# DU CEC 2025

## PHYSIOPATHOLOGIE DE L'HÉMOSTASE EN CEC

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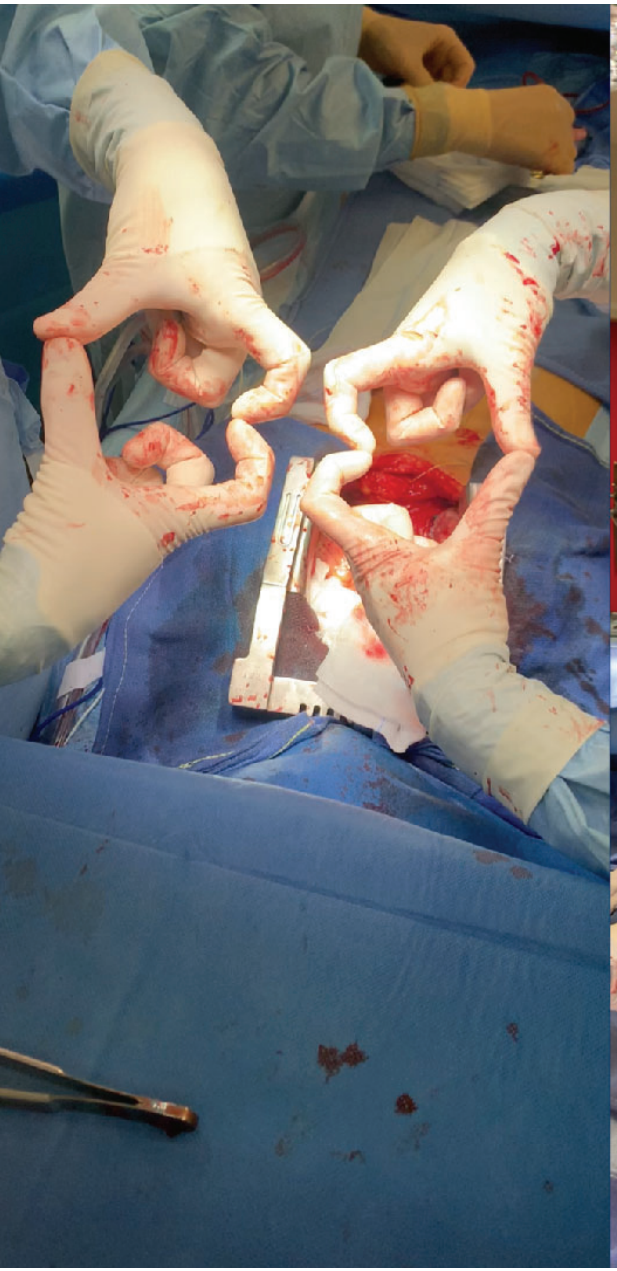
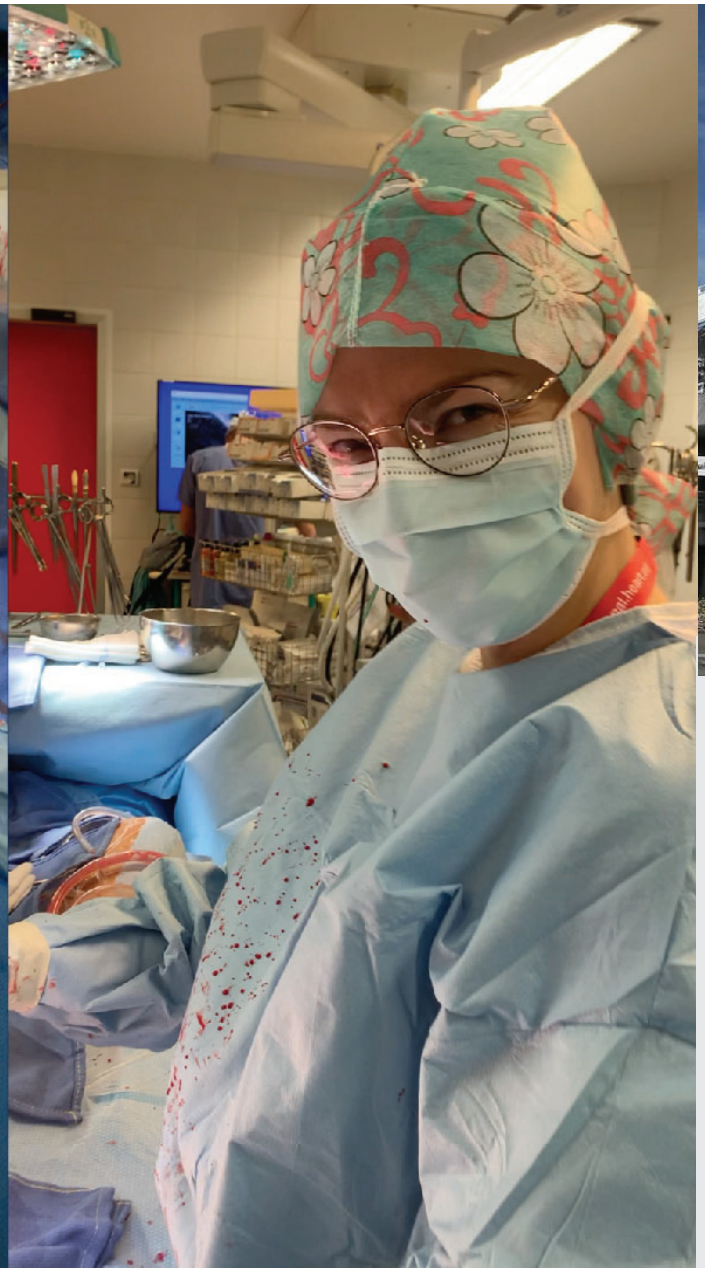




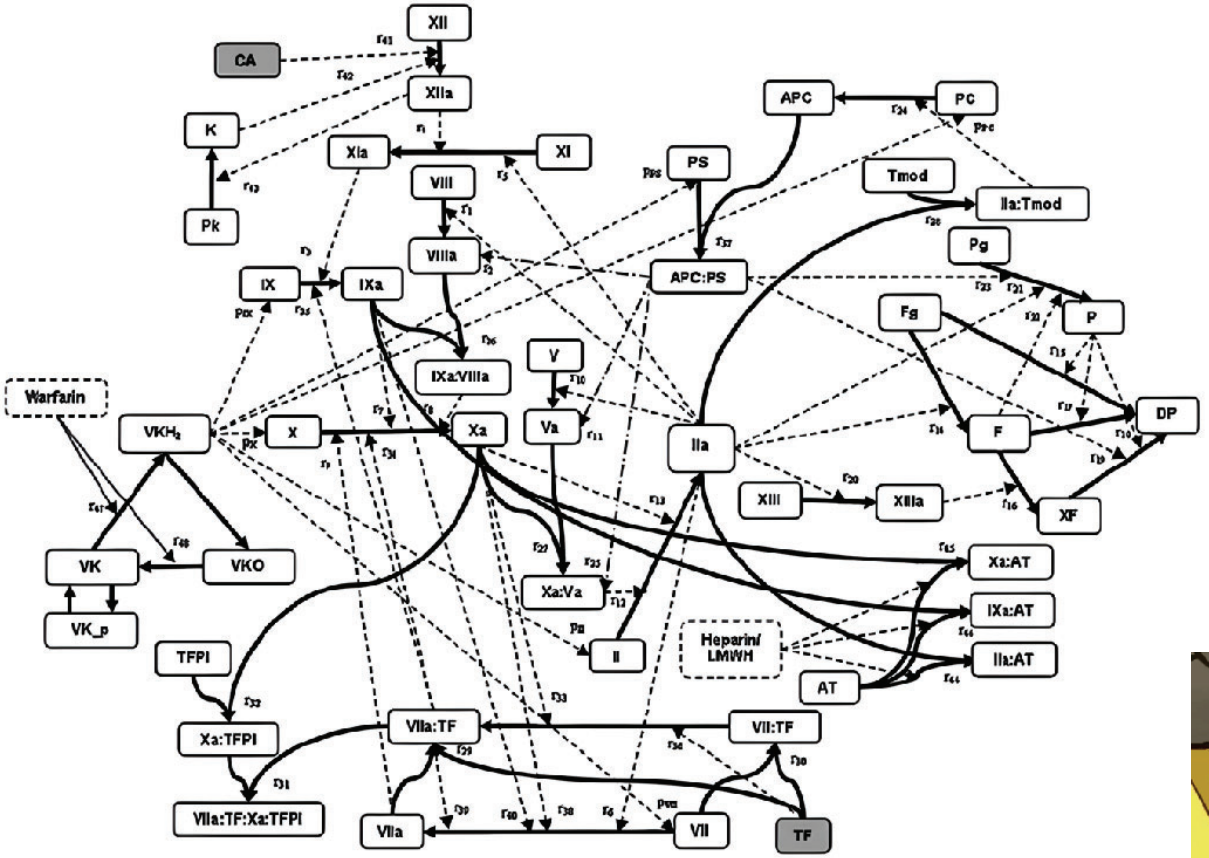
Bloc et Réa Cardiothoracique

Réa CTCV 17 lits

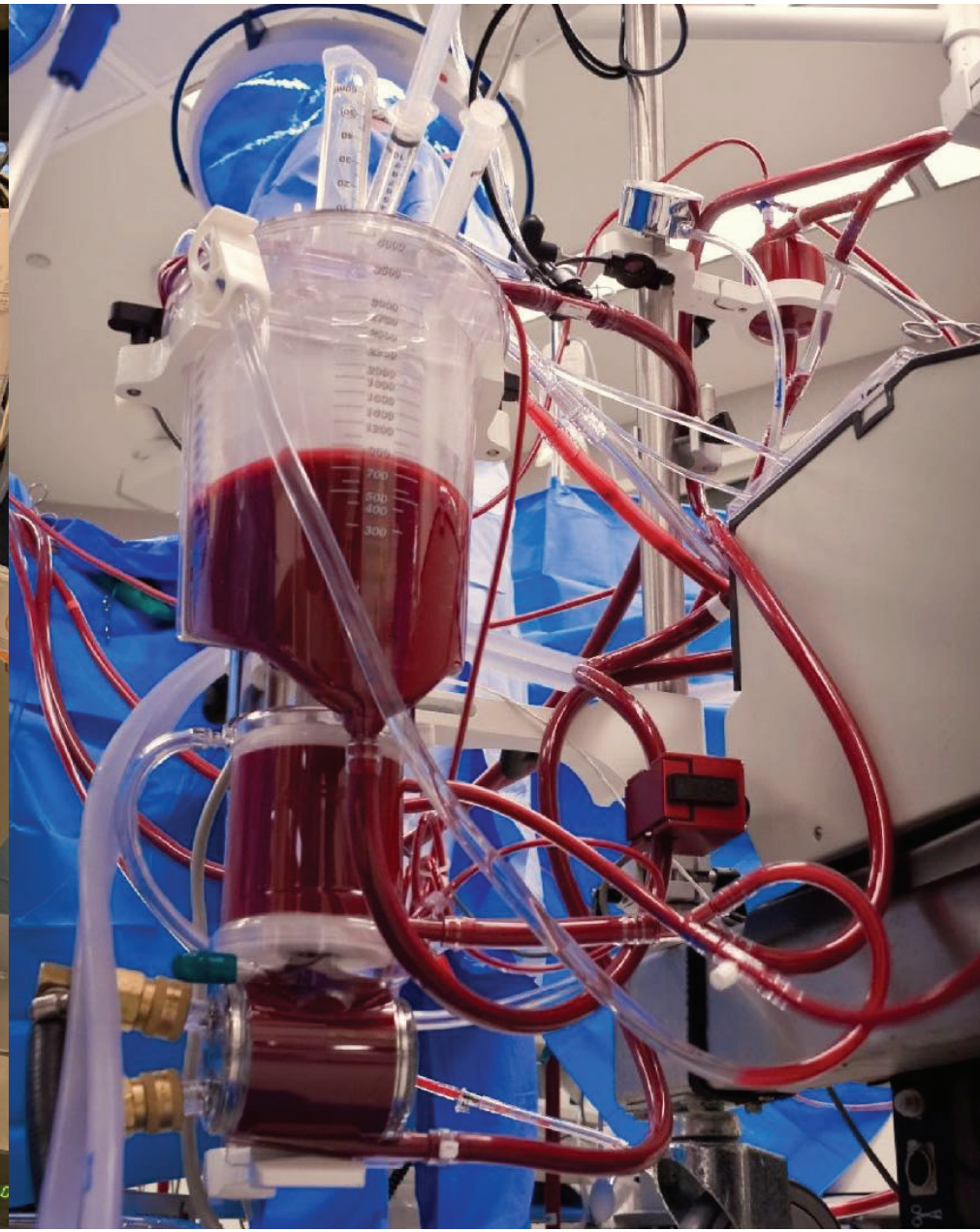
1200 CEC/an

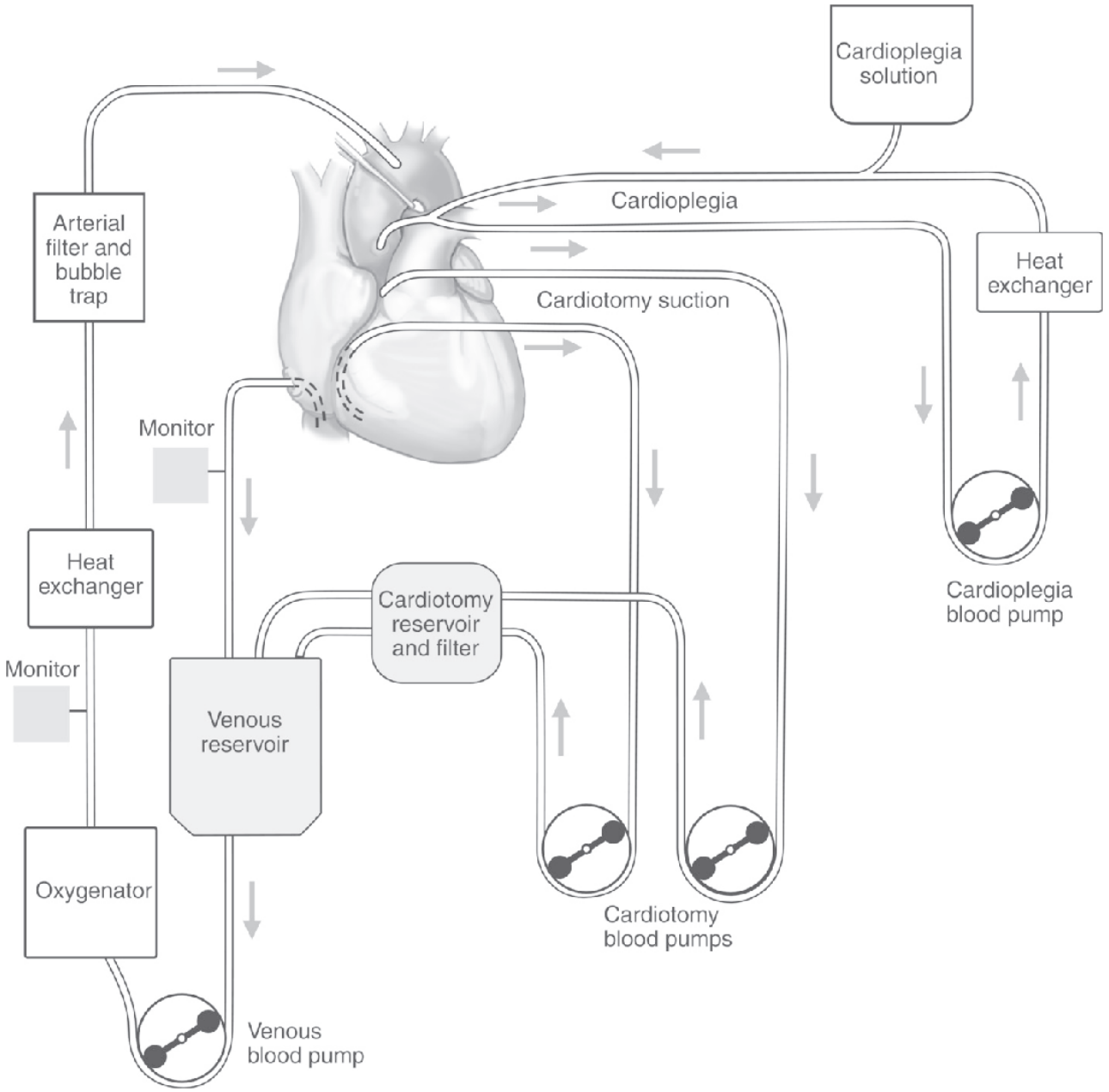
ECMO - Assistance - Greffe

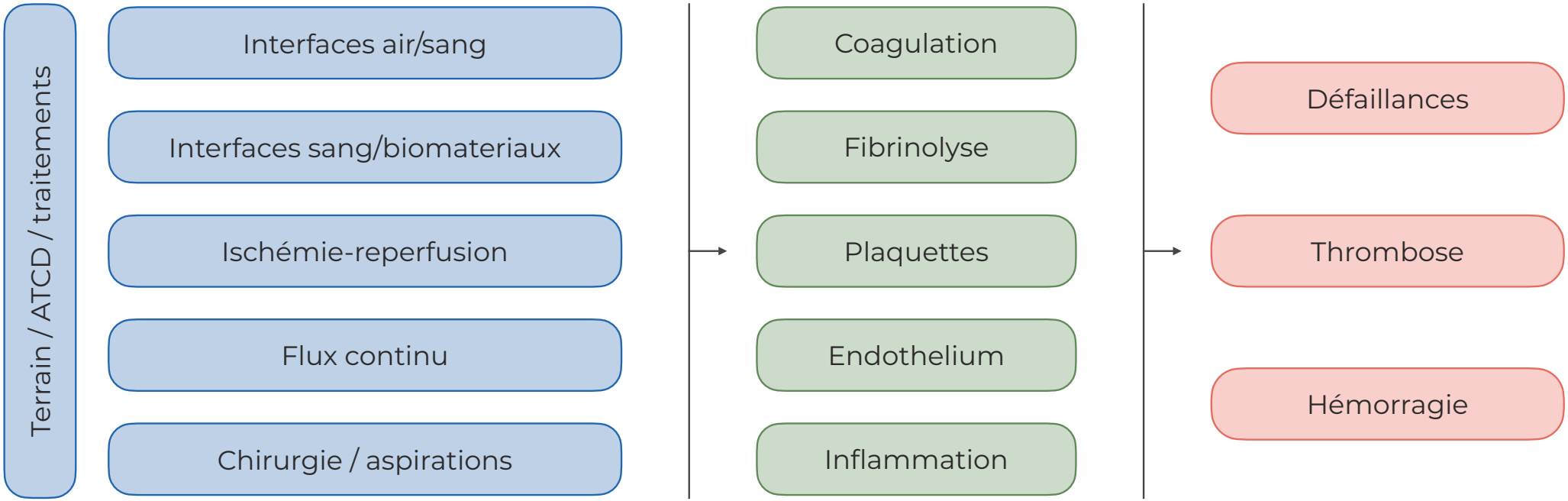
# Particularités de la chirurgie cardiaque


XII
CA
XIIa
K
XIa
XI
VIII
Pk
VIIIa
IX
IXa
IXa:VIIIa
V
Warfarin
VKH2
X
Xa
Va
IIa
VK
VKO
VK_p
Xa:Va
II
TFPI
Xa:TFPI
VIIa:TF
VII:TF
VIIa:TF:Xa:TFPI
VIIa
VII
TF
APC
PC
PS
APC:PS
Tmod
IIa:Tmod
Pg
P
Fg
F
DP
XIII
XIIIa
XF
Xa:AT
IXa:AT
IIa:AT
Heparin/
LMWH
AT

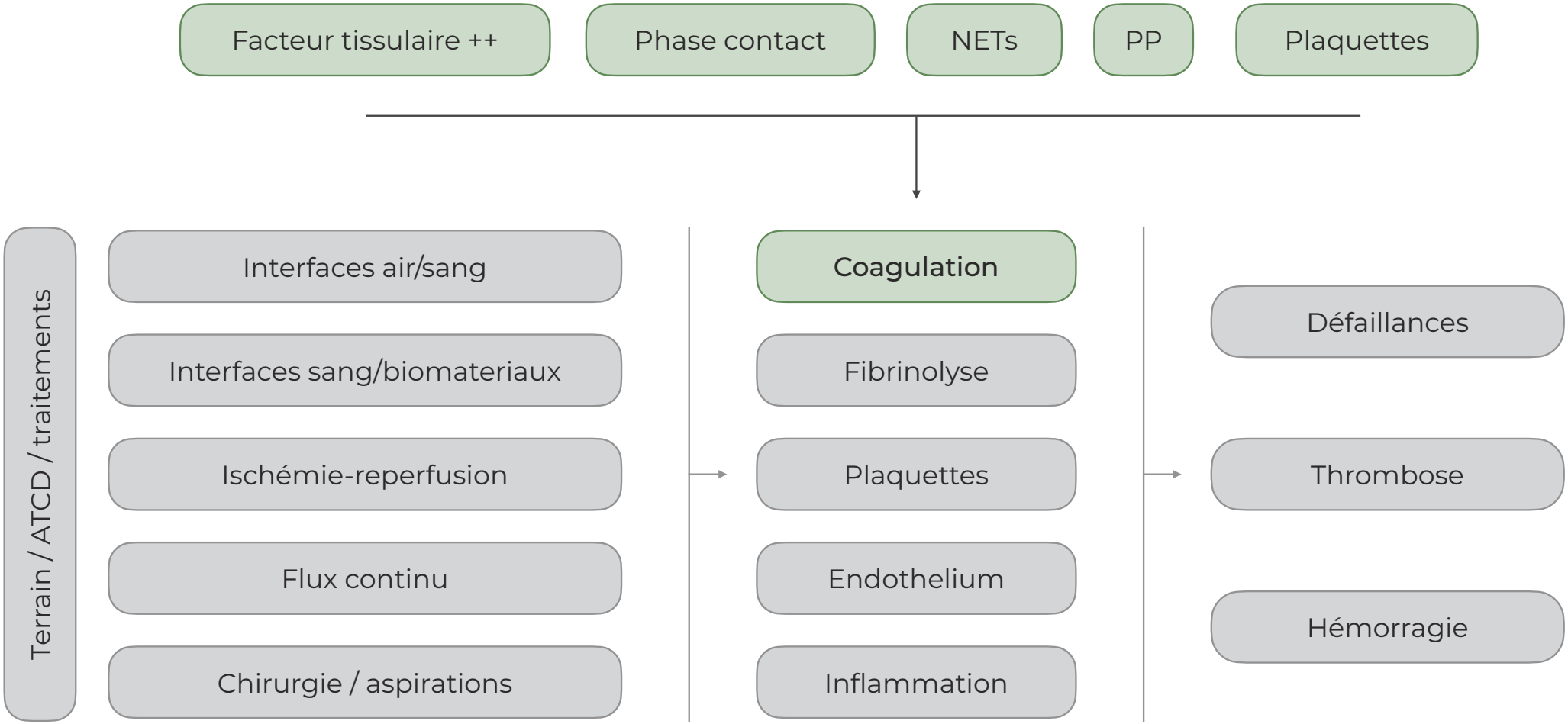

[adult swim]
gifs.com




Cardioplegia solution
Arterial filter and bubble trap
Cardioplegia
Heat exchanger
Cardiotomy suction
Monitor
Heat exchanger
Cardioplegia blood pump
Cardiotomy reservoir and filter
Monitor
Venous reservoir
Oxygenator
Cardiotomy blood pumps
Venous blood pump




Despotis et al, Clinical Chemistry 1997 // Bartoszko et al. Thromb Haemost. 2021;19:617–632.



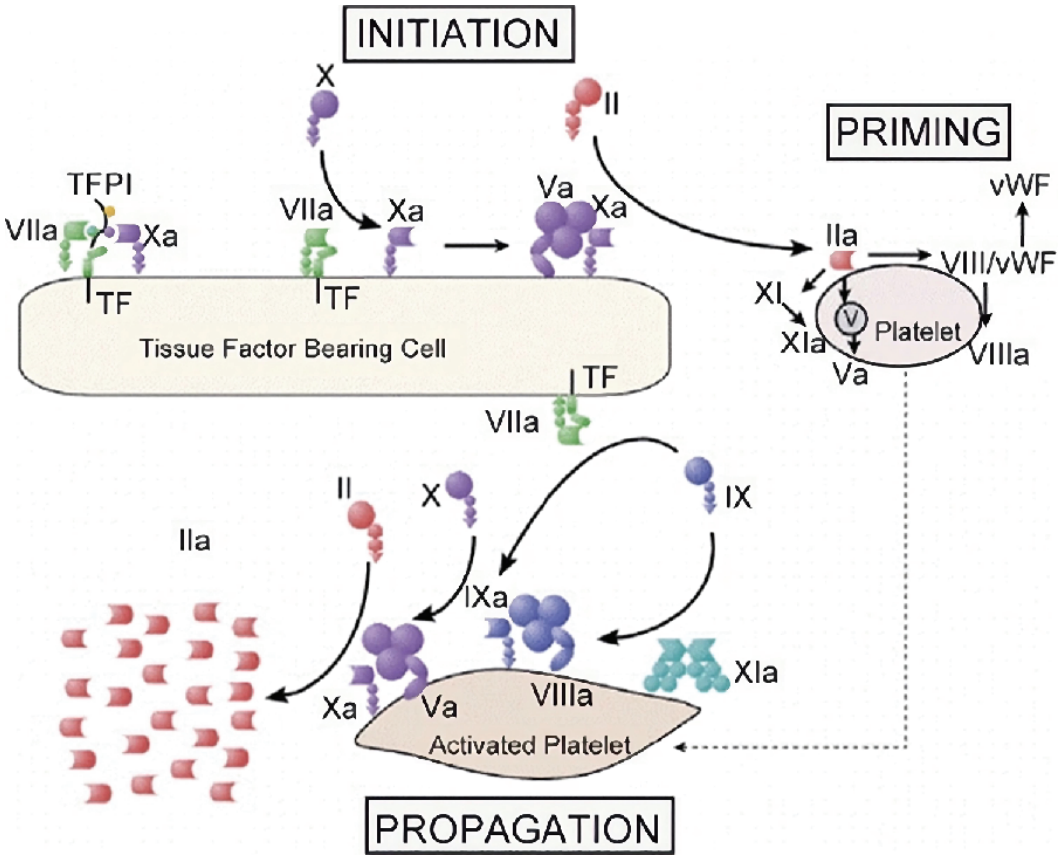

Despotis et al, Clinical Chemistry 1997 // Bartoszko et al. Thromb Haemost. 2021;19:617–632.

Thrombosis and Haemostasis
International Journal for Vascular Biology and Medicine

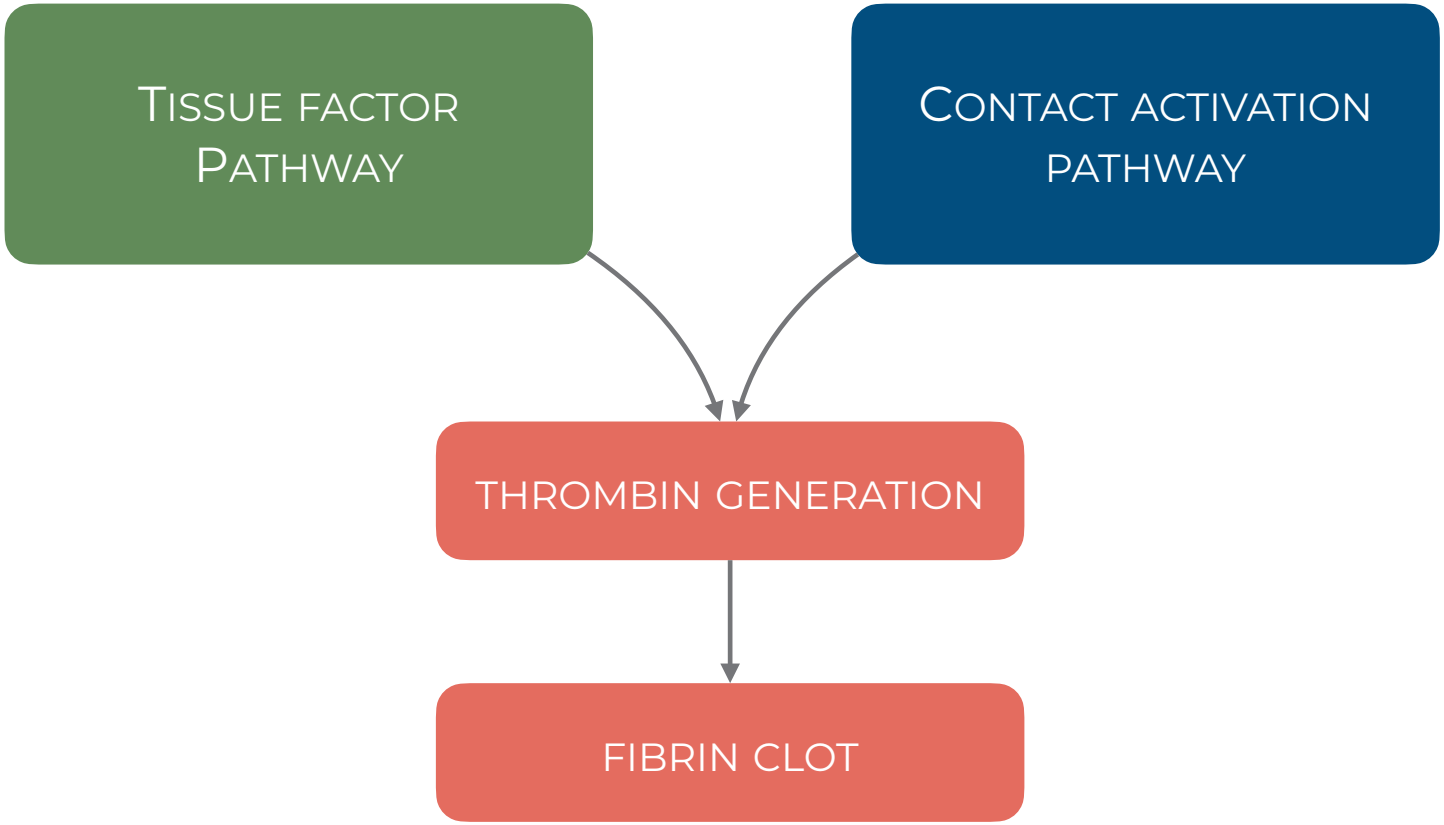
# A Cell-based Model of Hemostasis

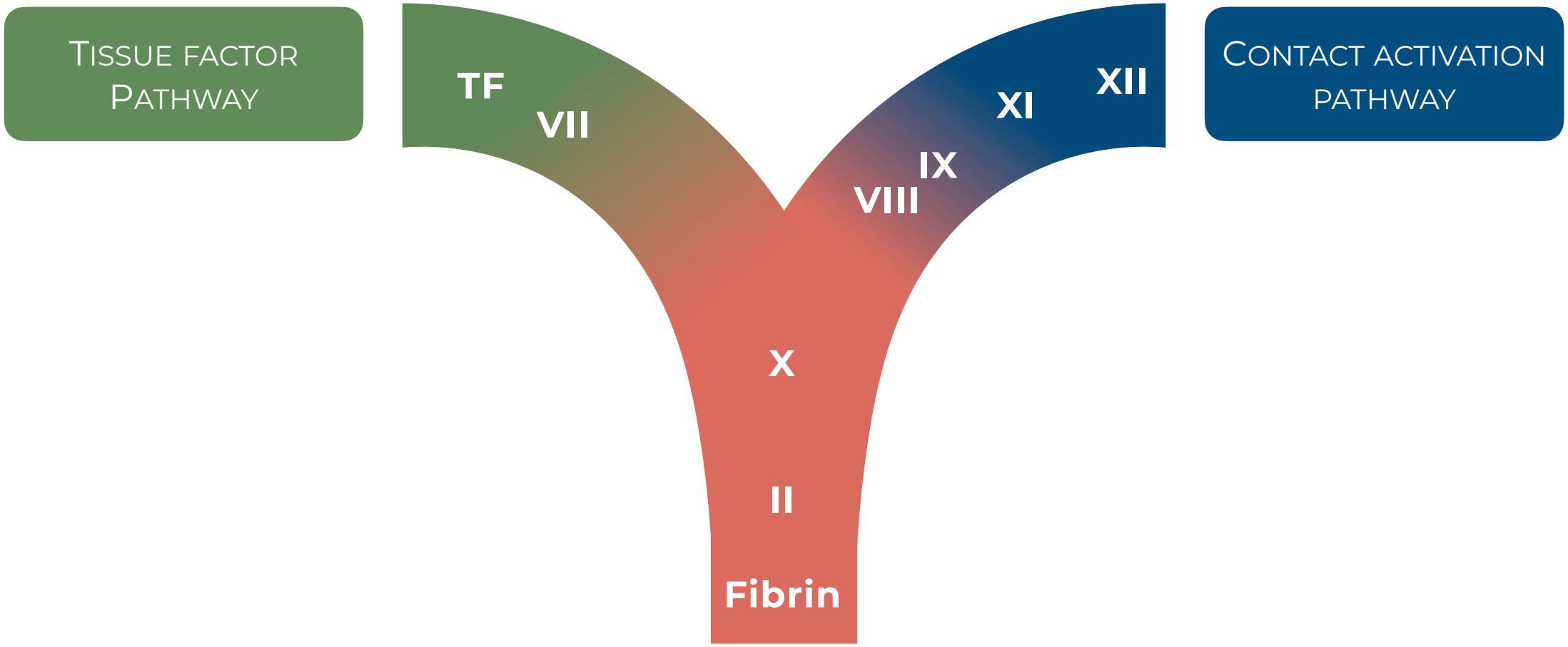
Maureane Hoffman, Dougald M. Monroe III

- Initiation
- Amplification
- Propagation



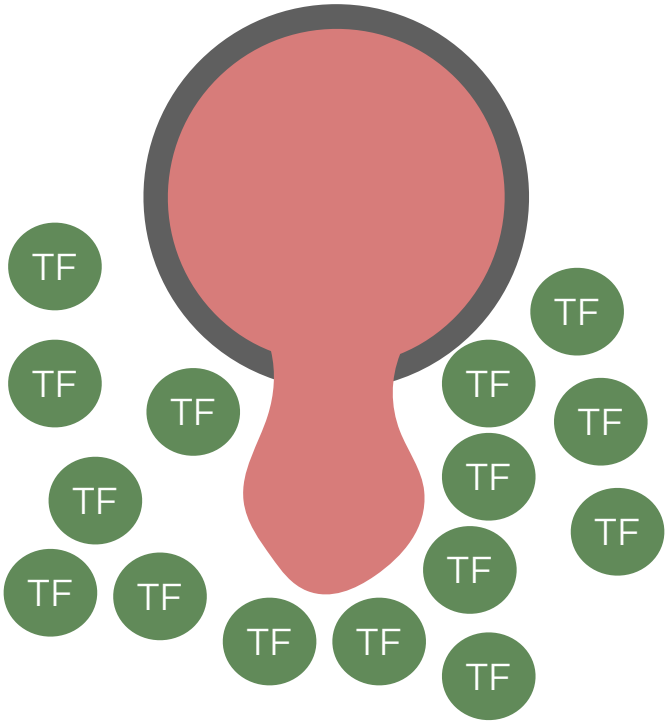

Monroe et al. Thromb Haemost 2001;85(06):958–65
Becker et al. J Thromb Thrombolysis 52, 397–402 (2021)


Tissue factor Pathway
Contact activation pathway
THROMBIN GENERATION
FIBRIN CLOT



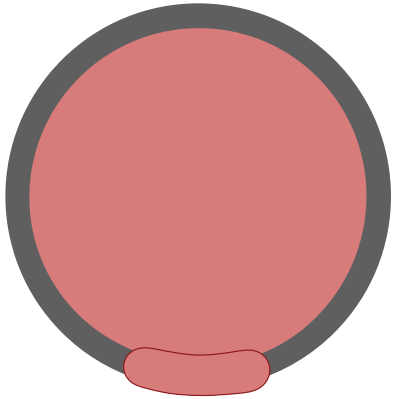

*Adapted from Hsu et al. JACC 2021*

# HEMOSTASIS

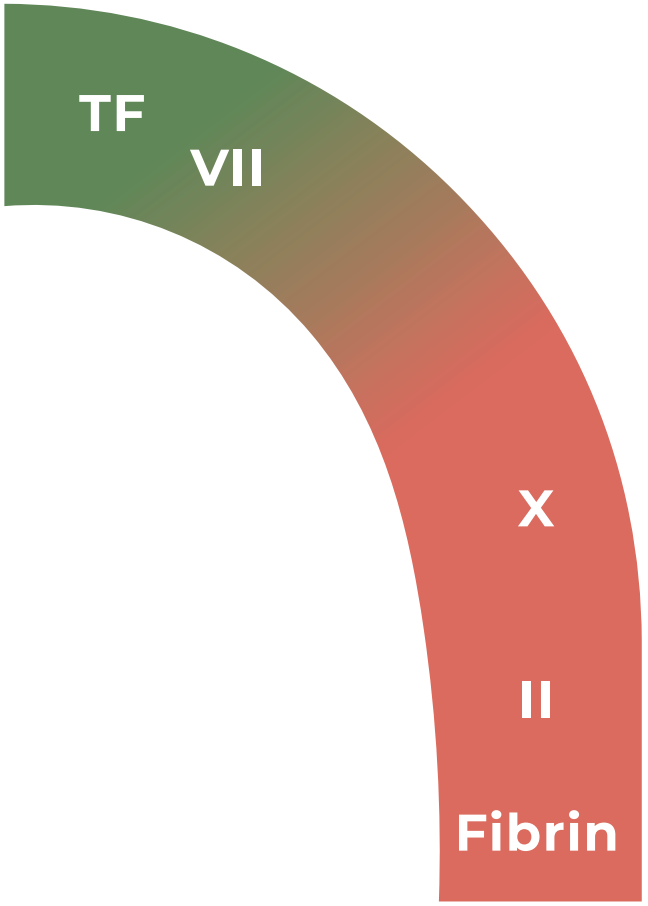



Vascular breach

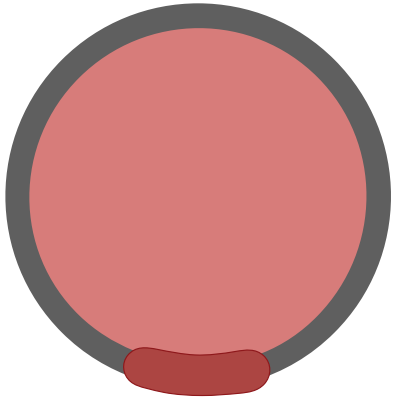
# HEMOSTASIS



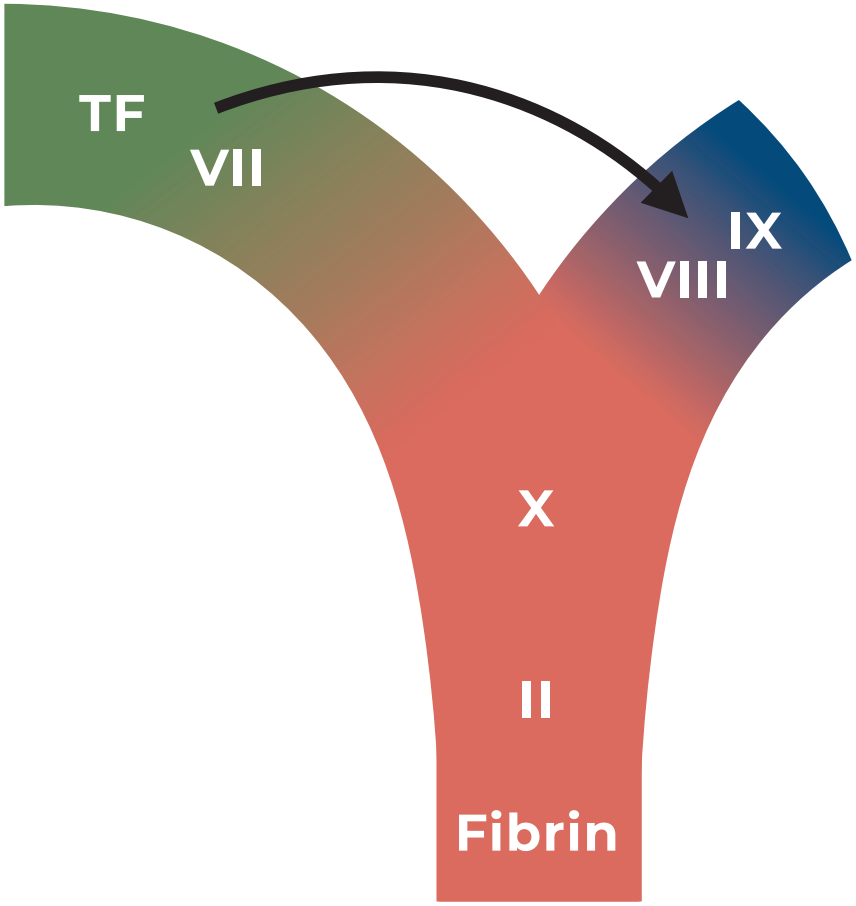
Unstable clot



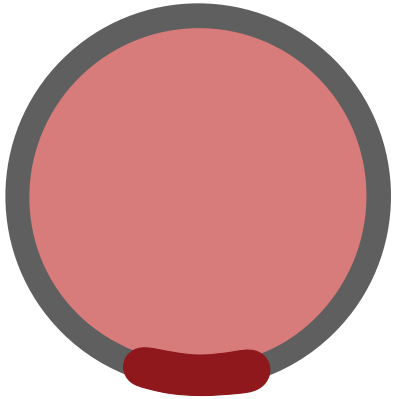
# HEMOSTASIS



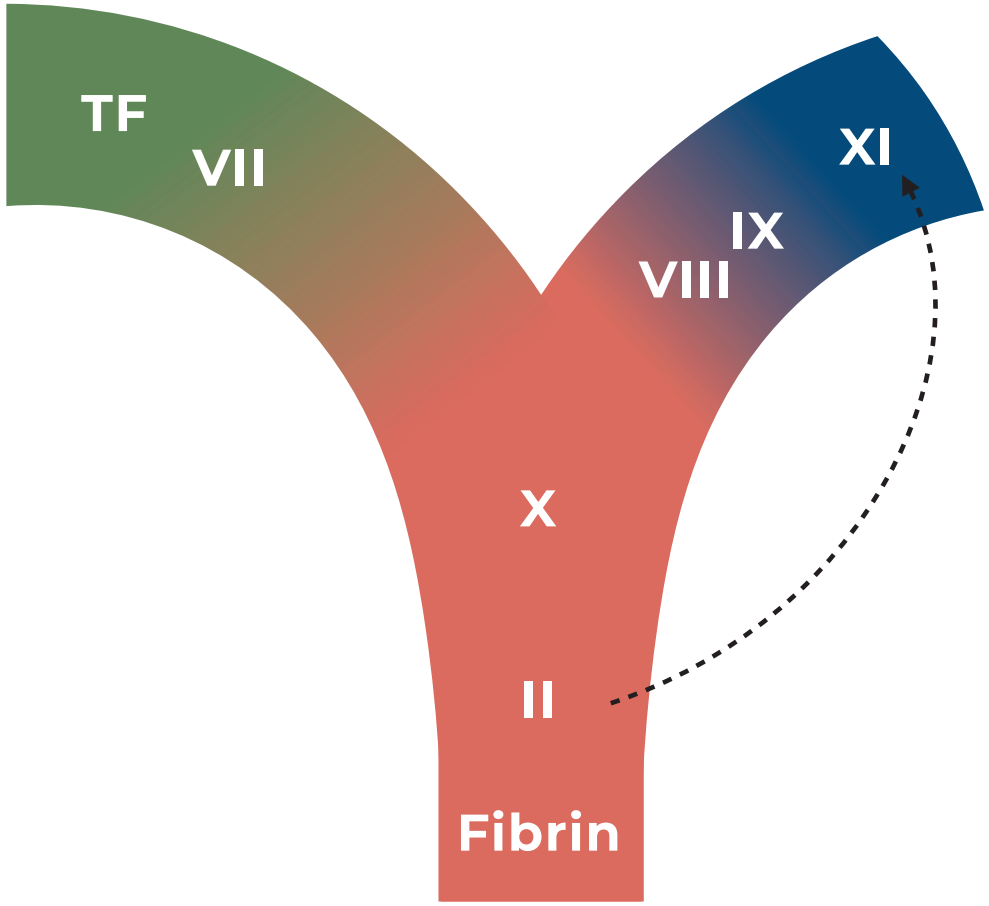
Stable clot



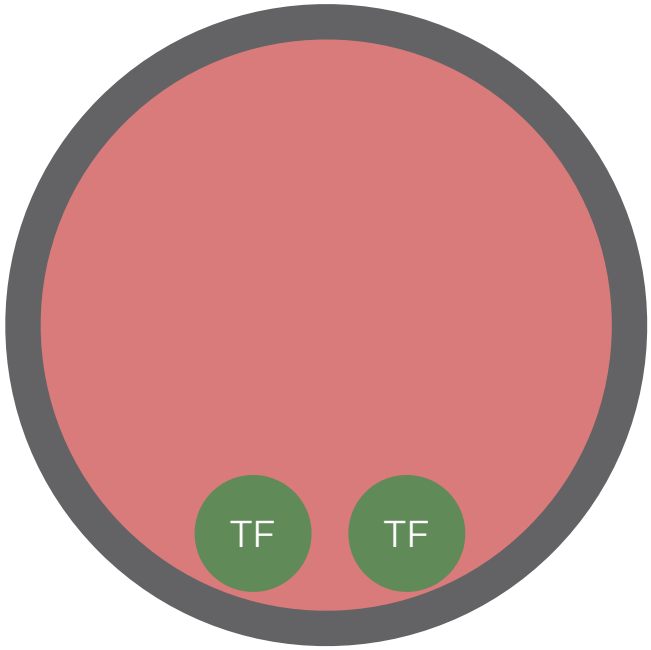
# HEMOSTASIS



Consolidated clot

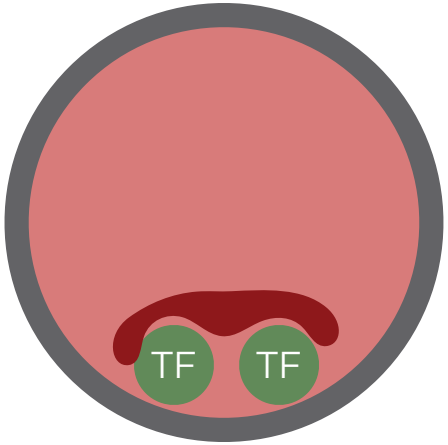


# THROMBOSIS (A/V)

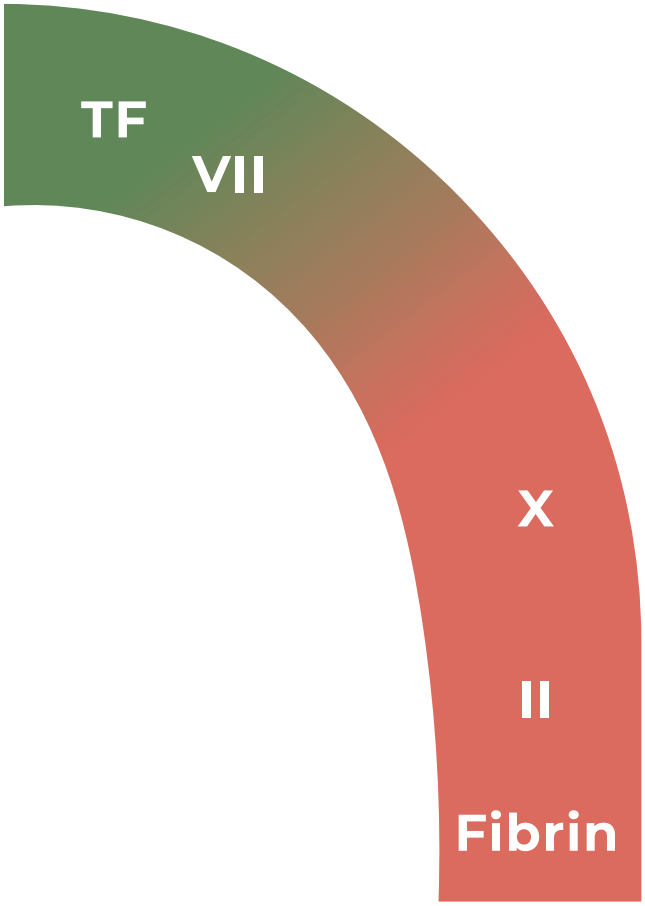



TF initiates thrombosis

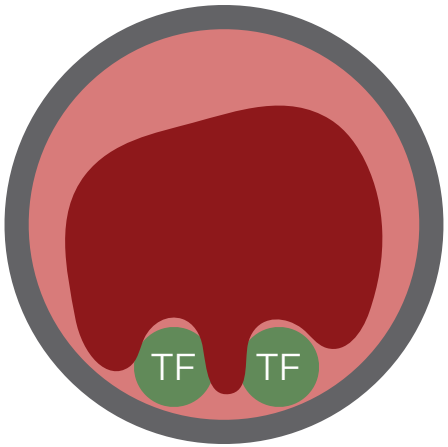
# THROMBOSIS (A/V)



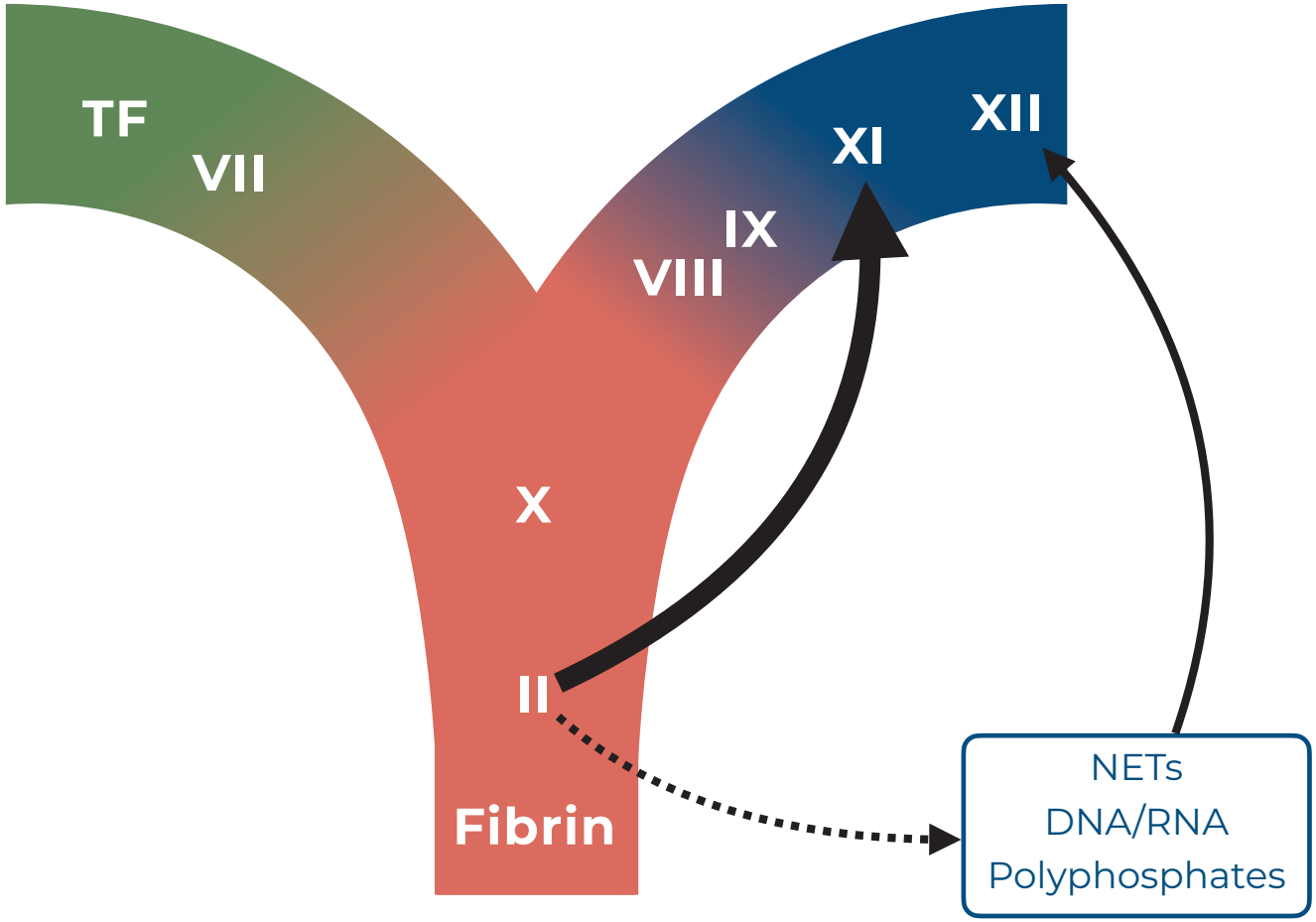

TF initiates thrombosis



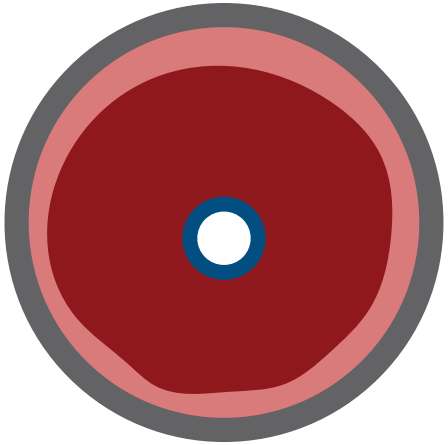
# THROMBOSIS (A/V)




Thrombus growth



# Articifial surface-associated thrombosis



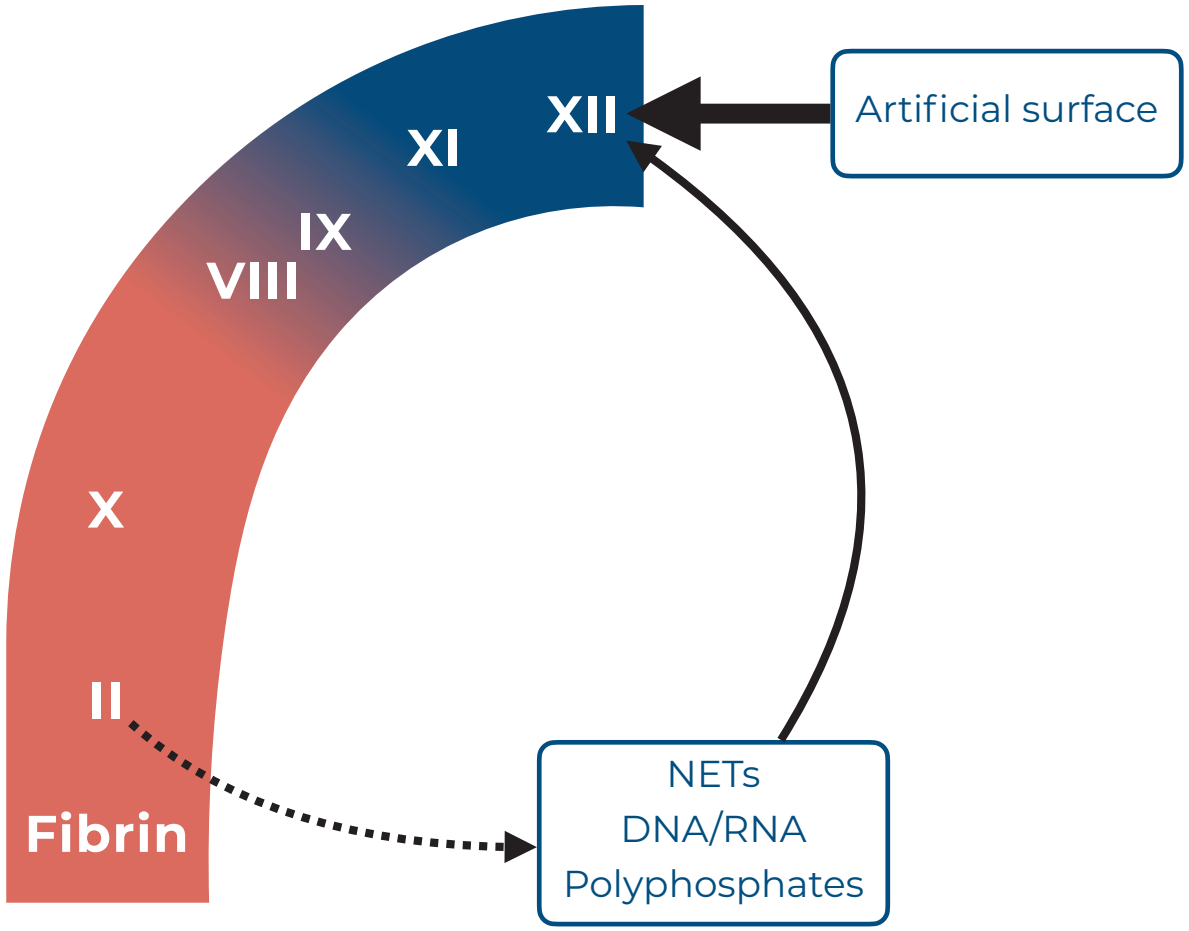
**Artificial surfaces**

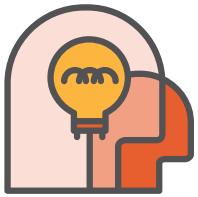
ECMO, CBP

VAD

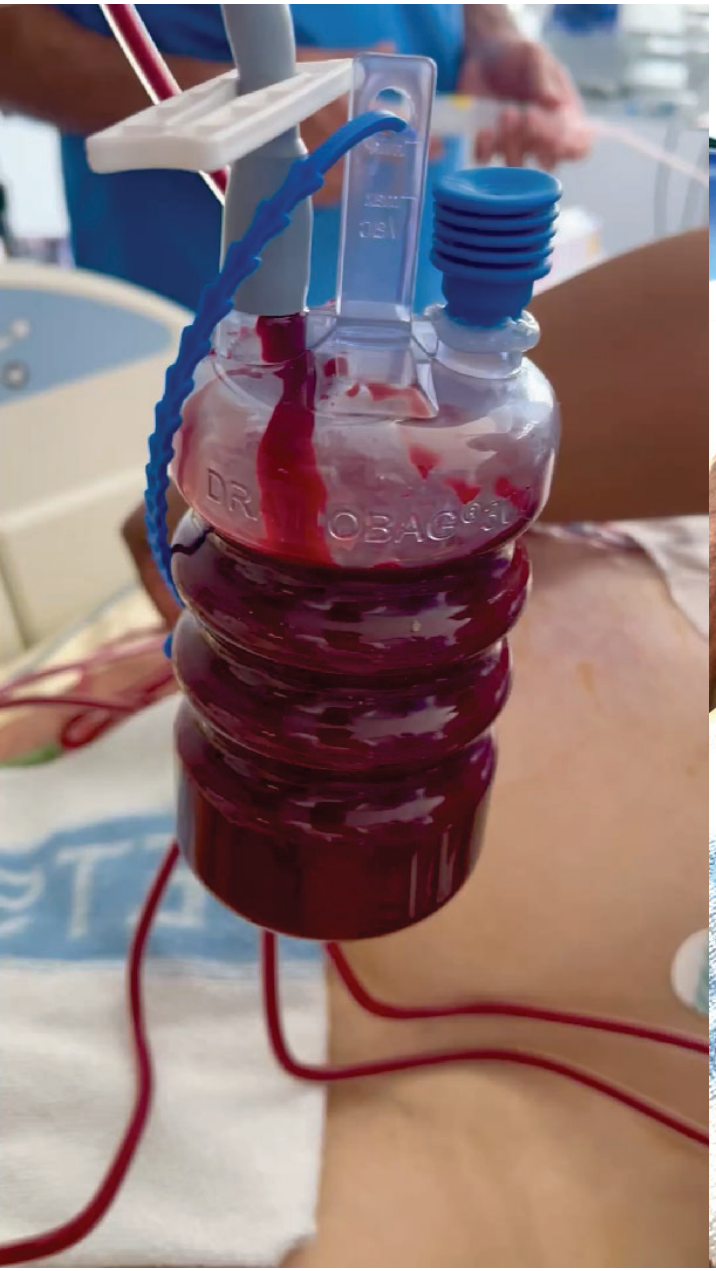
A/V lines

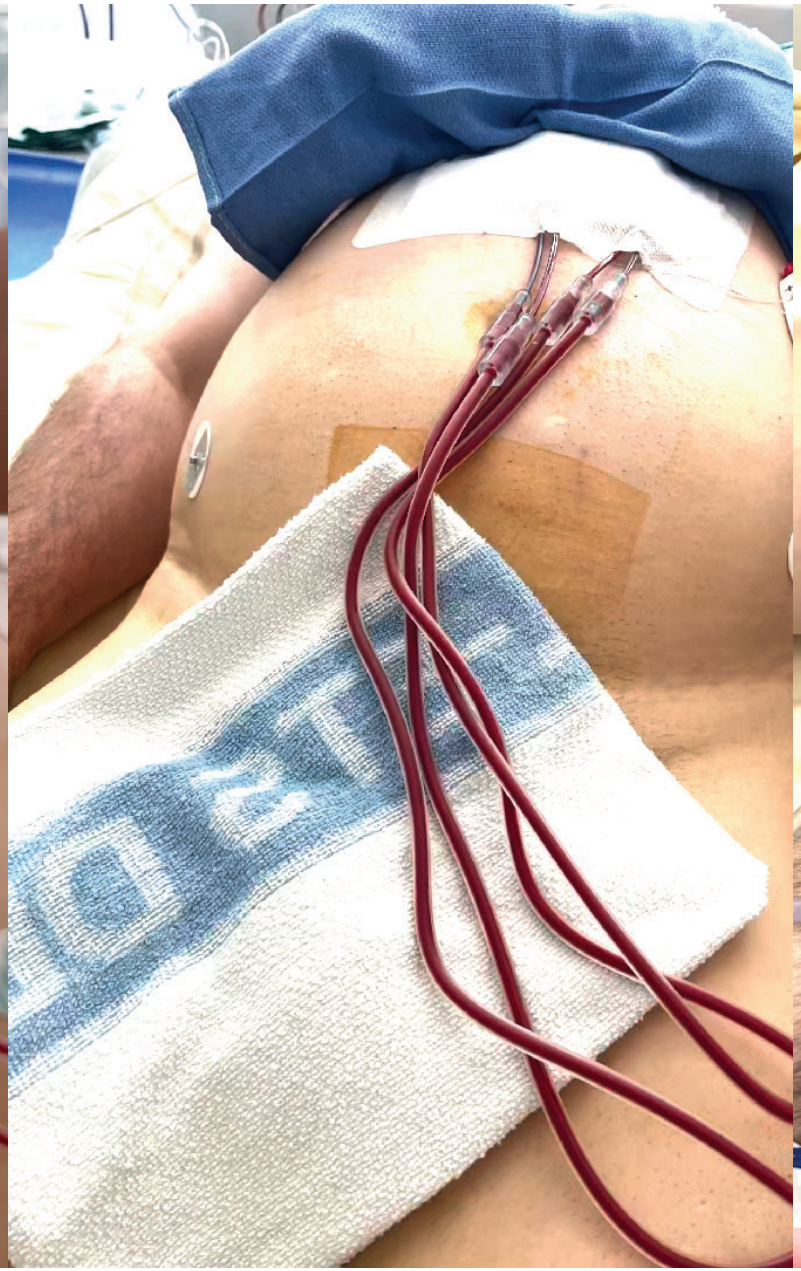
RRT

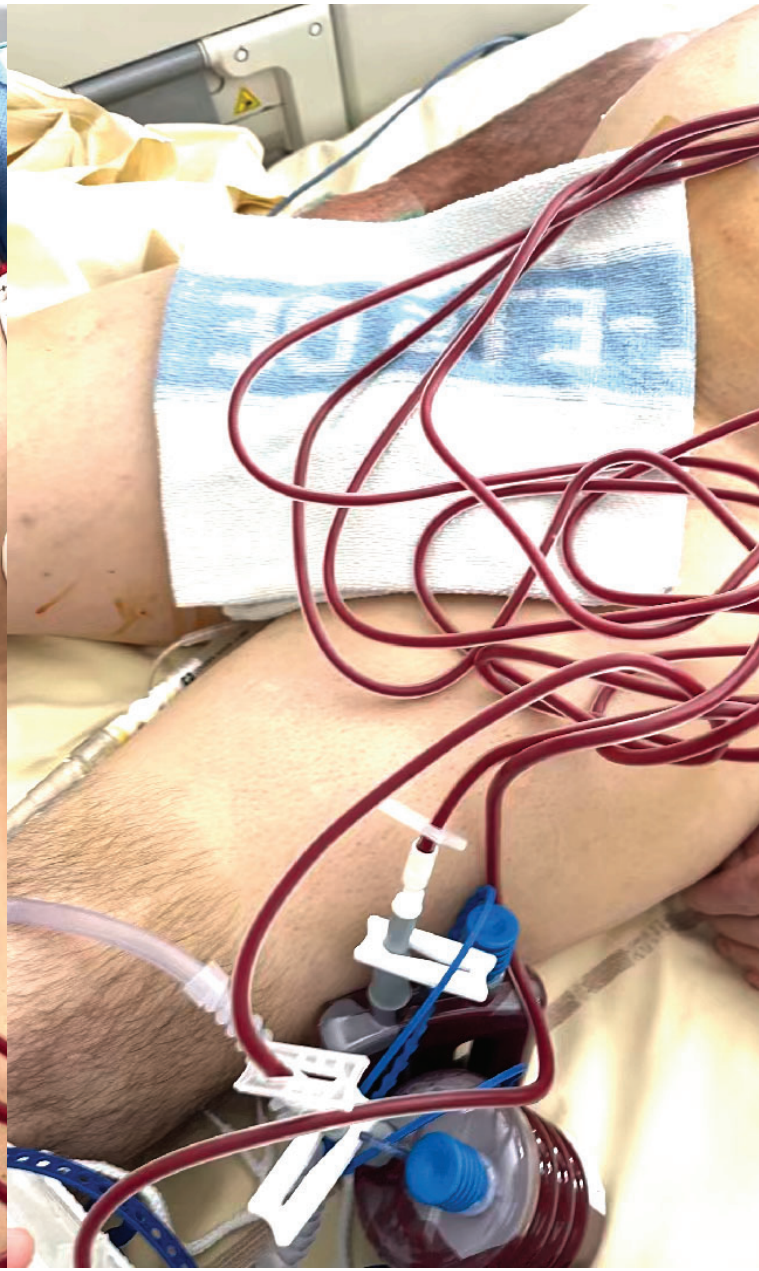




Quelles conséquences ?





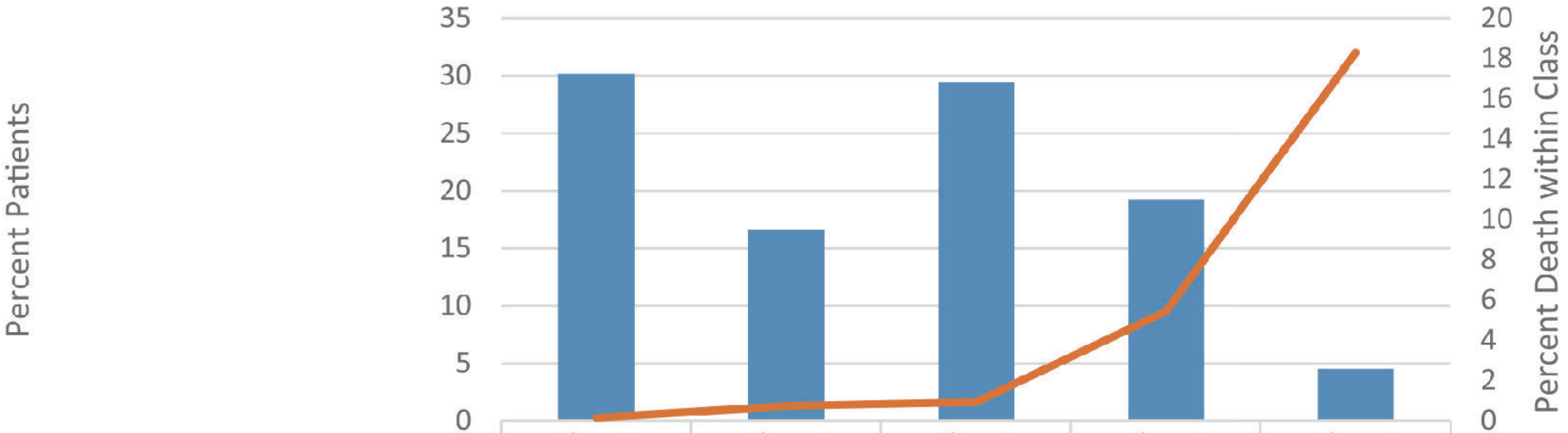


# Universal Definition of Perioperative Bleeding - UDPB

| Bleeding definition | Sternal closure delayed | Postoperative chest tube blood loss within 12 hours (mL) | PRBC (units)[a] | FFP (units) | PLT | Cryoprecipitate | PCCs | rFVIIA | Reexploration/tamponade |
|---|---|---|---|---|---|---|---|---|---|
| Class 0 | No | <600 | 0 | 0 | No | No | No | No | No |
| Class 1 | No | 601-800 | 1 | 0 | No | No | No | No | No |
| Class 2 | No | 801-1000 | 2-4 | 2-4 | Yes | Yes | Yes | No | No |
| Class 3 | Yes | 1001-2000 | 5-10 | 5-10 | N/A | N/A | N/A | No | Yes |
| Class 4 | N/A | >2000 | >10 | >10 | N/A | N/A | N/A | Yes | N/A |

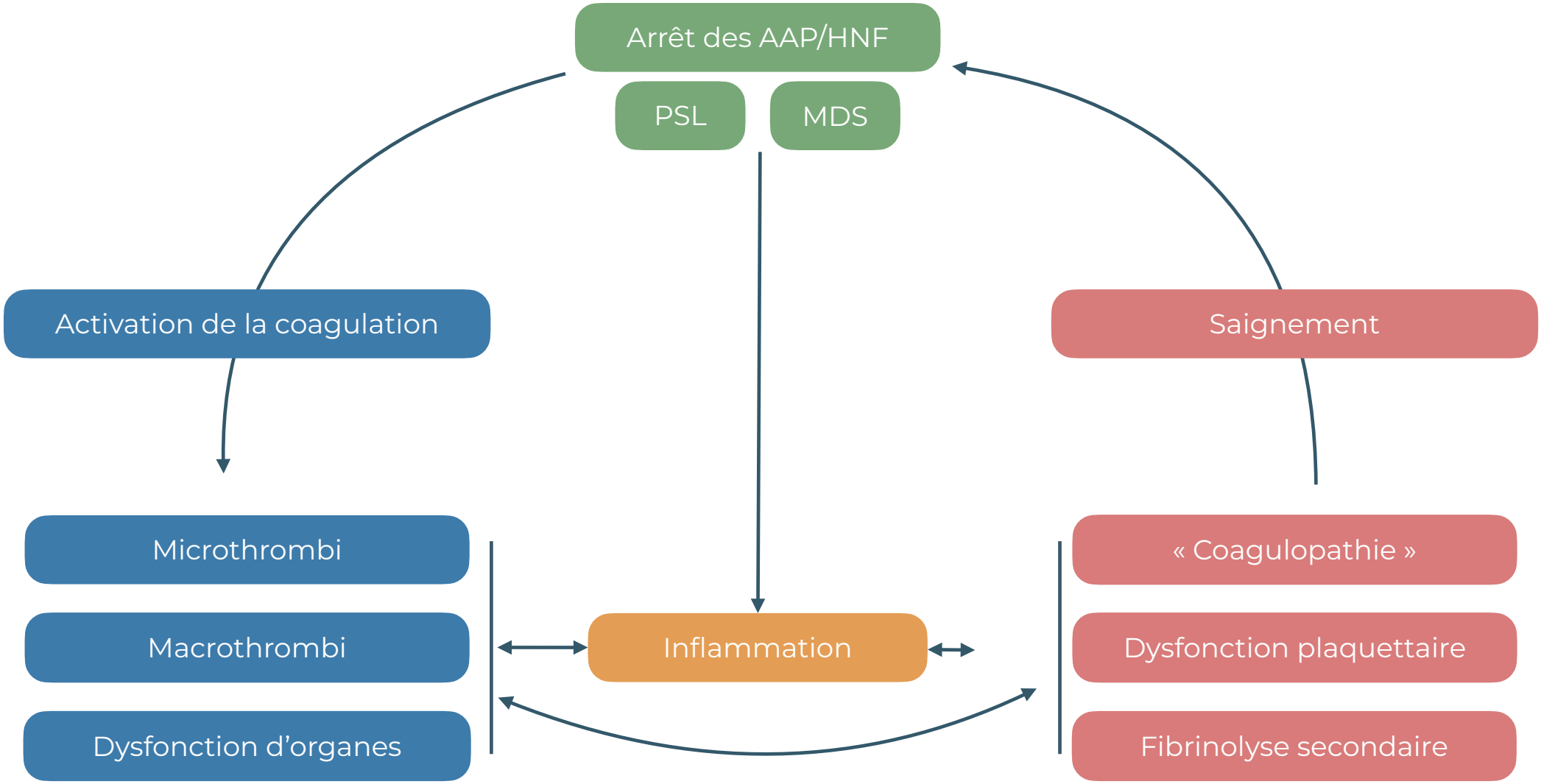
Dyke et al. J Thorac Cardiovasc Surg. 2014

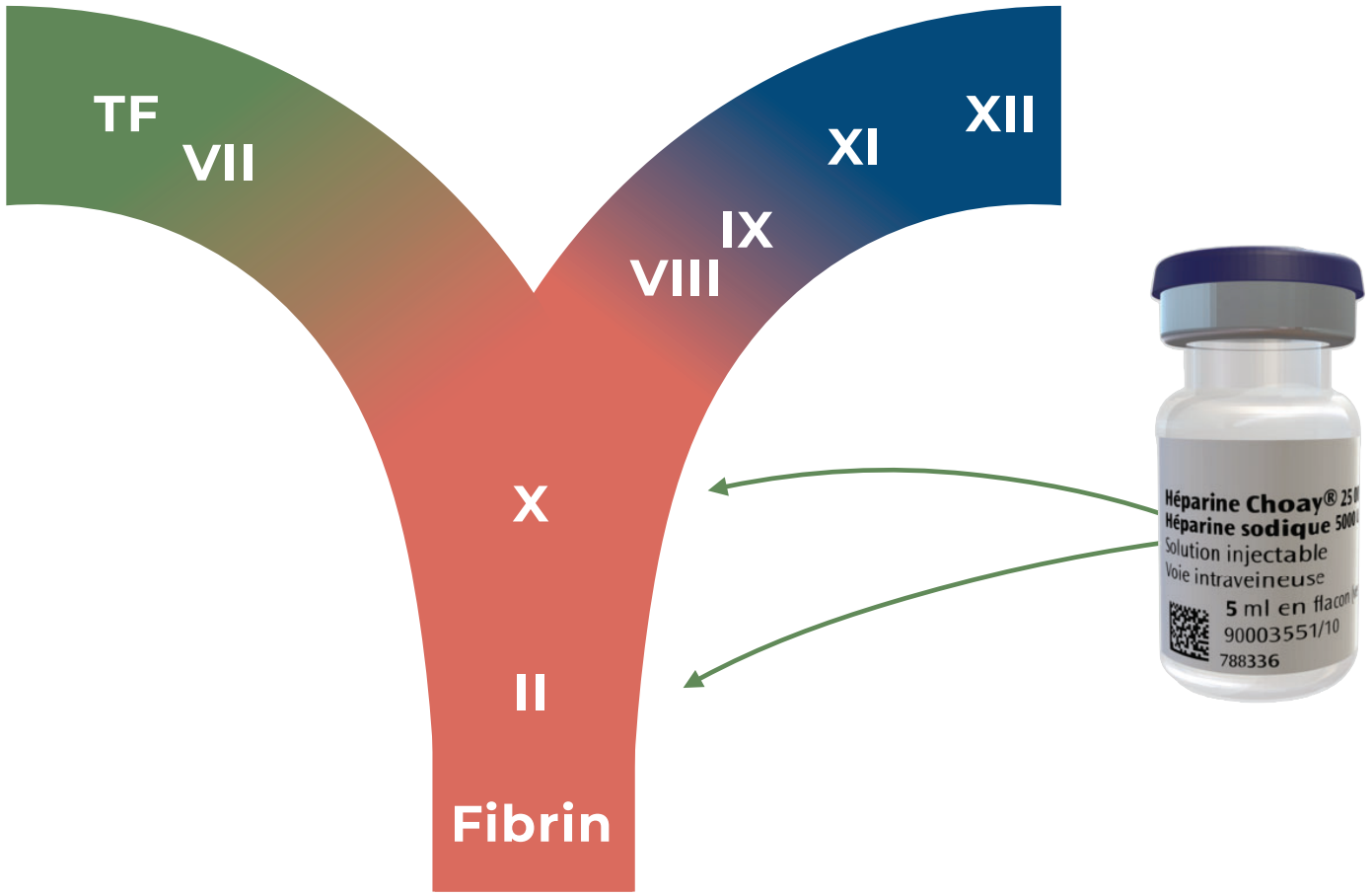
# Saignement en chirurgie cardiaque

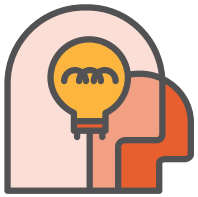



| | Class 0 (n=2199) | Class 1 (n=1209) | Class 2 (n=2144) | Class 3 (n=1401) | Class 4 (n=328) |
|---|---|---|---|---|---|
| Percent Total Patients within Bleeding Grade (%) | 30.2 | 16.6 | 29.45 | 19.24 | 4.5 |
| Percent Death within Bleeding Class (%) | 0.14 | 0.74 | 0.93 | 5.42 | 18.29 |

Bartoszko et al. Anesthesiology 2018


Arrêt des AAP/HNF
PSL
MDS
Activation de la coagulation
Saignement
Microthrombi
Macrothrombi
Dysfonction d'organes
Inflammation
« Coagulopathie »
Dysfonction plaquettaire
Fibrinolyse secondaire


TF
VII
XII
XI
IX
VIII
X
II
Fibrin
Héparine Choay®
Héparine sodique
Solution injectable
Voie intraveineuse
5 ml en flacon
90003551/10
788336



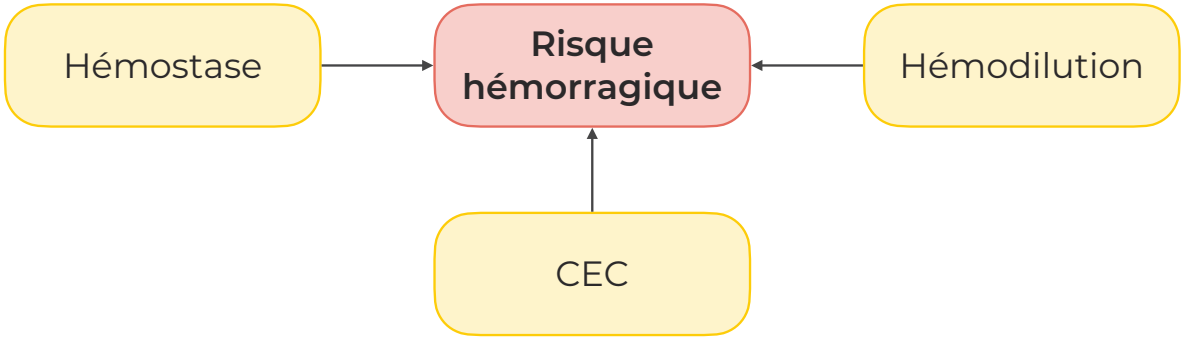
Deux objectifs majeurs en CEC

Minimiser le risque hémorragique

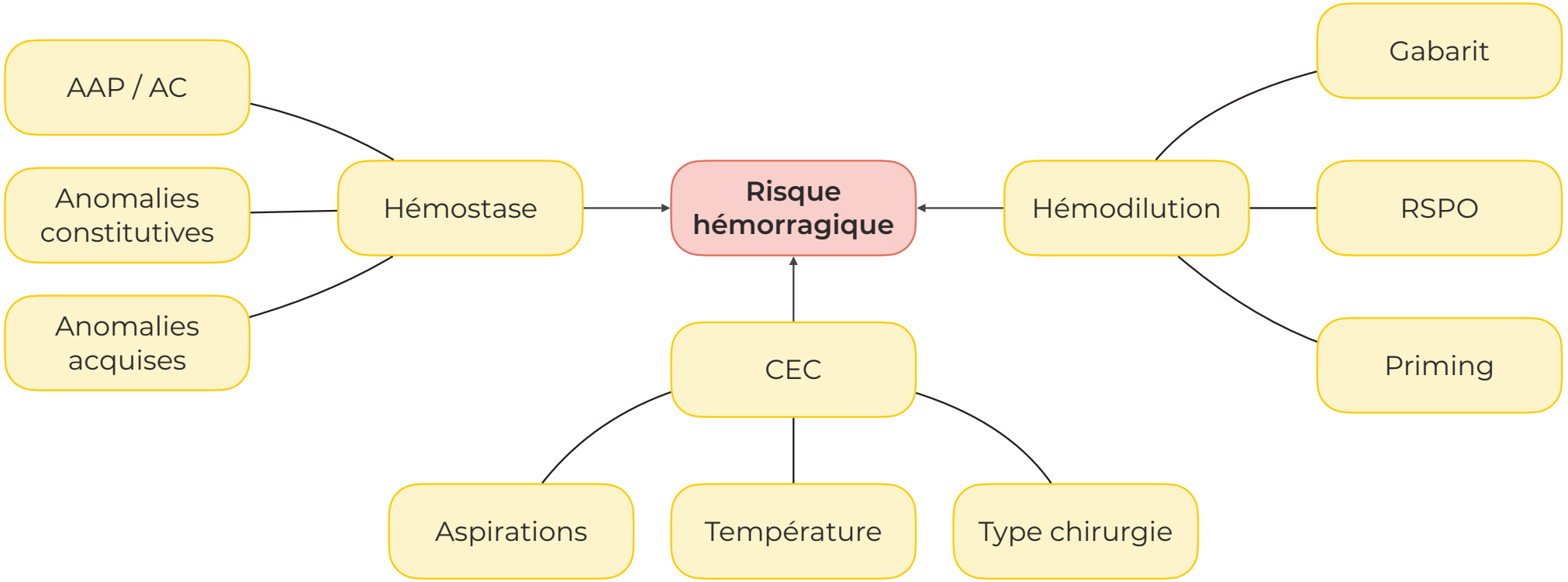
Optimiser la gestion de l’HNF

# Gestion pré-opératoire de l’hémostase

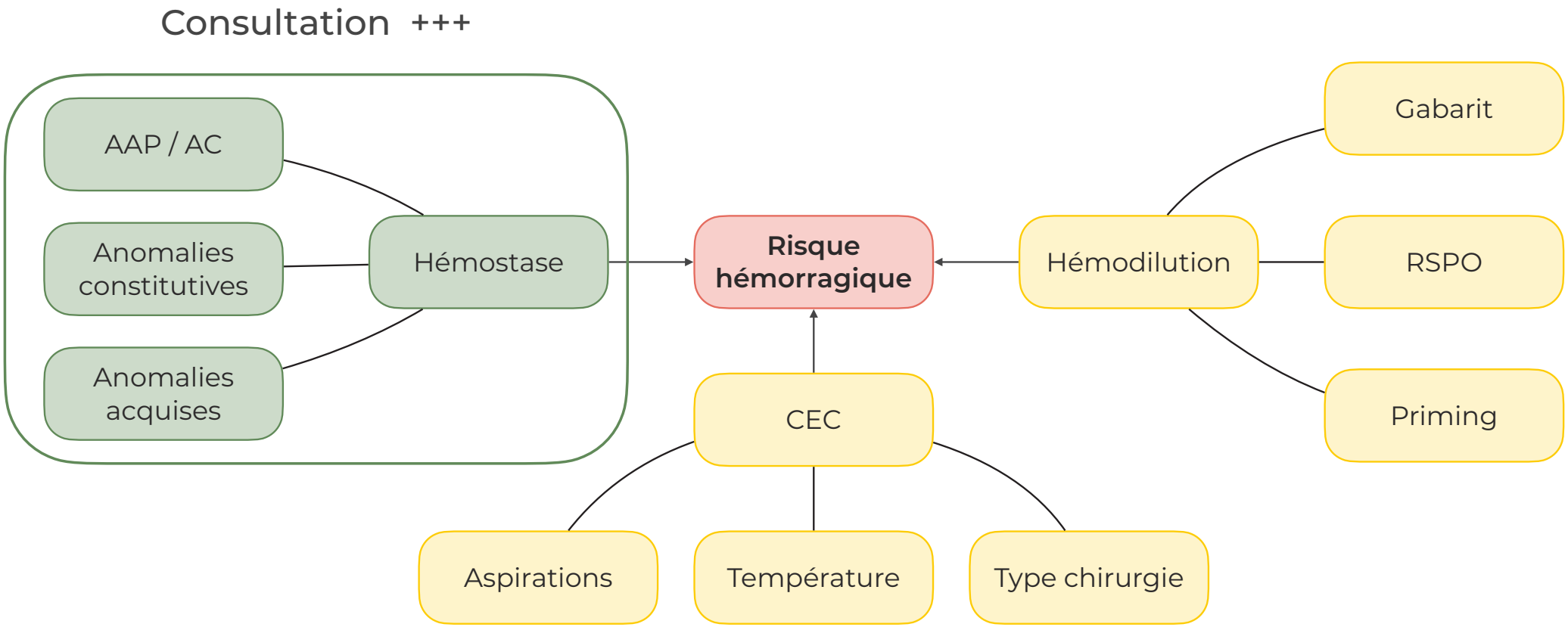
# Comment évaluer le risque hémorragique en préopératoire ?



# Comment évaluer le risque hémorragique en préopératoire ?



# Comment évaluer le risque hémorragique en préopératoire ?



| Risk factor | Value = 0 | Value = 1 |
|---|---|---|
| Surgery priority | Elective | Urgent or emergency |
| Surgery type | CABG or single valve | All other surgery types |
| Aortic valve disease | None | Stenosis, regurgitation, both |
| BMI | BMI greater/equal to 25 | BMI less than 25 |
| Age | Younger than 75 | 75 years or older |

**Table 1: Details of existing transfusion scoring systems**

| Trust score | Score | Track score | Score |
|---|---|---|---|
| Hb <13.5 g/dl | 1 | Age >67 years | 6 |
| Weight <77 kg | 1 | Weight <60 kg (female) or <85 kg (male) | 2 |
| Female sex | 1 | | |
| Age >65 years | 1 | Gender-female | 4 |
| Nonelective surgery | 1 | Complex surgery | 7 |
| Creatinine >1.36 mg/dl | 1 | Hematocrit (continuous) | 1 point per each value (%) below 40% |
| Previous cardiac surgery | 1 | | |
| Nonisolated operation | 1 | | |

Hb: Hemoglobin

Score de risque hémorragique
> interêt limité +++

Vuylsteke et al. EJCTS 2011 // Krishna et al. Annals of Cardiac Anaesthesia 2019

# Bilan d'hémostase préopératoire ?

Etude observationnelle
Chirurgie cardiaque complexe
N=101

**Table 3. Coagulation-Related Variables in Relation to Post-CPB Blood Loss**

| Variables (normal range) | Pre-CPB value[a] | ρ[b] | P | Post-CPB value[a] | ρ[b] | P | Δ (%)[c] | ρ[b] | P |
|---|---|---|---|---|---|---|---|---|---|
| Hemoglobin (140–180 g/L male; 120–160 g/L female) | 137 ± 16 | 0.02 | 0.8 | 91 ± 13 | −0.13 | 0.2 | −33 ± 8 | 0.22 | 0.03 |
| Platelet count (150–400 × $10^9$/L) | 240 ± 65 | −0.18 | 0.06 | 122 ± 51 | −0.38 | 0.0001 | −49 ± 15 | 0.3 | 0.003 |
| INR (0.8–1.2) | 1.1 ± 0.1 | 0.08 | 0.4 | 1.8 ± 0.5 | 0.27 | 0.006 | 65 ± 41 | −0.26 | 0.008 |
| PTT (26–38 s) | 31 ± 3 | 0.13 | 0.2 | 36 ± 12 | 0.17 | 0.1 | 17 ± 36 | −0.06 | 0.5 |
| Fibrinogen (2–4 g/L) | 3.4 ± 0.7 | 0.00 | 0.9 | 2.1 ± 0.6 | −0.26 | 0.008 | −38 ± 11 | 0.37 | 0.0002 |
| Factor II (0.7–1.4 U/mL) | 0.9 ± 0.2 | −0.09 | 0.3 | 0.5 ± 0.1 | −0.29 | 0.003 | −41 ± 11 | 0.3 | 0.003 |
| Factor V (0.7–1.3 U/mL) | 0.9 ± 0.2 | 0.05 | 0.6 | 0.5 ± 0.1 | −0.13 | 0.2 | −45 ± 13 | 0.18 | 0.07 |
| Factor VIII (0.5–1.6 U/mL) | 1.2 ± 0.4 | −0.17 | 0.1 | 1.0 ± 0.4 | −0.1 | 0.3 | −17 ± 39 | 0.02 | 0.9 |
| Factor X (0.7–1.3 U/mL) | 0.9 ± 0.2 | −0.02 | 0.8 | 0.5 ± 0.2 | −0.17 | 0.09 | −43 ± 16 | 0.16 | 0.1 |
| Factor XIII (0.8–1.6 U/mL) | 1.1 ± 0.3 | −0.07 | 0.5 | 0.7 ± 0.2 | −0.18 | 0.07 | −35 ± 12 | 0.16 | 0.1 |
| Antithrombin (0.9–1.2 U/mL) | 0.9 ± 0.1 | 0.09 | 0.4 | 0.6 ± 0.1 | −0.21 | 0.03 | −38 ± 11 | 0.31 | 0.002 |
| Prothrombin fragment F1 + 2 (69–229 ρmol/L) | 203 ± 101 | −0.18 | 0.07 | 735 ± 412 | 0.03 | 0.8 | 319 ± 275 | −0.19 | 0.05 |
| Thrombin-antithrombin complex (<400 μg/mL) | 5.3 ± 4.6 | −0.12 | 0.2 | 95 ± 55 | 0.24 | 0.01 | 2397 ± 1891 | −0.29 | 0.003 |
| Fibrin monomer complex (<6.0 μg/mL) | 5.1 ± 4.3 | 0.05 | 0.6 | 27 ± 34 | 0.23 | 0.02 | 562 ± 837 | −0.19 | 0.05 |
| Plasmin-alpha-2-antiplasmin complex (74–134 ηg/mL) | 135 ± 84 | 0.1 | 0.3 | 1746 ± 1306 | 0.11 | 0.3 | 1418 ± 1382 | −0.07 | 0.5 |

Karkouti et al . Anesthesia & Analgesia 2010;110(6):1533–40.

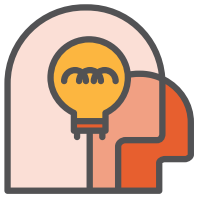
# Bilan d'hémostase préopératoire ?

**Table 4. Regression Analysis of Post-CPB Blood Loss (Log Transformation)**

| Variable | Coefficient (*b*) | SE | Bootstrap coefficient median (95% CI) | *t* | Squared partial correlation | *P* | Tolerance |
|---|---|---|---|---|---|---|---|
| Constant | 6.99 | 0.38 | | | | | |
| Previous Sternotomies | 0.64 | 0.25 | 0.64 (0.24–1.01) | 2.6 | 0.07 | 0.01 | 0.9 |
| Pre-CPB F1.2 level | −0.0022 | 0.0007 | −0.0021 (−0.0035 to −0.0008) | 3.3 | 0.1 | 0.001 | 0.9 |
| Post-CPB platelet count | −0.0038 | 0.0015 | −0.0037 (−0.007 to −0.0007) | 2.6 | 0.07 | 0.01 | 0.8 |
| Post-CPB FM level | 0.013 | 0.003 | 0.012 (0.006 to 0.019) | 4.3 | 0.17 | <0.0001 | 0.8 |
| δ Fibrinogen level | 0.013 | 0.006 | 0.013 (−0.0005 to 0.028) | 2.0 | 0.04 | 0.05 | 0.8 |

| Source of variation | Degrees of freedom | Sum of squares | Mean squares | *F* | *P* |
|---|---|---|---|---|---|
| Regression | 5 | 29.2 | 5.8 | 13.8 | <0.0001 |
| Residual | 93 | 39.4 | 0.4 | | |

Karkouti et al . Anesthesia & Analgesia 2010;110(6):1533–40.



Bilan d’hémostase préopératoire ?

TP / TCA ne prédisent pas le risque hémorragique

Fibrinogène mieux corrélé mais pas de seuil de sécurité

Tests viscoélastométriques et tests fonctionnels plaquettaires peu prédictifs et non validés dans cette indication

# 2024 EACTS/EACTAIC Guidelines on patient blood management in adult cardiac surgery in collaboration with EBCP

| Recommendations | Class | Level |
|---|---|---|
| Preoperative bleeding history, review of medications, and physical examination are recommended to identify patients at increased risk of bleeding. | I | C |
| Risk scores may be considered for initial screening to identify patients at increased risk of bleeding complications. | IIb | B |
| Preoperative fibrinogen levels may be considered to stratify the risk of bleeding. | IIb | B |
| Platelet function testing may be considered to guide the decision on the timing of cardiac surgery in patients who have recently received P2Y12 inhibitors. | IIb | B |
| Routine use of viscoelastic testing or platelet function testing is not recommended to predict bleeding. | III | C |

Casselman et al. EJCTS 2024

# Gestion des anticoagulants en chirurgie programmée

| Antithrombotique | Demi-vie | Pharmacologie | Dernière prise | Dosage préopératoire |
|---|---|---|---|---|
| Apixaban | 12 h | Inhibition du facteur Xa<br>Élimination rénale (≈ 30 %) et hépatique | J-3* | Non |
| Rivaroxaban | 5-13 h | Inhibition du facteur Xa<br>Élimination rénale (≈ 30 %) et hépatique | DFG ≥ 30 mL/min : J-3**<br>DFG < 30 mL/min : J-5 | Non |
| Dabigatran | 12-14 h | Inhibition du facteur IIa<br>Élimination rénale (≈ 80 %) et hépatique | DFG ≥ 50 mL/min : J-4<br>DFG < 50 mL/min : J-5 | Non |
| AVK | 30-45 h | Inhibition de la synthèse de la vitamine K<br>Métabolisme hépatique<br>Élimination sous forme inactive | J-5 | INR < 1,5 |

* sous réserve qu'une réduction posologique soit appliquée conformément au résumé des caractéristiques du produit si DFG < 30 mL/min ou si deux facteurs parmi : âge ≥ 80 ans, poids ≤ 60 kg, créatininémie ≥ 133 µmol/L.
** Réduction posologique indiquée si DFG < 50 mL/min.

| Antithrombotique parentéral | Demi-vie | Délai d'interruption préopératoire | Indication à un dosage préopératoire |
|---|---|---|---|
| HNF IVSE dose thérapeutique | 60-120 min | 6 h | Non |
| HNF SC dose préventive | 4 h | 4 h | Non |
| HBPM dose thérapeutique | 5-7 h | 24 h | Non |
| HBPM dose préventive | 5-7 h | 12 h | Non |
| Fondaparinux :<br>• dose préventive<br>• dose thérapeutique | <br>17-21 h<br>17-21 h | <br>36 h<br>96 h | <br>Oui si DFG < 50 mL/min<br>Anti-Xa fondaparinux < 0,2 µg/mL<br>Oui<br>Anti-Xa fondaparinux < 0,2 µg/mL |
| Danaparoïde sodique :<br>• dose préventive<br>• dose curative | <br>Anti-Xa : 25 h<br>Anti-IIa : 7 h<br>Anti-Xa : 25 h<br>Anti-IIa : 7 h | <br>36 h<br>96 h | <br>Avis spécialisé hémostase<br>Anti-Xa < 0,2 UI/mL<br>Avis spécialisé hémostase<br>Anti-Xa < 0,2 UI/mL |
| Argatroban IVSE | 50-60 min | 4 h | Non (sauf insuffisance hépatique) |
| Bivalirudine IVSE | 25-60 min selon DFG | 2 h | Non (sauf insuffisance rénale sévère) |

A. Mansour, A. Godier, Chapitre 5, Anesthésie-Réanimation en Chirurgie cardiaque Arnette 2025

# Gestion des AAP en chirurgie programmée

| Antithrombotique | Demi-vie | Pharmacologie | Dernière prise | Dosage préopératoire |
|---|---|---|---|---|
| Clopidogrel | 6 h | Inhibition irréversible du récepteur P2Y12 | J-5 | Non |
| Ticagrelor | 6-9 h | Inhibition réversible du récepteur P2Y12 | J-5*** | Non*** |
| Prasugrel | 3-7 h | Inhibition réversible du récepteur P2Y12 | J-7 | Non |

*** Une dernière prise à J-3 est possible, avec une vérification de la correction de l'inhibition plaquettaire par un test fonctionnel plaquettaire au sein d'une équipe experte. Près de 20 % des patients n'ont cependant pas récupéré des fonctions plaquettaires normales.

| Antithrombotique parentéral | Demi-vie | Délai d'interruption préopératoire | Indication à un dosage préopératoire |
|---|---|---|---|
| Cangrelor | 3-6 min | 60 min | Non |
| Eptifibatide | 2,5 h | 4 à 8 h (> 12 h si insuffisance rénale) | Non |
| Tirofiban | 1,5 h | 4 à 8 h (> 12 h si insuffisance rénale) | Non |

A. Mansour, A. Godier, Chapitre 5, Anesthésie-Réanimation en Chirurgie cardiaque Arnette 2025

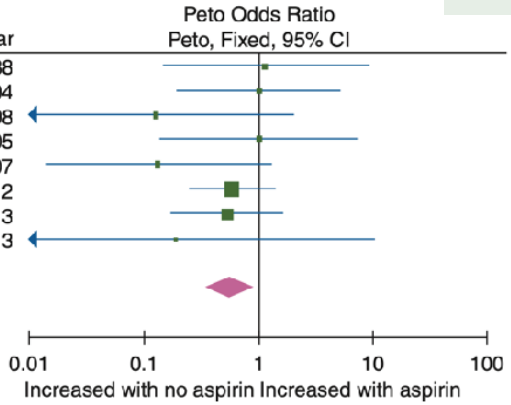
# Aspirine

Pontage uniquement
13 RCT // N = 2399
Études anciennes, pré-PBM
Posologies variables

## IDM post-op

| Study or subgroup | Aspirin Events | Aspirin Total | Control Events | Control Total | Weight | Peto Odds Ratio Peto, Fixed, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| Ferraris 1988 | 2 | 16 | 2 | 18 | 6.8% | 1.14 [0.15, 8.93] | 1988 |
| Kallis 1994 | 3 | 50 | 3 | 50 | 10.8% | 1.00 [0.19, 5.17] | 1994 |
| Klein 1998 | 0 | 40 | 2 | 38 | 3.7% | 0.12 [0.01, 2.04] | 1998 |
| Morawski 2005 | 2 | 51 | 2 | 51 | 7.3% | 1.00 [0.14, 7.31] | 2005 |
| Ghaffarinej 2007 | 0 | 100 | 3 | 100 | 5.6% | 0.13 [0.01, 1.29] | 2007 |
| Deja 2012 | 8 | 387 | 14 | 396 | 40.4% | 0.58 [0.25, 1.36] | 2012 |
| Mirhosseini 2013 | 5 | 60 | 9 | 60 | 23.5% | 0.53 [0.17, 1.60] | 2013 |
| Berg 2013 | 0 | 8 | 1 | 12 | 1.8% | 0.19 [0.00, 10.32] | 2013 |
| Total (95% CI) | | 712 | | 725 | 100.0% | 0.56 [0.33, 0.96] | |
| Total events | 20 | | 36 | | | | |

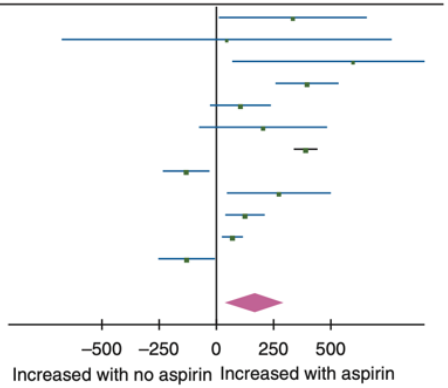
Heterogeneity: Chi²=4.22, df=7 (*P*=0.75); I²=0%
Test for overall effect: Z=2.11 (*P*=0.03)




## Saignement

| Study or subgroup | Aspirin Mean [mL] | Aspirin SD [mL] | Aspirin Total | Control Mean [mL] | Control SD [mL] | Control Total | Weight | Mean difference IV, Random, 95% CI [mL] | Year |
|---|---|---|---|---|---|---|---|---|---|
| Fuller 1985 | 1,038 | 665 | 21 | 704 | 235 | 9 | 6.5% | 334.00 [10.79, 657.21] | 1985 |
| Karwande 1987 | 623 | 943 | 14 | 578 | 847 | 10 | 2.5% | 45.00 [–675.83, 765.83] | 1987 |
| Ferraris 1988 | 1,513 | 977 | 16 | 916 | 482 | 18 | 3.9% | 597.00 [69.03, 1124.97] | 1988 |
| Sethi 1990 | 1,316 | 977 | 309 | 920 | 534 | 153 | 9.7% | 396.00 [258.06, 533.94] | 1990 |
| Goldman 1991 | 1,150 | 671 | 176 | 1,045 | 601 | 175 | 9.8% | 105.00 [–28.25, 238.25] | 1991 |
| Hockings 1993 | 1,193 | 826 | 50 | 989 | 591 | 52 | 7.2% | 204.00 [–75.68, 483.68] | 1993 |
| Kallis 1994 | 1,240 | 168 | 50 | 850 | 82 | 50 | 10.8% | 390.00 [338.18, 441.82] | 1994 |
| Klein 1998 | 465 | 165 | 37 | 597 | 266 | 36 | 10.3% | –132.00 [–233.87, –30.13] | 1998 |
| Morawski 2005 | 1,281 | 598 | 51 | 1,008 | 572 | 51 | 8.2% | 273.00 [45.89, 500.11] | 2005 |
| Ghaffarinej 2007 | 608 | 360 | 100 | 483 | 252 | 100 | 10.5% | 125.00 [38.87, 211.13] | 2007 |
| Deja 2012 | 820 | 353 | 387 | 750 | 303 | 396 | 10.8% | 70.00 [23.88, 116.12] | 2012 |
| Berg 2013 | 540 | 164 | 11 | 670 | 104 | 7 | 10.0% | –130.00 [–253.81, –6.19] | 2013 |
| **Total (95% CI)** | | | **1222** | | | **1057** | **100.0%** | **167.84 [39.14, 296.55]** | |

Heterogeneity: Tau² = 39332.77; Chi²=160.24, df=11 (*P*<0.00001); I²=93%
Test for overall effect: Z=2.56 (*P*=0.01)




Hastings et al. BJA 2015

# Aspirine

**ATACAS**
RCT 2x2 (aspirin et TXA)
Pas d'aspirine préop ou STOP >4j
**Dose unique préopératoire**

| Measure | Aspirin (n=1046) | Placebo (n=1052) | ARR % (95% CI) | P-Value |
|---|---|---|---|---|
| Death, Myocardial Infarction, Stroke, Renal Failure, PE, Bowel Infarction | 202 (19.3%) | 215 (20.4%) | 1.13% (-2.29% - 4.54%) | 0.55 |

| Measure | Aspirin | Placebo | ARR % (95% CI) | P-Value |
|---|---|---|---|---|
| Death | 14 (1.3%) | 9 (0.9%) | -0.48 (-0.41 - 1.37) | 0.30 |
| Myocardial Infarction (MI) | 144 (13.8%) | 166 (15.2%) | 2.01 (-1.02 - 5.05) | 0.20 |
| Stroke | 14 (1.3%) | 12 (1.1%) | -0.20 (-0.75 - 1.14) | 0.70 |
| Renal Failure | 49 (4.7%) | 41 (3.9%) | -0.79 (-0.95 - 2.52) | 0.39 |
| Pulmonary Embolism (PE) | 8 (0.8%) | 10 (1.0%) | 0.19 (-0.60 - 0.97) | 0.81 |
| Bowel Infarction | 0 (0.0%) | 2 (0.2%) | 0.19 (-0.07 - 0.45) | 0.50 |
| Reoperation for Hemorrhage | 19 (1.8%) | 22 (2.1%) | 0.27 (-0.91 - 1.46) | 0.75 |
| Cardiac Tamponade | 11 (1.1%) | 4 (0.4%) | 0.67 (-0.05 - 1.39) | 0.08 |

Myles et al. NEJM 2016; 374: 728-737 doi: 10.1056/NEJMoa1507688

# Bi-AAP et chirurgie cardiaque

Observationnelle (Angers)
Ajustement par PSM
Gestion optimale de la CEC
Aspirine vs biAAP

| Variable | Overall (n=2275) | ASA (n=1164) | DAPT (n=1111) | p-value |
|---|---|---|---|---|
| E-CABG score ≥2, n (%) | 94 (4.11) | 34 (2.92) | 59 (5.31) | 0.0065 |
| UDPB score ≥3, n (%) | 61 (2.68) | 21 (1.8) | 40 (3.57) | 0.0162 |
| BARC 4, n (%) | 96 (4.2) | 40 (3.44) | 57 (5.09) | 0.0626 |
| Reoperation for bleeding, n (%) | 75 (3.33) | 29 (2.49) | 46 (4.18) | 0.03 |
| Pleural effusion, n (%) | 84 (3.70) | 32 (2.75) | 51 (4.62) | 0.033 |
| Units of RBC transfused, mean (SD) | 0.402 (1.3) | 0.248 (1.1) | 0.56 (1.5) | <0.0001 |
| Units of FFP transfused, mean (SD) | 0.071 (0.5) | 0.045 (0.5) | 0.098 (0.5) | 0.021 |
| Units of PLT transfused, mean (SD) | 0.016 (0.18) | 0.009 (0.18) | 0.023 (0.17) | 0.08 |
| Overall transfusion, n (%) | 349 (15.3) | 109 (9.5) | 239 (21.5) | <0.0001 |
| Chest tube blood loss at 12H (mL), mean (SD) | 224 (161.9) | 192 (136.4) | 258 (178.8) | <0.0001 |
| Chest tube blood loss at 24H (mL), mean (SD) | 322 (211.3) | 284 (187.8) | 361 (226.9) | <0.0001 |
| Overall chest tube blood loss (mL), mean (SD) | 386 (296) | 338 (274.8) | 435 (309) | <0.0001 |

Eid et al. EJCTS 2024

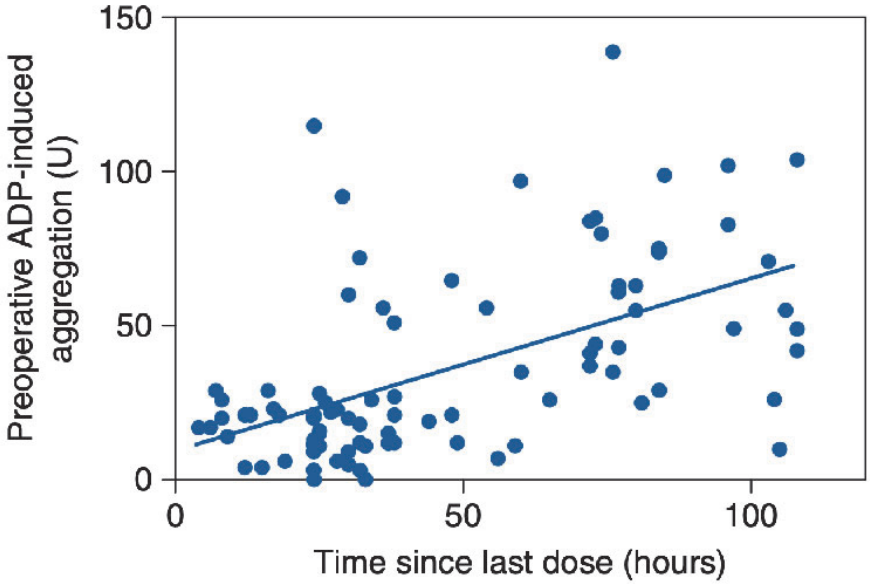
# Bi-AAP et chirurgie cardiaque

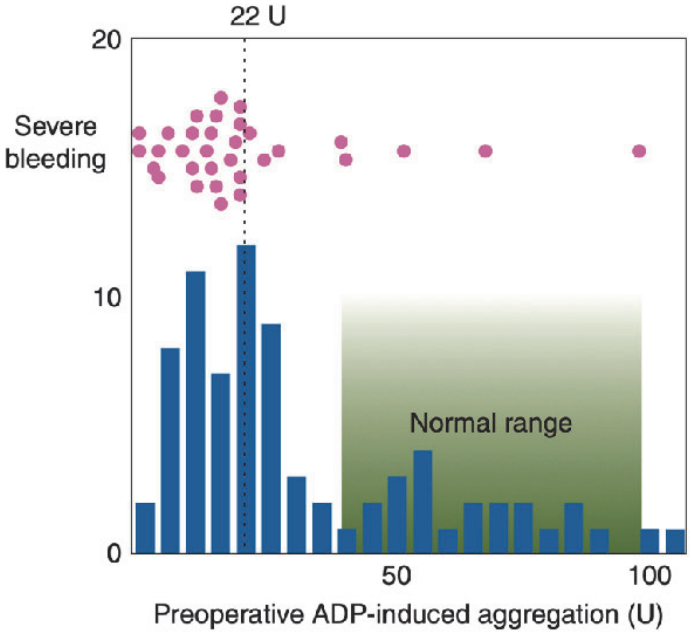
Observationnelle (Angers)
Ajustement par PSM
Gestion optimale de la CEC
Aspirine vs biAAP

| Variable | Overall (n=2275) | ASA (n=1164) | DAPT (n=1111) | p-value |
|---|---|---|---|---|
| 30-days mortality, n (%) | 25 (1.09) | 11 (0.94) | 14 (1.24) | 0.497 |
| Death of cardiac cause, n (%) | 10 (0.44) | 3 (0.26) | 7 (0.64) | 0.278 |
| Postoperative myocardial infarction, n (%) | 6 (0.26) | 2 (0.17) | 4 (0.34) | 0.415 |
| Stroke, n (%) | 15 (0.67) | 5 (0.43) | 10 (0.91) | 0.217 |
| TIA, n (%) | 9 (0.38) | 2 (0.17) | 7 (0.6) | 0.185 |
| AKI, n (%) | 189 (8.3) | 75 (6.44) | 113 (10.17) | 0.0025 |
| Wound infection, n (%) | 44 (1.94) | 13 (1.11) | 31 (2.8) | 0.010 |
| Ventilation time >24H, n (%) | 71 (3.12) | 24 (2.06) | 47 (4.2) | 0.0061 |
| ICU time (hours), mean (SD) | 88.8 (101.1) | 86.4 (90.3) | 91.3 (111.4) | 0.301 |
| Total hospitalization time (days), mean (SD) | 10.3 (6.6) | 9.8 (5.1) | 10.8 (7.8) | 0.0069 |

Eid et al. EJCTS 2024

# Ticagrelor: arrêt J-3 ou J-5 ?



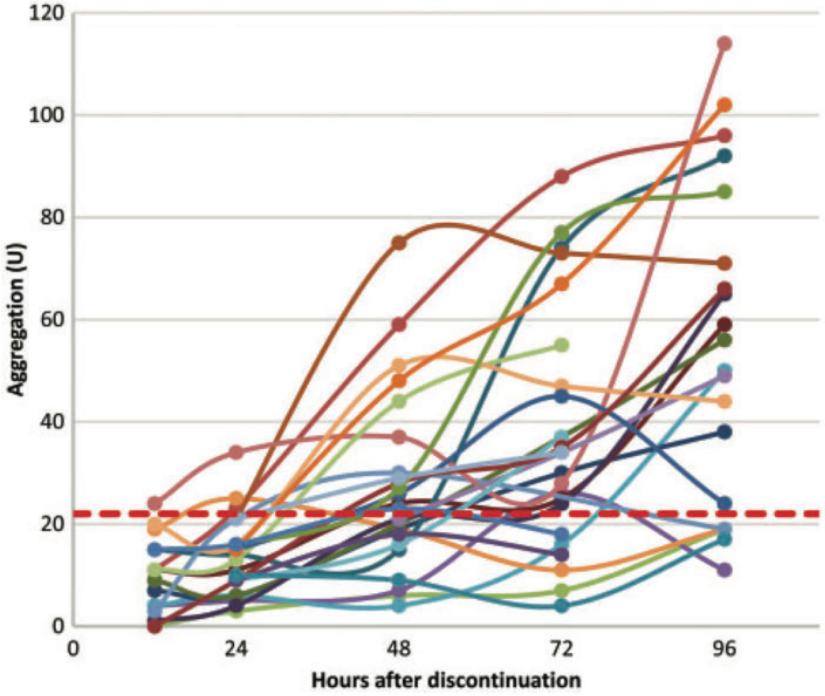




CABG // N=90
Multiplate
UDPB Score

Malm et al. BJA 2016

Diapo A. Godier

# Ticagrelor: arrêt J-3 ou J-5 ?



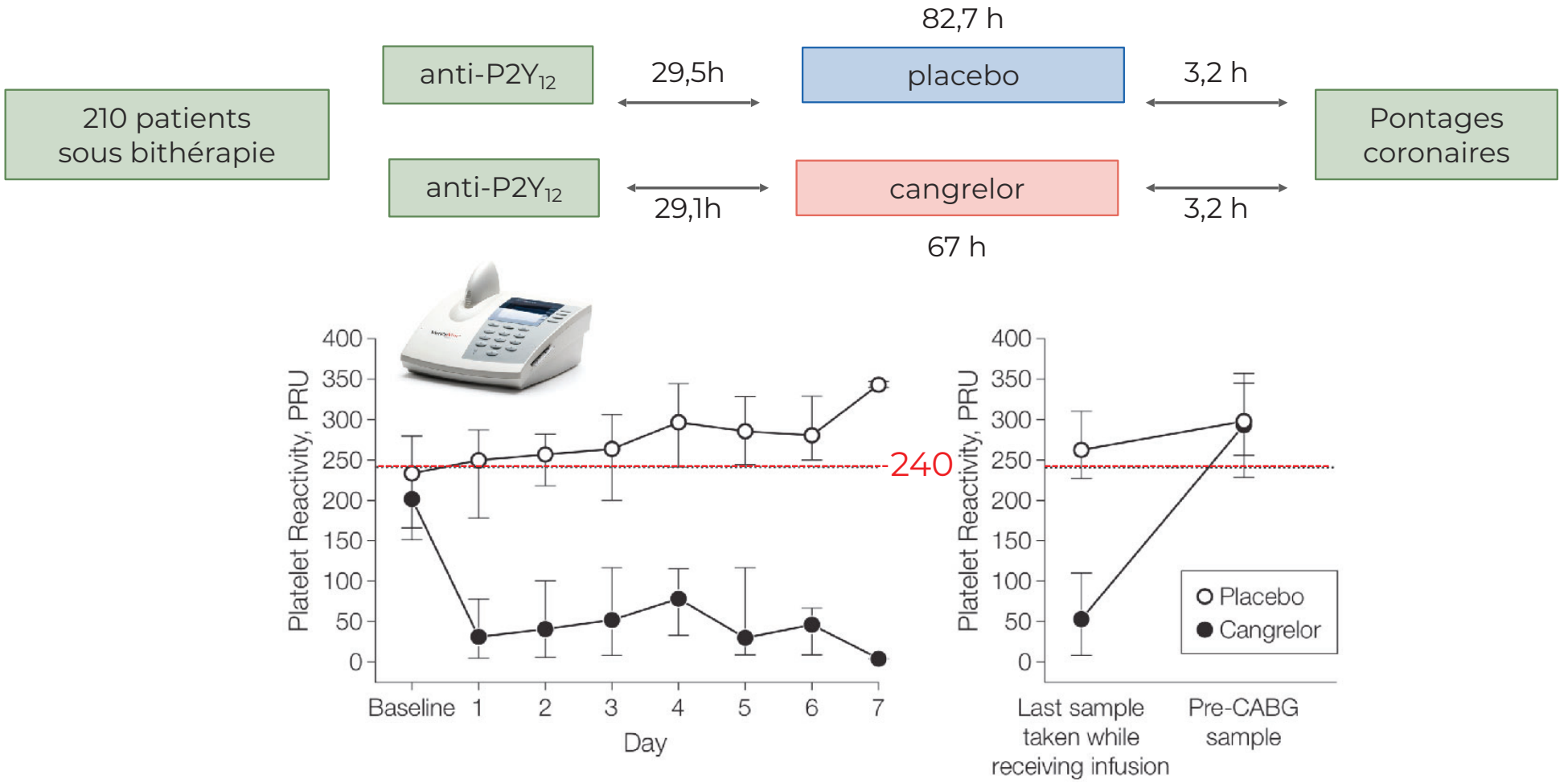

CABG // N=25
Multiplate
**À 72H : 25% < 22U**

Hansson et al. EJCTS 2017

Diapo A. Godier

# Bridging Antiplatelet Therapy With Cangrelor in Patients Undergoing Cardiac Surgery

## A Randomized Controlled Trial




Angiolillo et al. JAMA. 2012 January 18; 307(3): 265–274

Diapo A. Godier

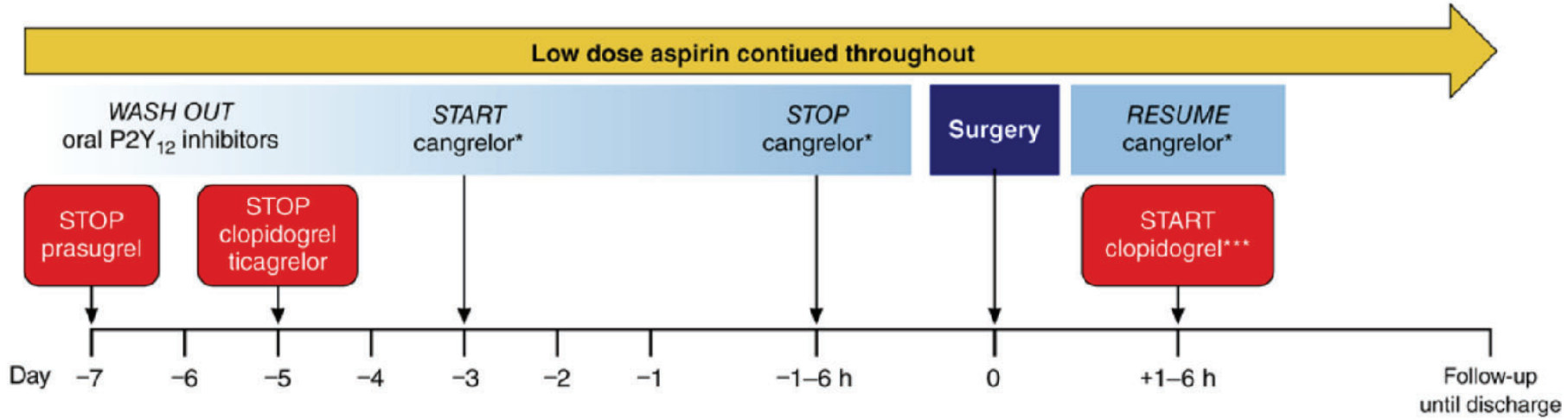
# Relais péri-opératoire par AAP IV

Circulation

## International Expert Consensus on Switching Platelet $P2Y_{12}$ Receptor–Inhibiting Therapies

Dominick J. Angiolillo, Fabiana Rollini, Robert F. Storey, Deepak L. Bhatt, Stefan James, David J. Schneider, Dirk Sibbing, Derek Y.F. So, Dietmar Trenk, Dimitrios Alexopoulos, Paul A. Gurbel, Willibald Hochholzer, Leonardo De Luca, Laurent Bonello, Daniel Aradi, Thomas Cuisset, Udaya S. Tantry, Tracy Y. Wang, Marco Valgimigli, Ron Waksman, Roxana Mehran, Gilles Montalescot, Francesco Franchi and Matthew J. Price

**A** Bridging from oral to IV $P2Y_{12}$ inhibitors




*Initiate within 72 hours from $P2Y_{12}$ inhibitor discontinuation at a dose of 0.75 µg/kg/min (no bolus) for a minimum of 48 hours and a maximum of 7 days.

**If oral administration not possible

***With 300–600 mg loading dose, as soon as oral administration possible. Prasugrel or ticagrelor discouraged

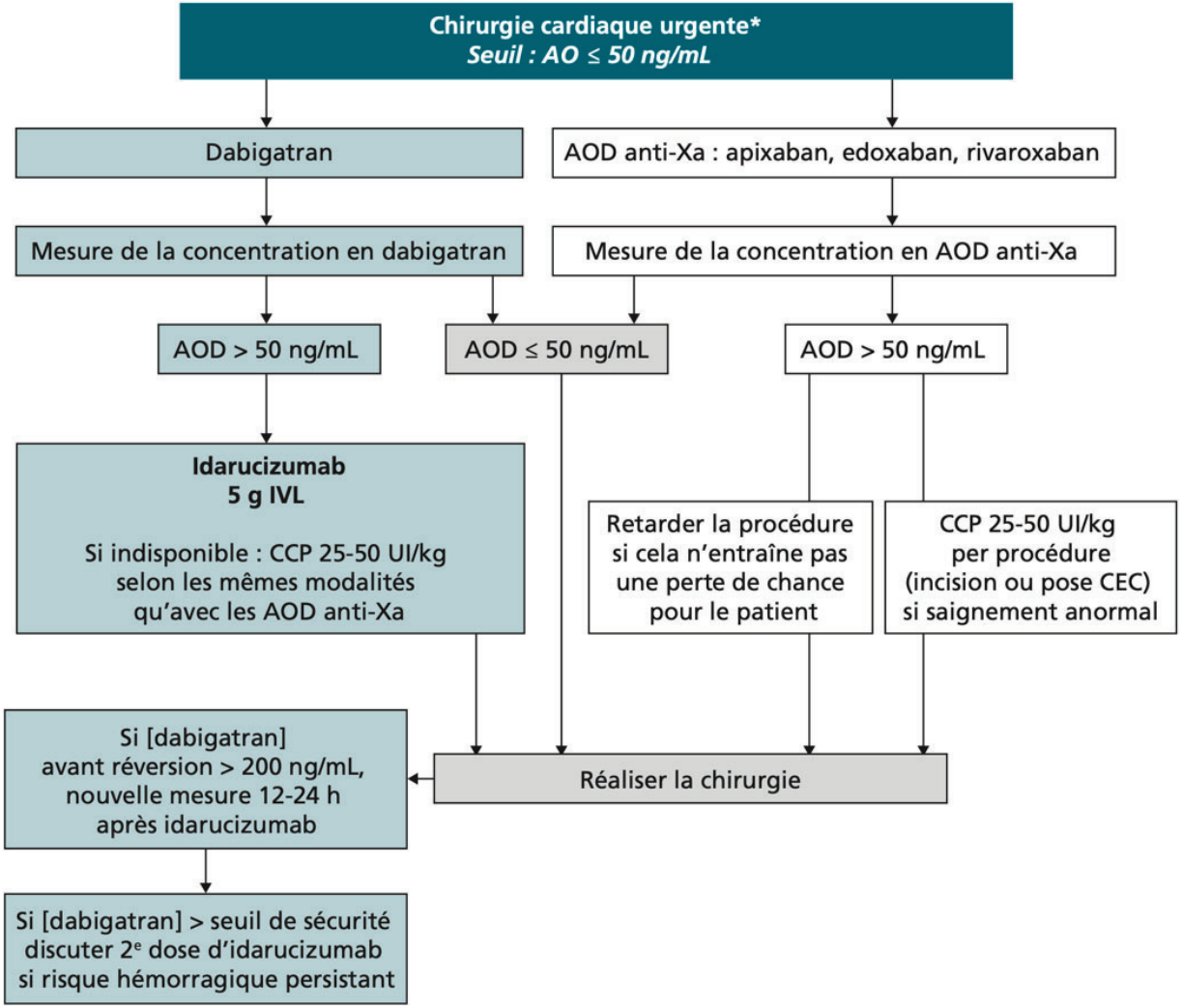
Angiolillo et al. Circulation. 2017;136:1955–1975

Angiolillo et al. JAMA. 2012 January 18; 307(3): 265–274

| Recommendations | Class | Level |
|---|---|---|
| In patients undergoing CABG who are taking ASA preoperatively, continuing ASA throughout the perioperative period is recommended to reduce myocardial ischemic events. | I | B |
| In patients at high risk of bleeding and transfusion or refusing blood transfusions, stopping ASA should be considered at least 4 days preoperatively. | IIa | C |
| In patients undergoing CABG, (re)starting ASA within 24 hours postoperatively to reduce myocardial ischemic events is recommended. | I | B |
| In elective cardiac surgery patients taking DAPT, discontinuation of ticagrelor for at least 3 days, clopidogrel for at least 5 days, and prasugrel for at least 7 days is recommended prior to surgery to reduce bleeding complications. | I | B |
| Testing residual platelet function may be considered in patients who have received P2Y12 inhibitors <7 days for guidance on the timing of cardiac surgery to reduce bleeding complications. | IIb | B |
| Bridging P2Y12 inhibitors with low-dose cangrelor until surgery may be considered in patients with high myocardial ischemic risk to reduce thrombotic complications. | IIb | C |

Casselman et al. EJCTS 2024

# Gestion préopératoire des AOD en chirurgie cardiaque urgente

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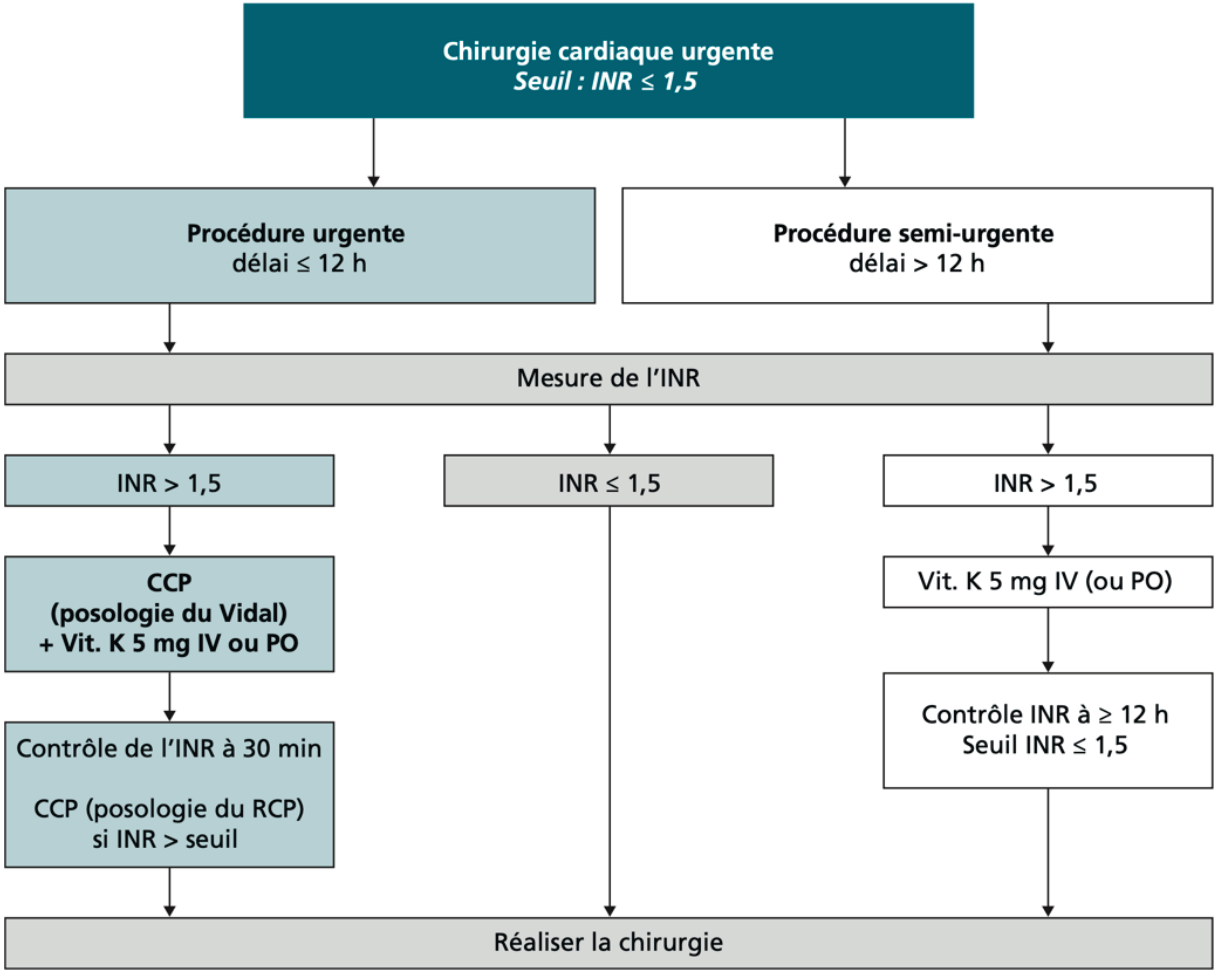
# Gestion préopératoire des AVK en chirurgie cardiaque urgente

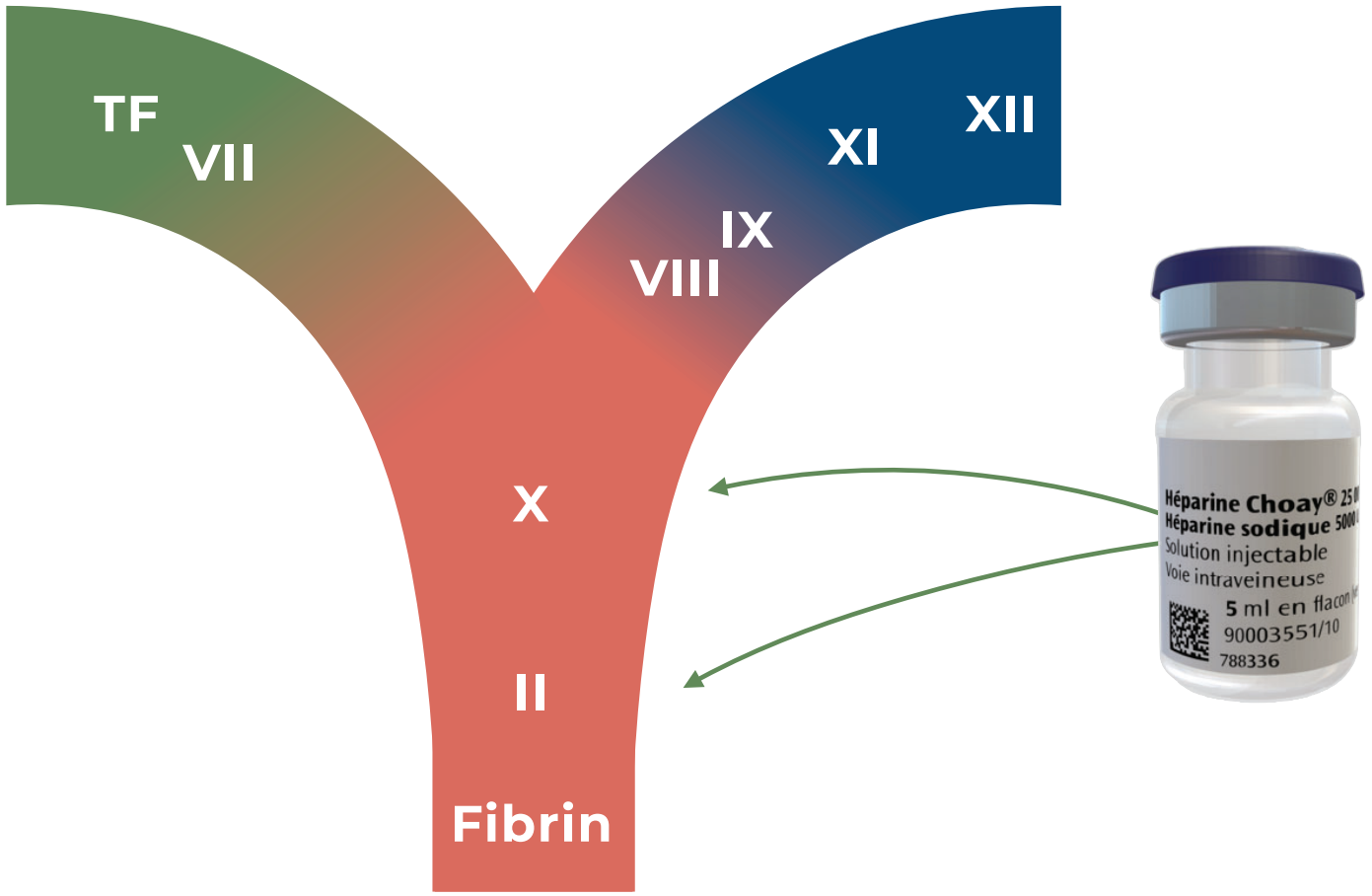



A. Mansour, A. Godier, Chapitre 5, Anesthésie-Réanimation en Chirurgie cardiaque Arnette 2025

# Gestion préopératoire des AAP en chirurgie cardiaque urgente

- Tests fonctionnels plaquettaires : identifier la présence d'un AAP P2Y12 // équipe entrainée
- Report si possible
- Sinon débuter l'intervention // neutralisation si saignement anormal
- Neutralisation des AAP P2Y12 : double dose standard de plaquettes (soit 2 × 0,5 à 0,7 × $10^{11}$ par 10 kg de poids corporel)
- Clopidogrel / prasugrel : efficacité limitée si dernière prise <6h
- Ticagrelor: transfusion inefficace si dernière prise <24h

# Gestion per-opératoire de l’hémostase


TF
VII
XII
XI
IX
VIII
X
II
Fibrin
Héparine Choay®
Héparine sodique
Solution injectable
Voie intraveineuse
5 ml en flacon
90003551/10
788336

# Adequate Anticoagulation During Cardiopulmonary Bypass Determined by Activated Clotting Time and the Appearance of Fibrin Monomer

John A. Young, M.D., C. Thomas Kisker, M.D., and Donald B. Doty, M.D.

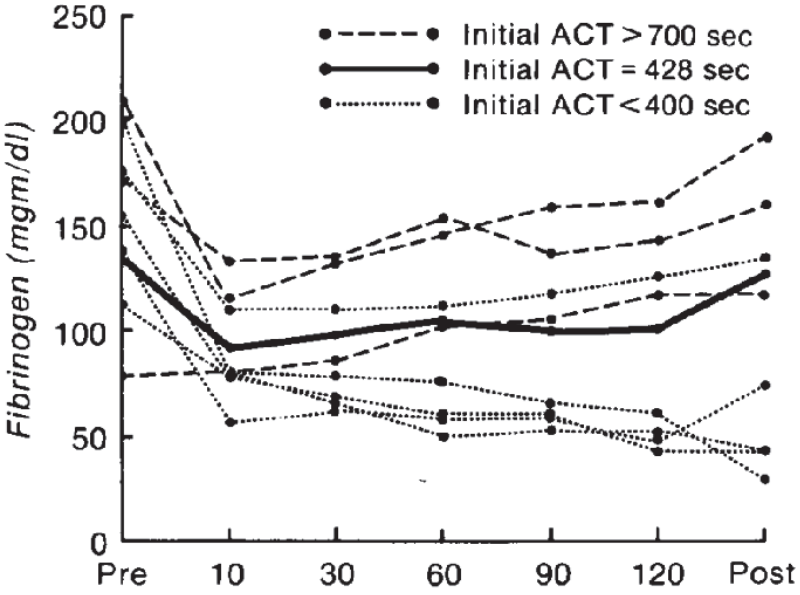



*Table 3. Coagulation Measurements in 5 Pediatric Patients*[a]

| Clotting Factors | Before CPB | After CPB |
|---|---|---|
| Fibrinogen (mg/100 ml) | 223 ± 39 | 152 ± 29 |
| Antithrombin-III (%) | 75 ± 10 | 49 ± 11 |
| Platelet count ($\times 10^3/mm^3$) | 379 ± 179 | 148 ± 58 |

[a]Whole-blood activated clotting time was 450 to more than 600 seconds after 40 to 73 minutes of CPB.

Young JA, Kisker CT, Doty DB. Adequate anticoagulation during cardiopulmonary bypass determined by activated clotting time and the appearance of fibrin monomer. ATS. 1978;26(3):231-240. doi:10.1016/s0003-4975(10)63676-4.

HNF per-CEC depuis 50 ans

HNF per-CEC depuis 50 ans


**MAIS…**

Niveau de preuve très faible

Pas de validation sur des critères robustes

Stratégies modernes CEC // Anesthésie-Réa // PBM

Variabilité importante entre les dispositif de mesure ACT

Timing / Programmation / Place en réanimation

Chirurgien

Perfusioniste

IADE

IBODE

**Anesthésiste-Réanimateur Cardiothoracique**

Hémodynamique

Respiratoire

Métabolique

PBM / hémostase

Anesthésie

Prise de décision clinique

# ACT pour la surveillance de l'HNF

Conditions pré-analytiques négligées

CV parfois élevés

Mauvaise sensibilité pour des héparinémies HNF <0,5 UI/mL

Variabilité inter-dispositifs majeure (parfois >20% !)

Effet variable des AC oraux : AVK/dabigatran vs AOD antiXa

Formation // CQ // regimentation EBMD

Niveau preuve (très) limité pour justifier les cibles adoptées

Qualité-Accréditation

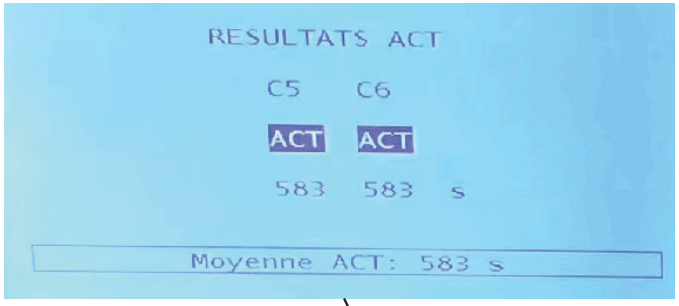
Annales de Biologie Clinique

Ann Biol Clin 2015 ; 73 (2) : 225-54

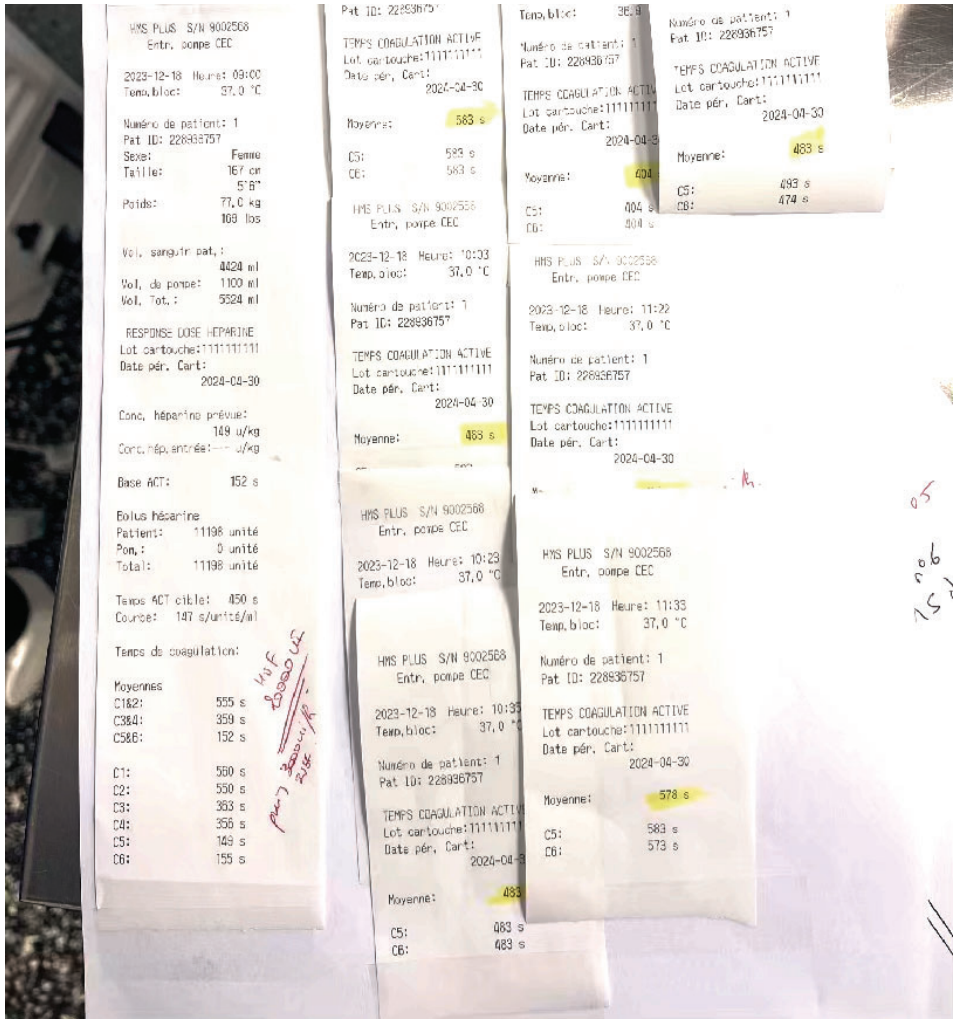
# Recommandations pour l'accréditation de l'*Activated clotting time* (ACT) pour la surveillance de l'anticoagulation par l'héparine non fractionnée selon la norme EN ISO 22870

## *Guidelines for certification of Activated clotting time (ACT) according to the EN ISO 22870 standards*

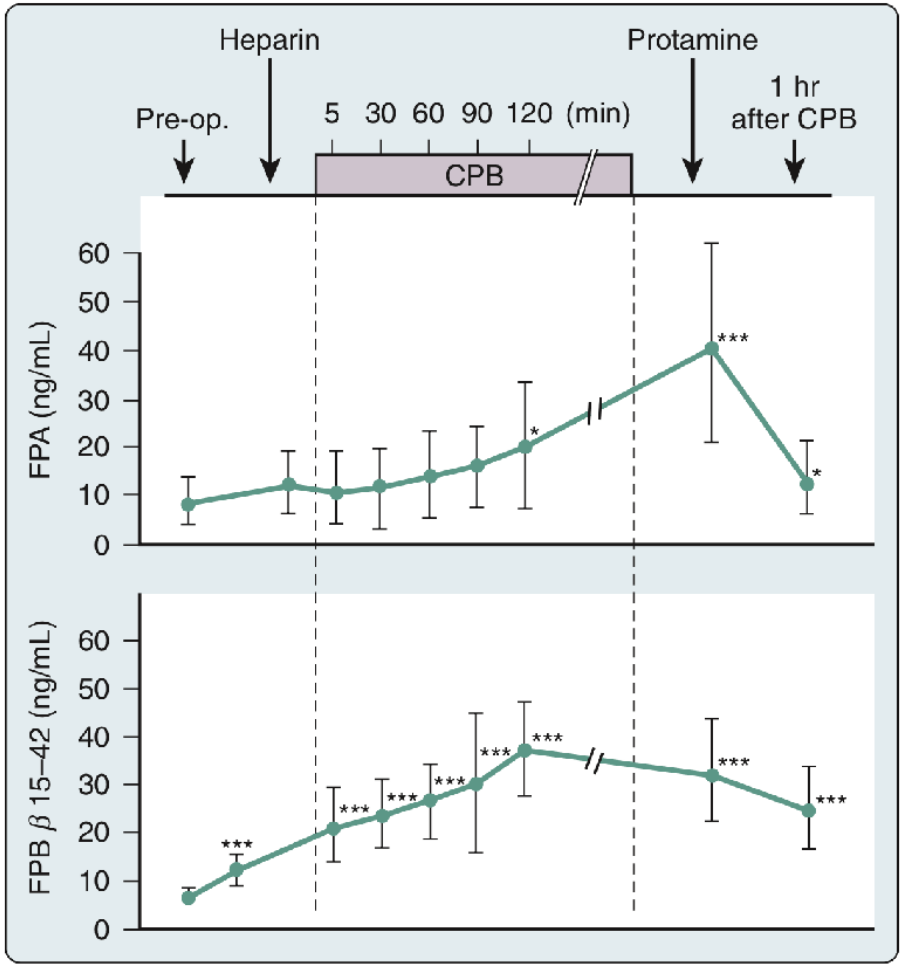
Dominique Lasne[1]
Anne Bauters[2]
Agnès Le Querrec[3]
Carole Bourdin[1]
Sophie Voisin[4]


RESULTATS ACT
C5 C6
ACT ACT
583 583 s
Moyenne ACT: 583 s

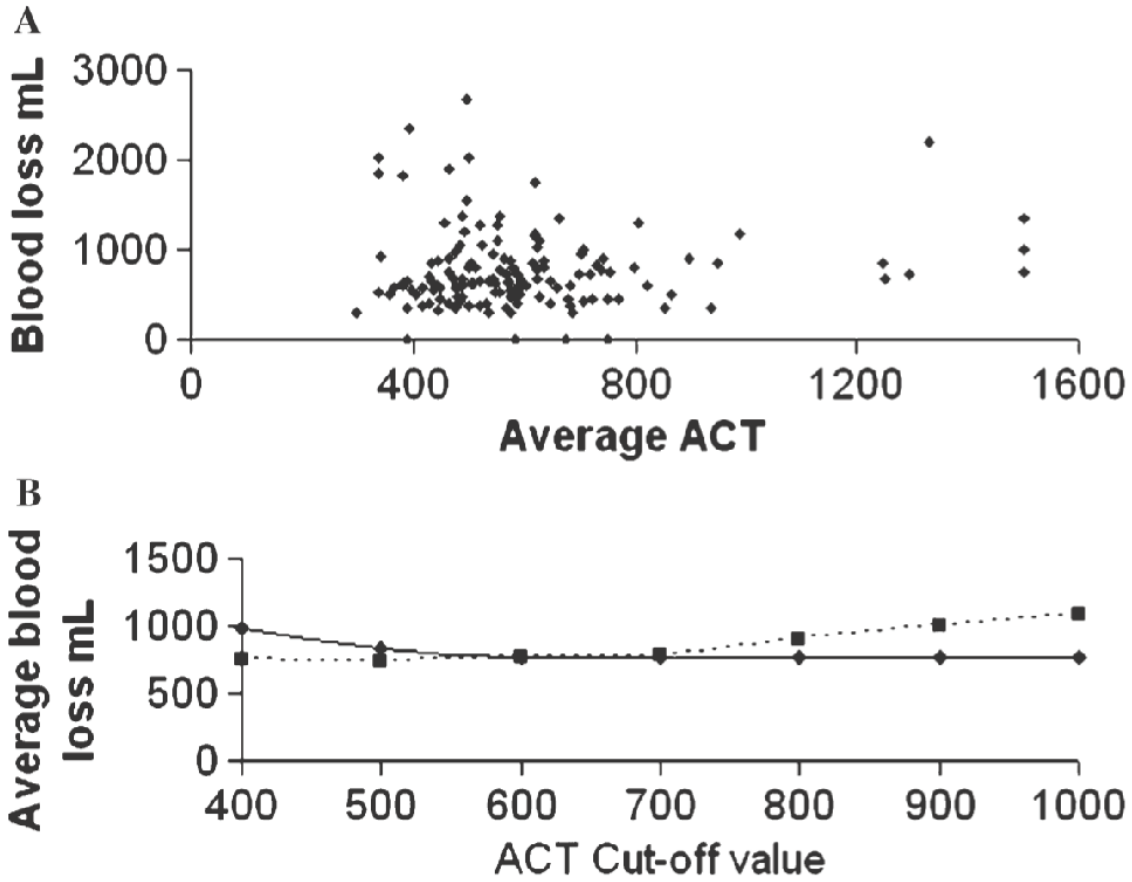

HR ACT
Marche Arrêt
RESULTATS ACT
C5 C6
ACT ACT
583 583 s
Moyenne ACT: 583 s
MENU PRINCIP.
SELECT PATIENT
HMS PLUS
Medtronic
Annuler
Entrée
Avancer Papier
Imprimer
Effac
Hemochron
HEMOCHRON Signature Elite
ITC
382
Test Completed
START
ID
QC
DATA BASE
PRINT/ SCAN
CANCEL
ENTER
NOTE


HMS PLUS S/N 9002568
Entr. pompe CEC
2023-12-18 Heure: 09:00
Temp.bloc: 37,0 °C
Numéro de patient: 1
Pat ID: 228936757
Sexe: Femme
Taille: 167 cm
5'6"
Poids: 77,0 kg
169 lbs
Vol. sanguin pat.: 4424 ml
Vol. de pompe: 1100 ml
Vol. Tot.: 5524 ml
RESPONSE DOSE HEPARINE
Lot cartouche:1111111111
Date pér. Cart: 2024-04-30
Conc. héparine prévue: 149 u/kg
Conc. hép. entrée: --- u/kg
Base ACT: 152 s
Bolus héparine
Patient: 11198 unité
Pom.: 0 unité
Total: 11198 unité
Temps ACT cible: 450 s
Course: 147 s/unité/ml
Temps de coagulation:
Moyennes
C1&2: 555 s
C3&4: 359 s
C5&6: 152 s
C1: 560 s
C2: 550 s
C3: 363 s
C4: 356 s
C5: 143 s
C6: 155 s
TEMPS COAGULATION ACTIVE
Lot cartouche:1111111111
Date pér. Cart: 2024-04-30
Moyenne: 583 s
C5: 583 s
C6: 583 s
Moyenne: 483 s
C5: 483 s
C6: 474 s
Moyenne: 578 s
C5: 583 s
C6: 573 s

# Une stratégie toujours non optimale




Tanaka et al. J Cardiothorac Anesth. 1989;3(2):181-188. doi:10.1016/s0888-6296(89)92642-2.




Palmer K, Ridgway T, Al-Rawi O, Poullis M. Heparin therapy during extracorporeal circulation: deriving an optimal activated clotting time during cardiopulmonary bypass for isolated coronary artery bypass grafting. J Extra Corpor Technol. 2012;44(3):145-150.

# 2024 EACTS/EACTAIC Guidelines on patient blood management in adult cardiac surgery in collaboration with EBCP

Plus de recommandation sur la cible d'ACT

« The efficacy of heparin anticoagulation is assessed using the ACT test, with target values between 300 and 600 s. These values vary depending on the measurement method and the heparin dosing strategy. »

Casselman et al. EJCTS 2024

**“Finding a common definition of heparin resistance in adult cardiac surgery: Communication from the ISTH SSC Subcommittee on Perioperative and Critical Care Thrombosis and Hemostasis”**

Comment

Alexandre Mansour, François Mullier, Thomas Lecompte
Emmanuel de Maistre, Isabelle Gouin-Thibault, Michael Hardy

Response

« They do not suggest any reasonable alternative. This highlights a common theme: **while everyone laments the existence of the ACT**, there has yet to be any widespread adoption of any other test.

**Every major society** involved with the care of cardiac surgical patients **has incorporated the ACT** along **with suggested targets**, into guideline documents »

# Prescription de l'HNF en per-CEC

## En pratique

- Protocole défini dans chaque centre // cible variable
  - 300-400UI/kg puis bolus et/ou IVSE
  - Titration / courbe de réponse Hepcon HMS Plus
  - Modèles PK
- Examen de biologie médicale délocalisée : maintenance, validation,...
- Monitorage basé sur anti-Xa : faisable, 3-4 UI/mL mais non validé...

Casselman et al. EJCTS 2024 // Eid et al EJCTS 2024 // Cartwright BJA Educ 2023

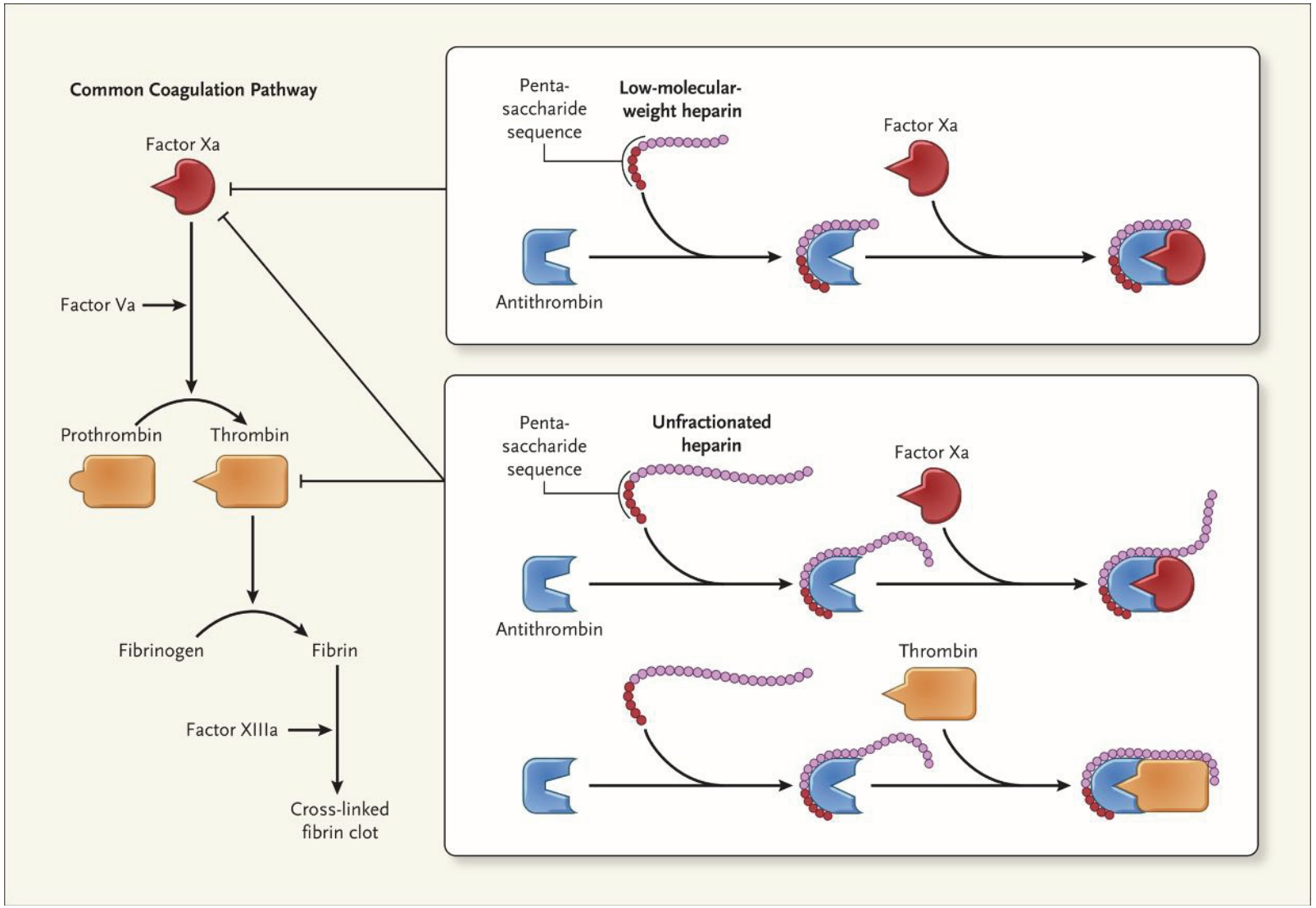
Réponse altérée à l’héparine ?

# Réponse altérée à l'héparine ?

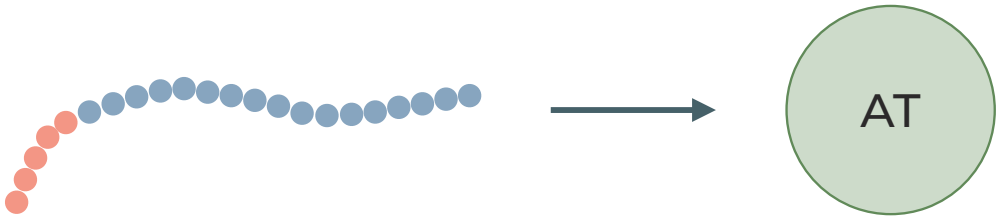
- « Résistance à l'héparine » >>> Réponse altérée à l'héparine

- ISTH SSC 2024 : ACT <480s malgré >500UI/kg HNF
  - Définition non validée
  - Variabilité HNF // ACT // conduite CEC

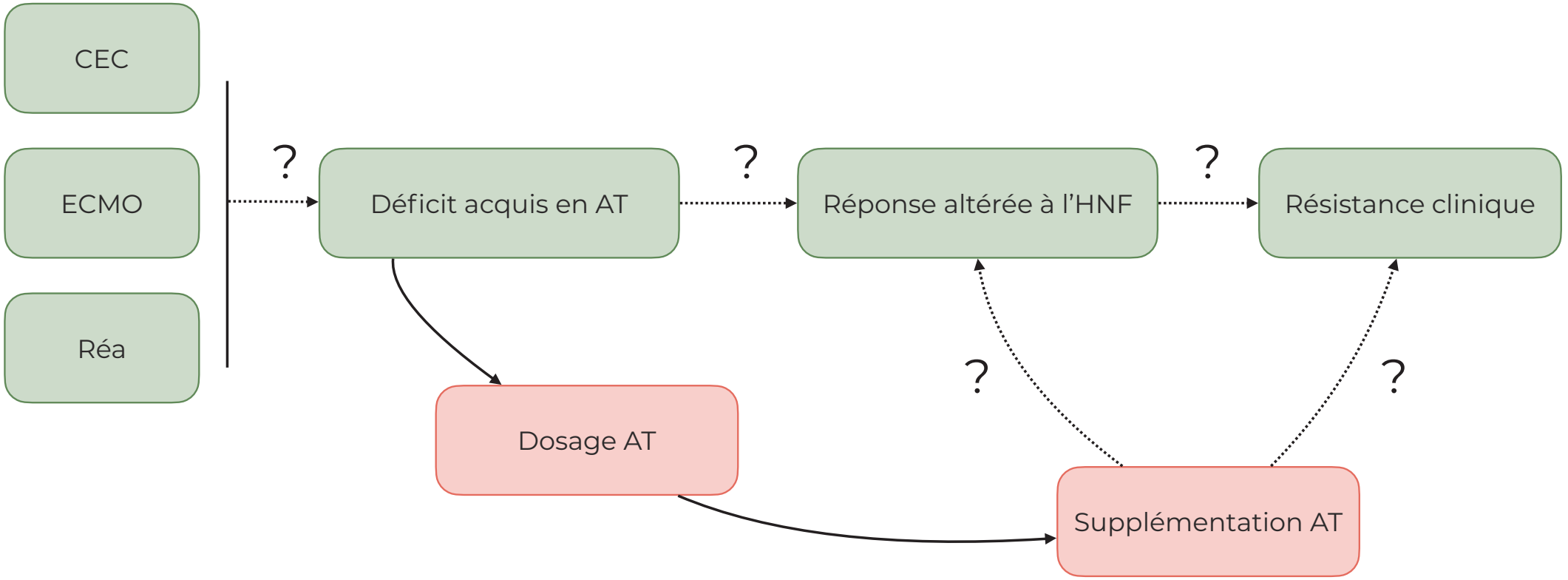
Casselman et al. EJCTS 2024 // Gouin-Thibault et al. TH Open 2024 // Mansour et al. JTH 2024 // // Cartwright BJA Educ 2023

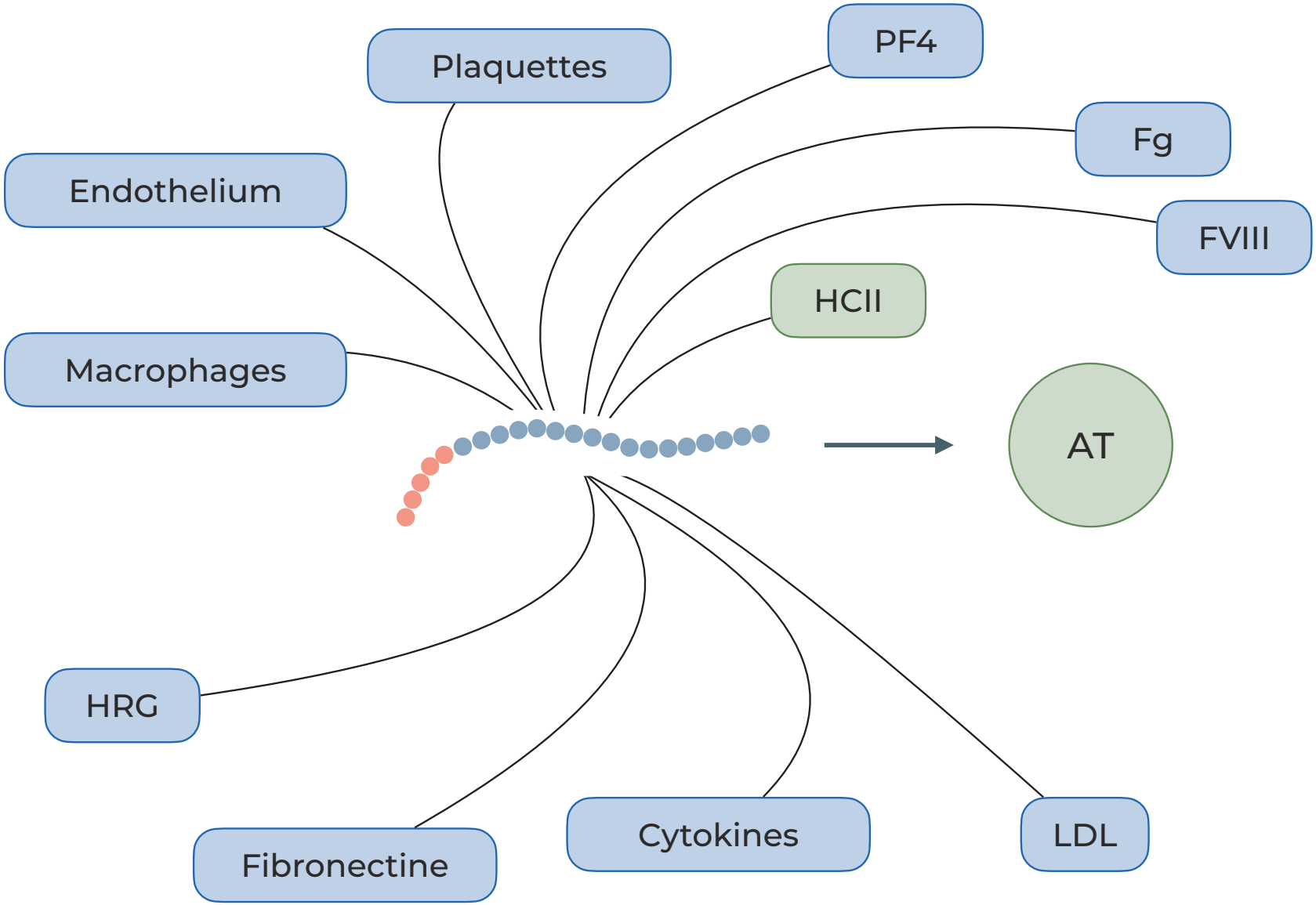


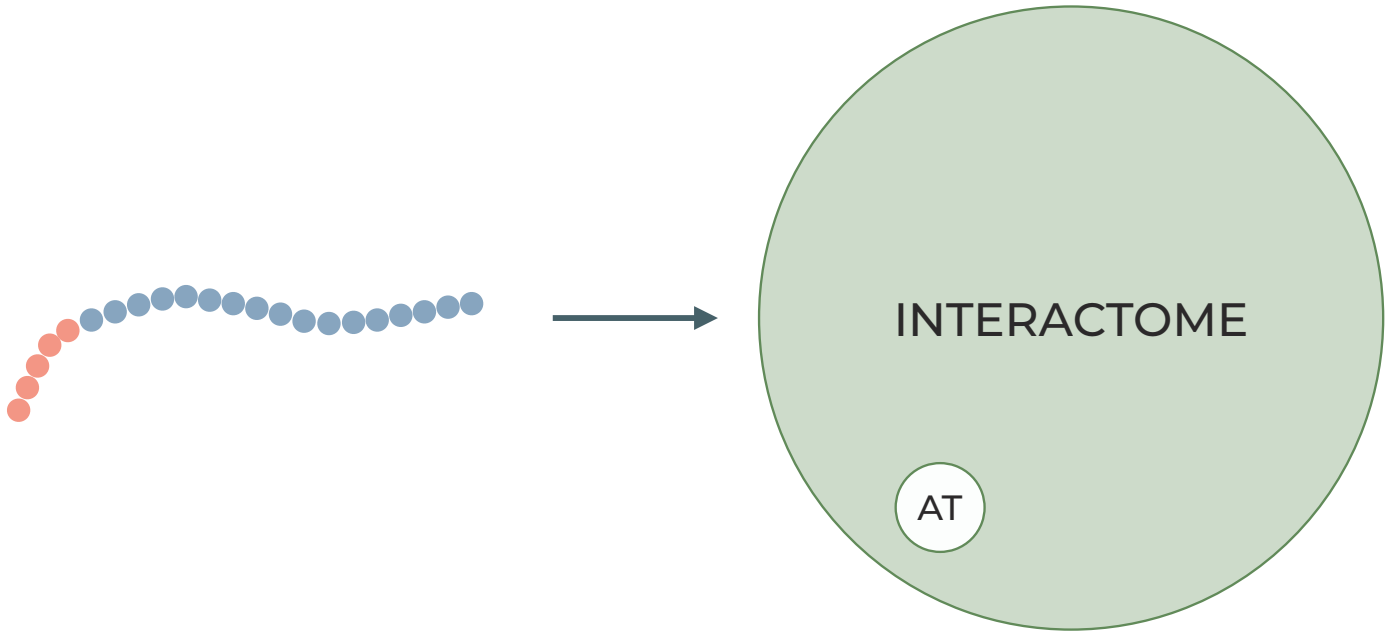

*Levy et al. NEJM 2021*


AT


Déficit **Héréditaire** en AT
Réponse altérée à l'HNF
Supplémentation


CEC
ECMO
Réa
?
Déficit acquis en AT
?
Réponse altérée à l'HNF
?
Résistance clinique
?
?
Dosage AT
Supplémentation AT


Plaquettes
PF4
Endothelium
Fg
FVIII
HCII
Macrophages
AT
HRG
Fibronectine
Cytokines
LDL


INTERACTOME
AT

# Déficit acquis en antithrombine

**Consommation**
**Diminution ½ vie**
**Dilution**

CIVD
Thrombose extensive, SAPL
CEC, ECMO

**Défaut de synthèse**

Ins. Hépato Cellulaire

**Excès d'élimination**

Syndrome néphrotique

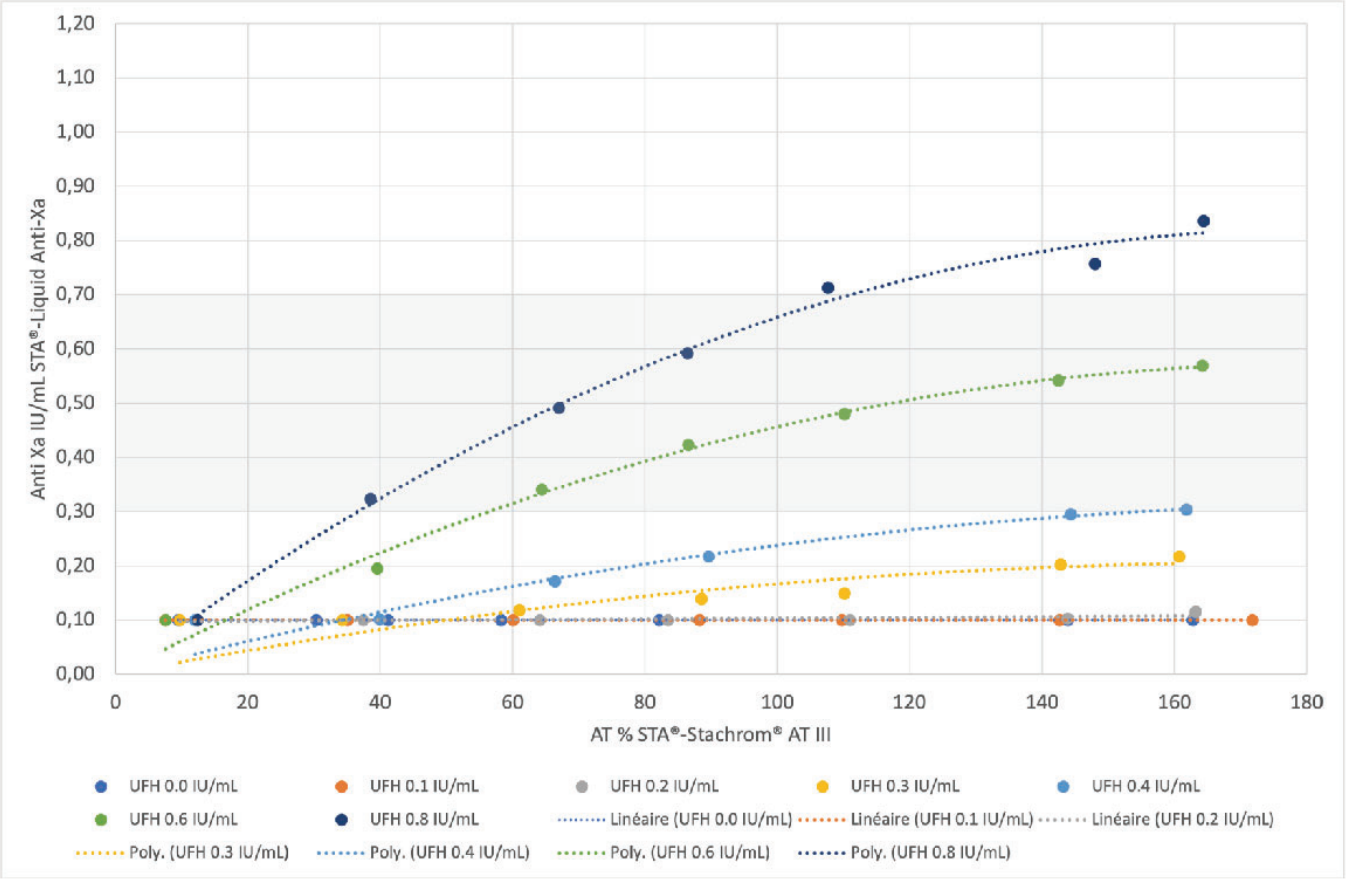
Déficit combiné acquis ≠ isolé constitutionnel (< 80%)

Retentissement du déficit en AT sur la réponse à l'HNF : dépend des tests, de la cause

Balance hémostatique très différente // variabilité ++ de présentation

# Antithrombin level and UFH anticoagulant activity

- In vitro study
- AT deficient plasma spiked with increased concentrations:
  - AT
  - UFH
- Anti-Xa (STA-liquid anti-Xa®)




**Relationship between entre AT and anti-Xa levels, without AT threshold**

**Detectable UFH activity and anti-Xa within the therapeutic range at low AT concentration**

Gueret P
Gouin-Thibault I
Lecompte T

# Réponse altérée à l'héparine ?

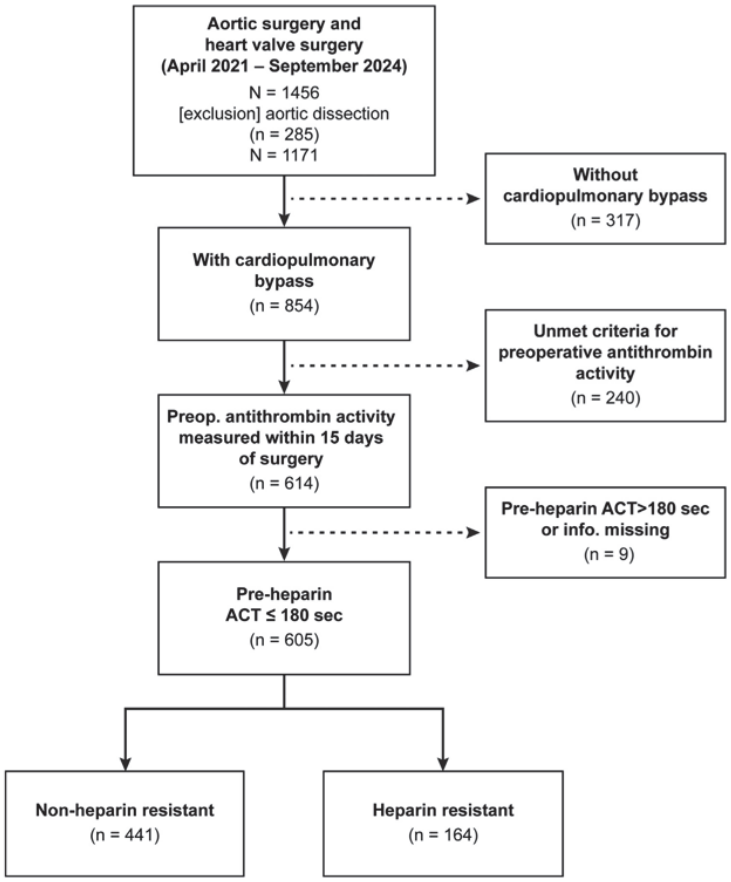
- « Résistance à l'héparine » >>> Réponse altérée à l'héparine

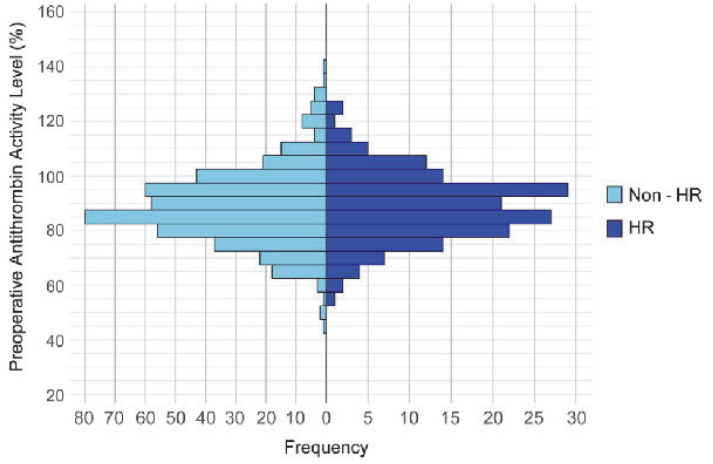
- ISTH SSC 2024 : ACT <480s malgré >500UI/kg HNF
  - Définition non validée
  - Variabilité HNF // ACT // conduite CEC

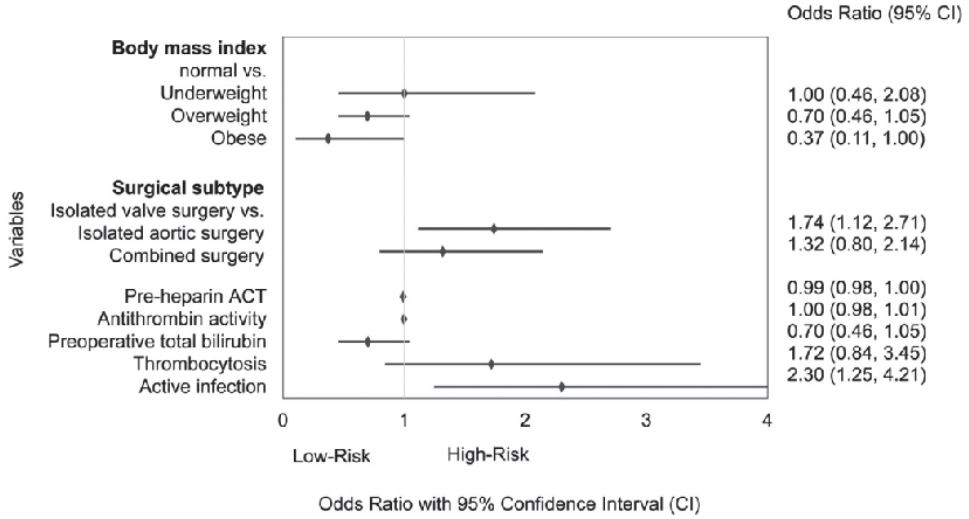
- Que faire en pratique : majorer HNF ? mesurer // supplémenter AT ?

Casselman et al. EJCTS 2024 // Gouin-Thibault et al. TH Open 2024 // Mansour et al. JTH 2024 // // Cartwright BJA Educ 2023

# Association réponse altérée - déficit AT ?




Kim et al. JCVA 2025

# *A Phase III, Double-blind, Placebo-controlled, Multicenter Study on the Efficacy of Recombinant Human Antithrombin in Heparin-resistant Patients Scheduled to Undergo Cardiac Surgery Necessitating Cardiopulmonary Bypass*

*Michael S. Avidan, M.B.B.Ch.,* Jerrold H. Levy, M.D.,† Jens Scholz, M.D.,‡ Elise Delphin, M.D.,§ Peter M. J. Rosseel, M.D.,‖ Michael B. Howie, M.D.,# Irwin Gratz, D.O.,** Charles R. Bush, M.D.,†† Nikolaos Skubas, M.D.,‡‡ Gabriel S. Aldea, M.D.,§§ Michael Licina, M.D.,‖‖ Laura J. Bonfiglio, B.S.N., C.R.N.A.,## Daniel K. Kajdasz, Ph.D.,*** Elizabeth Ott, M.D.,††† George J. Despotis, M.D.‡‡‡*

- Etude multicentrique (US et UE)
- 54 patients « résistants » (sur 296 inclus)
- Résistance : ACT < 480 sec après 400 U/kg d'HNF (dose initiale)
- Critère de jugement : proportion de patients nécessitant l'administration de 2 PFC per-CEC
- Randomisation :
  - Bolus de 75 U/kg AT (n=27)
  - Bolus de sérum physiologique (n=27)

**Résultats**

Aministration PFC : plus élevée placebo / AT

Dose d'héparine : plus élevée placebo / AT

6890 U/h (placebo) vs 3884 u/h (AT)

Clinique : pas de différence

Avidan et al. Anesthesiology 2005

# RCT AT (+20%) vs placebo
# N=425

| Parameter | AT (n=198) | Placebo (n=194) |
|---|---|---|
| **ACT ≥480 sec after one heparin dose (400 IU/kg)** | | |
| Yes | 178 (89.9%) | 152 (78.4%) |
| No | 20 (10.1%) | 42 (21.6%) |
| **ACT ≥480 sec after a maximum of three heparin doses** | | |
| Yes | 14 (7.1%) | 25 (12.9%) |
| No | 6 (3%) | 17 (8.8%) |
| **Additional measures performed** | | |
| Yes | 3 (1.5%) | 12 (6.2%) |
| No | 3 (1.5%) | 5 (2.6%) |
| **Lowest ACT during surgery, sec** | | |
| Mean (SD) | 548.1 (158.3) | 480.9 (112.7) |
| Median (min, max) | 492.5 (136, 1005) | 462.0 (93, 1000) |
| **Protamine (15 mg/h during the first 5 h post-operation)** | | |
| Yes | 178 (89.9%) | 173 (89.2%) |

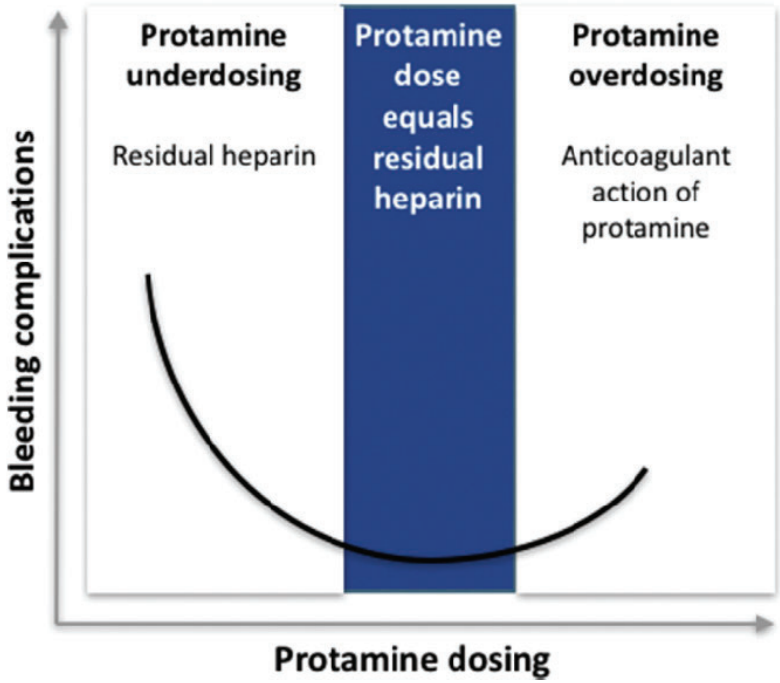
Moront et al. Anesth Analgesia 2022

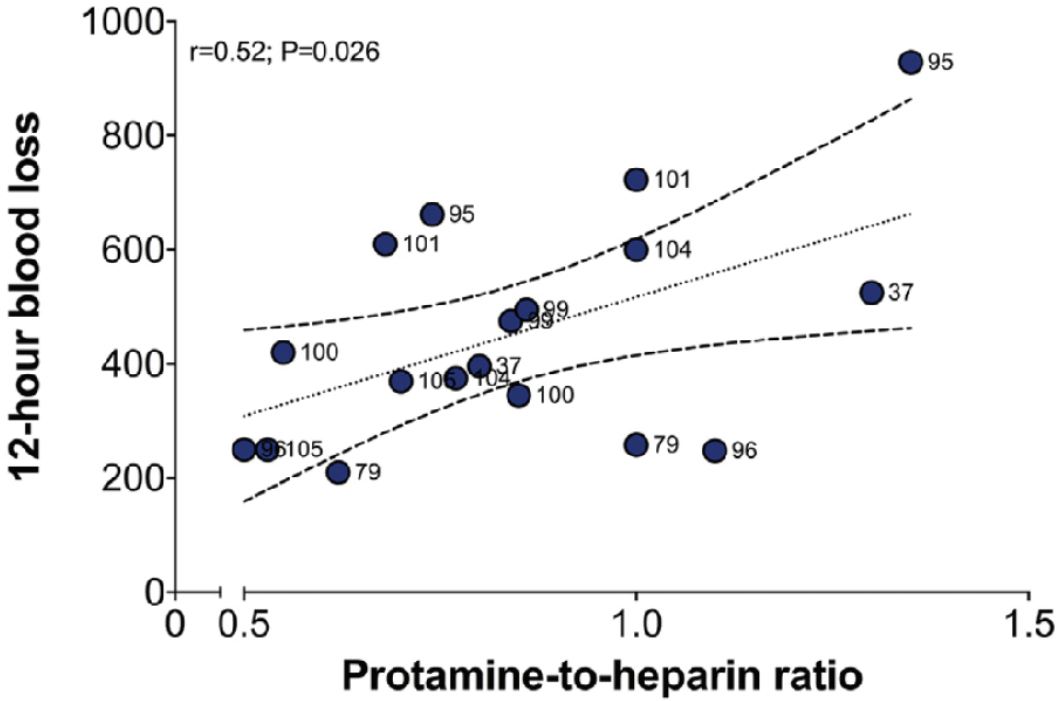
RCT AT (+20%) vs placebo
N=425

| Parameter | AT (n=198) | Placebo (n=194) | P-Value |
|---|---|---|---|
| **Component of the major morbidity composite, n (%)** | | | |
| Postoperative mortality | 7 (3.5) | 3 (1.5) | .338 |
| Stroke | 5 (2.5) | 8 (4.1) | .372 |
| AKI | 23 (11.6) | 5 (2.6) | <.001 |
| Surgical reexploration | 7 (3.5) | 12 (6.2) | .217 |
| Arterial or venous thromboembolic events | 10 (5.1) | 4 (2.1) | .172 |
| Prolonged mechanical ventilation | 45 (22.7) | 43 (22.2) | .894 |
| Infection | 8 (4) | 6 (3.1) | .620 |
| **Postoperative chest tube output, mL, mean (SD)** | | | |
| 12 h | 548.2 (360.1) | 586.8 (503.2) | .383 |
| 24 h | 847.5 (506.7) | 850.7 (605.9) | .955 |
| **Transfusion requirements, n (%)** | | | |
| Apheresis platelets | 61 (30.8) | 55 (28.4) | .310 |
| Cell saver | 164 (82.8) | 164 (84.5) | .447 |
| Cryoprecipitate | 22 (11.1) | 21 (10.8) | .989 |
| Fresh frozen plasma | 35 (17.7) | 33 (17.0) | .856 |
| Red blood cells | 90 (45.5) | 81 (41.8) | .585 |
| **Hospitalization, days, mean (SD)** | | | |
| Duration of ICU stay | 5.0 (3.7) | 5.1 (4.98) | .424 |
| Duration of hospital stay | 10.1 (6.41) | 10.2 (6.07) | .747 |

Moront et al. Anesth Analgesia 2022

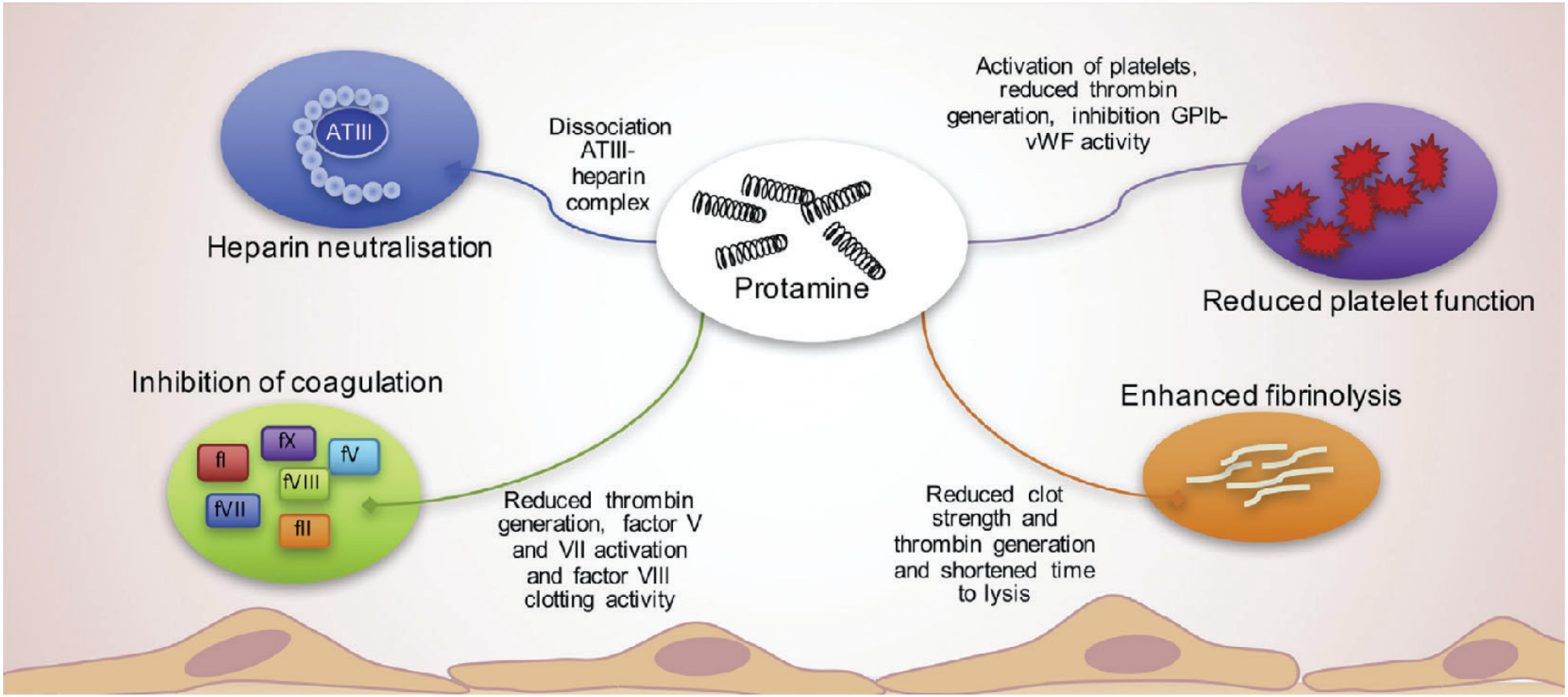
# Antagonisation de l’HNF par la protamine




Boer et al. BJA 2018 // Cartwright BJA Educ 2023

# Protamine



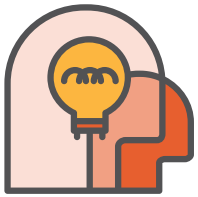

Boer et al. BJA 2018

# Anticoagulation non-héparinique

- Situation rare // séries de cas
- TIH, allergie héparine ou protamine, ACC
- Bivalirudine ou argatroban
- Pas de reversion // risque hémorragique ++ // surveillance ?

| Agent | Pump prime (mg) | Bolus (mg $kg^{-1}$) | Infusion | Clearance | Adjustments |
|---|---|---|---|---|---|
| Bivalirudin | 50 | 1 | 2.5 mg $kg^{-1}$ $h^{-1}$ | Proteolysis (80%); renal (20%) | (i) Reduced infusion with renal dysfunction<br>(ii) Further bolus 0.1–0.2 mg $kg^{-1}$ to achieve an ACT >300 |
| Argatroban | 4 | 0.1–0.3 | 5–25 mcg $kg^{-1}$ $min^{-1}$ | Hepatobiliary | (i) Consider 0.1 mg $kg^{-1}$ bolus titration to effect<br>(ii) Reduce infusion with liver disease<br>(iii) Can increase infusion to 40 mcg $kg^{-1}$ $min^{-1}$ |

Cartwright BJA Educ 2023



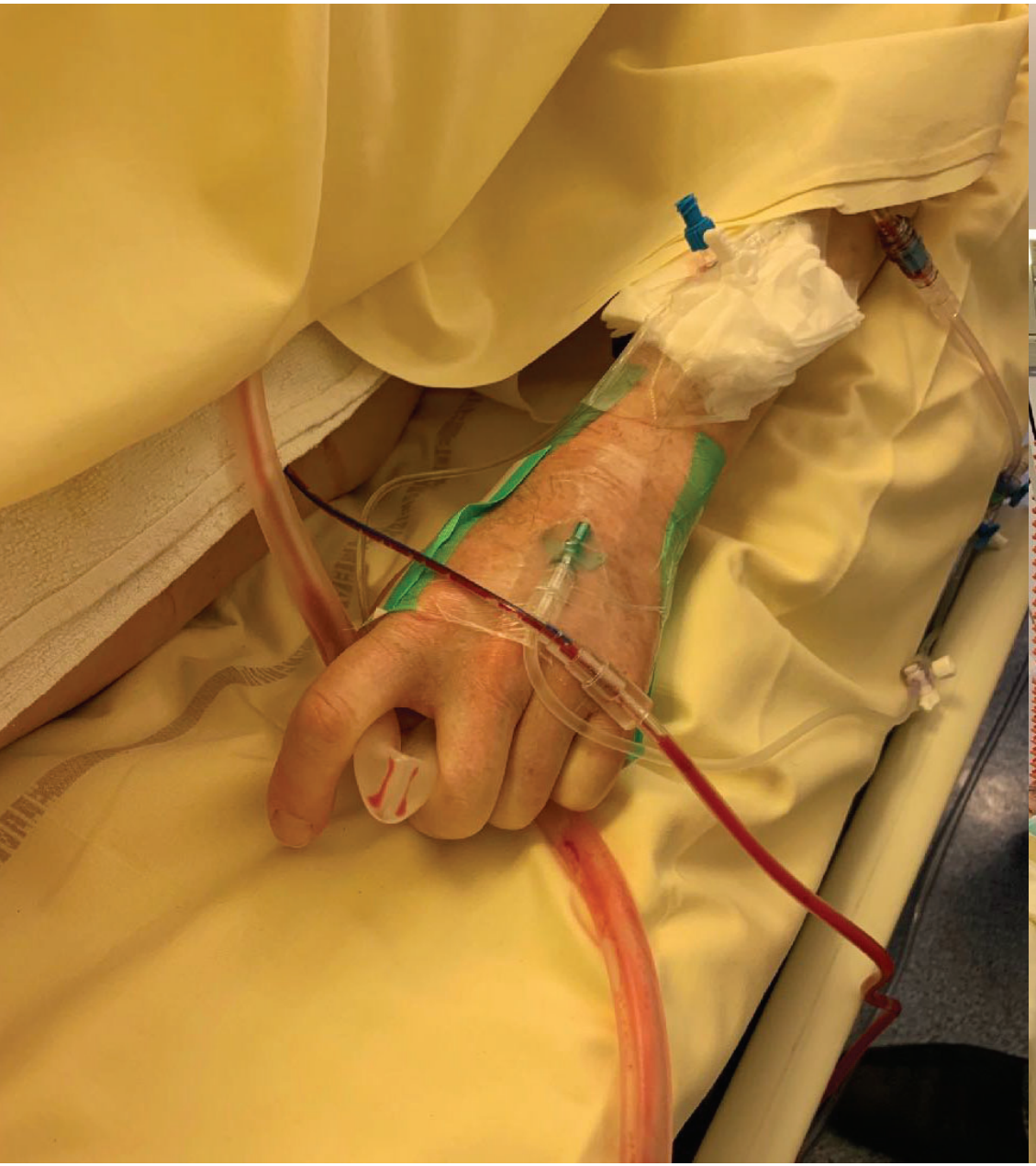
## Anticoagulation per-CEC

Héparine non fractionnée // surveillance ACT

Niveau preuve faible // cibles non validées // limites des test

Réponse altérée à l'héparine : définition ? majorer HNF ? AT ?

Peut-on prévenir le saignement post-CEC ?



# Traitement antifibrinolytique - TXA

Chirurgie cardiaque // CEC
Activation fibrinolyse ++
Secrétion tPA par endothelium
Activation phase contact

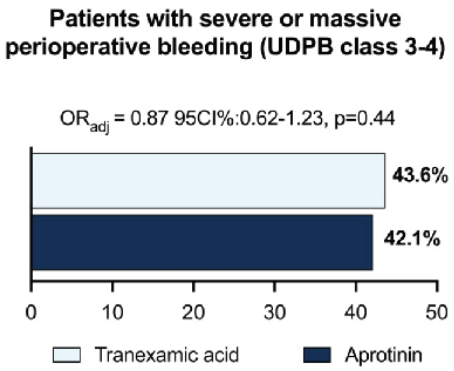
ATACAS
Plan factoriel 2x2 (aspirine et TXA)
TXA : 100 puis 50mg/kg

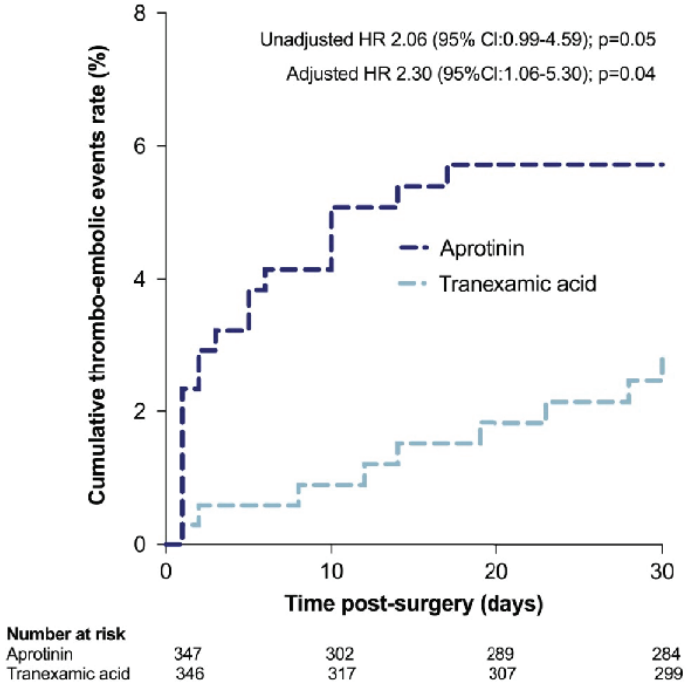
| Outcome or Event | Tranexamic Acid Group (N=2311) | Placebo Group (N=2320) | Risk Ratio (95% CI) | P Value |
|---|---|---|---|---|
| **Primary outcome: death, myocardial infarction, stroke, renal failure, pulmonary embolism, or bowel infarction** | 386/2310 (16.7%) | 420/2320 (18.1%) | 0.92 (0.81–1.05) | 0.22 |
| Myocardial infarction | 269/2310 (11.6%) | 300/2320 (12.9%) | 0.90 (0.77–1.05) | 0.19 |
| Stroke | 32/2309 (1.4%) | 35/2320 (1.5%) | 0.92 (0.57–1.48) | 0.81 |
| Renal failure | 98/2309 (4.2%) | 96/2320 (4.1%) | 1.03 (0.78–1.35) | 0.88 |
| Pulmonary embolism | 15/2309 (0.6%) | 15/2320 (0.6%) | 1.00 (0.49–2.05) | >0.99 |
| Bowel infarction | 8/2309 (0.3%) | 3/2320 (0.1%) | 2.68 (0.71–10.09) | 0.15 |
| **Reoperation** | | | | |
| Due to any cause | 32/2310 (1.4%) | 65/2320 (2.8%) | 0.49 (0.32–0.75) | 0.001 |
| Due to major hemorrhage | 18/2310 (0.8%) | 50/2320 (2.2%) | 0.36 (0.21–0.62) | <0.001 |
| Due to cardiac tamponade | 14/2310 (0.6%) | 23/2320 (1.0%) | 0.61 (0.32–1.19) | 0.19 |
| **Transfusion of red cells during hospitalization** | 759/2311 (32.8%) | 1086/2320 (46.8%) | | <0.001 |

Myles et al. NEJM 2017

# Aprotinine ?

Etude Observationnelle
N= 693
Chirurgie cardiaque à haut risque
Aprotinine vs Ac Tranexamique
UDPB score




Gallo et al. EJTCS 2024

# Conduite de la CEC et prévention de l’hémodilution

| Recommendations | Class | Level |
|---|---|---|
| Implementation of multiple institutional measures to reduce hemodilution during CPB is recommended to reduce anemia, transfusion, and postoperative bleeding. | I | B |
| Combining the priming volume with colloids to reduce transfusions is not recommended. | III | A |
| Optimizing CPB systems using coated and reduced surface areas and avoiding direct blood reinfusion are recommended to increase hemocompatibility and reduce bleeding complications. | I | B |
| MiECC should be considered over conventional CPB systems to reduce the risk of transfusions and bleeding. | IIa | B |
| The use of cell salvage should be considered in order to prevent transfusions. | IIa | B |
| Modified ultrafiltration should be considered as part of a blood conservation strategy. | IIa | A |
| Autologous priming, either retrograde or antegrade, is recommended as part of a blood conservation strategy. | I | A |
| Maintenance of normothermia during the entire surgical process should be considered to reduce coagulopathy and blood loss. | IIa | B |
| Maintenance of normal pH during the entire surgical process should be considered to reduce coagulopathy and blood loss. | IIa | B |
| In cases requiring hypothermia, mild hypothermia (above 28°C) is recommended over lower targeted temperatures to minimize postoperative blood loss. | I | B |

Casselman et al. EJCTS 2024

# Conduite de la CEC et prévention de l'hémodilution

Observationnelle (Angers)

Gestion optimale de la CEC
Pas d'aspiration
Circuit clos hépariné
ACT 250s

| Variable | Overall (n=2275) | ASA (n=1164) | DAPT (n=1111) | p-value |
|---|---|---|---|---|
| E-CABG score ≥2, n (%) | 94 (4.11) | 34 (2.92) | 59 (5.31) | 0.0065 |
| UDPB score ≥3, n (%) | 61 (2.68) | 21 (1.8) | 40 (3.57) | 0.0162 |
| BARC 4, n (%) | 96 (4.2) | 40 (3.44) | 57 (5.09) | 0.0626 |
| Reoperation for bleeding, n (%) | 75 (3.33) | 29 (2.49) | 46 (4.18) | 0.03 |
| Pleural effusion, n (%) | 84 (3.70) | 32 (2.75) | 51 (4.62) | 0.033 |
| Units of RBC transfused, mean (SD) | 0.402 (1.3) | 0.248 (1.1) | 0.56 (1.5) | <0.0001 |
| Units of FFP transfused, mean (SD) | 0.071 (0.5) | 0.045 (0.5) | 0.098 (0.5) | 0.021 |
| Units of PLT transfused, mean (SD) | 0.016 (0.18) | 0.009 (0.18) | 0.023 (0.17) | 0.08 |
| Overall transfusion, n (%) | 349 (15.3) | 109 (9.5) | 239 (21.5) | <0.0001 |
| Chest tube blood loss at 12H (mL), mean (SD) | 224 (161.9) | 192 (136.4) | 258 (178.8) | <0.0001 |
| Chest tube blood loss at 24H (mL), mean (SD) | 322 (211.3) | 284 (187.8) | 361 (226.9) | <0.0001 |
| Overall chest tube blood loss (mL), mean (SD) | 386 (296) | 338 (274.8) | 435 (309) | <0.0001 |

Eid et al. EJCTS 2024

# Pas de place pour PSL/MDS/pro-hémostatiques en prophylaxie du saignement

| Recommendations | Class | Level |
|---|---|---|
| Antifibrinolytic therapy is recommended to reduce bleeding and transfusions of blood products and reoperations for bleeding. | I | A |
| The prophylactic use of FFP to reduce bleeding is not recommended. | III | B |
| Prophylactic fibrinogen administration is not recommended. | III | A |
| The prophylactic use of DDAVP is not recommended to reduce bleeding complications. | III | A |
| The prophylactic use of rFVIIa is not recommended to prevent bleeding complications. | III | B |

Casselman et al. EJCTS 2024

# Gestion post-opératoire de l’hémostase

# Prévention de la MVTE postopératoire

- Risque de MVTE élevé > thromboprophylaxie
- Contentions élastiques graduées non recommandées
- Compressions pneumatiques intermittentes si risque élevé et CI anticoagulation

- Anticoagulation à dose préventive H+12 à H+24
  - Enoxaparine : 4 000 UI/j SC (2 000 UI/j si DFG 15 à 30 mL/min)
  - Tinzaparine : 4 500 UI/j SC, si DFG > 20 mL/min
  - Si DFG < 15 mL/min : HNF IVSE à dose préventive

# Anticoagulation après chirurgie valvulaire mécanique

- Risque thrombotique élevé > anticoagulation curative précoce et continue
- AOD contre-indiqués
- HBPM préférées aux HNF : simplicité // moindre variabilité // efficacité // moins de TIH

- A titre indicatif:
  - HBPM dose préventive H+12 heures
  - pas d'AAP, sauf PAC associées, stent coronaire < 6 mois, SCA < 12 mois, stent vasculaire périphérique < 1 mois ou procédure neuro-interventionnelle < 3 mois
  - HBPM à dose thérapeutique au 2e jour postopératoire : enoxaparine 100 UI/kg SC, deux fois par jour si DFG ≥ 30 mL/min

A. Mansour, A. Godier, Chapitre 5, Anesthésie-Réanimation en Chirurgie cardiaque Arnette 2025

# Gestion des AAP en postopératoire

- Aspirine faible dose (75-100 mg/j) <48h post-PAC : réduction morbidité CV
- Par extension indiquée en chirurgie non-coronarienne si pas d'anticoagualtion curative

- Bithérapie antiplaquettaire (ticagrelor)
    - Diminue le risque de thrombose de pontage à 1 an
    - Augmente le risque hémorragique

TIH ?

# Diagnostic et prise en charge d'une thrombopénie induite par l'héparine

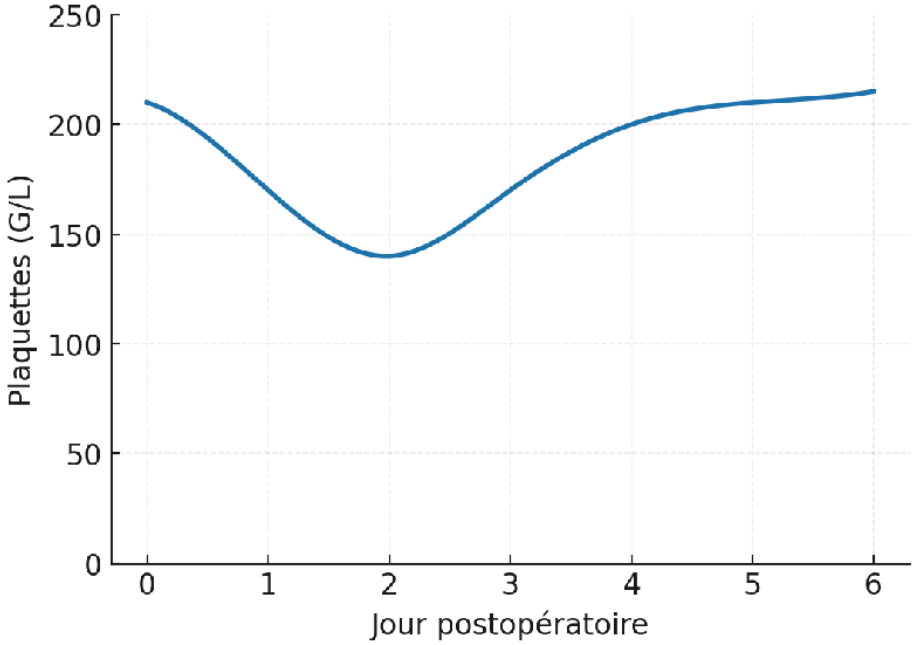
# 2019

Propositions du Groupe d'Intérêt en Hémostase Périopératoire (GIHP) et du Groupe Français d'études sur l'Hémostase et la Thrombose (GFHT)

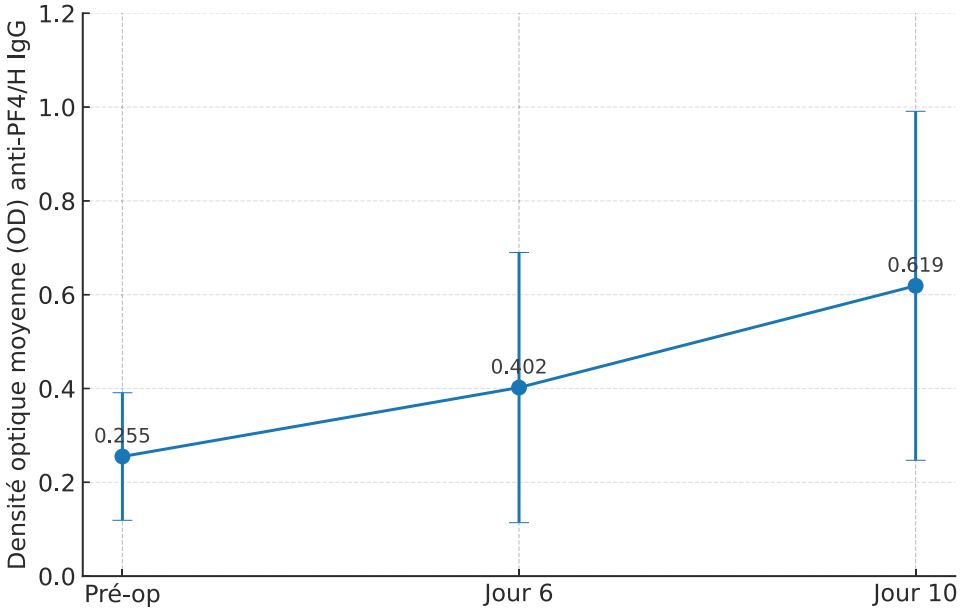
www.gihp.org

# En chirurgie cardiaque ?

## Plaquettes : évolution normale

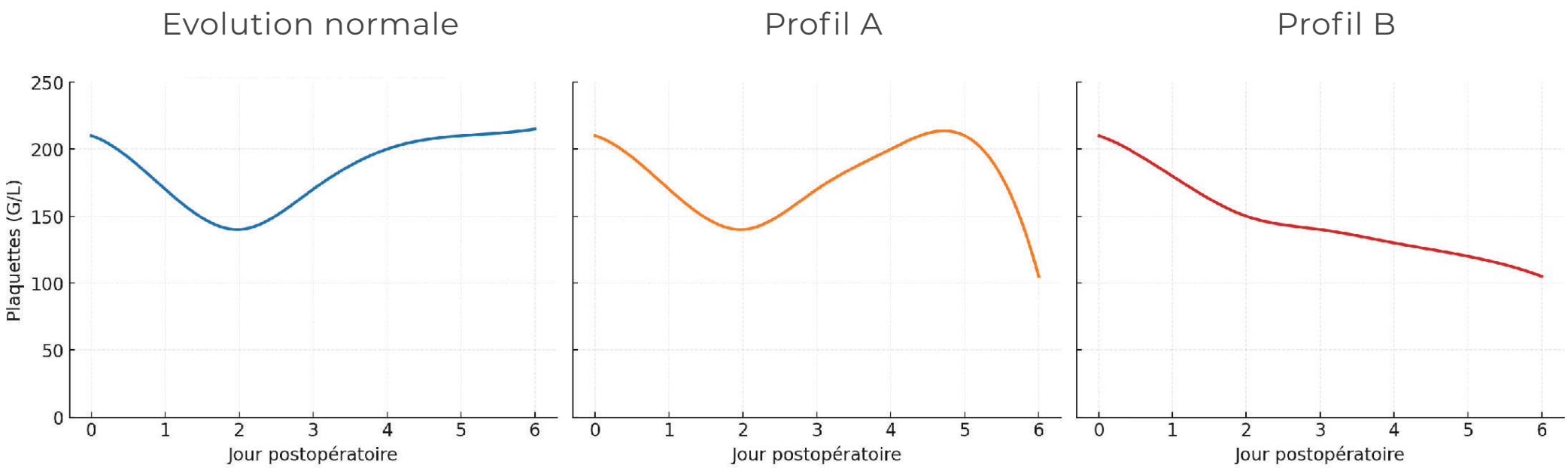



## Ac anti-PF4/HNF : évolution normale




Selleng et al. American Heart Journal 2010

# En chirurgie cardiaque: profils de TIH



# En chirurgie cardiaque:  pas de score 4T

| Items | | Points |
|---|---|---|
| Numération plaquettaire | Profil A | 2 |
| | Profil B | 1 |
| Délai entre la CEC et la date index | ≥5 jours | 2 |
| | <5 jours | 0 |
| Durée de la CEC | ≤118 min | 1 |
| | >118 min | 0 |

Score total :
≥2 points = forte probabilité de TIH
<2 points = faible probabilité de TIH

Lillo-Le Louët et al. J Thromb Haemost 2004

# ATCD TIH et CEC

Avant toute chirurgie cardiaque chez un patient ayant un antécédent documenté de TIH, il est proposé de rechercher systématiquement en ELISA des anticorps anti-FP4. (Accord fort)

Avant toute chirurgie cardiaque avec CEC chez un patient ayant une TIH aiguë ou subaiguë (<3 mois), il est proposé de définir le protocole d'anticoagulation péri- opératoire dans le cadre d'une concertation pluridisciplinaire. (Accord fort)

Chez un patient ayant une TIH aiguë ou subaiguë avec un titre significatif d'anticorps anti-FP4 (ELISA avec DO>1) et nécessitant une chirurgie cardiaque avec CEC, les stratégies possibles pour l'anticoagulation per-opératoire sont d'associer un agent antiplaquettaire IV (tirofiban ou cangrelor) et l'HNF, ou d'administrer une antithrombine directe IV (bivalirudine ou argatroban) avec une surveillance biologique étroite.

En urgence, Il est proposé de privilégier l'association d'un antiplaquettaire IV et d'héparine non fractionnée (Accord fort)

# Gestion du saignement post-CEC

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