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What is the best imaging protocol for LVO screening when outside of 0-6h window?

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Disclosures

Research support: EU, BMBF, BMWi, Microvention

Presentations: Bayer, Boehringer, Bracco, Codman, Penumbra, Sanofi, Siemens, Stryker

Consultancy: Acandis, Covidien/Medtronic, Medina, Microvention, Penumbra, Stryker, Sequent



“If you wish to converse with me, define your terms.” said Voltaire, “

How many a debate would have been deflated into a paragraph if the disputants had dared to define their terms!

—*Will Durant*

Where are you?

Principles

Good outcome

Proximal occlusion



High therapy effect

Proximal occlusion



Potential therapy effect

Any occlusion



Modify expectations: Skills and infrastructure

The lucky few

High-end imaging 24/7/365 available
Excellent interpretation skills 24/7/365 available



The majority


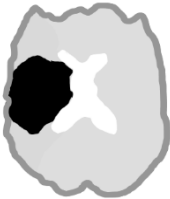

Mixed quality of CT/MRI equipment
Always some new Radiologists

The wasteland

Old NE-CT, „CTA-resistance“
Unfriendly radiologists, no interest in stroke



Where are you?

	Principles	The lucky few	The majority	The wasteland
Good outcome	Proximal occlusion 	Proximal occlusion Small core	Eyeballing with little software support*	Eyeballing with more software support*
High therapy effect	Proximal occlusion 	Proximal occlusion Medium core	Eyeballing only	Eyeballing only
Potential therapy effect	Any occlusion 	Any occlusion Large core	Eyeballing only	Eyeballing only

*Vendors, RAPID, Brainomix, ...

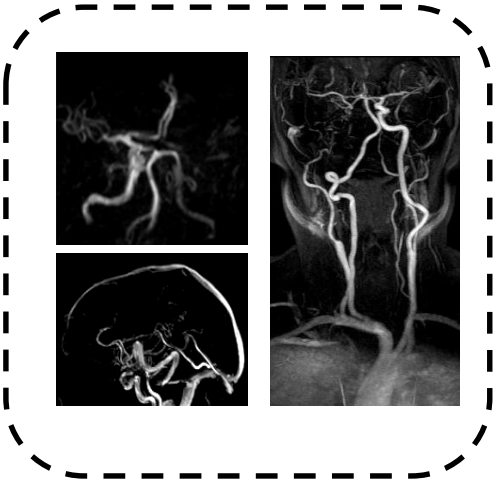
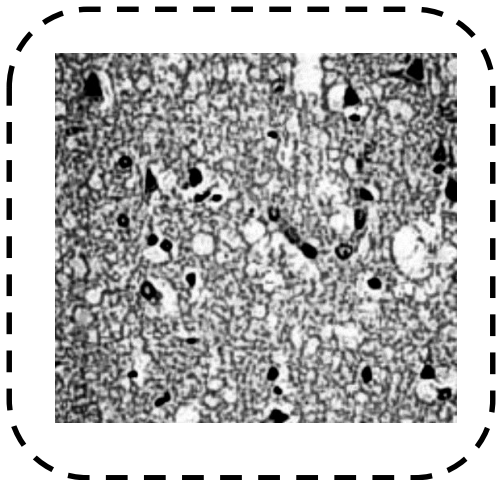
Pipes



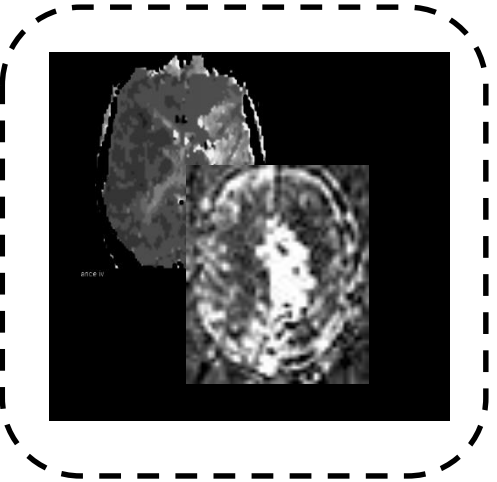
Perfusion



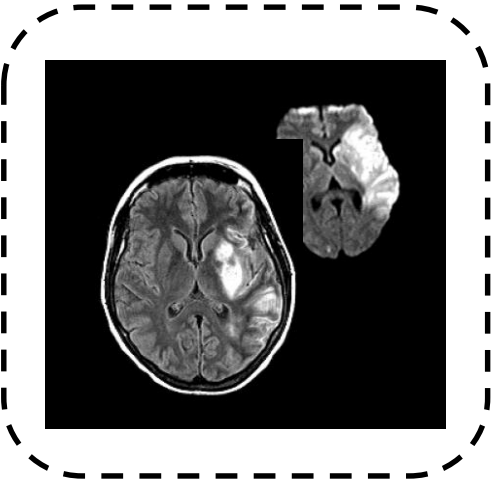
Infarct



Occlusion
Collaterals



„Tissue at risk“



Ischemic core

Why reanalyse a M1 occlusion?

acute



Differentiate between predicting
Good outcome and therapy effect!

F/U
Infarct



Full success!

Infarct volume 18 cm³
mRS (90) **5→0**

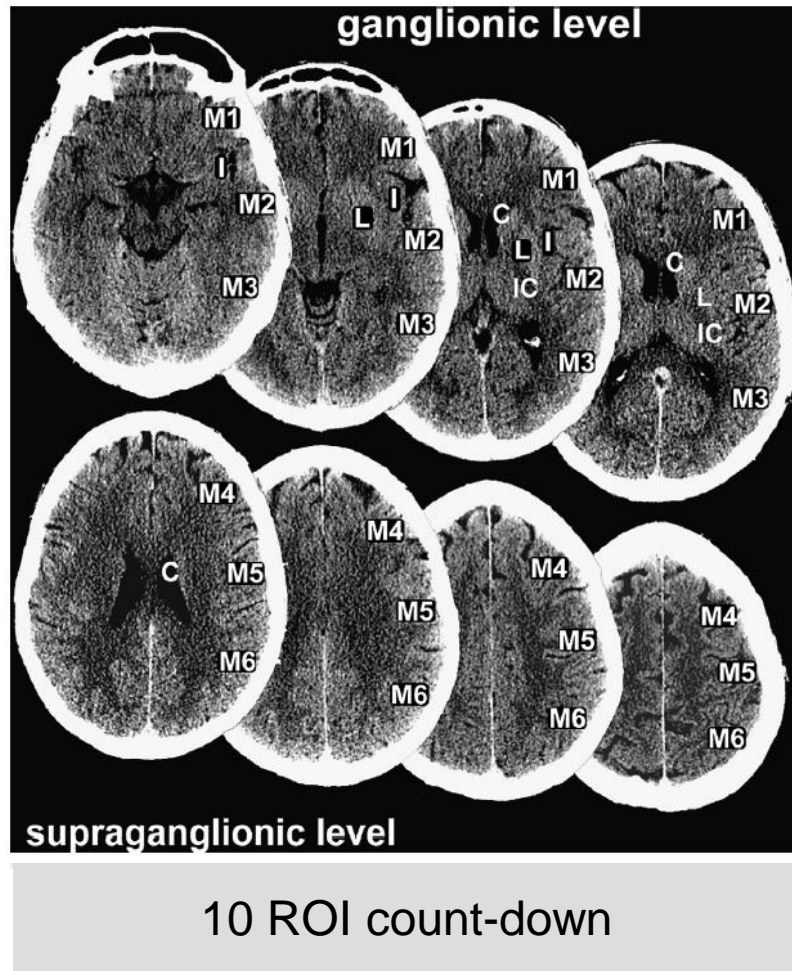
„Sub radar success“

Infarct volume 124 cm³
mRS (90) **5→3**

Futile recanalisation

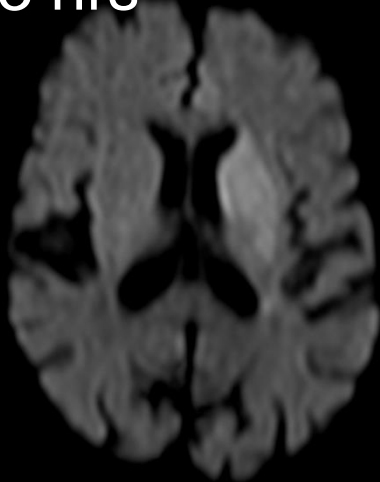
Infarct volume 402 cm³
mRS (90) **5→5**

ASPECTS on tissue damage?

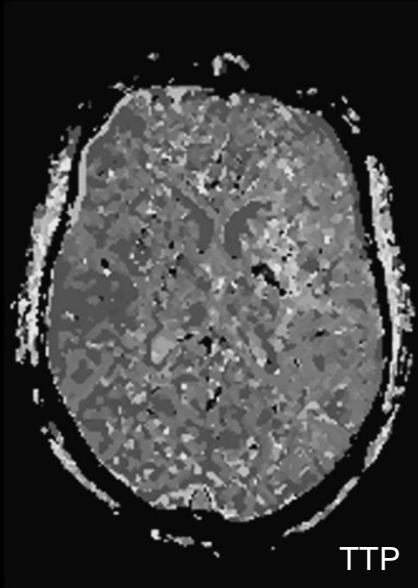


Ischemic core: lesions can grow for days

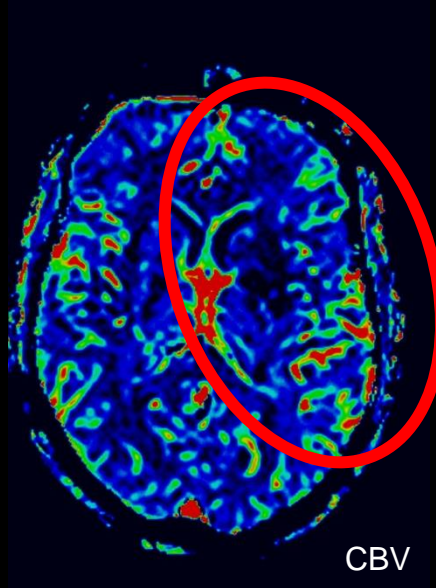
3 hrs



DWI



TTP



CBV



CE-MRA

27 hrs

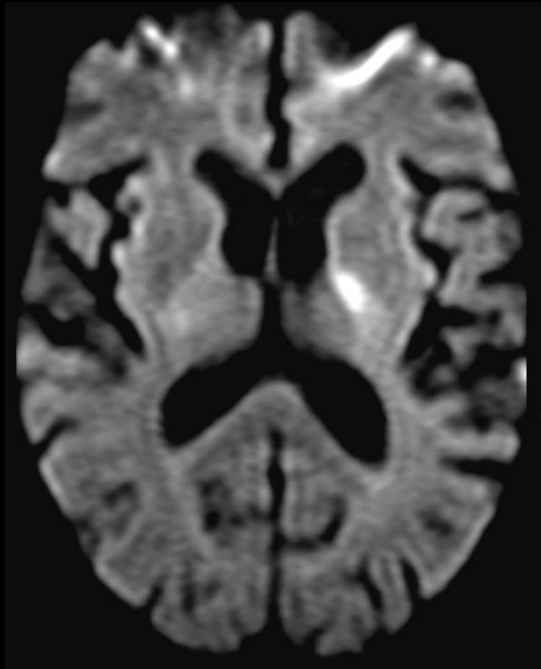
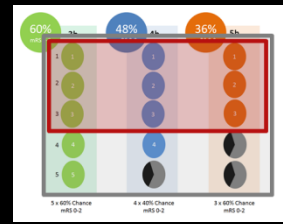


4 days

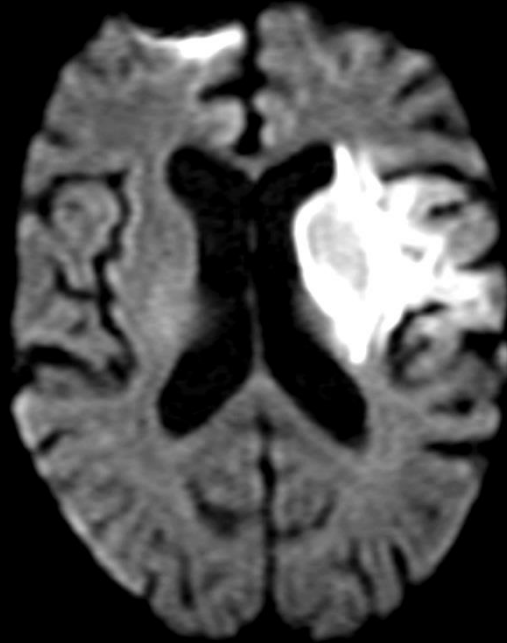


*74 y female, M1-occlusion, 2010, no recanalization because of „no mismatch“

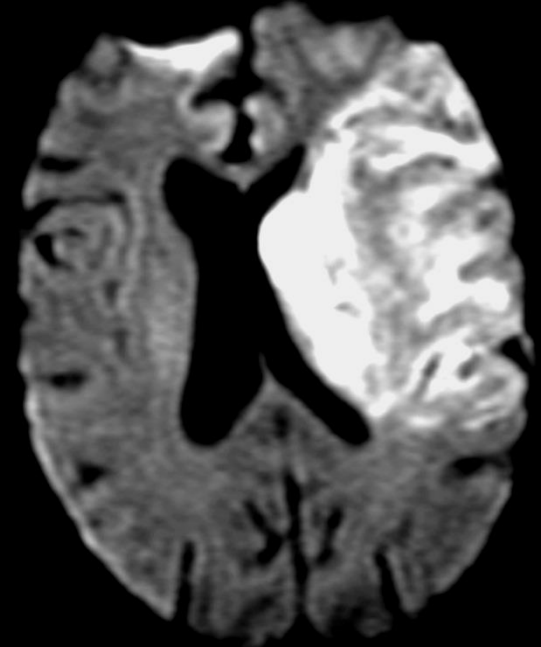
#1: Ischemic core: lesions can grow for days



3h



27 h



5 d

*74 y female, Carotid-T-occlusion, 2002, IA tPA without recanalization

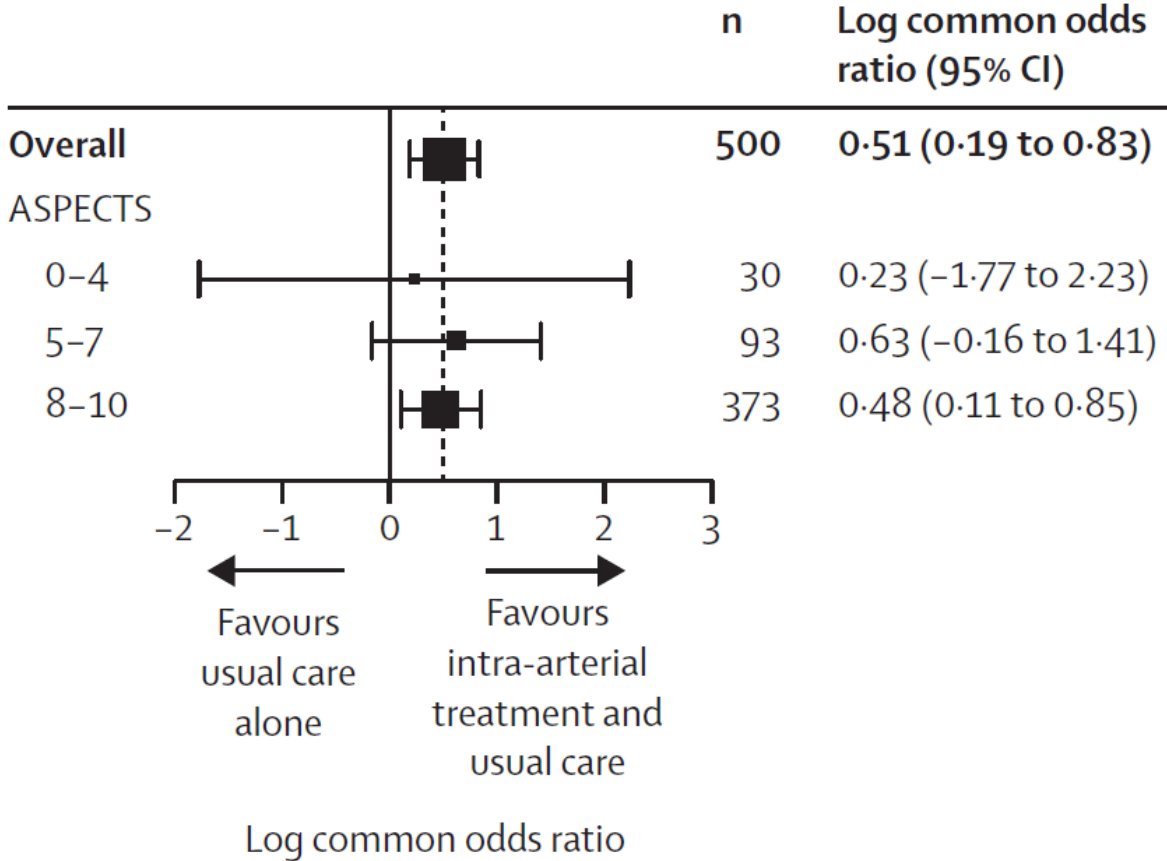
EROICAS (ESMINT, EANS, ESNR, ESO, EAN, EuSEM)

Which imaging selection criteria?

- Occlusions of **MCA (M1 or M2)** and/or of the intracranial ICA should be diagnosed with non-invasive imaging if possible before considering treatment. (Quality of evidence: **high**, Strength of recommendation: **strong**).
- EVT can be considered if there is an occlusion or stenosis of the MCA, ICA or vertebral/basilar artery in addition to a suitable intracranial target (tandem pathology). (Quality of evidence: **moderate**, Strength of recommendation: **strong**).
- The additional benefit of **advanced perfusion or collateral image processing** for patient selection is **not established** and requires further study. (Quality of evidence: **low**, Strength of recommendation: **strong**).

And the ASPECTS score?

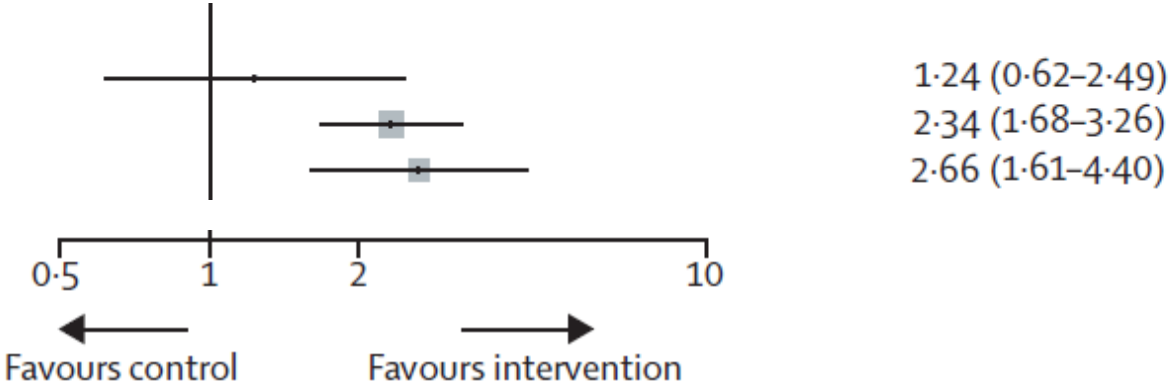
MR Clean: ASPECTS vs. MT effect



HERMES*: Meta-Analysis of individual patient data

ASPECTS ($p_{\text{interaction}} = 0.29$)

0-5	121
6-8	475
9-10	682



Confirmation from France: THRACE

Clinical

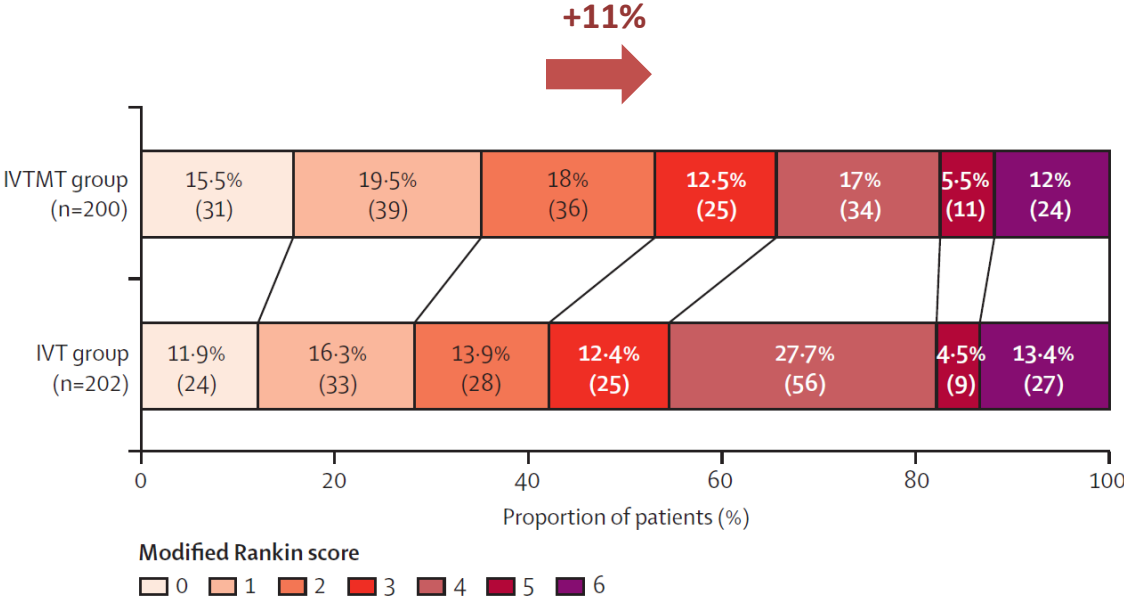
18–80 years, NIHSS score 10–25, IV tPA <3h (later <4h), MT start <5h

Imaging

CTA/MRA: occlusion of ICA, M1, superior third of basilar artery, cervical ICA occlusion excluded

No ASPECTS limit

**RCT, 414 patients from 26 centres in France
Duration: 06/10-02/15**



mTICI 2b–3: 69%

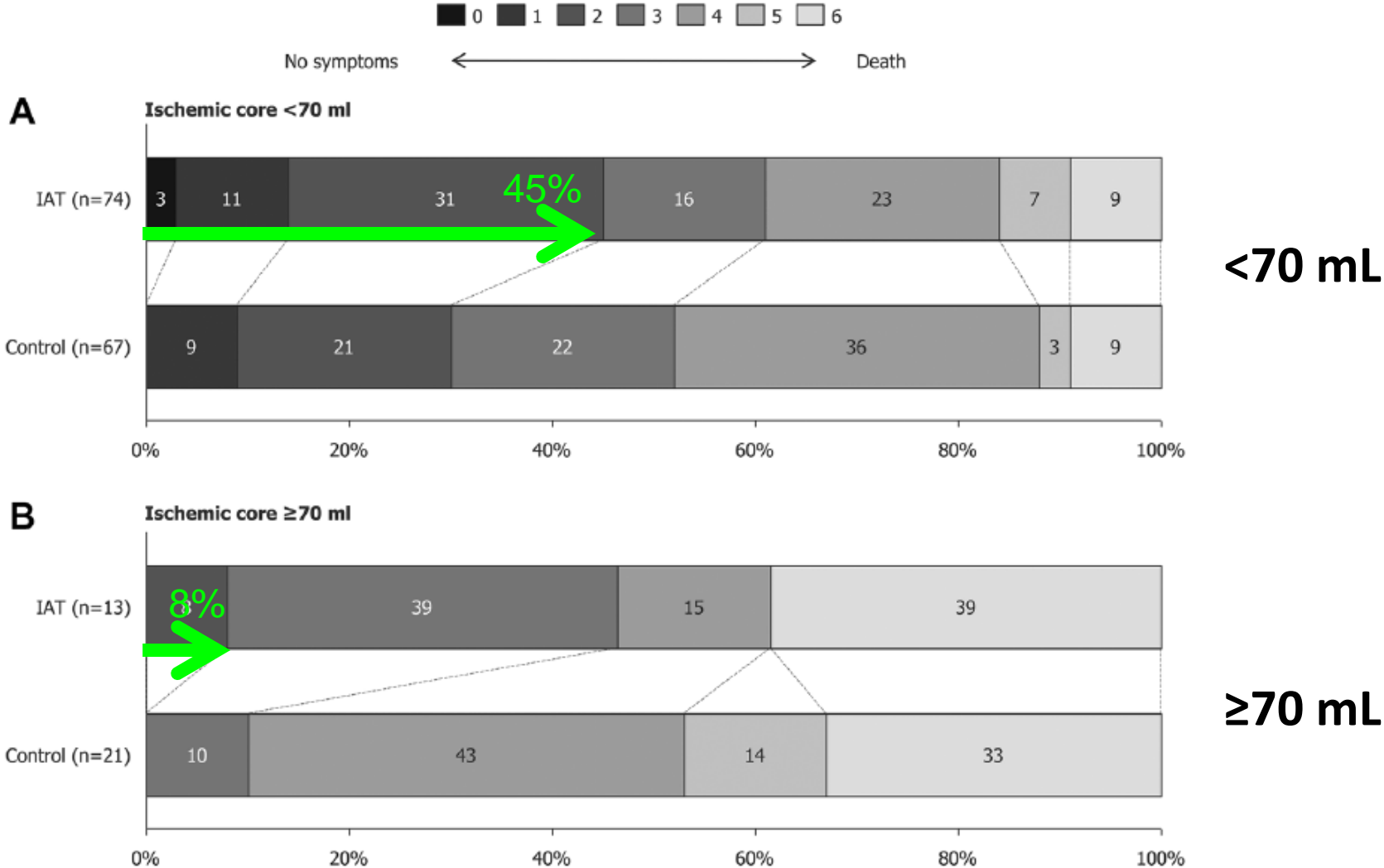
Bracad, S et al. Lancet Neurol 2016 Oct;15(11):1138-1147. Epub 2016 Aug 23. Mechanical thrombectomy after intravenous alteplase versus alteplase alone after stroke (THRACE): a randomised controlled trial.

EROICAS: Imaging criteria for thrombectomy

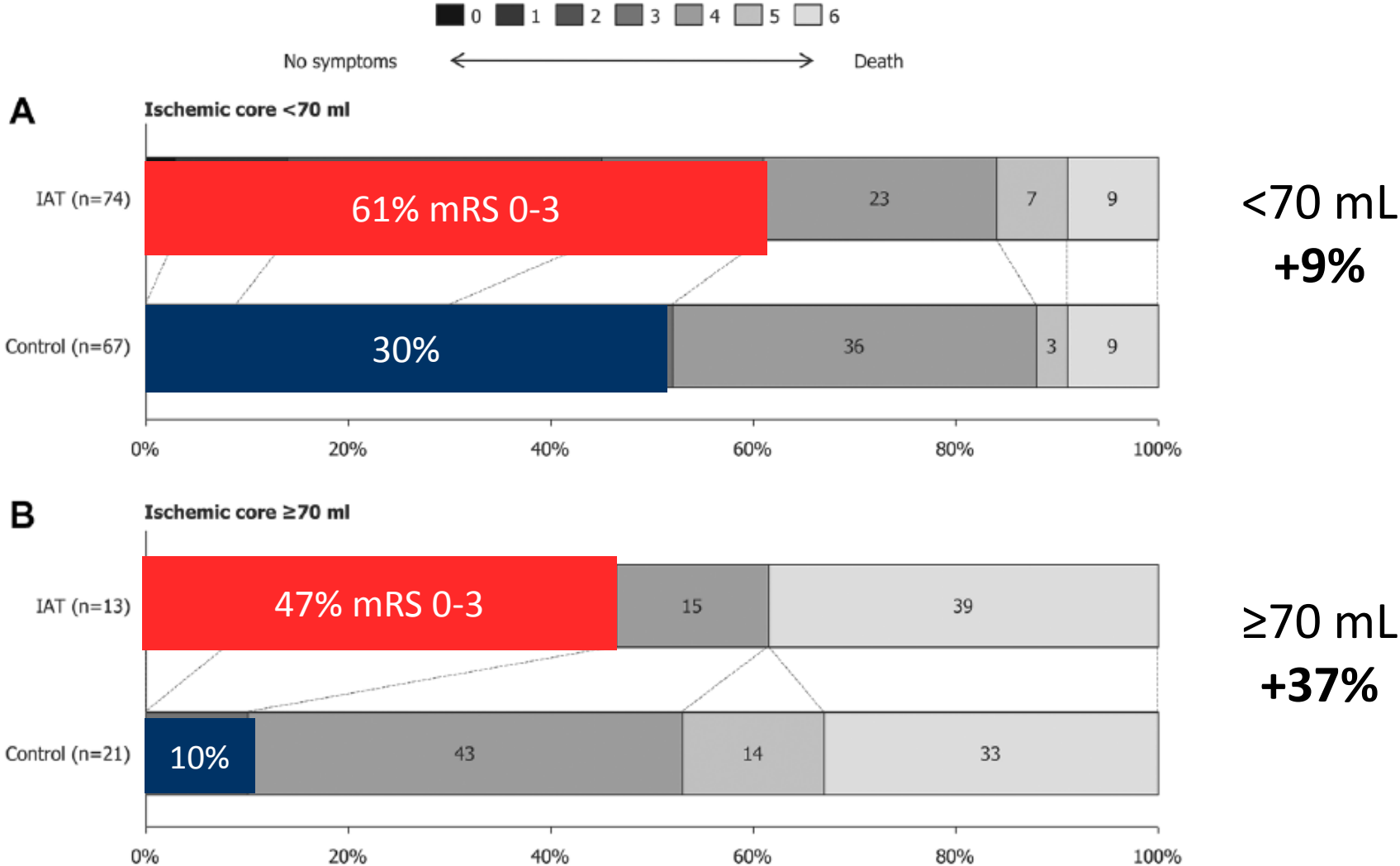
ASPECTS mentioned just under „**Additional information**“:

- The ASPECTS score has only moderate to good interobserver agreement in the hyperacute stroke setting.
- In patients with lower initial ASPECTS, the location of the hypodensity can be taken into consideration. No treatment interaction with ASPECTS has been demonstrated but ASPECTS 0-4 are barely represented in recent trials.
- **Further RCTs in patients with ASPECTS 0-5 are warranted.**

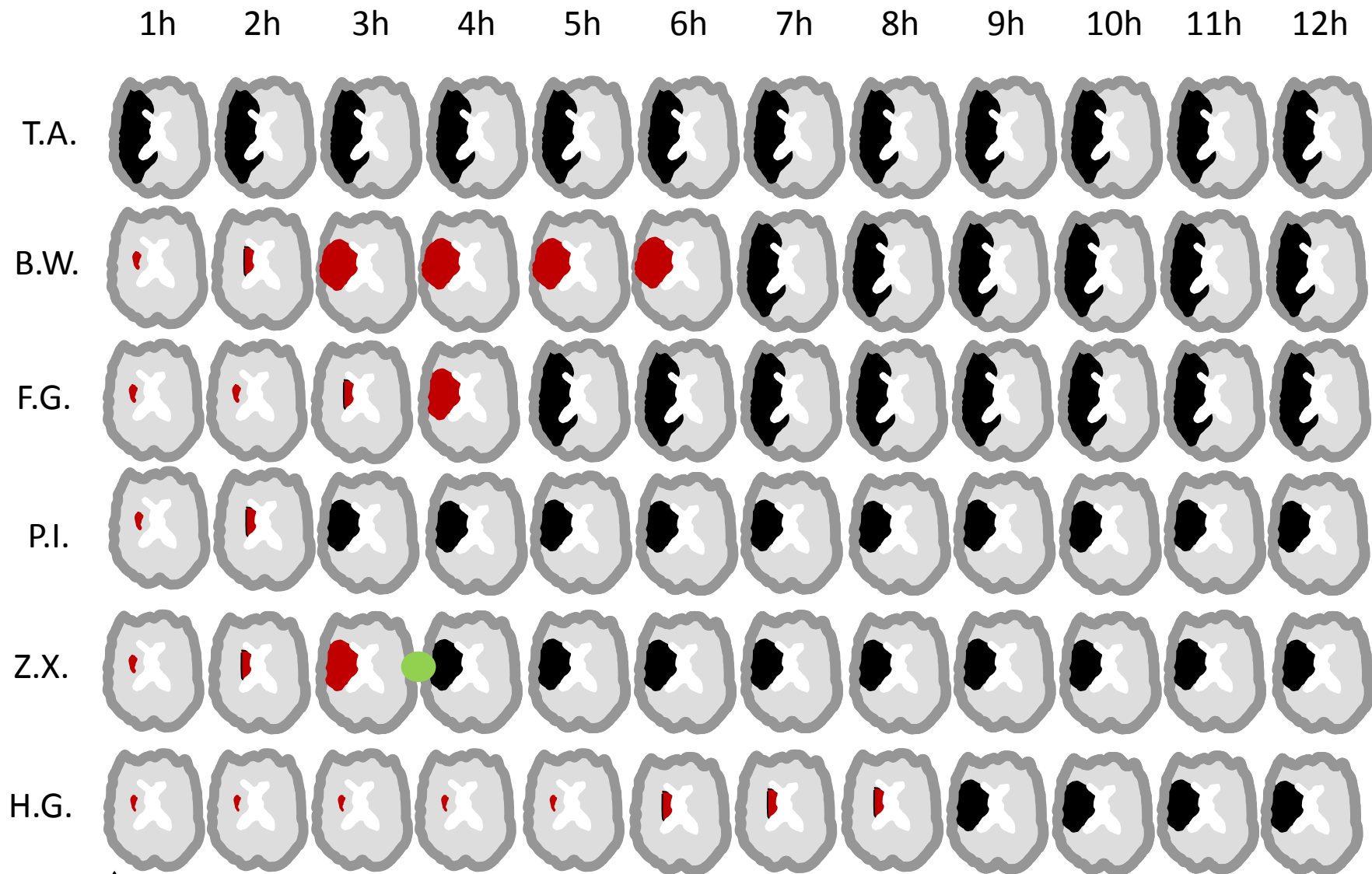
Ischemic core volume and outcome in MR Clean



Ischemic core volume and outcome in MR Clean





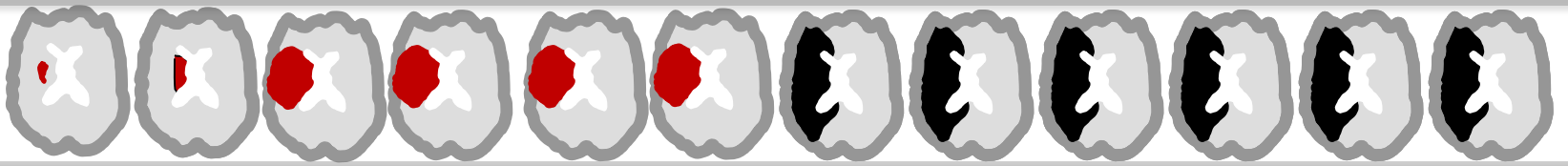


1h 2h 3h 4h 5h 6h 7h 8h 9h 10h 11h 12h

T.A.



B.W.



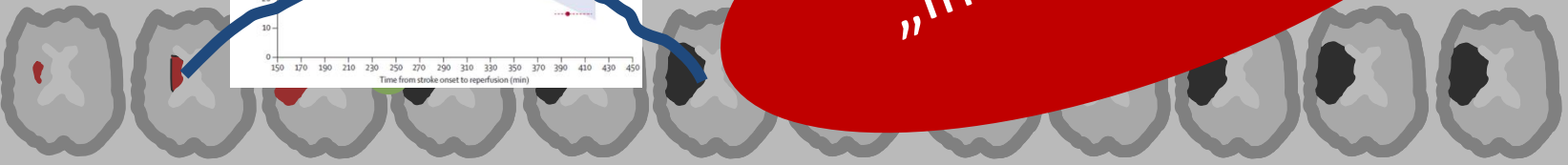
F.G.



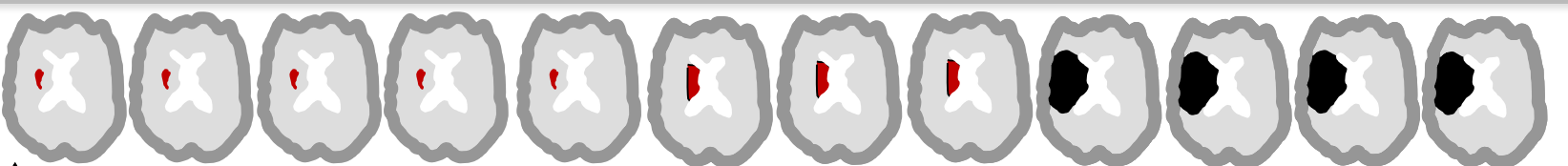
P.I.



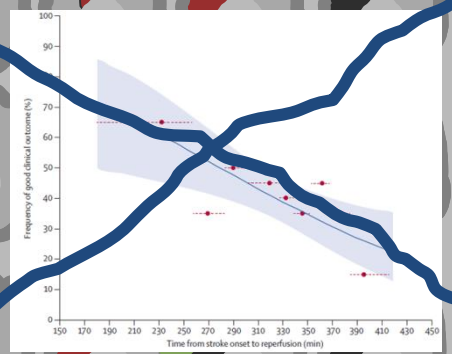
Z.X.



H.G.



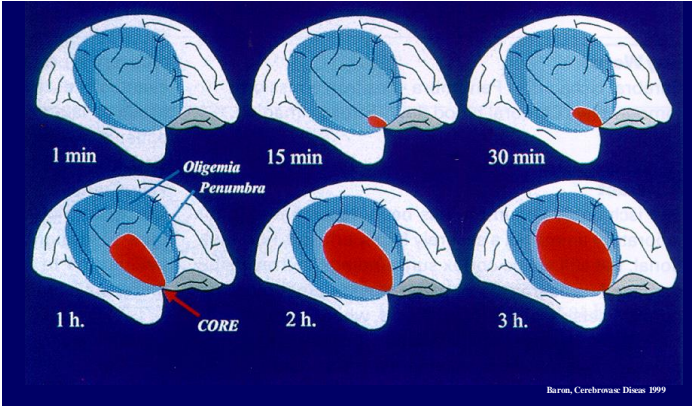
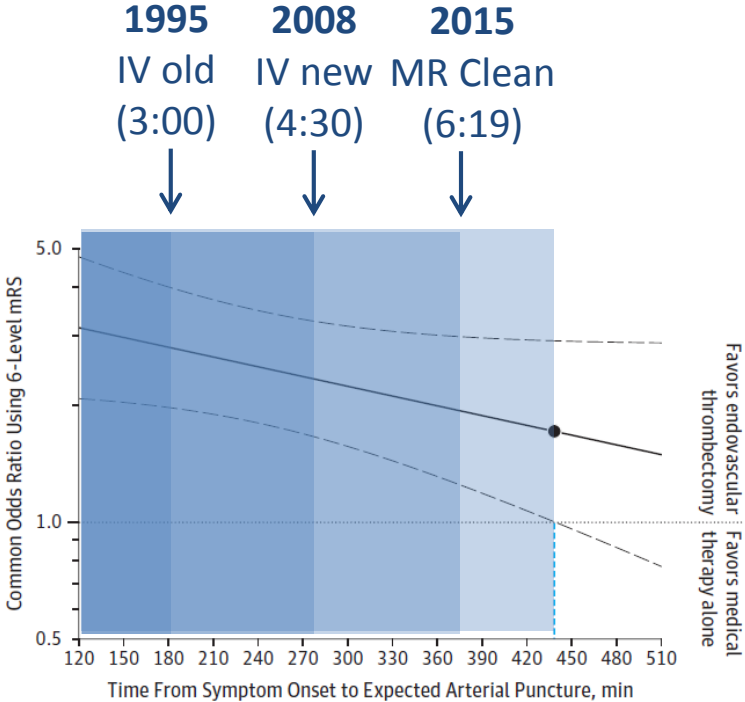
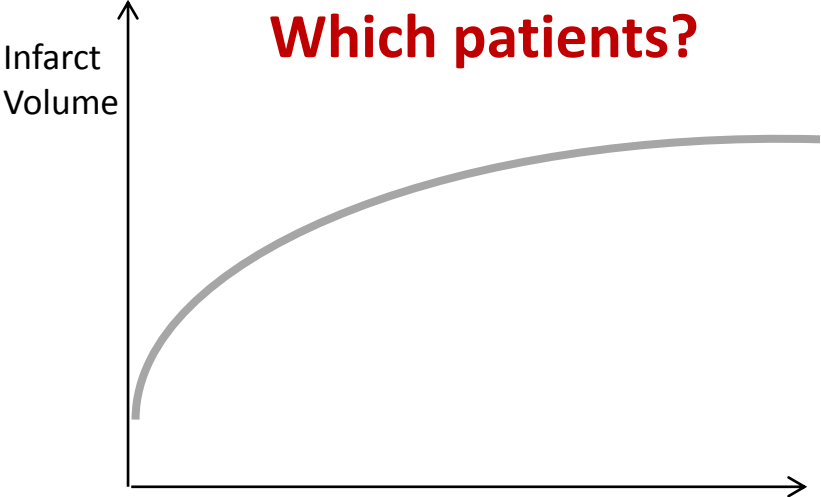
Volumen ↑



„Imaging is brain“

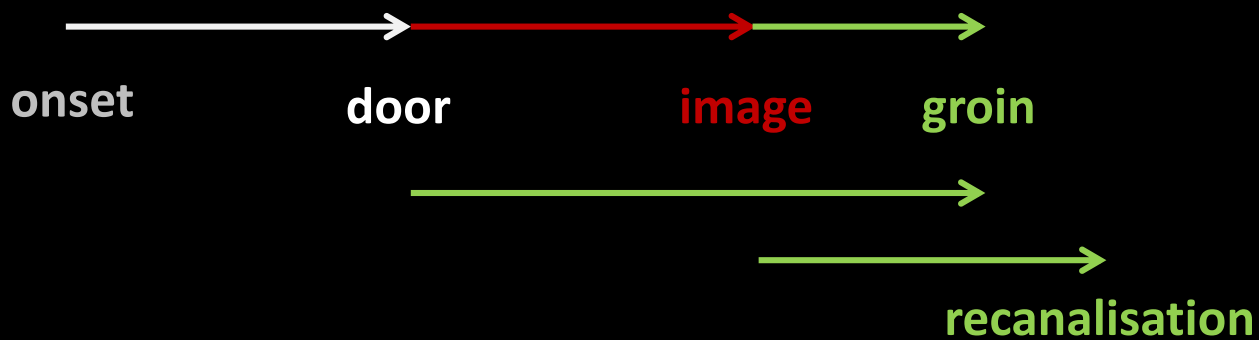
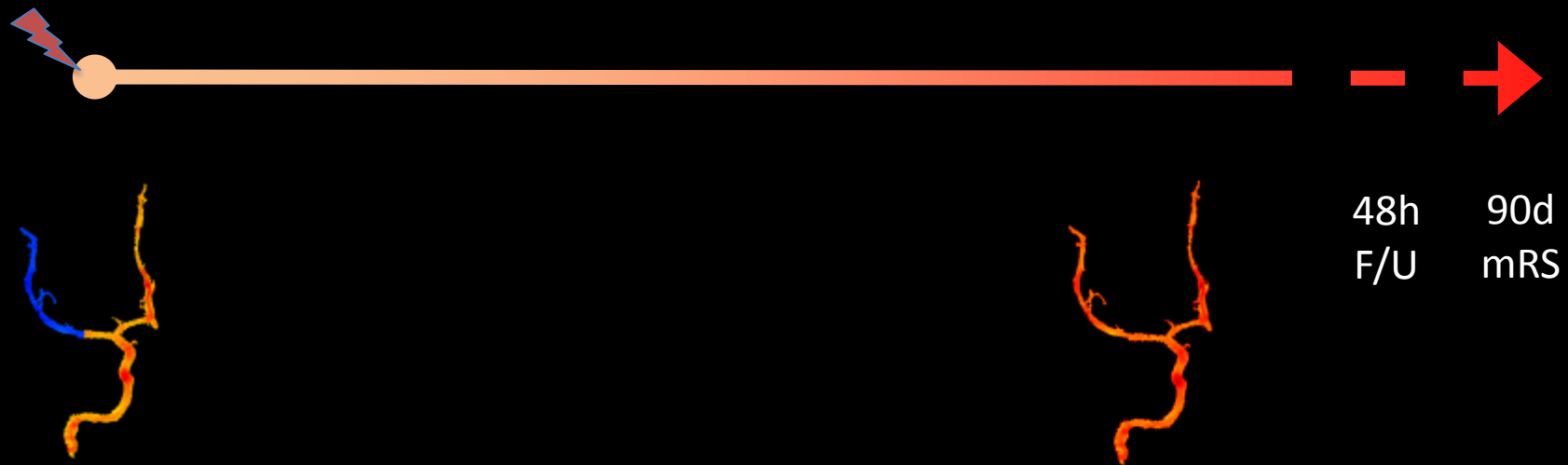
Onset to treatment time vs. treatment effect

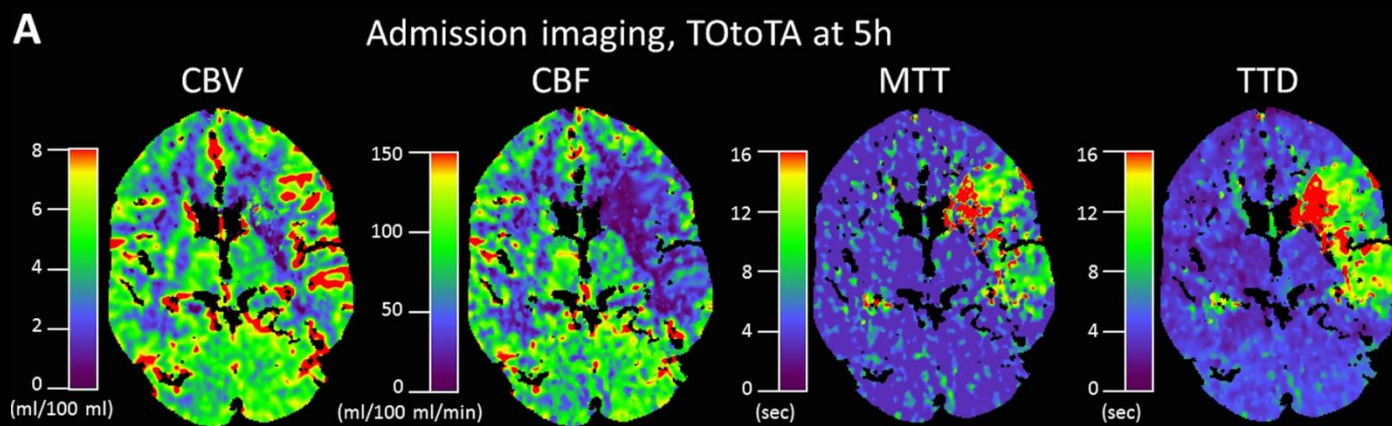
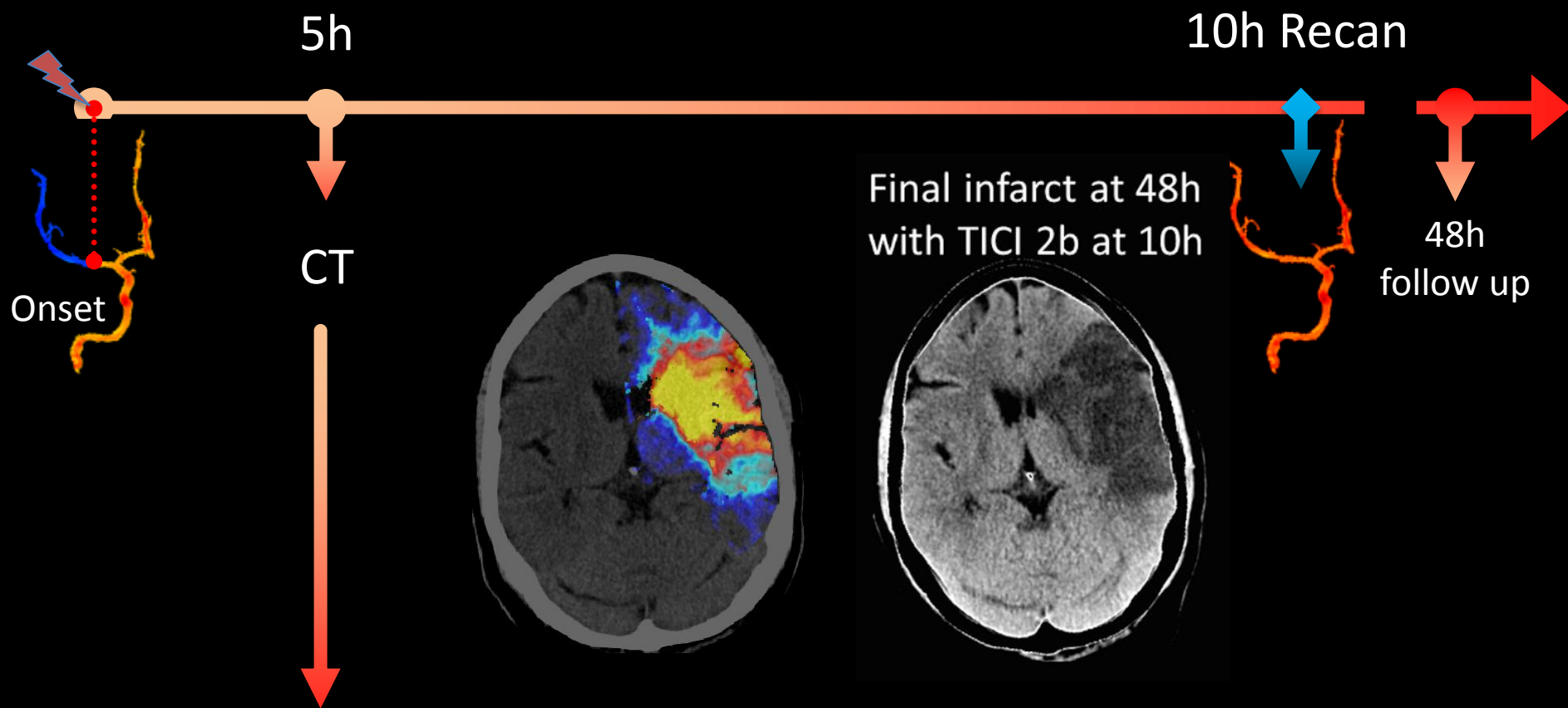
Average volume!
Which patients?

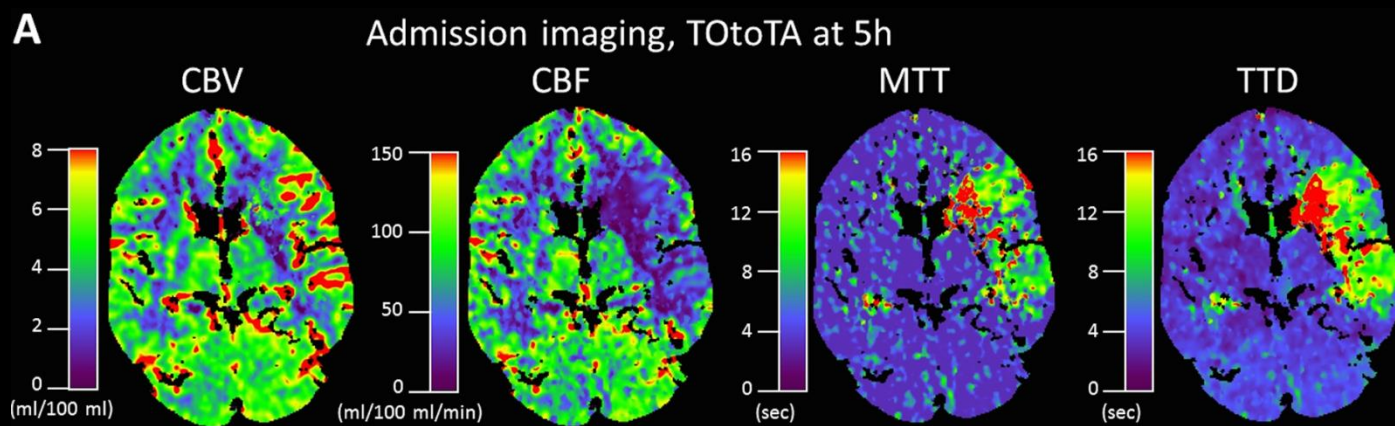
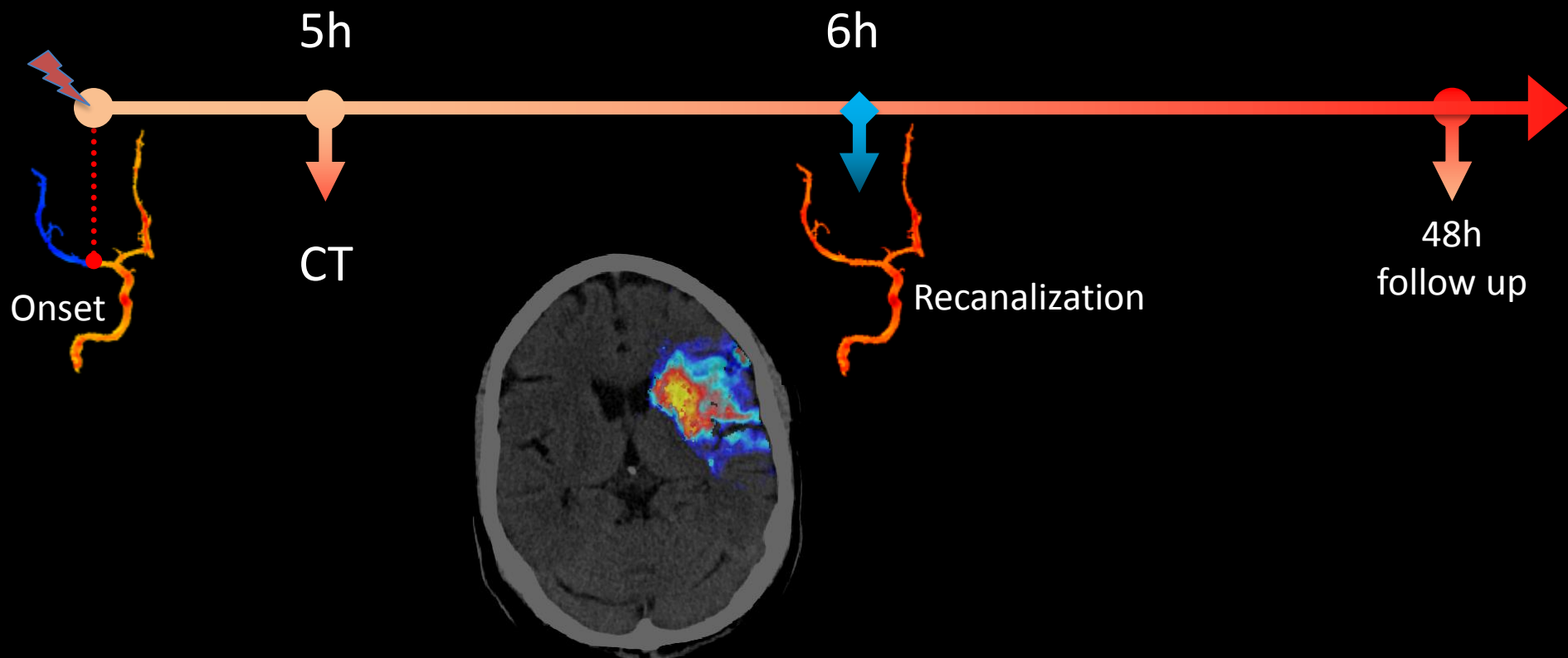


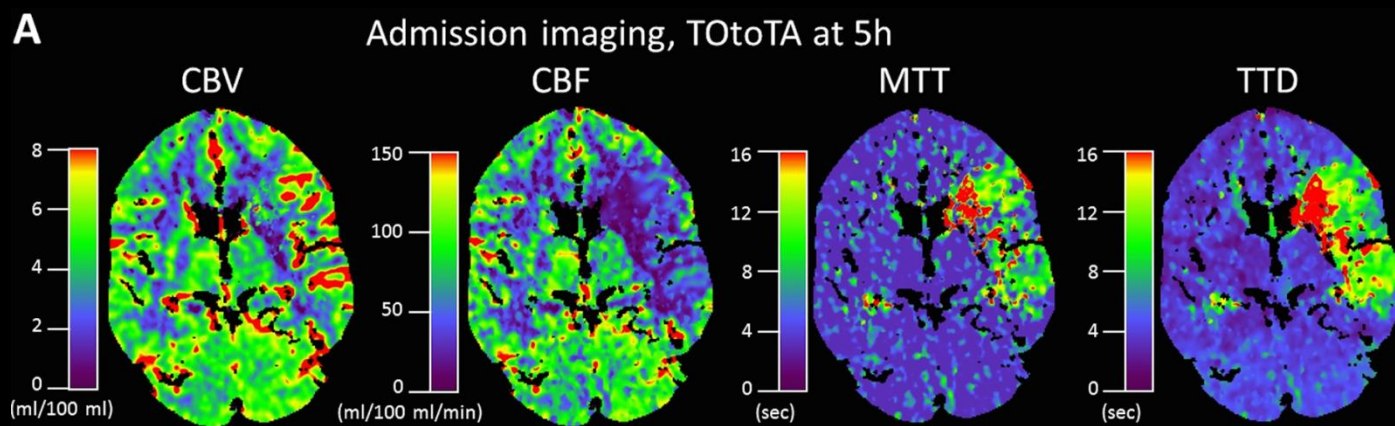
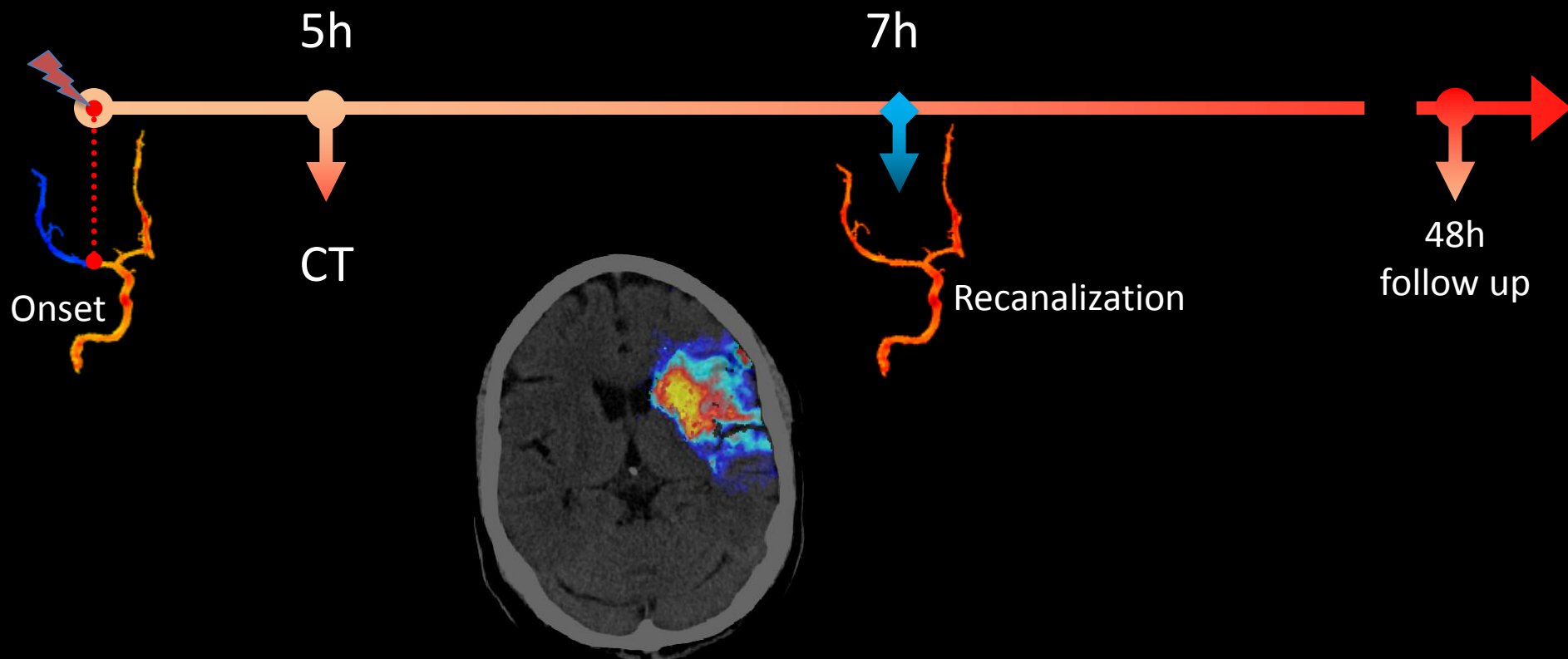
2016 HERMES: 7:18 h

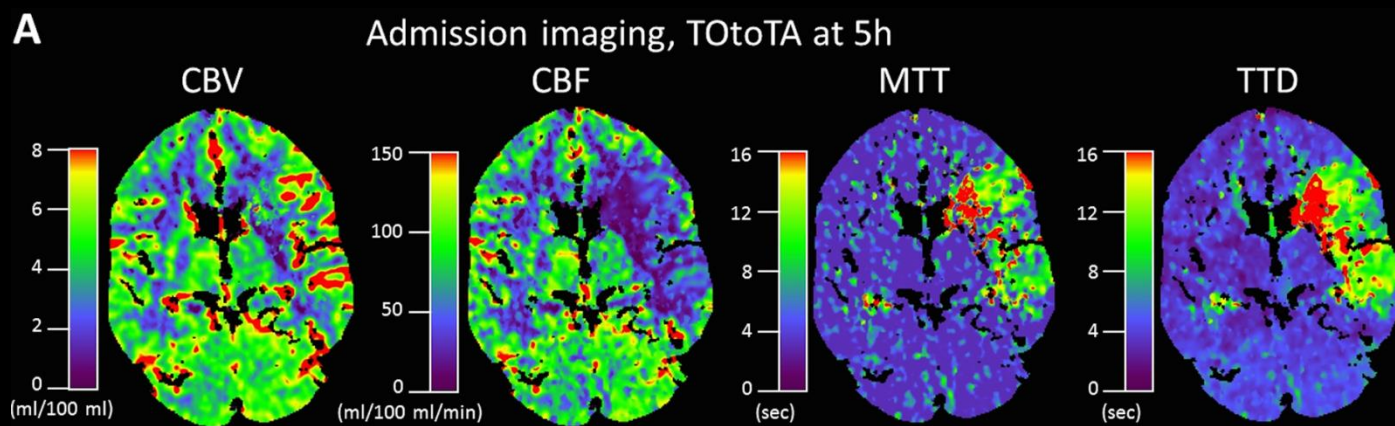
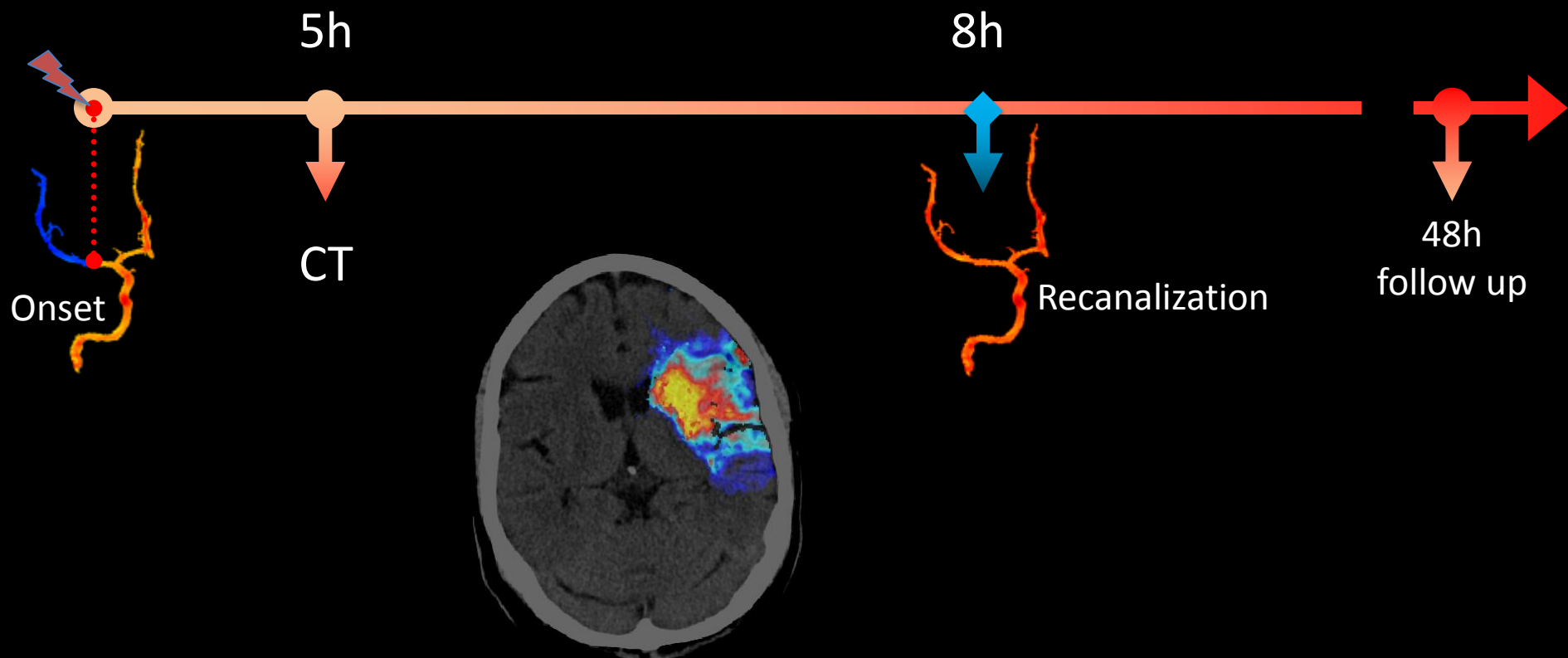


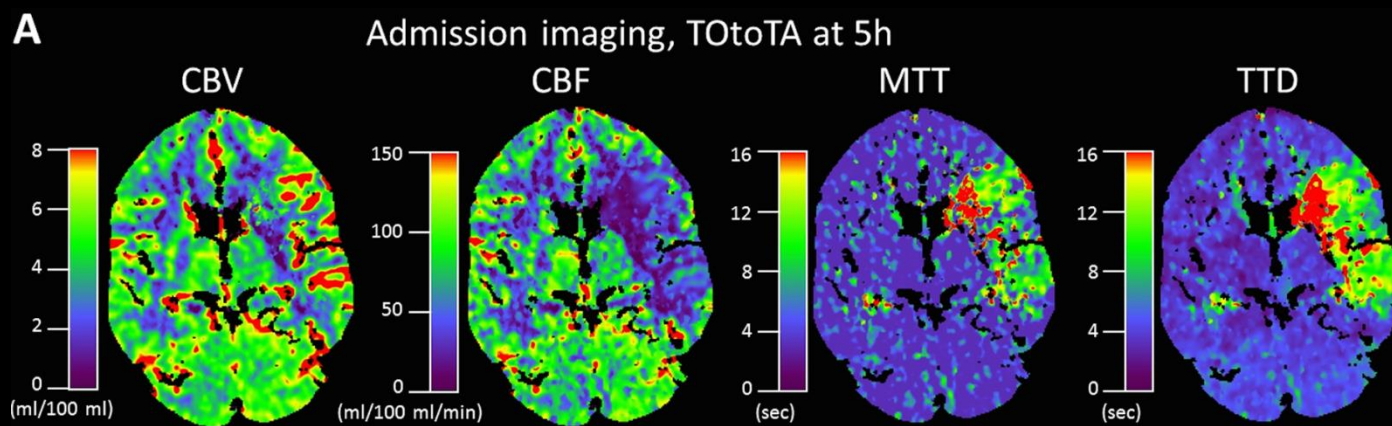
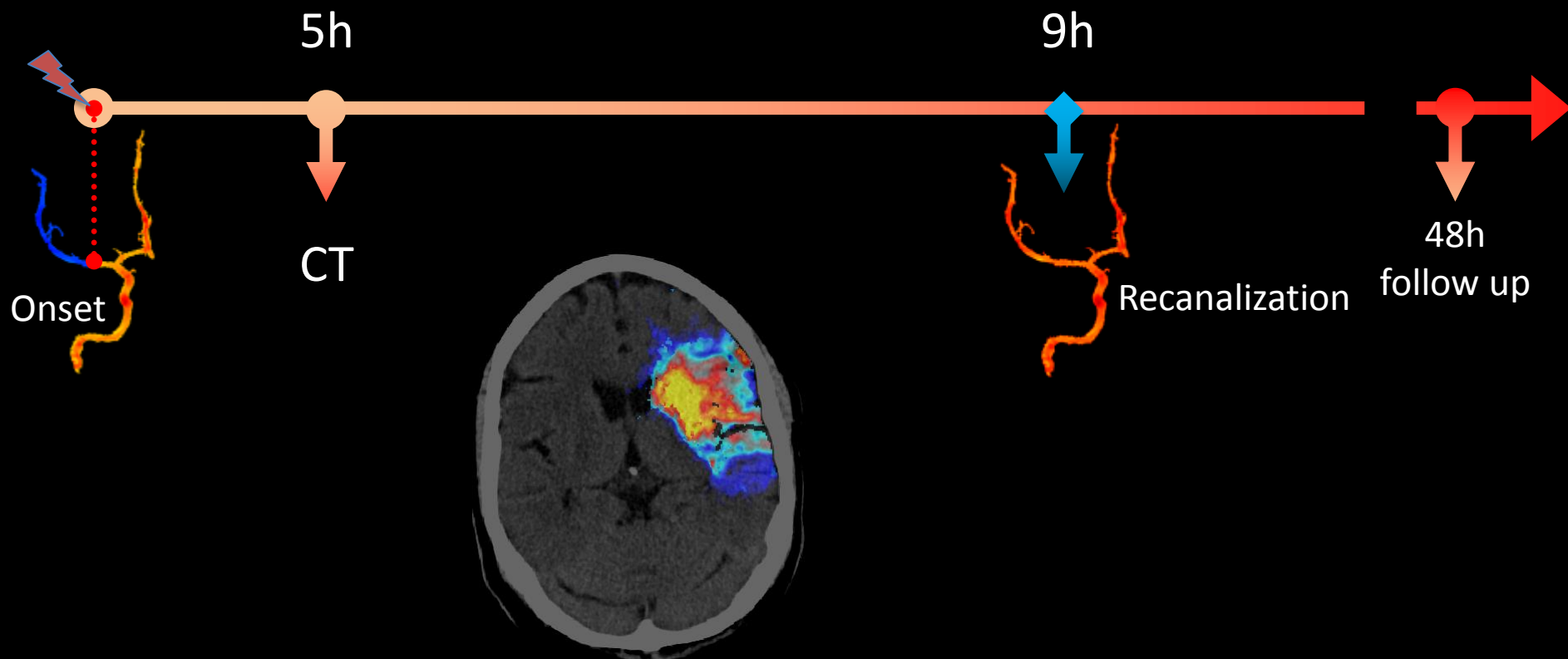


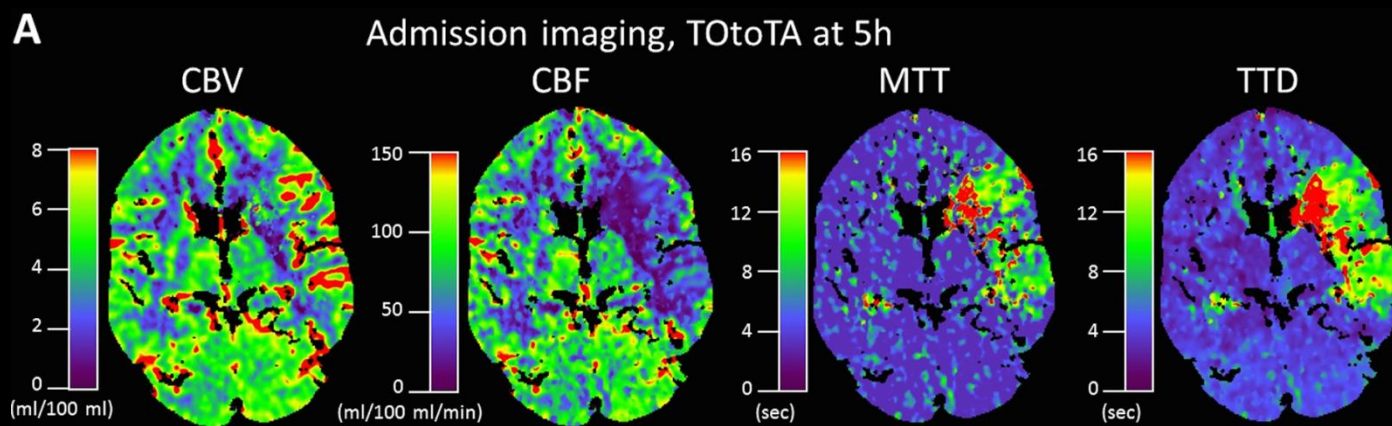
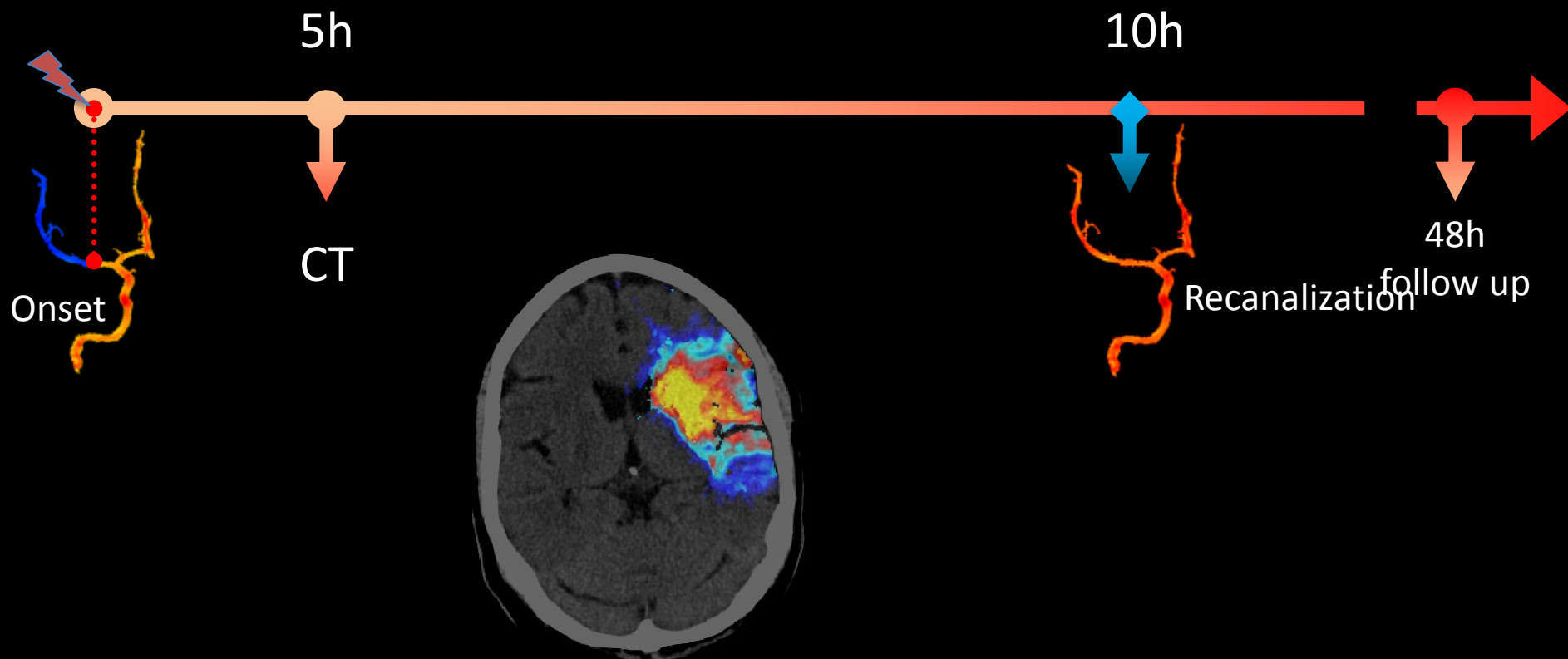


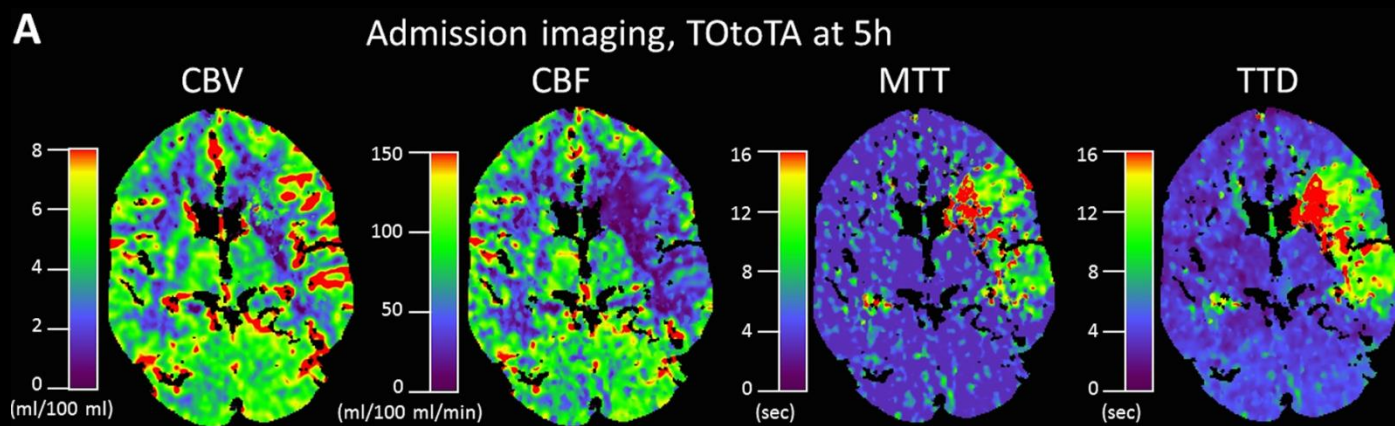
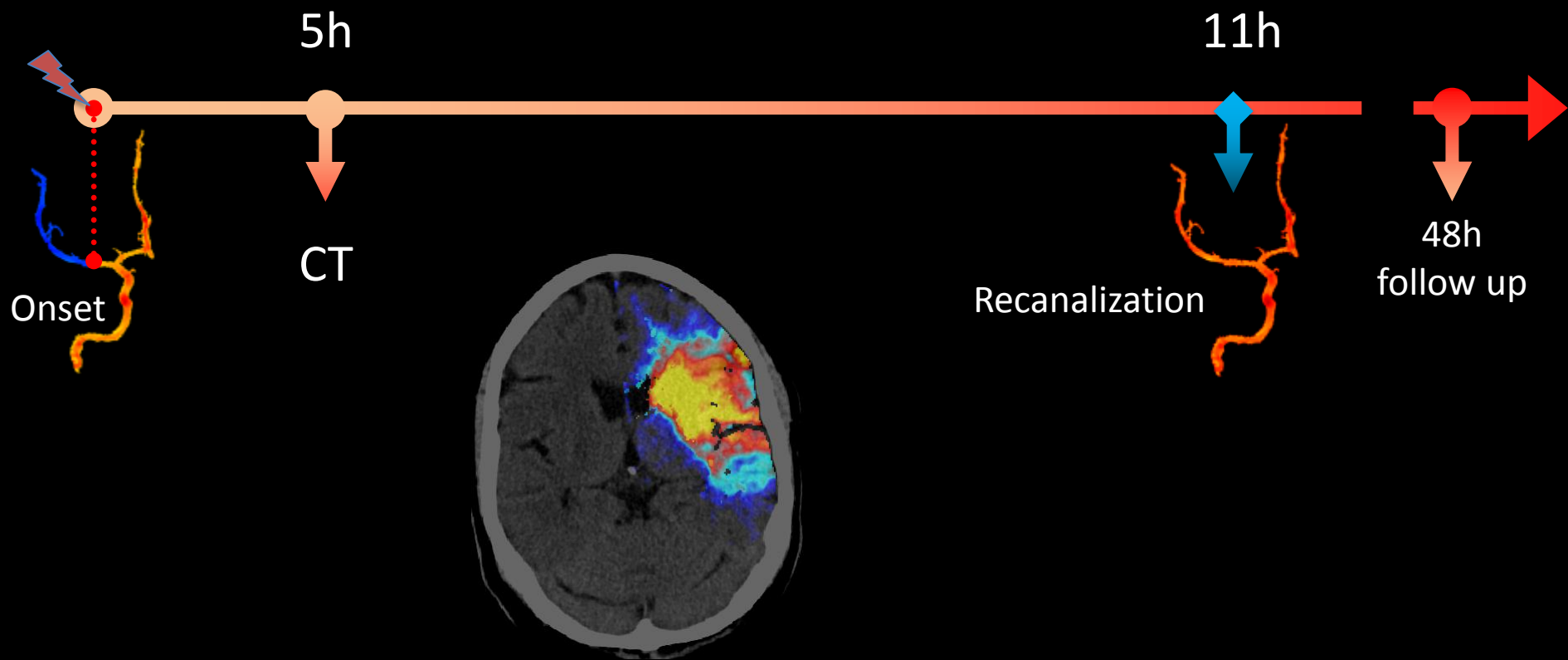


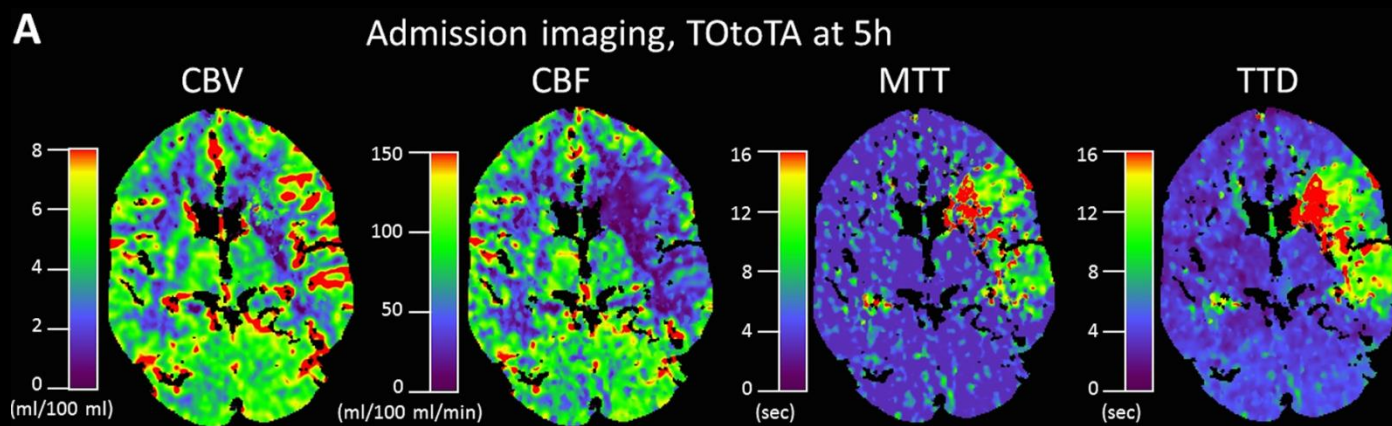
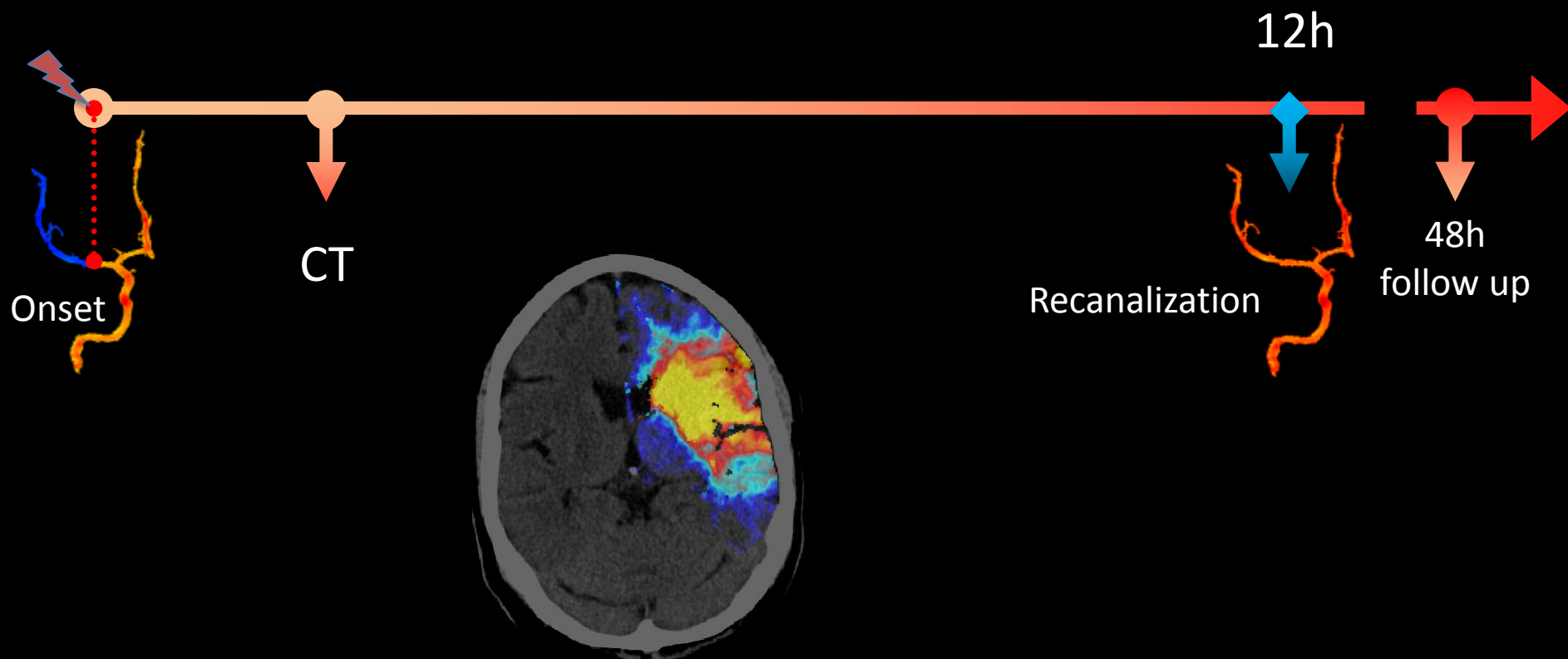




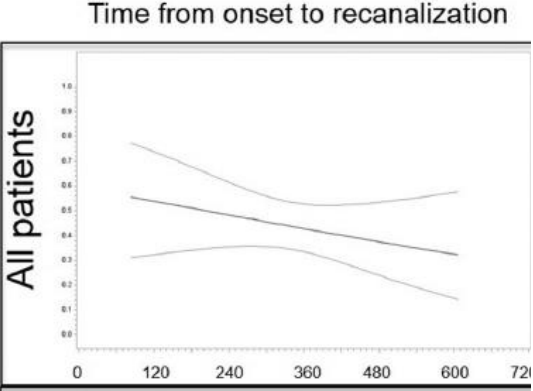




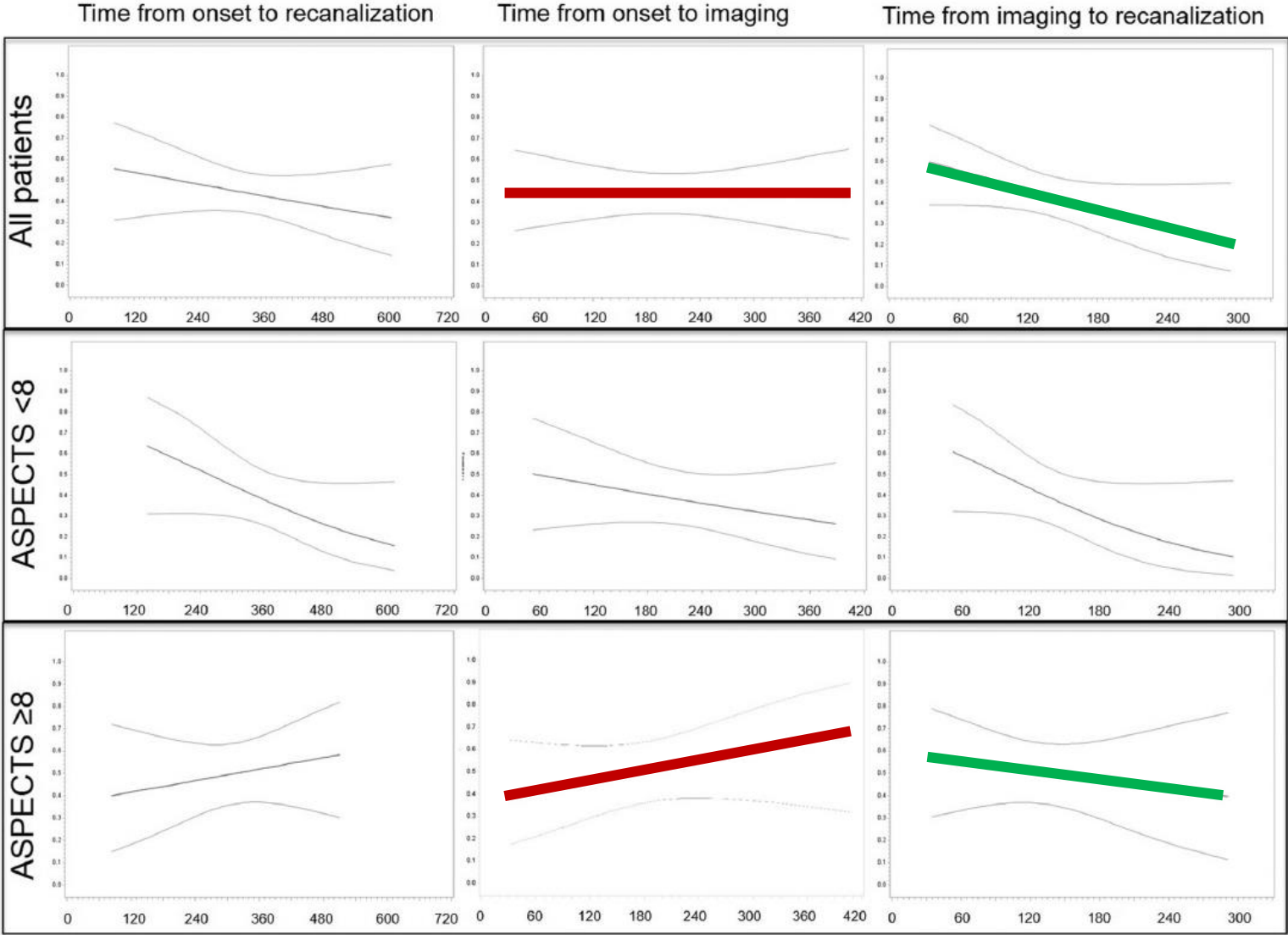




Probability of mRS score of 0-2



Probability of mRS score of 0-2



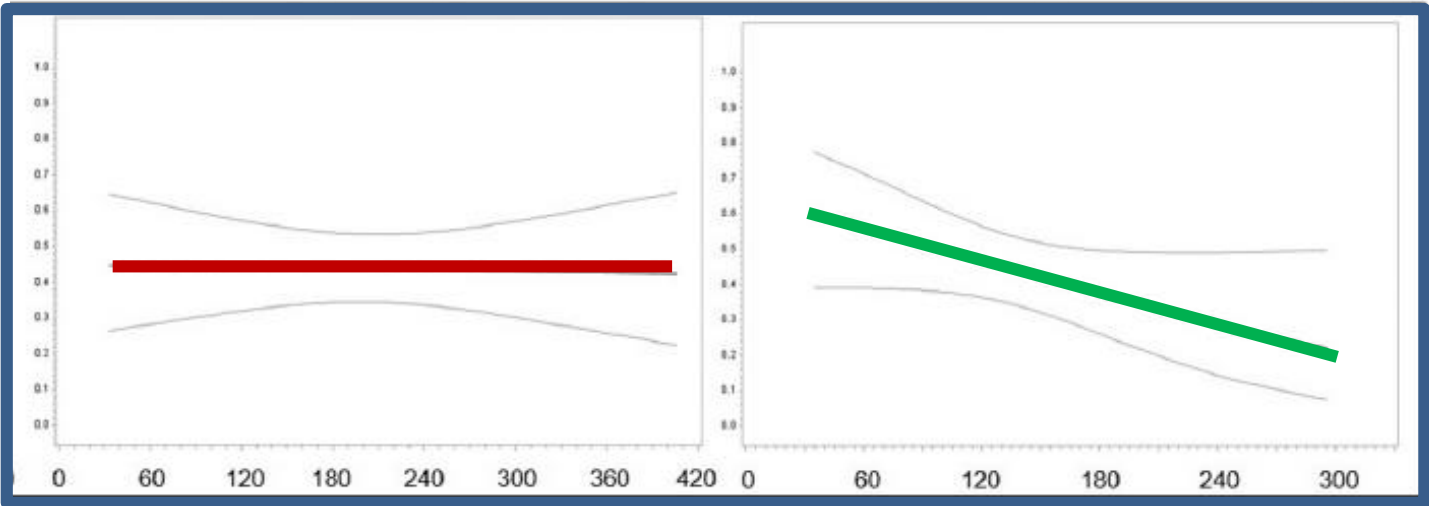
Probability of mRS score of 0-2



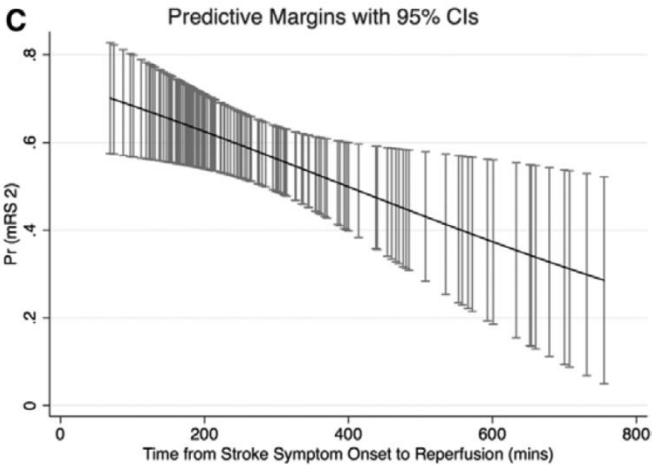
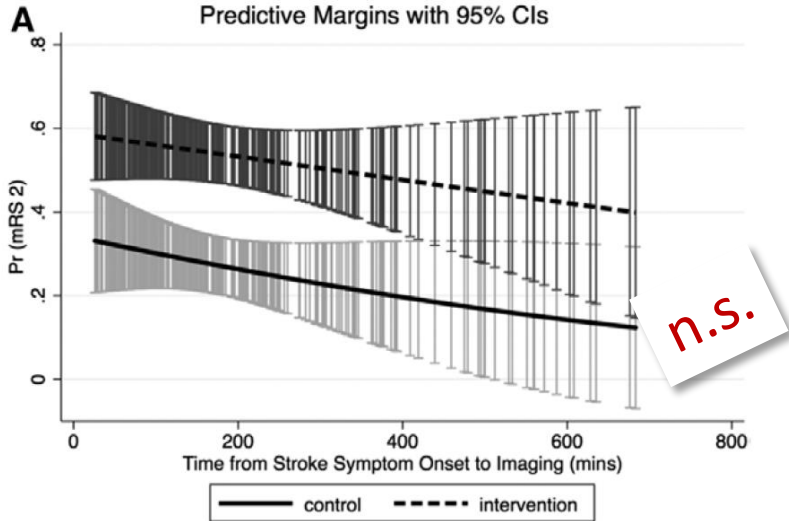
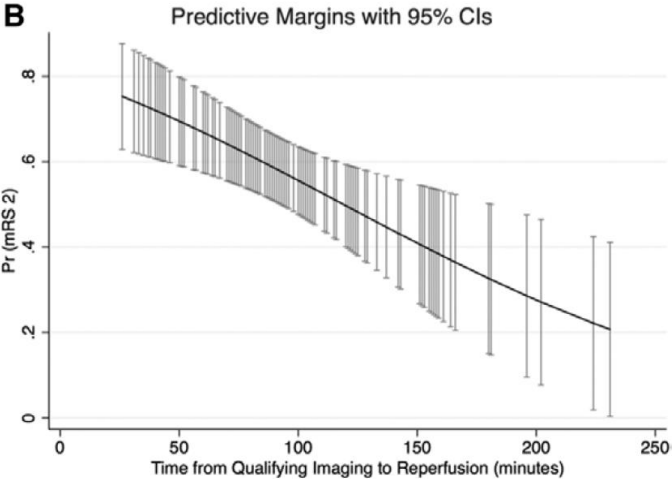
Time from onset to imaging

Time from imaging to recanalization

% of mRS (90d)



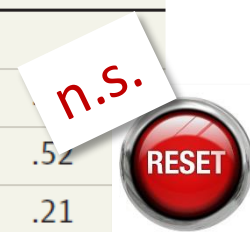
ESCAPE: only P2P counts ... ?



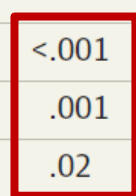
HERMES: Delay vs. mRS 0-2 (90 d)

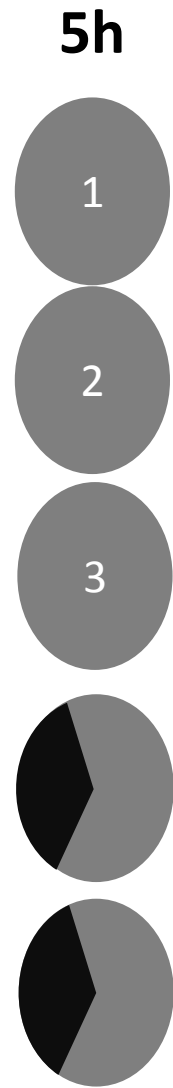
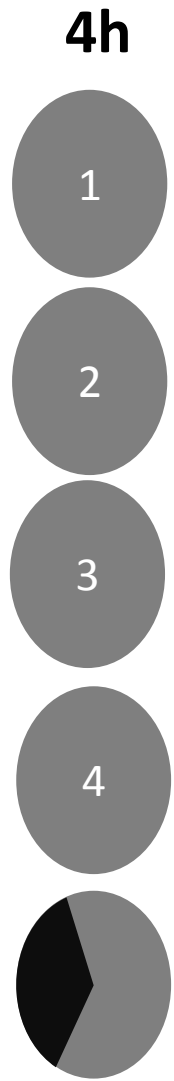
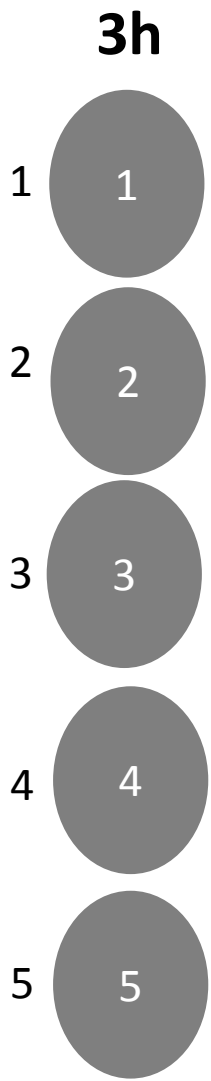
	Endovascular Thrombectomy		Medical Therapy		P Value for Interaction With Treatment Group
	OR (95% CI) per 1-Hour Delay	ARD, % (95% CI) per 1-Hour Delay ^a	OR (95% CI) per 1-Hour Delay	ARD, % (95% CI) per 1-Hour Delay ^a	
Symptom Onset-to-Reperfusion Time Interval (Expected)^d					
mRS shift ^b	0.87 (0.79 to 0.95)	-6.1	0.99 (0.90 to 1.09)	-0.4	.046
mRS 0-2	0.85 (0.77 to 0.95)	-4.0 (-6.4 to -1.3)	0.94 (0.83 to 1.06)	-1.2 (-3.5 to 1.2)	.25
Quality	1.16 (1.01 to 1.32)	2.0 (0.1 to 4.0)	0.88 (0.76 to 1.02)	-1.9 (-3.9 to 0.5)	.048
Symptom Onset-to-ED Arrival Time Interval					
mRS shift ^b	1.01 (0.93 to 1.09)	0.0 (-1.6 to 1.6)	0.99 (0.90 to 1.09)	-0.4	.52
mRS 0-2	1.00 (0.93 to 1.07)	0.0 (-1.6 to 1.6)	0.99 (0.90 to 1.09)	-0.4	.52
Quality	1.01 (0.88 to 1.16)	0.1 (-1.6 to 2.0)	0.90 (0.78 to 1.03)	-1.6 (-3.5 to 0.4)	.21
ED Arrival-to-Reperfusion Time Interval (Expected)^f					
mRS shift ^b	0.57 (0.48 to 0.67)	-16.7	0.95 (0.80 to 1.12)	-2.2	<.001
mRS 0-2	0.56 (0.45 to 0.70)	-16.7	0.95 (0.80 to 1.12)	-2.2	.001
Quality	0.91 (0.88 to 0.93)	-1.2 (-1.6 to -0.9)	1.06 (0.84 to 1.33)	0.9 (-2.5 to 4.8)	.02

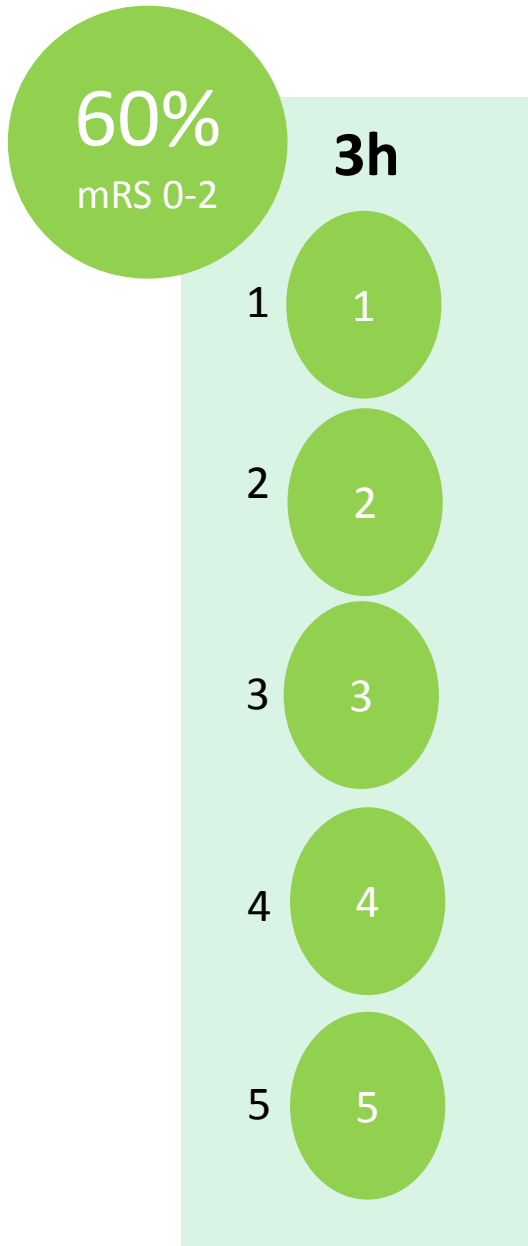
Absolute risk reduction (per h): **0**



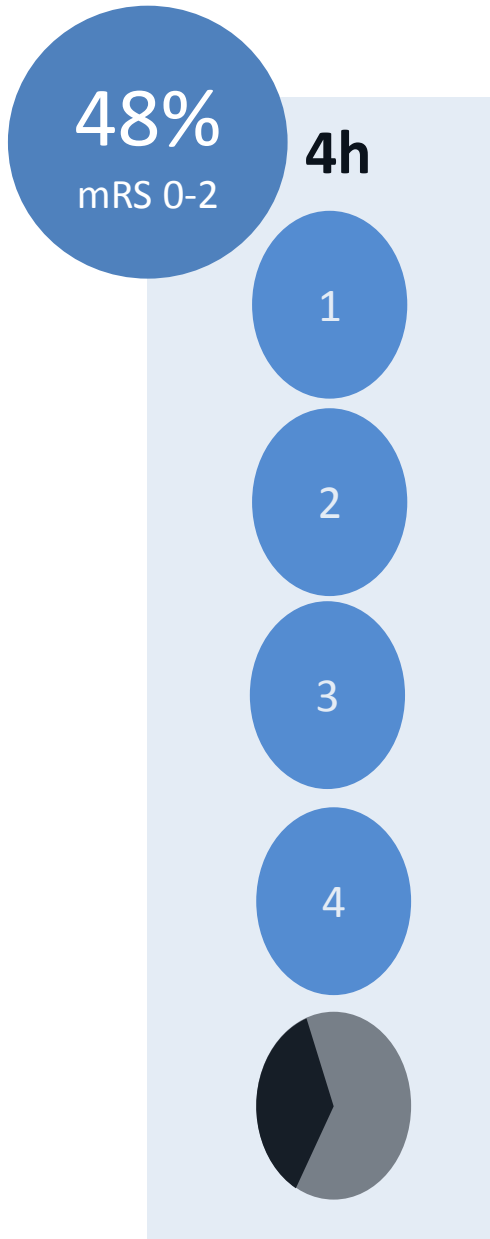
Absolute risk reduction (per h): **14%**



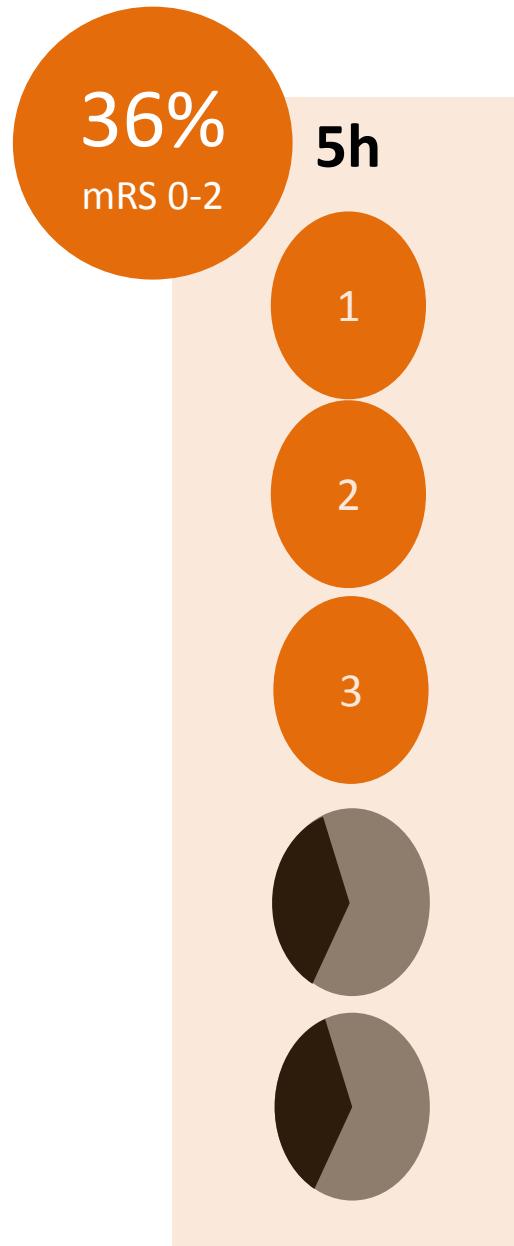




5 x 60% Chance
mRS 0-2



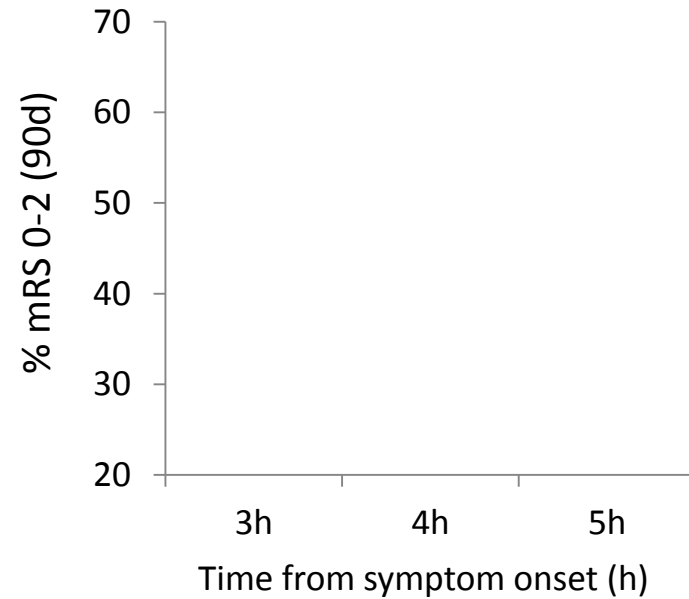
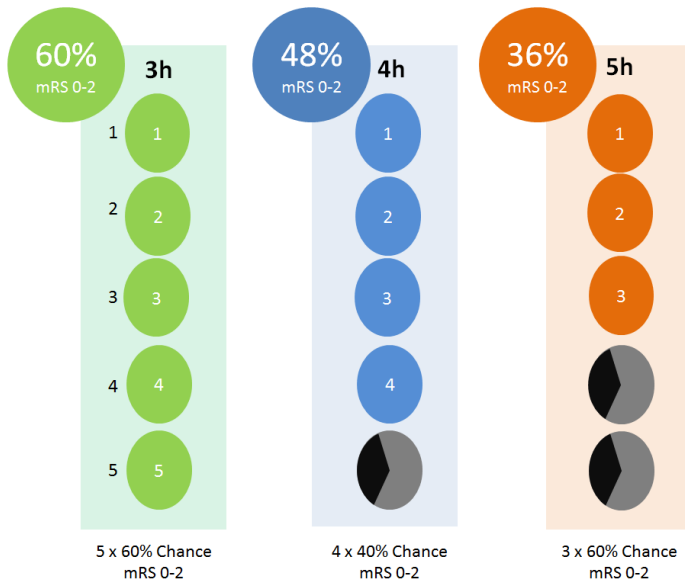
4 x 60% Chance
mRS 0-2



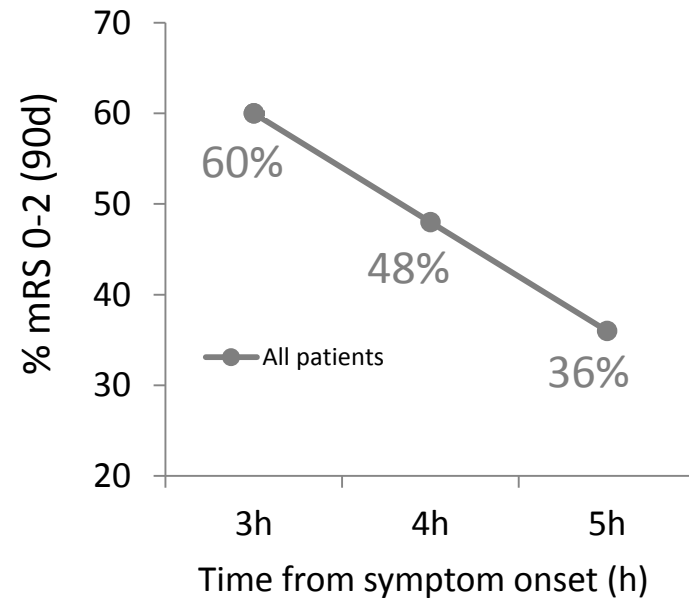
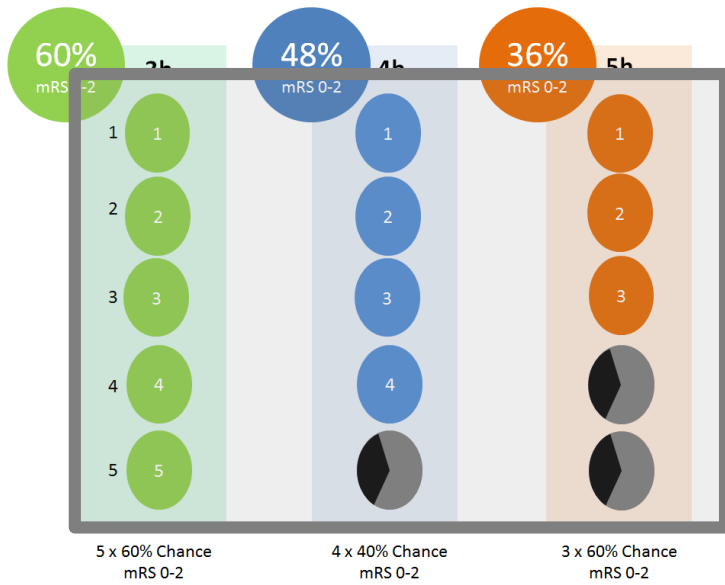
3 x 60% Chance
mRS 0-2



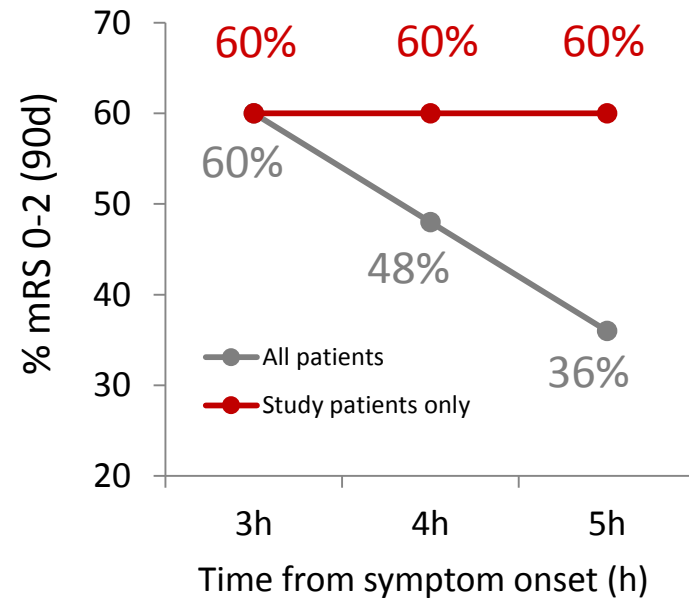
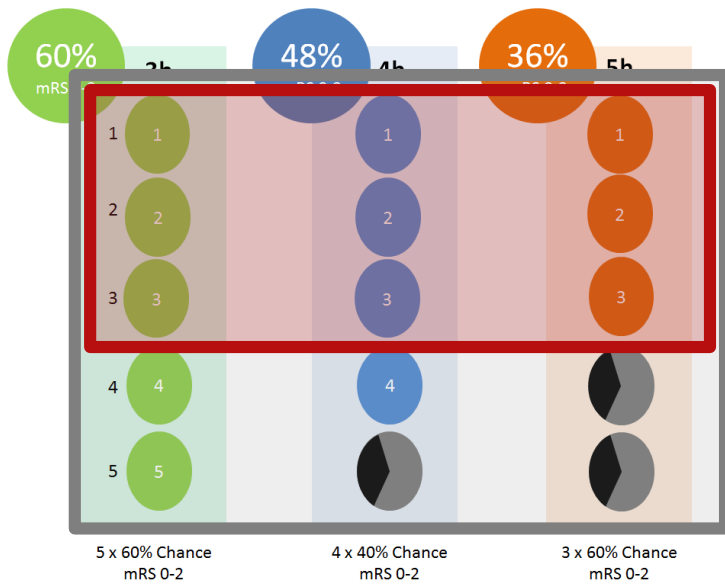
Time: all patients or just the chosen few ...



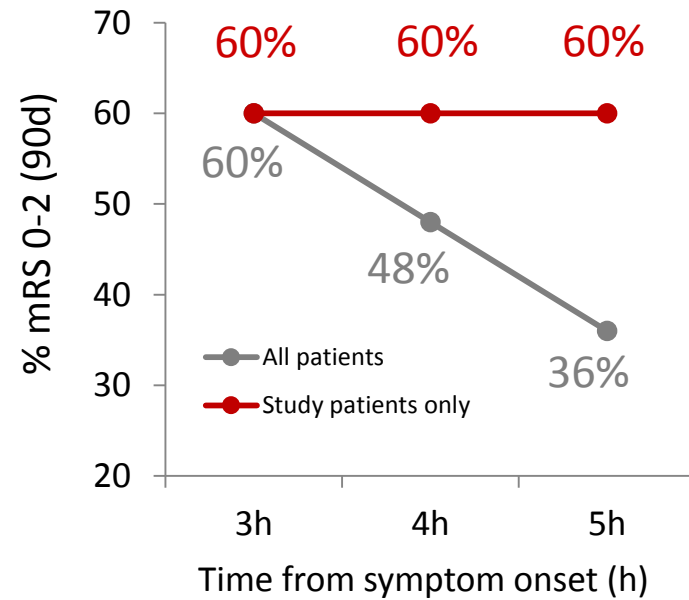
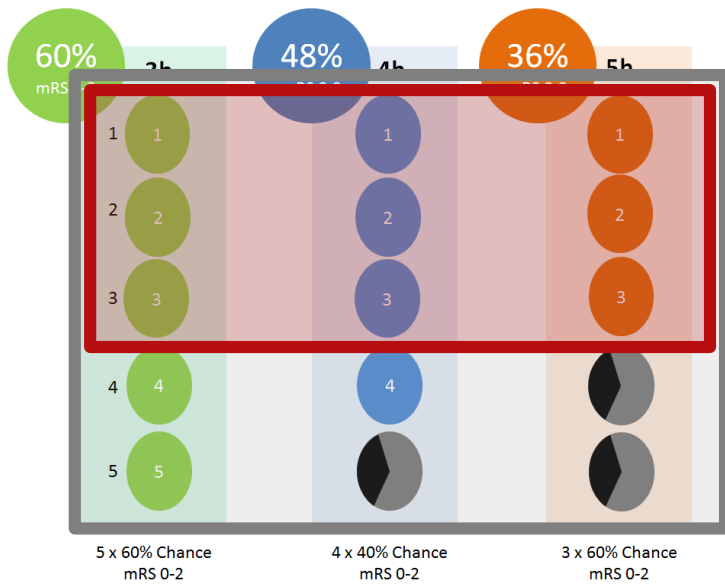
Time: all patients or just the chosen few ...



Time: all patients or just the chosen few ...



Time: all patients or just the chosen few ...



EROICAS: Which clinical selection criteria define candidates for additional thrombectomy compared to best medical therapy alone?

- Time from symptom onset to groin puncture should be preferably **within 6 h**. (Quality of evidence: high, Strength of recommendation: strong).
- Time from symptom onset to groin puncture should be no later than 12 h. **Advanced imaging** might help in identifying patients with potential benefit in the **6–12 h** time window. (Quality of evidence: very low, Strength of recommendation: weak).
- Application of an upper age limit is not justified. (Quality of evidence: high, Strength of recommendation: strong).



DAWN study

Presented at ESOC 05/2017

Stroke imaging

Proof of occlusion: mandatory

Define your terms: core is king

Good outcome vs. therapy effect vs. avoid harm

Know your limitations: reading aids helpful?

Time is brain: but there is no limit

„Good brain“ is time invariant