

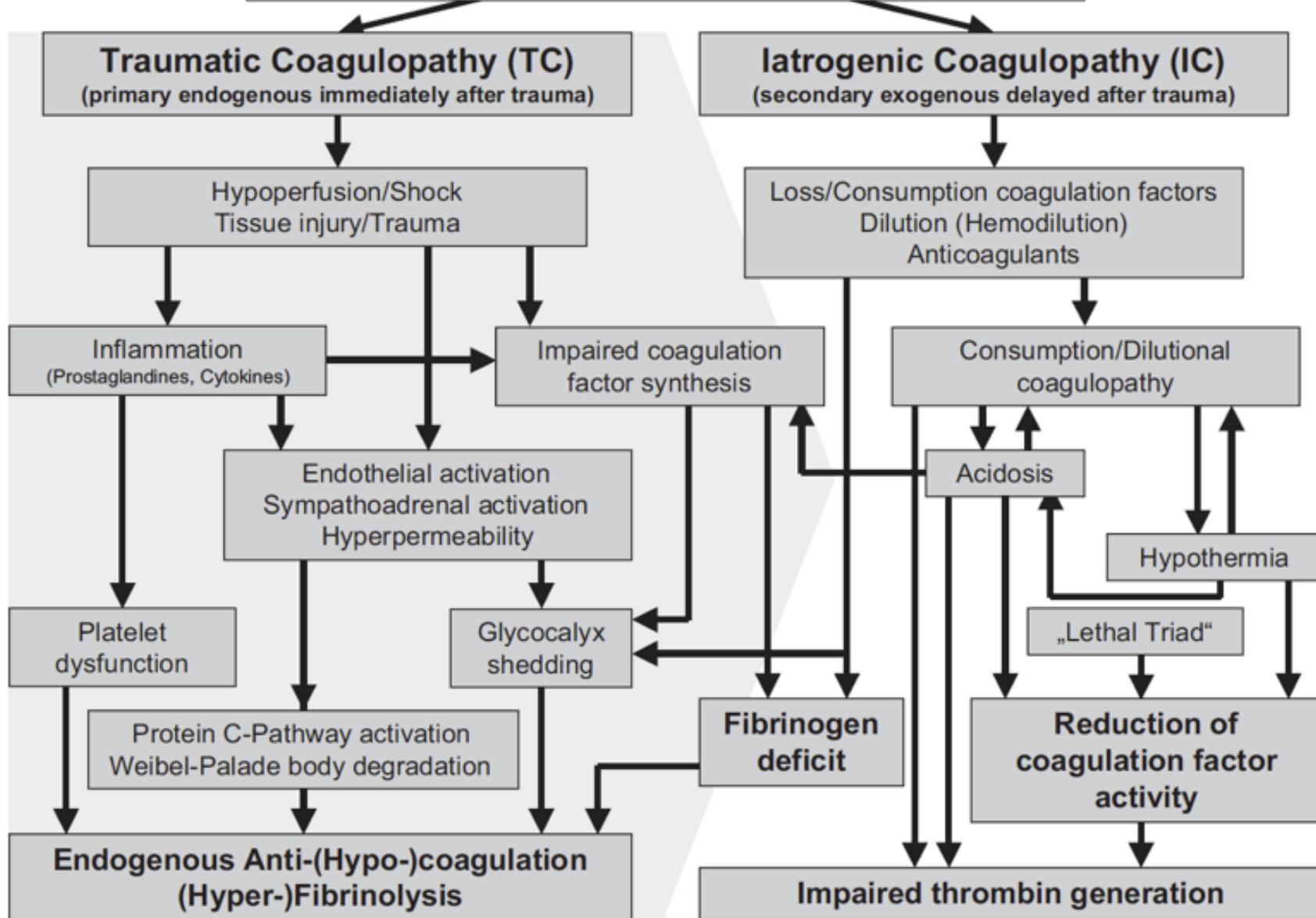


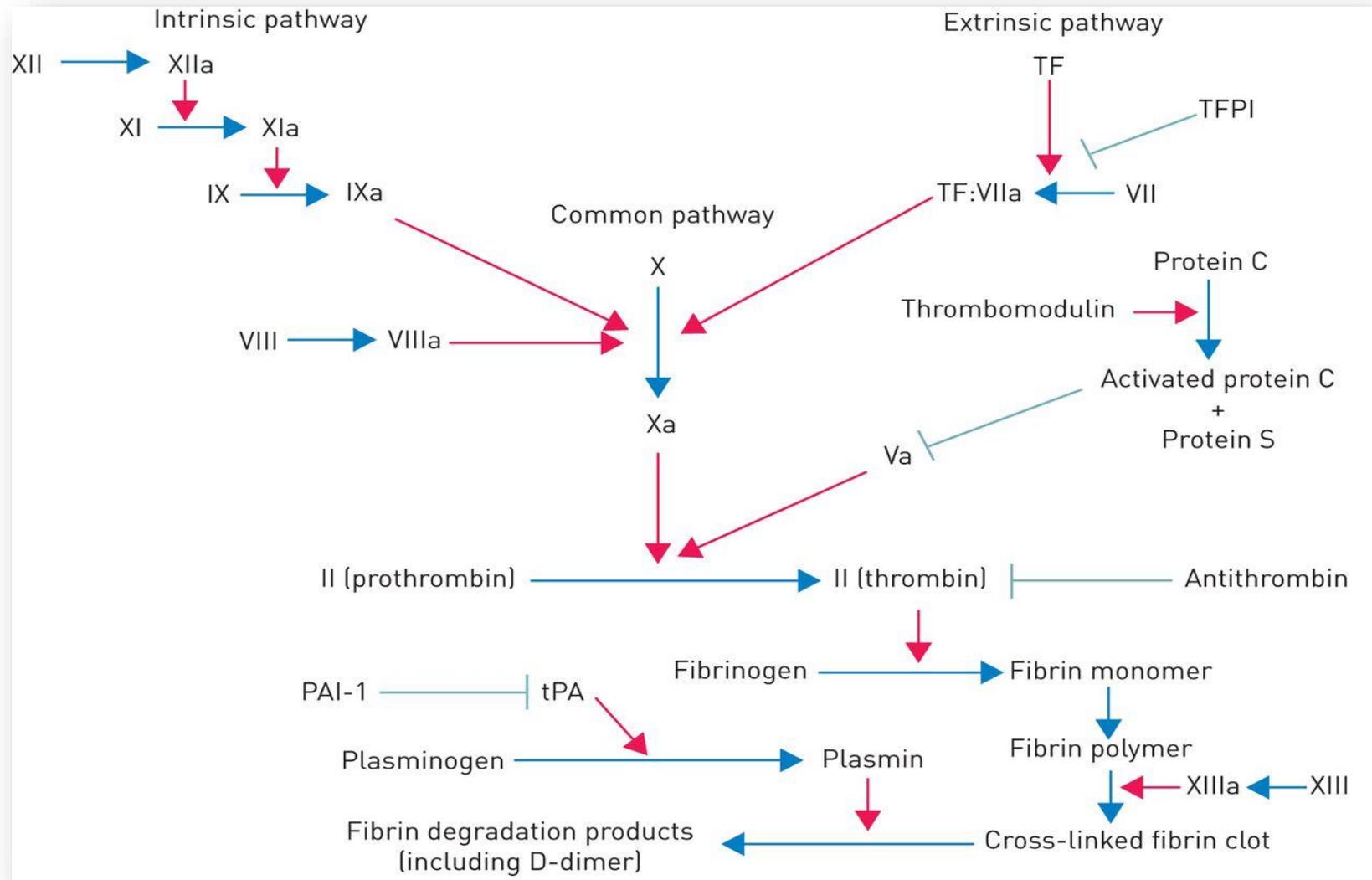
## Comprendere l'emorragia intraoperatoria: appropriatezza diagnostica e terapeutica

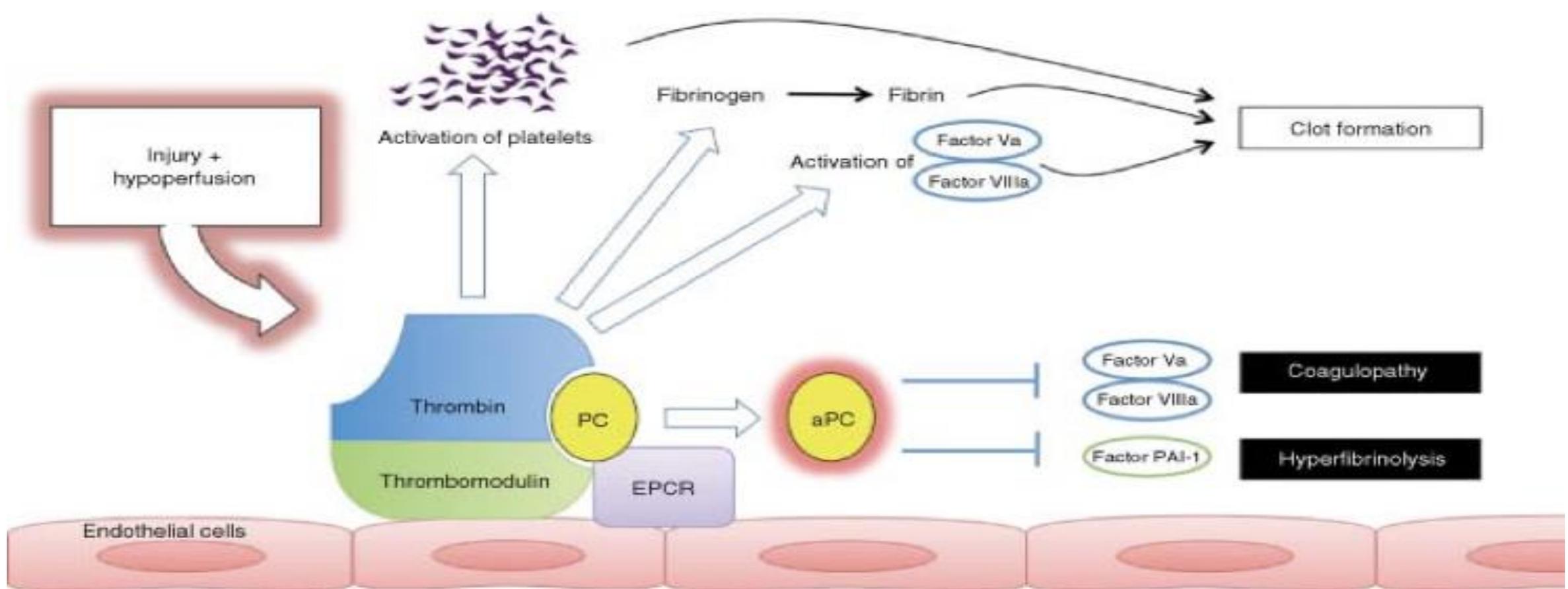
Matteo Parrinello

Gavazzeni Humanitas Hospital, Bergamo, Italy

# Trauma-induced Coagulopathy (TIC)







overview of the thrombin–thrombomodulin complex and protein C (PC) in inducing coagulopathy after trauma. Injury and hypoperfusion induce excess expression of thrombomodulin on the endothelial cell wall. Following a thrombin burst, thrombin combines with thrombomodulin and the endothelial protein C receptor (EPCR); this complex activates protein C. Activated protein C (aPC) probably plays an essential role by inhibiting factors V, VIII and plasminogen activator inhibitor (PAI) 1, causing a hypocoagulable and hyperfibrinolytic state

## Correlation between laboratory coagulation testing and thromboelastometry is modified during management of trauma patients

**Jean-Stéphane David, MD, PhD, Maeva Durand, MD, Albrice Levrat, MD, Mathilde Lefevre, MD, Lucia Rugeri, MD, Marie-Odile Geay-Baillat, MD, Kenji Inaba, MD, MSc, and Pierre Bouzat, MD, PhD, Lyon, France**

*Scarsa sensibilita' e specificita'  
(non tengono conto del contributo di endotelio, piastrine, fibrinogeno)*

*30-60min*

*J Trauma Acute Care Surg.*  
2016;81: 319–327.

RANDOMIZED CONTROLLED TRIAL

Goal-directed Hemostatic Resuscitation of  
Trauma-induced Coagulopathy

*A Pragmatic Randomized Clinical Trial Comparing a Viscoelastic Assay to  
Conventional Coagulation Assays*

*Eduardo Gonzalez, MD,\* Ernest E. Moore, MD,\*† Hunter B. Moore, MD,\* Michael P. Chapman, MD,\*  
Theresa L. Chin, MD,\* Arsen Ghasabyan, MPH,\* Max V. Wohlauer, MD,\* Carlton C. Barnett, MD,\*†  
Denis D. Bensard, MD,\*† Walter L. Biffl, MD,\*† Clay C. Burlew, MD,\*† Jeffrey L. Johnson, MD,\*†  
Fredric M. Pieracci, MD, MPH,\*† Gregory J. Jurkovich, MD,\*† Anirban Banerjee, PhD,\*  
Christopher C. Silliman, MD, PhD,\*‡§ and Angela Sauaia, MD, PhD\*¶*

*Studia la cinetica della formazione del coagulo*

*5-20 min*

*Ann Surg 2016;263:1051–1059*

Contents lists available at ScienceDirect



ELSEVIER

# The American Journal of Surgery

journal homepage: [www.americanjournalofsurgery.com](http://www.americanjournalofsurgery.com)



## Discrepancies between conventional and viscoelastic assays in identifying trauma-induced coagulopathy

Joshua J. Sumislawski <sup>a,\*</sup>, S. Ariane Christie <sup>b</sup>, Lucy Z. Kornblith <sup>b</sup>, Gregory R. Stettler <sup>a</sup>, Geoffrey R. Nunns <sup>a</sup>, Hunter B. Moore <sup>a</sup>, Ernest E. Moore <sup>a</sup>, Christopher C. Silliman <sup>c</sup>, Angela Sauaia <sup>a</sup>, Rachael A. Callcut <sup>b</sup>, Mitchell Jay Cohen <sup>a</sup>

## CCTs vs VET

-

### ORIGINAL ARTICLE

## Feasibility of Using Rotational Thromboelastometry to Assess Coagulation Status of Combat Casualties in a Deployed Setting

Catherine M. Doran, MRCS, Tom Woolley, FRCA, and Mark J. Midwinter, MD, FRCS

*J Trauma.* 2010;69: S40–S48

### ORIGINAL ARTICLE

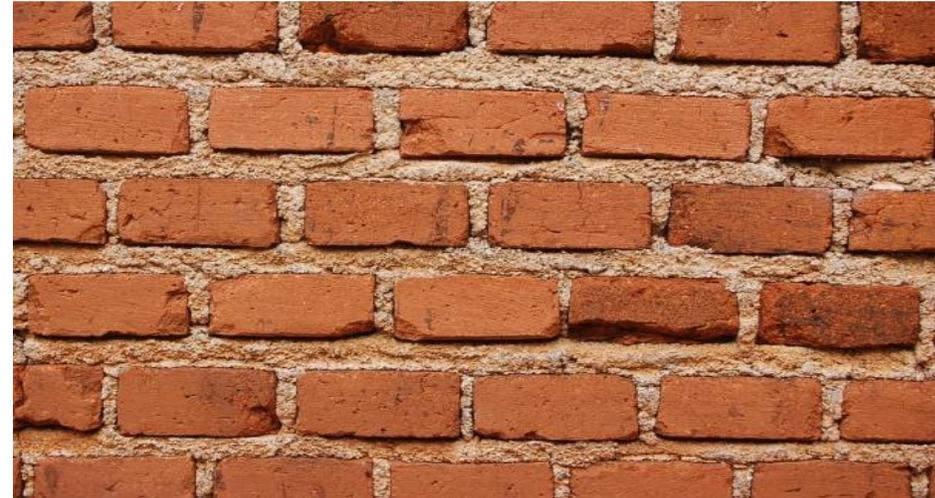
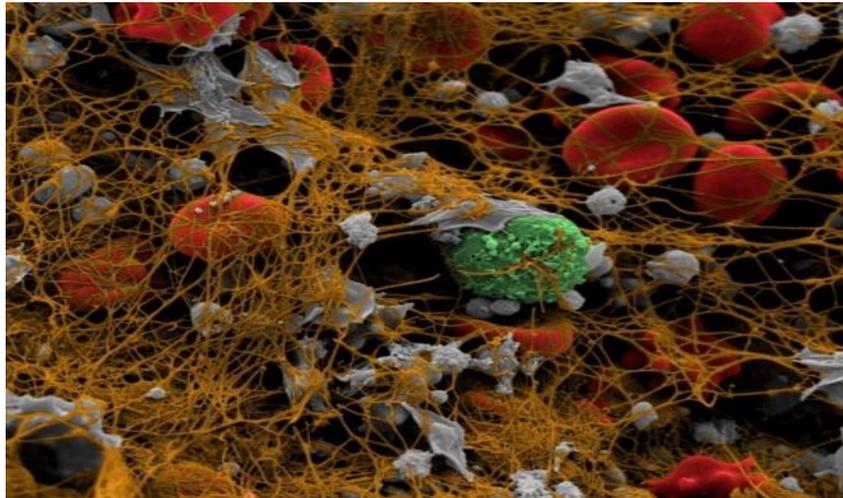
## Data-driven Development of ROTEM and TEG Algorithms for the Management of Trauma Hemorrhage

*A Prospective Observational Multicenter Study*

Kjersti Baksaas-Aasen, MD,\* Susan Van Dieren, PhD,† Kirsten Balvers, PhD,† Nicole P. Juffermans, PhD,‡ Pål A. Næss, PhD,\* Claire Rourke, BSc,§ Simon Eaglestone, PhD,§ Sisse R. Ostrowski, PhD,¶ Jakob Stensballe, PhD,|| Simon Stanworth, PhD,\*\* Marc Maegele, PhD,†† J. C. Goslings, PhD,‡ Pär I. Johansson, PhD,¶ Karim Brohi, MD,§ and Christine Gaarder, PhD§§, the TACTIC/INTRN collaborators

# The Wall: Il Coagulo

*la stabilità determinerà un'emostasi normale  
oppure un'emorragia*



*Resistance* to mechanical stress and fibrinolysis  
together with *flexibility* to deformation

## The physical properties of clot:

not a *gas*

not a *liquid*

not a *solid*



- *gas*
- *liquid*
- ***solid (GEL)***

Gel é un materiale colloidale bifasico elastico, costituito da liquido disperso ed inglobato nella fase solida. Il liquido “abita” nella struttura costituita dal solido, che a sua volta sfrutta la tensione superficiale del liquido per non collassare”

Gels are defined as a substantially dilute cross-linked system, which exhibits no flow when in the steady-state. By weight, gels are mostly liquid, yet they behave like solids due to a three-dimensional cross-linked network within the liquid”

# I test

davanti alla possibilità di un evento “sfavorevole”, uno strumento utile sono i test

## ✓ Test di screening

(alto NPV, alta sensibilità, pochi falsi negativi)

→ servono per escludere l’evento sfavorevole

## ✓ Test diagnostici

(alto PPV, alta specificità, pochi falsi positivi)

→ servono per fare la diagnosi differenziale,  
una volta che l’evento sfavorevole si è verificato

# Goal directed coagulation therapy with POC tests



TEG ®

*cuvette con perno fisso e filo  
torsionale*



ROTEM ®

*cuvette con perno rotante e sistema  
ottico di rilevamento*





OPEN

# Multicenter Evaluation of the Quantra QPlus System in Adult Patients Undergoing Major Surgical Procedures

Danja S. Groves, MD, PhD,\* Ian J. Welsby, MD,† Bhiken I. Naik, MBBCh,\*  
Kenichi Tanaka, MD,‡ Jennifer N. Hauck, MD,† Charles S. Greenberg, MD,§  
Deborah A. Winegar, PhD,|| and Francesco Viola, PhD||

Anesth Analg 2020;130:899–909

Open access

Original research

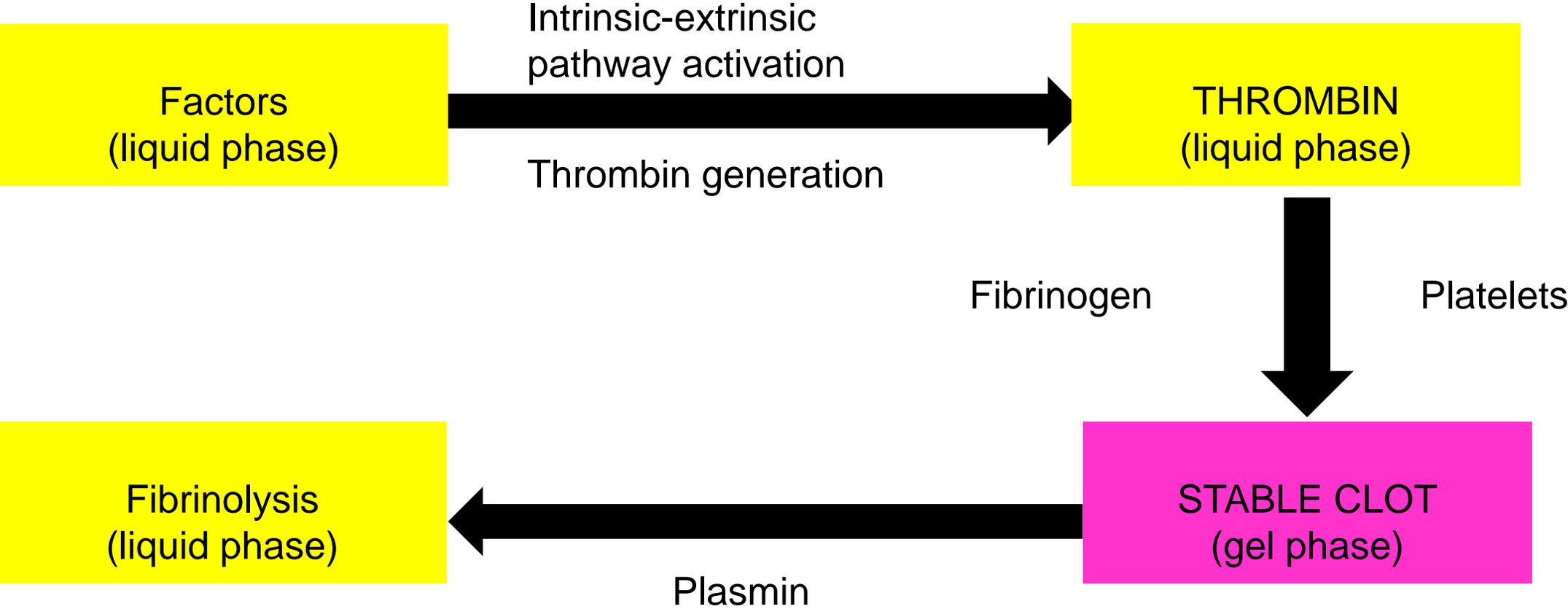
Trauma Surgery  
& Acute Care Open

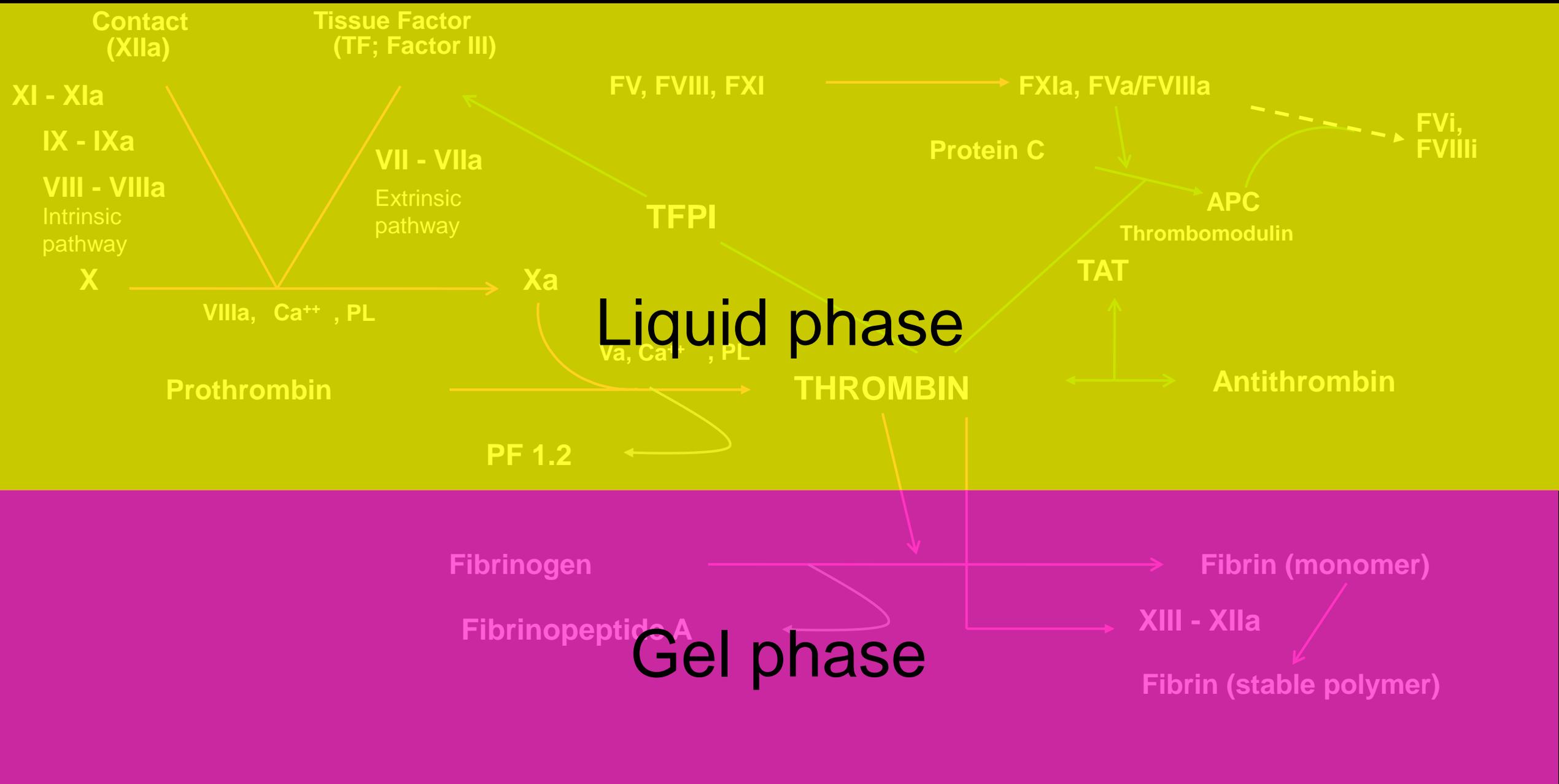
## Initial clinical experience with the Quantra QStat System in adult trauma patients

Edward A Michelson,<sup>1</sup> Michael W Cripps,<sup>2</sup> Bradford Ray,<sup>3</sup> Deborah A Winegar,<sup>4</sup>  
Francesco Viola<sup>4</sup>

Michelson EA, et al. *Trauma Surg Acute Care Open* 2020;5:e000581.

# A real coagulation model

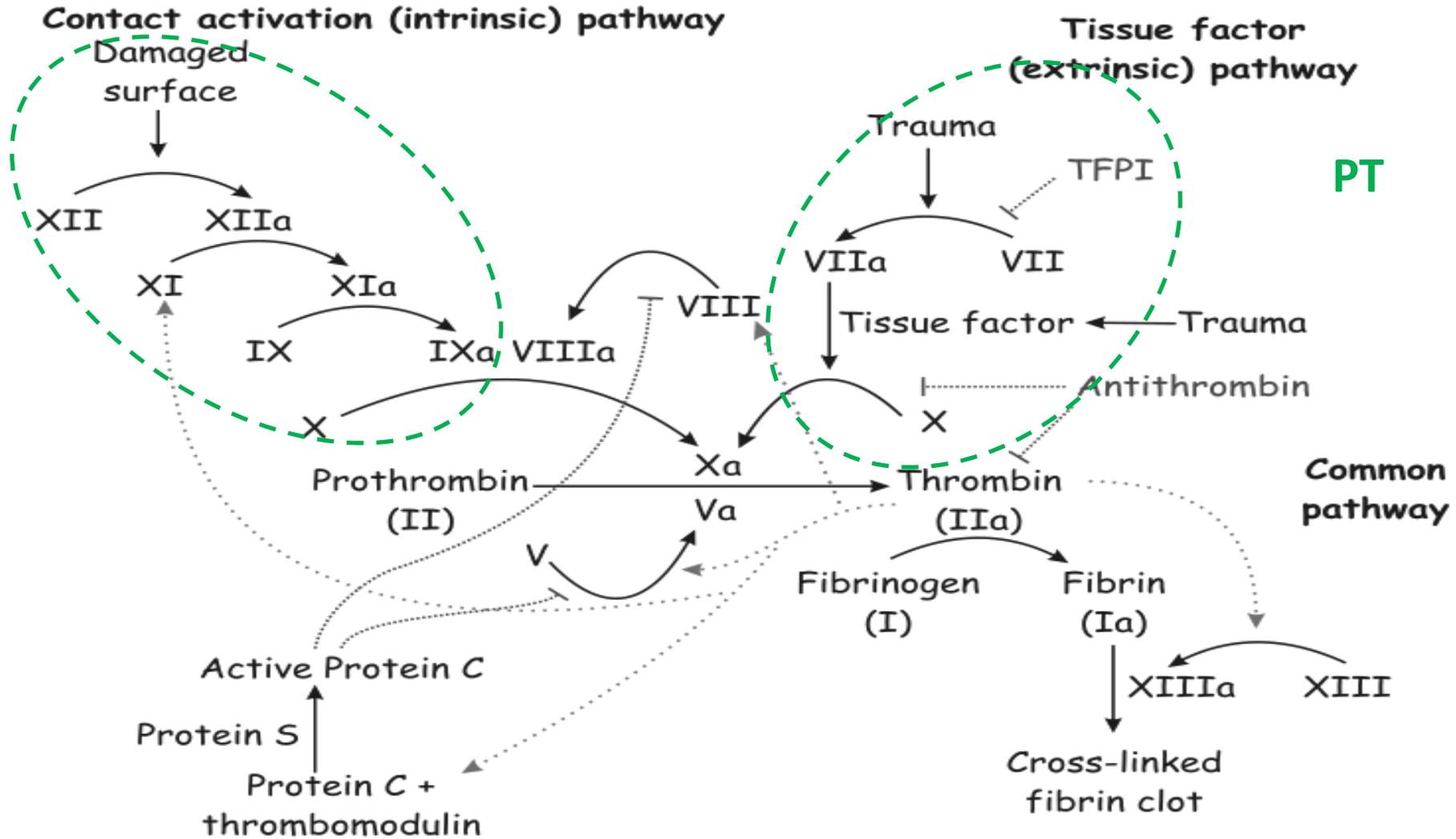




# esami di laboratorio

aPTT

PT



Liquid Phase:

- FII
- FV
- FVII
- FX
- FXI
- FXII

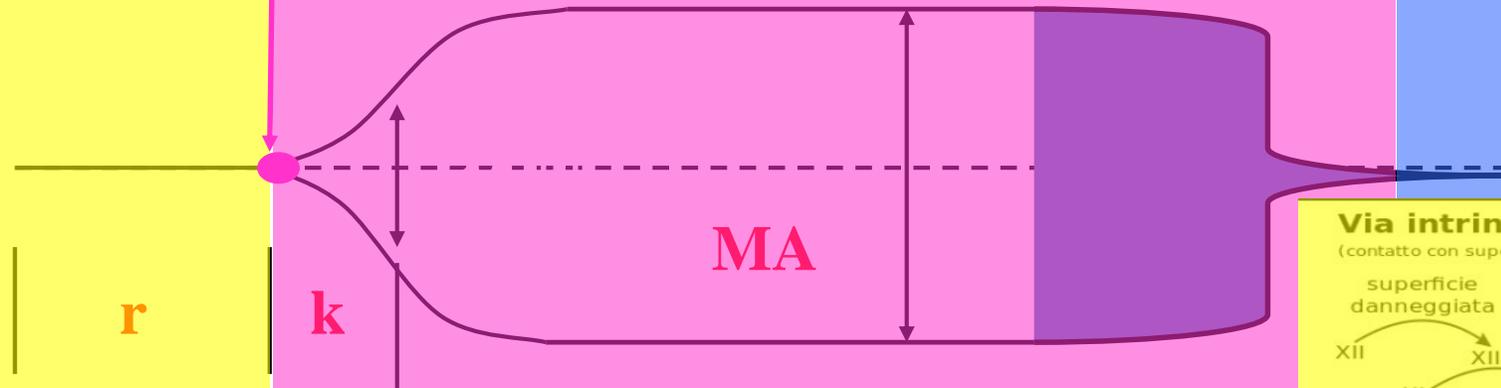
Gel phase:

- Fibrinogeno
- Piastrine

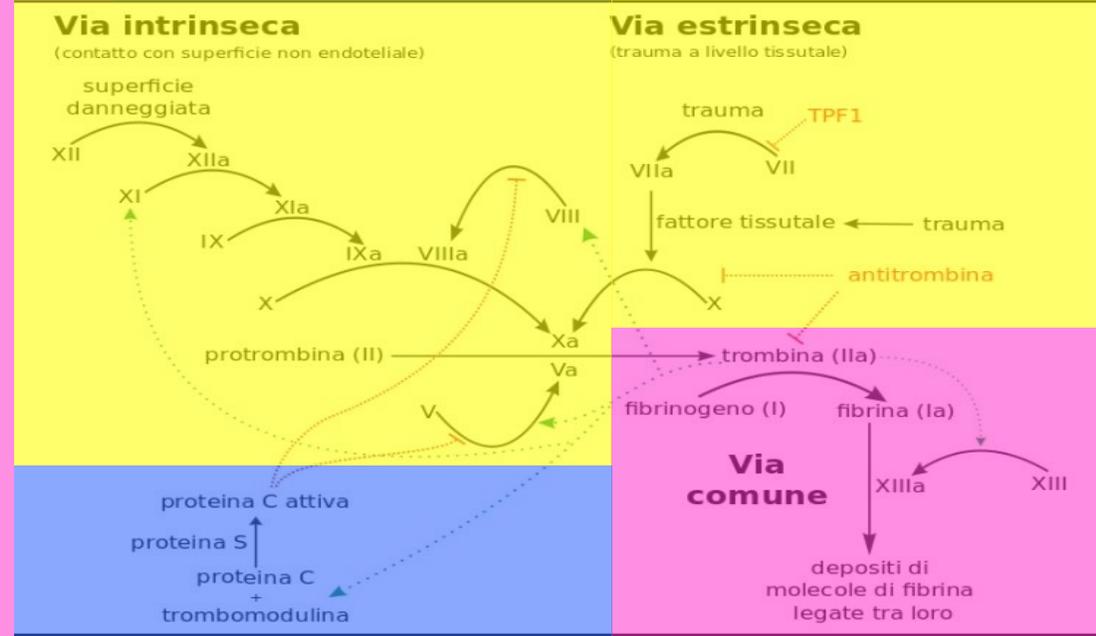
Liquid phase:

- Clot Lysis: Protein C+S

GEL Point trombinico



Lysis

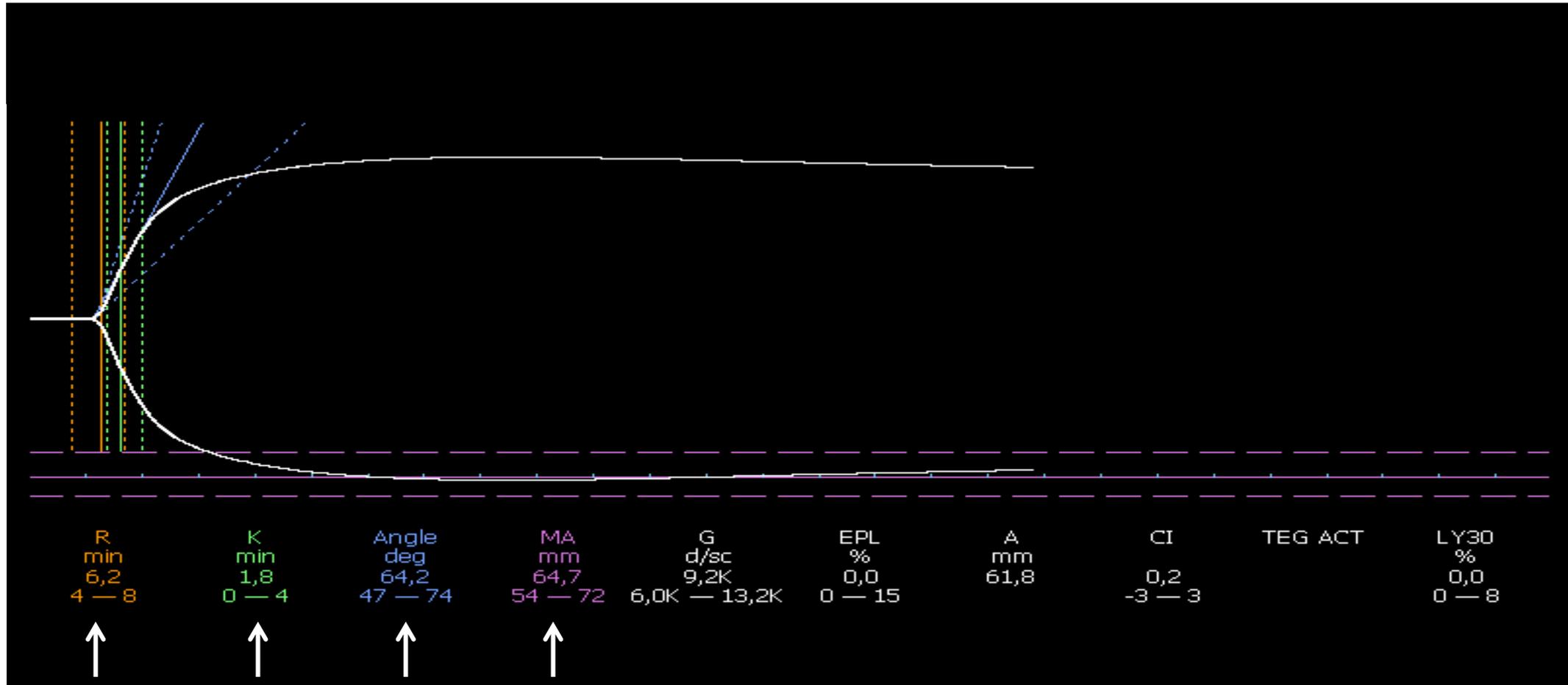


# Cause di sanguinamento NON chirurgico

- ✓ Eparina residua
- ✓ Ridotta generazione di trombina
- ✓ Deficit di stabilità del coagulo per ipofibrinogenemia
- ✓ Deficit di stabilità del coagulo per piastrinopenia
- ✓ Deficit di stabilità del coagulo per disfunzione piastrinica
- ✓ Iperfibrinolisi (rara)

# Tromboelastogramma TEG®

curva normale



... escluse tutte le cause NON chirurgiche di sanguinamento con i test viscoelastici ...

resta da fare l'emostasi **chirurgica!**

# Cause di sanguinamento NON chirurgico

## ✓ **Eparina residua**

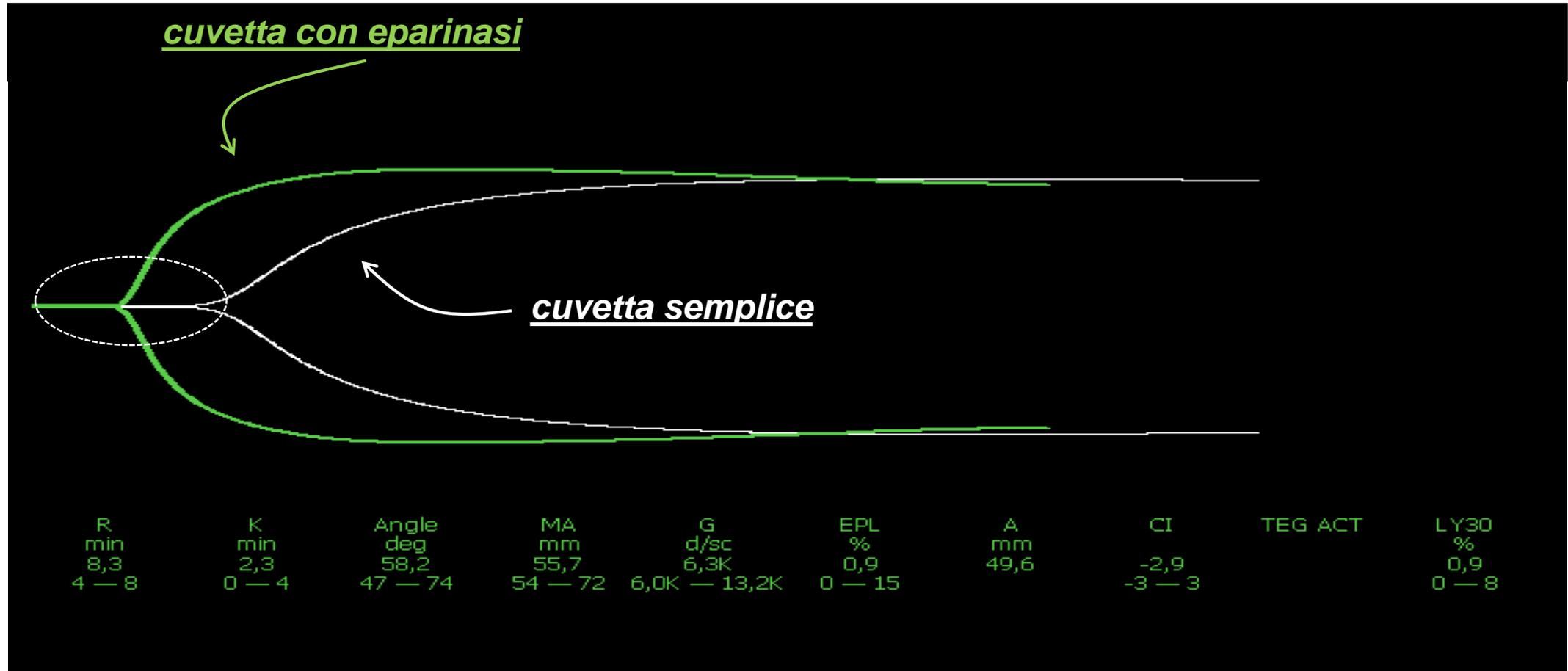
- ✓ Ridotta generazione di trombina
- ✓ Deficit di stabilità del coagulo per ipofibrinogenemia
- ✓ Deficit di stabilità del coagulo per piastrinopenia
- ✓ Deficit di stabilità del coagulo per disfunzione piastrinica
- ✓ Iperfibrinolisi (rara)

## ✓ Eparina residua

- ACT value back to preoperative value is not per se guarantee that heparin has been totally reversed
- TEG and ROTEM are not designed to identify the correct protamine dose, but they provide useful information about the possibility of residual heparin action after protein reversal in bleeding patients.

# Tromboelastogramma TEG®

cuvette con eparinasi



Effetto residuo dell'eparina

# ROTEM

Eparina a bordo

## EXTEM

normale

## INTEM

CT lungo

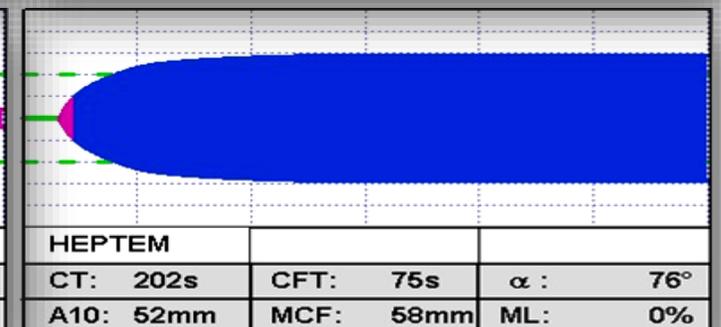
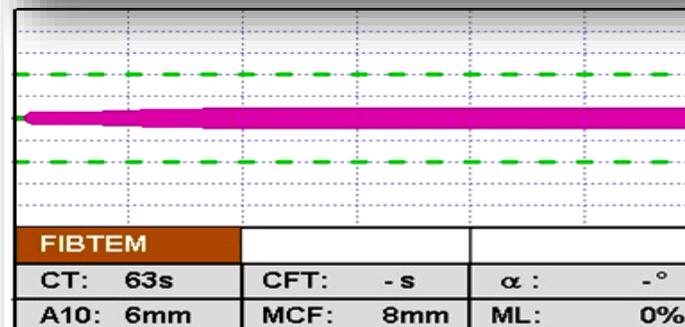
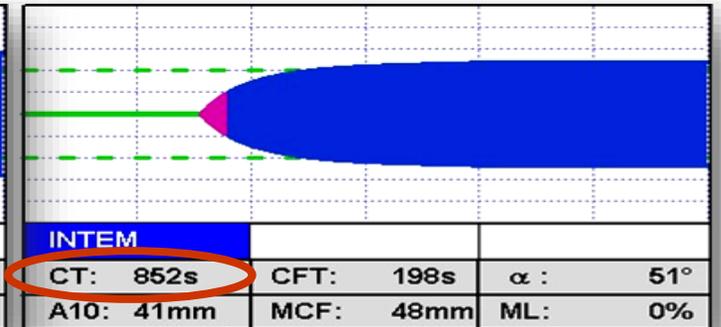
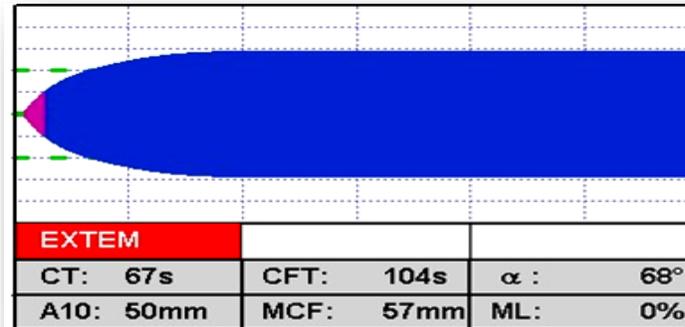
Ampiezza leggermente ridotta

## FIBTEM

Ampiezza normale

## HEPTEM

CT e MCF normali

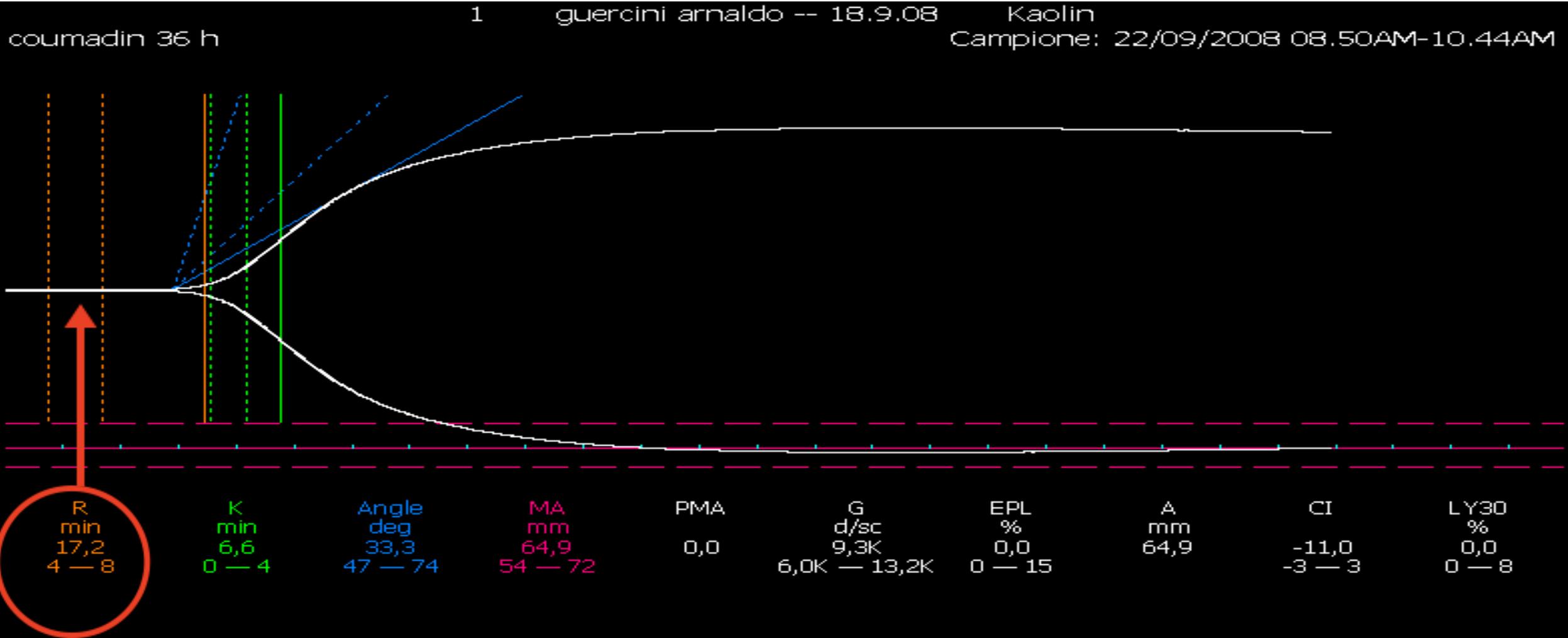


# Cause di sanguinamento NON chirurgico

- ✓ Eparina residua
- ✓ **Ridotta generazione di trombina**
- ✓ Deficit di stabilità del coagulo per ipofibrinogenemia
- ✓ Deficit di stabilità del coagulo per piastrinopenia
- ✓ Deficit di stabilità del coagulo per disfunzione piastrinica
- ✓ Iperfibrinolisi (rara)

# Tromboelastogramma TEG®

ridotta generazione di trombina



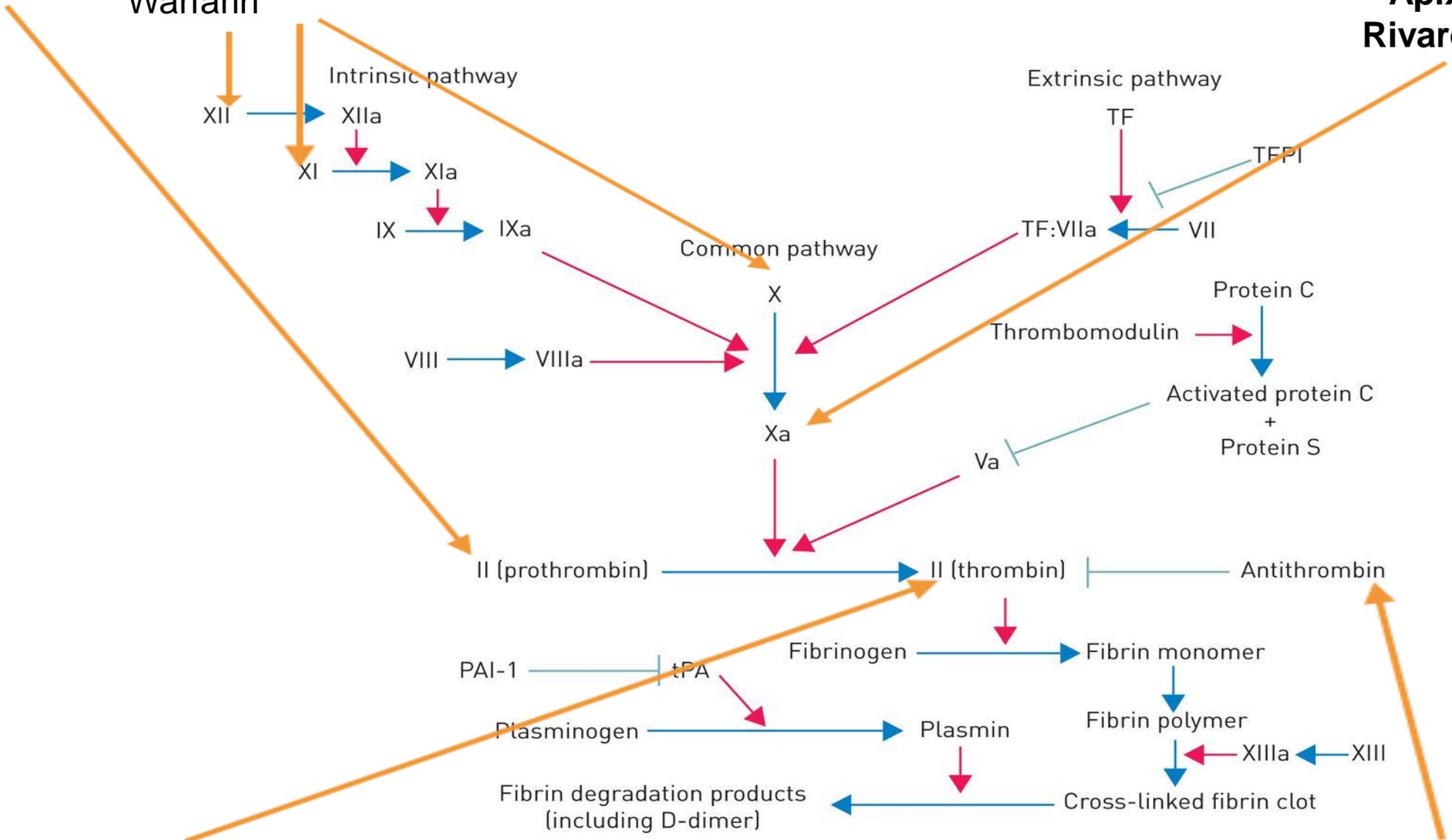
Emodiluzione? Consumo di fattori? Sanguinamento massivo? Terapia anticoagulante?

# Vitamin K antagonist

Warfarin

# Direct Xa factor inhibitors

Apixabam  
Rivaroxabam



# Direct thrombin inhibitors

Dabigatran  
Bivalirudin

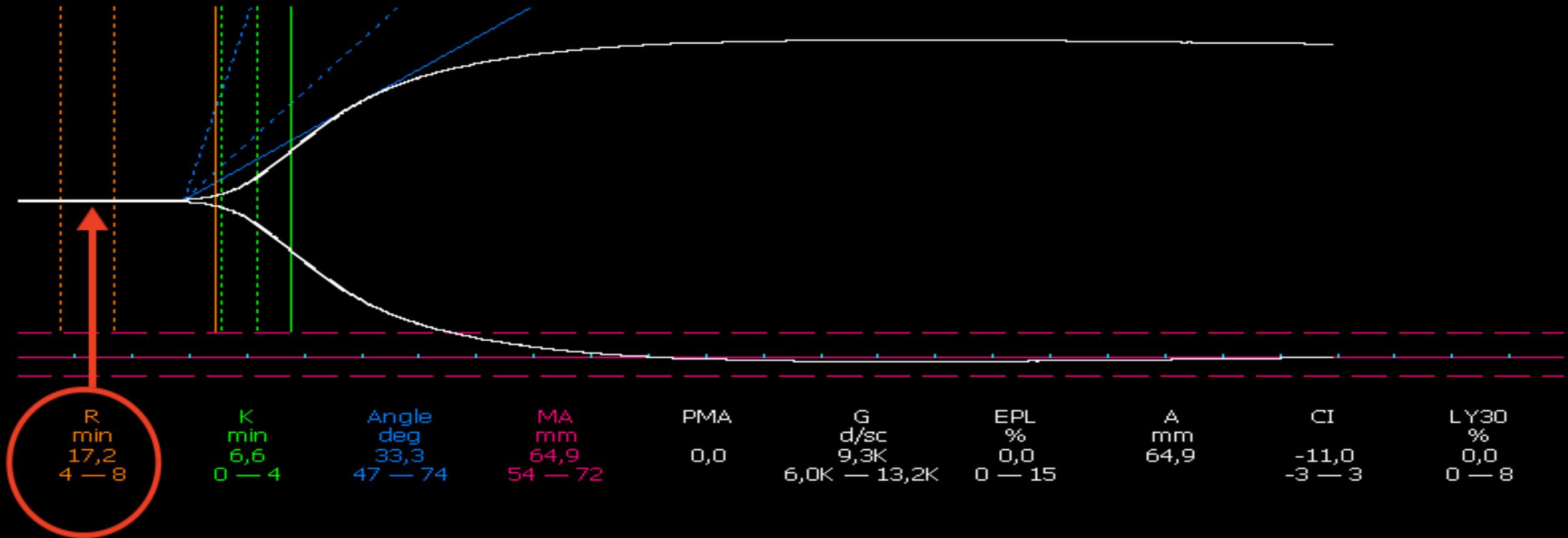
# Indirect thrombin inhibitors

LMWH  
heparin

# Warfarin: monitoraggio e trattamento

ridotta generazione di trombina

1 guercini arnaldo -- 18.9.08 Kaolin  
coumadin 36 h Campione: 22/09/2008 08.50AM-10.44AM



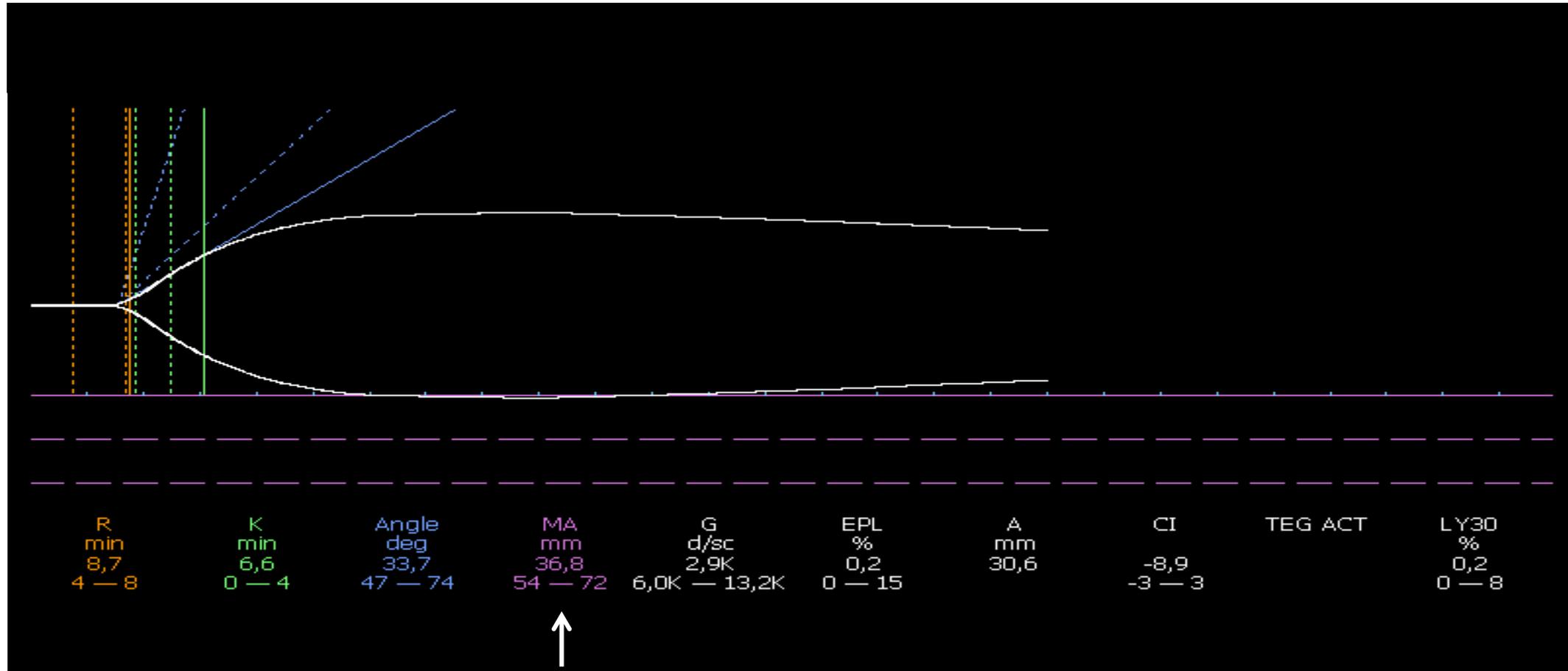
PCC (a 4 fattori) 25 UI/kg o FFP

# Cause di sanguinamento NON chirurgico

- ✓ Eparina residua
- ✓ Ridotta generazione di trombina
- ✓ **Deficit di stabilità del coagulo per ipofibrinogenemia**
- ✓ Deficit di stabilità del coagulo per piastrinopenia
- ✓ Deficit di stabilità del coagulo per disfunzione piastrinica
- ✓ Iperfibrinolisi (rara)

# Tromboelastogramma TEG®

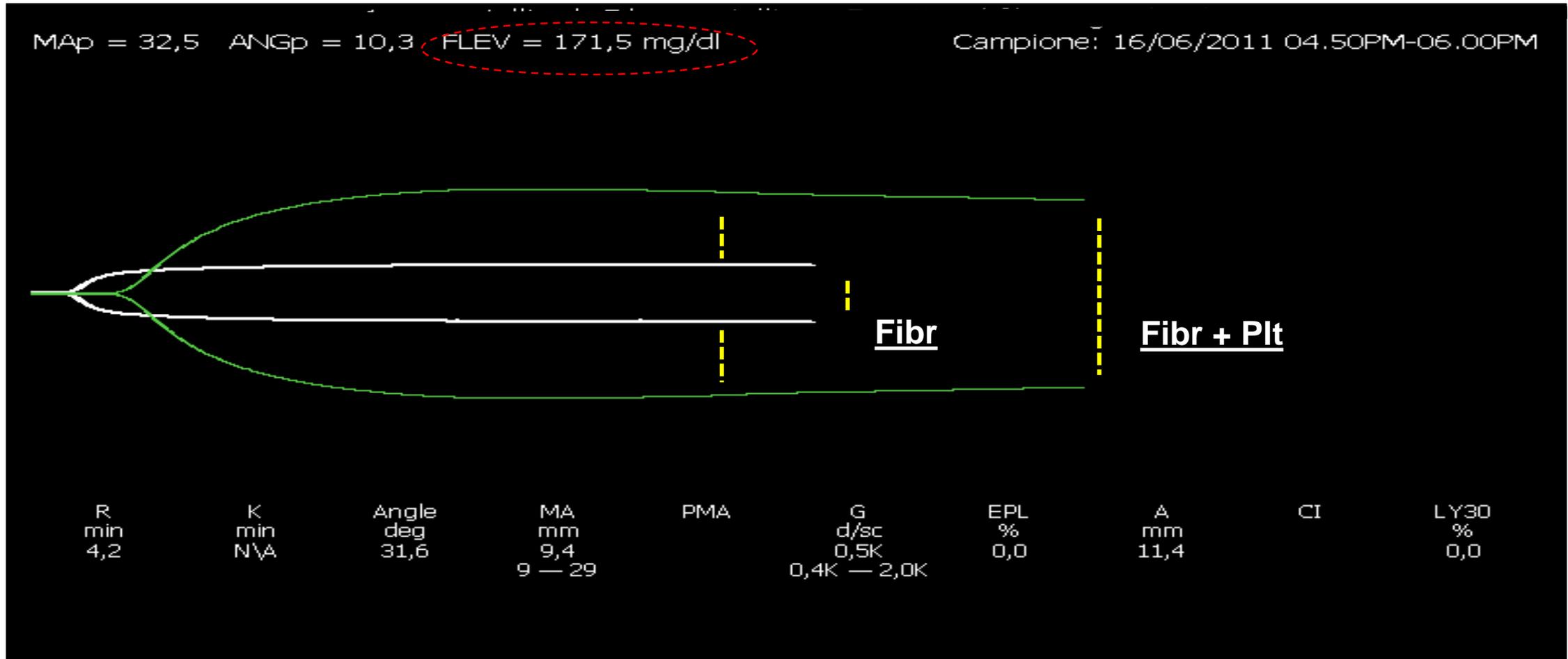
curva patologica



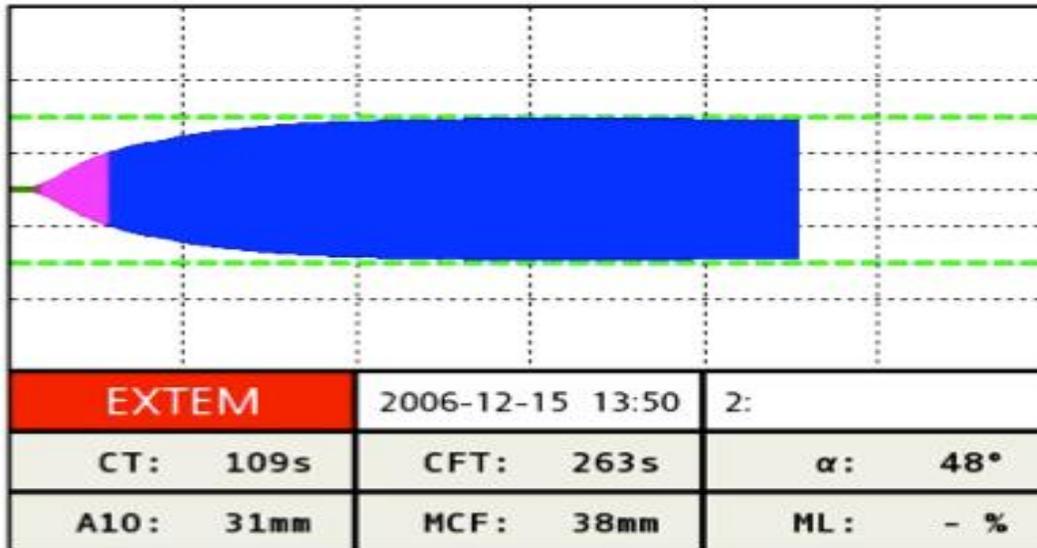
Deficit del fibrinogeno o piastrinopenia → **MA più bassa**

# Tromboelastogramma TEG®

## fibrinogeno funzionale

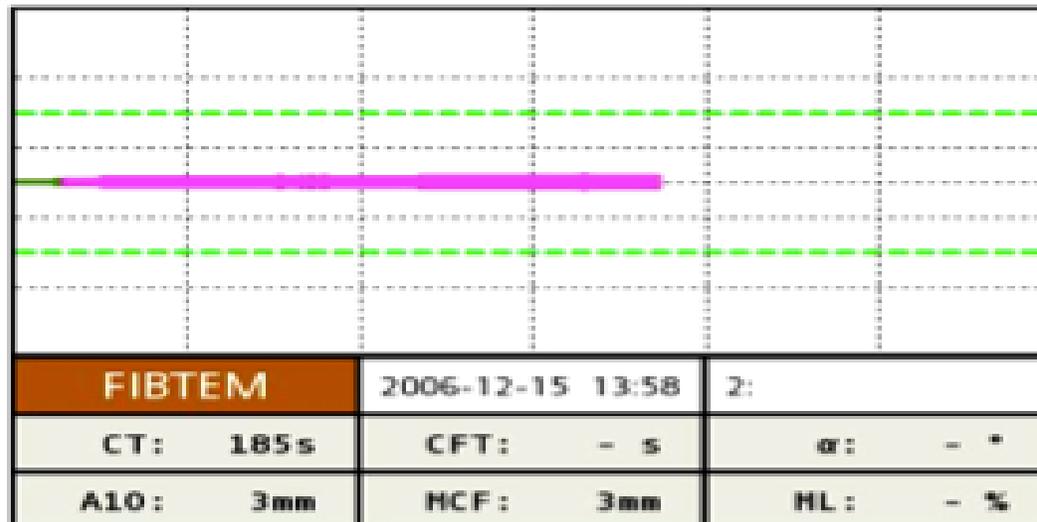


Algoritmo di calcolo per la concentrazione

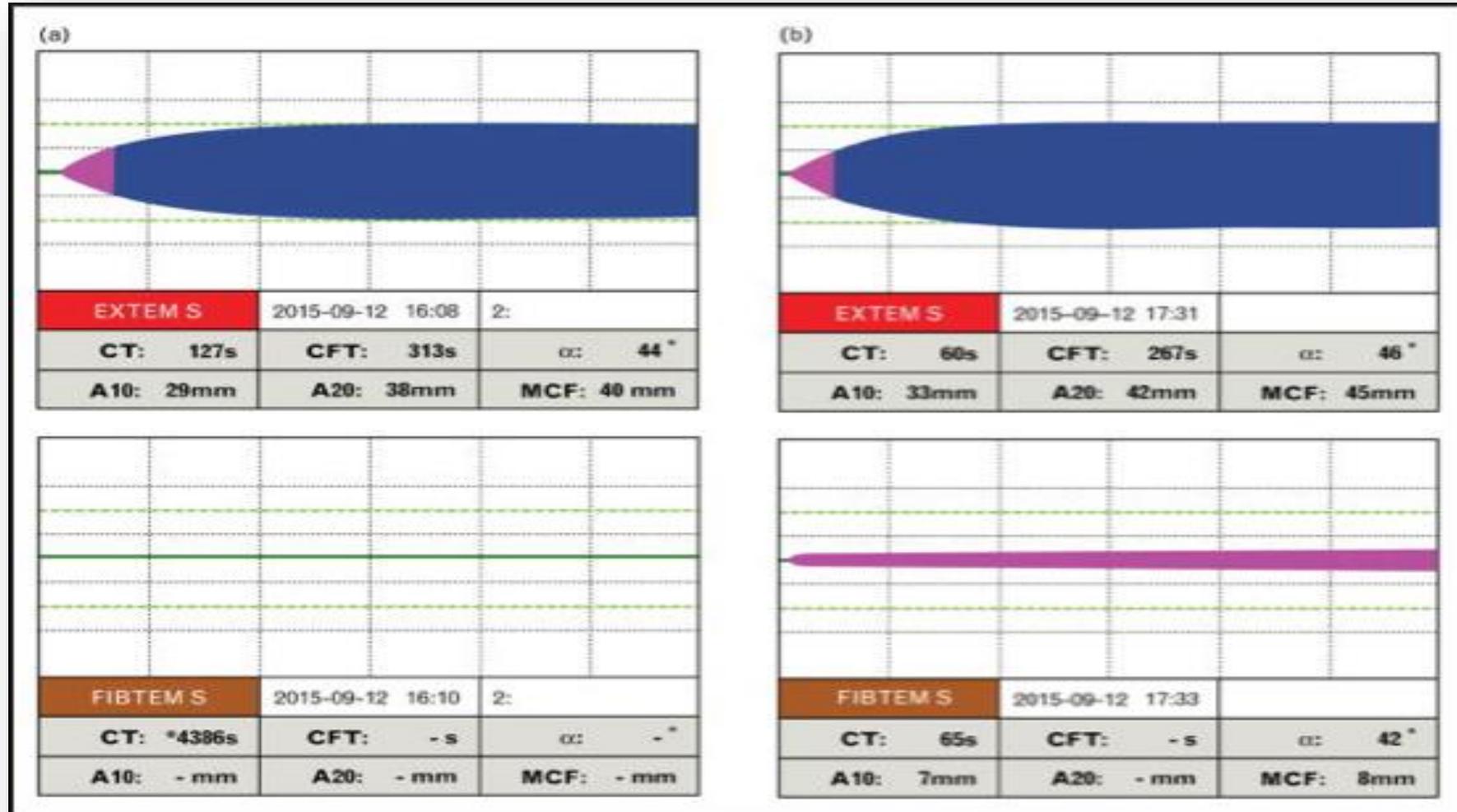


EXTEM: CT normal, MCF low amplitude

## Fibrinogen deficiency



FIBTEM: MCF low amplitude



**Fibrinogen deficiency**

**After fibrinogen implementation**

**Come rimpiazzare il fibrinogeno?**

CARDIOVASCULAR

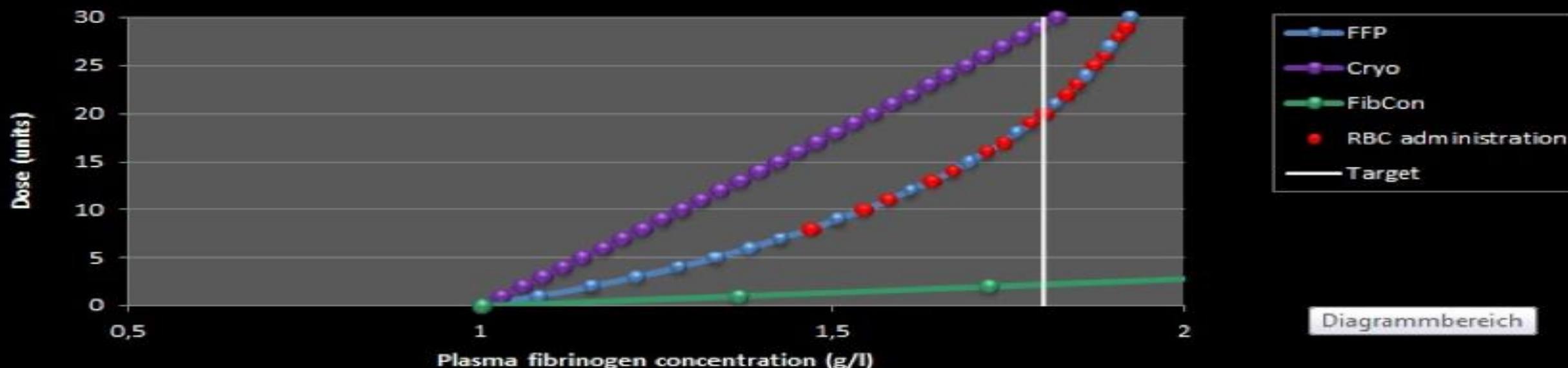
# Theoretical modelling of fibrinogen supplementation with therapeutic plasma, cryoprecipitate, or fibrinogen concentrate

P. W. Collins<sup>1\*</sup>, C. Solomon<sup>2,3</sup>, K. Sutor<sup>4</sup>, D. Crispin<sup>4</sup>, G. Hochleitner<sup>5</sup>, S. Rizoli<sup>6</sup>, H. Schöch<sup>7,8</sup>, M. Schreiber<sup>9</sup> and M. Ranucci<sup>10</sup>

## Dose calculation

	FFP	Cryo	FibCon	
Dose	20	30	3	units
Volume	5000	375	150	ml
Resultant Fib concentration	1,80	1,82	2,07	g/l

## Fibrinogen concentration graph



Diagrammbereich

# Cause di sanguinamento NON chirurgico

- ✓ Eparina residua
- ✓ Ridotta generazione di trombina
- ✓ Deficit di stabilità del coagulo per ipofibrinogenemia
- ✓ **Deficit di stabilità del coagulo per piastrinopenia**
- ✓ **Deficit di stabilità del coagulo per disfunzione piastrinica**
- ✓ Iperfibrinolisi (rara)

# ROTEM

## Piastrinopenia o disfunzione piastrinica

**EXTEM** **INTEM**

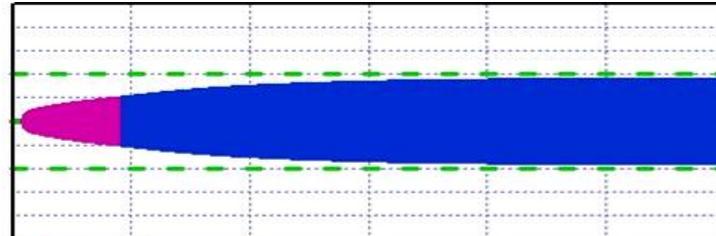
CT normale  
Bassa ampiezza

**FIBTEM**

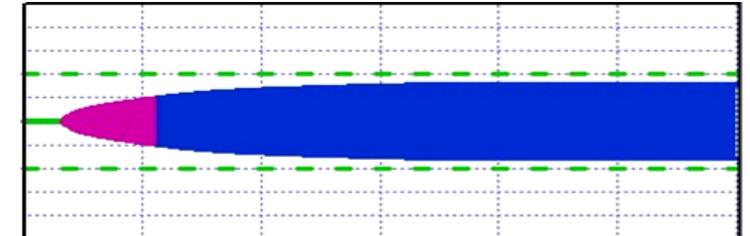
Ampiezza normale

**APTEM** ≈ EXTEM

No iperfibrinolisi



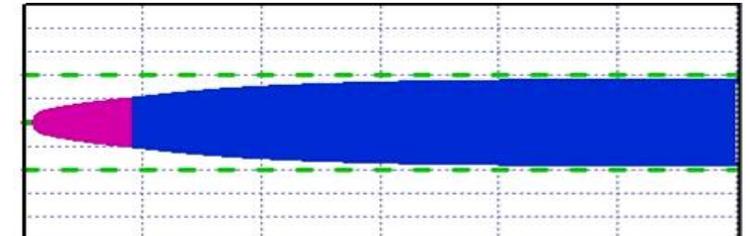
EXTEM		
CT: 57s	CFT: 444s	$\alpha$ : 80°
A10: 23mm	MCF: 35mm	ML: -%



INTEM		
CT: 200s	CFT: 449s	$\alpha$ : 72°
A10: 23mm	MCF: 32mm	ML: -%

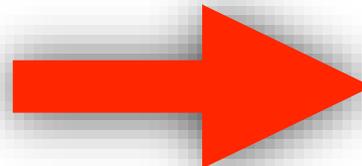


FIBTEM		
CT: 67s	CFT: -s	$\alpha$ : -°
A10: 15mm	MCF: 16mm	ML: -%



APTEM		
CT: 52s	CFT: 398s	$\alpha$ : 80°
A10: 25mm	MCF: 35mm	ML: -%

Platelet deficiency

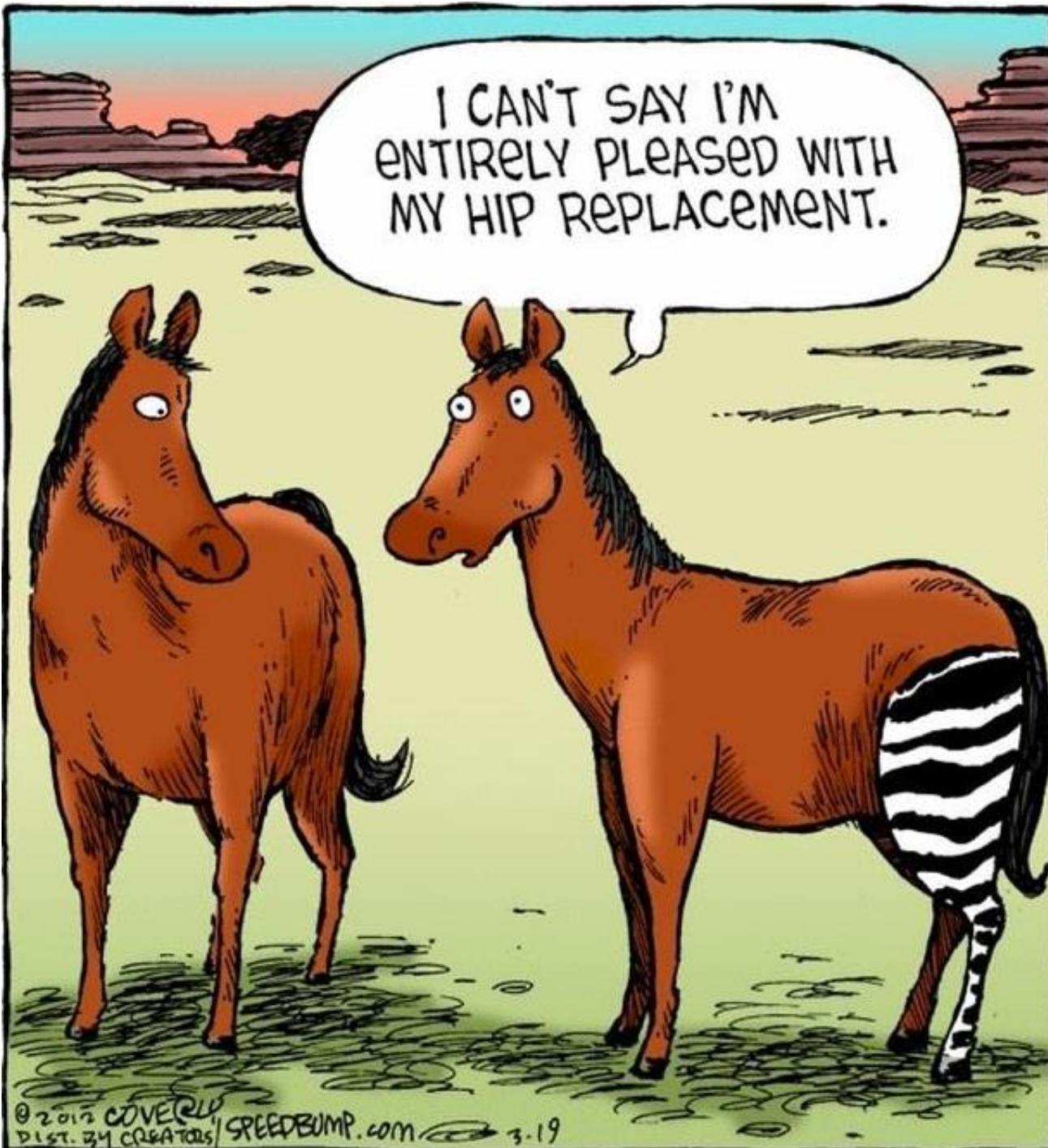


Platelet transfusion

**Misurare ciò che facciamo ci aiuta a  
proporzionare le nostre terapie**



*thanks to T.Aloisio*



I CAN'T SAY I'M ENTIRELY PLEASED WITH MY HIP REPLACEMENT.

**GRAZIE**

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**HUMANITAS**  
GAVAZZENI

*Grazie*