

Point-of-Care Diagnostic

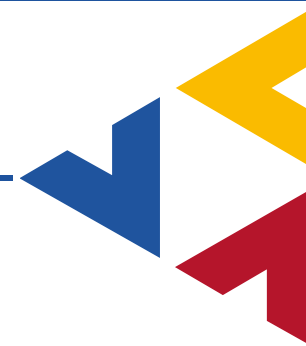


Dr. Kristian-Christos Ngamsri

**Department of Anesthesiology and Intensive Care Medicine,
University Hospital of Tübingen**

January 22, 2020

kristian.ngamsri@med.uni-tuebingen.de



Eberhard-Karls-Universität

UKT

Universitätsklinikum Tübingen

Point-of-Care Diagnostic Tools

- coagulation

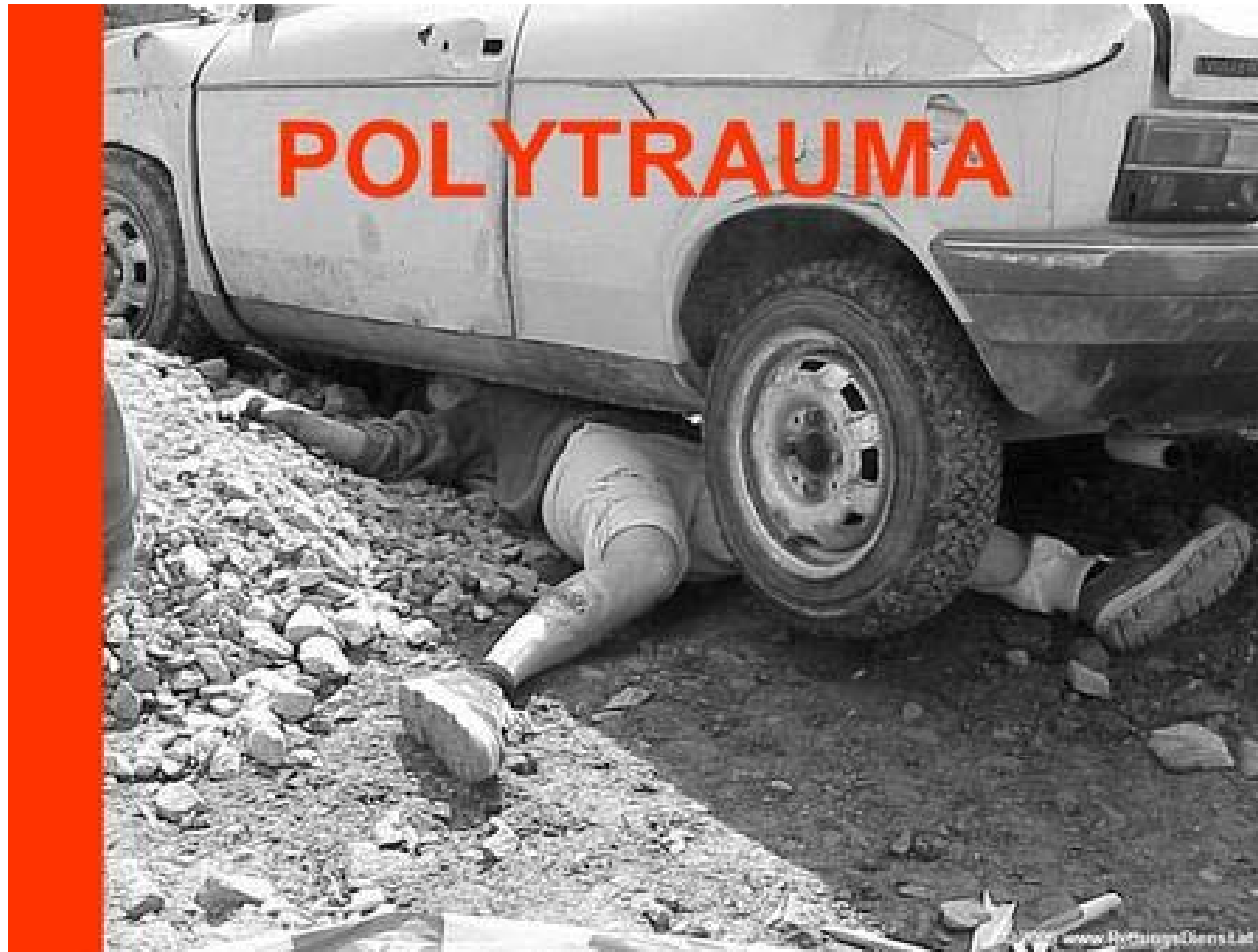


- blood gases analysis



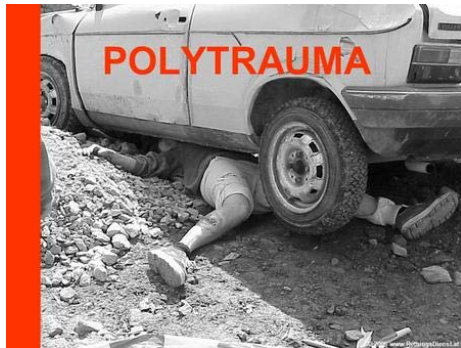
Coagulation – Point-of-Care Monitoring

Why?



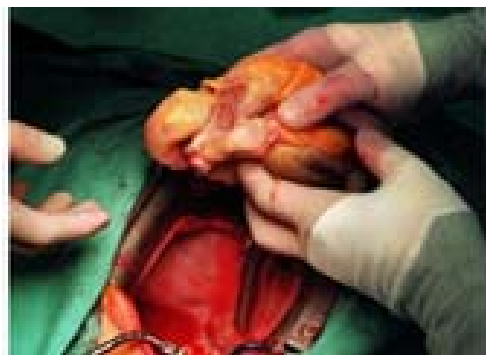
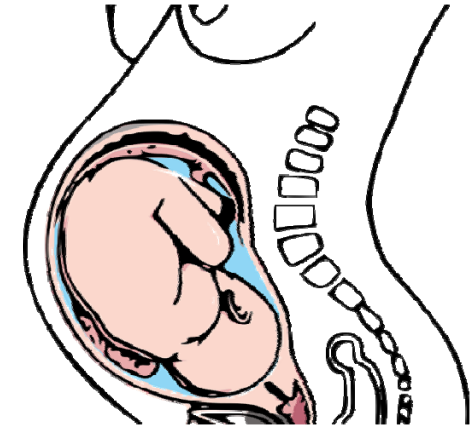
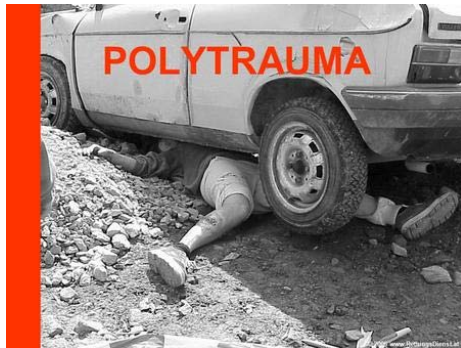
Coagulation – Point-of-Care Monitoring

Why?



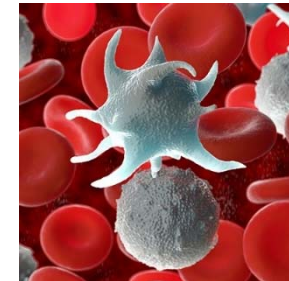
Coagulation – Point-of-Care Monitoring

Why?

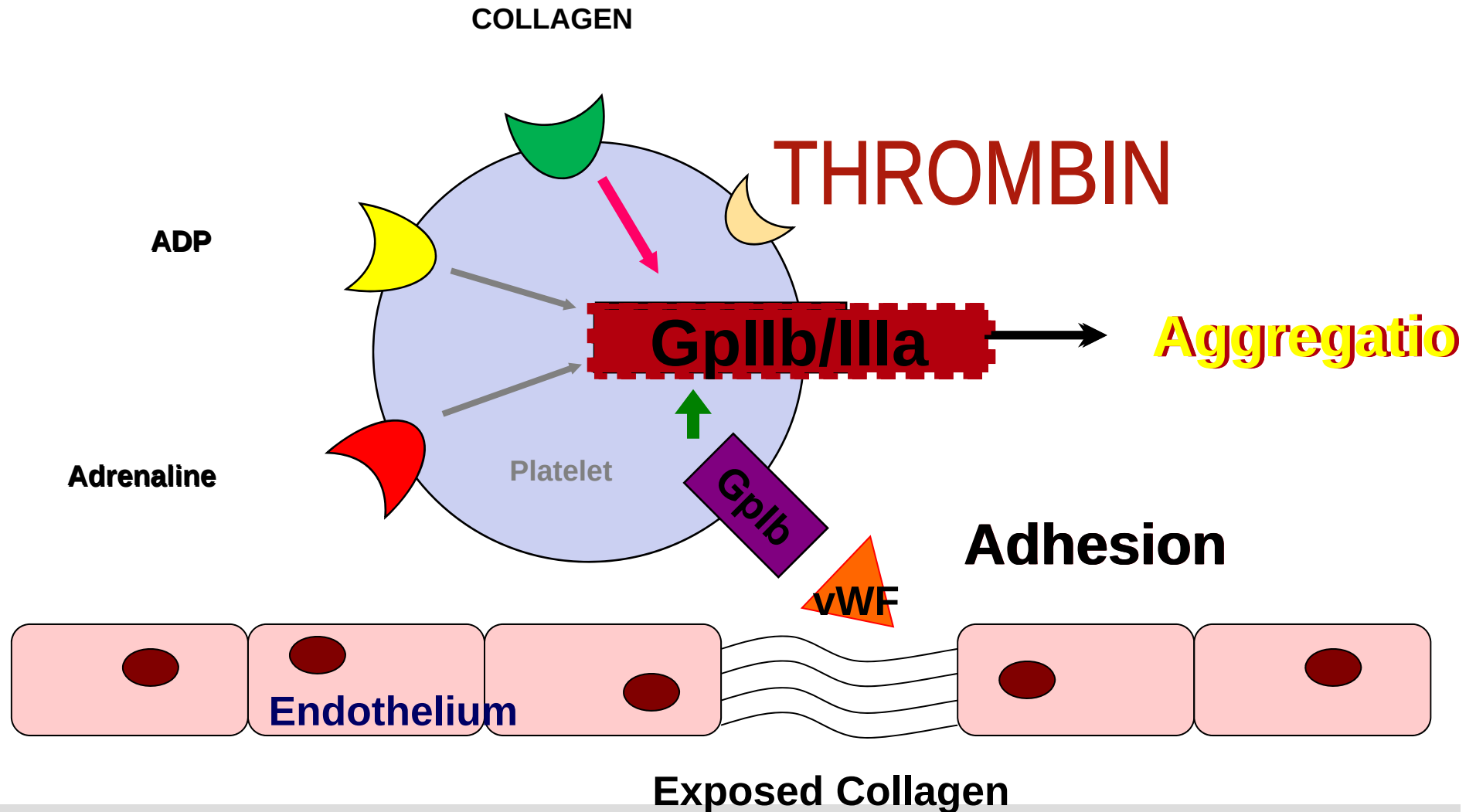


3 Major systems involved

- ▶ Vessel wall
 - Endothelium
 - ECM=BM (type 4 collagen + other proteins)
- ▶ Platelets
- ▶ Coagulation factors
 - factors (proteins) -> active and inactive forms



Platelets



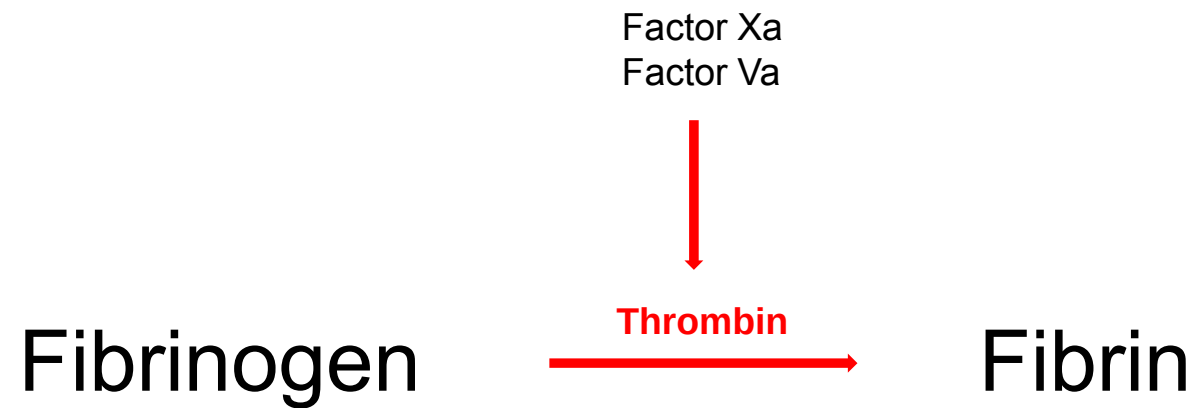
Coagulation Cascade

- ▶ Enzymatic cascade (amplification)
- ▶ Several serine proteases
 - Produced by liver tissue (most)
 - Require Vitamin K (several)
- ▶ 3 protein co-factors (not enzymes)
- ▶ Requires Ca^{2+}
- ▶ Reversible (via production of plasmin)

Coagulation cascade

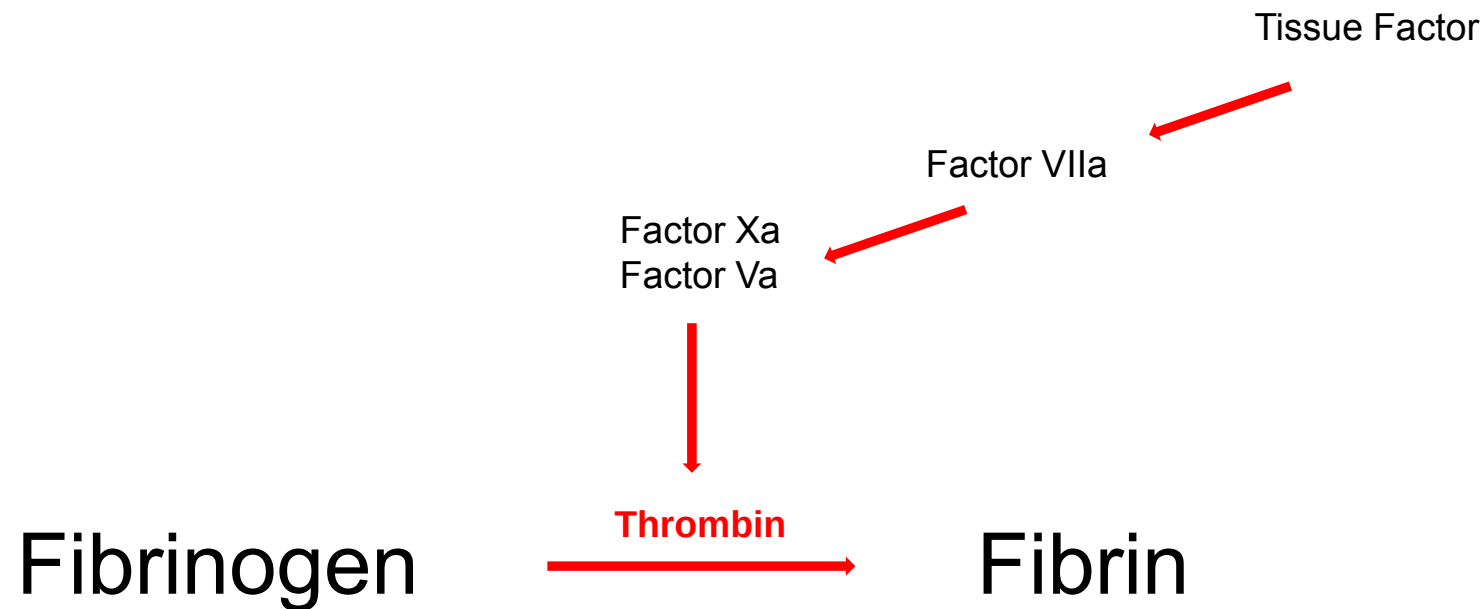
Fibrinogen $\xrightarrow{\text{Thrombin}}$ Fibrin

Coagulation cascade



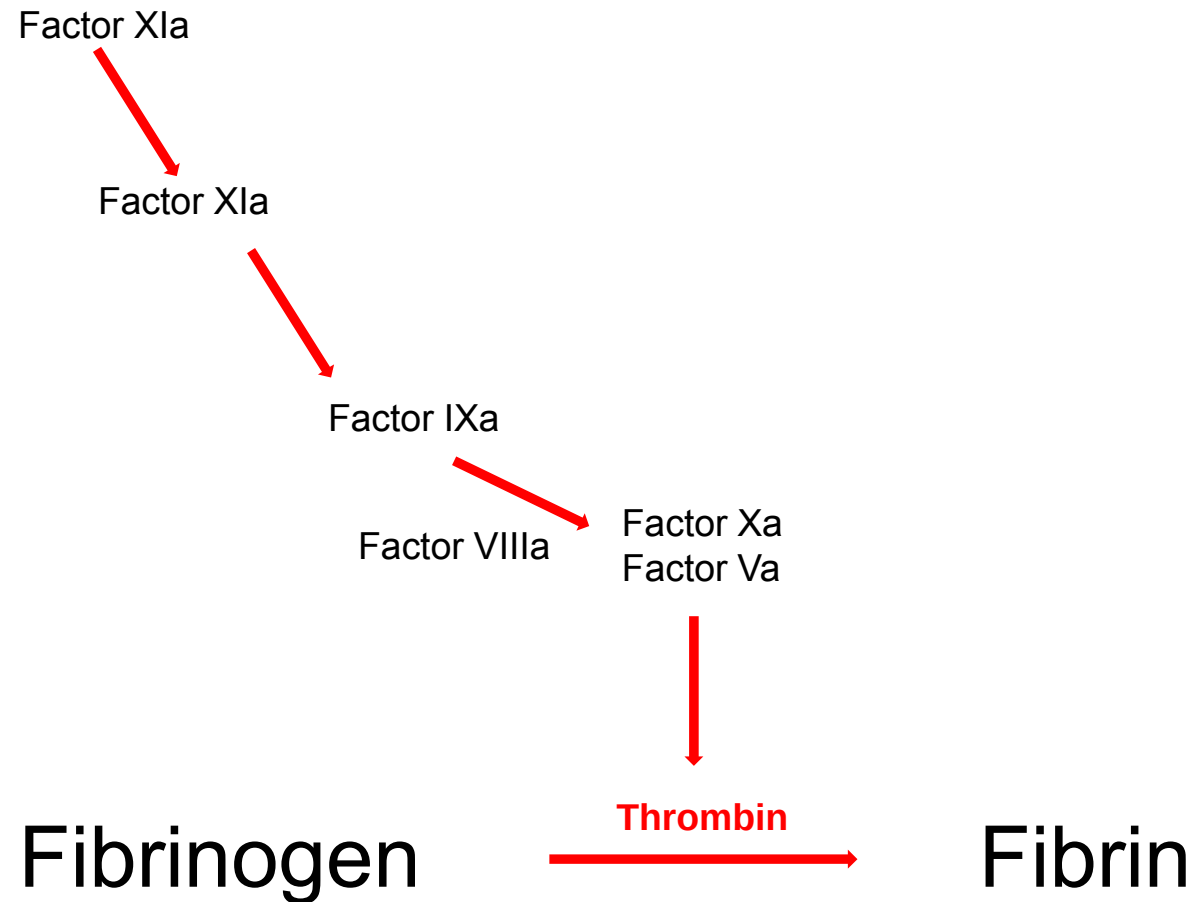
Coagulation cascade

Extrinsic Pathway

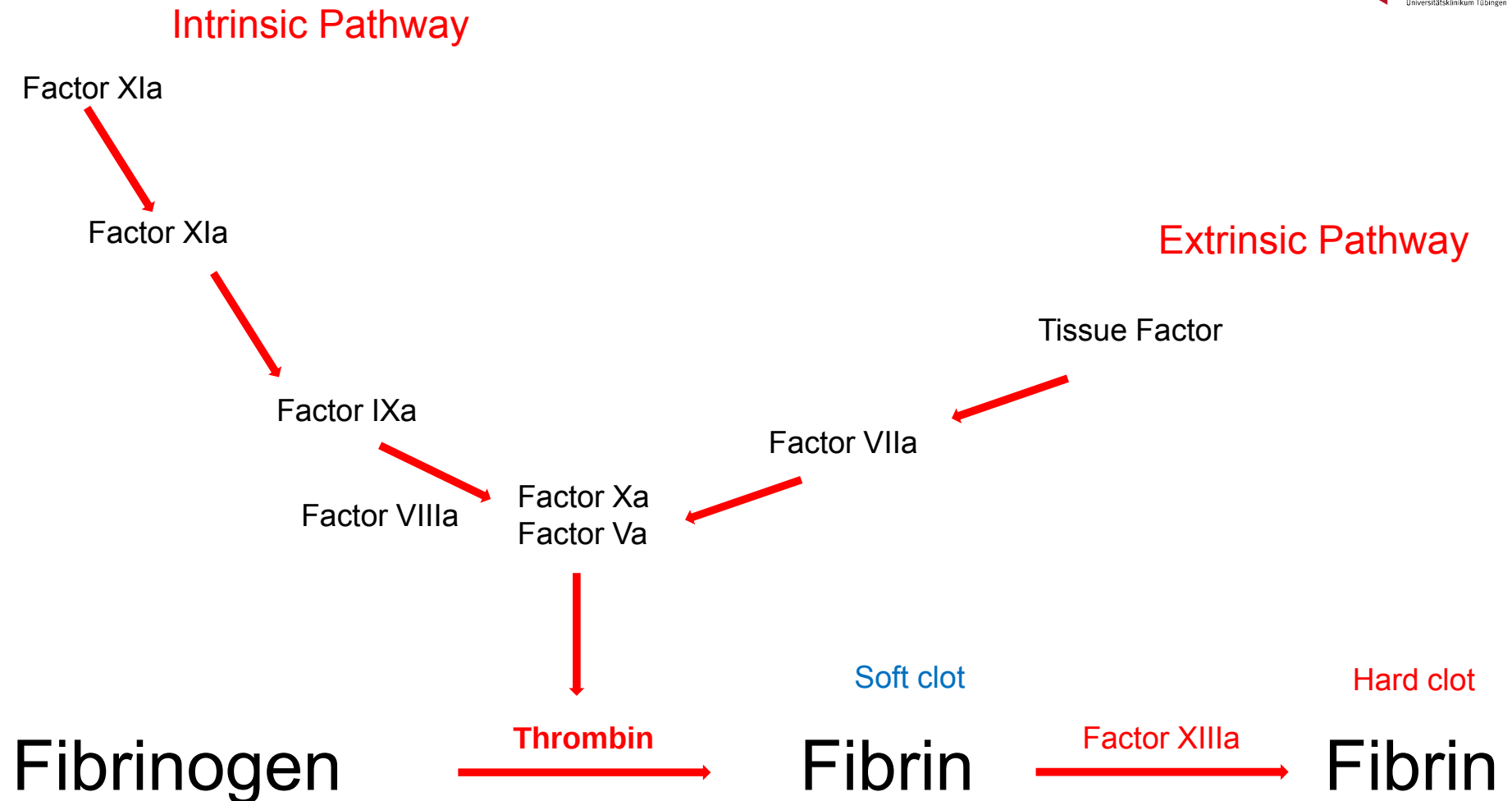


Coagulation cascade

Intrinsic Pathway



Coagulation cascade



Coagulation cascade



Intrinsic Pathway

All clotting factors are within the blood Vessels

Clotting slower (minutes)

Activated partial thromboplastin test (aPTT)

Extrinsic Pathway

Initiating factor is outside the vessel – tissue factor

Clotting – faster – in seconds

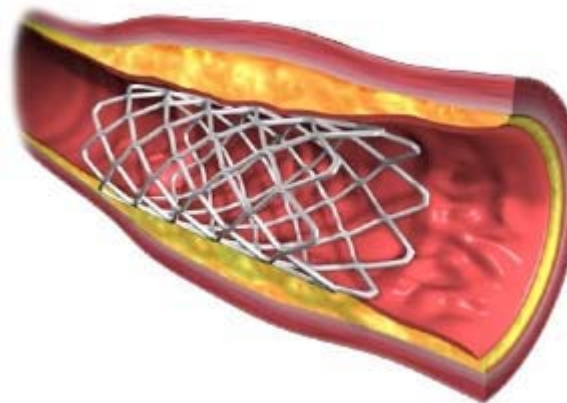
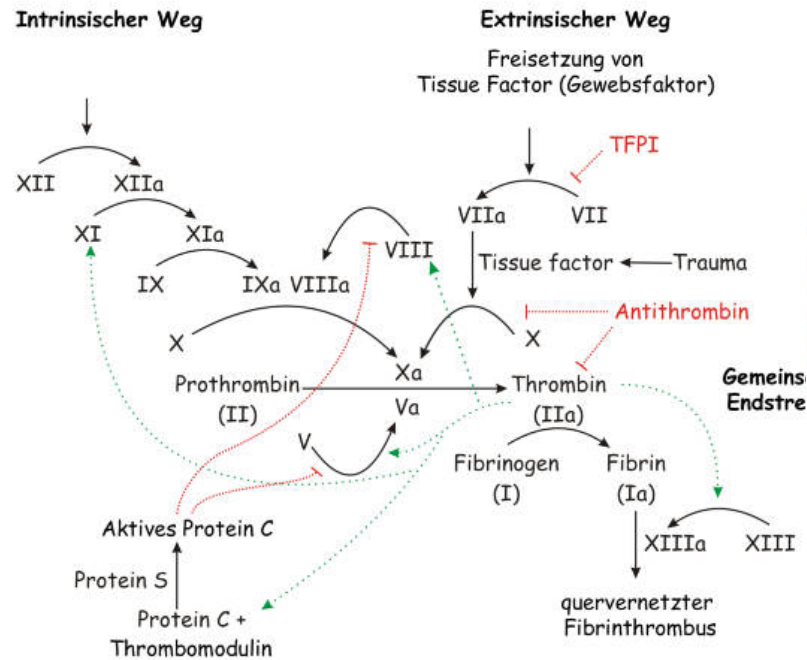
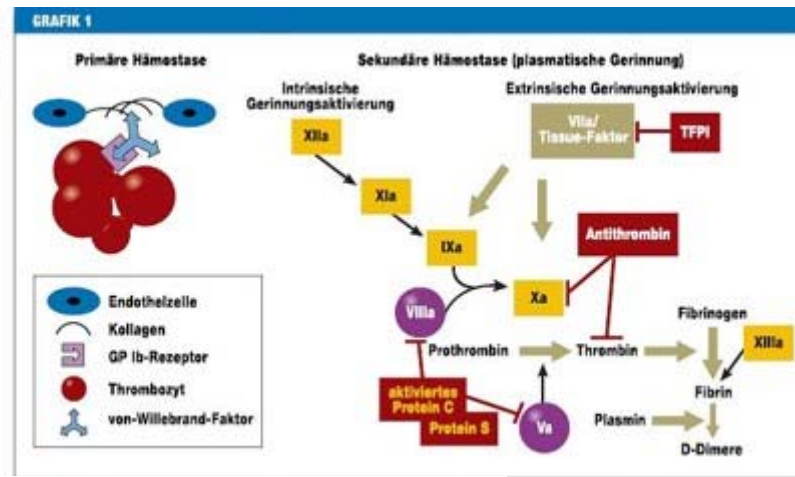
Prothrombin test (PT or Quick)

Coagulation – Point-of-Care Monitoring

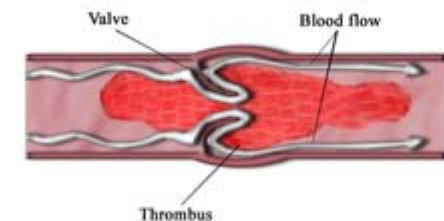
Why?



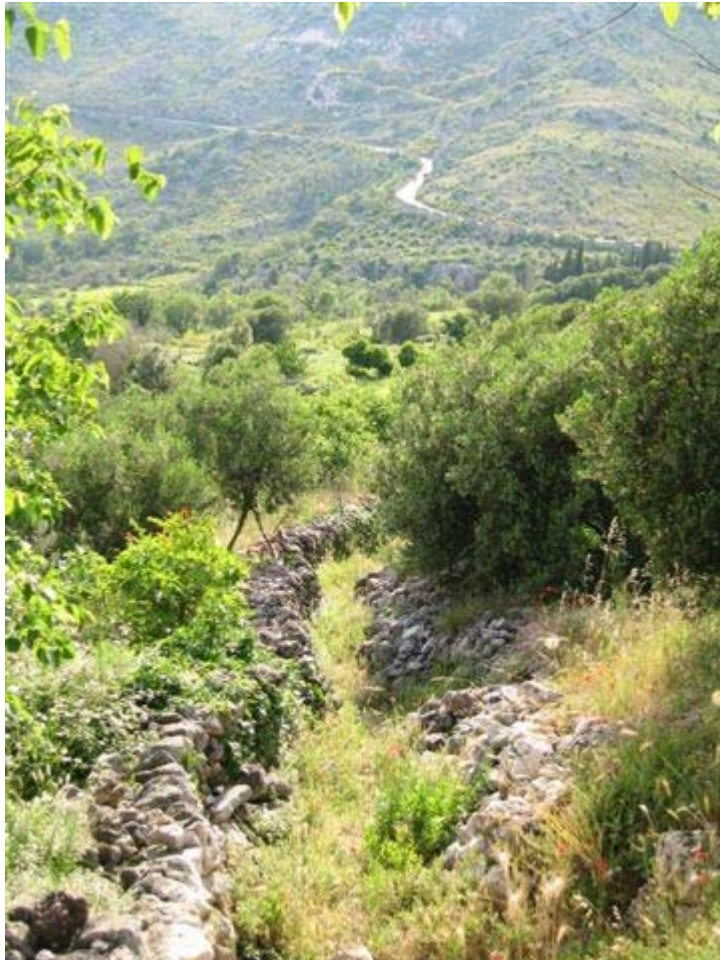
Schematische Darstellung der primären und sekundären Hämostase



Blood Clot Diagram



Coagulation – Point-of-Care Monitoring

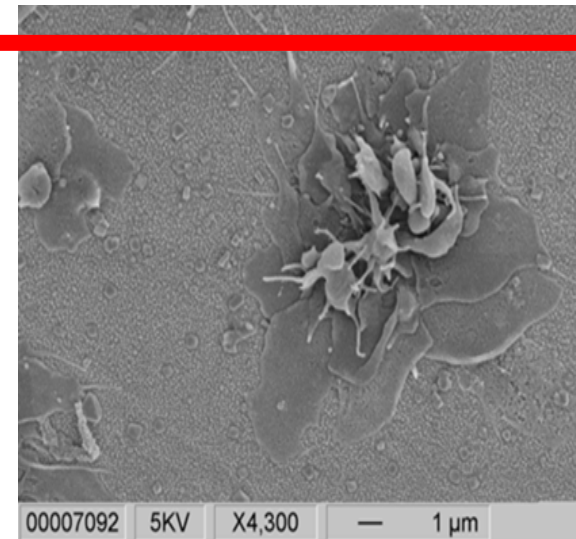


Coagulation – Point-of- Care Monitoring



Multiplate platelet function analyzer

- ▶ Based on principle of impedance aggregometry (Cardinal und Flower, 1979)
- ▶ Whole blood function analysis of thrombocytes
- ▶ Point-of-care tool

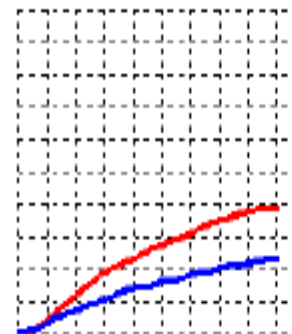




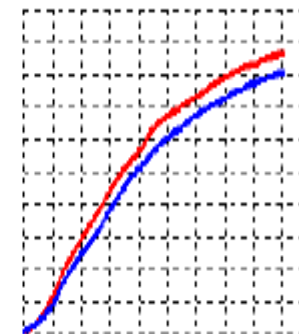
300µl blood +
300µl NaCl 0,9%

Application of activators

- Quick performance (10 minutes)
- fast answers
- less blood drawn

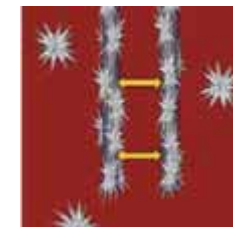
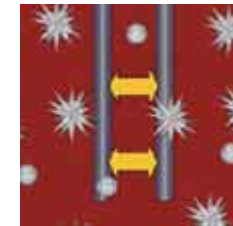
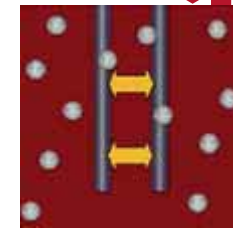
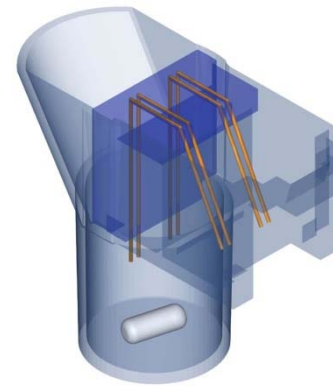


with ASS

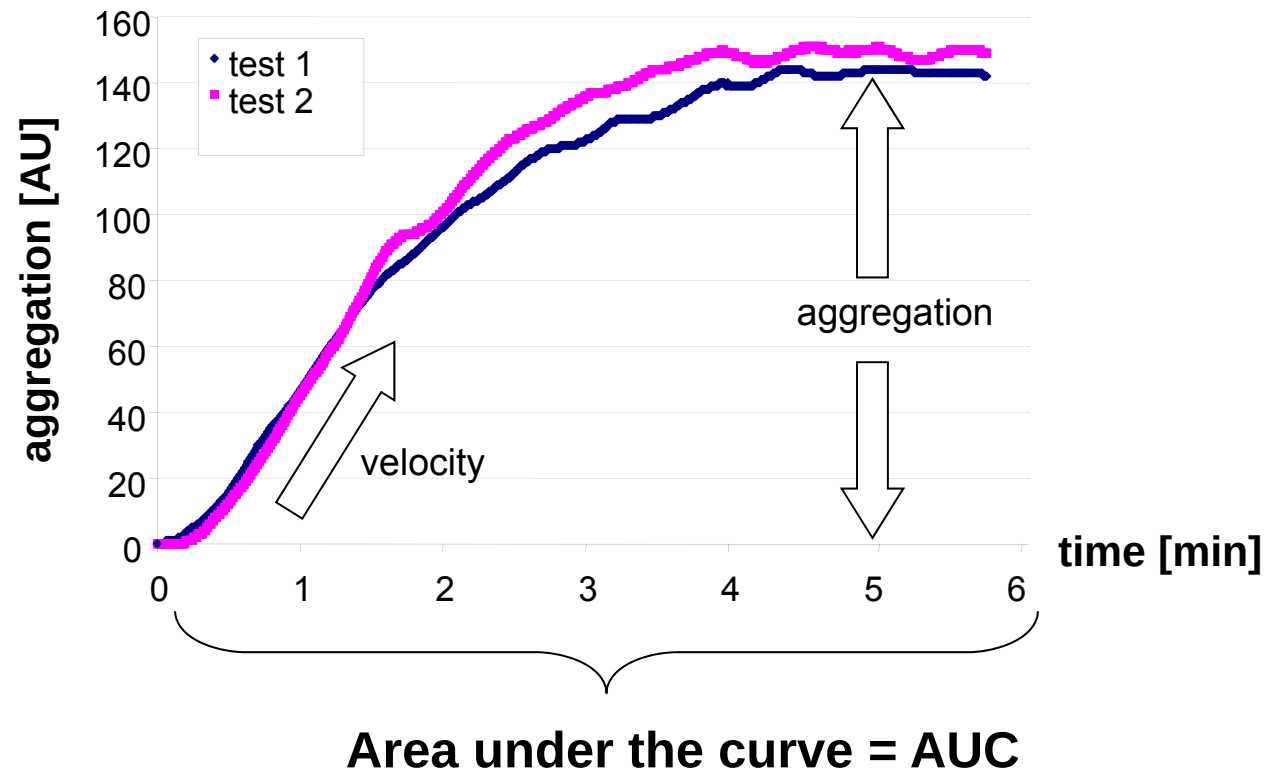


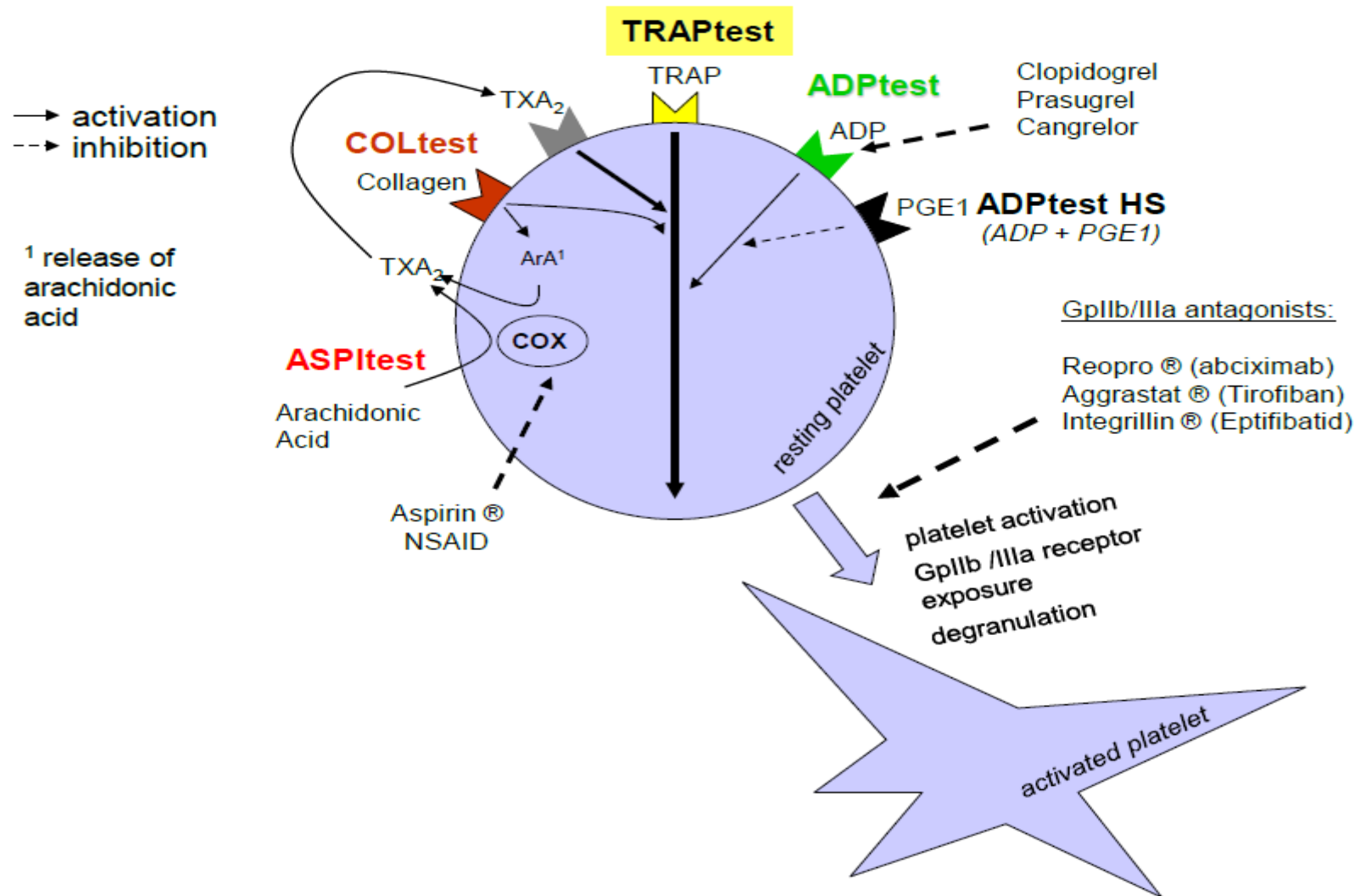
without ASS

Multiplate platelet function analyzer



- Activated platelets adhere on the surface of the sensor
- Platelets aggregates form an insulation layer
- The impedance between the electrodes rises





Case report 1

women, 78 years old

Re – ACVB

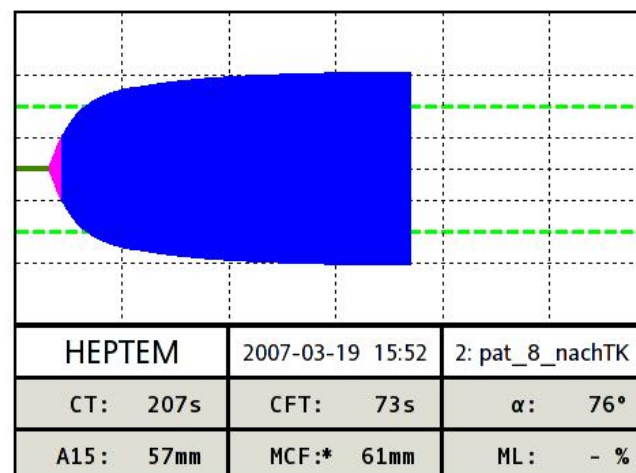
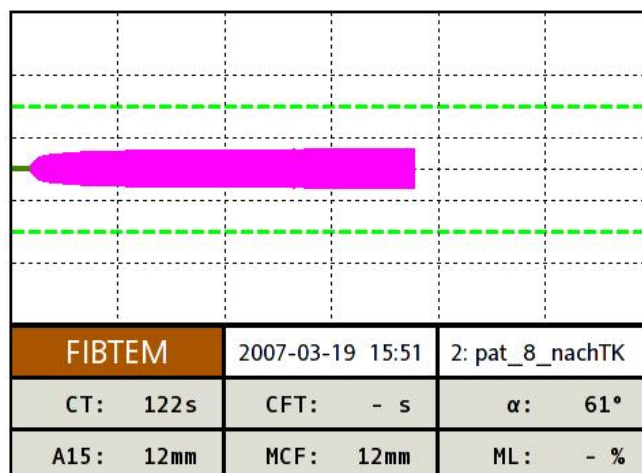
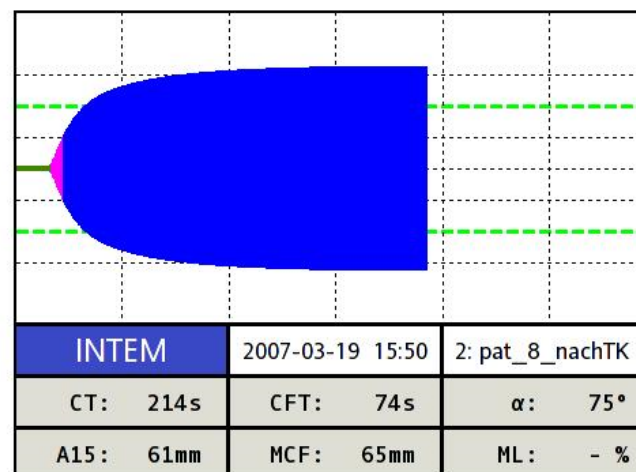
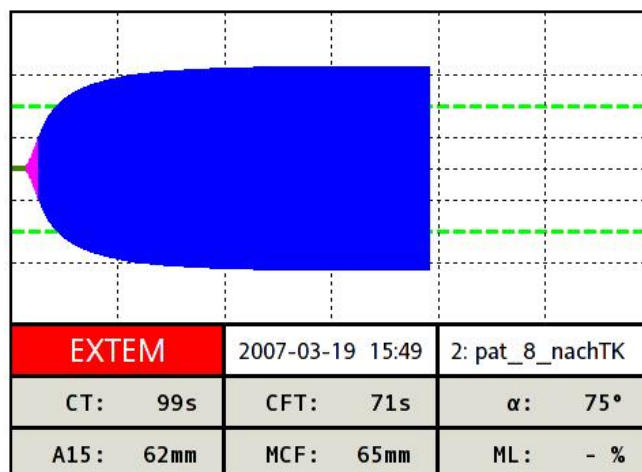
HLM: 125 min

Blood lose: 1000 ml postoperative

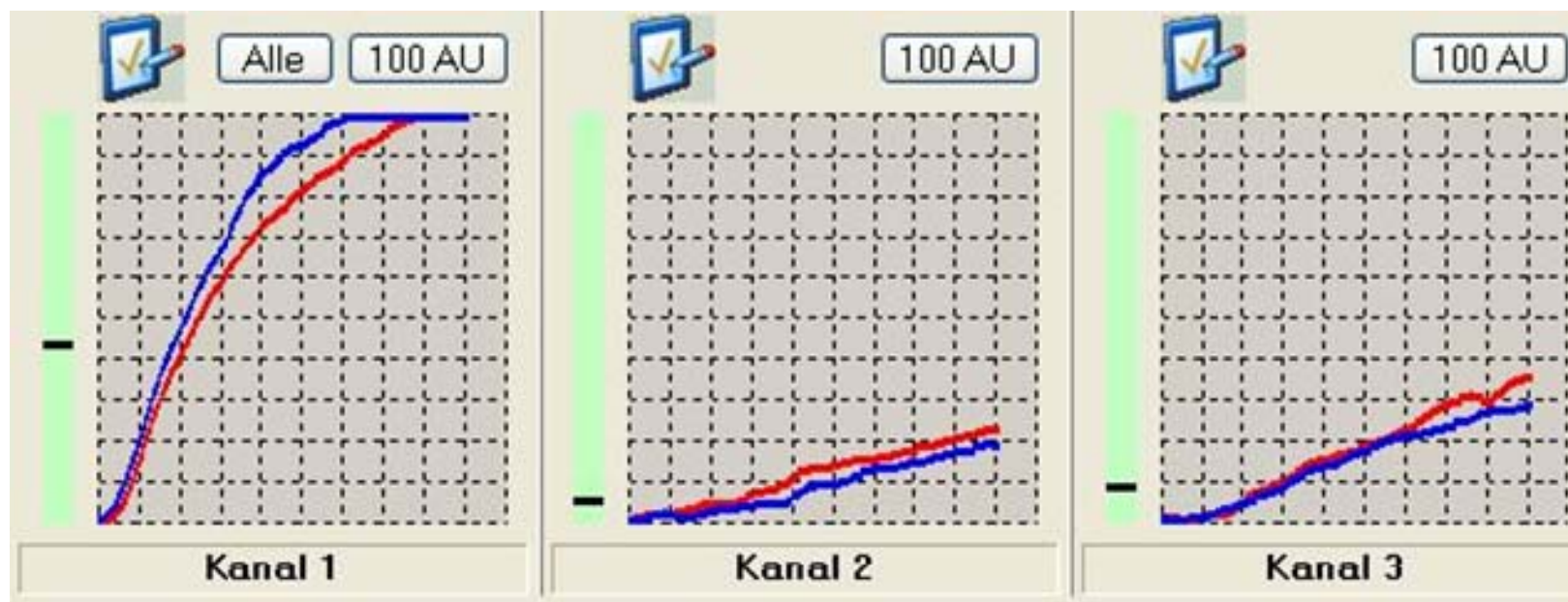


Auftragsnummer	Referenzbereich	Einheit	V853288	V853289	80918460	61945880	80918462	80923779
Probenentnahmedat.			3.9.2008	3.9.2008	4.9.2008	4.9.2008	4.9.2008	4.9.2008
Probenentnahmezeit			00:00	00:00	01:13	07:00	07:00	18:00
Thrombozyten im BB	150 - 440	/ nl			152		178	96
Gerinnung-Routine								
TPZ	70 - 120	%			120		114	63
INR					0.89		0.92	1.39
PTT	28 - 38	sec			43		35	38
Fibrinogen	150 - 450	mg/dl			225		227	204
Antithrombin-Aktivität (FII-Inhib.)	> 80	%			64		97	62
Thrombinzeit	16 - 20	sec						15

Rotem



Multiplate



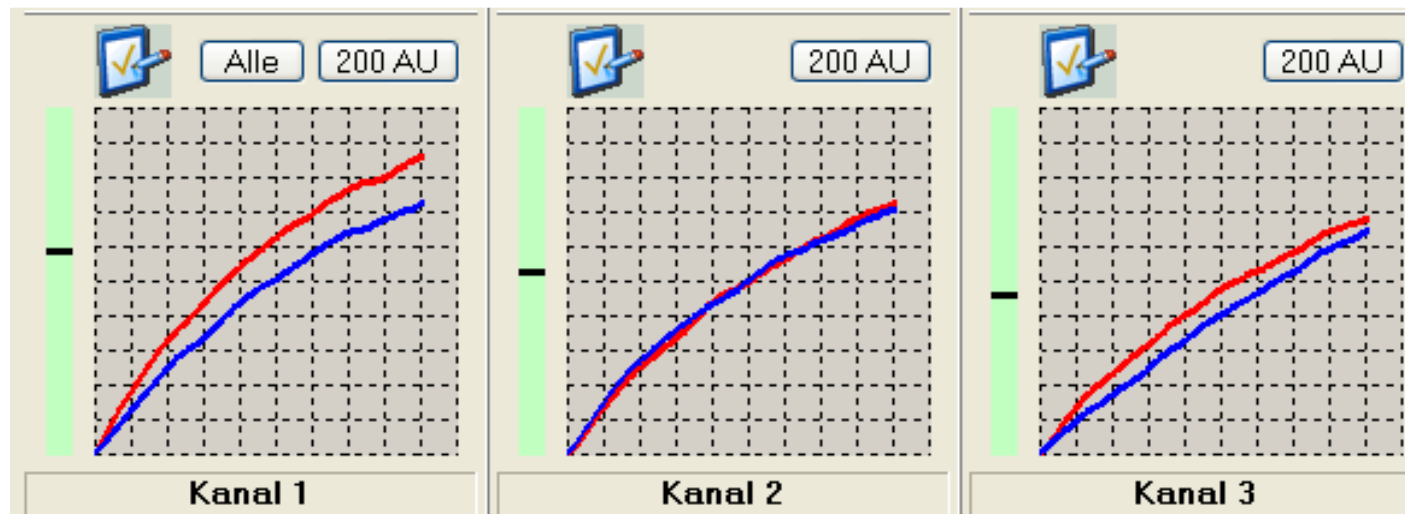
TRAPtest

ASPItest

ADPtest

Multiplate

after 3 platelet rich plasma concentrate



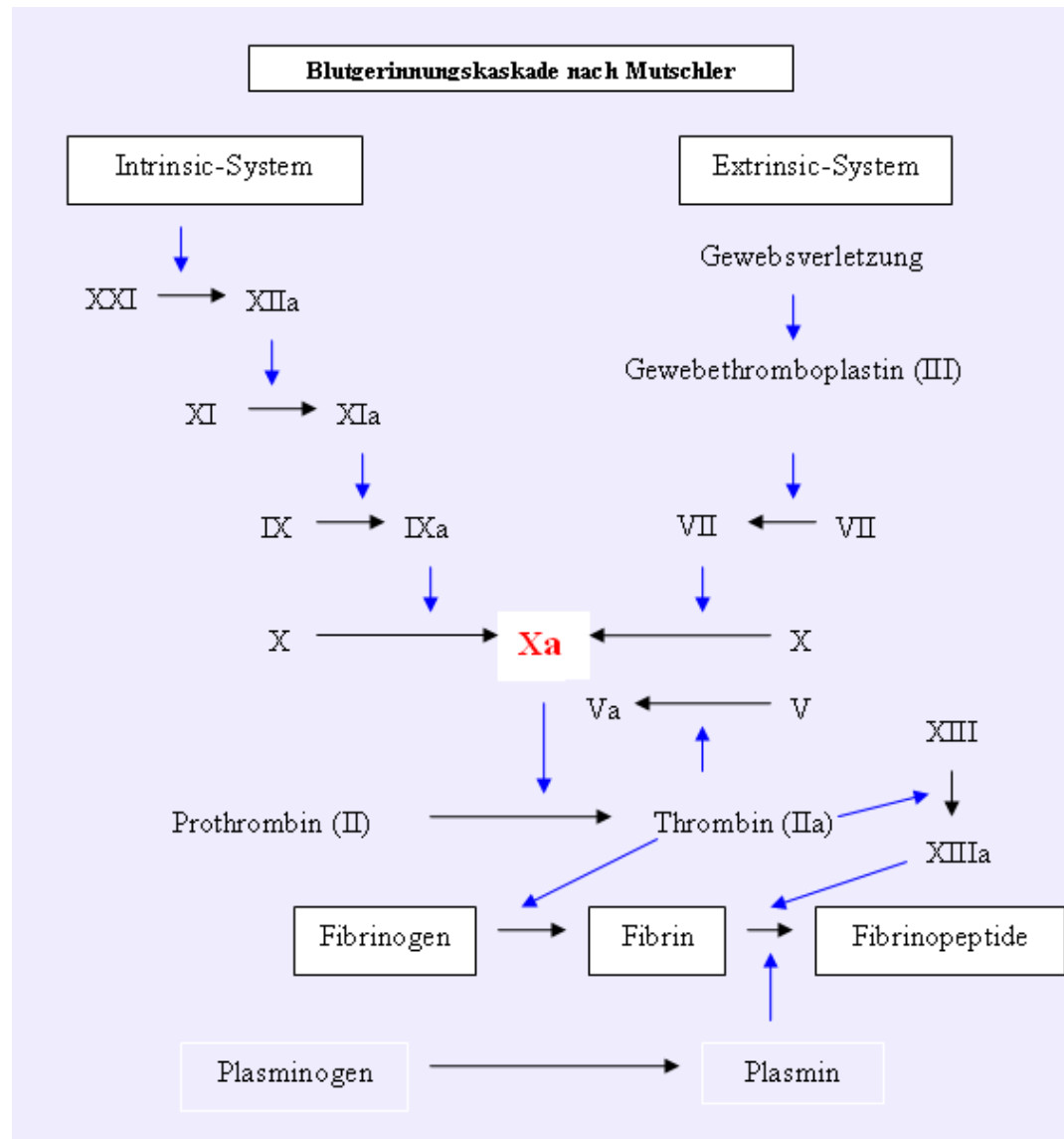
TRAPtest

ASPItest

ADPtest

Standard coagulation analysis

aPTT



**Quick /
INR**

**Fibrinogen
-level**

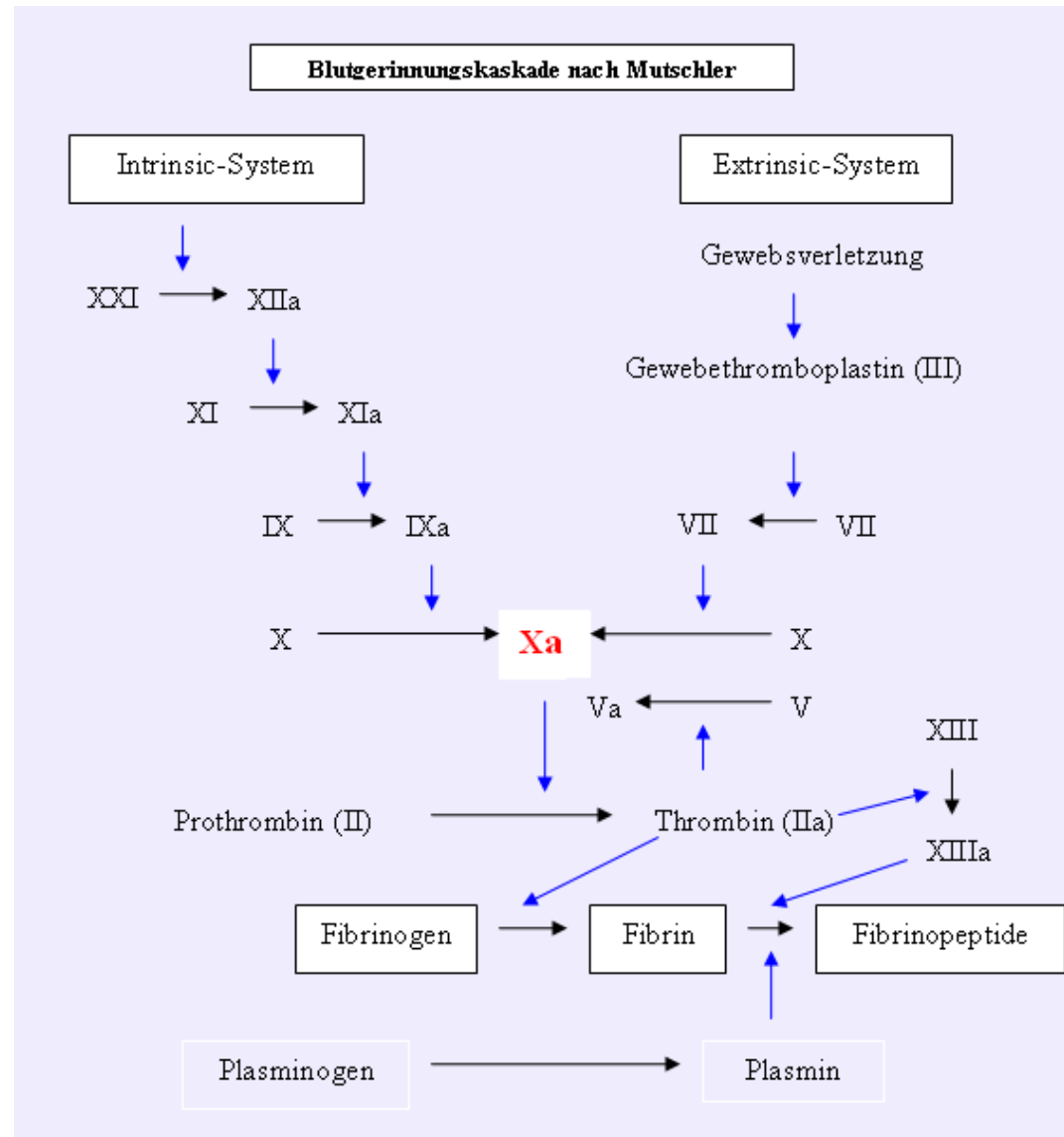
FXIII-level

Rotem/TEG – Point-of-care analysis



Rotem – Point-of-care analysis

**inTEM/
hepTEM**

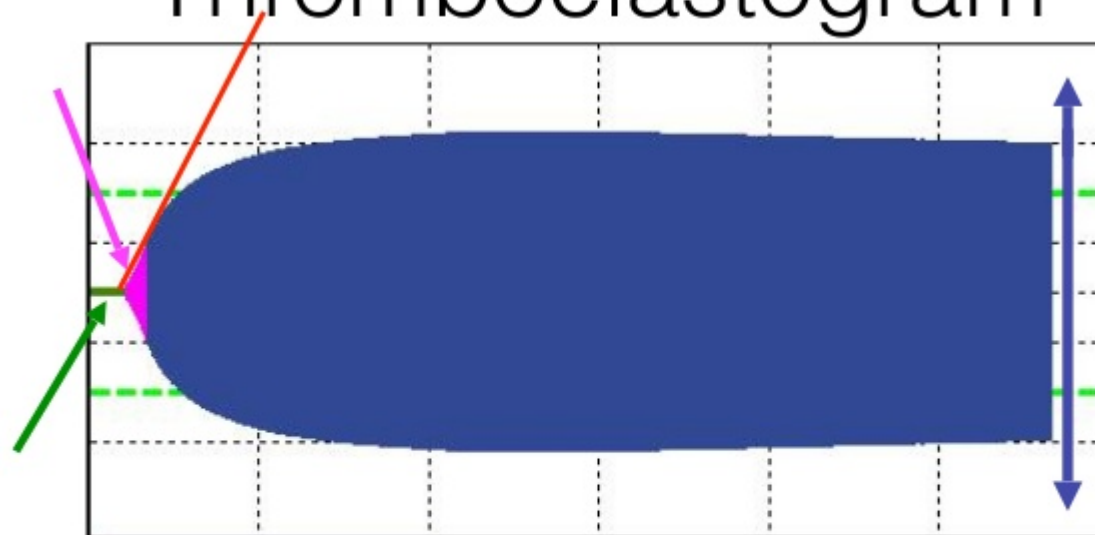


exTEM

fibTEM

apTEM

Thromboelastogram



ROTEM is een meting van viscoelasticiteit over tijd

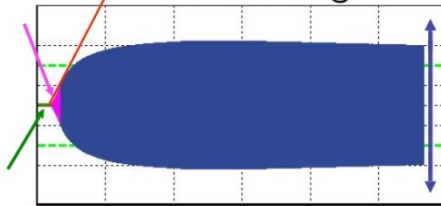
CT – clotting time; “initiation phase”

CFT – Clot formation time; “propagation phase”

α -angle – propagation phase

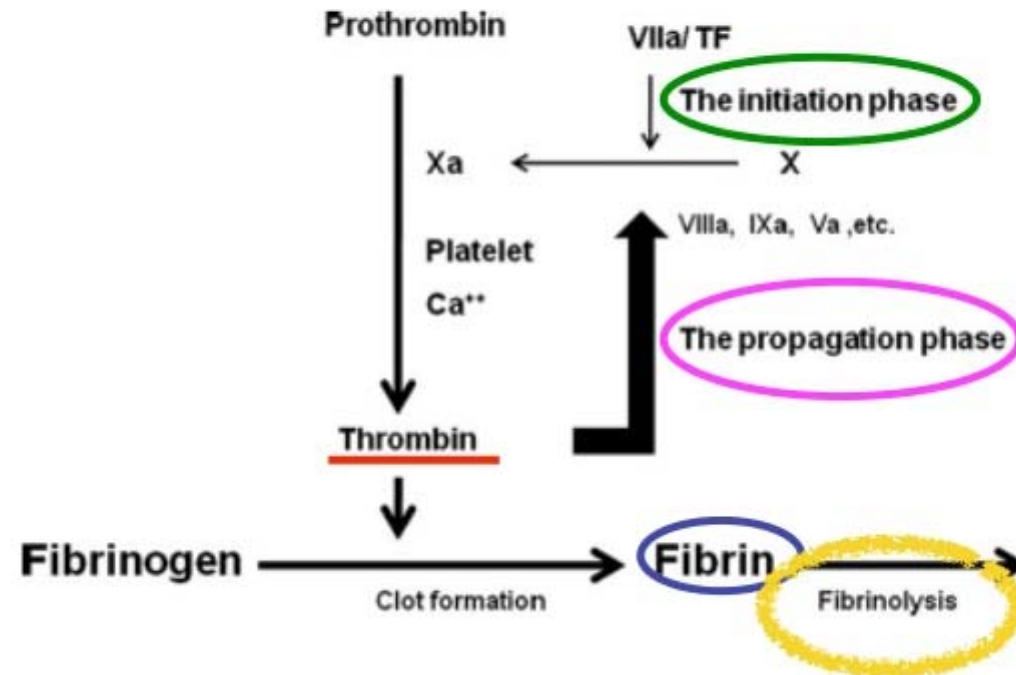
MCF – Maximum Clot formation;

Thromboelastogram

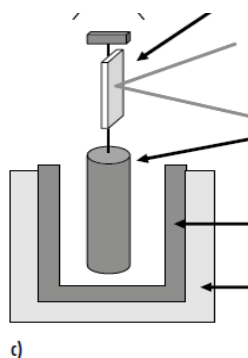


ROTEM is een meting van viscoelasticiteit over tijd
 CT – clotting time; "initiation phase"
 CFT – Clot formation time; "propagation phase"
 α -angle – propagation phase
 MCF – Maximum Clot formation;

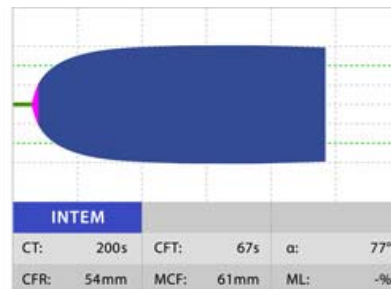
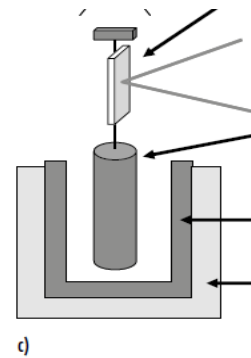
Stolling



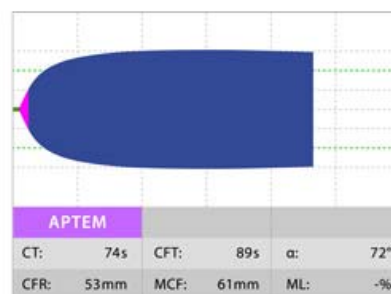
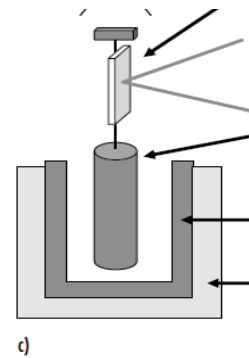
(1) Extem



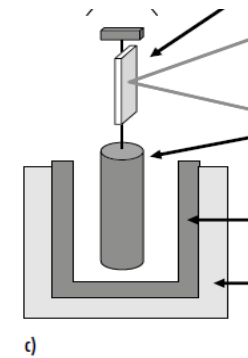
(2) Intem



(3) Fitem



(4) Hep/Aptem



Laboratory Value	Interpretation	Blood Product Transfusion	QUALITATIVE INTERPRETATION = PATTERN RECOGNITION
R less than 4 min	Enzymatic Hypercoagulability	No treatment if bleeding	 Normal R/K/MA: Angle Normal
R between 11-14 min	Low clotting factors	Plasma and RBC's	 Anticoagulants/hemophilia Factor Deficiency R/K = Prolonged MA: Angle = Decreased
R greater than 14 min	Very low clotting factors	Plasma and RBC's	
a-angle < 45 degrees	Low fibrinogen level	Cryoprecipitate/ Fibrinogen / Platelets	 Platelet Blockers Thrombocytopenia/Thrombotic R = Normal; K = Prolonged MA = Decreased
MA between 46-54 mm	Low platelet function	Platelets/ Cryoprecipitate/ Fibrinogen	
MA between 41-45 mm	Very low platelet function	Platelets/ Cryoprecipitate/ Fibrinogen	 Fibrinolysis R = Normal; MA = Continuous Decrease
MA at 40 mm or less	Extremely very low platelet function	Platelets/ Cryoprecipitate/ Fibrinogen	
MA greater than 73 mm	Platelet Hypercoagulability	No treatment if bleeding	 Hypercoagulation R/K = Decreased MA: Angle = Increased
LY30 greater than 3% , CI less than 1.0	Primary fibrinolysis	Tranexamic acid 1g IV over 10 minutes followed by 1g in 250cc NS infused over 8 hours	
			 D.I.C. Stage 1 - Hypercoagulable + secondary fibrinolysis
			 State 2 - Hypocoagulable state

• Refer to TEG analysis tree for values outside these ranges

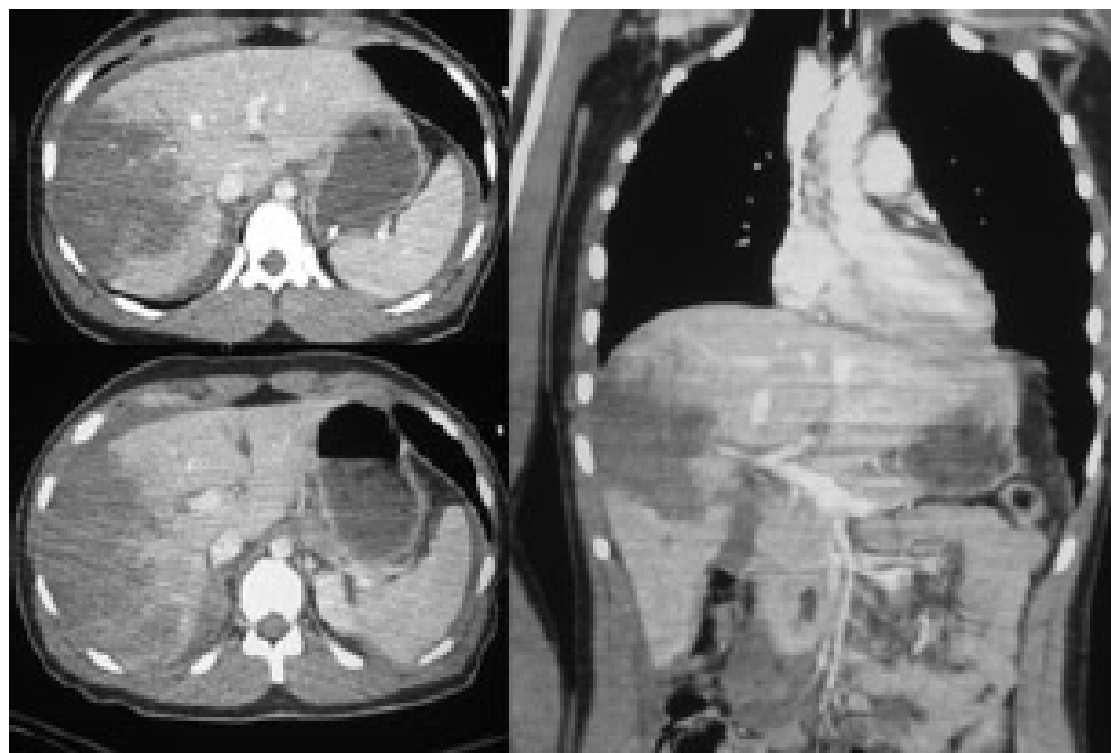
Case report 2



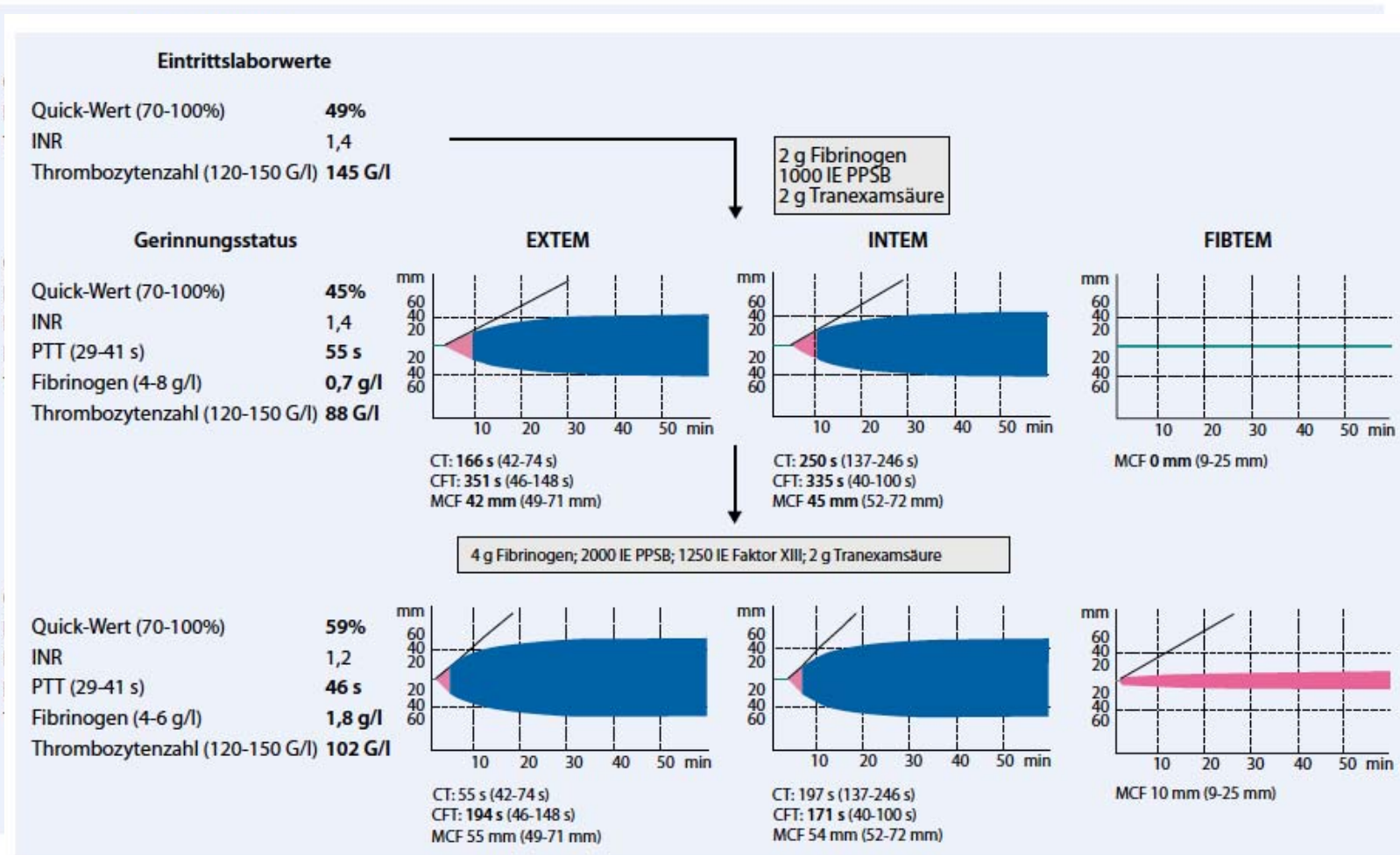
- women, 17 years old
- drop down 7m eter (climb accident)
- Sings of volumen deficiency shock
- Intubation and volumen challenge
- Helicopter transfer to hospital



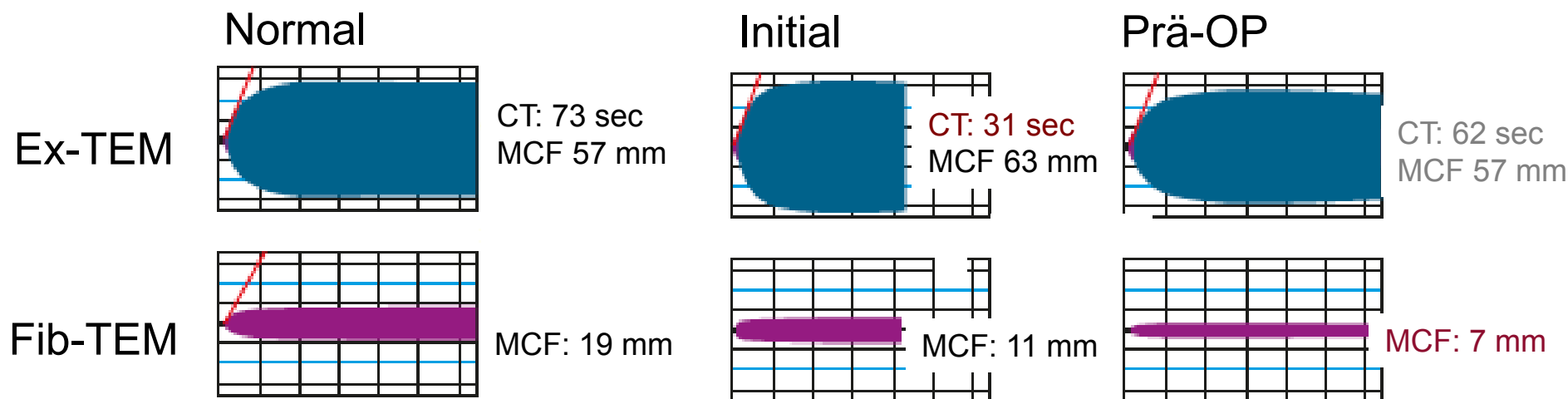
- Thoracic trauma
- Liver purely tore
- Pelvic fracture



Case report 2

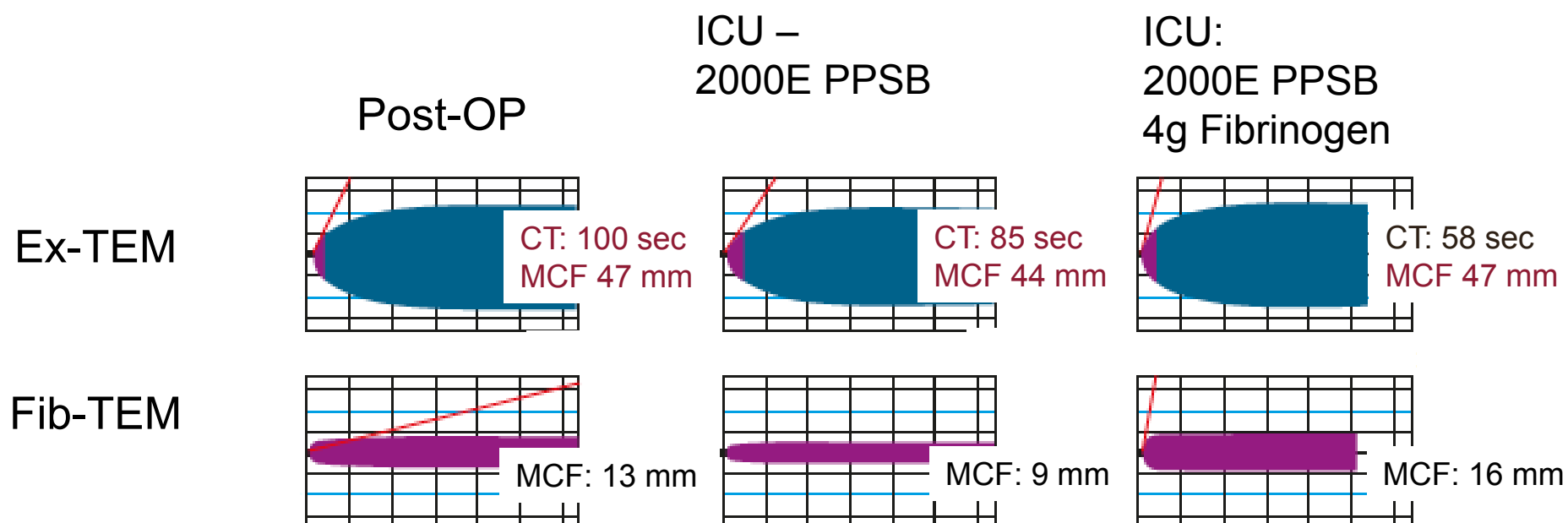


Hemoglobin: 9,1 g/dl
Hematocrit: 20%
Thrombocyte counts: $263 \times 10^3/\mu\text{l}$
Prothrombintime: 20.7 sec (Norm: 11-13.5 sec)
aPTT: 38 sec (normal: 26 - 35 sec)
Fibrinogen 1,33 g/l (Norm: 2 - 4.5 g/l)
Temperature = 34° C



Intra-OP:

- Partial hepatectomy (Segm. VI – VIII) and Packing
- 12 EK
- 9 g Fibrinogen



Blood gases analysis – Point-of-care

CRITICAL SECOND PTY LTD. www.criticalsecond.com

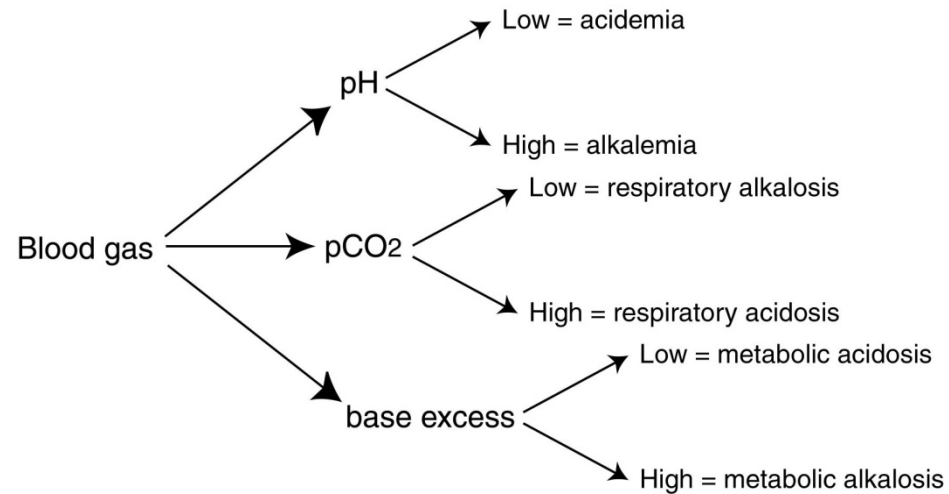
BLOOD GAS ANALYSIS

Blood Gases: Normal Values	
Arterial	Venous
7.35-7.45	pH 7.31-7.41
80-100 mm Hg	pO ₂ 30-40 mm Hg
35-45 mm Hg	pCO ₂ 41-51 mm Hg
21-25 mEq/L	HCO ₃ 22-29 mEq/L
95%-98%	O ₂ sat 80%-85%
-2 to +2	BE 0 to +4

Interpreting ABG's

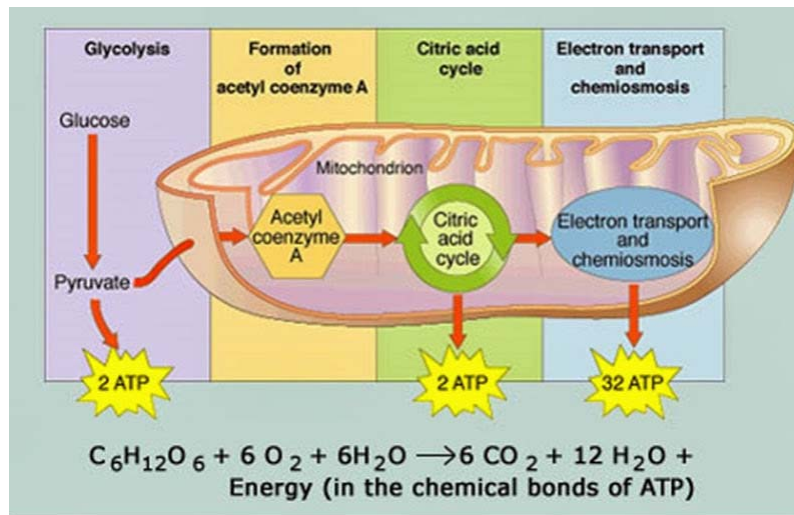
1. Check pH
 - ↑ = alkalosis
 - ↓ = acidosis
2. Check pCO₂
 - ↑ = CO₂ retention (hypoventilation); respiratory acidosis or compensating for metabolic alkalosis
 - ↓ = CO₂ blown off (hyperventilation); respiratory alkalosis or compensating for metabolic acidosis
3. Check HCO₃
 - ↑ = nonvolatile acid is lost; HCO₃ is gained (metabolic alkalosis or compensating for respiratory acidosis)
 - ↓ = nonvolatile acid is added; HCO₃ is lost (metabolic acidosis or compensating for respiratory alkalosis)
4. Determine imbalance
5. Determine whether compensation exists

www.criticalsecond.com



Blood gases analysis – Point-of-care

What do we need oxygen for?

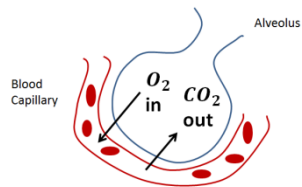


Respiration

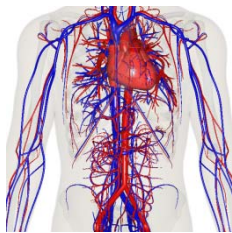


- **ventilation**

movement of air between the environment and the lungs via inhalation and exhalation



- **gas exchange**



- **oxygen transport**

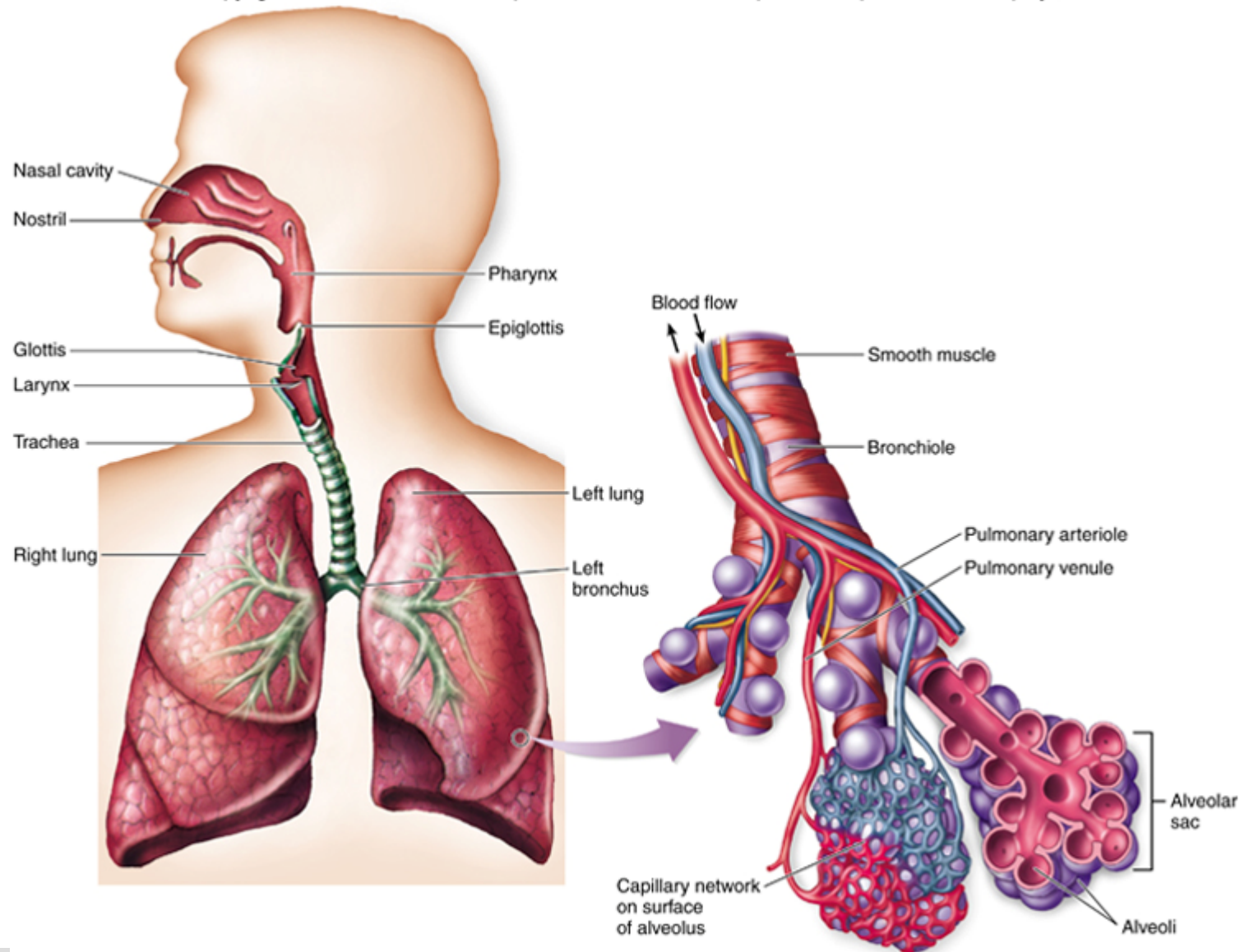


- **oxygen consumption**



Ventilation

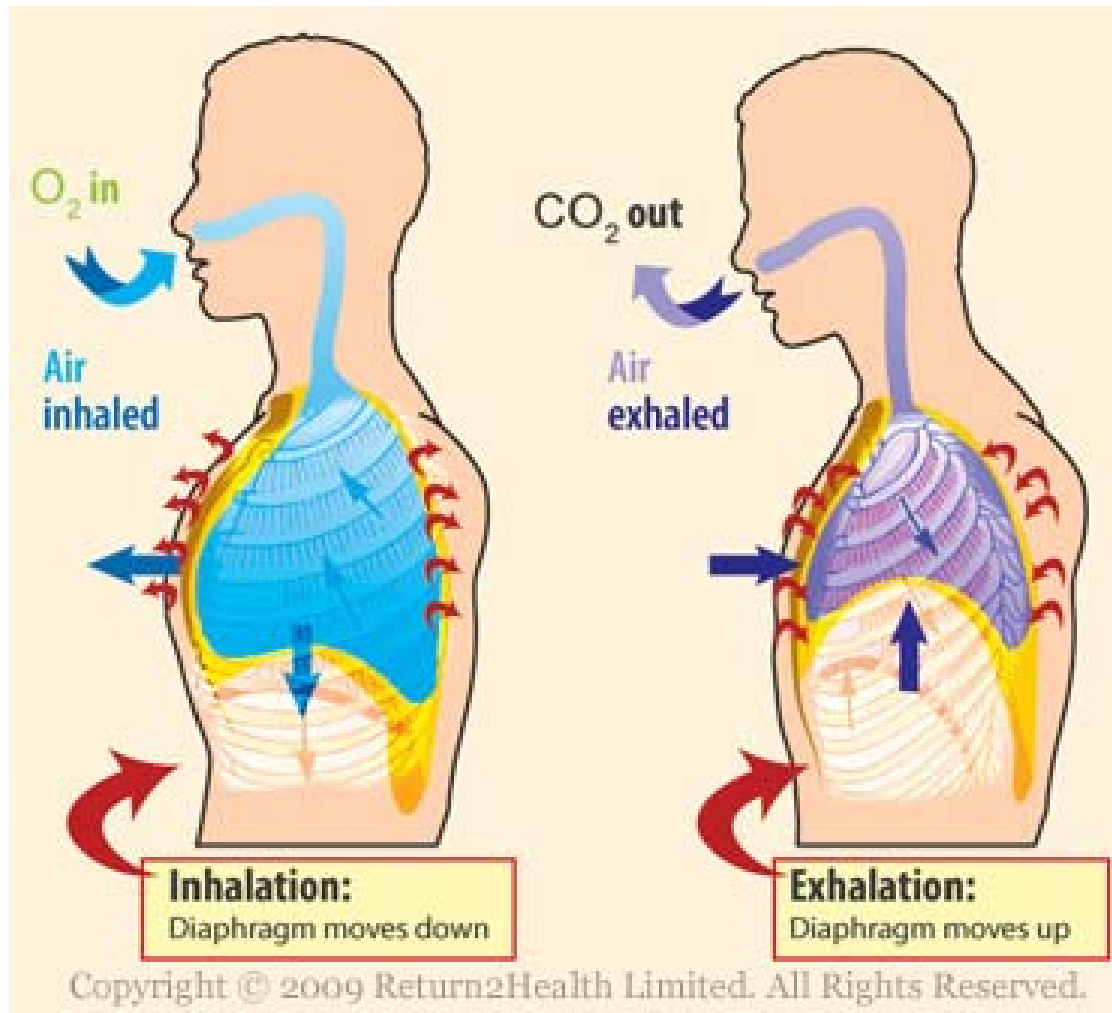
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.





Ventilation mechanics

Why is the air travelling into the lungs?





Ventilators

Parameters to control ventilation/ ventilators:

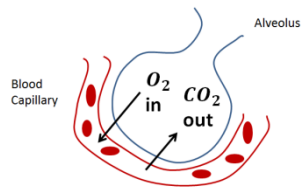
- **respiratory rate** 12-15 /min
- **respiratory volume** ~7 ml /kgKG
- **respiratory pressure** 15-20 mmHg
- **inspiratory time : expiratory time** 1:2
- **inspiratory flow** 30 l/min
- **end-expiratory pressure** 5-10 mml



Respiration

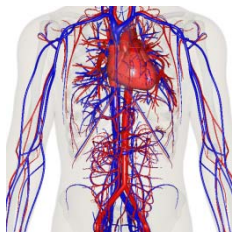


- ventilation



- **gas exchange:**

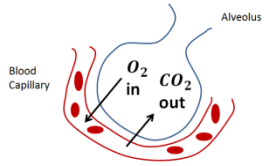
diffusion of O₂ from into the blood,
diffusion of CO₂ out of the blood



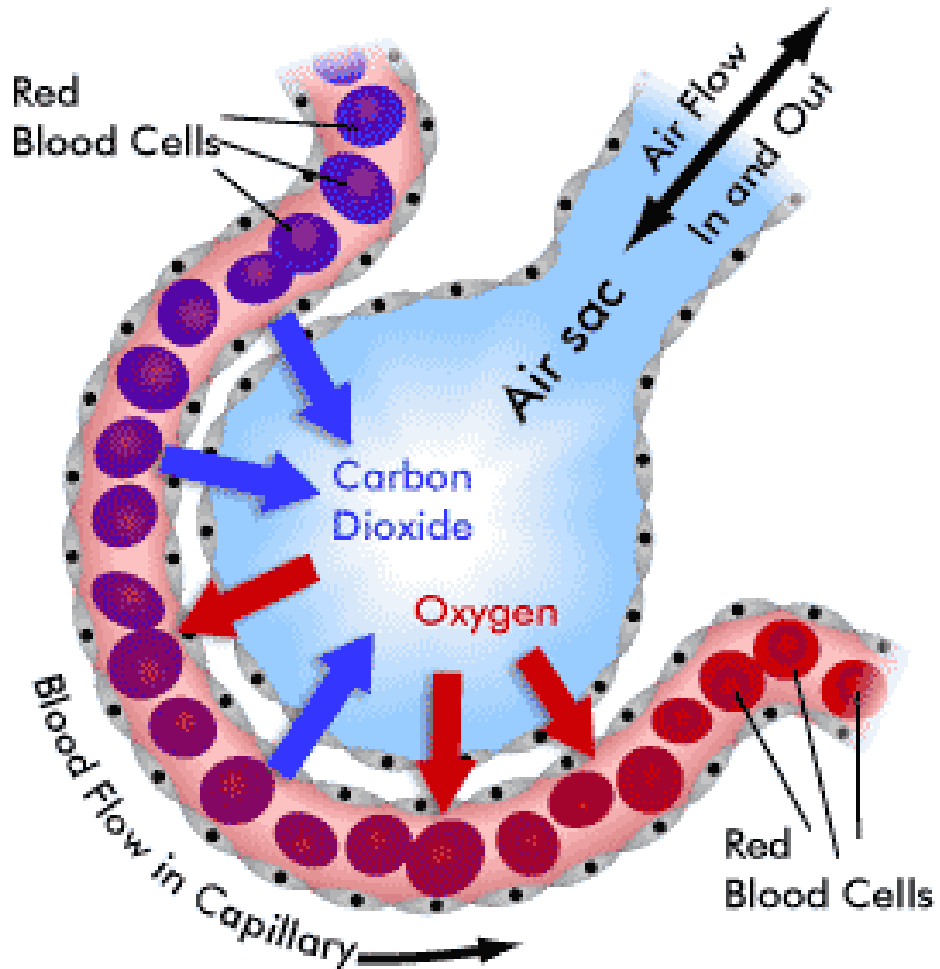
- oxygen transport



- oxygen consumption



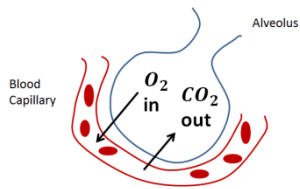
Gas exchange



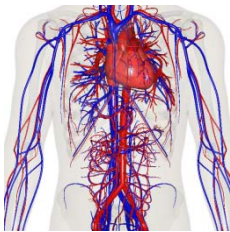
Respiration



- ventilation



- gas exchange



- **oxygen transport:** Perfusion is the process by which the cardiovascular system pumps blood throughout the lungs to place of oxygen consumption

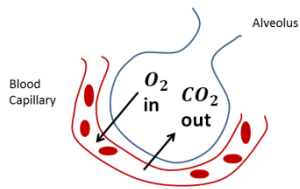


- oxygen consumption

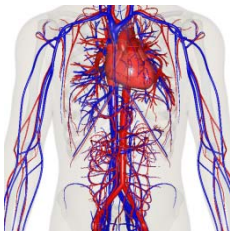
Respiration



- ventilation



- gas exchange



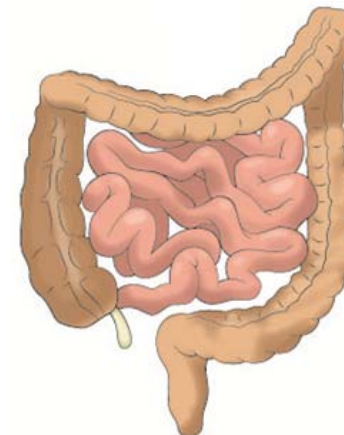
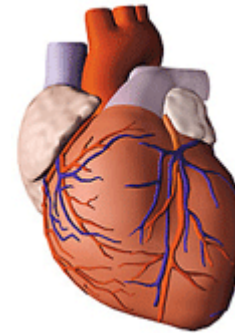
- oxygen transport



- oxygen consumption



Oxygen consumption

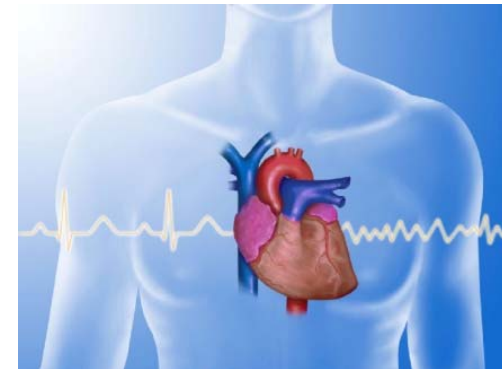
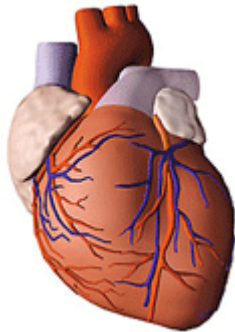


dreamstime.com



Oxygen consumption

Inadequate oxygen supply



CPR



**Cardio
Pulmonary
Resuscitation**



Arterial blood gases



After a pulse is found, a blood sample is taken from the artery

ADAM.

measurement :

- pH
- pO_2
- pCO_2
- HCO_3^-
- And many more (not primarily ventilation associated)

Normal Blood Gas Values

	Arterial	Venous	Capillary
pH	7.35 - 7.45	7.31-7.41	7.35-7.45
pCO₂	35 - 45 mm Hg	40-50	Same
pO₂	75 - 100 mm Hg	36-42	< than arterial
HCO₃	22-26 meQ/L	Same	Same
BE	-2 to +2	Same	Same
Oxygen Saturation	>95%	60-80	< than arterial

Case report - What do you do?

Patient:

- 65 years
- Smoker
- no medical history

Situation:

- intubated, anestezied for
- laparoscopic cholecystectomy
- SpO₂: shows 85% and rings alert

- Suregon asks you:
„Is there a problem?“



What do you do?

Pulse oxymetry:

- Is there a good plethysmograph? – Is there a good curve?
 - If no, check patient! -> blood pressure, capnography, device position
 - If yes, check -> capnography

Capnography:

- Is the CO₂ within the range of 35mmHg -40mmHg?
 - If below -> Is the patient still adequately ventilated, what is the blood pressure
- What does the curve look like?

What do you do?

Pulse oxymetry:

- Is there a good plethysmograph? – Is there a good curve?
 - If no, check patient! -> blood pressure, capnography, device position
 - If yes, check -> capnography

Capnography:

- Is the CO₂ within the range of 35mmHg -40mmHg?
 - If below -> Is the patient still adequately ventilated, what is the blood pressure
- What does the curve look like?

Check ventilation and connections

Auscultate patients chest

Draw arterial blood gases

- Arterial blood gas analysis reveals:

Inspired oxygen

85% (FiO_2 0.85) estimated
normal values

PaO_2 19.5 kPa (147 mmHg)

> 10 kPa (75 mmHg) on air

pH 7.10

7.35 – 7.45

PaCO_2 18.0 kPa (135 mmHg)

4.7 – 6.0 kPa (35 – 45 mmHg)

HCO_3^- 36 mmol l^{-1}

22 – 26 mmol l^{-1}

BE + 12 mmol l^{-1}

+/- 2 mmol l^{-1}

- Arterial blood gas analysis reveals:

Inspired oxygen		85% (FiO ₂ 0.85) estimated <u>normal values</u>
PaO ₂	19.5 kPa (147 mmHg)	> 10 kPa (75 mmHg) on air
pH	7.10	7.35 – 7.45
PaCO ₂	18.0 kPa (135 mmHg)	4.7 – 6.0 kPa (35 – 45 mmHg)
HCO ₃ ⁻	36 mmol l ⁻¹	22 – 26 mmol l ⁻¹
BE	+ 12 mmol l ⁻¹	+/- 2 mmol l ⁻¹

Summary: The significant acidemia pH 7.10 indicate an acute respiratory acidosis as a result of a respiratory arrest.

Take home

- Point-of-care analysis
 - bedside
 - quick performance and fast results
 - quick re-evaluation of the case
 - Low costs but economical?!



Thank you for your attention! Questions?

kristian.ngamsri@med.uni-tuebingen.de

