TEG/ROTEM: Applications for New Brunswick (Atlantic Canada)

ATEM conference
Dr. Michael Crozier

21 September 2017

Acknowledgement

- Dr. Sandro Rizoli MD PhD FRCSC FACS

- Professor Surgery & Critical Care Medicine, University of Toronto
  Chief Trauma & Acute Care Service, St Michael's Hospital
  Endowed Chair in Trauma Care
  Past President Trauma Association of Canada

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Conflicts of Interest: None Declared

Objectives

- Introduction to trauma resuscitation and applications for thromboelastography
- How the technology works
- How to integrate TEG/ROTEM into your hospital or trauma system

What is the best way to resuscitate bleeding patients?

- Trauma, Anesthesia, Critical Care, Obstetrics, Cardiac Surgery

How do we do this vs. how should we do this?

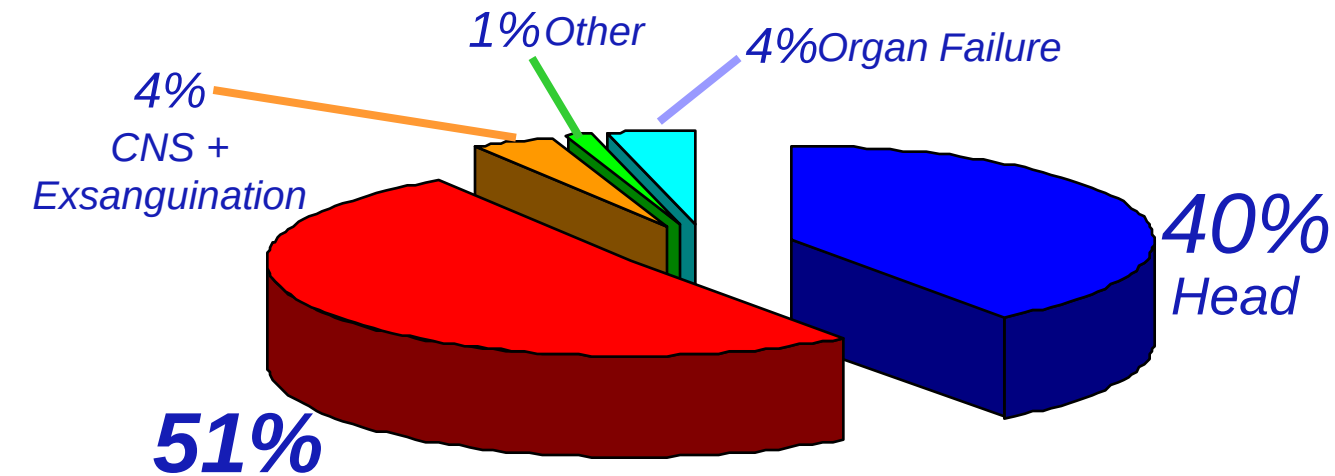
- Traditional vs. Incipient Approaches

Implications:

- Patient Morbidity and Mortality
- Blood products
- Cost

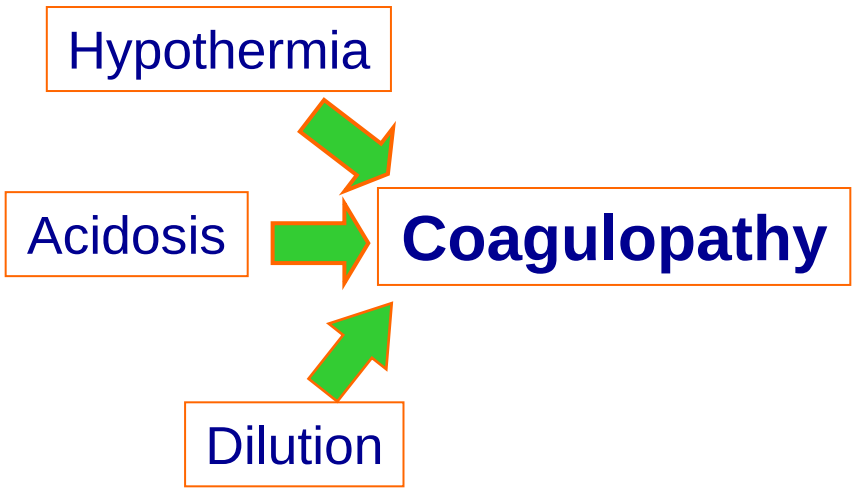
Introduction

trauma = lots bleeding
bleeding = can't clot
bleeding patients = die



Sauaia et al J Trauma 1995;38:185

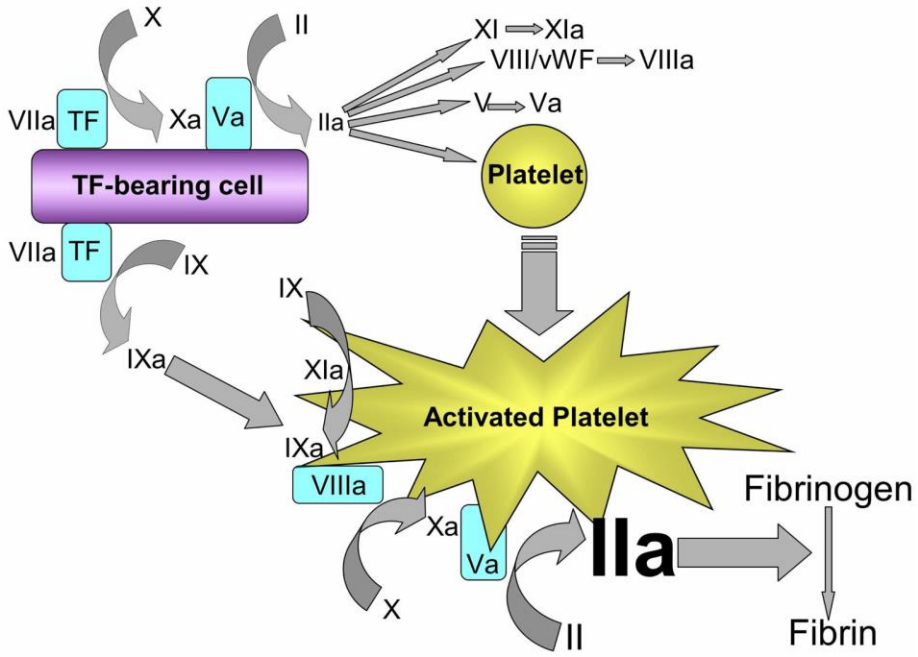
Background



Acute Trauma Coagulopathy

- early, organ failure
- 25% patients
- shock, injury, hypothermia
- dilution worsen
- blood, ICU, ventilation,
- 3x death

How does it all work?



Too complex
+ poor understanding

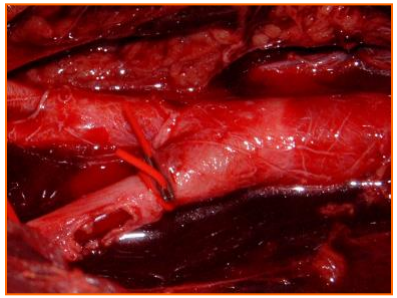
Simple:
- Clot/clotting factors
- fibrinogen *(obstetric)*
- platelets *(cardiac sx)*
- anti-fibrinolytics

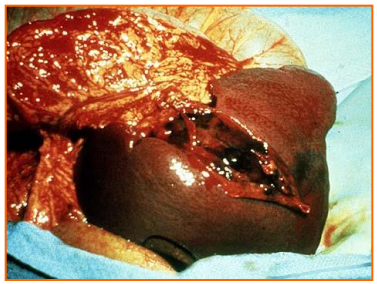
Little by little we advance

Bleeding is a Challenge to Manage

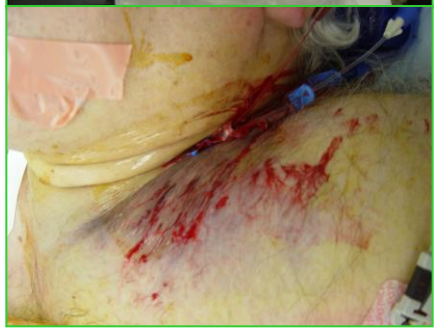
Clinical prediction = sensitivity 66%, PPV 35%

Mechanical





Coagulopathic



Strategy 1 – Crystalloid

Crystalloid-based resuscitation

XX century [illegible] is bad

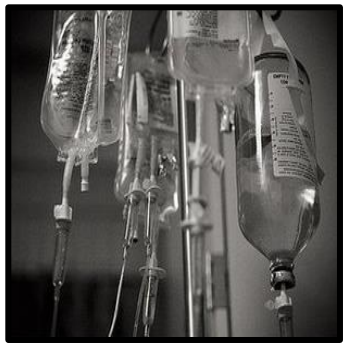
brain, lung, [illegible]edema

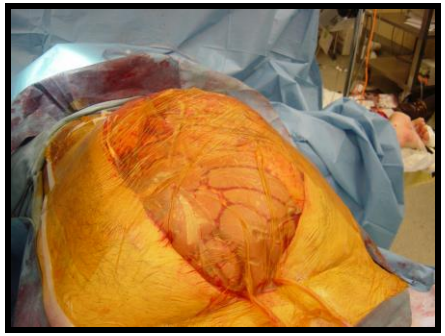
open abdo[illegible]

dilution = m[illegible] coag[illegible]pathy

more transfusion

more hypothermia





Strategy 2 – Ratio

Blood-based hemostatic resuscitation

Presume coagulopathic

Standard of care – hypotension = blood

Damage control resuscitation 1:1:1

- RBC + plasma + platelet
- blood early, blind, < crystalloids

MTP – blood bank + TR +OR + lab

Strategy 3 – Customized

Goal-directed resuscitation

1. Entire medicine is changing

2. High-stress situation – wrong decisions:

   acute & massive bleeding
   high risk of dying & time is essential
   multiple professionals
   activate MTP, blood transfusion, OR vs. CT scan

3. Directed by what? Lab tests?

ROTEM/TEG – Why to use it?
Many reasons:

a. diagnose hyper fibrinolysis

b. fibrinolysis shutdown

c. presence anticoagulants

d. decide what blood product

e. decide when to stop

Conventional lab NOT good

INR – warfarin; PTT – hemophilia

- poor plat plasma
- no correlation *in vivo* bleeding
- interpretation unknown
- extrapolated for trauma
- clinical interpretation
- **TIME** – 88 min *(10-15min)*

Summary

Coagulopathy: *complex, change time, dynamic*

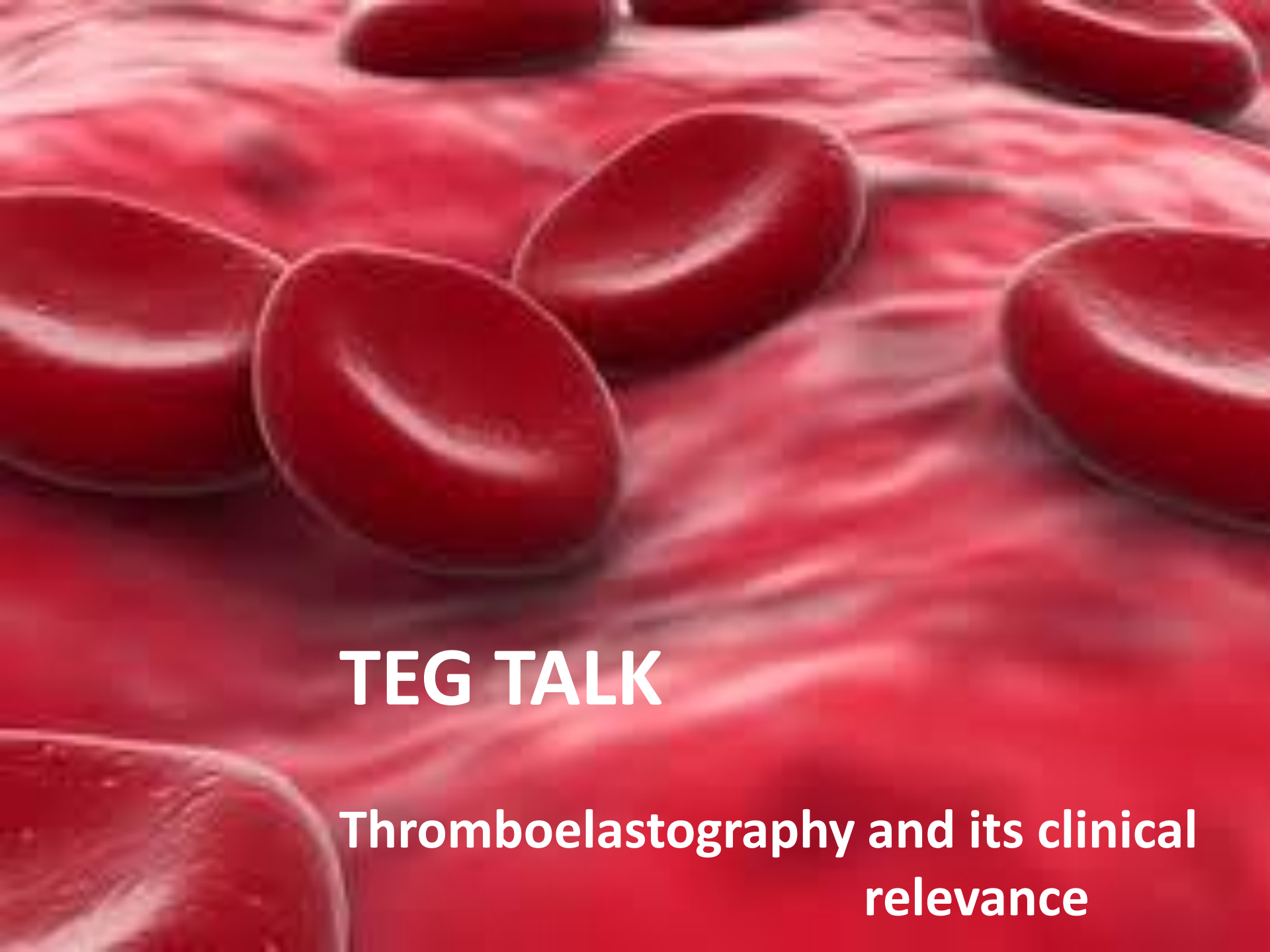
Trauma resuscitation *(or any major bleeding)*
Not much time – initiate blood 1:1:1
Prone errors – customize resuscitation

TEG/ROTEM *(not perfect)*

a. diagnose hyper fibrinolysis
b. fibrinolysis shutdown
c. presence anticoagulants
d. decide what blood product
e. decide when to stop

Summary

- Why don’t we have this strategy available to us in New Brunswick (Atlantic Canada)?
- Should we?



TEG TALK

Thromboelastography and its clinical relevance

Introduction

Clinica Chimica Acta 436 (2014) 143–148

Contents lists available at ScienceDirect

Clinica Chimica Acta

journal homepage: www.elsevier.com/locate/clinchim

Invited critical review

Why is everyone so excited about thromboelastrography (TEG)?

Brad S. Karon *

Department of Laboratory Medicine and Pathology, Mayo Clinic, 200 First Street SW, Rochester, MN 55905

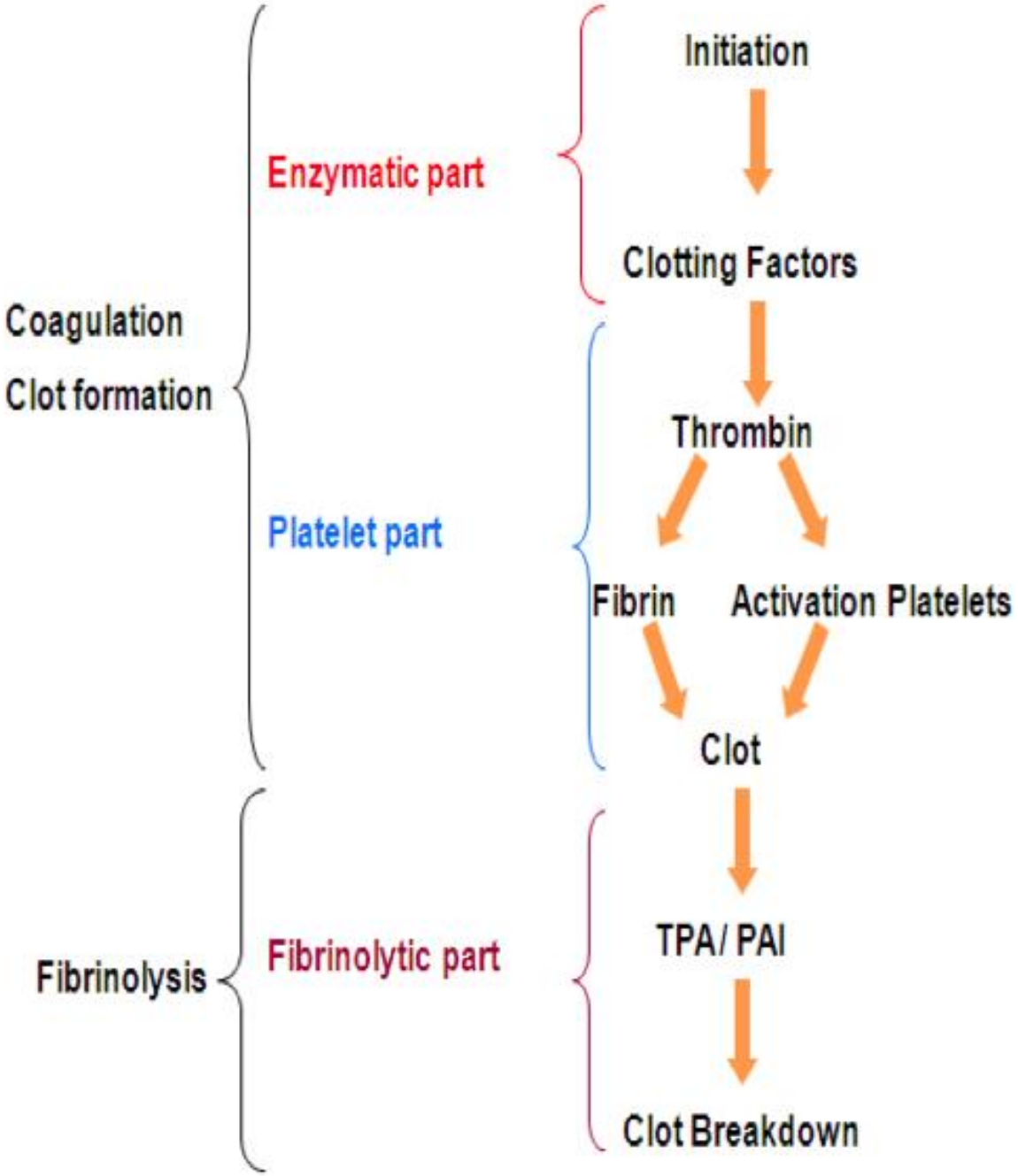
Components of Coagulation

- Local tissue effects
- Platelet aggregation **~Plt count**
- Intrinsic Pathway (F 8, 9, 11, 12) **~ PTT**
- Extrinsic Pathway (tissue Fctr and F7) **~PT**
- Common Pathway (Xa, thrombin, fibrinogen)

~TT

~fibrinogen

- Fibrinolysis (plasmin→plasminogen) and



Enzymatic part: Initiation of coagulation is dependenton coagulation factor concentration

Platelet part: Thrombin generation on the activated platelets generate fibrin from fibrinogen, which cross links with platelets building the clot. Dependent on platelets and fibrinogen

Fibrinolytic part. Dissolves the clot, dependent on fibrinand tPA (from endothelial cells)

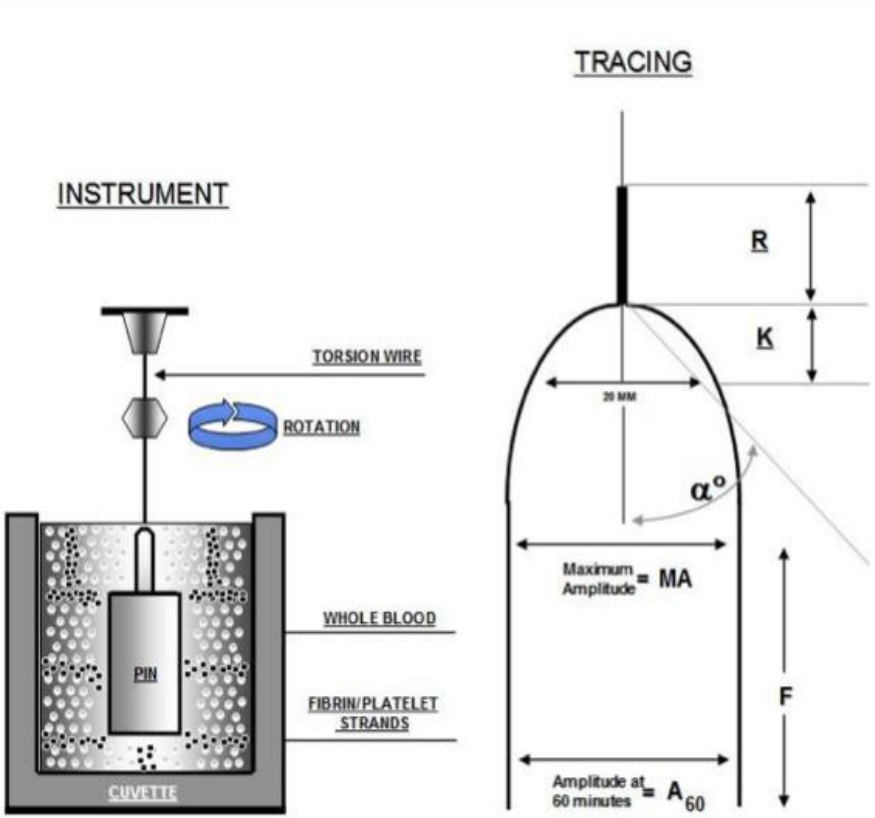
Viscoelastography

- monitors the clotting of whole blood in a cup or small container
- TEG (thromboelastography) is just one type.
- Two commercial types:

  TEG (cup spins / pin stationary)

  ROTEM (cup stationary / pin spins)

TEG Assay

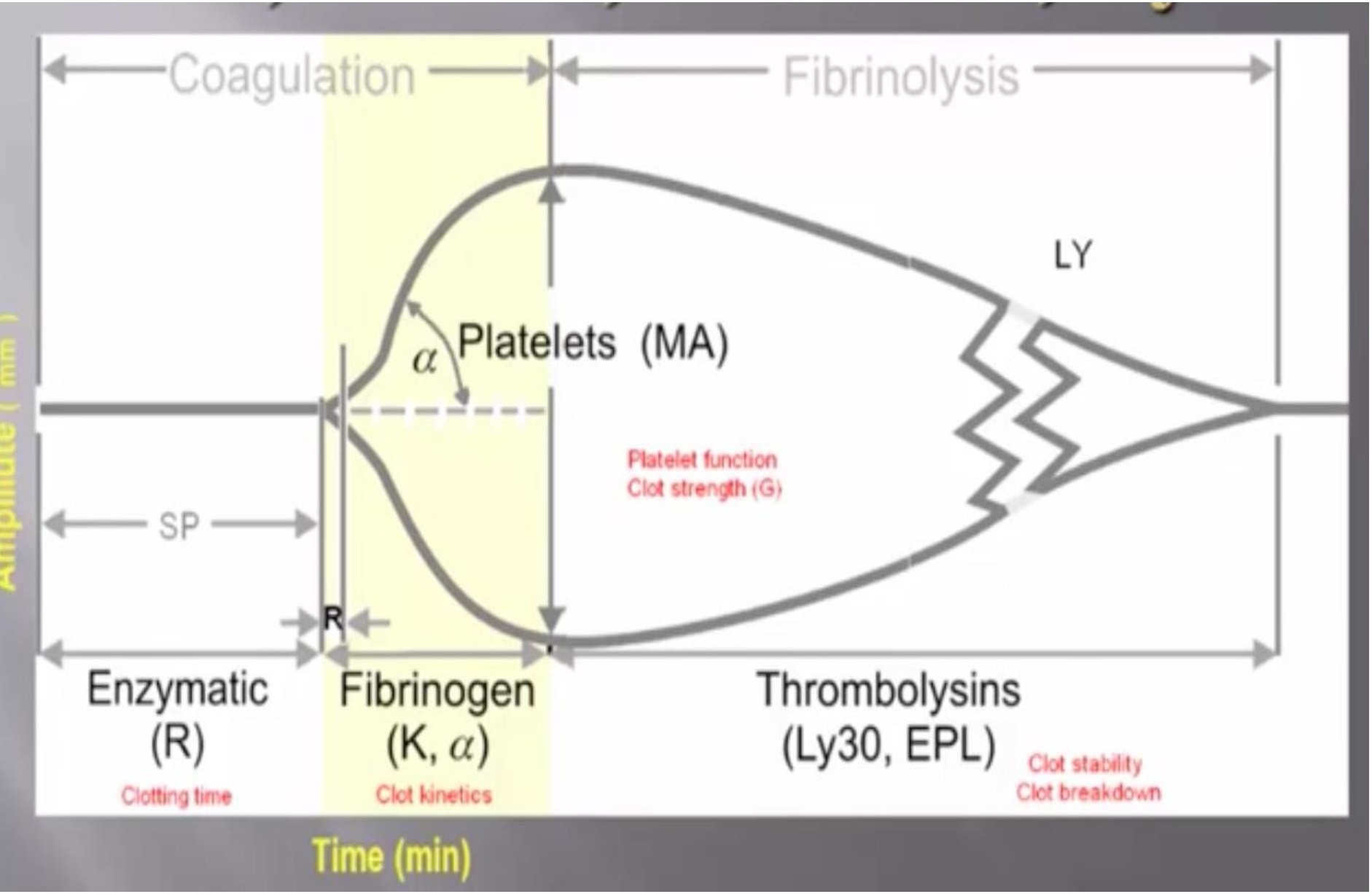


The thromboelastogram (TEG) measures whole clot strength. A cuvette warmed to 37° C is housed in the machine body, and a suspended piston is lowered into which 0.35 ml of whole blood is placed. Once the nonstimulated intrinsic cascade action creates clot, fibrin platelet strands are formed that adhere to the piston and the cuvette. The cuvette moves in a 4.5° arc rotation, applying stretch to the clot. Clot strength is measured over time on a paper tracing from which standard parameters can be measured. The TEG assesses clot function from the time of initial clot formation through the acceleration phase, clot strengthening, and retraction until eventual lysis. The five parameters most often used (R, K, alpha, MA, and A60) are measured in either millimeters or degrees (alpha). R= reaction time: K= coagulation time: Alpha= clot formation rate: MA= maximum amplitude: A60= amplitude 60 minutes after MA: A60MA= whole blood clot lysis index: F= whole blood lysis time (Speiss, 1990, and Tuman et al. 1989).

- A whole blood sample (citrated or non-citrated) is placed into a cuvette and a cylindrical pin is immersed.
- The pin is free-pending and the cup oscillates.
- The clotting process is detected via a torsion wire.
- The TEG is extremely sensitive to vibrations and mechanical shocks.

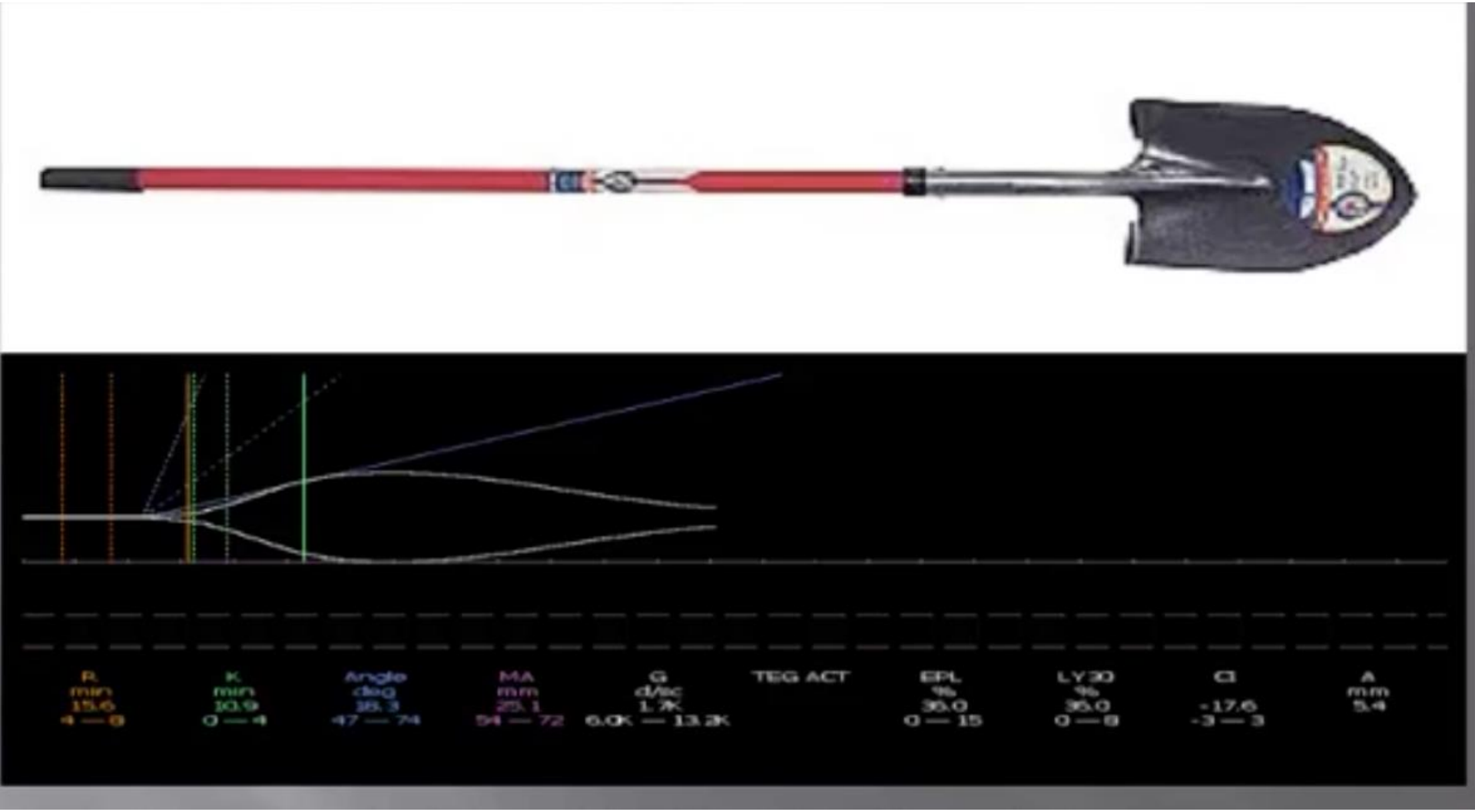
Assay Time = 15-20 min

https://youtu.be/gJwU7g0mn8M

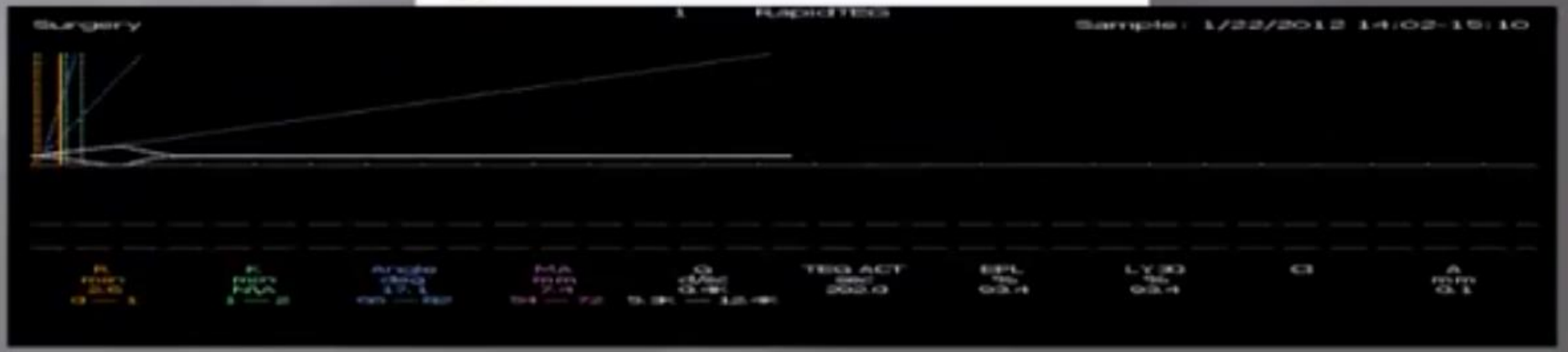

Coagulation
Fibrinolysis
LY
α
Platelets (MA)
Platelet function
Clot strength (G)
SP
R
Enzymatic
(R)
Clotting time
Fibrinogen
(K, α)
Clot kinetics
Thrombolysins
(Ly30, EPL)
Clot stability
Clot breakdown
Time (min)


UnionTools
EVERY NORMAL CANADIAN NEEDS A SNOW SHOVEL
Surgery
4 Kaolin
Sample: 1/22/2012 15:24-16:04
R
min
3.4
4 — 8
K
min
1.1
0 — 4
Angle
deg
74.2
47 — 74
MA
mm
62.9
54 — 72
G
d/sc
8.9K
6.0K — 13.3K
TEG ACT
EPL
%
0 — 15
LY30
%
0 — 8
CI
2.9
-3 — 3
A
mm
66.4

The Grave Digger



TIME TO PLANT
DAISIES



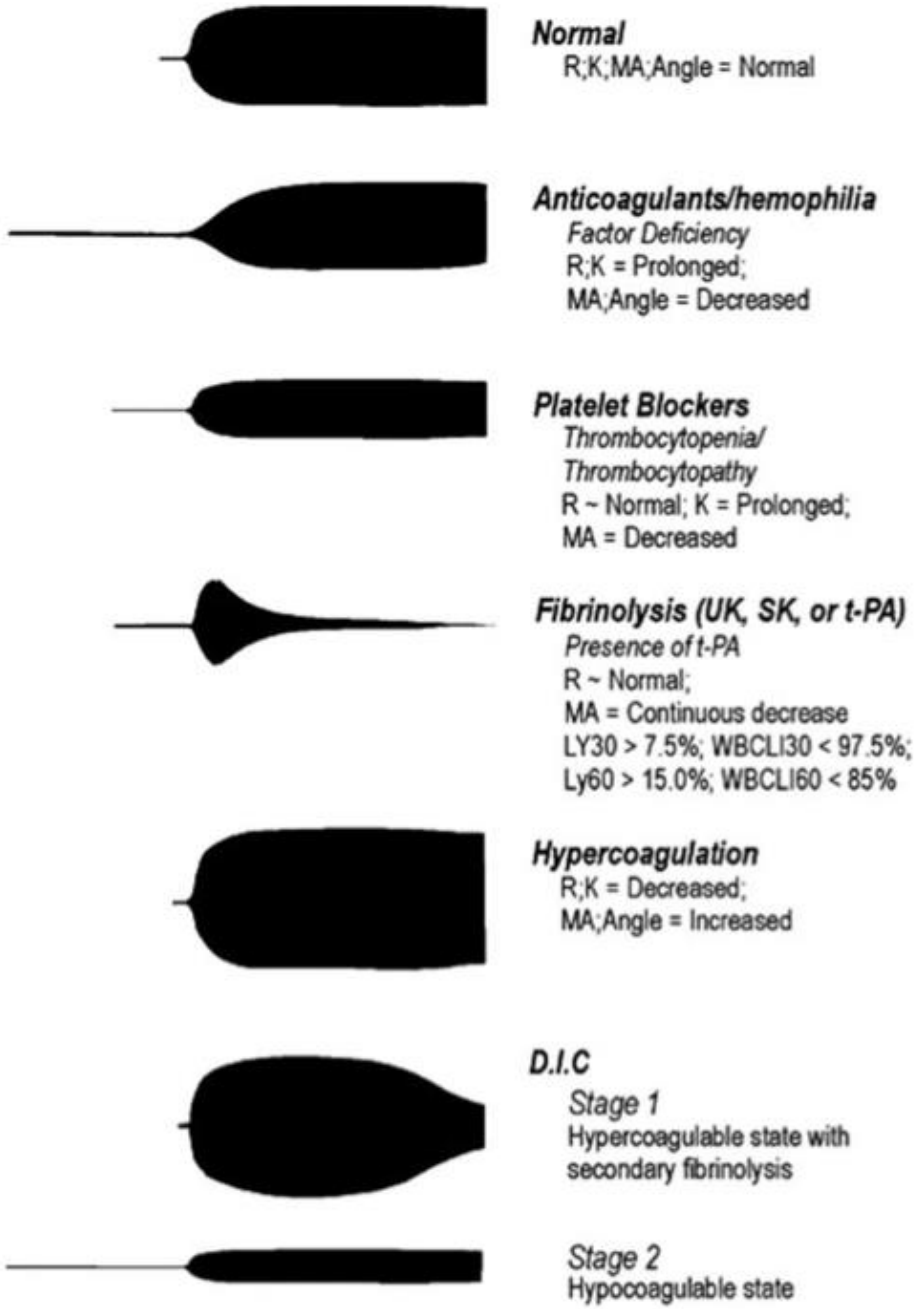


Figure 5. A depiction of a normal TEG output as compared to output seen in various coagulopathic states.

Remote visualization

Canadian National Advisory Committee on Blood Product use – MT Consensus Statement

Critical Care 2011 15 p242

- Where available local testing (Rotem or TEG) are acceptable tools in a Goal Directed Approach to Massive Transfusion
- Specific lab tests used, and the goals of therapy, can be locally determined with emphasis on the value of tests with rapid turn around.

WTA 2013 PLENARY PAPER

The International Normalized Ratio overestimates coagulopathy in stable trauma and surgical patients

Sean P. McCully, MD, MS, Loic J. Fabricant, MD, Nicholas R. Kunio, MD, Tahnee L. Groat, MPH, Katherine M. Watson, BA, Jerome A. Differding, MPH, Thomas G. Deloughery, MD, *and* **Martin A. Schreiber, MD,** *Portland, Oregon*

J Trauma and Acute Care Surgery Jan 2013 vol 75 p. 947-

Assessing *specific* platelet function with PlateletMapping

3. Define effect of agonist on platelet contribution to clot strength
   - ADP (Plavix ®)
   - AA (Aspirin)

Cost / Benefits

- Not designed for mass testing
- U.S. studies show reduced blood prod use in Massive Bleeds $$
- Possible reductions in the 4 Ts
  TRIM transfusion related immuno-modulation
  TACO transfusion assoc circulatory overload
  TRALI transfusion related acute lung injury
  TAE thrombotic adverse events

"*HEMOVIGILANCE*"

- Optimize pre-op erythrpoesis
- Reduce operative loss
- Optimize physiologic tolerance to loss
- Use anti-fibrinolytics (when can)
- GOAL DIRECT :

  red cells Plt clotting factors

  and

  Fluids

ANESTHESIOLOGY MARCH 2017

Risk Factors and Clinical Outcomes Associated with Perioperative Transfusion-associated Circulatory Overload

Leanne Clifford, B.M., Qing Jia, M.D., Arun Subramanian, M.B.B.S., Hemang Yadav, M.B.B.S., Darrell R. Schroeder, M.S., Daryl J. Kor, M.D.

"Why is better recognition and prevention of transfusion-associated circulatory overload important?"

TACO - most common trans-fusion complication

25% of all transfusions
Occur peri-operatively

75% of TACO occurs in
Non-emergent surgeries

MAY be preventable

Outcomes from TACO

- 2X risk of post op mechanical ventilation (70% vs 30%)
- ~2X ICU Length of stay (11d vs 6d)
- 2X hospital length of stay (20d vs 9d)
- Reduced one year mortality 28% vs 16%

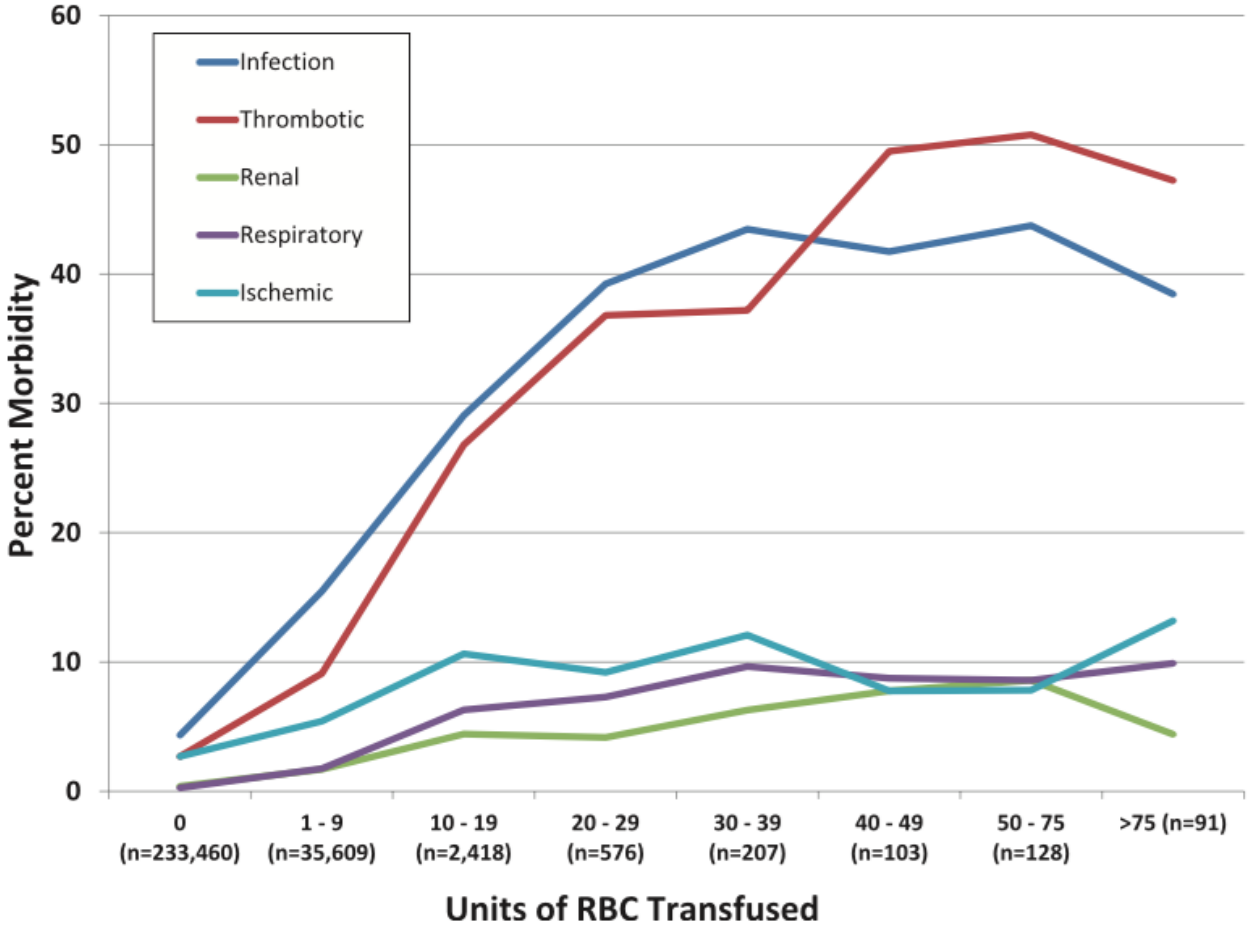
Conclusion

- *“Until targeted therapies are available to treat TACO, prevention remains paramount with the avoidance of unnecessary transfusions being critically important. Particularly careful consideration regarding the appropriateness of a transfusion episode and the management of nonsanguineous fluid therapies should be employed”*

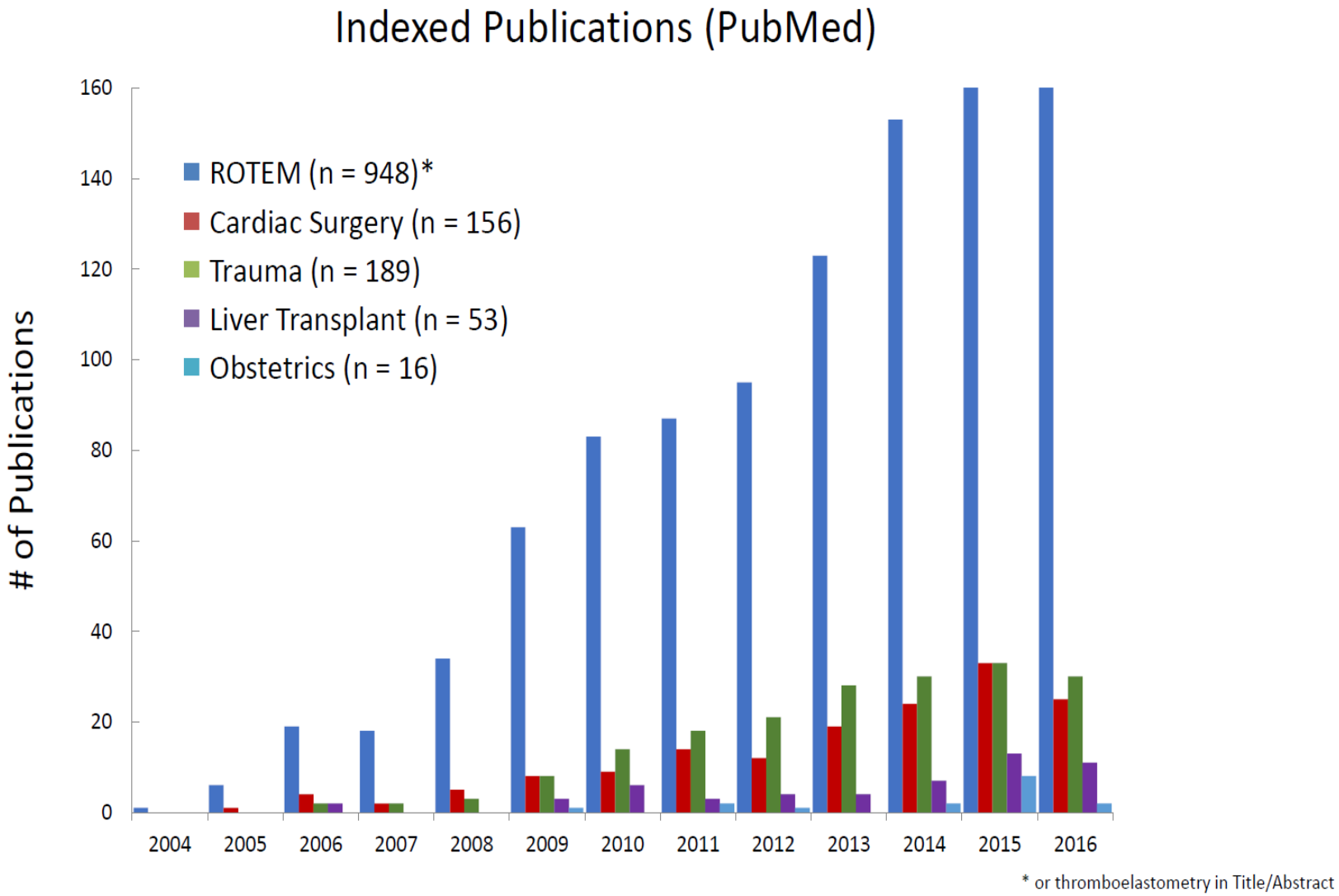
Morbidity and Mortality after High-dose Transfusion

ANESTHESIOLOGY 2016; 124:387-95

Daniel J. Johnson, B.S., Andrew V. Scott, B.S., Viachaslau M. Barodka, M.D., Sunhee Park, M.D., Jack O. Wasey, B.M., B.Ch., Paul M. Ness, M.D., Tom Gniadek, M.D., Ph.D., Steven M. Frank, M.D.



TEG or ROTEM-based Approach in Laboratory Medicine



J. Trudeau, Transfusion Medicine Rounds, Vancouver

TEG® 5000, Haemonetics Corp.

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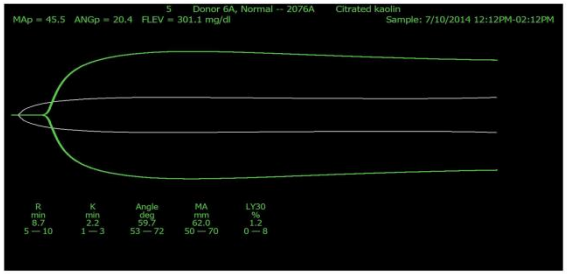
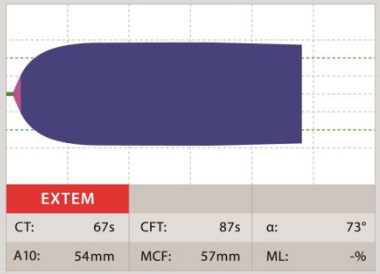


ROTEM® Delta, TEM Systems

Images of the ROTEM® *delta* thromboelastometry analyzer and ROTEM® tracings are reproduced with permission of TEM Systems, Inc. and its parent company Tem International GmbH. ROTEM® is a registered trademark of Tem International GmbH.



- ROTEM :
  - Approved by FDA in 2011
  - Approved by Health Canada in 2012

ROTEM

- Gives quick data about whole coagulation system in real time
- Whole blood is used, no need to process or handle the sample
- Numerical results are compared to well-established reference ranges
- Can be used as POC device or Laboratory –based analyser
- Testing results facilitates in goal-directed management of critically ill patients (trauma, surgical, ICU)
- Helps to decrease unnecessary blood product usage and further risks of blood transfusions
- Especially crucial for early detection of unwanted fibrinolysis or fibrinolytic shut-down

"ROTEM-Based Coagulation Management in Cardiac Surgery and Major Trauma" ; Kenichi A. Tanaka et al. *J of Cardiothoracic and Vascular Anesthesia,* 2012

POC vs Lab-based ROTEM

Advantages

- Point of Care

- No specimen transport
- Faster TAT (Turnaround time) and real time management

- Lab-based

- Quality assurance and lab. accreditation standards are maintained
- All users are standardized, no need to train staff in multiple clinical areas
- Prevents mistakes from inappropriate use
- Increases involvement of Hematopathologists and TM specialists

POC vs Lab-based ROTEM

Disadvantages

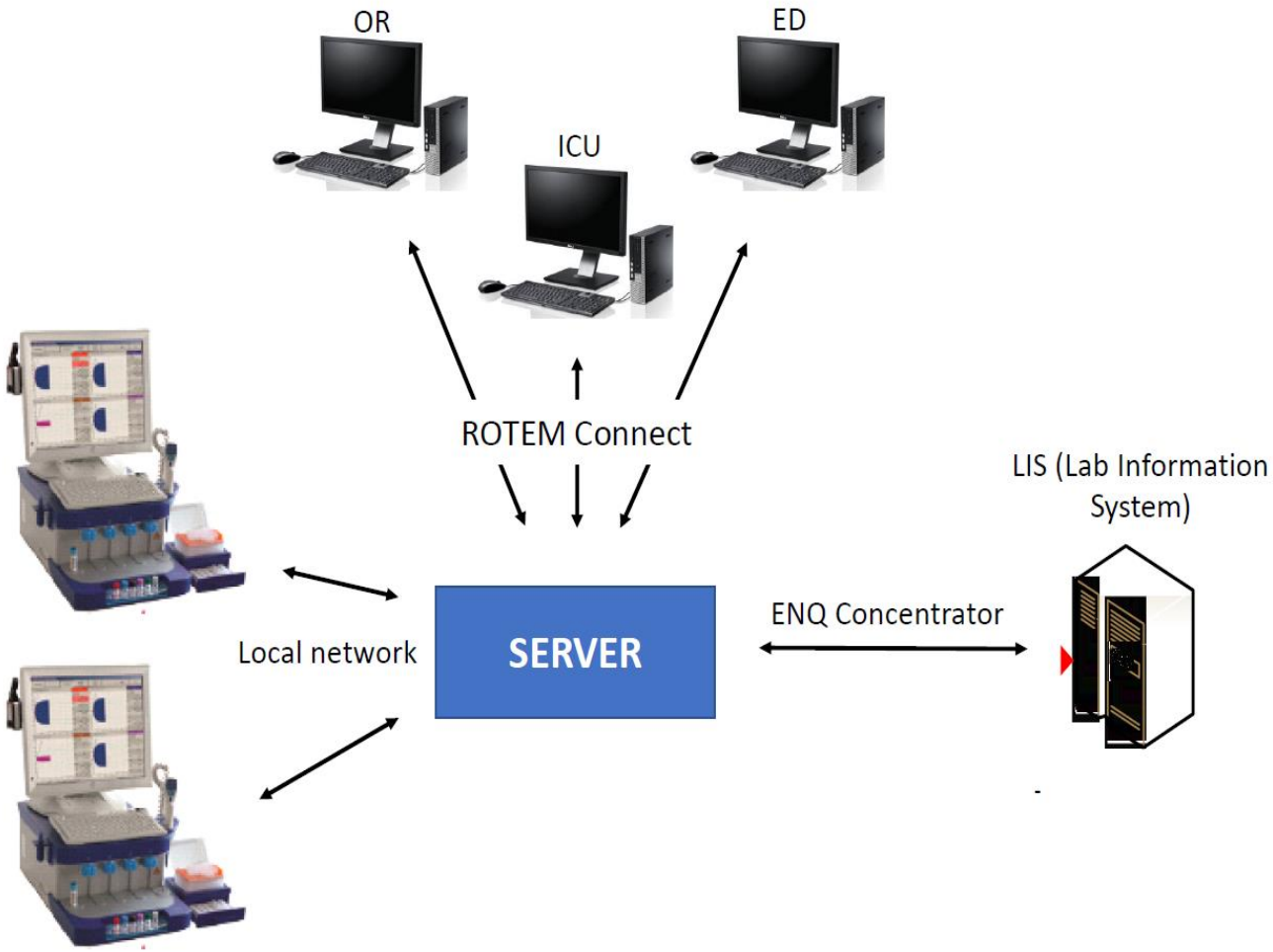
- Point of Care

  - Multiple analysers needed in multiple clinical areas or use will be restricted based on accessibility
  - Requires dedicated staff (RT, RN, Physician) to be taken away from active patient management
  - No automated entry of results in to LIS and EHR
  - QA and QC protocols still requires regular Lab. oversight and involvement

- Lab-based

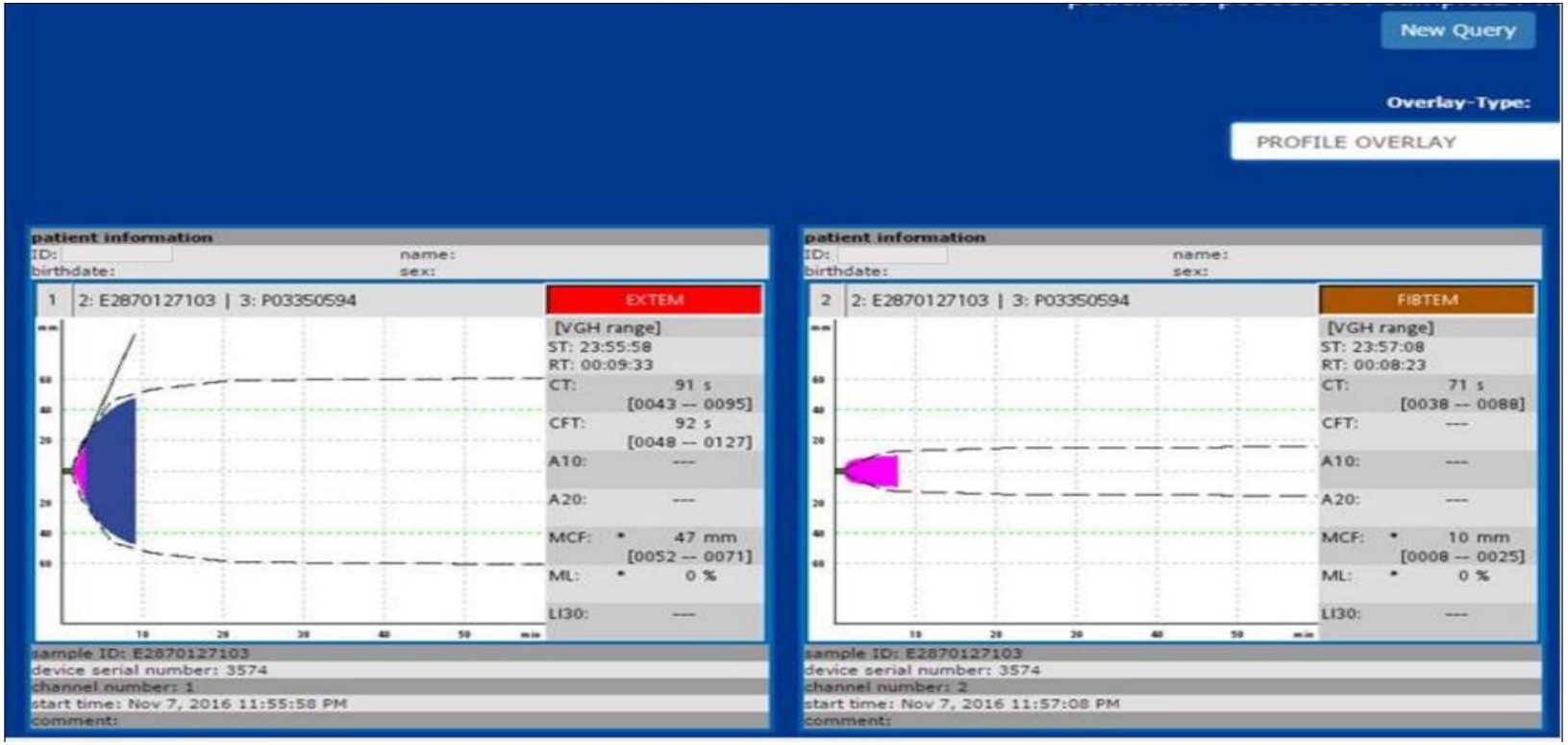
  - Requires good communication between care areas and Lab. for faster TAT
  - Specimen transport to the Lab. delays the testing (5-10 min)
  - Well-established specimen transport protocols needed if pneumatic tube system is used

Result Reporting



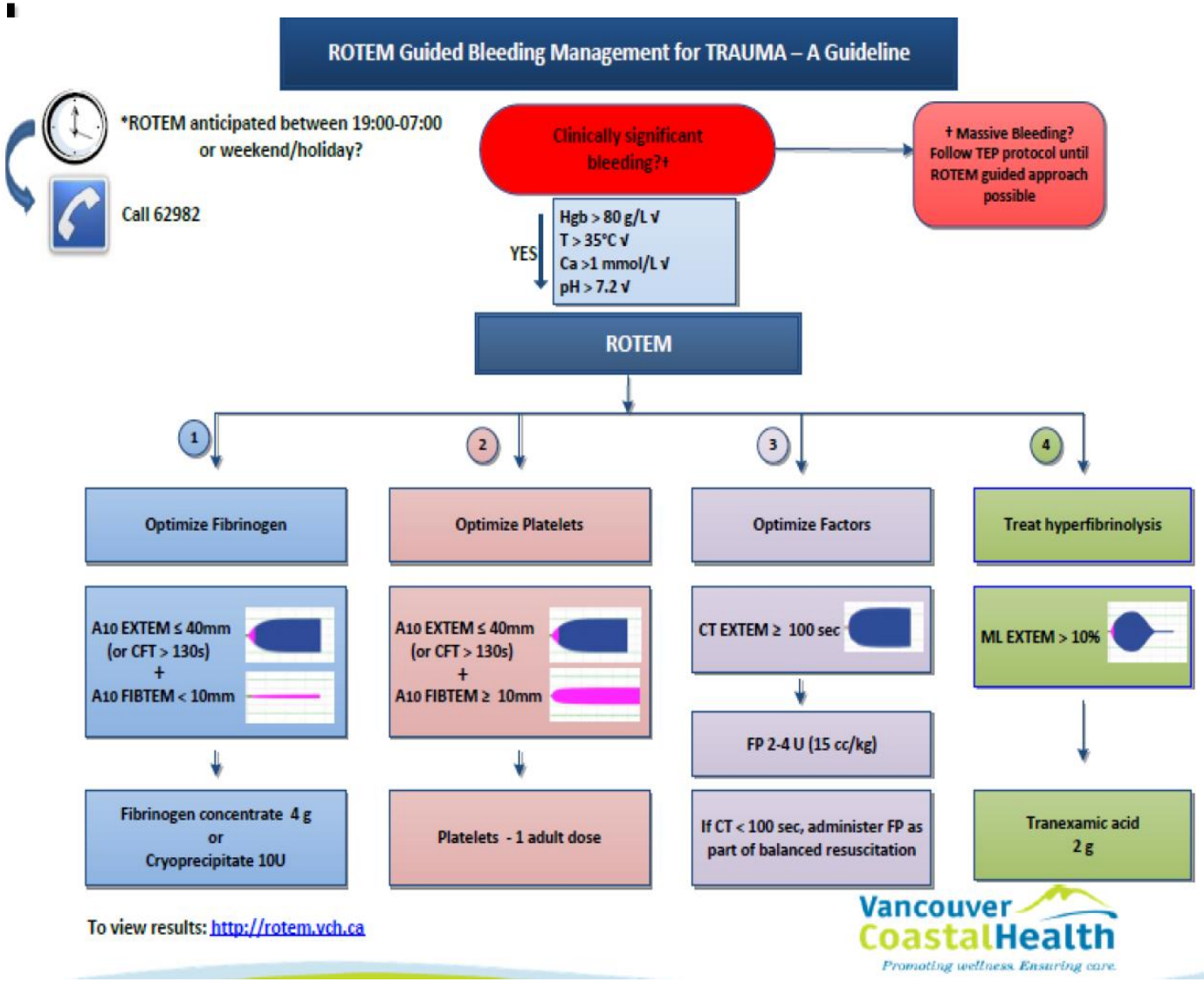
Result Reporting

ROTEM Connect – Live – streaming of data

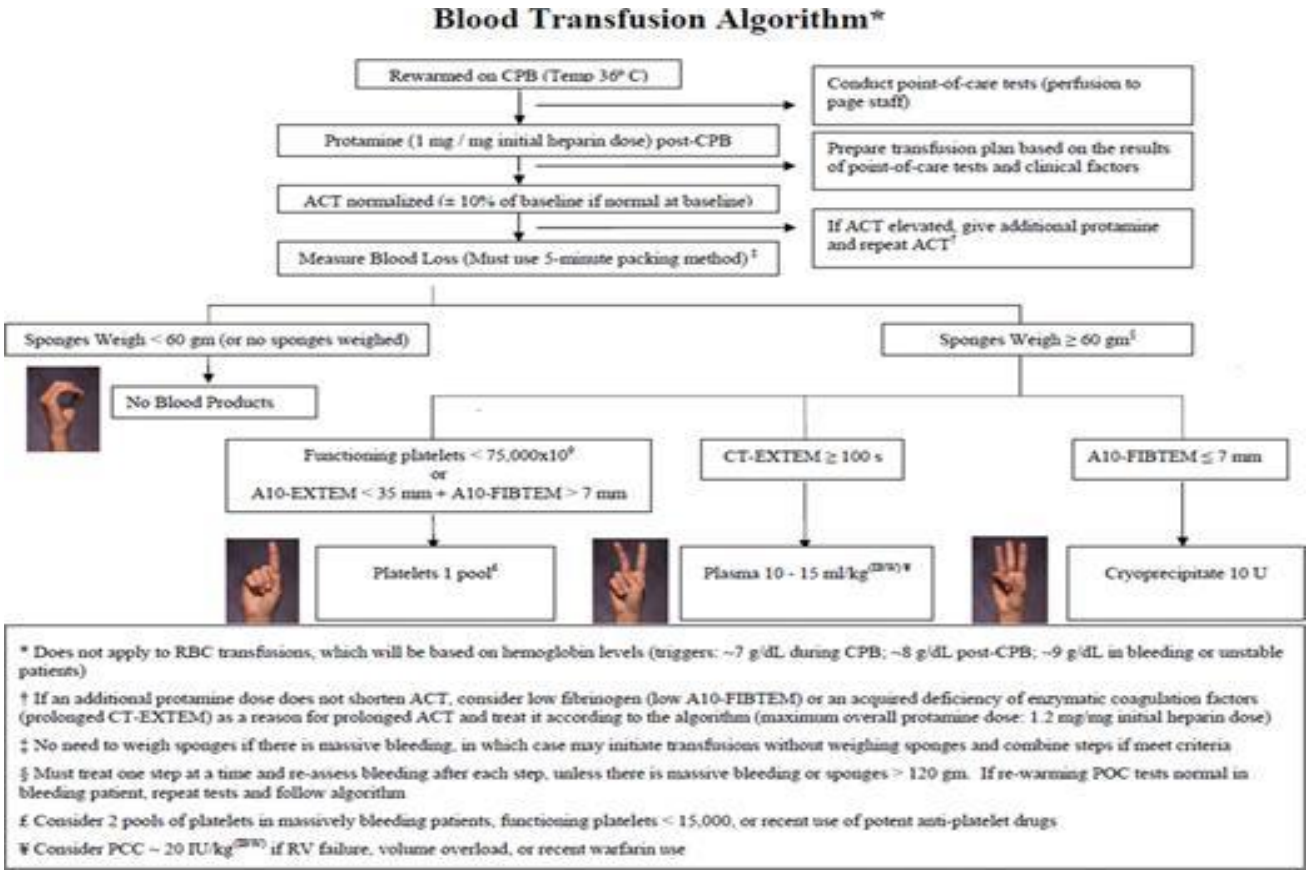


Courtesy of Dr.Trudeau, Vancouver Coastal Health

ROTEM-based Transfusion Alg



ROTEM-based Transfusion Algorithms



UHN, Blood Transfusion Algorithm for Cardiac Cases

A Canadian study…

Evaluation of a Novel Transfusion Algorithm Employing Point-of-care Coagulation Assays in Cardiac Surgery

A Retrospective Cohort Study with Interrupted Time–Series Analysis

Keyvan Karkouti, M.D., Stuart A. McCluskey, M.D., Ph.D., Jeannie Callum, M.D., John Freedman, M.D., Rita Selby, M.D., Tarik Timoumi, M.D., Debashis Roy, M.D., Vivek Rao, M.D., Ph.D.

(ANESTHESIOLOGY 2015; 122:560-70)

	Pre-algorithm (n = 1131)	Post-algorithm (n = 1170)	P-value
RBC Transfusions	52%	41%	< 0.001
PLT Transfusions	34%	23%	< 0.001
FFP Transfusions	34%	14%	< 0.001
≥ 4 RBC units	13%	7%	< 0.001
rFVIIa	3%	1%	< 0.001

In Summary

- ROTEM testing will be a useful tool in goal-directed management of critically ill patients
- We would have centralized approach and perform all ROTEM testing in the Lab.
- Results are reported in real time to patient care areas
- Using the goal-oriented transfusion algorithm, clinicians may appropriately select necessary transfusion components instead of empirically administering all components with potential hazardous effects
- ROTEM testing implemented Canadian sites report in-return cost savings (reduced blood product use and other lab. test ordering)

QUESTIONS?

- CADTH report
- Thank you