Viscoelastic Testing: Role & Target

Sandro Rizoli, MD PhD FRCSC FACS
Professor Surgery & Critical Care Medicine
Medical Director Trauma & Acute Care Surgery
President Panamerican Trauma Society

St. Michael's
Inspired Care. Inspiring Science.

Disclosure

KCI Canada
CSL Behring
NovoNordisk

more ROTEM – SMH

Trauma Induced Coagulopathy (TIC)

- common = 25% patients
- intrinsic – immediate *(at the scene)*
- organ failure/dysfunction
- mortality 3 – 4x
- complex *(many different hemostatic defects)*

- NOT dilution, consumptive, DIC
- 1st cause preventable deaths

Stone Age

Most important determinants: who & time

21M, multiple chest/abd GSW, 1am Friday
few minutes to SMH
TTL Dr Andrew Petrosoniack
blood trauma bay

agonal breathing – finger thoracostomy
loose pulses = ED thoracotomy
heart pulsating + aorta clamp

Stone Age

anesthesia staff trauma bay – OR immediately

blown out common iliac vein + segment II liver
gross contamination *(gastric + bowel perforations)*

obvious coagulopathy
ligate vein + hepatectomy + pack abd/chest

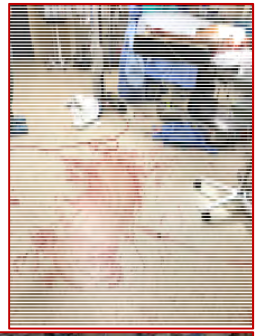
TNICU = resuscitation (25U RBC) = 1pm back OR

Stone Age

2nd surgery, same day
no crystalloid + infusion TXA
anesthesia x2 + Dr Sholzberg

no mechanical source – blood = water

about 75U RBC ++++++++
rFVIIa = first clots seen



ROTEM Tells Story *(100u RBC)*

	1am	7am	10am	next day
CT *(43-82)*	98	664	181	57
CFT *(48-127)*	171		755	148
A10 *(43-65)*	37	6	2	40
MCF *(52-70)*	49	12	25	52
ML *(<15%)*	1	0	0	1
FIBTEM A10 MCF *(7-24)*	7	6	2	15

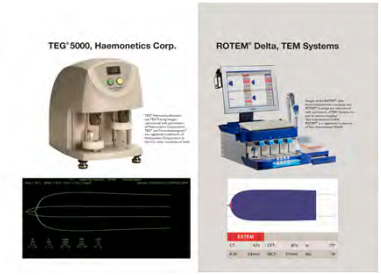
Clinical Case II

elective surgery – small incision
? injury vena cava – hole not seen
coagulopathic – packed – MSICU

Few hours later:
ROTEM fully corrected but output >1.5L
Team reluctant return OR

Who is really important in resuscitation?
How important VET (role) and what target?

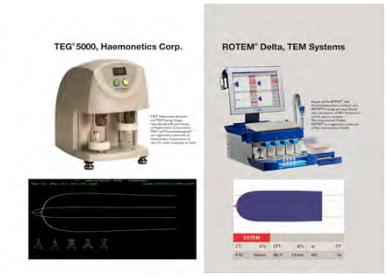
It is a Lab Test



1. not accurate *(Cochrane Review 2015 – research only)*
2. not validated *(Solomon; Scand J Clin Lab Invest 2016)*
3. unable differentiate dilution from low platelets

4. unable # cappilary & large vessel *(Campbell JT 2015)*
5. INR faster, cheaper, better tx *(Goodman JT 2015)*
6. evidence observational trials *(Da Luz Crit Care 2014)*

It is a Lab Test



7. may increase use fibrinogen
8. variable agreement SCT (Holcomb; Ann Surg 2012)
9. requires local standard techniques
10. lack uniformity, high coefficient of variance

    (Kitchen; Semin Thromb Hemost 2010)
11. different results, different centres
12. TEG # ROTEM *(Da Luz; Crit Care 2014)*
13. many variables interfere results *(Inaba; JT 2015)*

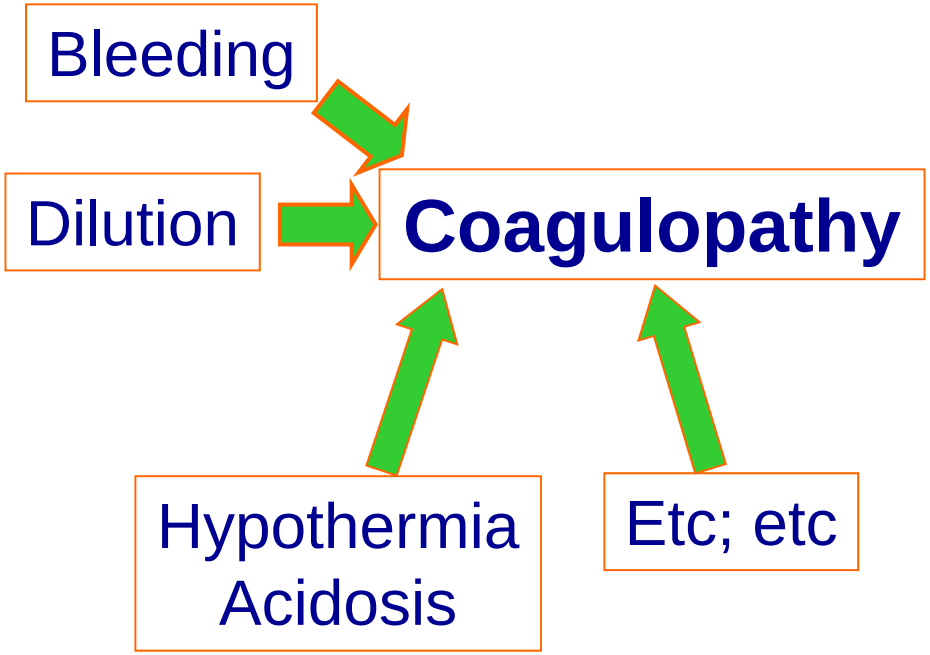
Why Bother?

1. making clinical decisions is not easy
2. **time** to decisions critical
3. do not know resuscitation

Managing Complex Problem

1. trauma coagulopathy NOT simple
   surgical vs. coagulopathic
2. cannot # physiologic – pathologic
3. change over time
4. dynamic changes & imbalances
   (*thrombin generation – clot lysis*)

Physiology – NOT Good



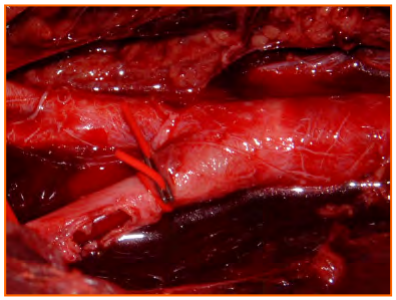
XXI Century

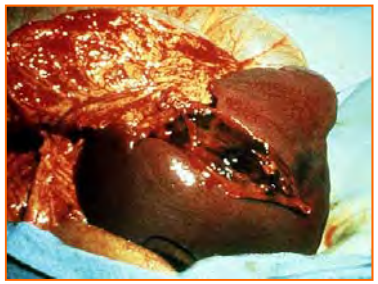
- Endogenous
- Early
- 25% patients
- 3x mortality
- Shock
- NOT addressed

Clinical Judgment NOT Good

Organ failure – 25% patients – **can't tell**

Mechanical





Coagulopathic

Resuscitation Strategies NOT Good

Resuscitation: **1:1:1**

Formula *(one size all)*

everyone is *(or will be)* coagulopathic
everyone needs plasma *(± platelet)*

a. blood early
b. restrict crystalloids
c. no lab

Static Lab Tests NOT Good

PT-INR

warfarin, not designed dynamic measure

PTT

designed screen hemophilia

measure single CF <30%

Fibrinogen

Nothing Klaus method in MH

Dzik WH et al. Crit Care, 2011;15(6):242.

Are TEG & ROTEM Good?

1. growing evidence usefulness
2. growing clinical use

cardiac surgery, liver transplant, OB, TRAUMA

Reasons:

- *diagnose multiple defects*
- *point-of-care = time*
- *clinical useful = guide tx.*

Cost-Effective

National Institute Health Care Excellence
Commissioned systematic review (NICE)

1. add or replace conventional tests??
2. any abnormal parameter = risk transfusion
3. more effective + cheaper than SCT

cost-effective if >80 tests/year

worth (training & implementation)

Predict Transfusion & Mortality

Predict = maybe reduce transfusion & mortality

da Luz; Rizoli; Nascimento; Callum; Adhikari
TEG & ROTEM diagnosis coagulopathy, transfusion & mortality trauma. Critical Care 2014 Sep 18:518

Veigas; Rizoli; Nascimento; da Luz
Thresholds ROTEM diagnosis & management bleeding trauma patients. Scand J Trauma Resusc Emerg Med 2016

Targets

Consensus Conference on TEM-based Transfusion Guidelines for Early Trauma Resuscitation

SHERATON PHILADELPHIA UNIVERSITY CITY HOTEL
3549 Chestnut Street, Philadelphia, PA 19104

Start: Tuesday, Sept 9 2014 8:00 AM – 5:00 PM
End: Wednesday, Sept 10 2014 8:00 AM to 12:00 Noon

JTACS 2015, 78:1220

Targets

Consensus Conference – Philadelphia
Guidelines early resuscitation

Massive transfusion

EXTEM A5≤35mm *(clot strength)*

Davenport Crit Care Med 2011, 39:1

FIBTEM A10 ≤7 *(lysis)* = best predictor MT

Schochl Crit Care 2011,15:265

Targets

Any transfusion

clot strength and fibrinolysis

EXTEM/FIBTEM A5/MCF ≤35mm

RBC = 35%, 88% (INR 17%;96%); FFP = 36%, 87% (INR 20%; 96%)

Davenport Crit Care Med 2011, 39:1

monitor response FC/cryo correct EXTEM/FIBTEM

stop or do not initiate transfusion (+ clinical)

Rourke J Thromb Haemost 2012, 10:1342

Targets

Mortality

low clot strength & fibrinolysis

FIBTEM MCF≤7 *(21%vs.9%)*;EXTEM CT≥100;
EXTEM MCF≤45 *(27%vs.9%)*

Fibrinolysis

FIBTEM MCF = good discriminator

Schochl J Neurotrauma 2011, 28:2033

Targets

Anti-fibrinolytics

Don’t wait for abnormal test

Any lysis = give more

Platelets

Not good discriminator

Consider other tests

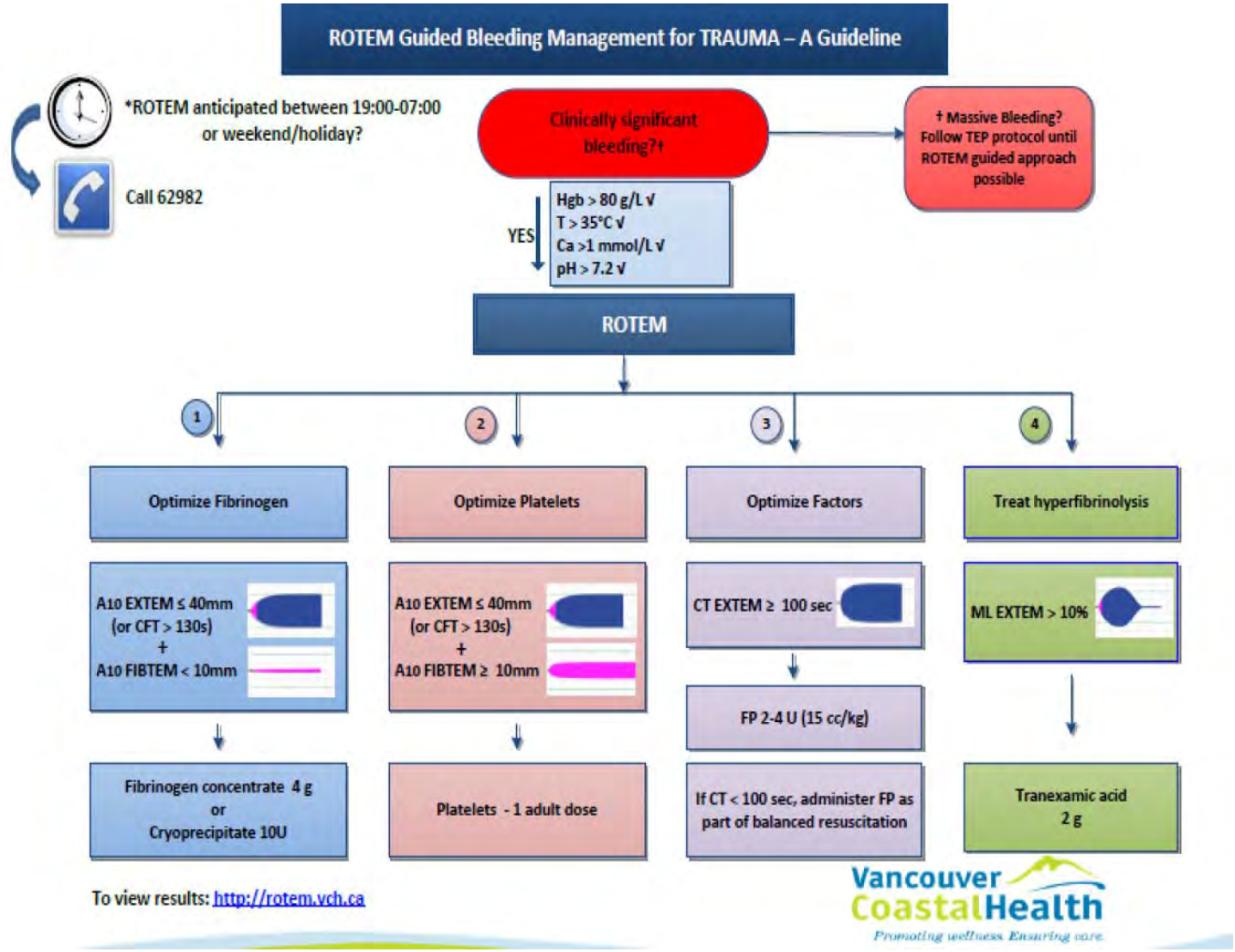
Gonzalez & Moore RCT

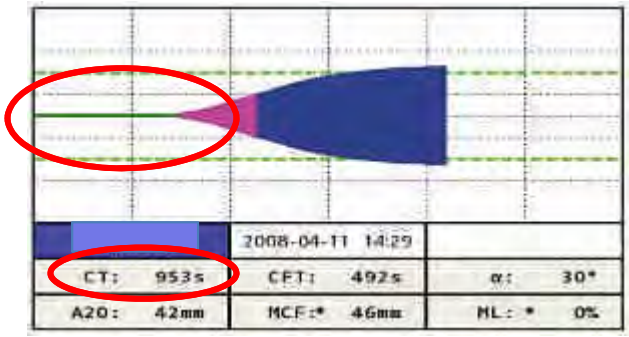
MTP directed TEG or SCT; 111 patients

Hg≤10 = RBC; INR≥1.5 = FFP;
fibrinogen<150 = cryo; <100.000 = plat

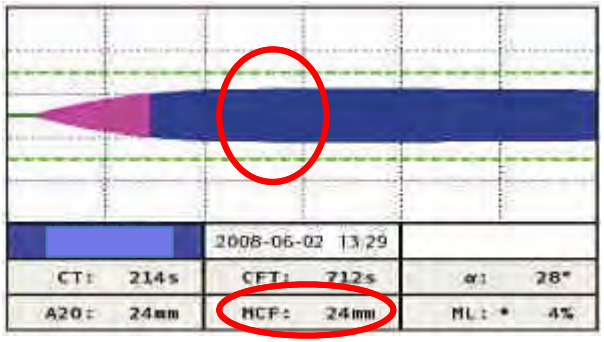
ACT>140 = 2U FFP + 10U cryo + 1 plat
ACT 111-139 = 2U FFP
Angle<63 = 10U cryo; LY30>3% = TXA

TEG = >survival, more FFP/plat

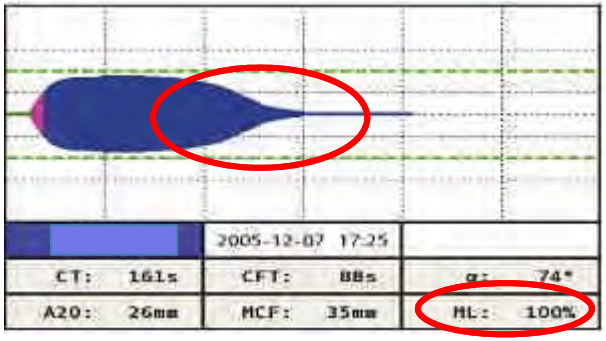

ROTEM Guided Bleeding Management for TRAUMA – A Guideline
*ROTEM anticipated between 19:00-07:00 or weekend/holiday?
Call 62982
Clinically significant bleeding?†
† Massive Bleeding? Follow TEP protocol until ROTEM guided approach possible
YES
Hgb > 80 g/L √
T > 35°C √
Ca >1 mmol/L √
pH > 7.2 √
ROTEM
1
2
3
4
Optimize Fibrinogen
Optimize Platelets
Optimize Factors
Treat hyperfibrinolysis
A10 EXTEM ≤ 40mm (or CFT > 130s) + A10 FIBTEM < 10mm
A10 EXTEM ≤ 40mm (or CFT > 130s) + A10 FIBTEM ≥ 10mm
CT EXTEM ≥ 100 sec
ML EXTEM > 10%
FP 2-4 U (15 cc/kg)
Fibrinogen concentrate 4 g or Cryoprecipitate 10U
Platelets - 1 adult dose
If CT < 100 sec, administer FP as part of balanced resuscitation
Tranexamic acid 2 g
To view results: http://rotem.vch.ca
Vancouver CoastalHealth
Promoting wellness. Ensuring care.



Activation coagulation CT ≥80s (+ N MCF) **consider FFP**



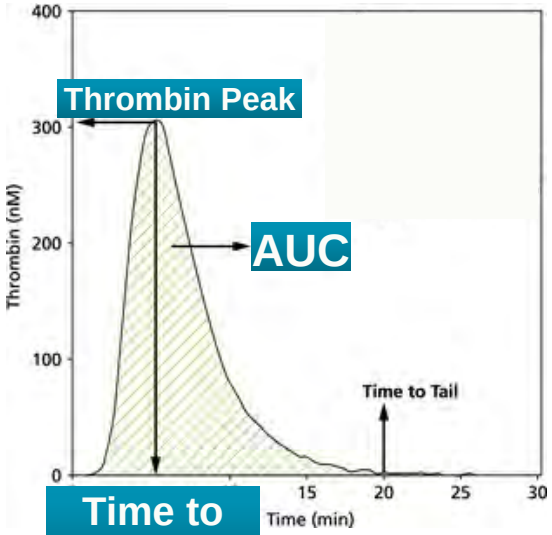
Clot formation MCF/A10≤35 cryo/plat

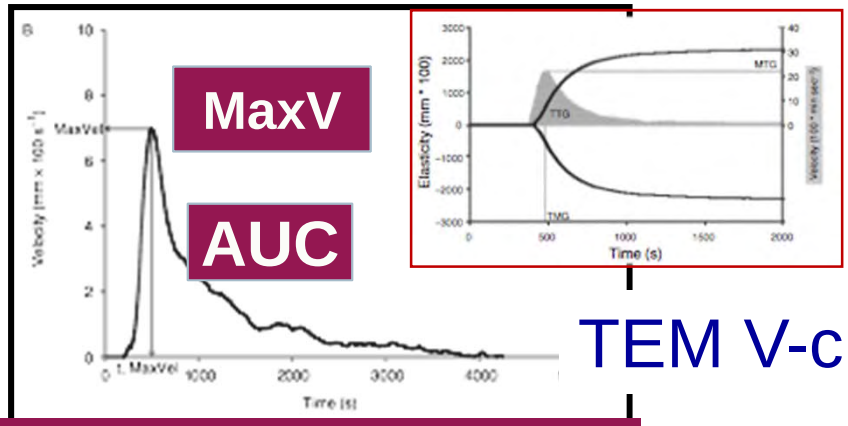


Fibrinolysis ML=100% consider TXA

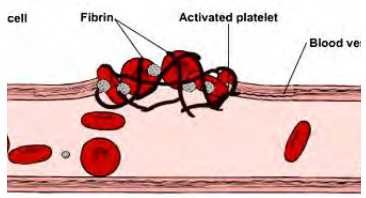
Derivate Parameters

Thrombin = calibrated automated thrombogram
SMH = TG associated MT & mortality
ROTEM V-curve, 550 severe
drop MaxV = increase 0.7U transfusion, mortality





Clot Structure = Stability



Thrombin & fibrinogen

Fibrinogen → fibrin monomers → fibers/meshwork

THROMBIN

High

thinner – dense
highly branched fibers
resistant fibrinolysis

LOW

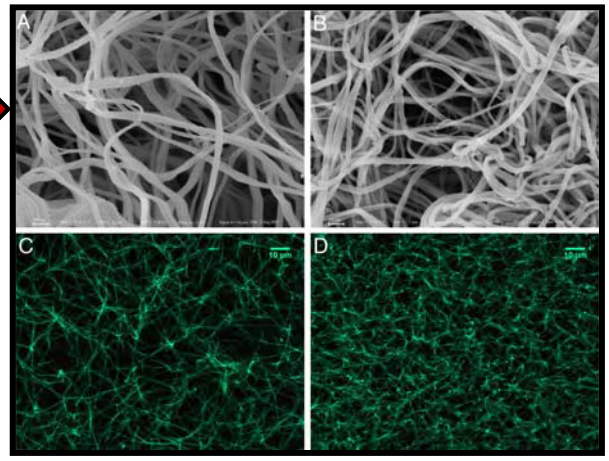
thicker fibers – network
unbranched fibers
susceptible lysis

Clot Structure = Stability

Fibrin structure (size/how compact) = stability

also clot contraction – RBC

low thrombin susceptible lysis



high thrombin resistant lysis

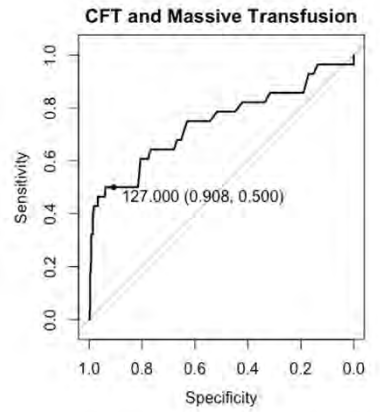
Wolberg, Campbell Transf Apher Sci. 38,15 2008

Clot Formation Time

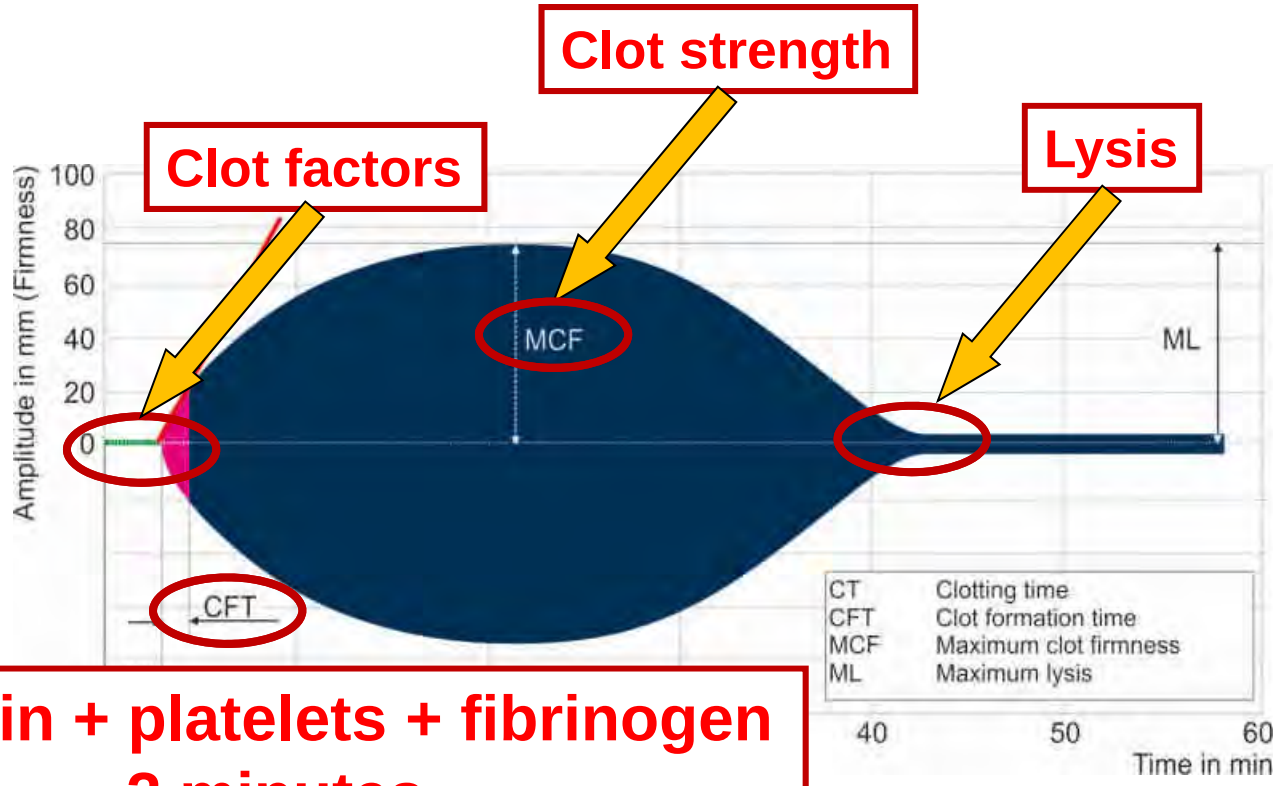
CFT corresponds TEG k

Depends:

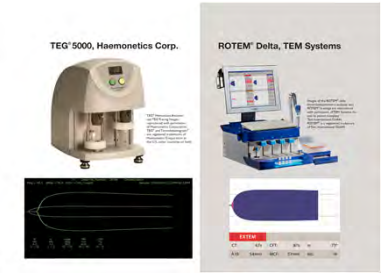
- thrombin generation
- platelet count & function
- fibrinogen concentration
- fibrin polymerization



Generate a Graph



thrombin + platelets + fibrinogen
2 minutes



Conclusions

Role:

lab tests – many limitations

advantages: time + guide clinical decision

part of MTP

Target:

Canadian consensus JTACS 2015

any abnormal result = concerning

CT (clotting factors); clot strength; lysis

CFT = 2 min. thrombin + plat. + fibrinogen

Thank you