

heparin & extracorporeal circulation

an overview of bleeding & clotting
during extracorporeal circulation



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about my person

- 1974
- perfusionist since 2000
- eccp 2003
- usz: 2000-2003, 2007-2008
- triemli: 2003-2010
- DAS medical technology 2009 (Berner FH)
- klinik hirslanden zürich: 2010-today

swiss society of perfusion:

- 2002-2007: board member, delegate german part of switzerland
- 2013-today: president, together with j.consiglio (bern, insel)



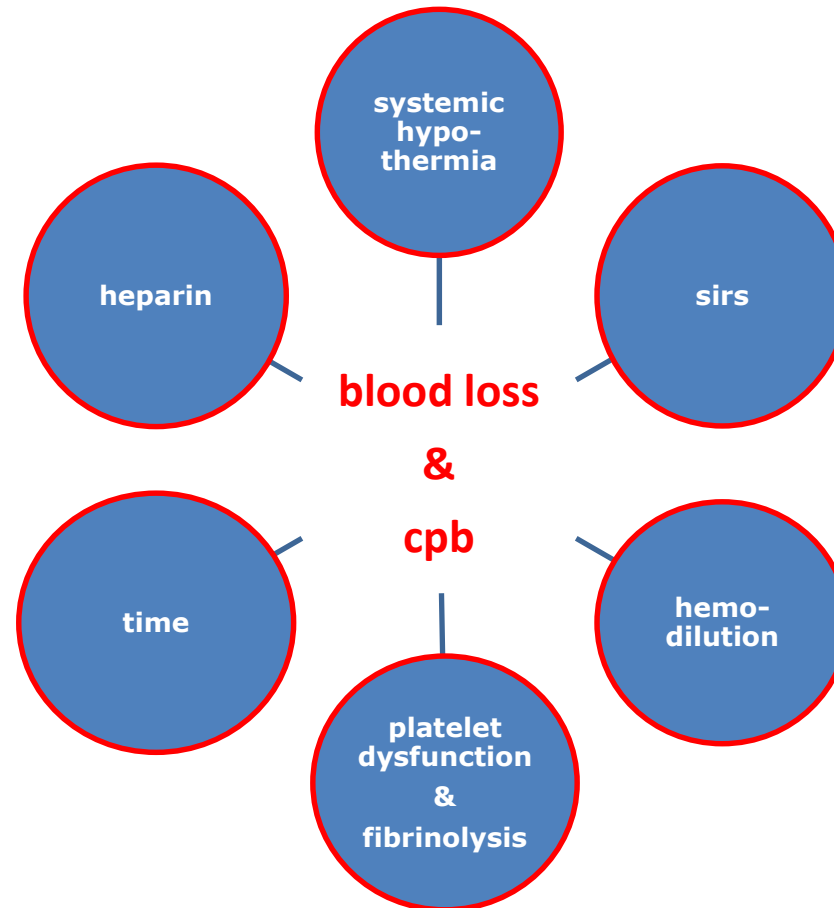
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content

- factors influencing haemostasis associated with cardiopulmonary bypass
- activation of coagulation on cardiopulmonary bypass
- unfractionated heparin, antithrombin, protamine
- choice of cardiopulmonary bypass setup: influence on coagulation?
- standard sequence for anticoagulation management during cardiac surgery
- surveillance of anticoagulation during ecc: poc-devices
- heparin, ecc & special challenges

factors influencing haemostasis associated with cardiopulmonary bypass





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activation of coagulation on cpb



interdependency of artificial surfaces and blood

1. transformation of proteins

- enhancement of coagulation
- activation of complement system
- generation of vasoactive mediators

2. activation and destruction of blood components

3. toxicity e.g. sterilisation process, plasticiser



unfractionated heparin (ufh)

heparin properties

- anticoagulating
- antithrombotic
- antiinflammatoric
- increases platelet aggregation (low dose)
- decreases platelet aggregation (high dose)
- increases fibrinolysis

heparin effect: influencing factors

- body weight & blood volume
- platelet count
- **at III concentration:
heparin resistance**
- other binding proteins :
heparin rebound
- liver & kidney function

disadvantages

- **coagulation still occurs**
- **thrombin formation still occurs**



antithrombin

- serpin (serine protease inhibitor), produced by the liver, normal activity 80-120%
- slow inhibitor; immediately and massively enhanced when binded to heparin
- main targets: **thrombin, f Xa**
- usually not determined preoperatively!
- causes of atIII deficiency:

drug induced (**heparin resistance**)
accelerated consumption: sepsis, dic

dilution: cpb

decreased synthesis: liver cirrhosis
increased excretion: protein-losing states
familial



protamine

- 5 kda, positively charged polypeptide derived from salmon sperm
- antidot to ufh
- usually 1mg protamine per 100 i.u. ufh (1:1 reversal)
- **excessive administration:** unbound protamine inhibits fibrin generation, platelet reactivity, adhesion and aggregation associated with increased bleeding
- **heparin rebound:** heparin released from protein binding sites after protamine reversal associated with increased bleeding
- **adverse side effects:** arterial hypotension, pulmonary vasoconstriction, reduced cardiac output, anaphylaxis
- **cave: cardiotomy suction!**



cpb-setup: influence on coagulation?

clinical outcome:

NO EVIDENCE

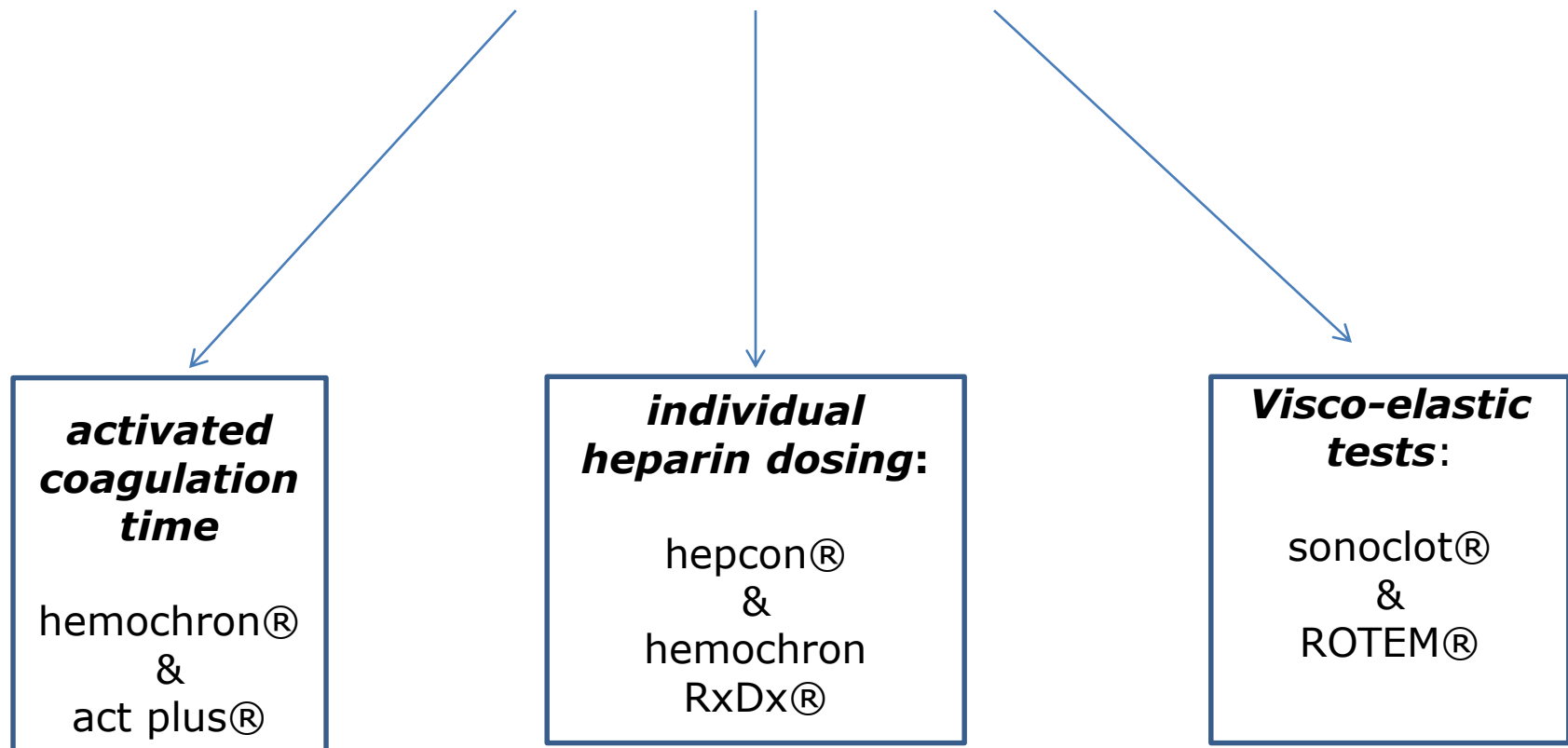
bartels c. et al (2001): extrakorporale zirkulation-wissenschaftlich begründet? steinkopff, darmstadt

Typ
roler

ting

non-
eparin-
coated

surveillance of anticoagulation during ecc: POC-devices



act: activated coagulation time

- Hattersley 1967, Bull 1975
- standard whole blood test
- different tests, different activators, wide ranges
- susceptible to variation
- maintain act > 480 s during cpb
- **no direct correlation with anti-Xa measures**
- **no evidence regarding the minimal, safe or ideal target of each test**



Hemochron® Response
Int. Technidyne Inc., Edison, NJ, USA



ACT Plus®
Medtronic, Parker, CO, USA

individual heparin/protamine dosing

- measures patient's heparin sensitivity to a known quantity of heparin
- 3-point-dose-response curve:
- protamine dose response similarly
- more expensive than ACT
- blood loss and transfusions can be reduced: Jobes 1995, Despotis 1995
- less protamine doses: Shore-Lesserson 1998



Medtronic
Hepcon®

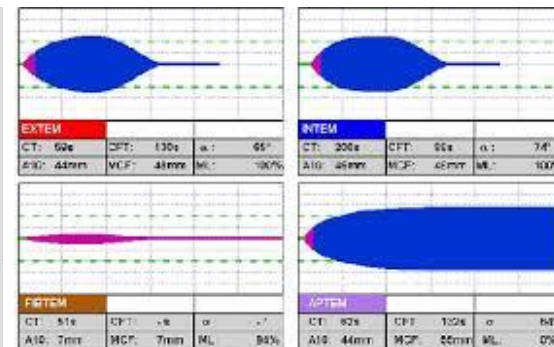
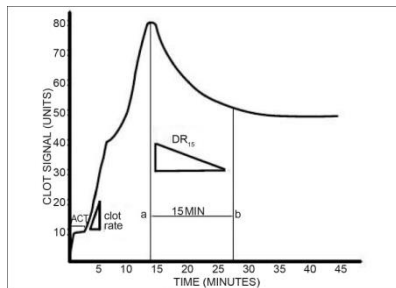
visco-elastic tests

sonoclot®

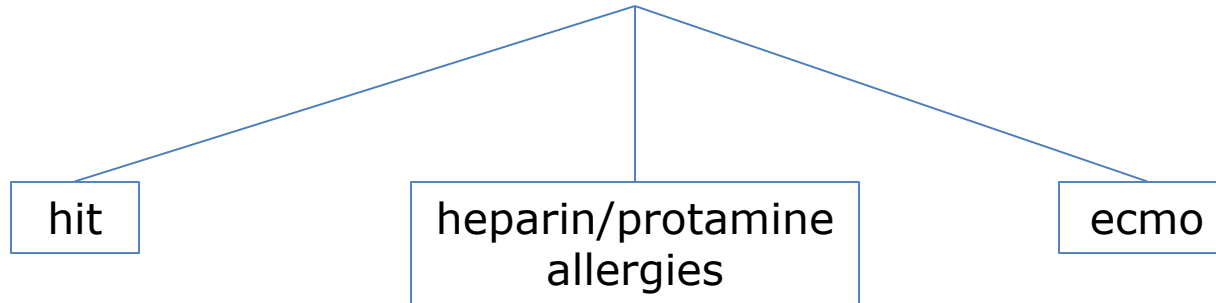
rotem®

- tubular probe oscillating up & down within blood sample
- impedance corresponding clotting process
- graph: clot signal values vs time
- information on entire haemostasis including coagulation factors, fibrin gel formation, clot retraction, fibrinolysis

- measurement of clot strength
- information on hyperfibrinolysis, substitution of factors, fibrinogen and platelets, heparin- & protamine dosage



heparin, ecc & special challenges



- avoidance of heparine
- define standards and use protocols
- team work



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