

Basic Science Summer School

European Heart House, Sophia Antipolis, France

18 June 2017 – 22 June 2017

Session III

Thrombosis and coagulation

June 19 2017

13:30-15:00

Novel oral anticoagulants: mechanisms of
action and therapeutic indications

Raffaele De Caterina



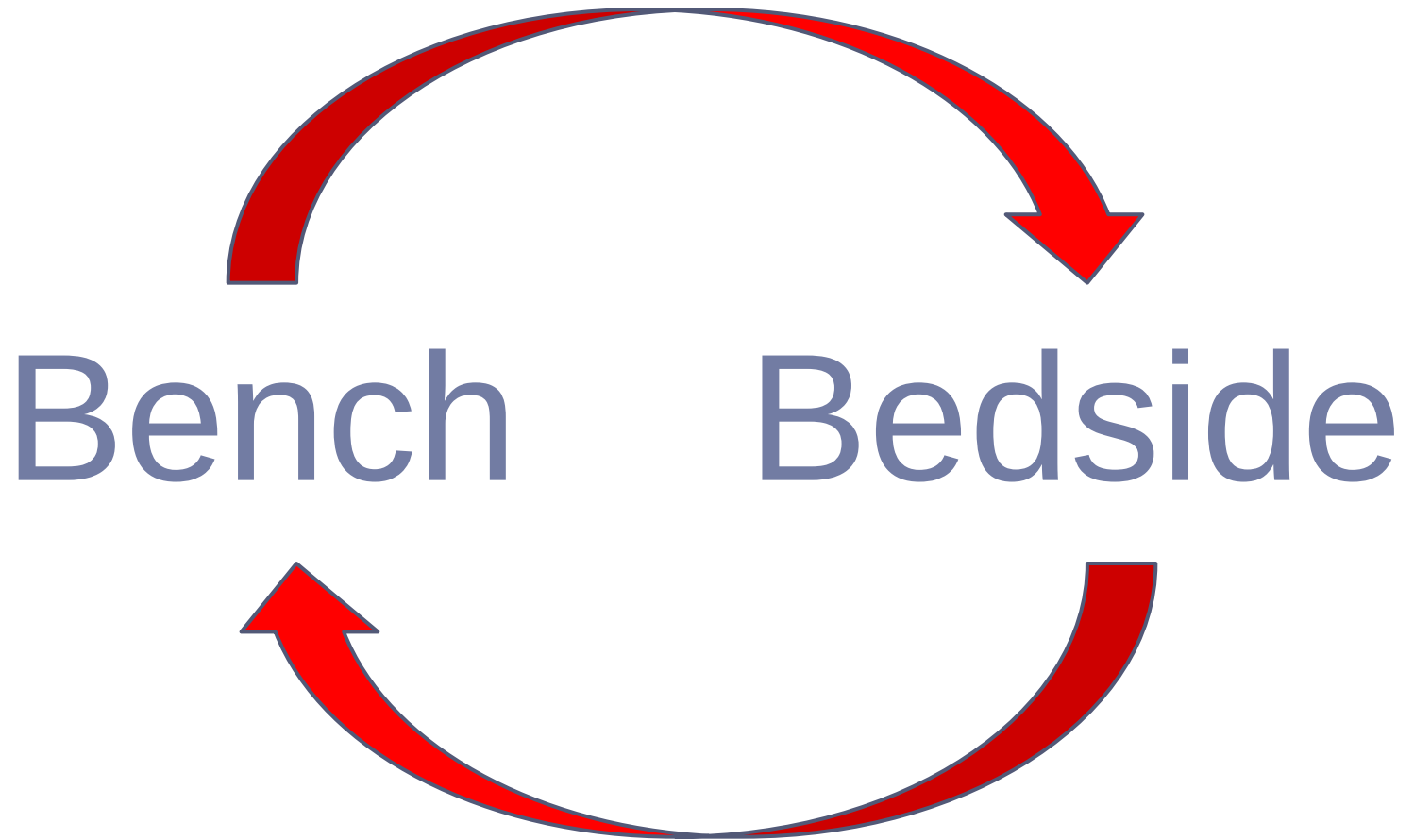
“G. d’Annunzio” University – Chieti and
“G. Monasterio” Foundation – Pisa, Italy

June 19, 2017 – 14:15-15:00

- ▶ Co-author ESC Guidelines on Atrial Fibrillation 2010-2012
- ▶ Steering Committee member, National Coordinator for Italy, and Co-author of APPRAISE-2, ARISTOTLE, AVERROES, ENGAGE-AF, Re-DUAL PCI
- ▶ Fees, honoraria and research funding from Sanofi-Aventis, Boehringer Ingelheim, Bayer, BMS/Pfizer, Daiichi-Sankyo, Novartis, Merck



Why talking about clinical trials to basic scientists



Agenda

- ▶ The history of oral anticoagulation
- ▶ The NOAC revolution
- ▶ Highlights from clinical trials: from bedside to bench
 - ▶ Once day vs twice day
 - ▶ Intracranial hemorrhage
 - ▶ New treatment indications



Agenda

- ▶ The history of oral anticoagulation

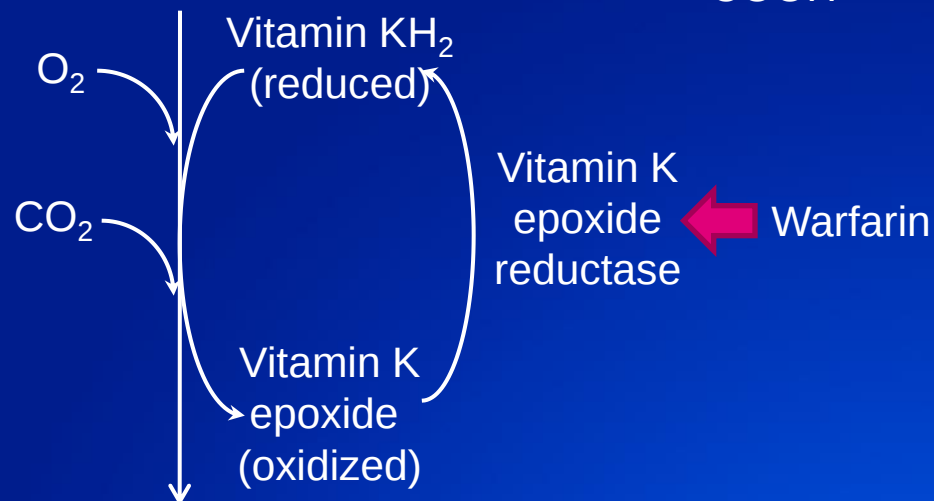
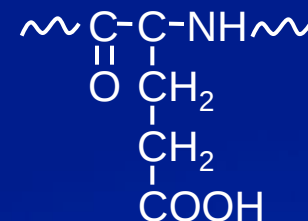


Oral anticoagulants: warfarin

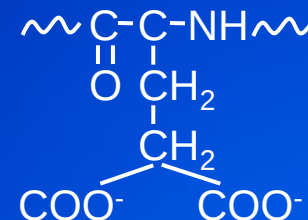


- ▶ Dosing
 - Oral; varies, depending on coagulation monitoring tests
- ▶ Monitoring
 - Usually monthly, testing INR
 - INR target of 2.5, range 2.0–3.0
- ▶ Adverse events
 - Bleeding, bruising
 - Many significant and potential food and drug interactions
- ▶ Unique advantage
 - Only anticoagulant available for long-term use

Precursors of clotting
Factors: prothrombin, VII,
IX, X, protein C, protein S



Active clotting Factors:
prothrombin, VII, IX, X,
protein C, protein S





The discovery of warfarin

- ▶ The sweet clover problem
- ▶ Link's isolation of the oral anticoagulant
- ▶ From test tube to rat poison – Karl Link
- ▶ From rat poison to clinical application



 W A R F



1951 advertisement for warfarin

Of 1,386 of the Nation's
County Agricultural Agents...

98.4% report
"Complete or Satisfactory"
control with warfarin



- ✓ 94.2% "COMPLETE KILL"
- ✓ 84.2% "SATISFACTORY CONTROL"
- ✓ 1.8% "UNSATISFACTORY RESULTS"

To test the effectiveness of warfarin on a nationwide basis, county agricultural agents in all of the 48 states were asked to report on local results obtained on a representative number of good, average, and poor farms. The 1,386 county agent reports received represent thousands of individual baiting trials. These reports conclusively show:

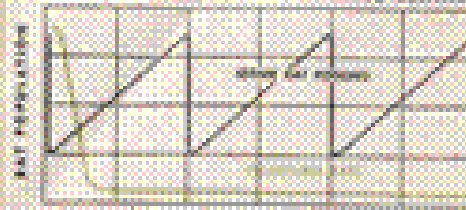
1. That warfarin can be used effectively by the untrained person, merely by following the label instructions. In this survey, all trials were made by untrained persons without the benefit of special instructions.
2. That warfarin can be used effectively in every state in the Union under all different geographical conditions.
3. That warfarin can be used effectively under all climatic conditions.
4. That warfarin can be used effectively against all forms of rats and mice found in the United States.

WARFARIN PRODUCES RESULTS!

Ask your county agricultural agent, or your local health officer

By a National Survey, 18 out of 19 county agents who originally reported "unsatisfactory results" later, after additional experience with warfarin, reported highly satisfactory results.

warfarin PROVIDES CONTINUOUS CONTROL

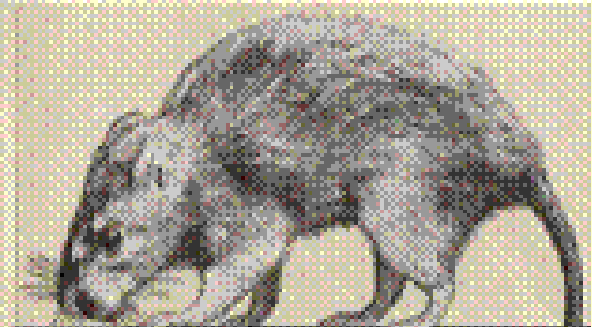


Without "warfarin" rats climb back to their normal level after a short time. With "warfarin" rats remain low, when properly used, unless the rat population is so low that it takes time to build up again.

warfarin rat and mouse killers ARE RECOMMENDED FOR:

FARMS	HOUSES
FOOD STORES	RESTAURANTS
SHOPS	WAREHOUSES
BARRACKS	BRIDGE AND ELEVATOR
FEED STORES	CRANE FACTORIES
BARRIS	MARKETS
PUR FARM	HATCHERIES
POULTRY FARMS	HOSPITALS
PACKING PLANTS	STOCKYARDS
SUGAR CANE PLANTATIONS	APARTMENTS
MANUFACTURING PLANTS	BOGS
RECREATION	ALLEYS
PARKS	DUMPS

... AND ALL OTHER PLACES
SUBJECT TO RAT OR MOUSE INFESTATION.



The New, Proven
Way to
KILL RATS
and mice — with
RODENTICIDES
containing newly-discovered
warfarin*

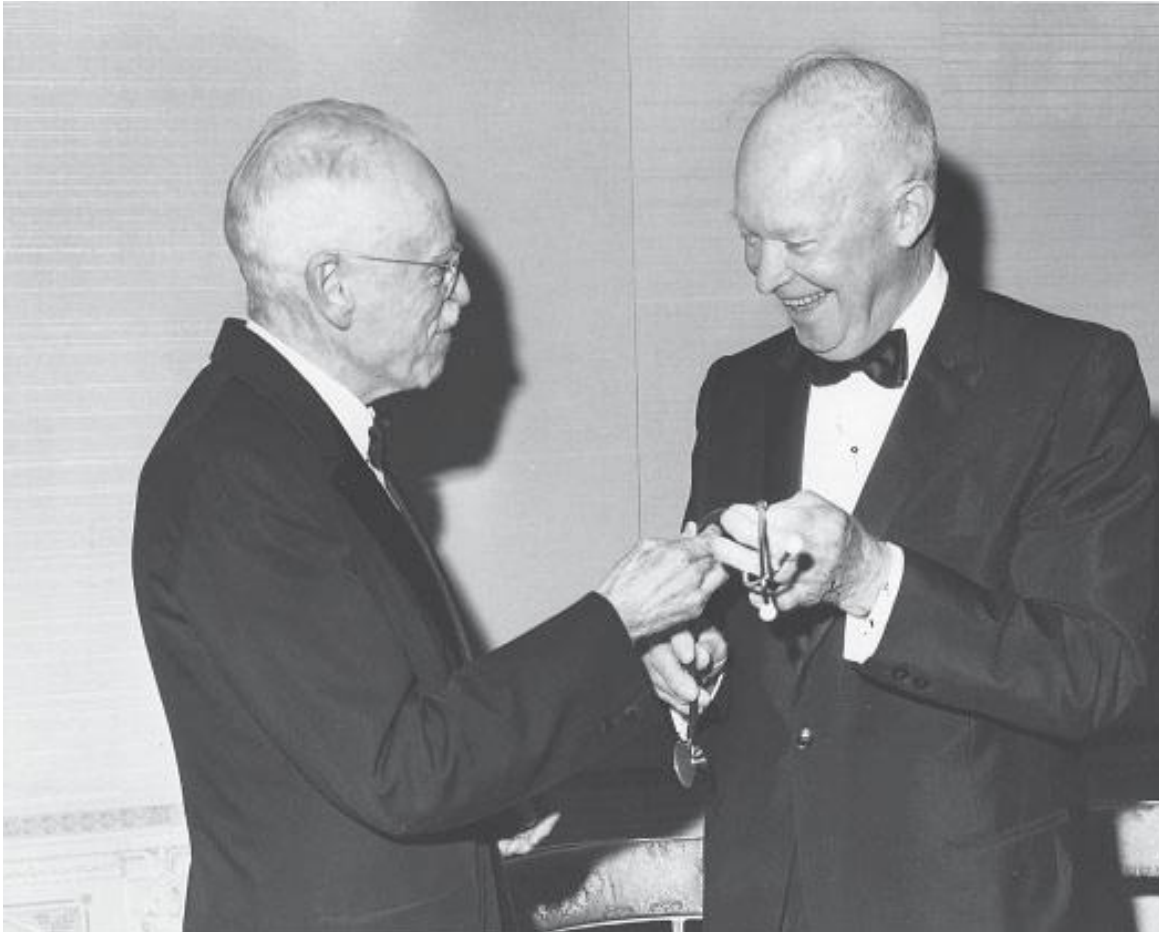
*Warfarin is a substance discovered at the University of Wisconsin and developed by the Wisconsin Alumni Research Foundation.

© 1951, WARD

WARD, Animal & S. L.

Eisenhower's Billion-Dollar Heart Attack — 50 Years Later

Franz H. Messerli, M.D., Adrian W. Messerli, M.D., and Thomas F. Lüscher, M.D.

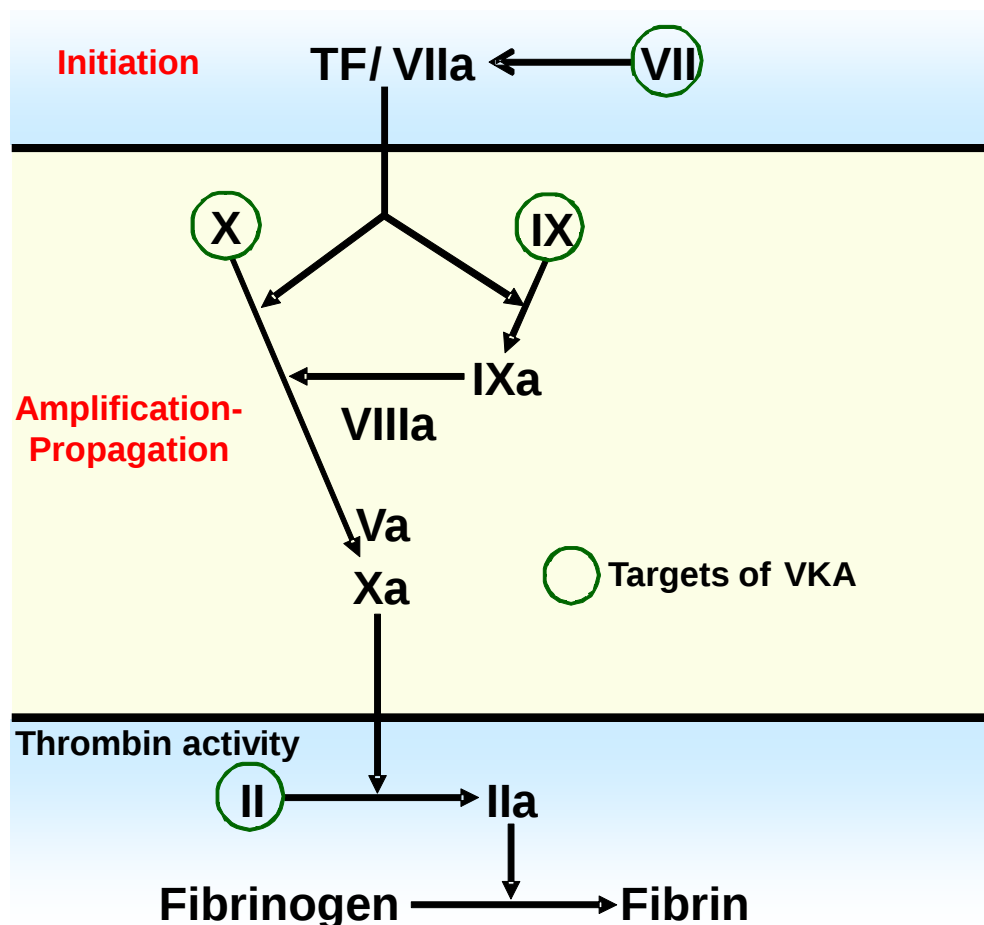


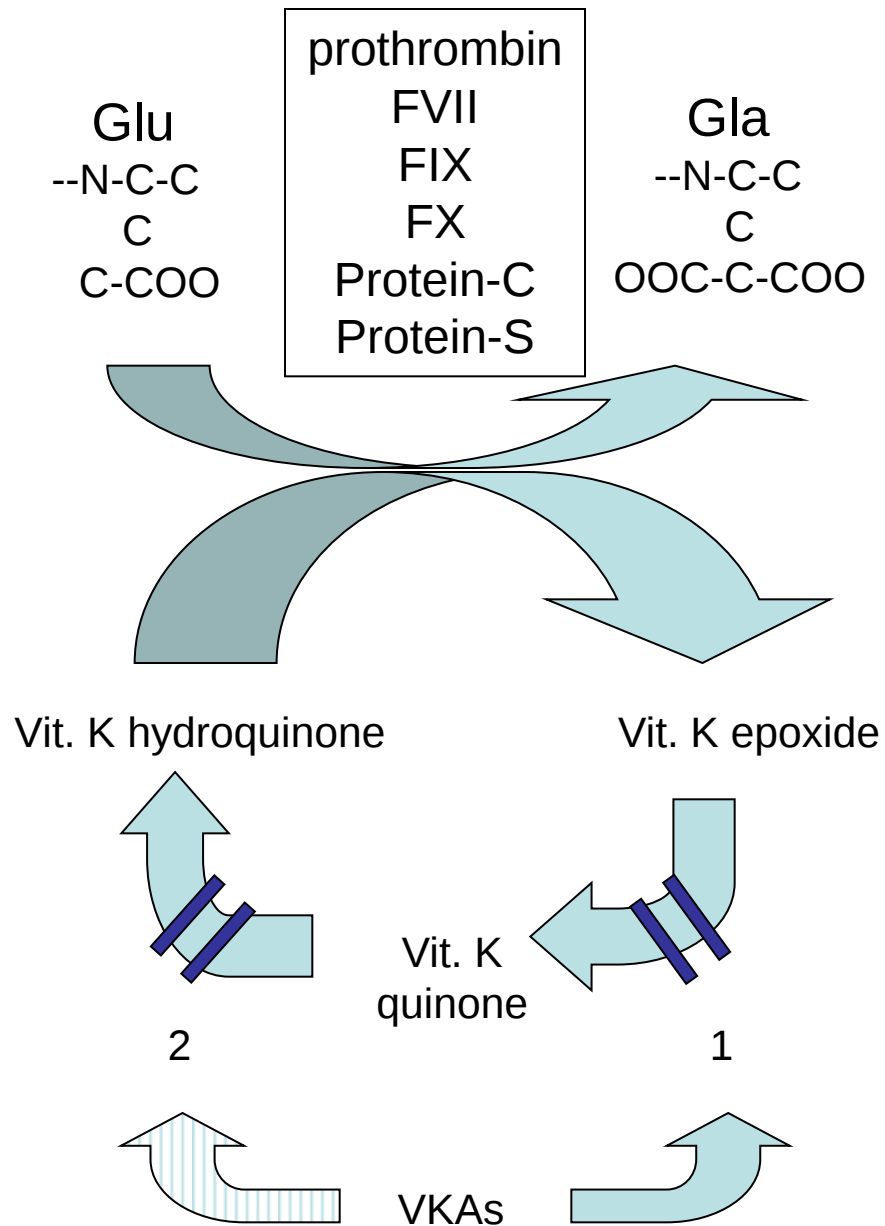
n engl j med 353;12
www.nejm.org
september 22, 2005

► Dr. Paul Dudley White and Former President Dwight D. Eisenhower, 1963.

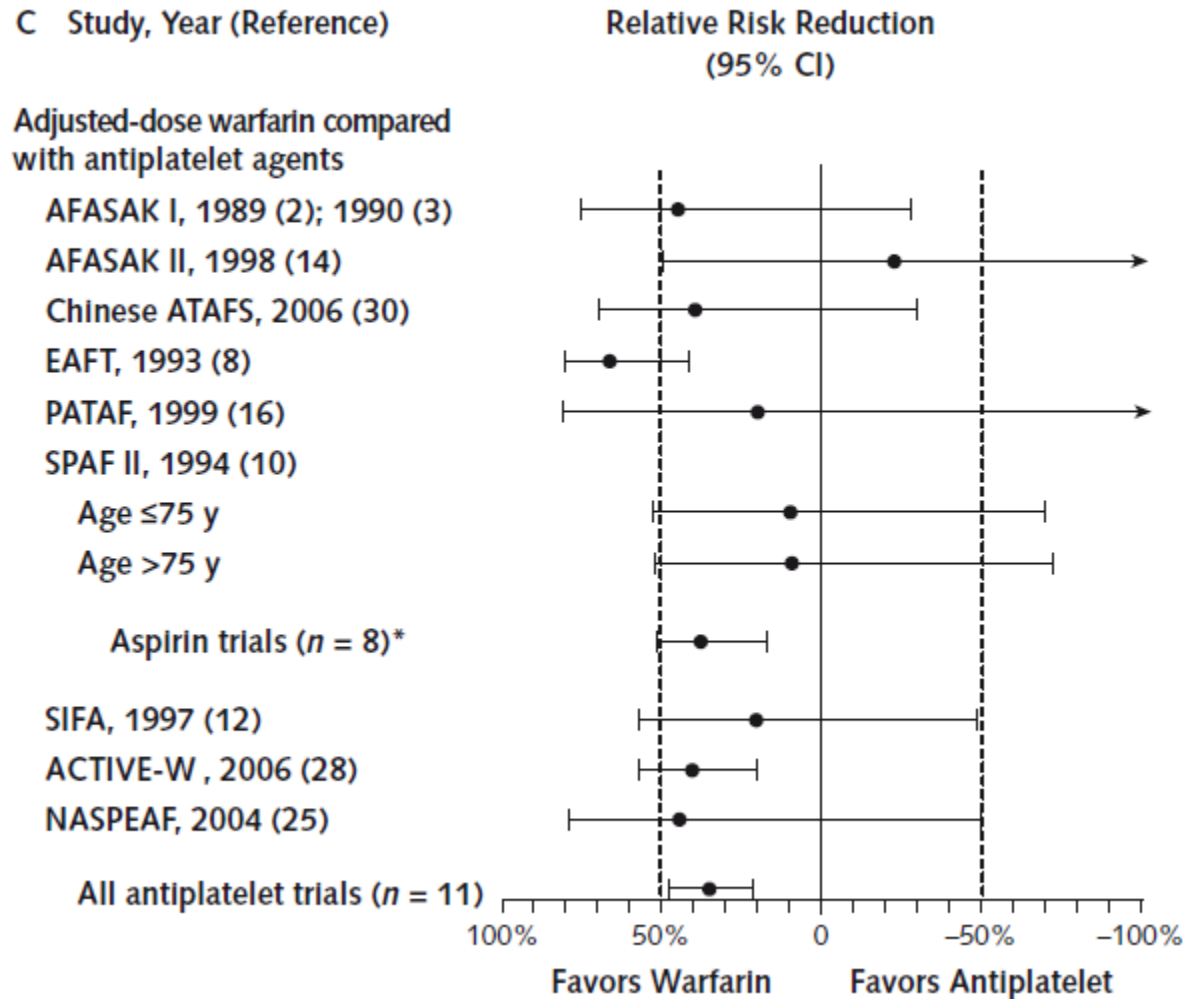
General mechanisms of coagulation and targets of anticoagulants (Section I)

Position Paper of the ESC Working Group on Thrombosis – Task Force on Anticoagulants in Heart Disease

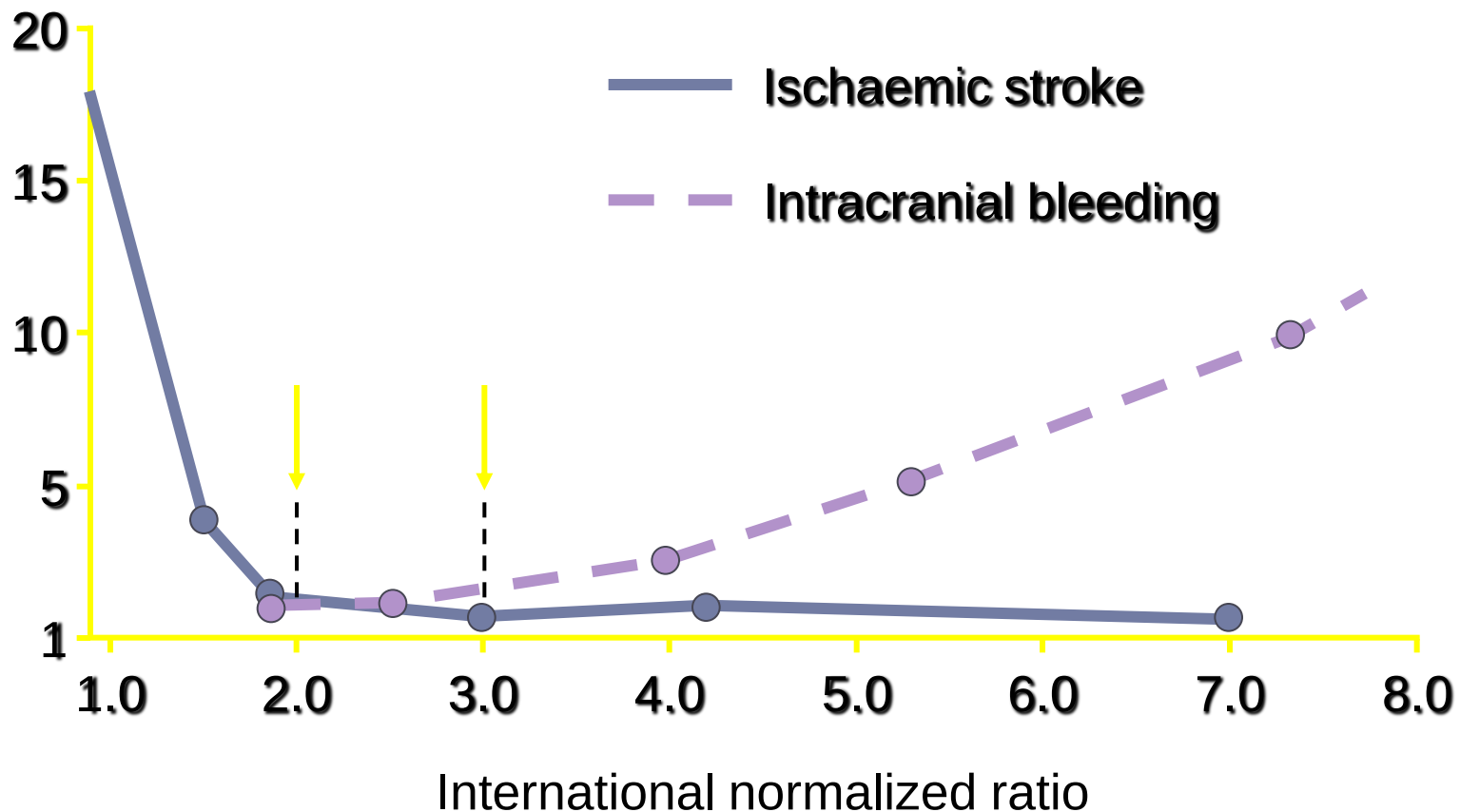




Antiplatelet drugs vs warfarin in stroke prevention in atrial fibrillation

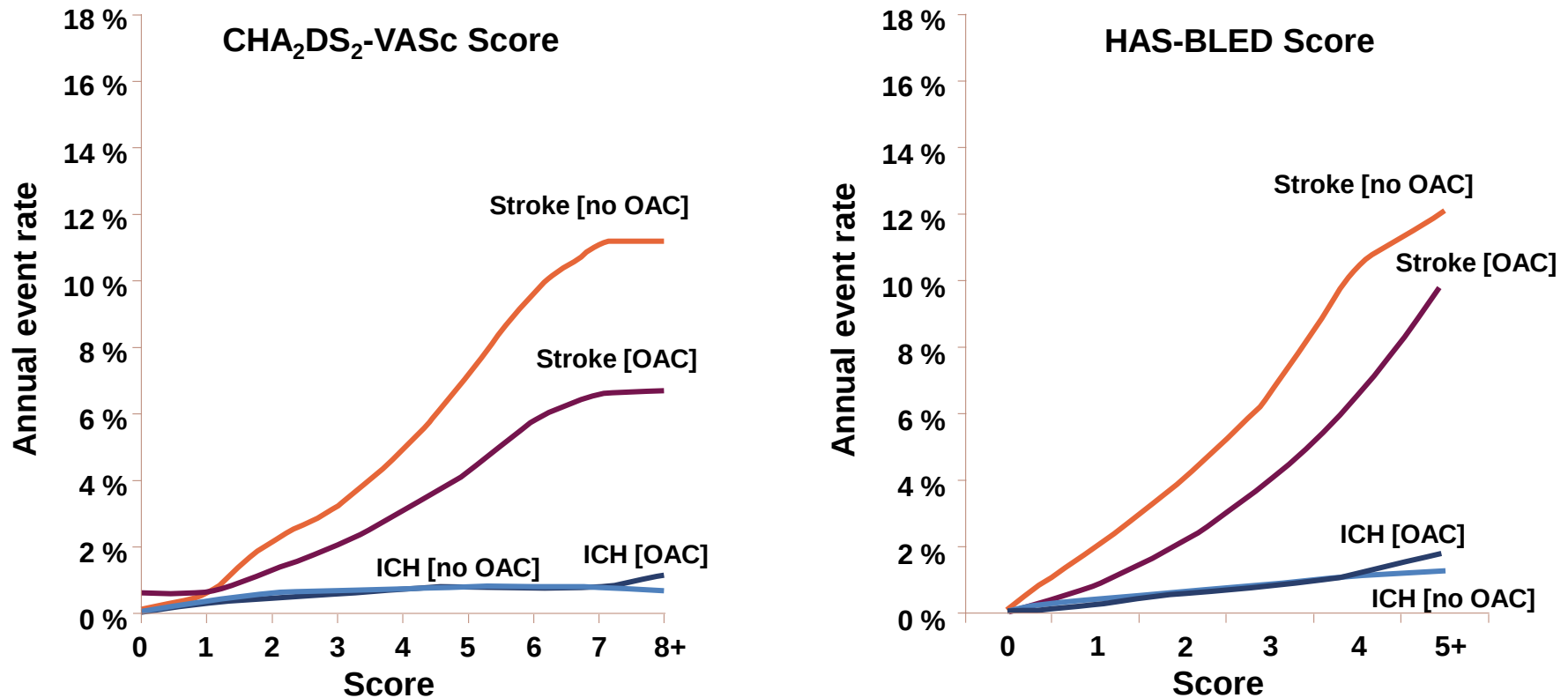


Adjusted odds ratios for ischaemic stroke and intracranial bleeding in relation to INR



The Risk of Ischemic Stroke “Without” OAC Exceeds the Risk of Intracranial Bleeding “With” OAC*

Relation between risk scores and annual event rates
of ischemic stroke and ICH in relation to use of oral anticoagulation
in 159,013 Swedish AF patients followed up for 1.5 ± 1.1 years (2005–2008)

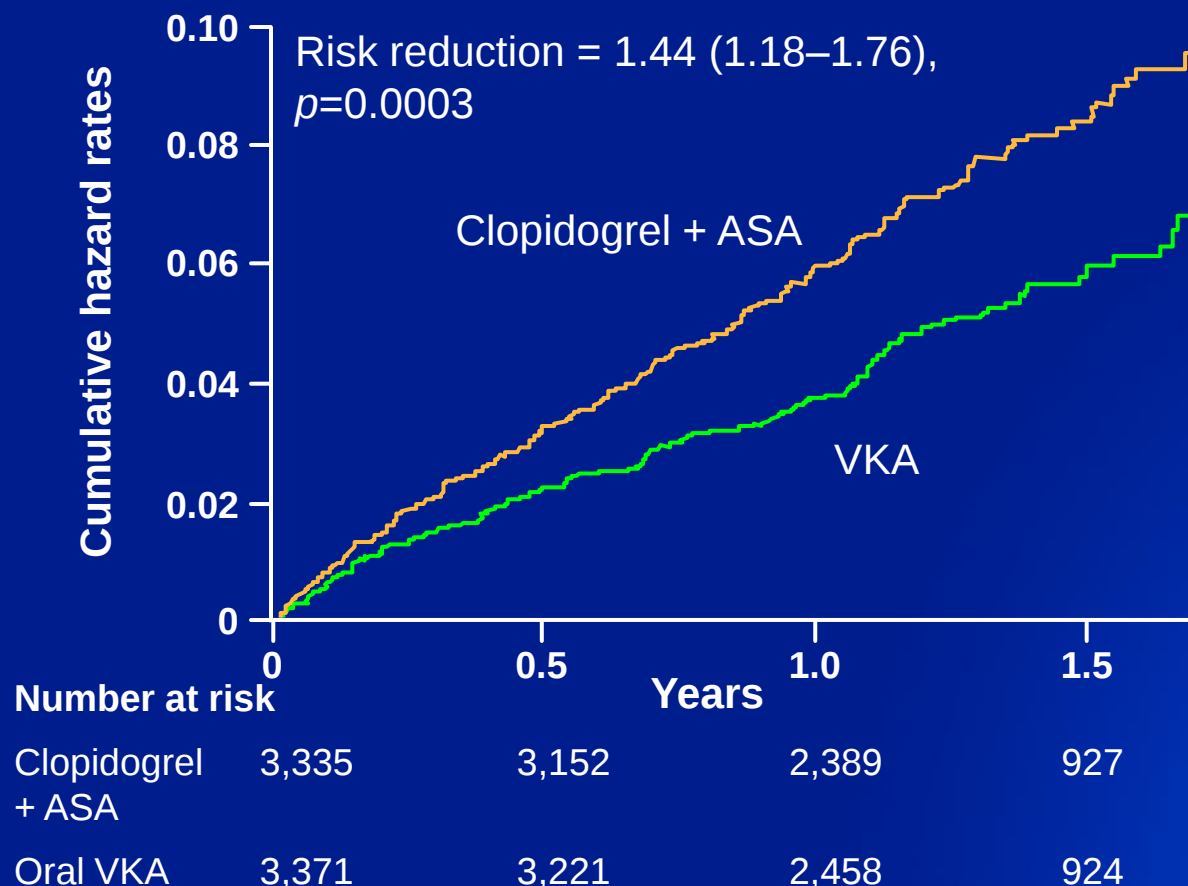


*Except those with a very low risk of stroke
OAC = oral anticoagulants; ICH = intracranial hemorrhage

AF: ACTIVE-W trial

▶ No benefit from adding clopidogrel to ASA vs VKA

Cumulative risk of primary outcome



▶ Stopped early

▶ Efficacy

- VKA: 165 (3.93%/year)
- Clopidogrel/ASA: 234 (5.5%/year)

▶ Safety

- No significant difference in major haemorrhage rates
- VKA: 2.2%
- Clopidogrel/ASA: 2.4%

Warfarin: contraindications

- ▶ Pregnancy
 - Associated with developmental abnormalities
- ▶ Threatened abortion, eclampsia and pre-eclampsia
- ▶ Recent surgery
 - CNS; eye; traumatic surgery, resulting in large open surfaces
- ▶ Bleeding tendencies associated with active ulceration or overt bleeding
 - GI, GU or RT
 - Cerebrovascular haemorrhage aneurysms– cerebral, dissecting aorta
 - Pericarditis and pericardial effusions
 - Bacterial endocarditis
- ▶ Unsupervised patients with
 - Senility
 - Alcoholism
 - Psychosis, or
 - Other lack of patient co-operation
- ▶ Spinal puncture
- ▶ Any diagnostic or therapeutic procedures with potential for uncontrollable bleeding
- ▶ Miscellaneous
 - Major regional
 - Lumbar block anaesthesia
 - Malignant hypertension
 - Known warfarin hypersensitivity

CNS, central nervous system; GI, gastrointestinal; GU, genitourinary; RT, reproductive tract

Warfarin: drug interactions

- ▶ Many drugs have the potential to interact with warfarin

Specific drugs reported

acetaminophen
 alcohol
 allopurinol
 aminosalicic acid
 amiodarone HCl
 argatroban
 acetylsalicylic acid
 atorvastatin
 azithromycin
 bivalirudin
 capecitabine
 cefamandole
 cefazolin
 cefoperazone
 cefotetan
 cefoxitin
 ceftriaxone
 celecoxib
 cerivastatin
 chenodiol
 chloramphenicol
 chloral hydrate
 chlorpropamide
 cholestyramine
 cimetidine
 ciprofloxacin
 cisapride
 clarithromycin
 clofibrate
 COUMADIN overdose
 cyclophosphamide
 danazol
 dextran
 dextrothroxine
 diazoxide
 diclofenac
 dicumarol
 diflunisal
 disulfiram
 doxycycline
 erythromycin
 esomeprazole
 etidacrylic acid
 ezetimibe
 fenofibrate
 fenoprofen
 fluconazole
 fluorouracil
 fluoxetine
 flutamide
 fluvastatin
 fluvoxamine
 gefitinib
 gemfibrozil
 glucagon
 halothane
 heparin
 ibuprofen
 itosamide
 indomethacin
 influenza virus vaccine
 itraconazole
 ketoprofen
 ketorolac
 lansoprazole
 lepirudin
 levamisole
 levofloxacin
 levothyroxine
 liothyronine
 lovastatin
 mefenamic acid
 methimazole
 methyl dopa
 methylphenidate
 methylsalicylate
 ointment (topical)
 metronidazole
 miconazole (intravaginal, oral, systemic)
 moricizine hydrochloride
 nalidixic acid
 naproxen
 neomycin
 norfloxacin
 ofloxacin
 olsalazine
 omeprazole
 oxandrolone
 oxaprozin
 oxymetholone

pantoprazole
 paroxetine
 penicillin G, intravenous
 pentoxifylline
 phenylbutazone
 phenytoin
 piperacillin
 piroxicam
 pravastatin
 prednisone
 propafenone
 propoxyphene
 propranolol
 propylthiouracil
 quinidine
 quinine
 rabeprazole
 ranitidine
 rofecoxib
 sotalolol
 simvastatin
 stanazolol
 streptokinase
 sulfamethizole
 sulfamethoxazole
 sulfinpyrazone
 sulfisoxazole
 sulindac
 tamoxifen
 tetracycline
 thyroid
 ticarcillin
 ticlopidine
 tissue plasminogen activator (t-PA)
 tolbutamide
 tramadol
 trimethoprim/
 sulfamethoxazole
 urokinase
 valdecoxib
 valproate
 vitamin E
 zafirlukast
 zileuton

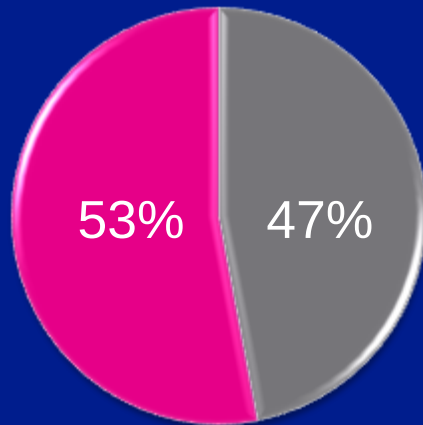
▶ Highlights

- Atorvastatin, simvastatin
- Esomeprazole, lansoprazole
- Paracetamol, ASA, ibuprofen
- Propranolol, naproxen
- Chloramphenicol, clarithromycin, tetracycline, penicillin G, metronidazole ...
- Alcohol

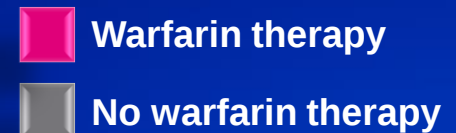
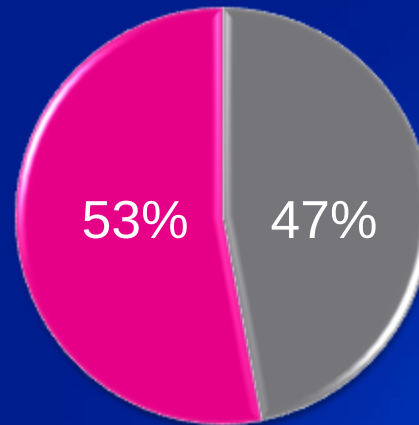
Underutilization of anticoagulation in AF*

Approximately half of high-risk patients with AF receive warfarin therapy

13 community hospitals



21 academic hospitals



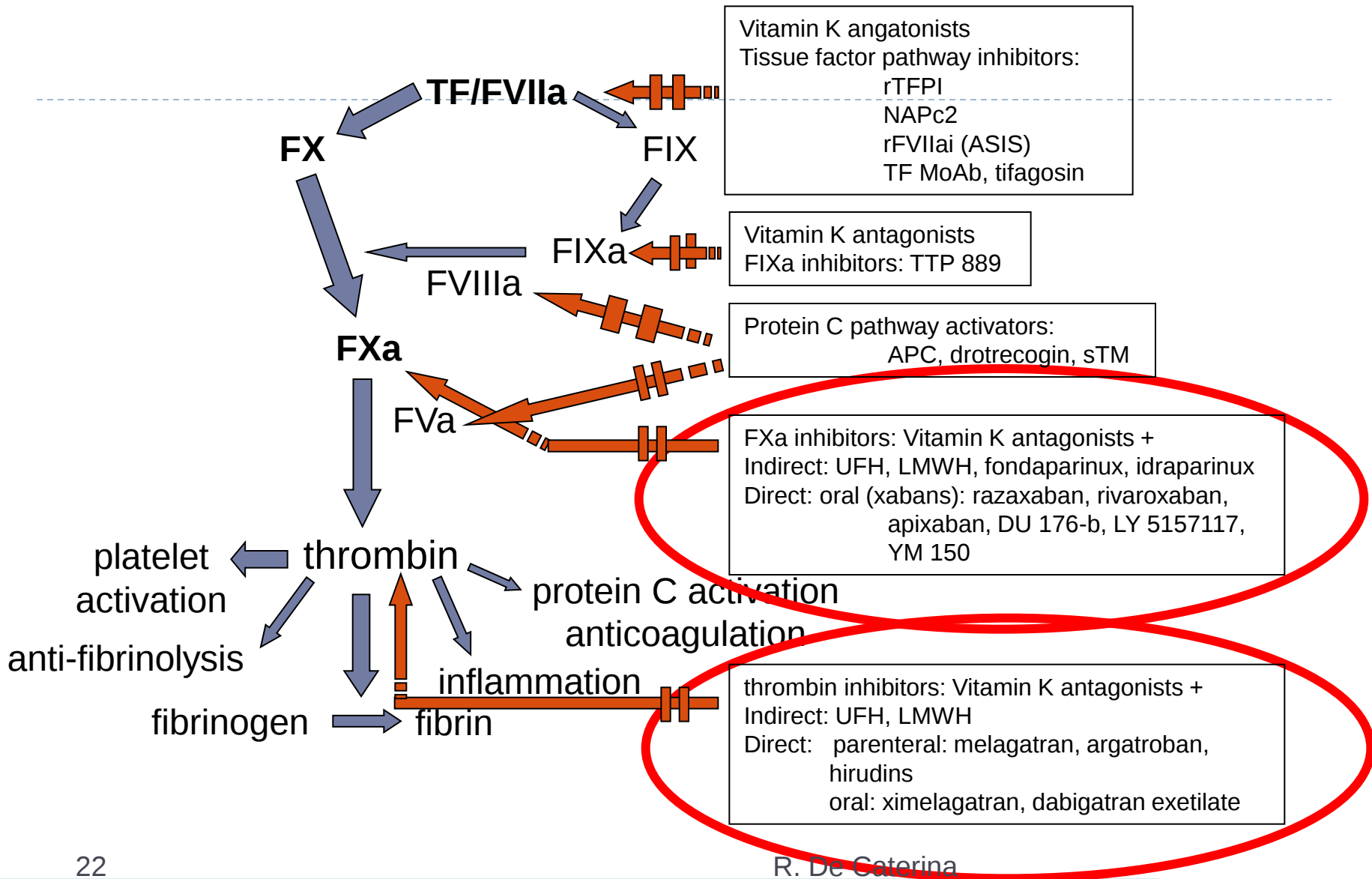
*US population January–December 2002
Waldo et al. *J Am Coll Cardiol* 2005

Therefore

- ▶ there was still a need for safe, effective, oral anticoagulants that do not require monitoring

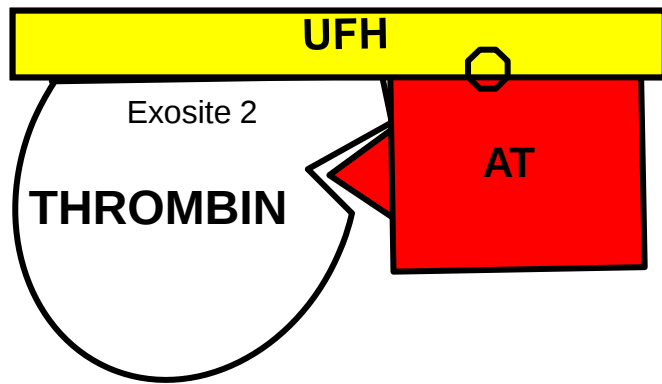
Novel Vitamin K Antagonists

Agent	Route	Dosing	Half-life (hours)	Metabolism	Drug Interactions	Clearance	Phase of Development
ATI-5923 (Tecarfarin)	Oral	Variable, 1X daily	119	Cellular esterases	No P450 metabolism. Less or no drug interactions	100% liver	Phase II study completed

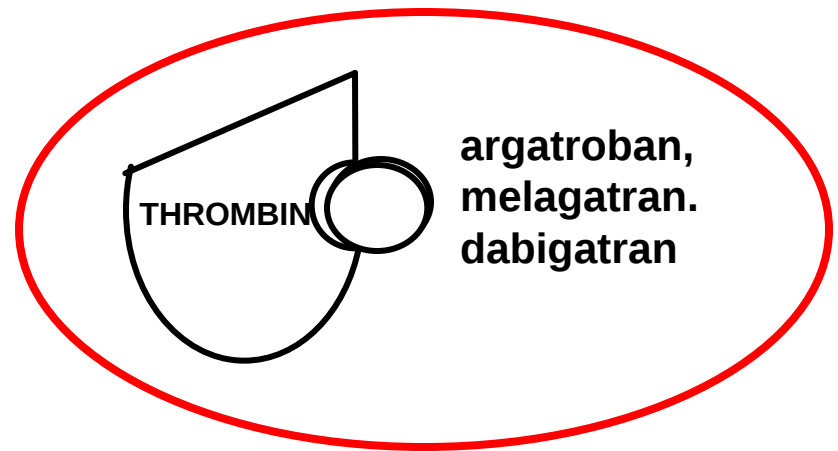
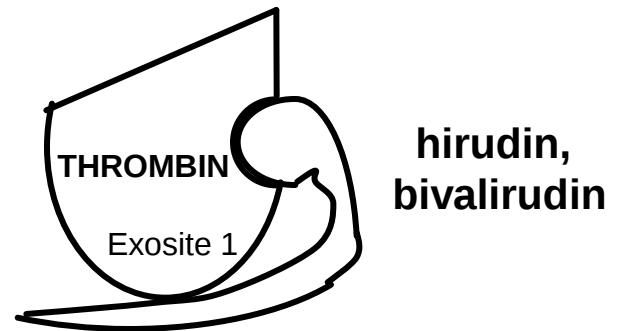


Thrombin inhibitors

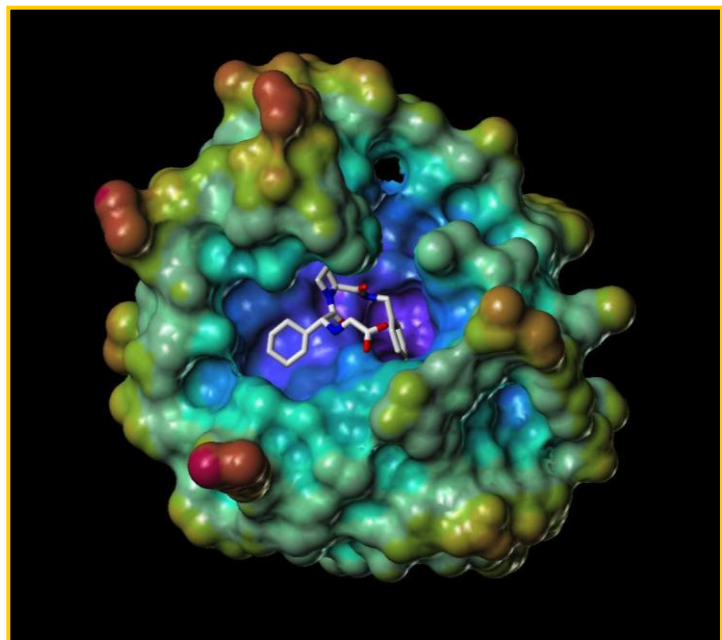
indirect



direct



Direct thrombin inhibition



- ▶ Oral ximelagatran rapidly absorbed and biotransformed to the active form, melagatran
- Renal excretion
- Clinical studies demonstrate efficacy with bid dosing
- No coagulation monitoring required
- Low potential for drug/food/alcohol interaction
- Fixed dosing and predictable response



melagatran

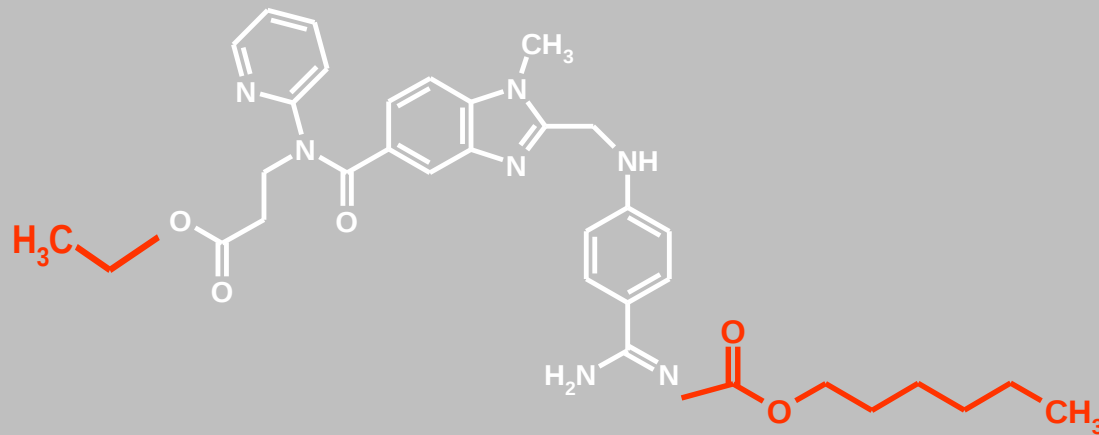
R. De Caterina

ALAT > 3x ULN



Dabigatran Etexilate:

A Novel Direct Thrombin Inhibitor

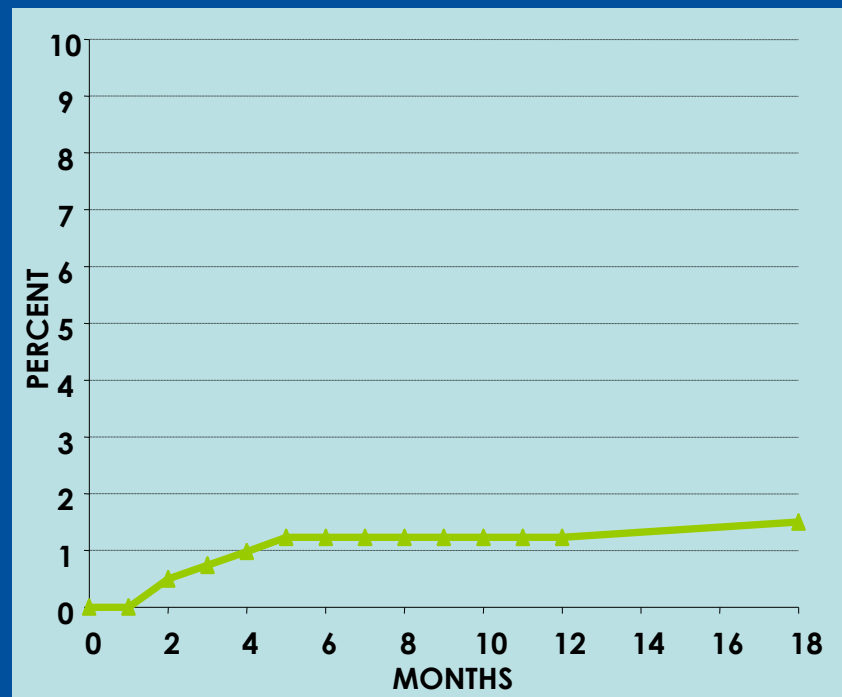
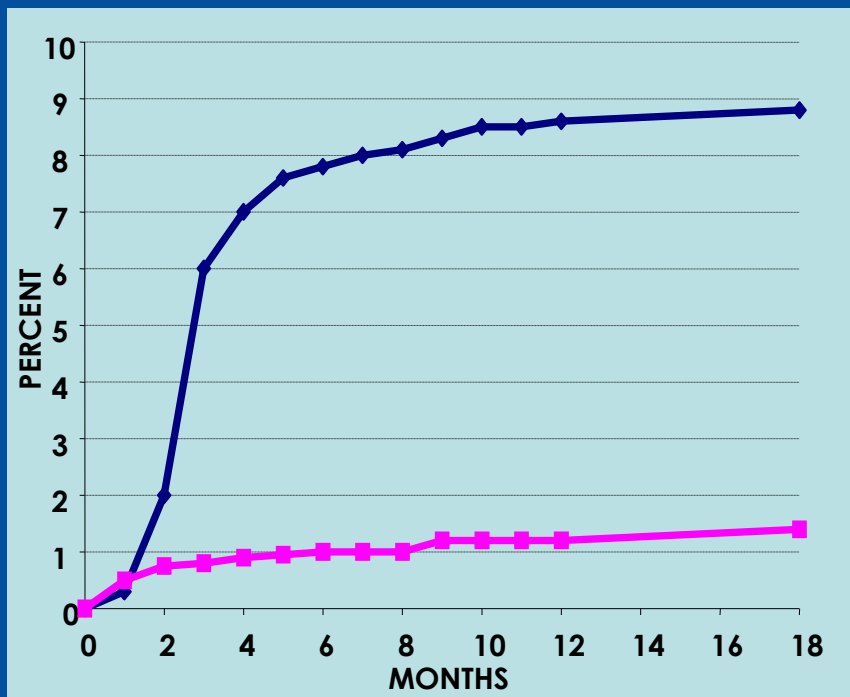


Dabigatran **etexilate**



Liver Function Test

Cumulative risk of alanine aminotransferase greater than 3x the upper limit of normal vs. time after randomisation

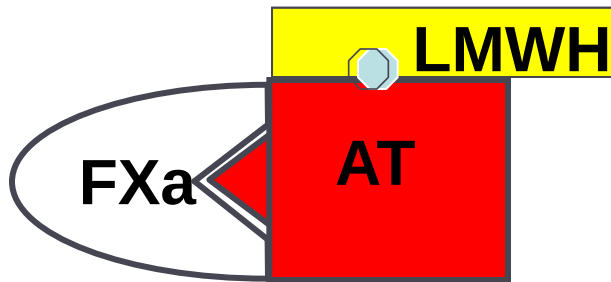


Ximelagatran ◆
Comparator ■
Dabigatran ▲

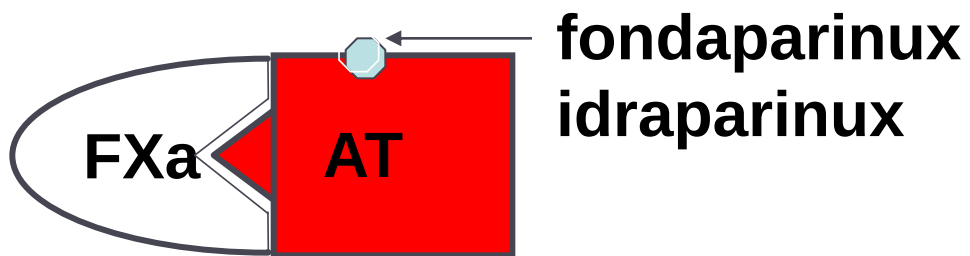
Ximelagatran and comparator data from Astra Zeneca Briefing Document for FDA Advisory Committee Meeting, Sept 10, 2004, page 128
Dabigatran data from PETRO and PETRO-Ex, data on file

Oral FXa inhibitors, vs. LMWH vs. pentasaccharides

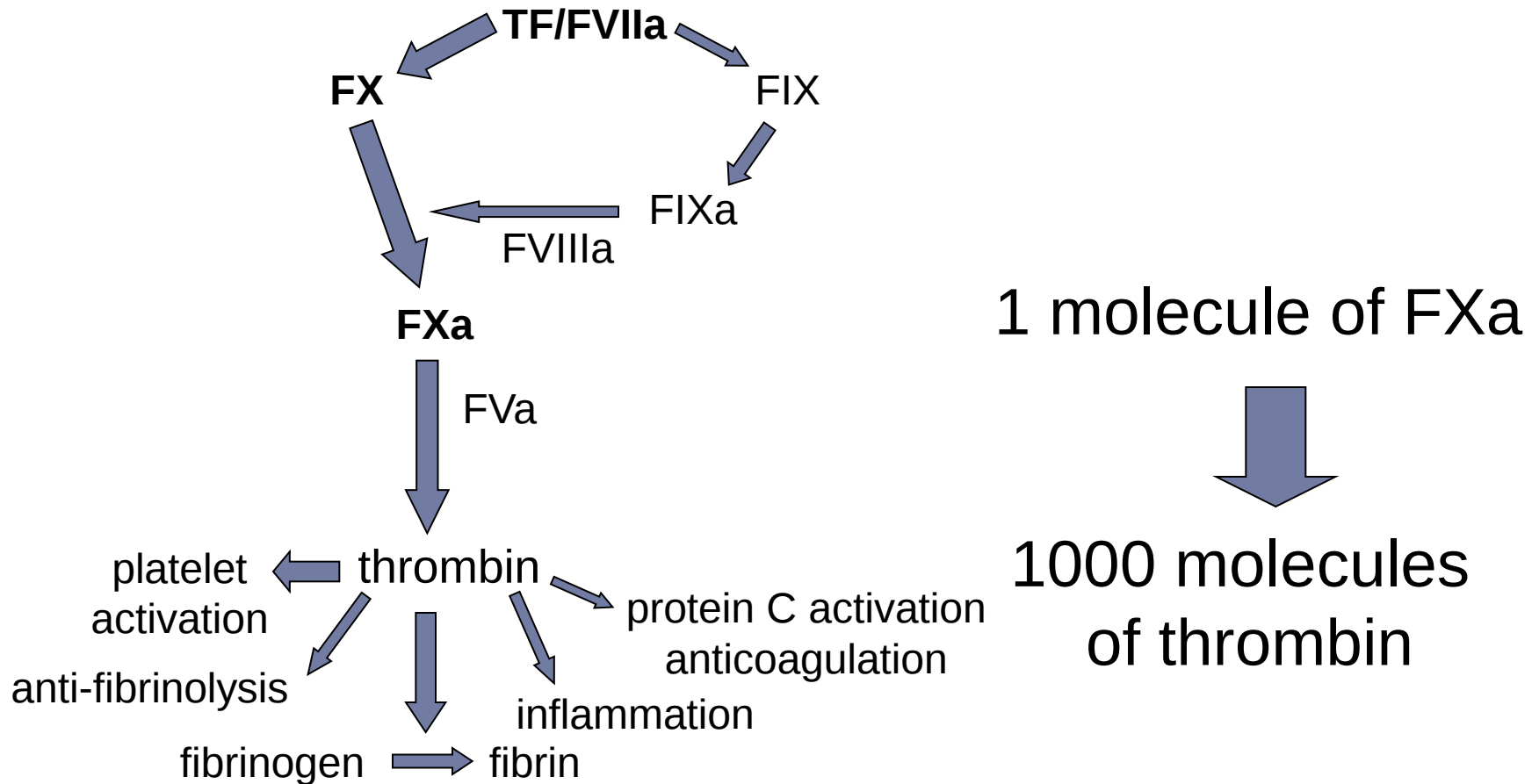
parenteral



oral



Coagulation: an amplifying cascade



Mann KG, et al..J Thromb Haemost 2003; 1:1504–14.

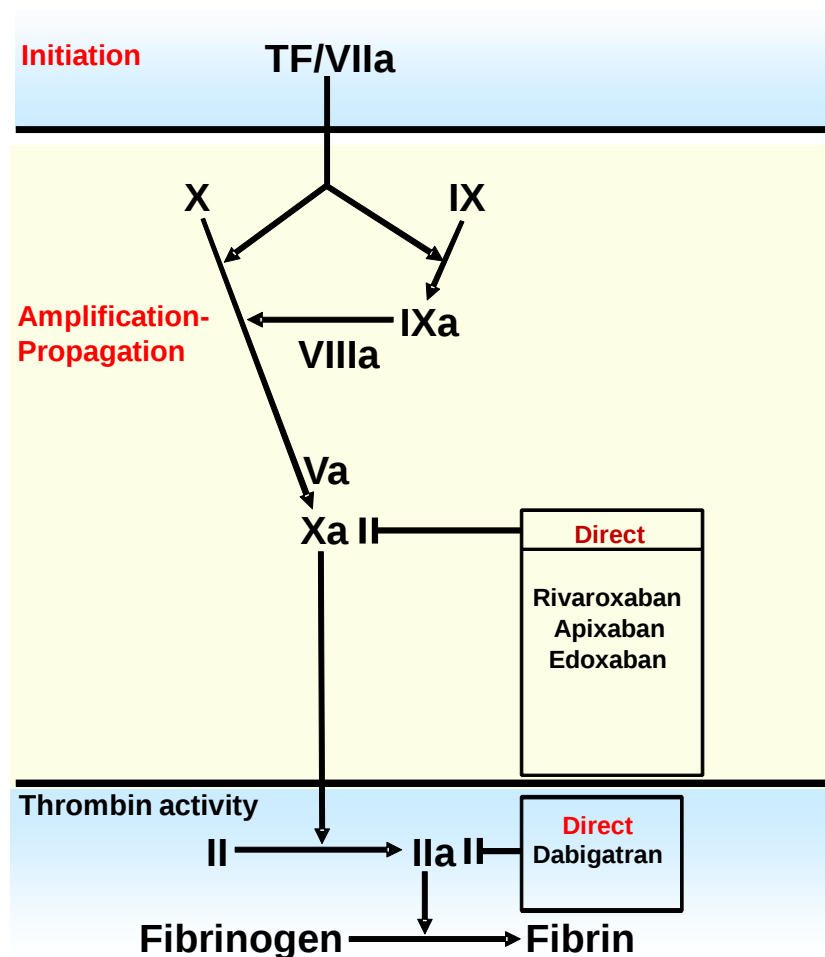
Agenda

- ▶ The history of oral anticoagulation
- ▶ The NOAC revolution



General mechanisms of coagulation and targets of anticoagulants (Section I)

Position Paper of the ESC Working Group on Thrombosis – Task Force on Anticoagulants in Heart Disease



Features of novel oral anticoagulants

	Dabigatran ¹	Rivaroxaban ^{1,2}	Apixaban ^{1,3}	Edoxaban ⁴⁻⁶
Target	Ila (thrombin)	Xa	Xa	Xa
Hours to Cmax	1.25-3	2-4	3-4	1-2
CYP metabolism	None	32%	Minimal	<4%
Bioavailability	6%	80%	60%	62%
Transporters	P-gp	P-gp/BCRP	P-gp/ BCRP	P-gp
Protein binding	35%	93%	87%	50%
Half-life	14-17 h	7-11 h	8-15 h	8-10 h
Renal elimination	80%*	33%#	25%#	35%#

BCRP, breast cancer resistance protein
 CYP, cytochrome P450; P-gp, P-glycoprotein
 NR, not reported

*Of absorbed substance

#Of ingested substance

1. Eriksson et al. Clin Pharmacokinet 2009;48:1-22; 2. Xarelto [package insert]. Titusville, NJ: Janssen Pharmaceuticals, Inc.; 2011; 3. ELIQUIS Summary of Product Characteristics. Bristol Myers Squibb/Pfizer EEIG, UK; 4. Ruff et al. Hot Topics in Cardiology 2009;18:1-32; 5. Matsushima et al. Am Assoc Pharm Sci 2011; abstract;
6. Ogata et al. J Clin Pharmacol 2010;50:743-53

Having more effective or safer anticoagulants was not the original hypothesis for their development

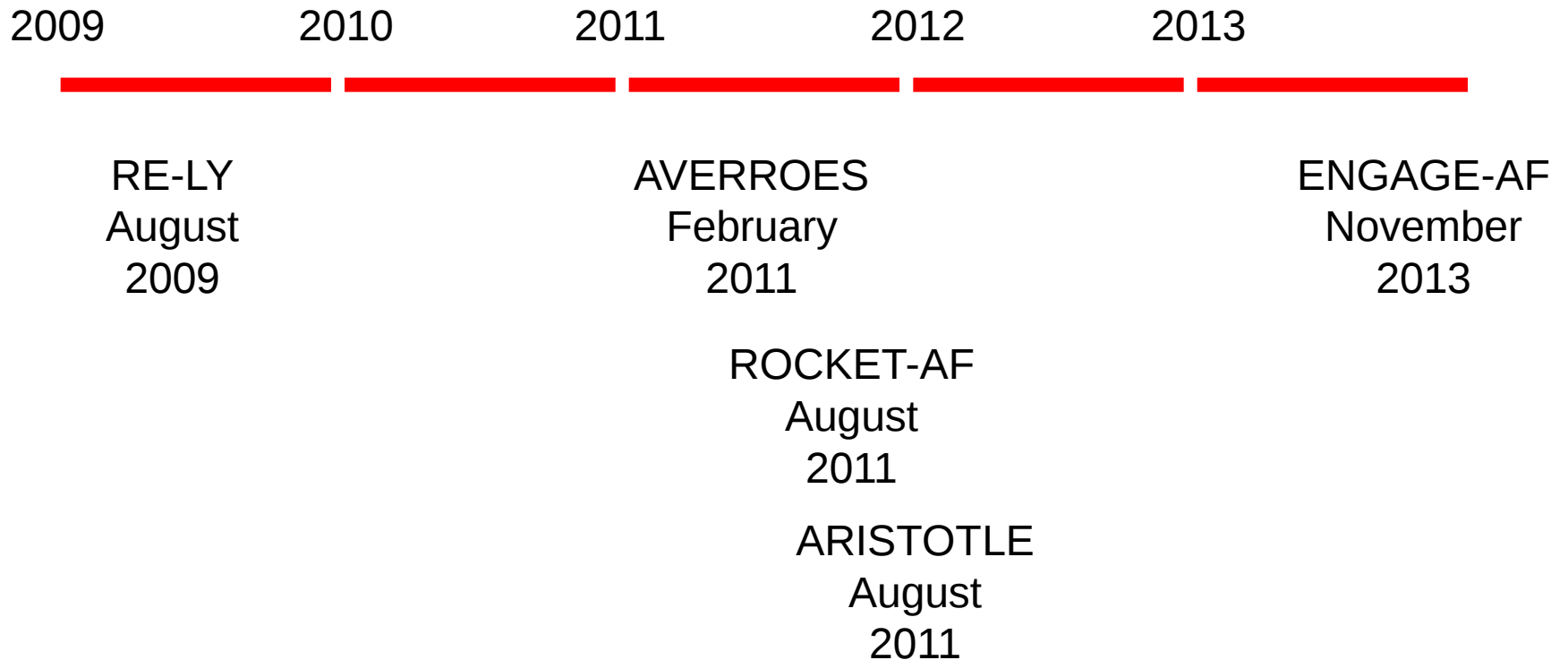
- ▶ the original hypothesis was to find “non-inferior” agents compared with warfarin, with **better acceptance because of the lack of need of frequent coagulation testing**



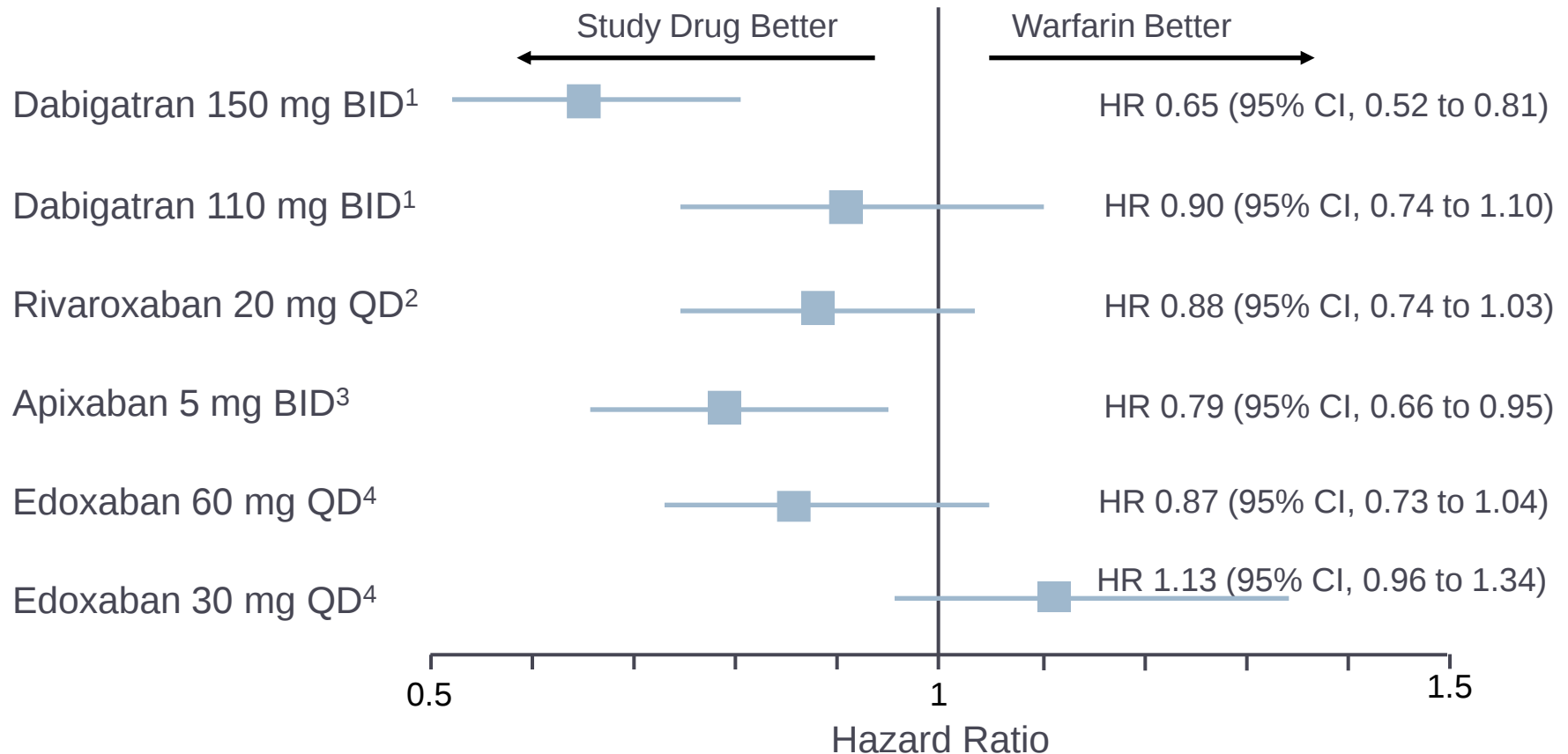
Can NOACs in SPAF offer
a better risk-benefit
profile?



NOACs in atrial fibrillation - Timelines



New Anticoagulant Therapies Compared to Warfarin: Stroke or Systemic Embolism



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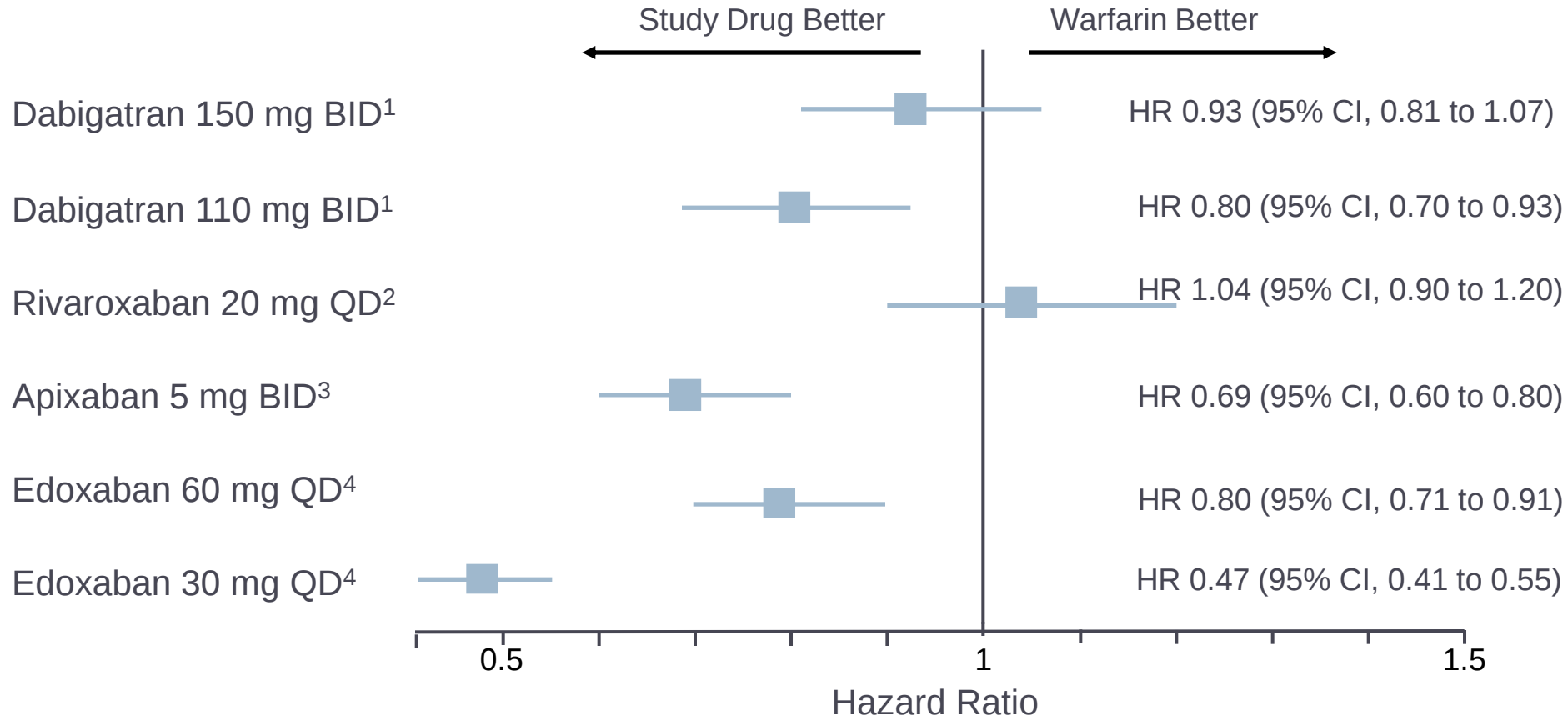
1. Connolly SJ et al. *N Engl J Med*. 2010;363:1875-1876.

2. Patel MR et al. *N Engl J Med*. 2011;365:883-891.

3. Granger CB et al. *N Engl J Med*. 2011;365:981-992.

4. Giugliano RP et al, for the ENGAGE-AF TIMI 48 Investigators; *NEJM*; 2013, doi: 10.1056/NEJMoa1310907

New Anticoagulant Therapies Compared to Warfarin: Major Bleeding



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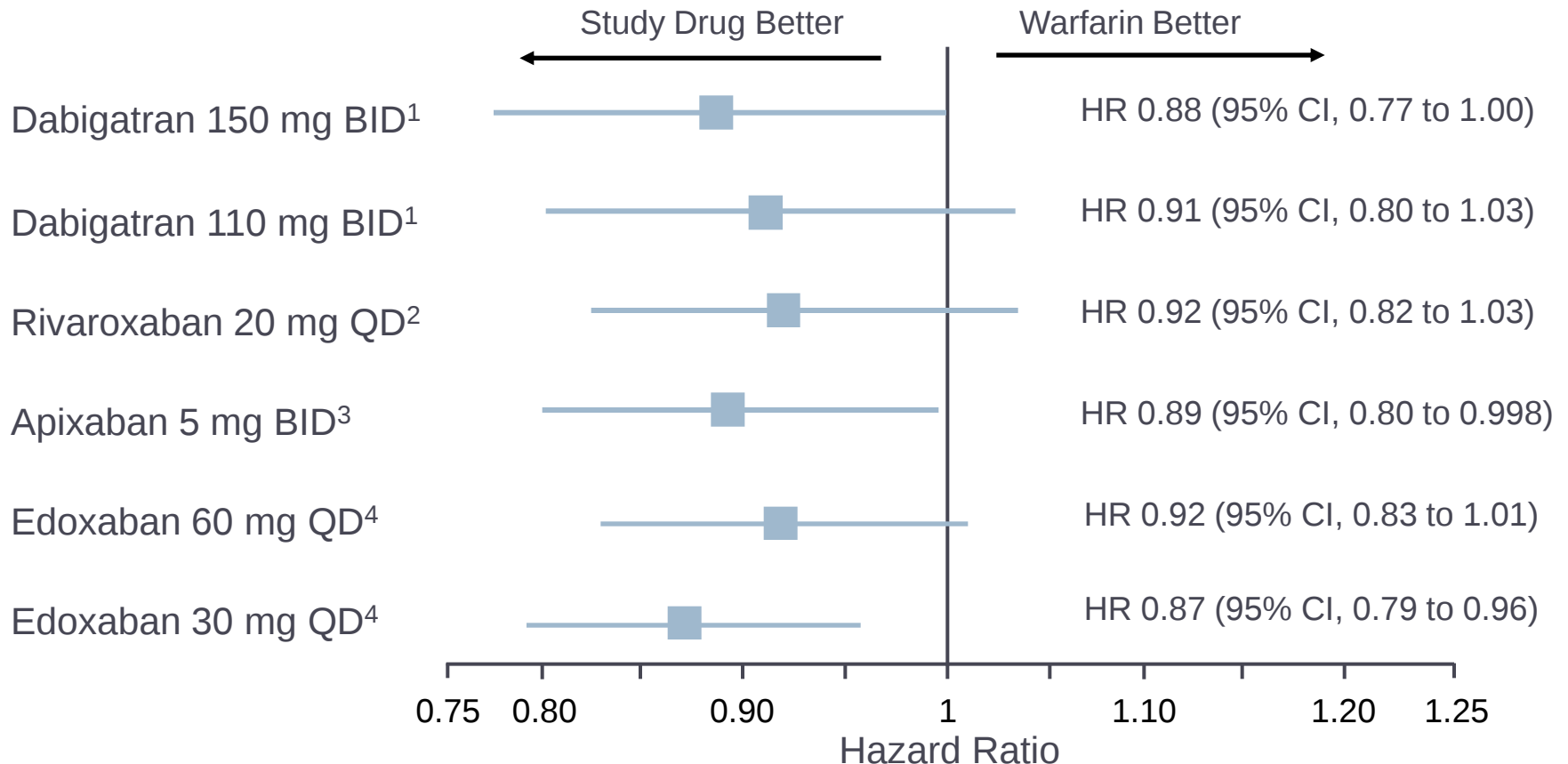
1. Connolly SJ et al. *N Engl J Med*. 2010;363:1875-1876.

2. Patel MR et al. *N Engl J Med*. 2011;365:883-891.

3. Granger CB et al. *N Engl J Med*. 2011;365:981-992.

4. Giugliano RP et al, for the ENGAGE-AF TIMI 48 Investigators; *NEJM*; 2013, doi: 10.1056/NEJMoa1310907

New Anticoagulant Therapies Compared to Warfarin: All-Cause Mortality



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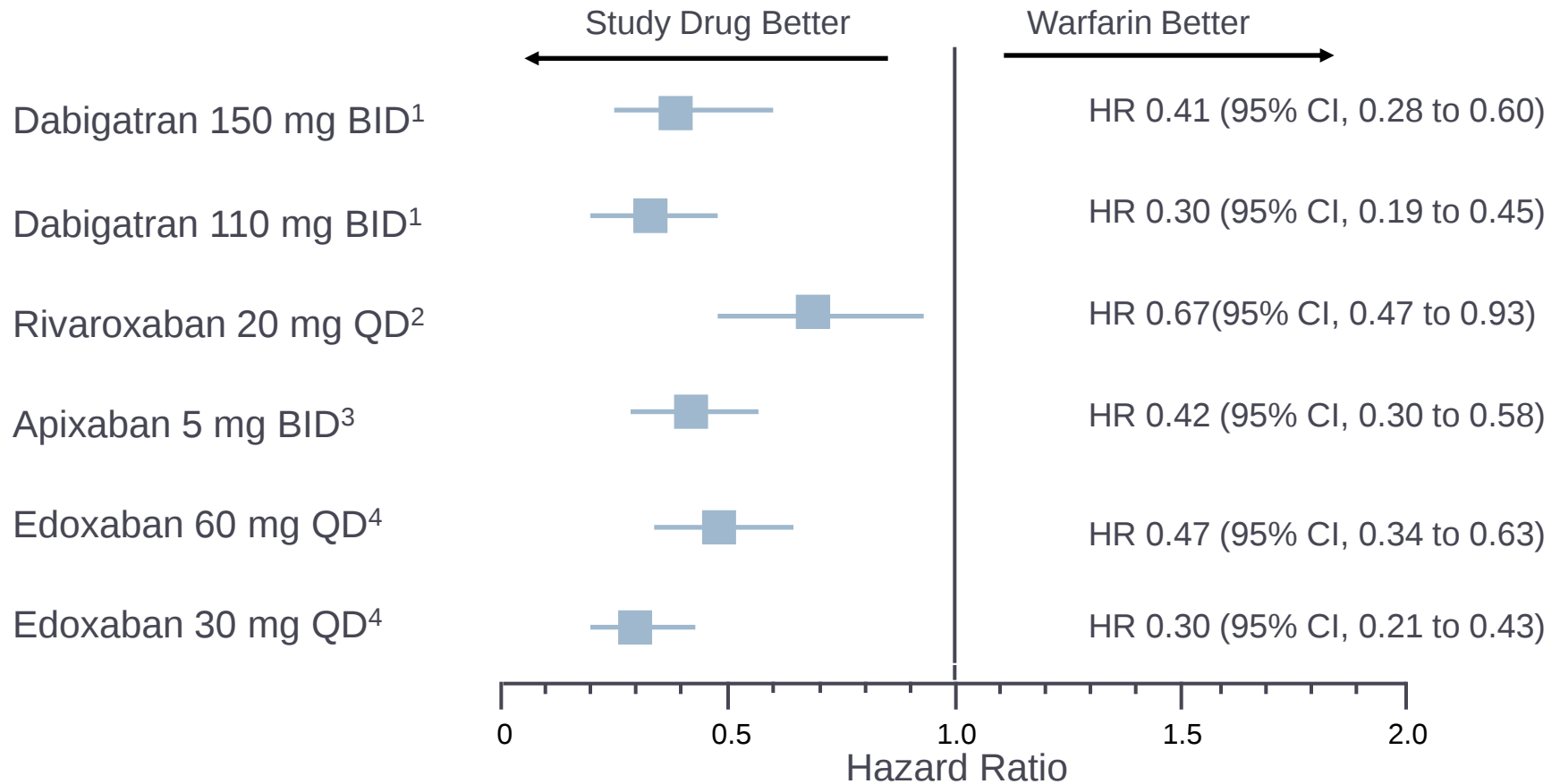
1. Connolly SJ et al. *N Engl J Med*. 2010;363:1875-1876.

2. Patel MR et al. *N Engl J Med*. 2011;365:883-891.

3. Granger CB et al. *N Engl J Med*. 2011;365:981-992.

4. Giugliano RP et al, for the ENGAGE-AF TIMI 48 Investigators; *NEJM*; 2013, doi: 10.1056/NEJMoa1310907

New Anticoagulant Therapies Compared to Warfarin: Intracranial Hemorrhage



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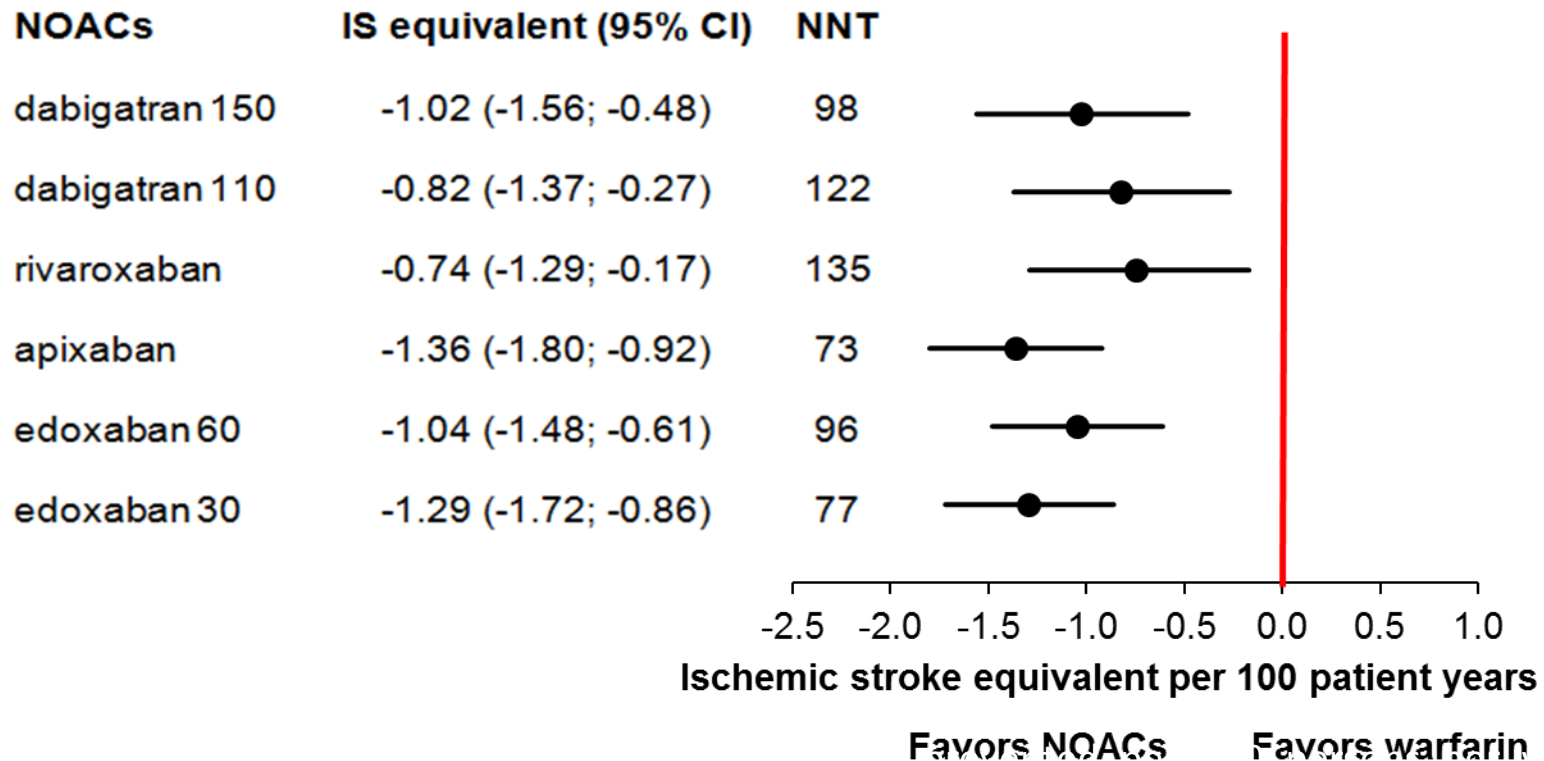
1. Connolly SJ et al. *N Engl J Med*. 2010;363:1875-1876.

2. Patel MR et al. *N Engl J Med*. 2011;365:883-891.

3. Granger CB et al. *N Engl J Med*. 2011;365:981-992.

4. Giugliano RP et al, for the ENGAGE-AF TIMI 48 Investigators; *NEJM*; 2013, doi: 10.1056/NEJMoa1310907

NCB (95%CI) of all treatment arms vs warfarin for the composite outcome including ischemic stroke + systemic embolism + myocardial infarction + hemorrhagic stroke + adjusted major bleeding



Agenda

- ▶ The history of oral anticoagulation
- ▶ The NOAC revolution
- ▶ Highlights from clinical trials: from bedside to bench
 - ▶ Once day vs twice day



Once vs twice daily – an important choice!

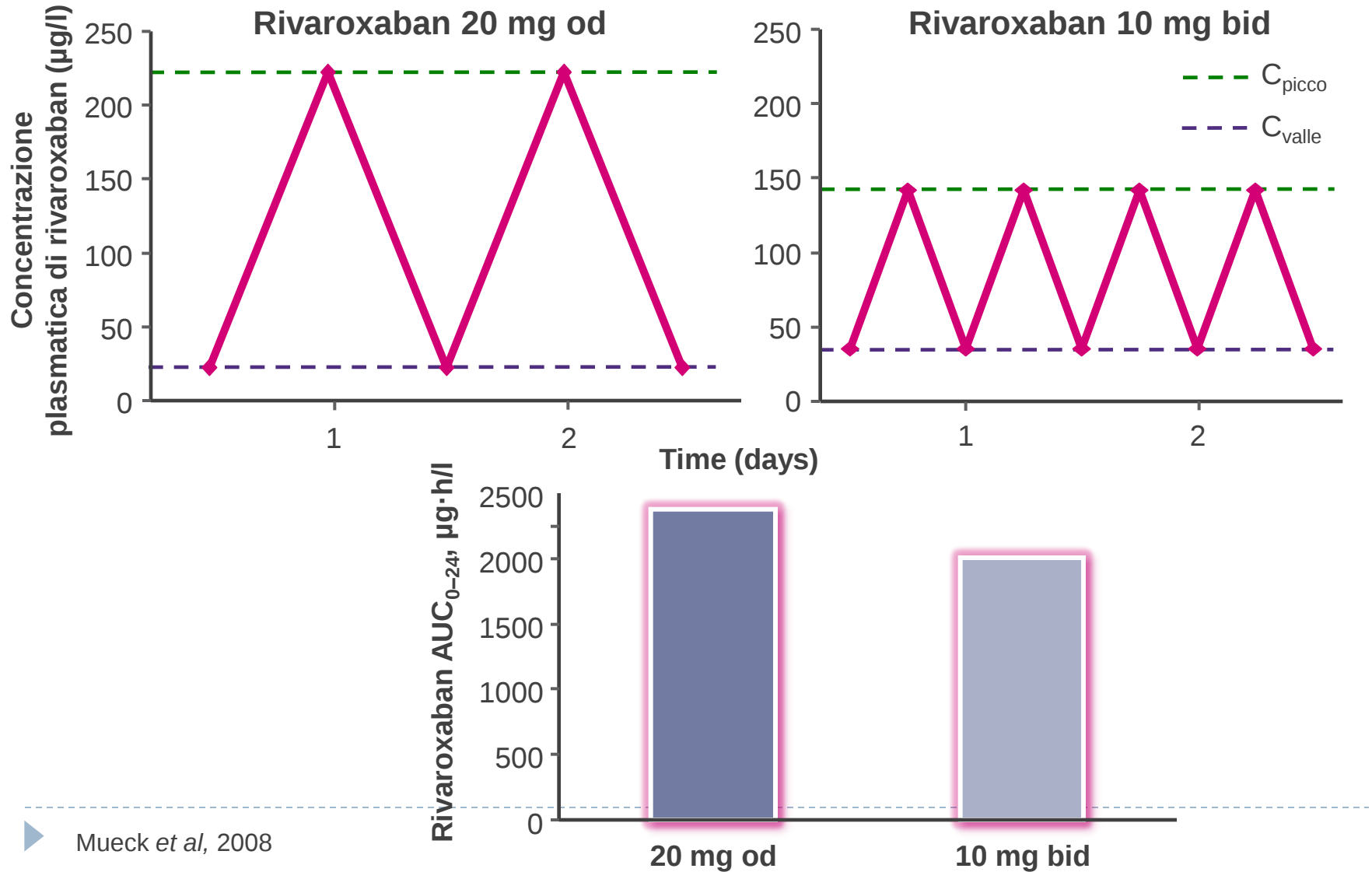
- ▶ The choice of the dose and regimen of administration is crucial in drug development
- ▶ Dose selection has to consider all elements maximizing efficacy while preserving safety
- ▶ It is selected in phase II studies – ideally, but not always – in the same patient population to whom the drug should be given
- ▶ Everything else being equal, patient's convenience (e.g., once daily dosing) is taken into account, as it increases adherence
- ▶ Adherence to the selected drug dosing is a major factor in the difference between a registration clinical trial and the actual post-marketing use of the drug

Influence of PK and PD parameters on dosing regimens

- ▶ The pharmacokinetic (PK) and pharmacodynamic (PD) characteristics of the new oral anticoagulants provide the opportunity for either od or bid dosing
- ▶ Determination of the optimal dosing regimen must be based on assessment of benefit (reduction in thrombotic events) versus risk (increase in bleeding events) in clinical studies



Rivaroxaban dosing od vs bid



No doubts that in AF patients compliance to therapy is better with OD than with BID dosing

Adv Ther (2012) 29(8):675–690.
DOI 10.1007/s12325-012-0040-x

ORIGINAL RESEARCH

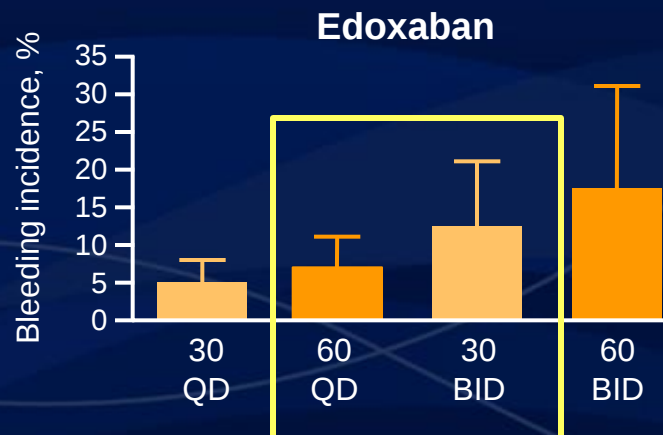
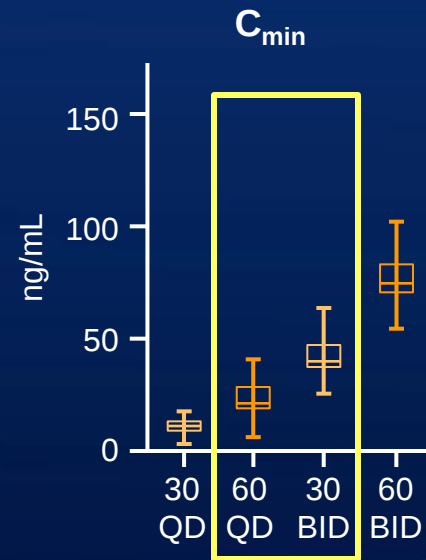
Impact of Daily Dosing Frequency on Adherence to Chronic Medications Among Nonvalvular Atrial Fibrillation Patients

François Laliberté · Winnie W. Nelson · Patrick Lefebvre · Jeff R. Schein · Jonathan Rondeau-Leclaire · Mei Sheng Duh

CONCLUSION

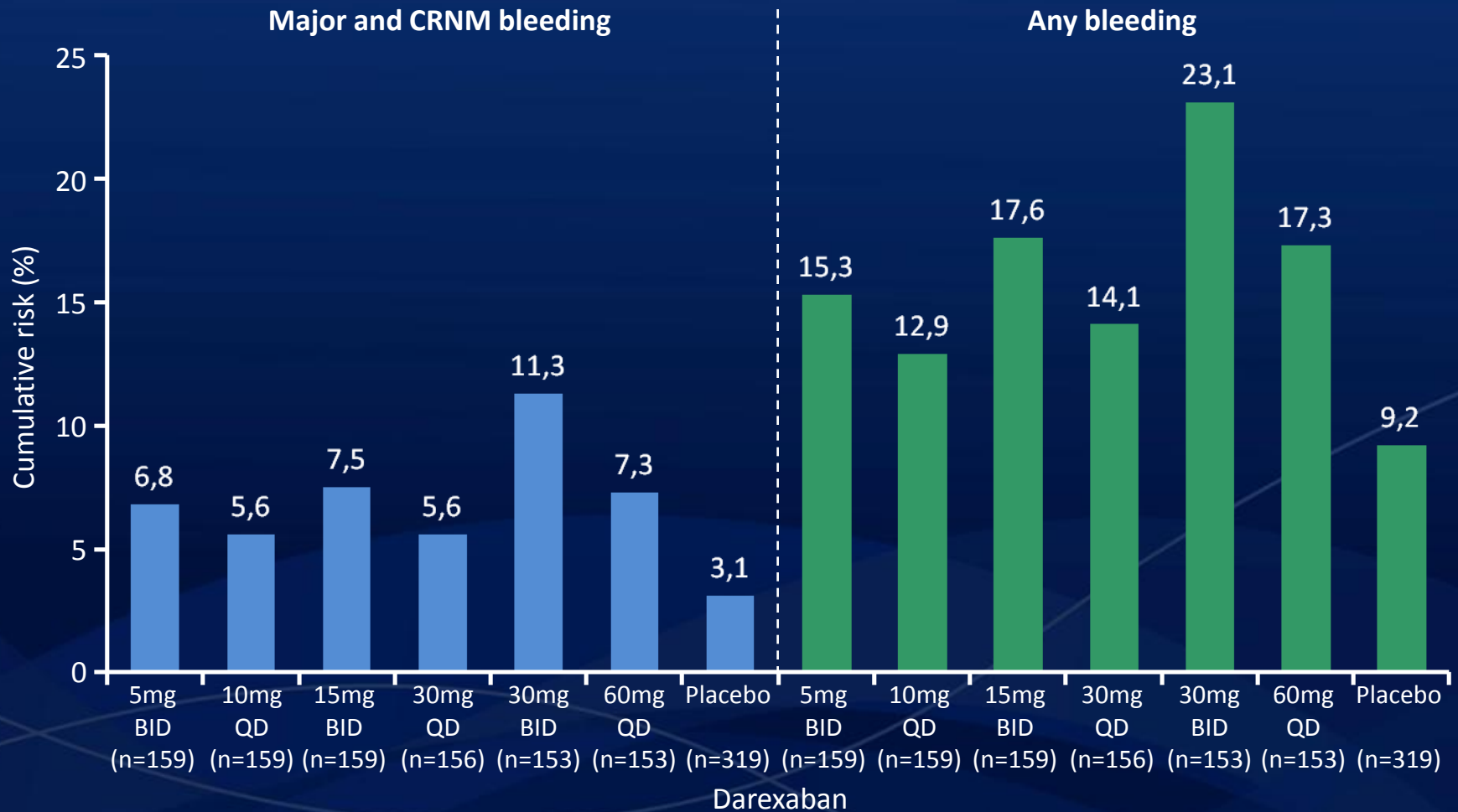
This large population-based study of >10,000 patients, based on real-world data, indicates that nonvalvular AF patients treated with q.d. dosing regimens for chronic medications were associated with approximately a 26% higher likelihood of adherence compared with subjects on b.i.d. regimens. The findings were consistent across two methods of determining medication adherence.

Edoxaban phase II dose finding study in atrial fibrillation: exposure and bleeding



AUC, area under the plasma concentration-time curve from 0 to 24 hours at steady-state;
C_{max}, maximum steady-state plasma concentration;
C_{min}, minimum steady-state concentration;
QD, once daily;
BID, twice daily

RUBY-1: cumulative risk of major and clinically relevant non-major bleeding and any bleeding events at 6 months (safety analysis set)



CRNM, clinically relevant non-major
BID, twice daily; QD, once daily

Therefore (conclusions):

- ▶ OD therapy in long-term stroke prevention in atrial fibrillation:
 - ▶ Appears to be as effective as BID
 - ▶ Appears to be as safe as BID
 - ▶ It might actually be safer than BID (indirect evidence from other anticoagulants)
 - ▶ It is certainly more appealing for the patient

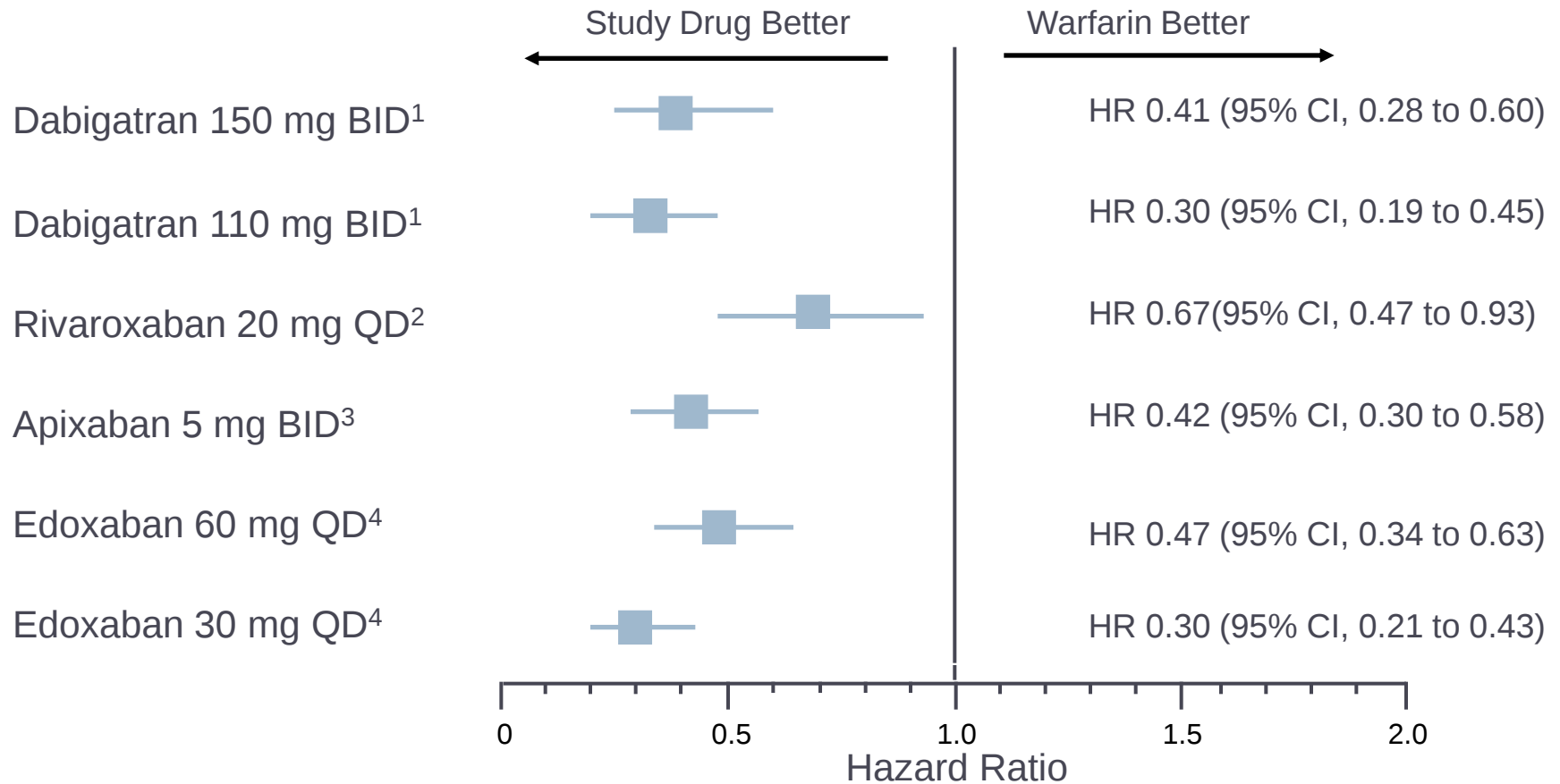


Agenda

- ▶ The history of oral anticoagulation
- ▶ The NOAC revolution
- ▶ Highlights from clinical trials: from bedside to bench
 - ▶ Once day vs twice day
 - ▶ Intracranial hemorrhage



New Anticoagulant Therapies Compared to Warfarin: Intracranial Hemorrhage



This chart may not be reproduced for other internal training or for external use.

1. Connolly SJ et al. *N Engl J Med*. 2010;363:1875-1876.

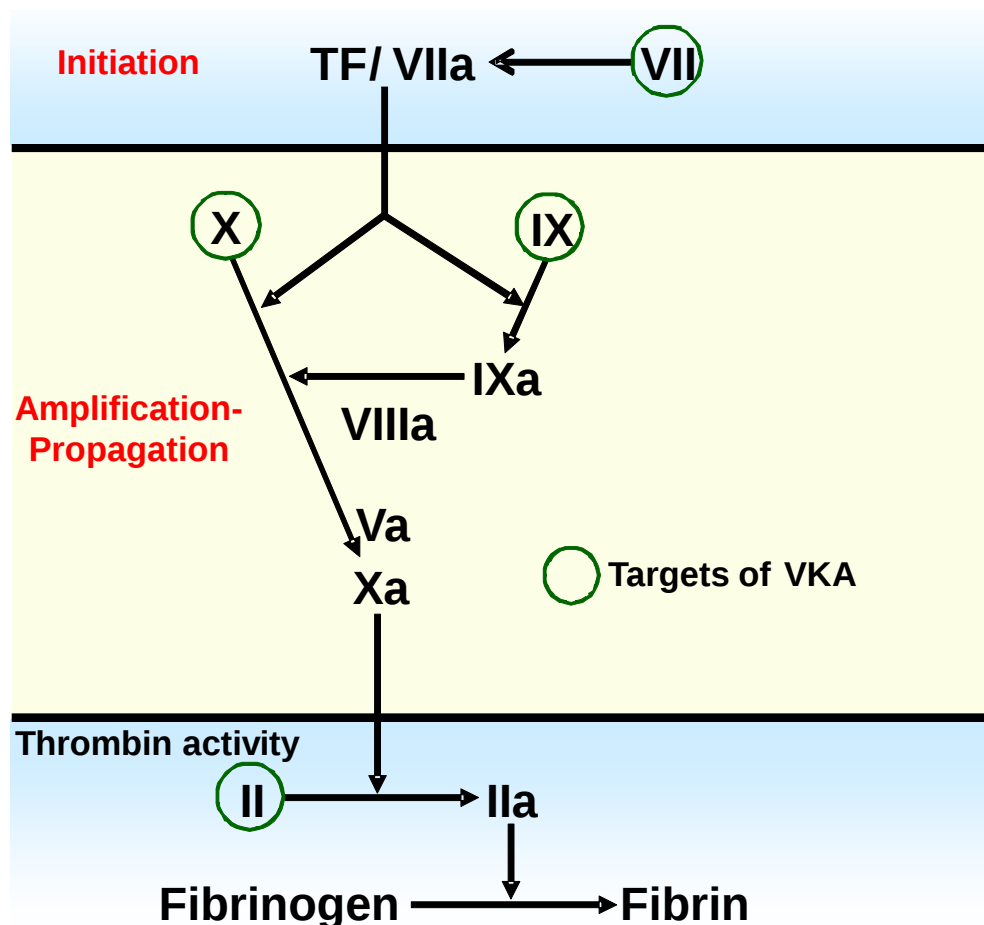
2. Patel MR et al. *N Engl J Med*. 2011;365:883-891.

3. Granger CB et al. *N Engl J Med*. 2011;365:981-992.

4. Giugliano RP et al, for the ENGAGE-AF TIMI 48 Investigators; *NEJM*; 2013, doi: 10.1056/NEJMoa1310907

General mechanisms of coagulation and targets of anticoagulants (Section I)

Position Paper of the ESC Working Group on Thrombosis – Task Force on Anticoagulants in Heart Disease



Why is warfarin more dangerous than NOACs as to intracranial hemorrhage?

- ▶ Warfarin interferes with the formation of a gamma-carboxylated bioactive form of Factor VII
- ▶ Factor VII is a crucial mediator of tissue-factor initiated coagulation (the extrinsic pathway)
- ▶ The brain is extremely rich in tissue factor, possibly («teleologically») aimed at preventing the catastrophic occurrence of intracerebral bleeding
- ▶ By interfering with this pathway, warfarin has a high risk of intracranial hemorrhage, a risk not shared by NOACs



Agenda

- ▶ The history of oral anticoagulation
- ▶ The NOAC revolution
- ▶ Highlights from clinical trials: from bedside to bench
 - ▶ Once day vs twice day
 - ▶ Intracranial hemorrhage
 - ▶ New treatment indications – coronary artery disease



A P2Y₁₂ inhibitor is recommended, in addition to aspirin, for 12 months unless there are contraindications such as excessive risk of bleeds.

- Ticagrelor (180 mg loading dose, 90 mg twice daily) is recommended, in the absence of contraindications,^e for all patients at moderate-to-high risk of ischaemic events (e.g. elevated cardiac troponins), regardless of initial treatment strategy and including those pretreated with clopidogrel (which should be discontinued when ticagrelor is started).
- Prasugrel (60 mg loading dose, 10 mg daily dose) is recommended in patients who are proceeding to PCI if no contraindication.^e
- Clopidogrel (300–600 mg loading dose, 75 mg daily dose) is recommended for patients who cannot receive ticagrelor or prasugrel or who require oral anticoagulation.

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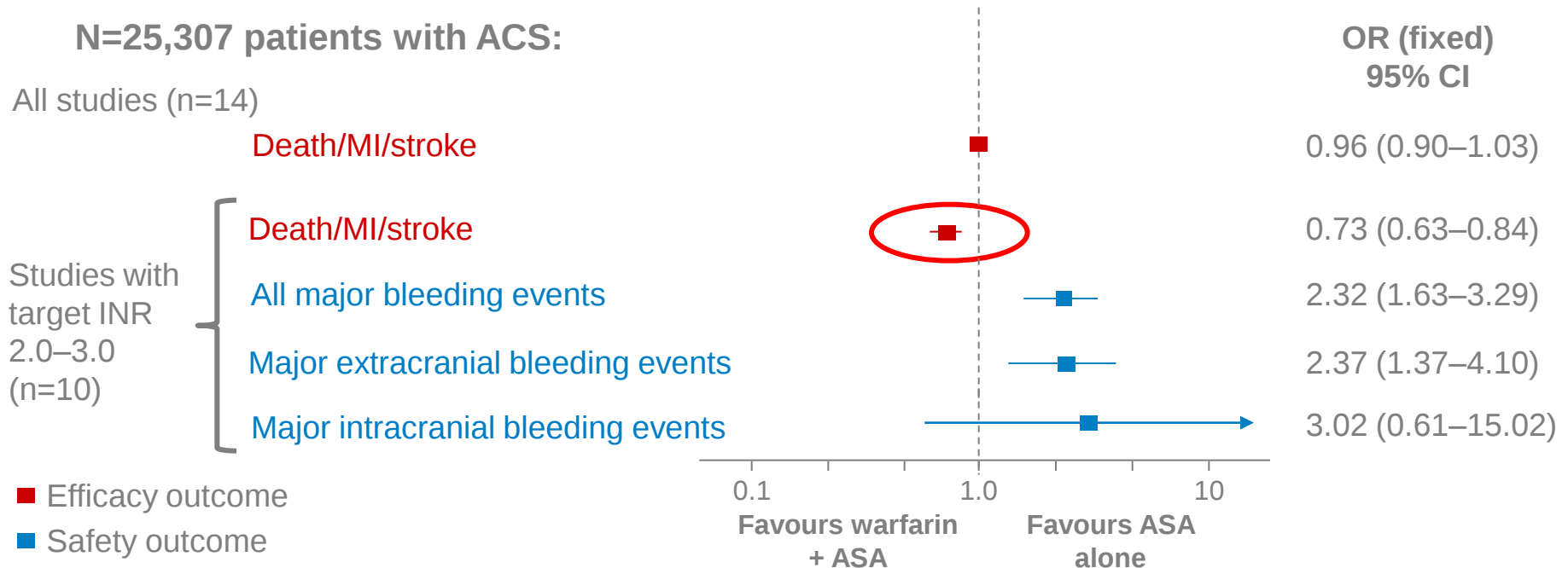


2015 ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation

Why adding an anticoagulant
long-term?



Meta-analysis: ASA + warfarin reduced CV outcomes vs ASA alone

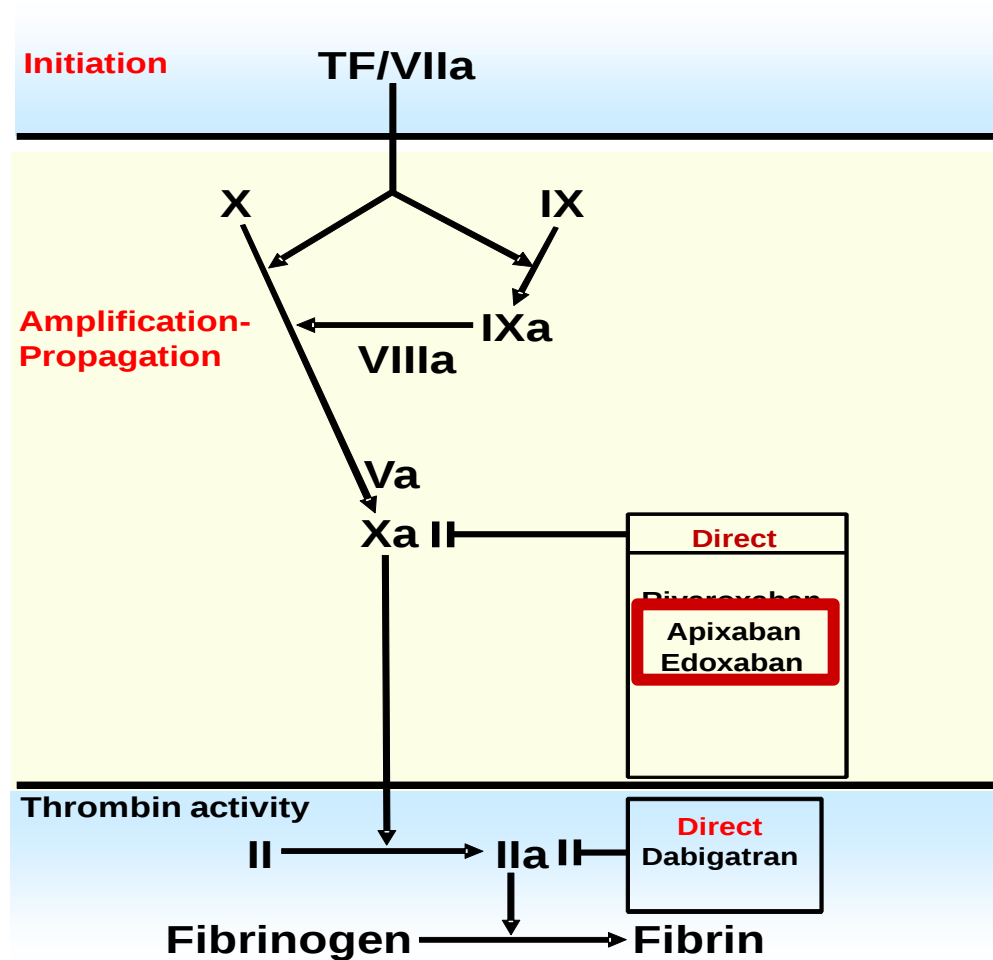


- ▶ Warfarin + ASA versus ASA alone:
 - ▶ Reduces death/MI/stroke only when the correct therapeutic dose is applied (INR 2.0–3.0)
 - ▶ Increases the risk of major bleeding events

ACS, acute coronary syndrome; ASA, acetylsalicylic acid; CI, confidence interval; CV, cardiovascular; INR, international normalized ratio; MI, myocardial infarction; OR, odds ratio.

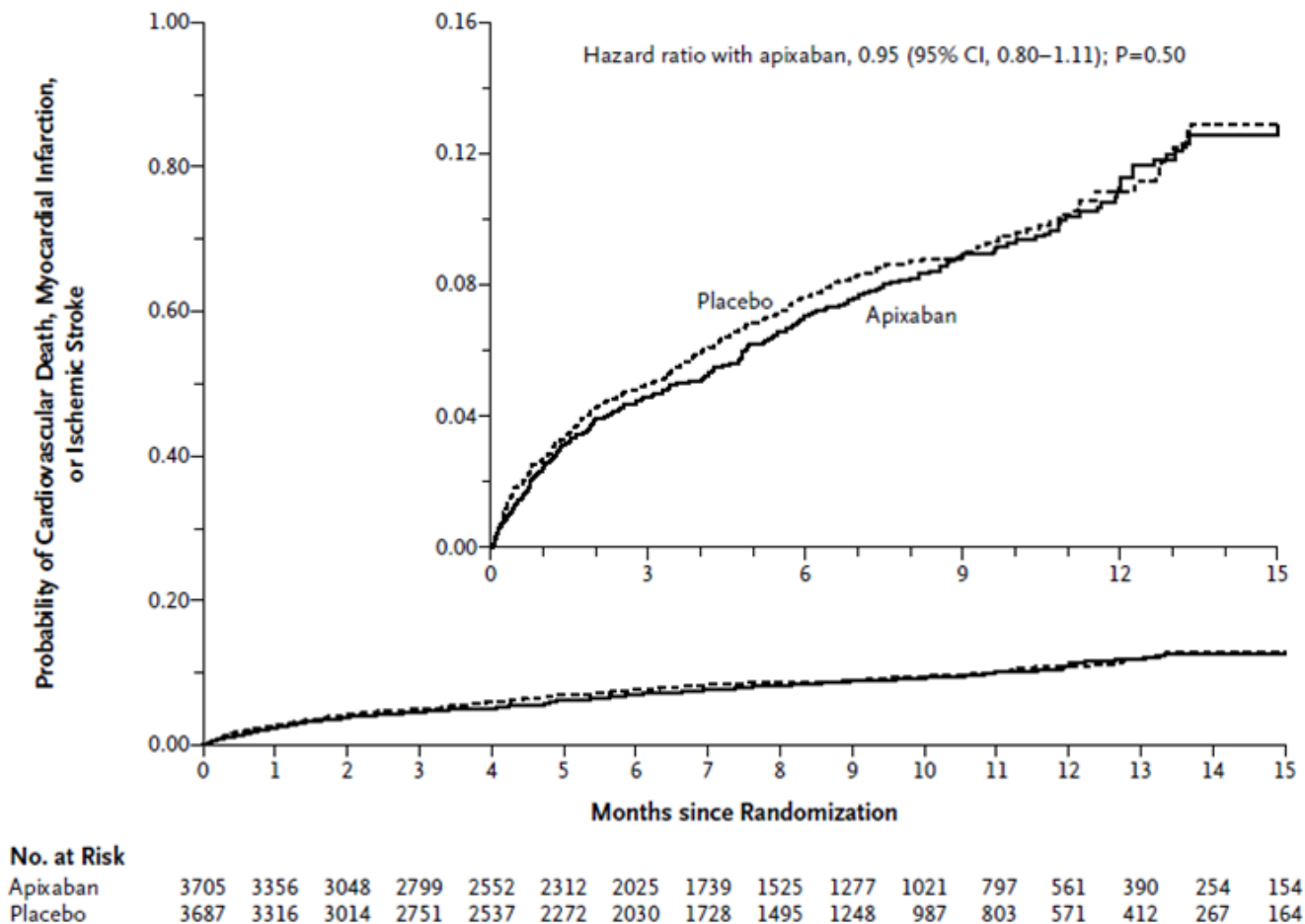
Andreotti *et al. Eur Heart J* 2006;27:519–26.

A new era in anticoagulation



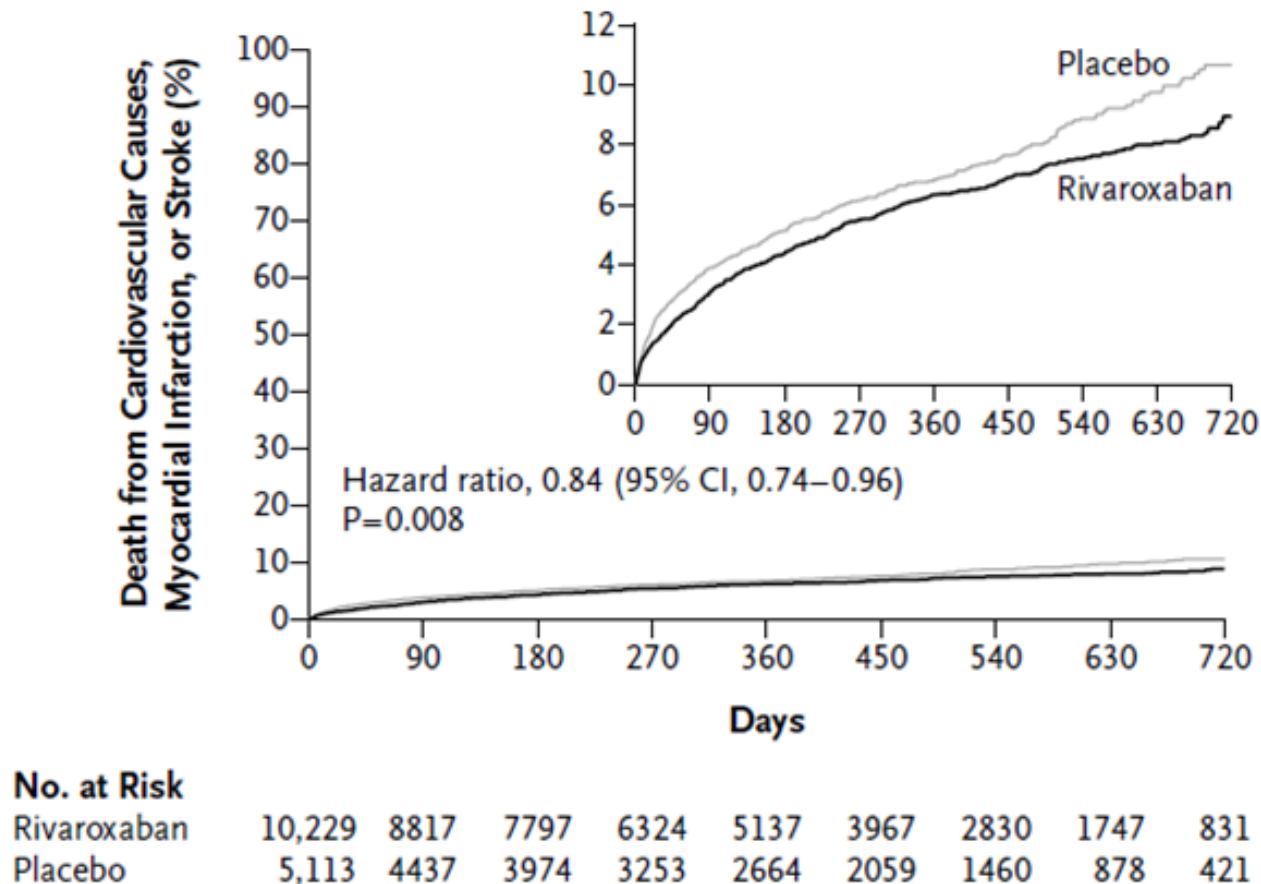
De Caterina *et al. Thromb Haemost* 2013;109:569–79.

APPRAISE-2: Primary efficacy outcome (CV death, MI, stroke)



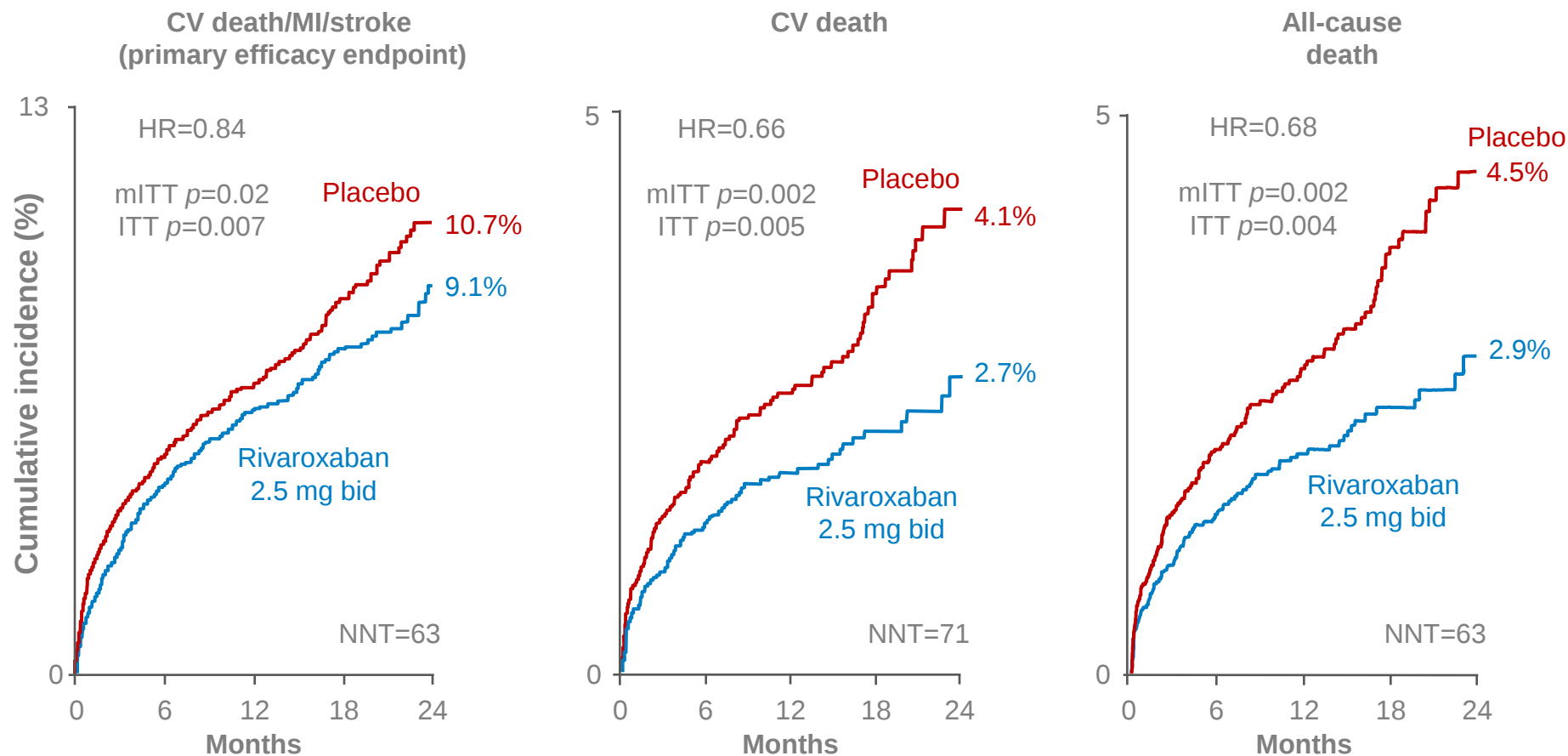
Alexander *et al.* *N Engl J Med* 2011;365:699–708.

ATLAS ACS 2–TIMI 51: Primary efficacy outcome (CV death, MI, stroke)



ATLAS ACS 2–TIMI 51: rivaroxaban 2.5 mg bid significantly reduced CV events and death

The primary efficacy endpoint reduction was driven by reduced mortality



Both strata. bid, twice daily; CV, cardiovascular; HR, hazard ratio; ITT, intention to treat; MI, myocardial infarction; mITT, modified intention to treat; NNT, number needed to treat.

1. Mega et al. *N Engl J Med* 2012;366:9–19; 2. Gibson et al. *AHA* 2011 (www.clinicaltrialresults.org).

Rivaroxaban 2.5 mg bid in ATLAS ACS 2–TIMI 51 vs standard antiplatelet therapy showed...

- ▶ Greater efficacy, including fewer deaths and reduction in stent thrombosis (not shown)
- ▶ An important increase in bleeding, including intracranial haemorrhage (ICH), but without any increase in fatal bleeding or fatal ICH
- ▶ Even greater benefits in patients with elevated cardiac biomarkers and without previous stroke/TIA

Difficulties in buying this concept

- ▶ Triple therapy in ACS is more complicated than DAPT using ticagrelor (or prasugrel)
- ▶ Identifying candidate patients is somewhat complicated
- ▶ Clopidogrel perceived as «an old drug»
- ▶ Is the lower mortality with rivaroxaban real? «*One swallow does not make spring*»
- ▶ Difficulties in accepting the much higher rates of bleeding

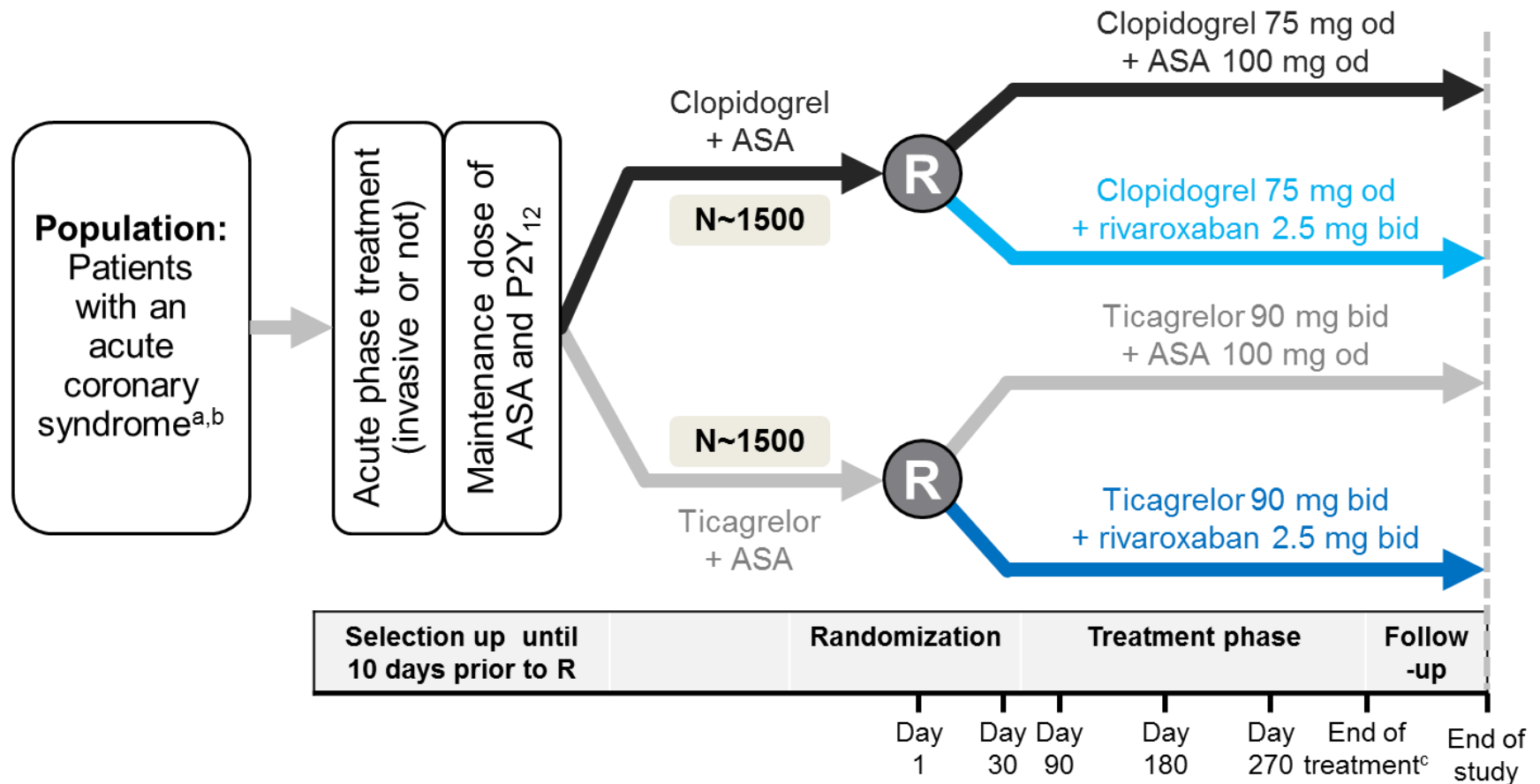


Can we then use rivaroxaban
dropping aspirin in CAD?



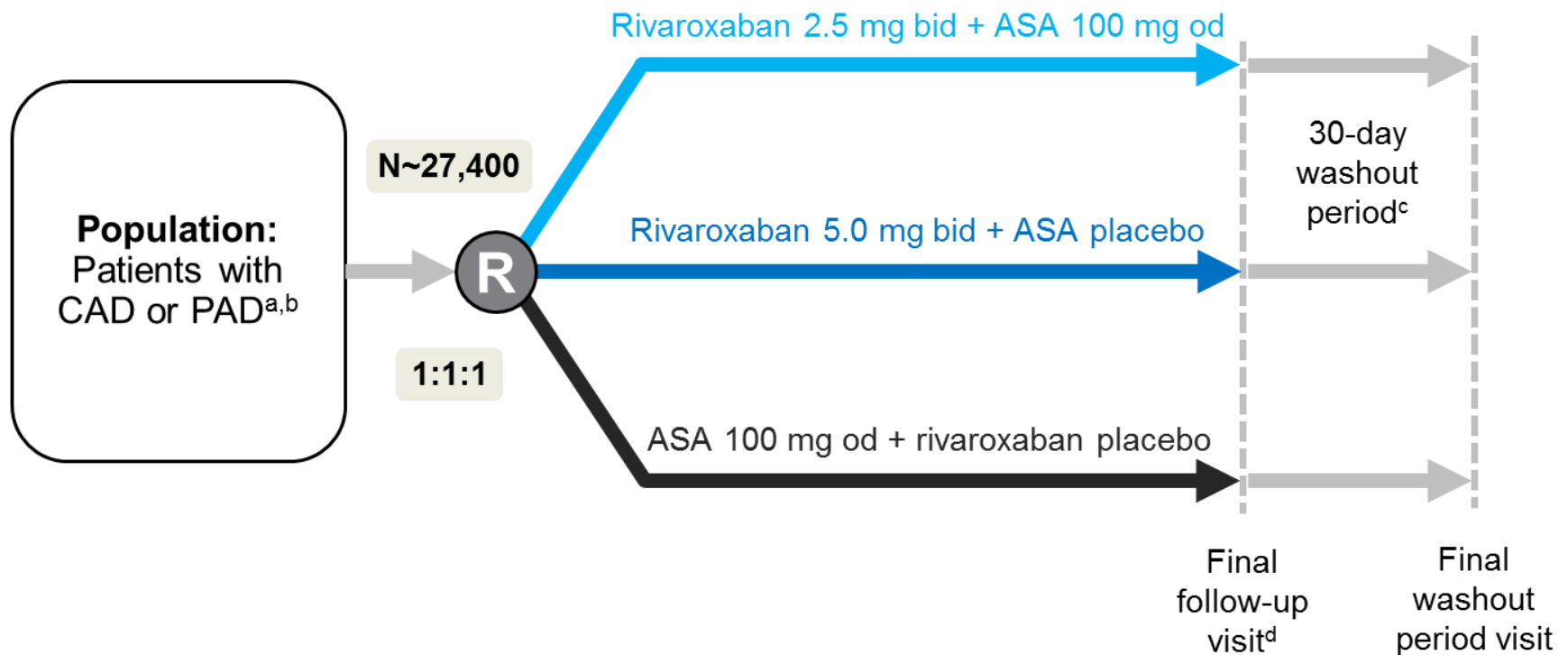
GEMINI-ACS-1 Study Design

Objective: Safety of rivaroxaban versus ASA in addition to either clopidogrel or ticagrelor therapy in patients with a recent ACS



COMPASS Study Design

Objective: Efficacy and safety of rivaroxaban, low-dose rivaroxaban plus ASA or ASA alone for reducing risk of MI, stroke or CV death in patients with CAD or PAD





News Release

Not intended for U.S. and UK Media

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Phase III COMPASS study with Bayer's Rivaroxaban in Patients with Coronary or Peripheral Artery Disease Shows Overwhelming Efficacy and Meets Primary Endpoint Early

08 Feb 2017



Conclusions

- ▶ A very exciting era in cardiology with NOACs, about 70 years after the patenting of warfarin as a rat poison!



Stay tuned!

