |
| **Pulse Rate** = **126**bpm (105-140) | **Pulse Rate** = **100**bpm (90-110) |
| **Temperature** = **34.9**°C (34.4-35.6) | **Temperature** = **35.8**°C (35.7-35.8) |
| **pH** = **7.27** (7.19-7.32) | **pH** = **7.36** (7.28-7.4) |
| **Base Excess** = **-5** (-9 to -3) | **Base Excess** = **-2** (-5 to +1) |

**Admission Median results with Inter-Quartile Range (IQR) in brackets**