

# POST ENDOVASCULAR THROMBECTOMY CARE: Evidence, Practice, and Evolving Challenges

Alonso Alvarado-Bolanos

Stroke and Interventional Neurology

# Evaluation

For the **Provincial Stroke Rounds Planning Committee**:

- To plan future programs
- For quality assurance and improvement
- For **You**: Reflecting on what you've learned and how you plan to apply it can help you enact change as you return to your professional duties
- For **Speakers**: The responses help understand participant learning needs, teaching outcomes and opportunities for improvement.

Please take 2 minutes to fill the evaluation form out. Thank you!



# Disclosures

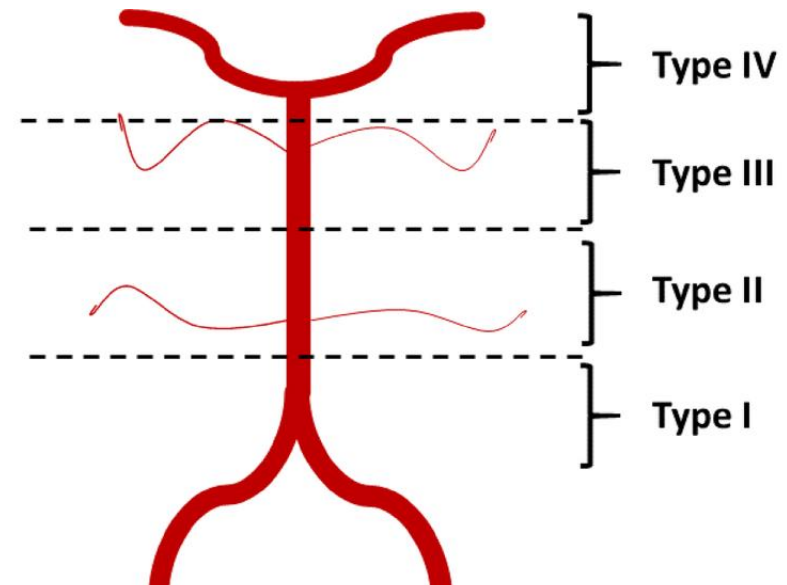
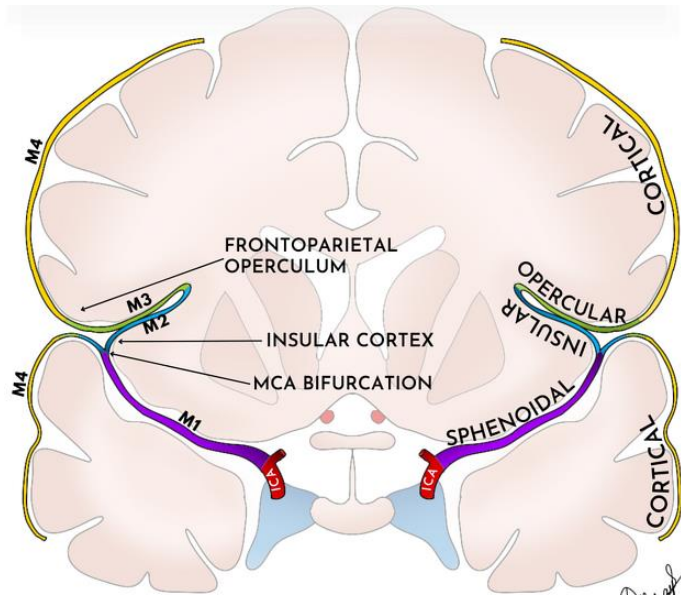
- **Disclosure of Affiliations & Financial Support**
- **Speaker Name:** Alonso Alvarado Bolanos
- **Affiliations:** I have no relationships with for-profit or not-for-profit organizations
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- This session/program has not received financial or in-kind support.

# Agenda

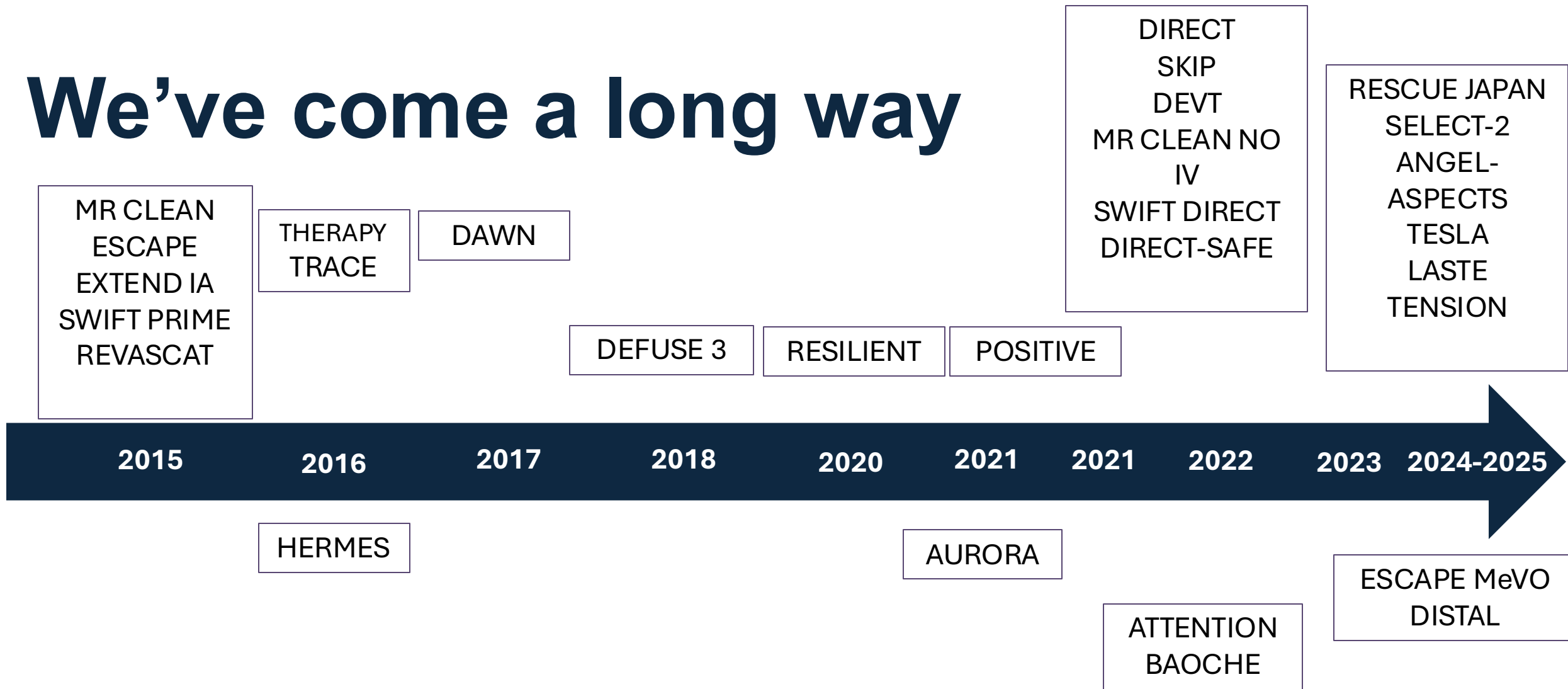
- Evolution of EVT - we are treating more patients
- Post EVT patients belong to ICU
- Factors influencing post EVT care
- Procedural complications
- Blood pressure target after EVT
- Monitoring after EVT

# Setting some common ground

- Nearly 30% of acute ischemic strokes are due to a LVO
- All guidelines recommend post EVT care to happen at *intensive care units with stroke-specialized nursing and physicians*



# We've come a long way



# We've come a long way

MR CLEAN  
ESCAPE  
EXTEND IA  
SWIFT PRIME  
REVASCAT

2015

2016

2017

2018

2020

2021

2021

2022

2023

2024-2025

HERMES



<6 hrs



# We've come a long way

DAWN

DEFUSE 3

RESILIENT

POSITIVE

2015

2016

2017

2018

2020

2021

2021

2022

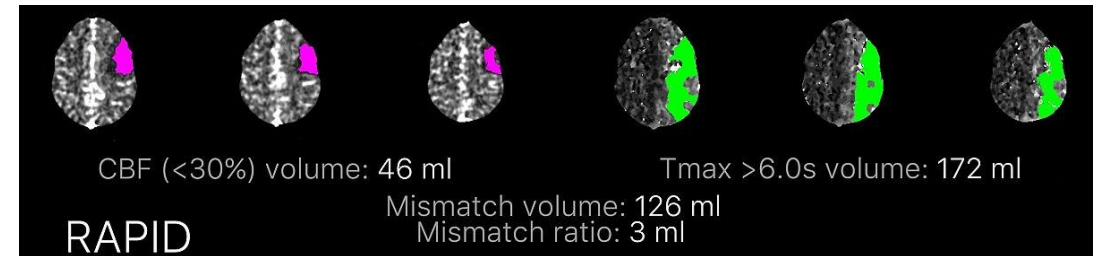
2023

2024-2025

AURORA



<24 hrs



# We've come a long way

DIRECT  
SKIP  
DEVT  
MR CLEAN NO  
IV  
SWIFT DIRECT  
DIRECT-SAFE



2015

2016

2017

2018

2020

2021

2021

2022

2023

2024-2025



ATTENTION  
BAOCHE

# We've come a long way

RESCUE JAPAN  
SELECT-2  
ANGEL-  
ASPECTS  
TESLA  
LASTE  
TENSION

2015

2016

2017

2018

2020

2021

2021

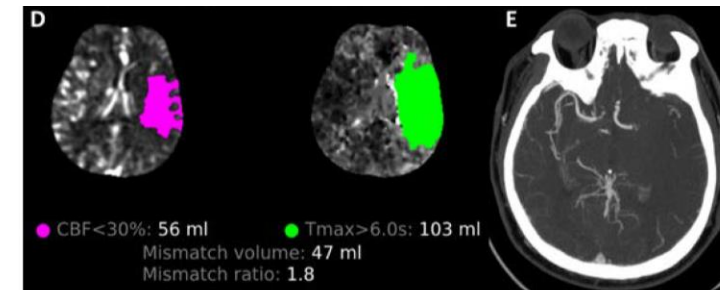
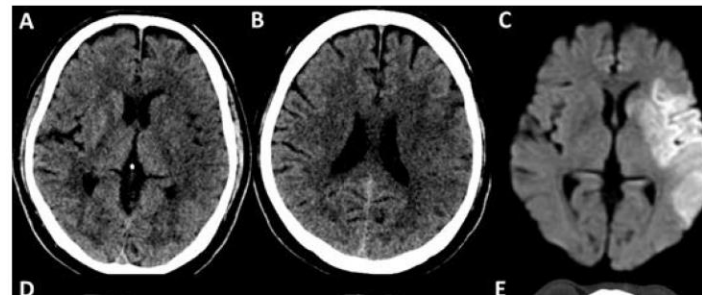
2022

2023

2024-2025

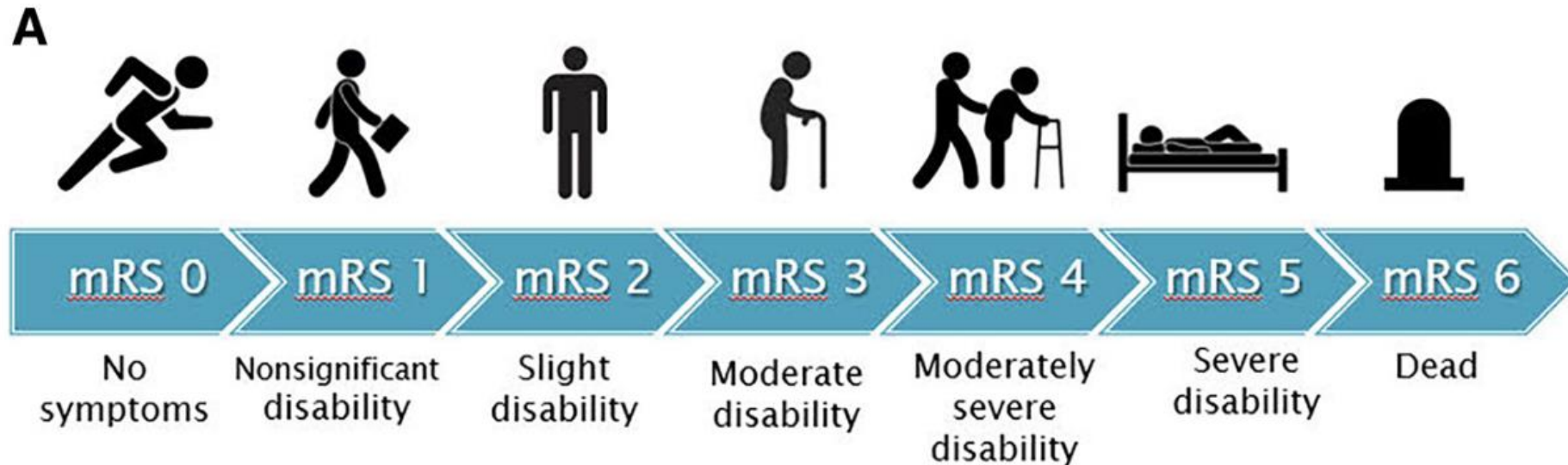


<24 hrs

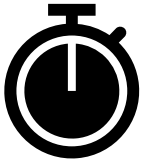


# Endovascular thrombectomy is among the most powerful interventions in medicine

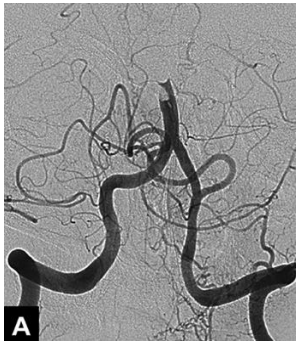
NNT to reduce disability 1 point: **2.6**



# We are bringing more patients for EVT



Late window: >6 hrs



Posterior circulation

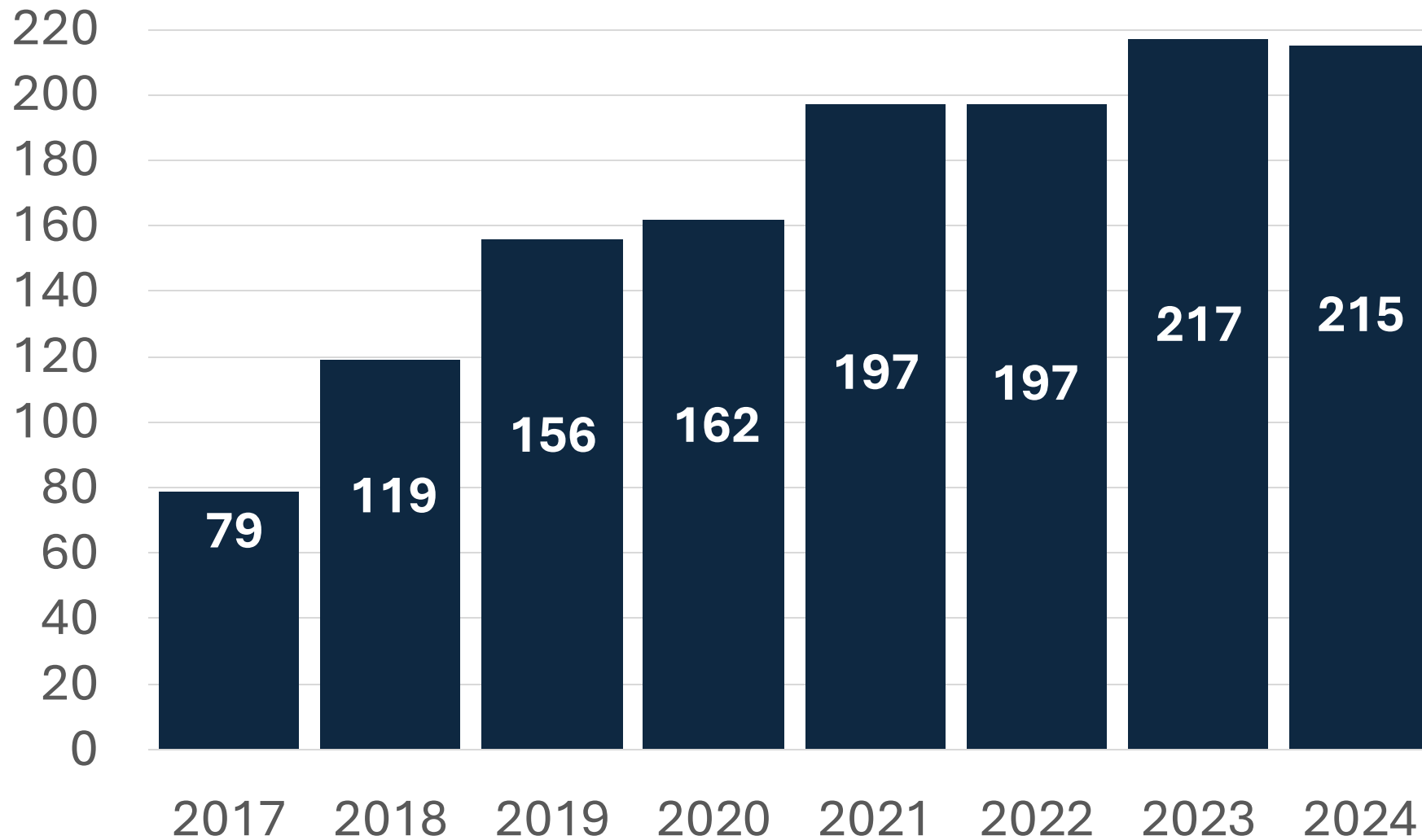


Low ASPECTS



Medium vessel  
occlusions

## EVT at LHSC

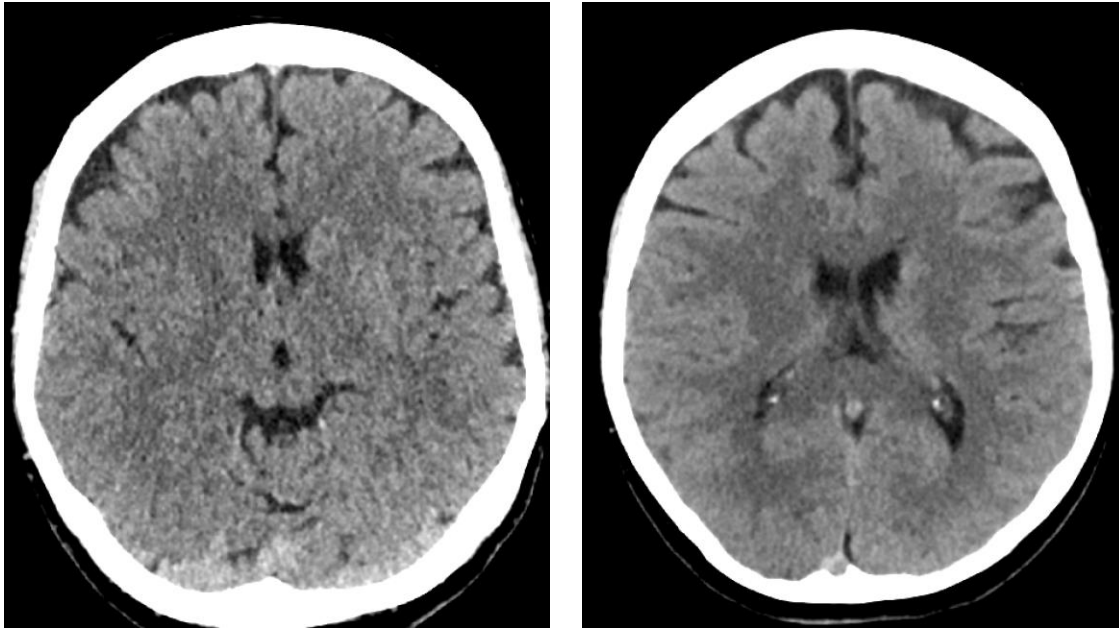


# Same procedure, 2 very different tales

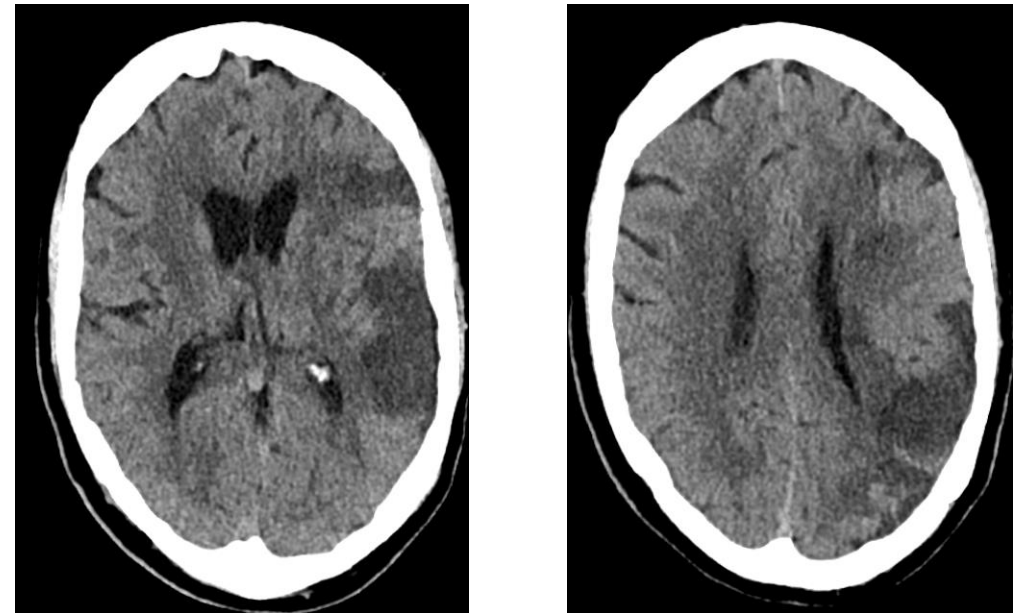
- 57-year-old-woman
  - LSW: 1200 while doing PT
  - 1 week before left knee injury, meniscus?
  - NIHSS: 19, right MCA syndrome
  - TNK 13:12 (72 min after LSW)
  - PMH: left knee injury, fall and left leg pain
- 67-year-old-male
  - LSW? Lives alone, son talked to him 2 days ago. Neighbors had not seen him for 2 days
  - EMS sent to his house and noted to have profound aphasia and confusion
  - PMH: OH abuse, substance abuse (cocaine+), active smoking, GERD
  - Transferred from Marathon as life or limb

# Same procedure, 2 very different tales

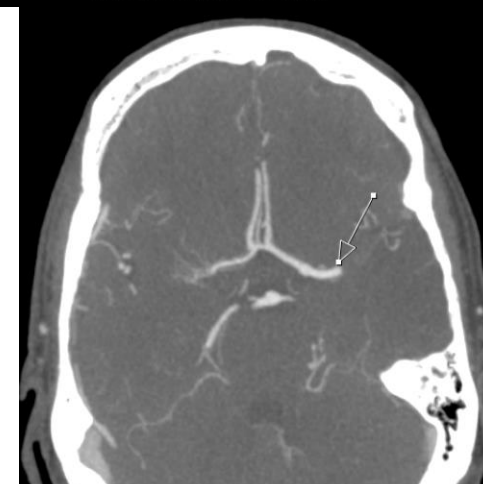
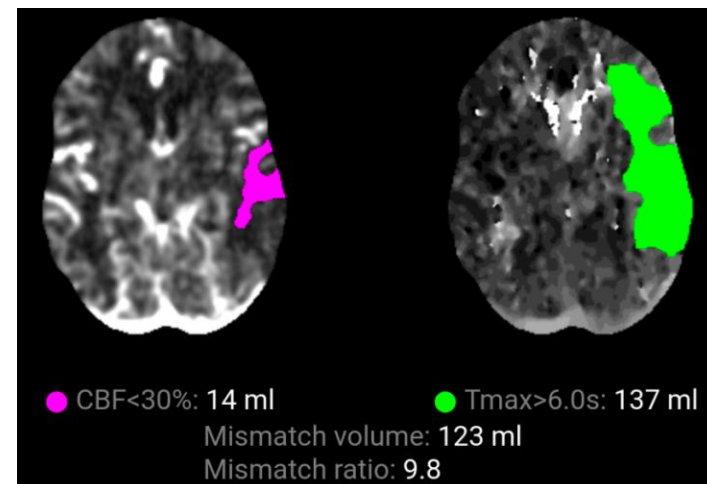
- NIHSS 19 points



- NIHSS 16 points
- Very agitated



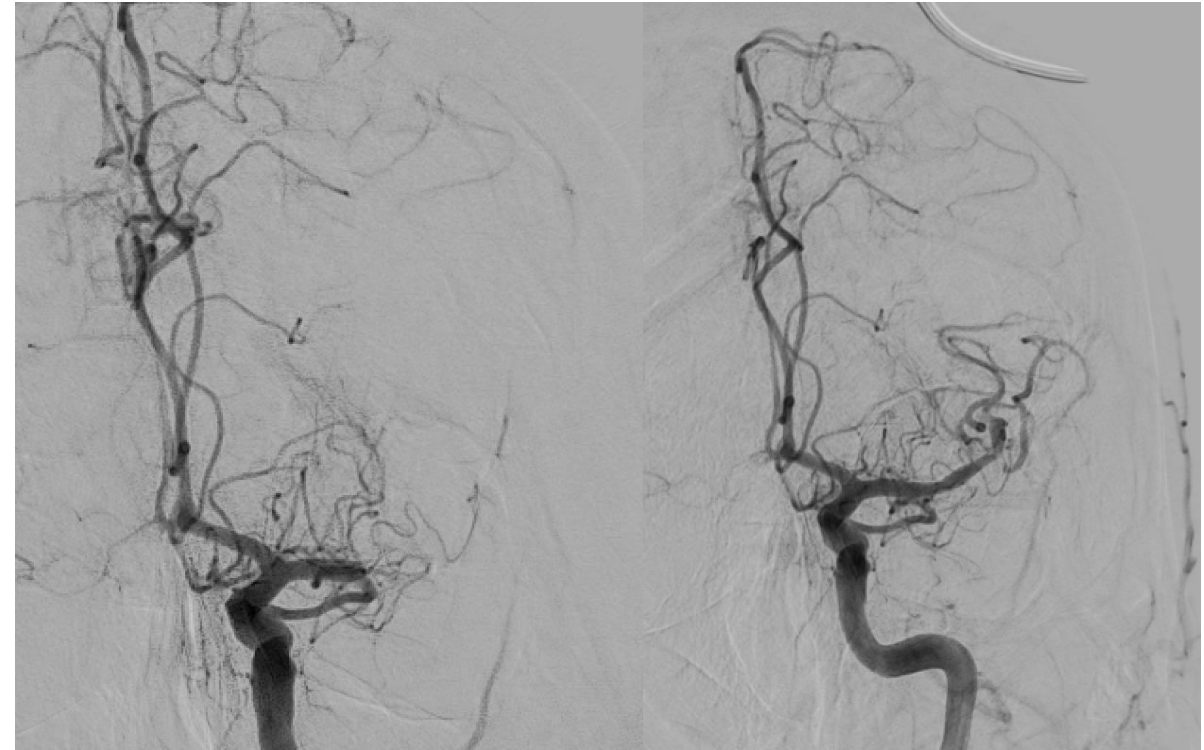
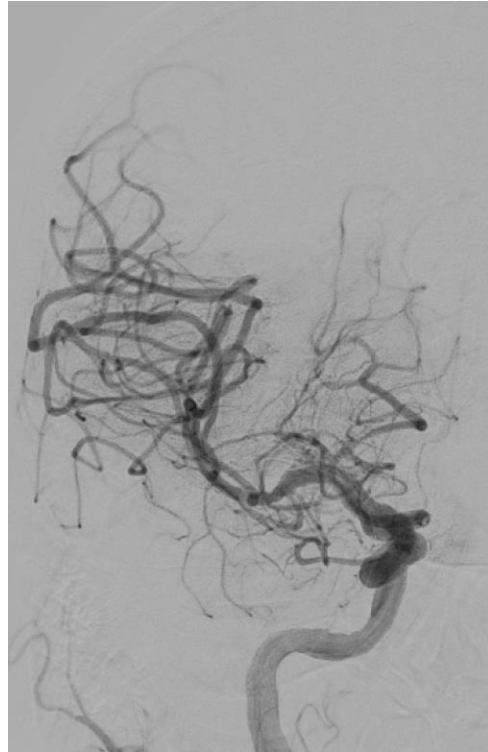
# Same procedure, 2 very different tales



# Same procedure, 2 very different tales



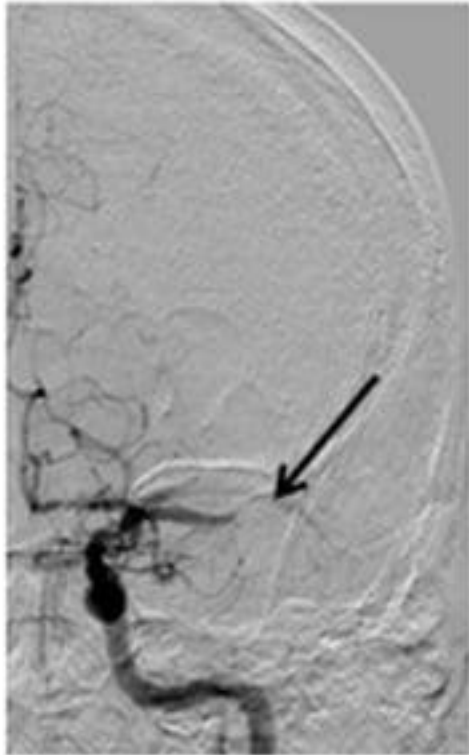
mTICI 3, 3 passes:  
Aspiration + Combined  
NIHSS 24 hrs: 2



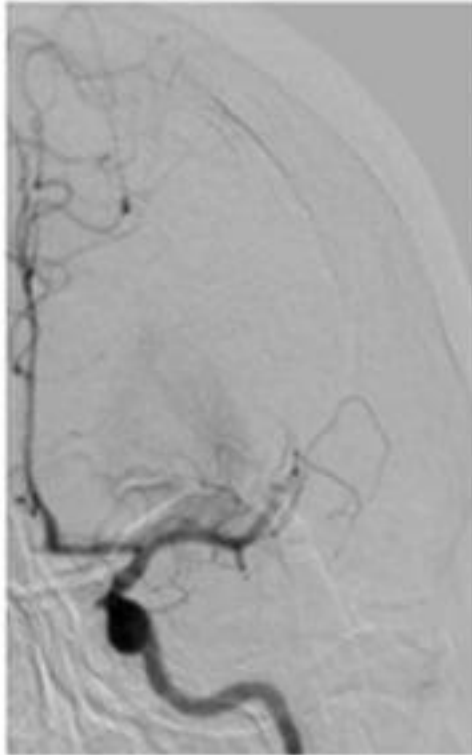
mTICI 2B, 2 passes:  
Aspiration + Combined  
NIHSS 24 hrs: 12

# mTICI score

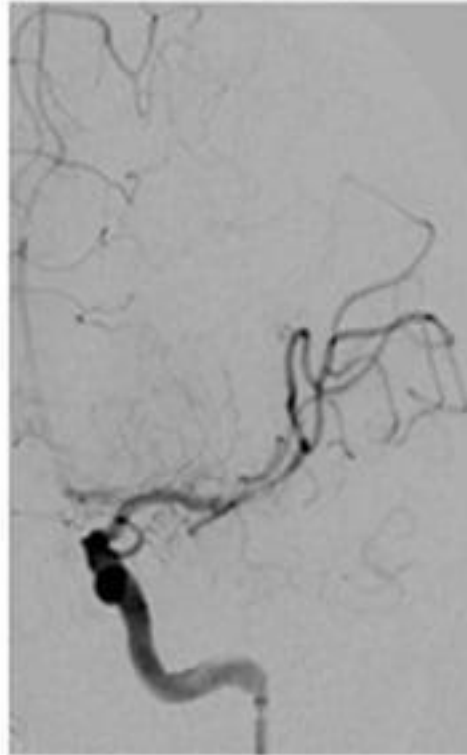
mTICI 0



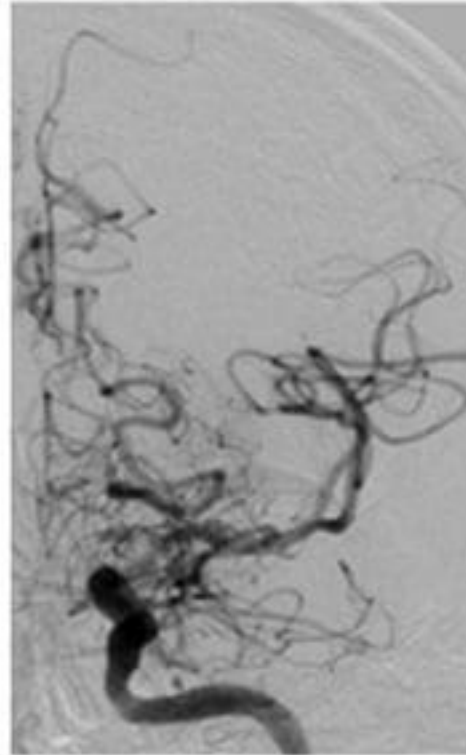
mTICI 1



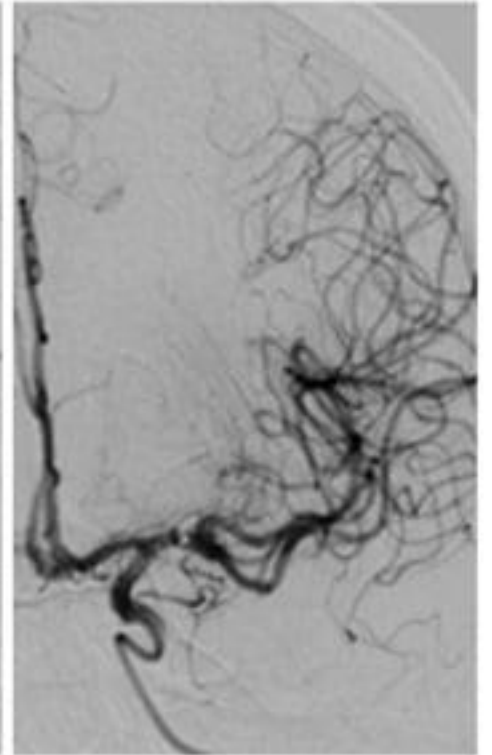
mTICI 2a



mTICI 2b



mTICI 3



# Same procedure, 2 very different tales

ICU for 2 days

- DVT found
- Started on heparin infusion for 6 days
- Apixaban 5 mg BID
- TTE: PFO
- DC home 6 days after stroke

ICU for 3 days

- Severe agitation, CIWA protocol
- Groin hematoma, needing pressure X 20 min
- Dexmedetomidine infusion for 6-8 hrs
- Labetalol infusion due to SBP>180 mmHg
- Naso-gastric tube
- Aspiration pneumonia
- 16 days after: transferred to SJH
- 3 months mRS: 2

# Main factors influencing post EVT care

## Patient



1. Comorbidities
2. Site of occlusion (anterior vs posterior circulation)
3. Severity/large core
4. Mechanism of stroke

## Other therapies



## Procedural information



# Main factors influencing post EVT care

## Patient



## Other therapies



1. Intravenous Thrombolysis
2. Other antiplatelets (GP IIb/IIIa inhibitors)

## Procedural information



# Main factors influencing post EVT care

## Patient



## Other therapies



## Procedural information



1. Access/closure
2. Success
3. Complications
4. Sedation vs GA

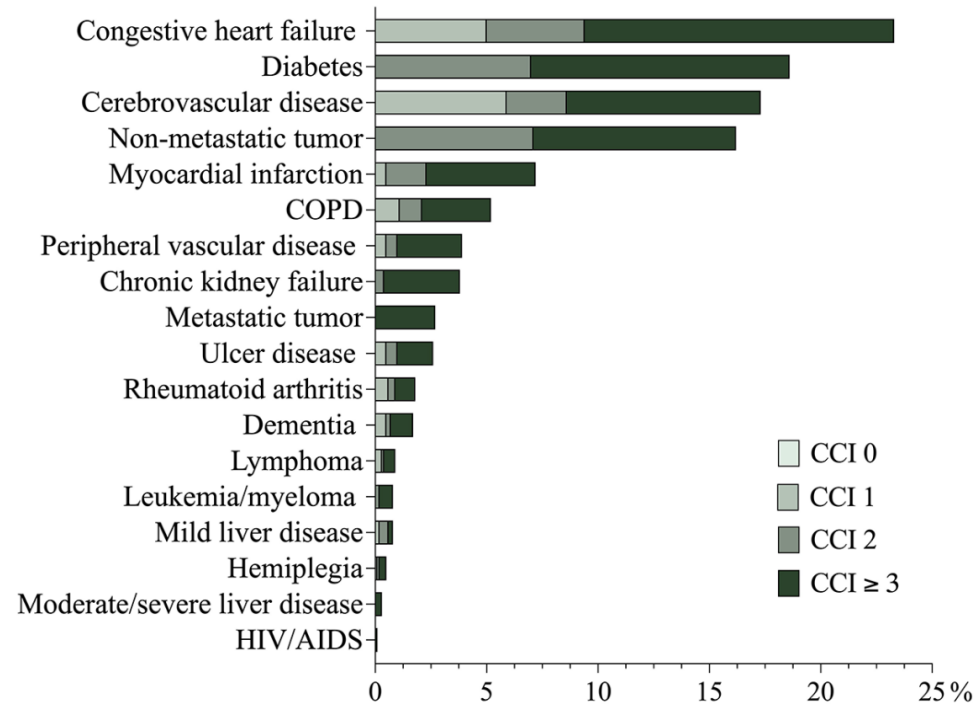
# We are bringing more patients for EVT

## Patient

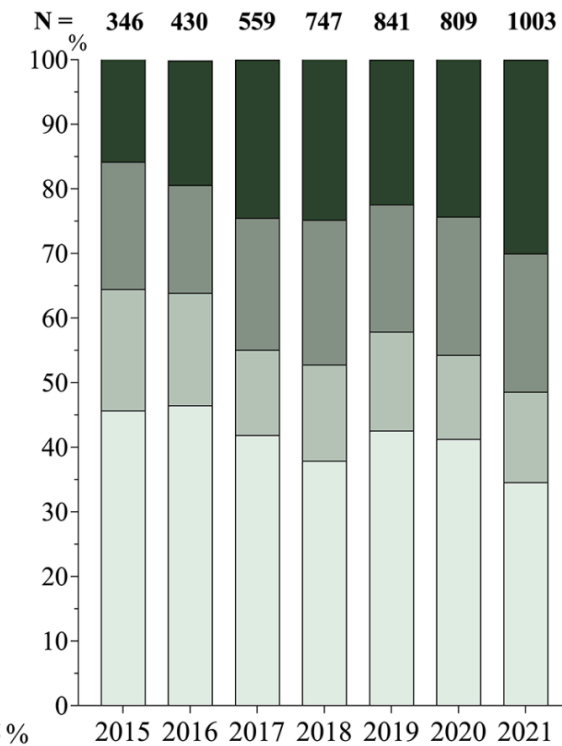


But patients are sicker

(a) Prevalence of comorbidities and their association with CCI burden group



(b) Annual number of EVTs



Very severe comorbidity

2015: 16%

2021: 30%

# We are bringing more patients for EVT

## Patient

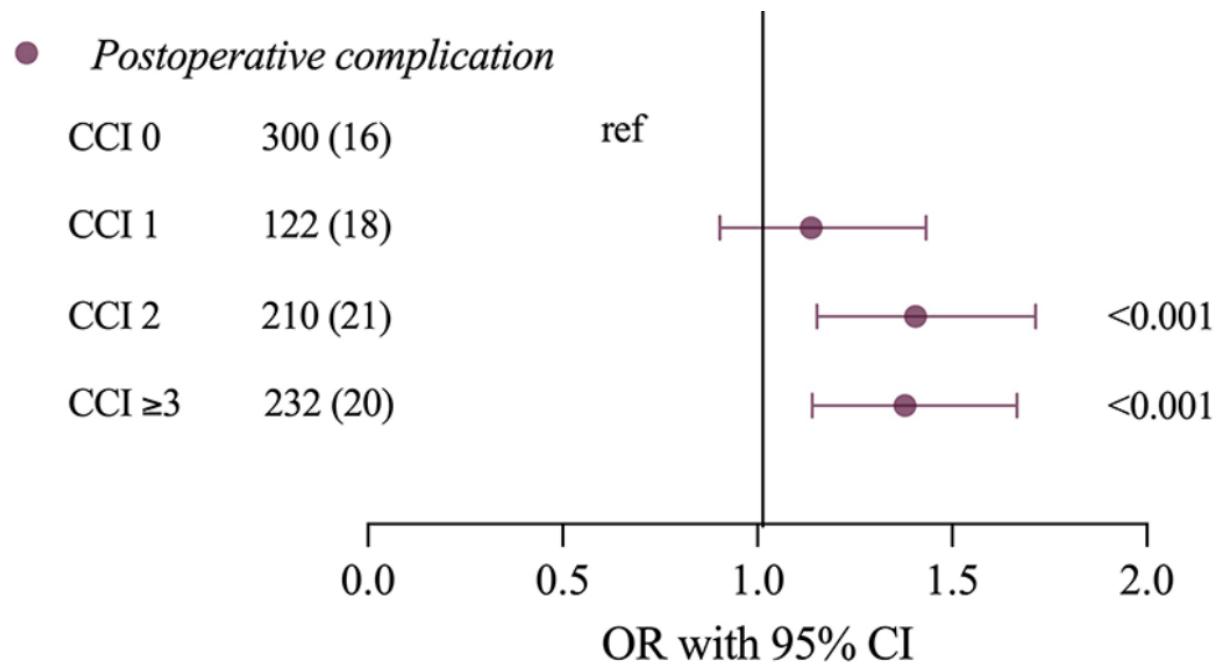


Very severe  
comorbidity

2015: 16%

2021: 30%

But patients are sicker



## Postoperative complications

-ICH

-sICH

-Malignant edema

-Severe infection

-Cardiovascular events

Patients with severe comorbidity were **1.3 X** more likely to have postoperative complications

# We are bringing more patients for EVT

## Patient

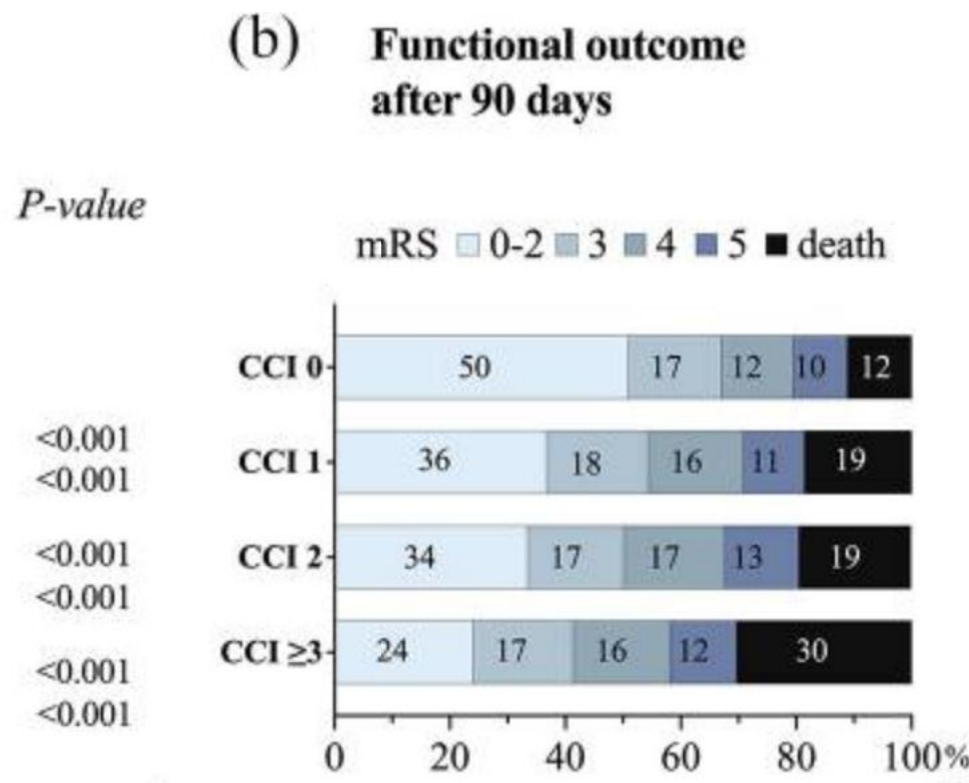


Very severe  
comorbidity

2015: 16%

2021: 30%

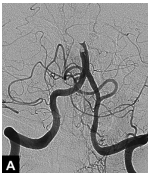
But patients are sicker

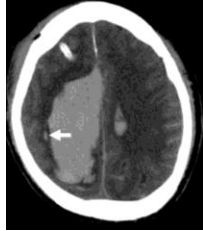



**Comorbidity burden in  
EVT-treated patients is  
linked to worse outcomes  
despite similar  
recanalization rates**

# Same procedure, different outcomes

Patient



	NNT*	Early Neurological recovery**	sICH 	Mortality 
<b>HERMES (&lt;6hrs)</b>	<b>2.7</b>	<b>50%</b>	<b>4.4%</b>	<b>15.3%</b>
<b>Extended window (6-24 hrs)</b>	<b>3.0</b>	<b>40%</b>	<b>5.3%</b>	<b>16.5%</b>
<b>Posterior circulation</b>	<b>3.0</b>	<b>&lt;10%</b>	<b>5.0%</b>	<b>36%</b>
<b>Large core</b>	<b>4.7</b>	<b>30%</b>	<b>5.5%</b>	<b>31.5%</b>

\*NNT to  
reduce  
disability  
1 point



\* \* Drop in  
NIHSS >8  
points or  
NIHSS 0-1  
at day 7

# Intravenous Thrombolysis

Does thrombolysis really make things more dangerous? (Patients with LVO <4.5hrs otherwise eligible for thrombolysis)

Other  
therapies



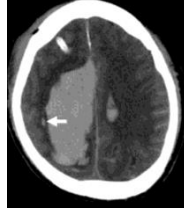

	mRS 0-2	Any ICH	sICH 	Mortality 
EVT alone	46%	27.8%	4.9%	17.4%
EVT + IVT	45%	36.3%	5.8%	16.5%
NINDS trial (thrombolysis <3 hrs)	39%	10.6%	6.4%	17%

# Intravenous Thrombolysis

Does thrombolysis really make things more dangerous? (Patients with LVO <4.5hrs otherwise eligible for thrombolysis)

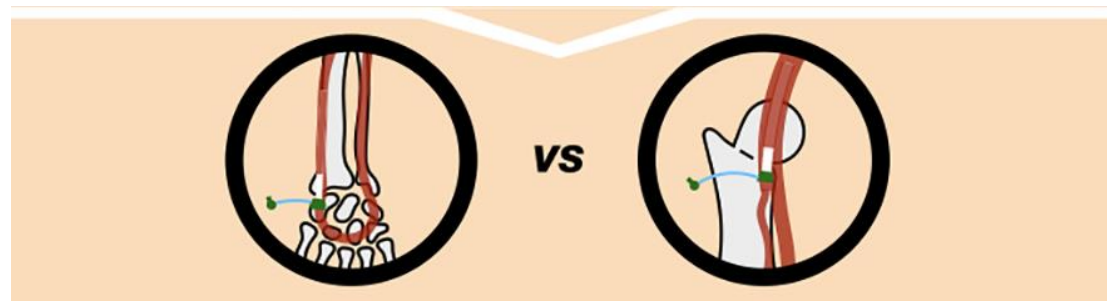
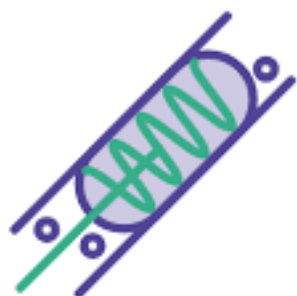
Other  
therapies



	mRS 0-2	Any ICH	sICH 	Mortality 
<b>EVT + Thrombolysis</b>	45%	36.3%	5.8%	16.5%
<b>Large core</b>	19.4%	35%	5.5%	31.5%

# Access – Radial vs Femoral

Procedural  
information



TICI 2c-3



Puncture to first  
pass time



Puncture to  
recanalization time



Severe access  
complications



Access  
conversion



sICH

TRA	43 (74.1%)	26' (20 - 40)	60' (44-81)	1 (1.7%)	7 (12.1%)	4 (7%)
TFA	43 (74.1%)	20' (17 - 28)	43' (28-74)	1 (1.7%)	5 (8.6%)	4 (7%)

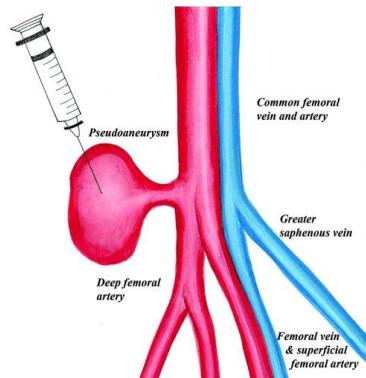
n=296

# Femoral access complications



**Groin hematoma**  
**3.8%**

**Retroperitoneal  
bleeding**  
**1.3%**



**Pseudoaneurysm**  
**1.3%**

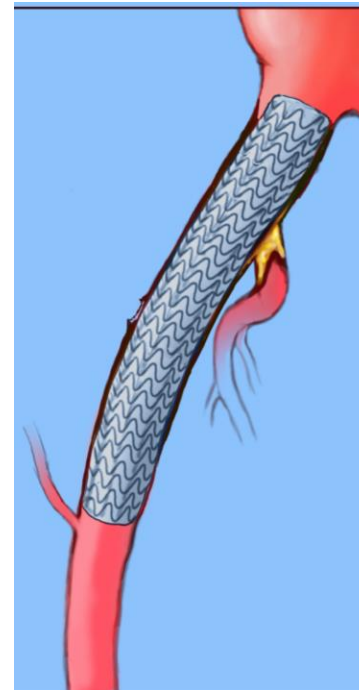
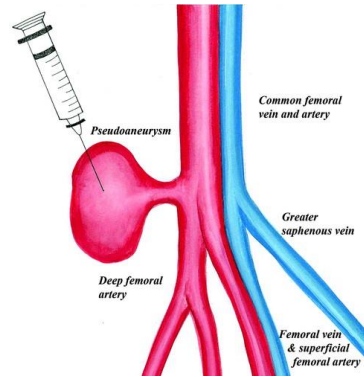
**Limb ischemia**  
**3.8%**



n=296

# Femoral access complications

**Any  
complication:  
7.8%**



**Complications  
requiring  
intervention:  
2.0%**

**Table 2: Access-site complication rates**

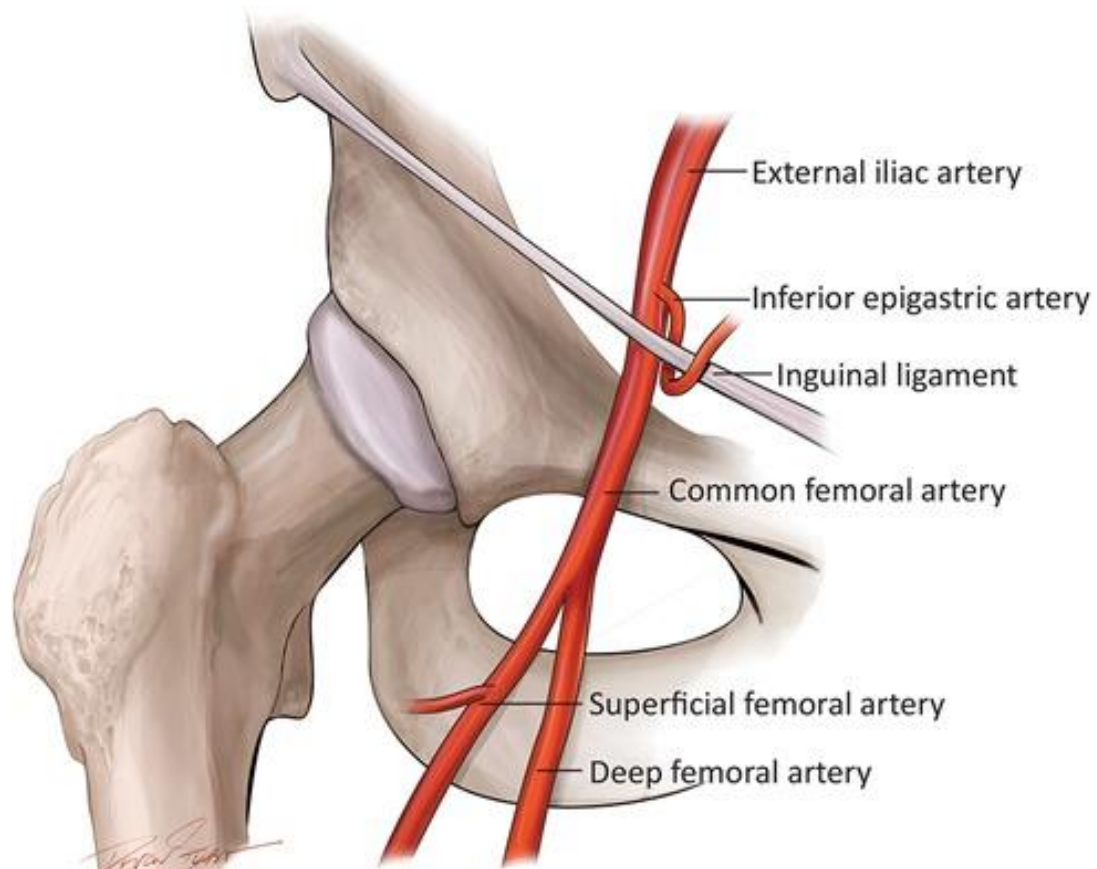
Trial	Non-Major AEs	Serious AEs	TAEs
SWIFT <sup>a</sup>	NA	4/144 (2.78%)	NA
ESCAPE <sup>b</sup>	12/165 (7.27%)	2/165 (1.21%)	14/165 (8.48%)
REVASCAT <sup>c</sup>	NA	NA	12/103 (11.65%)
EXTEND-IA <sup>d</sup>	NA	1/35 (2.86%)	NA
DAWN <sup>e</sup>	NA	1/107 (0.93%)	NA
MR RESCUE <sup>f</sup>	NA	0/64 (0%)	NA
THRACE <sup>g</sup>	NA	3/145 (2.07%)	NA

**Note:**—NA indicates not applicable; AE, adverse event; TAE, total adverse event.

<sup>a</sup> No AE reported. Table 1 reports 4 groin complications; Table 5 reports 9 major adverse events at the access site.

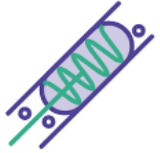
<sup>b</sup> Serious adverse events resulted in death, prolonged hospital stays, re-admission, or were severe or life-threatening. All minor events consisted of femoral hematomas.

# Access site assessments



# Access site assessments

- Every 15 minutes for 1 hour, every 30 minutes for 1 hour, and every hour for 4 hours
- Special focus on pulses, signs of poor perfusion, bleeding, hypotension
- Some challenges:
  - Long bedrest times
  - Uncooperative patient
- Pro tips:
  - When in doubt hold pressure even if suspecting retroperitoneal !
  - If popliteal pulse is present, it is unlikely to be acute limb ischemia

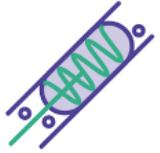


# Procedural complications

	RCT	Procedural complications *
Early window	REVASCAT	13.5%
Delayed window	DAWN	7%
Posterior circulation	ATTENTION	14%
Large core	RESCUE JAPAN	8.9%
MeVO	DISTAL	10%

\* Dissection, perforation, re-occlusion, embolization to new territory





# Procedural complications

## *Dissection*

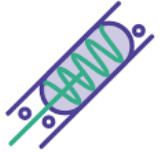


- *Antiplatelets*
- *Stent*

*Unstandardized antiplatelet  
regimen*

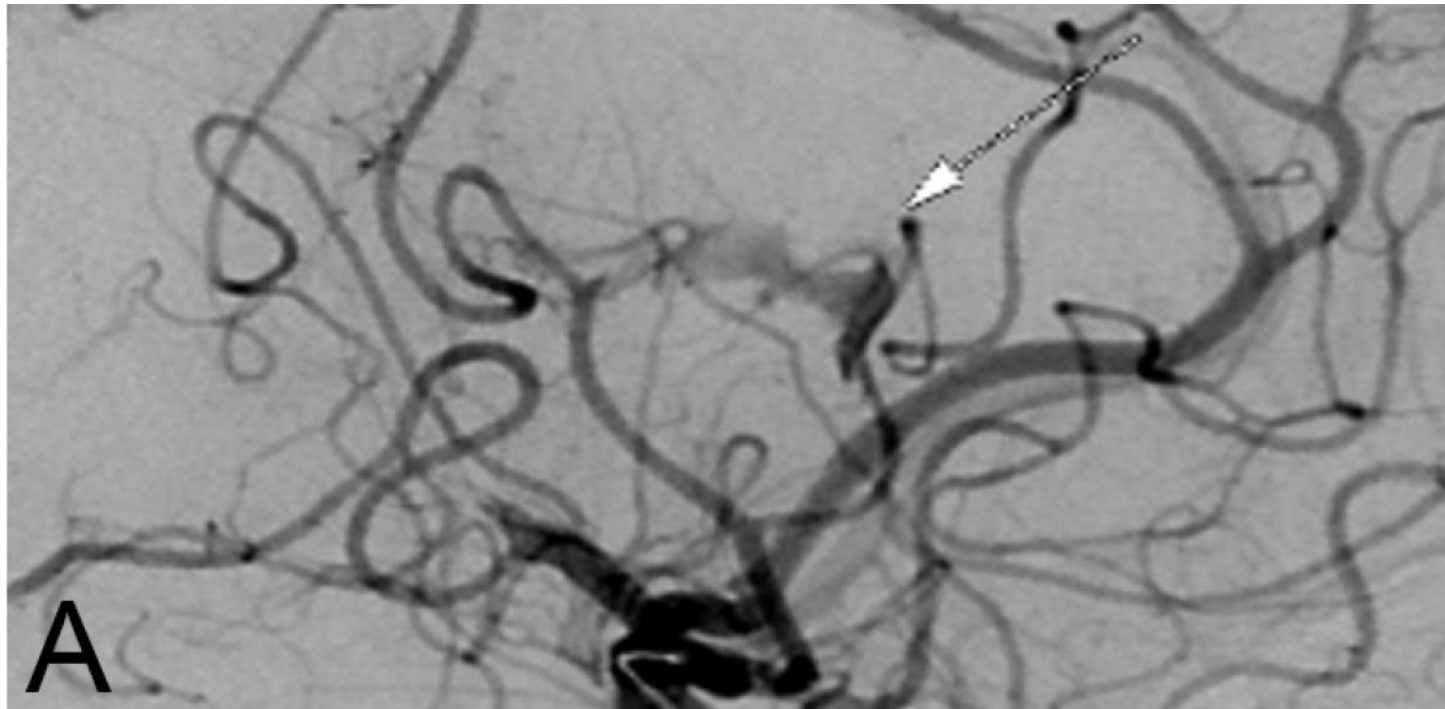
***GPIIIB/IIIa infusion for 4-6 hrs +  
DAPT***



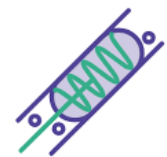


# Procedural complications

## *Vessel perforation*



- Usually self limiting
- ICA flow arrest
- Local flow arrest with microcatheter
- Vessel sacrifice
- **Reverse thrombolysis?**
- **SBP target <140 mmHg**

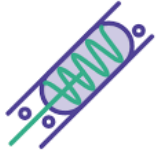


# Procedural complications

*Vessel perforation –  
reverse thrombolysis*

**Table 6.** Management of Symptomatic Intracranial Bleeding Occurring Within 24 Hours After Administration of IV Alteplase for Treatment of AIS (Table view)

COR IIb	LOE C-E0
Stop alteplase infusion	
CBC, PT (INR), aPTT, fibrinogen level, and type and cross-match	
Emergent nonenhanced head CT	
Cryoprecipitate (includes factor VIII): 10 U infused over 10–30 min (onset in 1 h, peaks in 12 h); administer additional dose for fibrinogen level of <150 mg/dL	
Tranexamic acid 1000 mg IV infused over 10 min OR ε-aminocaproic acid 4–5 g over 1 h, followed by 1 g IV until bleeding is controlled (peak onset in 3 h) (Potential for benefit in all patients, but particularly when blood products are contraindicated or declined by patient/family or if cryoprecipitate is not available in a timely manner.)	
Hematology and neurosurgery consultations	
Supportive therapy, including BP management, ICP, CPP, MAP, temperature, and glucose control	



# General anesthesia vs conscious sedation

- At least 8 RCTs looking to answer this question
- Inconsistent results
- Largest meta-analysis suggests: **Higher successful recanalization with GA**

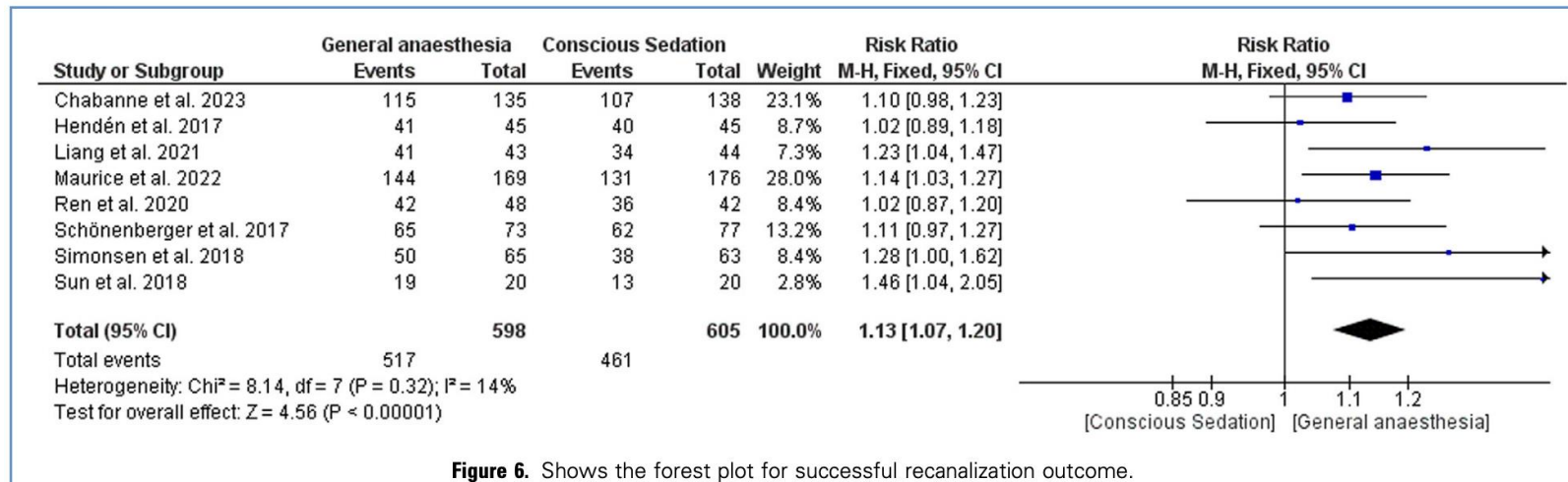
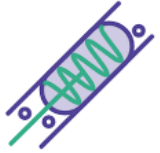
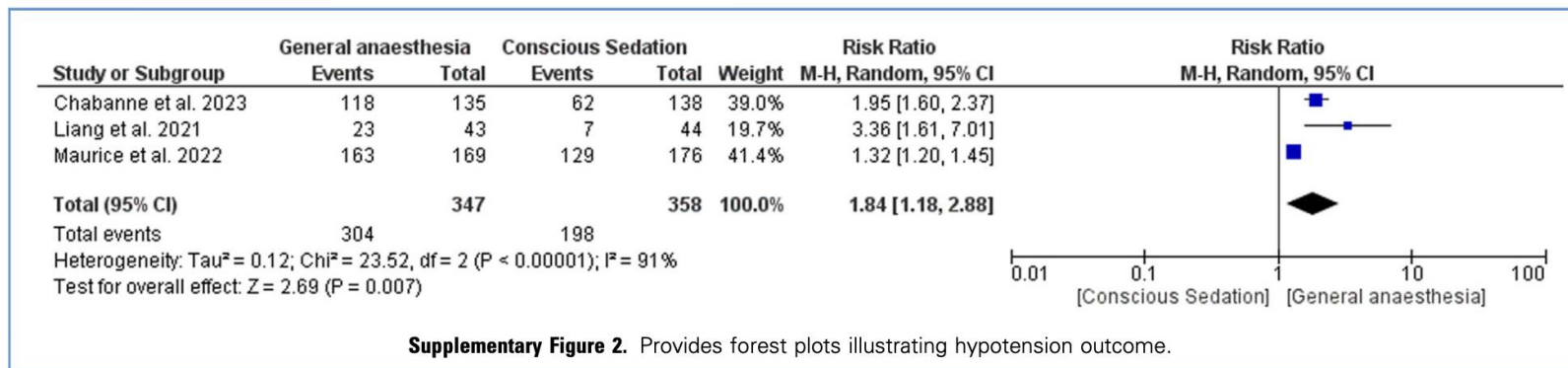


Figure 6. Shows the forest plot for successful recanalization outcome.



# General anesthesia vs conscious sedation

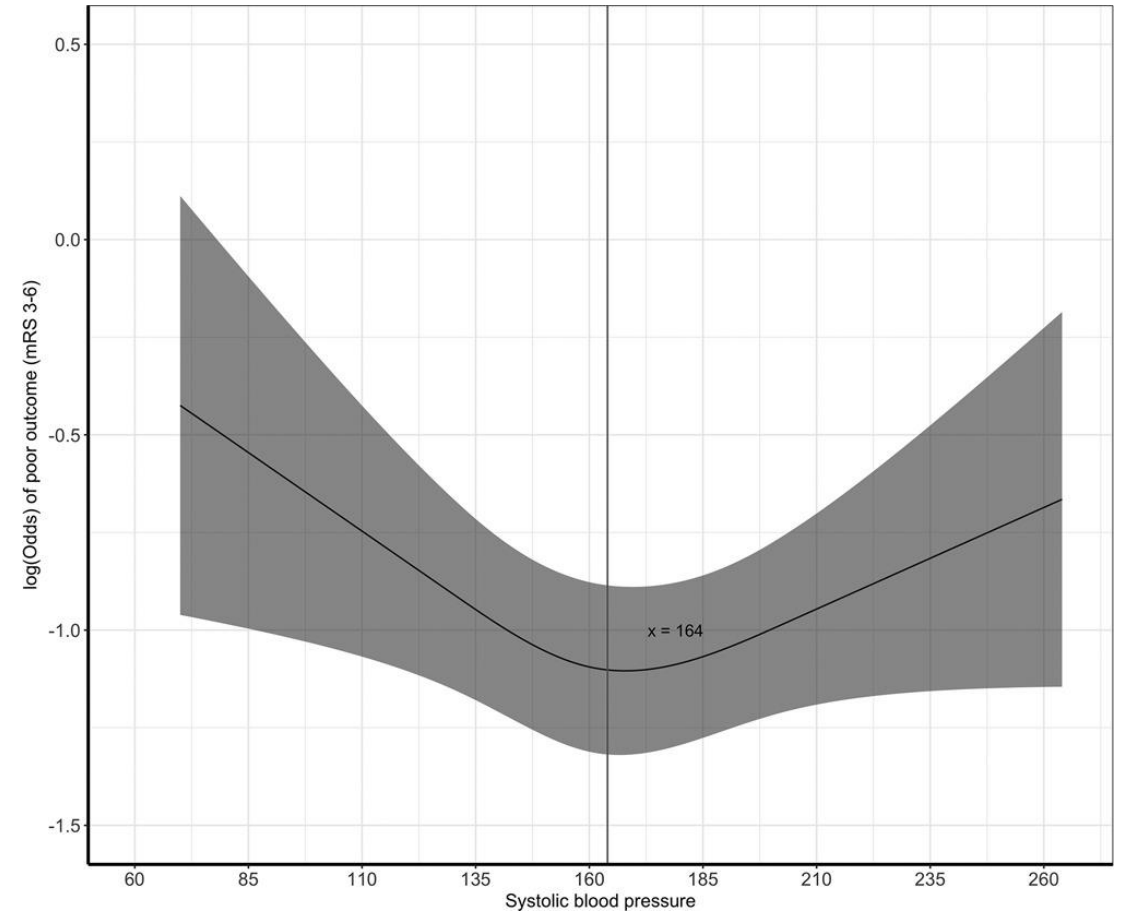
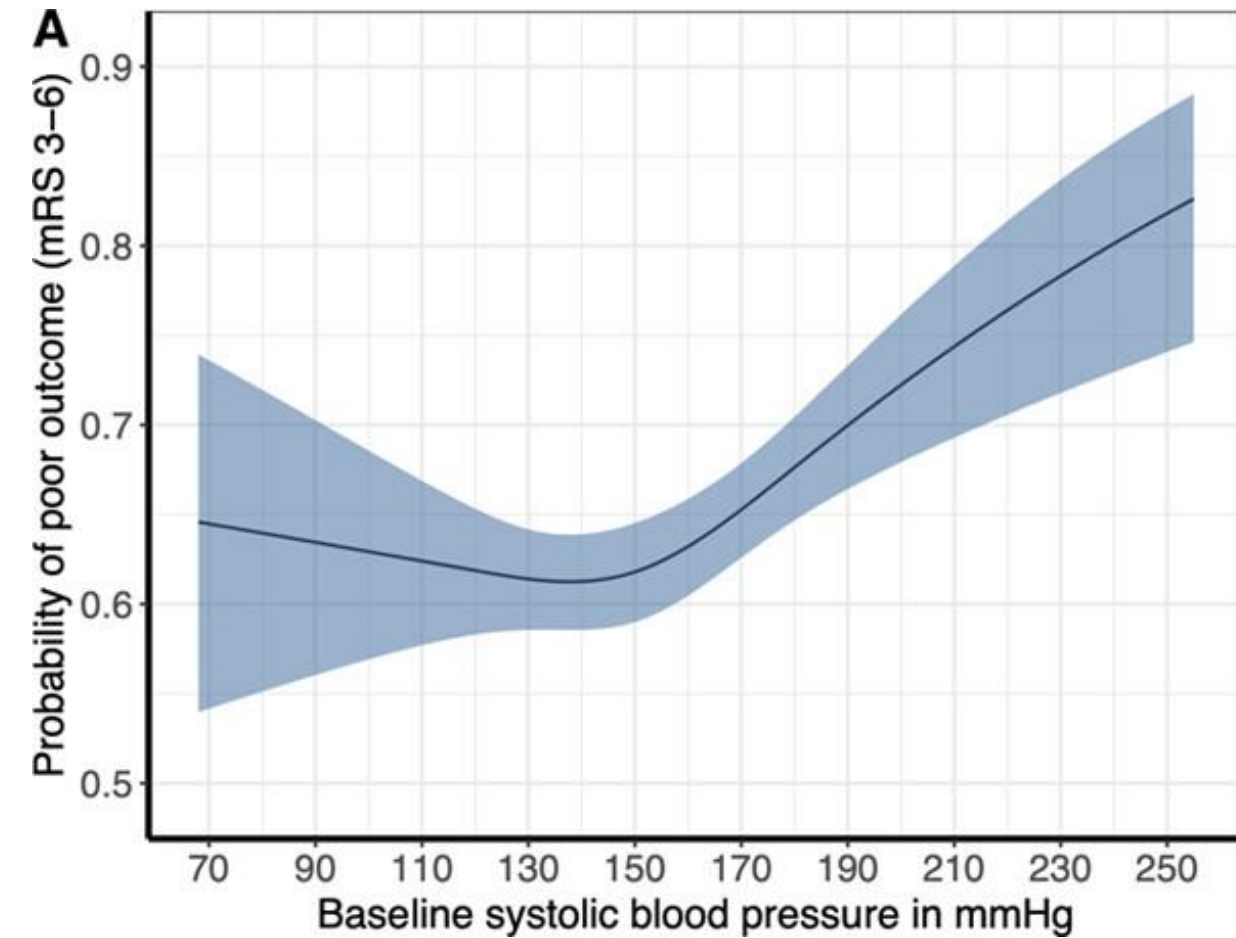
- At least 8 RCTs looking to answer this question
- Inconsistent results
- Largest meta-analysis suggests: **Higher risk of hypotension with GA**



# General anesthesia vs conscious sedation

- At least 8 RCTs looking to answer this question
- Inconsistent results
- Largest meta-analysis suggests neutral for:
  - Good and excellent functional outcomes
  - Symptomatic ICH
  - Mortality

# Blood pressure target



# Blood pressure target

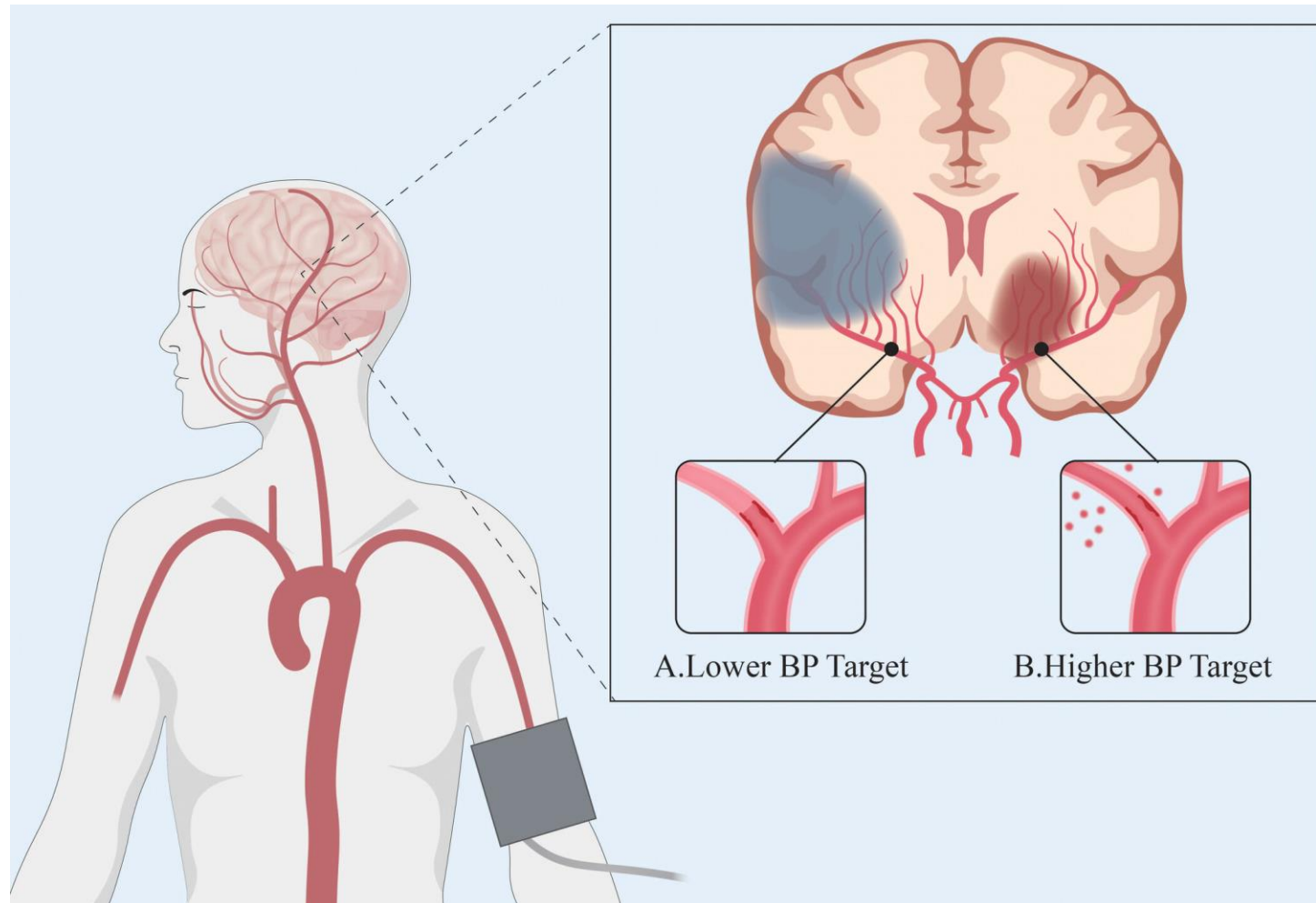
## **Favors SBP <140 mmHg**

- Reduced risk of hemorrhagic transformation
- Reduced risk of reperfusion injury
- Observational studies have found association between high BP and worse outcomes

## **Favors SBP <180 mmHg**

- Reduced risk of infarct growth
- Support collateral flow
- Complications from aggressive BP management

# Blood pressure target



# Blood pressure target

**Table 1** Baseline characteristics of the included studies

Author, Year	Country	Sample size <sup>#</sup>	Intensive/ Standard* (mm Hg)	Achieved SBP target* (mm Hg)	Onset to puncture (minutes)*	stroke severity (NIHSS)*	Primary outcomes	Antihypertensive drugs	Time of duration(h)
Mazighi,2021	France	318	100~129/130~180	128(11)/138(17)	285 (234,357)/297 (220,353)	18 (12~20)/17 (13~20)	abcd	Nicardipine	24
Yang,2022	China	816	<120/140~180	NA	NA	15 (10~20)/15 (10~20)	abcd	--	72
Mistry,2023	USA	71	<140/<180	122 (15)/129 (20)	NA	16 (11~23)/14 (11~17)	abc	Nicardipine	24
Nam,2023	South Korea	302	<140/140~180	135(20)/141 (20)	388(224,693)/356(208,730)	13(6)/12(7)	abc	Nicardipine	24
Ma,2023	China	102	130~140/160~180	134(8)/153(4)		22/21	abc	Nitroglycerin	72
Guan,2024	China	80	110~140/<180	NA	NA	NA	ab	Urapidil	72

<sup>#</sup> The number of patient who finished the study and data was available

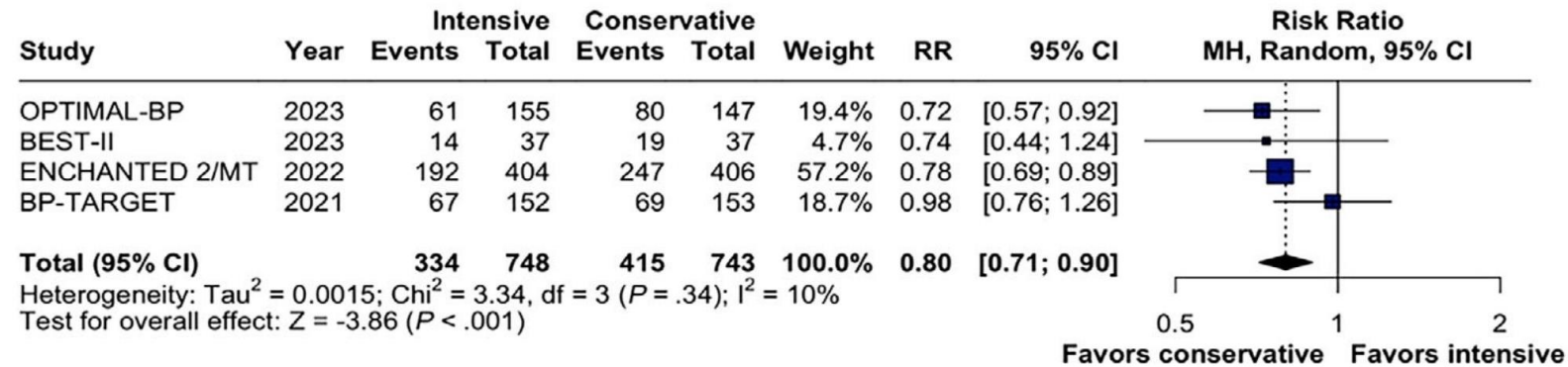
\* Intensive systolic blood pressure target group VS. Standard systolic blood pressure target group

aFavorable outcome at 90-day (mRS score = 0–2), b 90-day mortality, c sICH, d 7-day mortality

# Blood pressure target

## Functional outcome

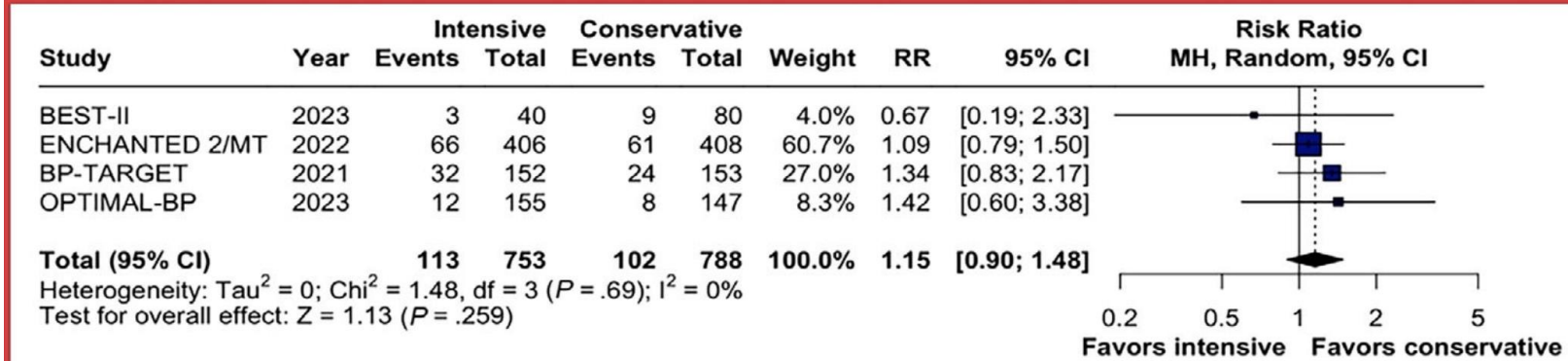
### (A) Modified Rankin Scale (0-2) at 90 days



# Blood pressure target

## Mortality

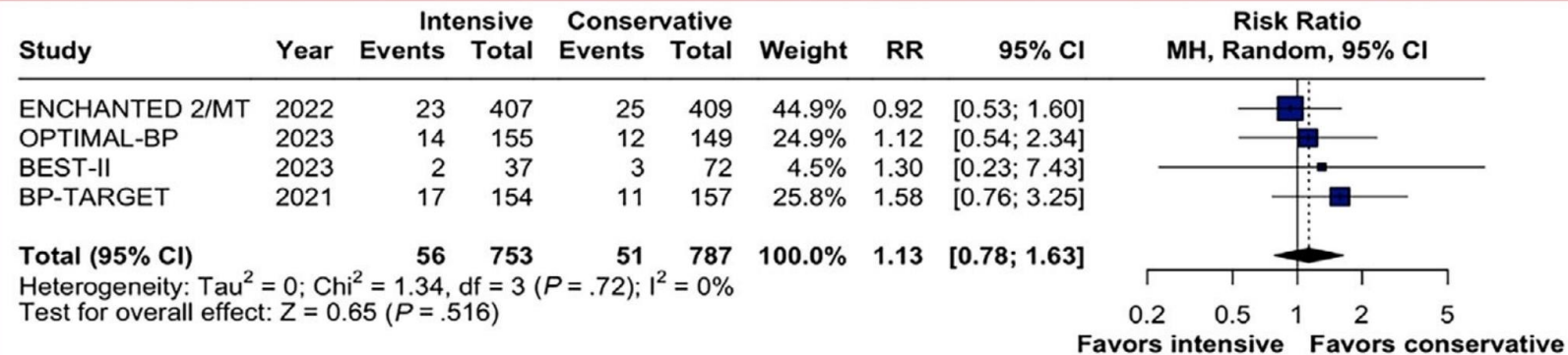
### (D) All-cause mortality



# Blood pressure target

## Symptomatic ICH

### (E) sICH within 36 hours



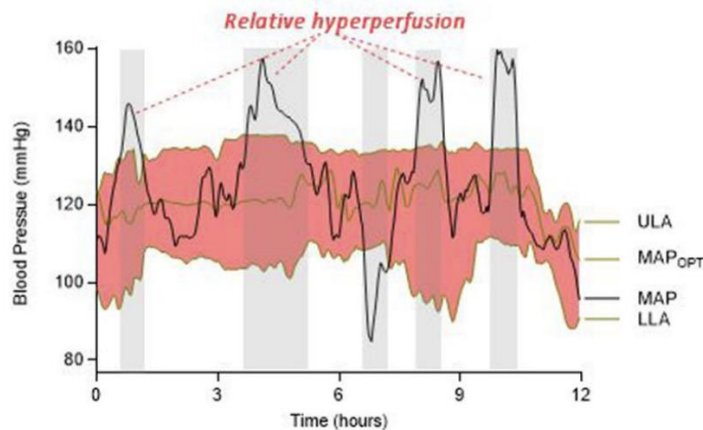
# Blood pressure target

After endovascular thrombectomy		
2a	B-NR	9. In patients who undergo EVT, it is reasonable to maintain BP at a level $\leq 180/105$ mm Hg during and for 24 hours after the procedure. <sup>14-17</sup>
3: Harm	A	10. In patients with AIS with LVO of the anterior circulation who have been successfully recanalized by endovascular therapy (mTICI 2b, 2c, or 3) and without other indication for blood pressure management target, intensive SBP reduction target of $<140$ mm Hg for the first 72 hours is harmful and not recommended. <sup>18-21</sup>

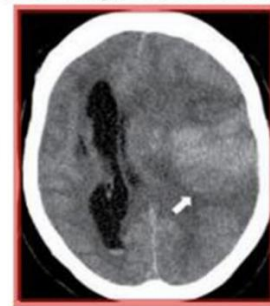
# Blood pressure target

- Most trials only included patients with successful EVT (mTICI  $\geq 2$ B)
- Individualized BP management
  - Should the target be different in unsuccessful cases ?
  - Is the target independent of initial BP ?
- Is the difference in the variability?

ABP deviating from autoregulatory limits



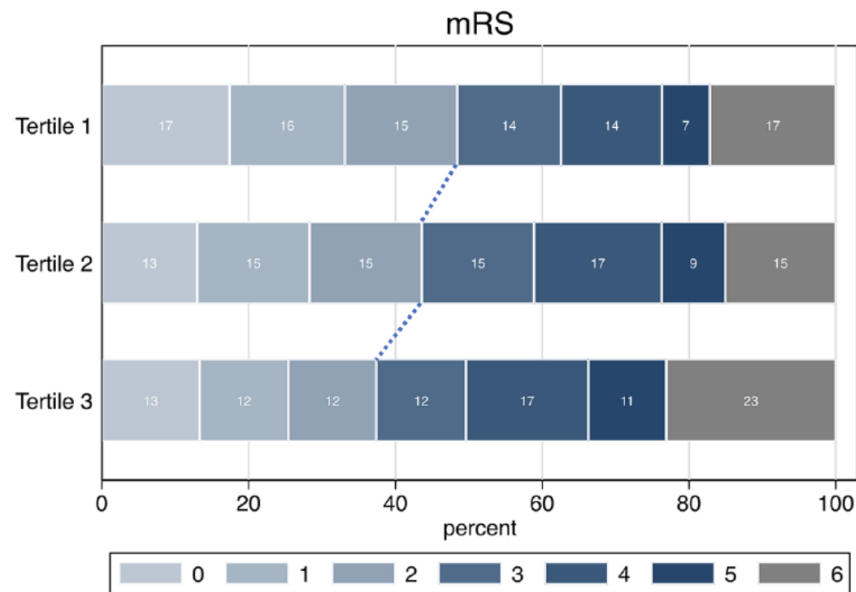
Hemorrhagic Transformation



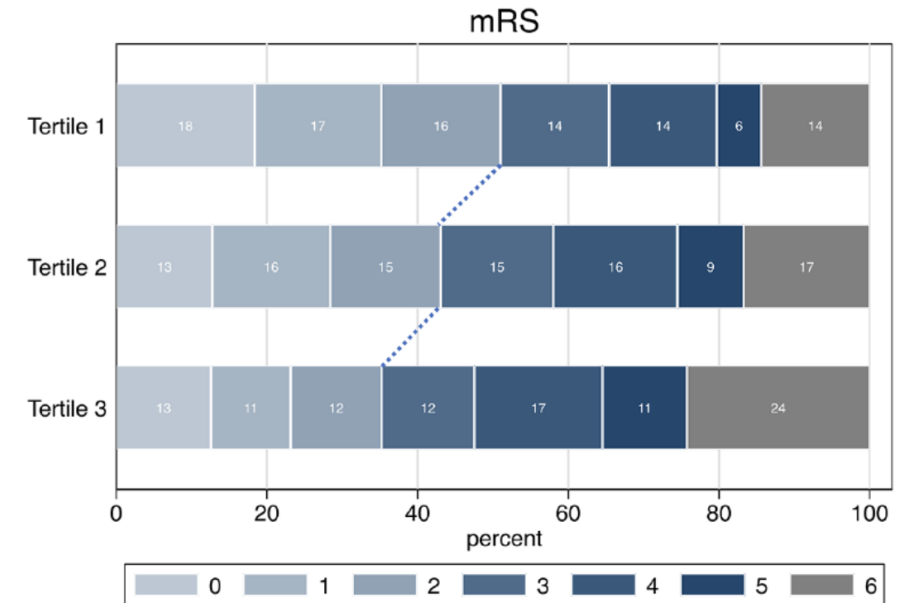
Poor Functional Outcome

# Blood pressure target

-Is the difference in the variability? n=2640 from 5 observational studies

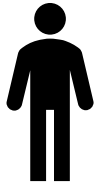


**Figure 1.** Distribution of mRS-scores at 90 days among different SBP SD tertiles.  
mRS: modified Rankin Scale; SBP SD: systolic blood pressure standard deviation.



**Figure 3.** Distribution of mRS-scores at 90 days among different SBP CV tertiles.  
mRS: modified Rankin Scale; SBP CV: systolic blood pressure coefficient of variation.

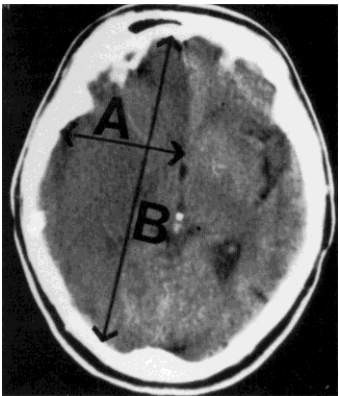
# Close neuromonitoring



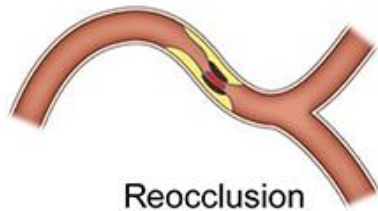
Frequent neurological assessment (Logic behind it)

- *Neurological assessment every 15 minutes for 1 hour and every 30 minutes for 1 hour*

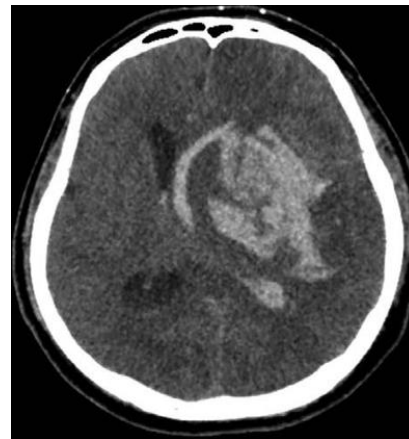
1



2



3



4

Other causes of fluctuations:

- Seizures
- Metabolic/infectious encephalopathy

# Close neuromonitoring

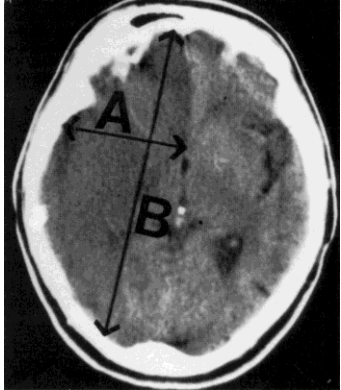


Frequent neurological assessment (Challenges)

- Incomplete recovery
- Difficult neurological exam
- Bedrest
- Agitated/confused/uncooperative patients

1

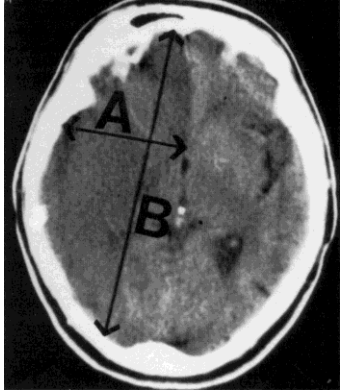
# Mass effect



- Rate of decompressive hemicraniectomy after EVT: ~10-15%
- More common in patients with large core
- Clear evidence of functional benefit and reduced mortality in <60 y
- Clear evidence of reduced mortality only in >60y
- Should be done <48 hrs

1

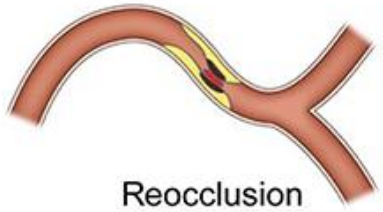
# Mass effect



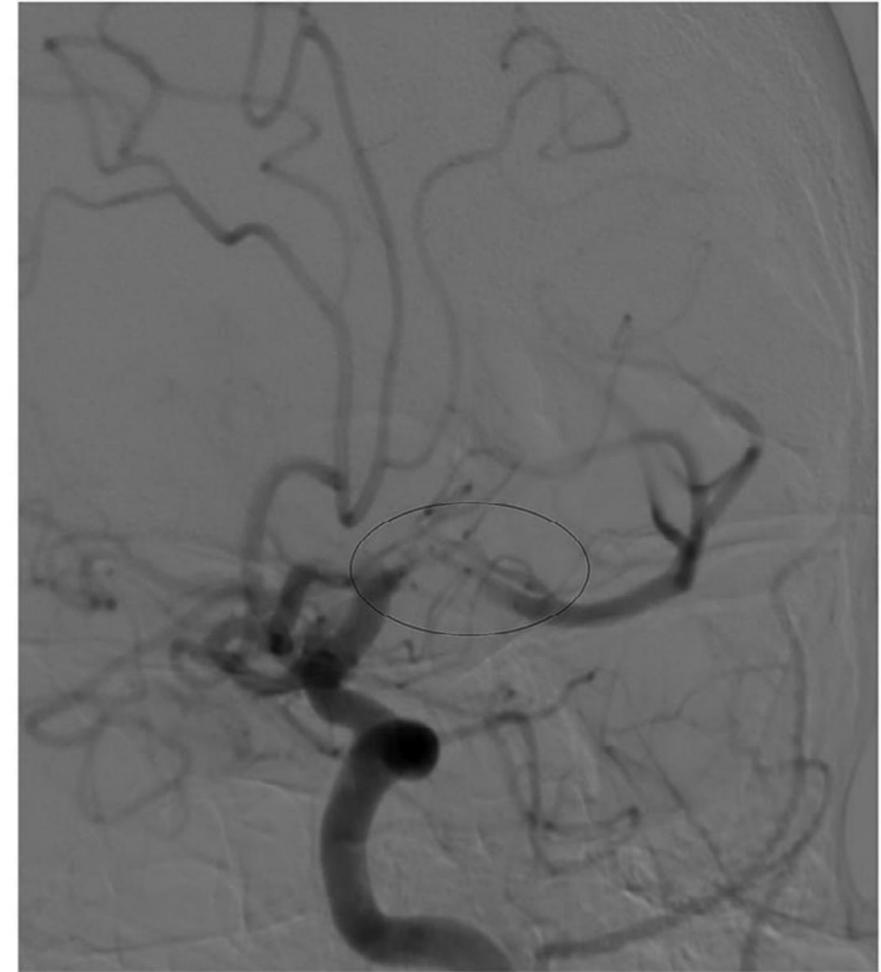
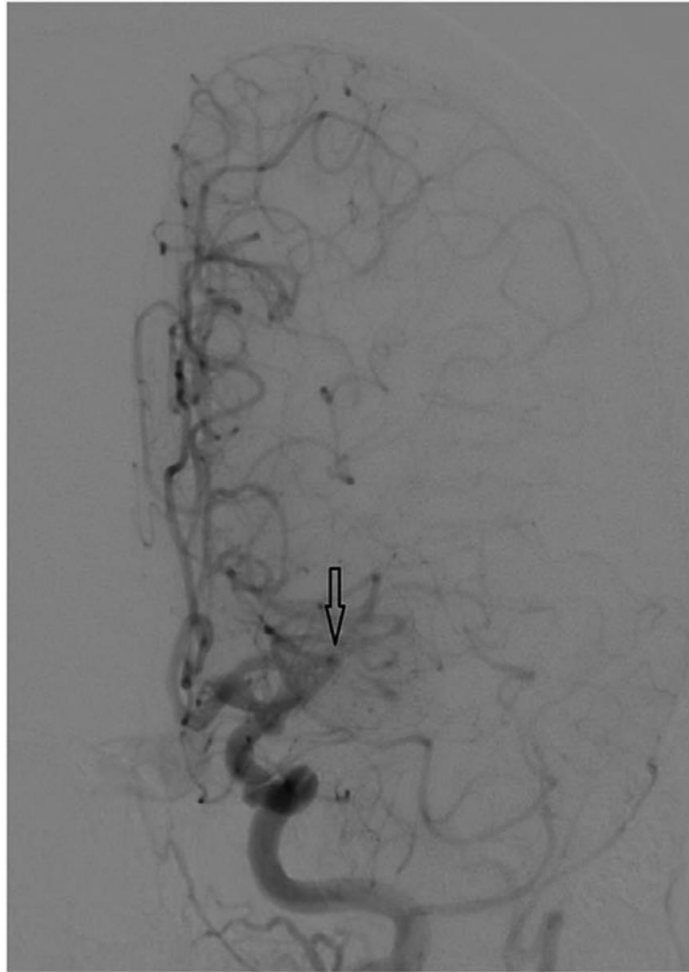
- Osmotic therapy can be considered as a bridge therapy to a surgical intervention (2a recommendation)
- Evidence of harm: hypothermia, barbiturates and corticosteroids
- No benefit: IV glibenclamide

## 2

# Ischemic stroke recurrence



- Infrequent: 5%
- 2 main scenarios:
  - 1. Cardioembolic
  - 2. Intracranial atherosclerosis

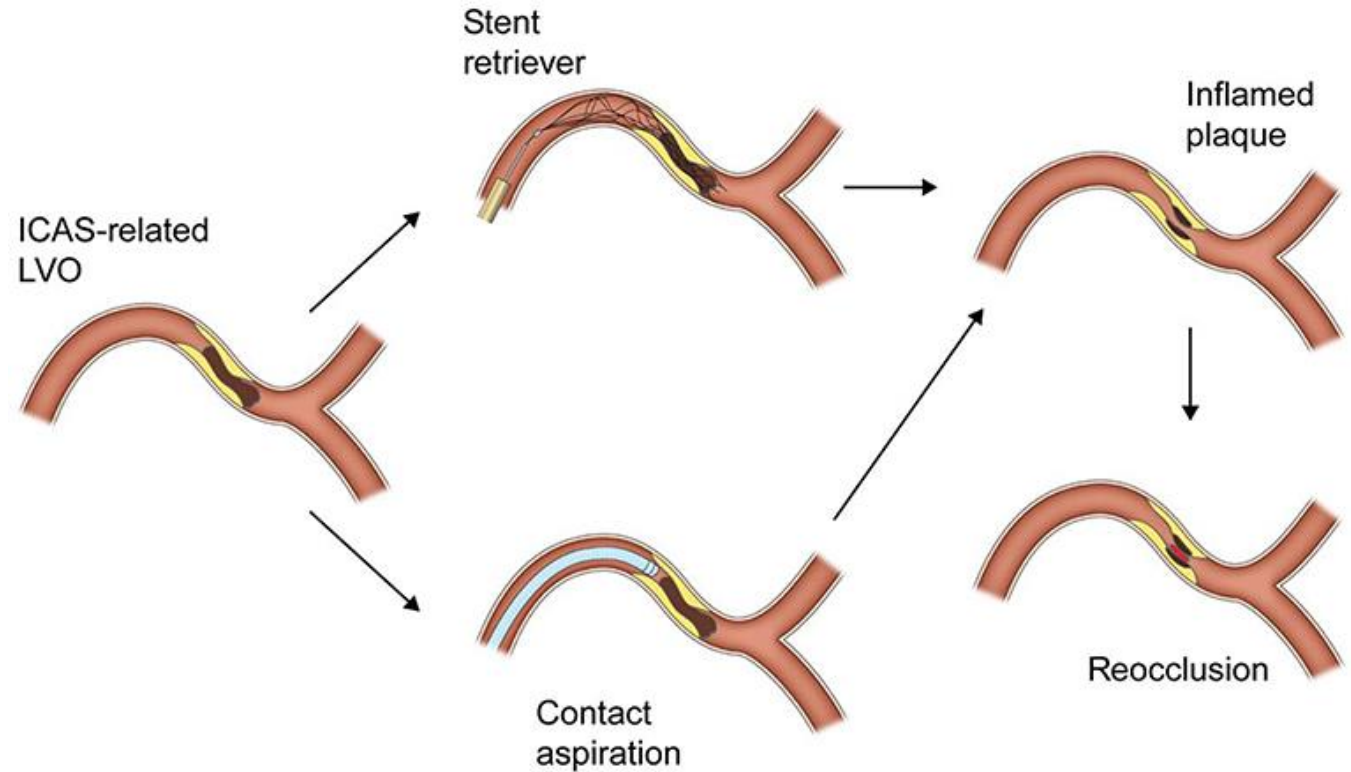


# Ischemic stroke recurrence

- Infrequent: 1-2%
- 2 main scenarios:
  - 1. Cardioembolic
  - 2. Intracranial atherosclerosis

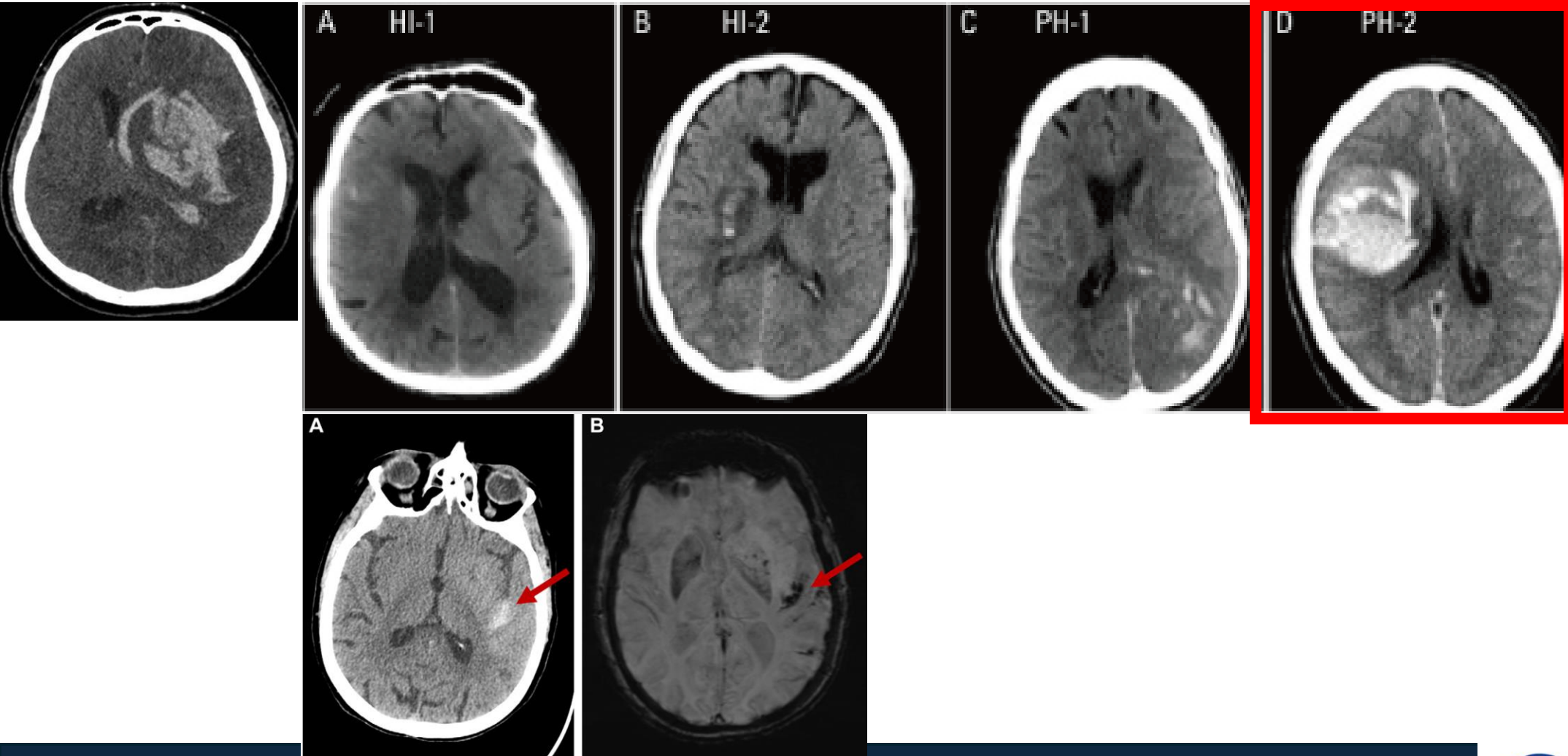
Options:

1. GP IIB/IIIA infusion
2. Rescue stenting
3. Submaximal angioplasty



3

# Hemorrhagic Transformation

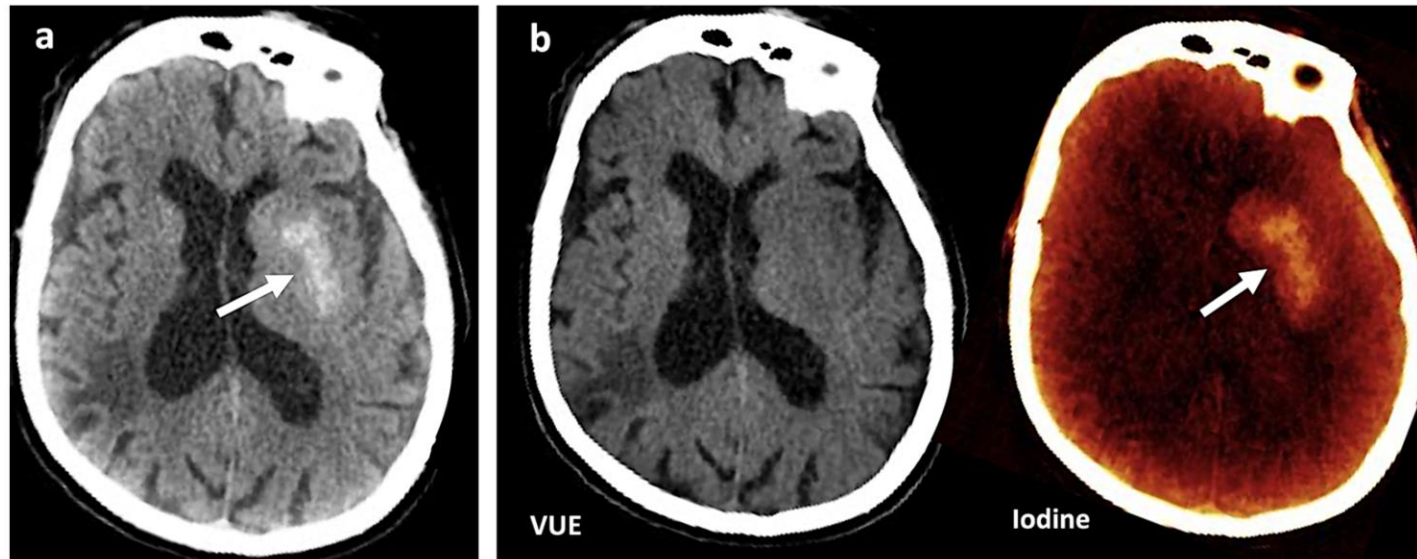


# 3

## Hemorrhagic Transformation

- It is not always easy to determine if hyperintensities on CT are blood or contrast

Dual energy CT can help

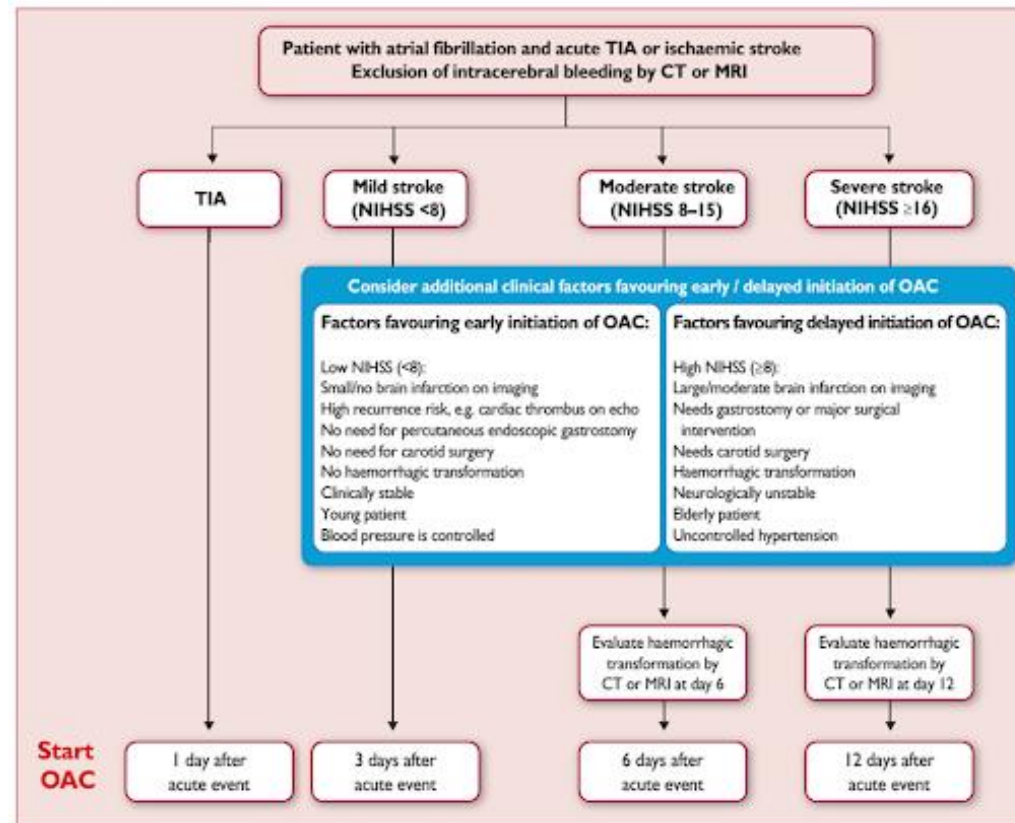


# Antithrombotics

- All guidelines recommend: CT head ~24 hrs to assess hemorrhagic transformation
- At 24 hrs: ASA + LMWH
- What about anticoagulation?

# Antithrombotics

- What about anticoagulation? - *The “1-3-6-12-day rule” is dead*

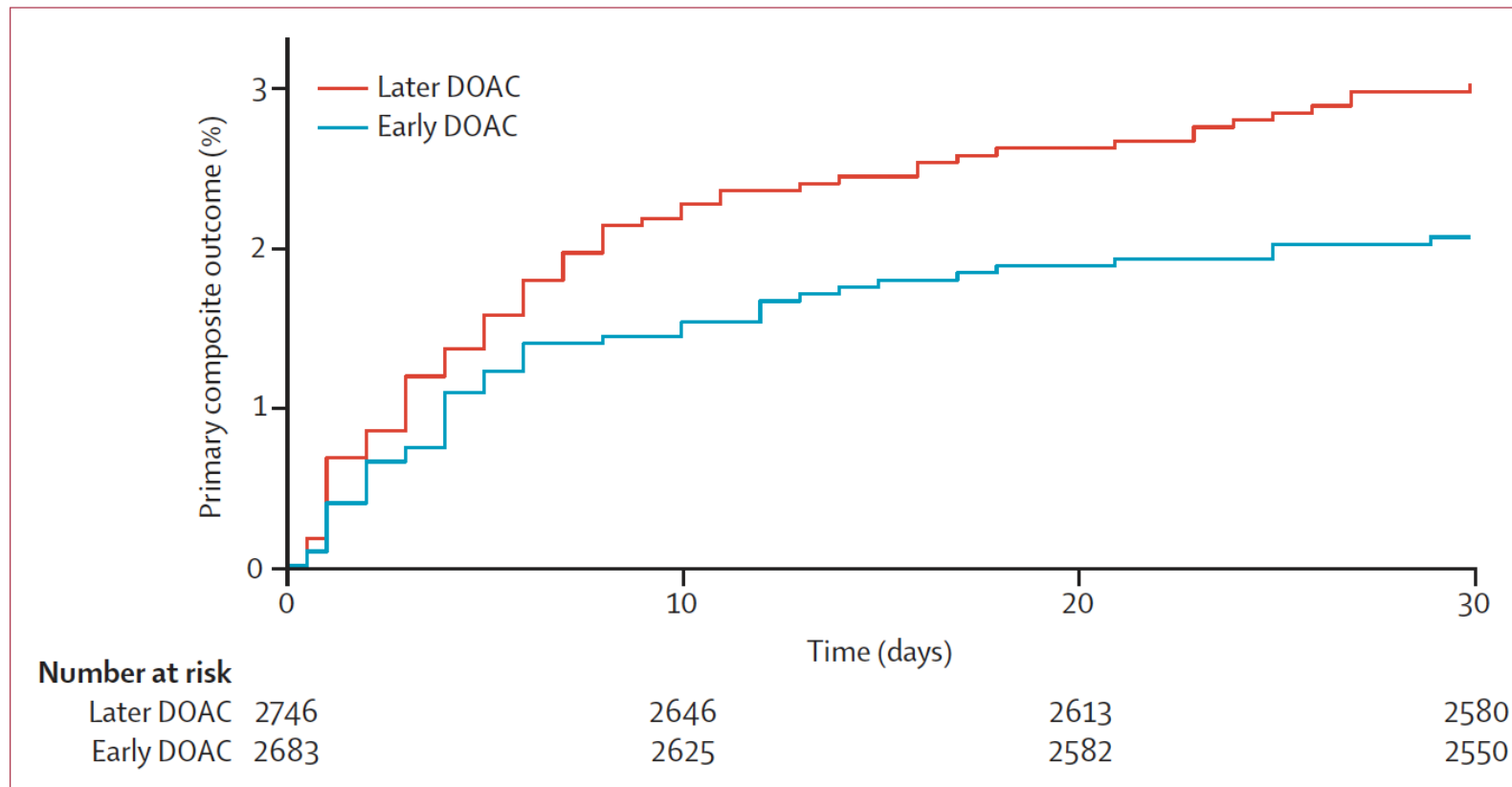


# Antithrombotics

What about anticoagulation?

- 4 RCTs looking at early vs delayed anticoagulation
- Different definitions of early vs delayed, in general 4 days was the cut-off
- Rationale: there is a risk of recurrent ischemic stroke while awaiting restarting anticoagulation
- DOACs have a lower risk of ICH compared to VKA

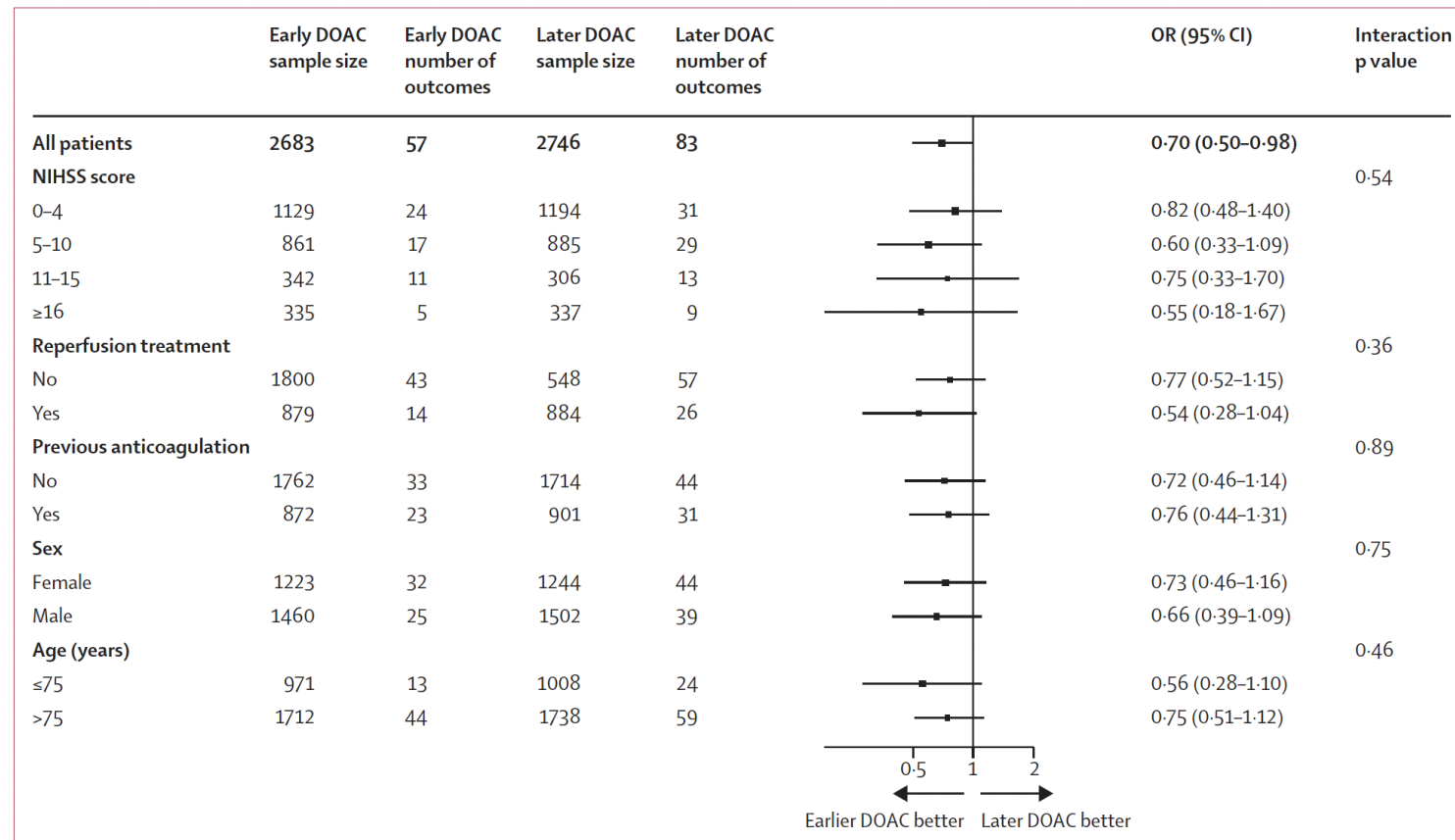
# Antithrombotics



**Figure 2: Primary composite outcome at 30 days by DOAC initiation timing (cumulative hazard)**

Log-rank p value: 0.034. DOAC=direct oral anticoagulant.

# Antithrombotics



**Figure 3: Primary outcome overall and by subgroups of interest**

Interaction p value refers to the interaction term between early versus later DOAC and the baseline characteristic with respect to the primary outcome.

DOAC=direct oral anticoagulant. NIHSS=National Institutes of Health Stroke Scale. OR=odds ratio.

# Antithrombotics

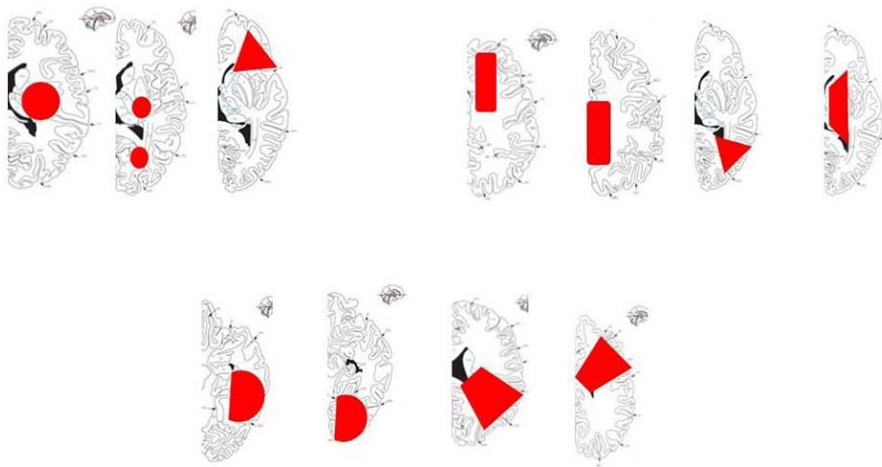
<48 hrs

ELAN stroke size classification

Minor

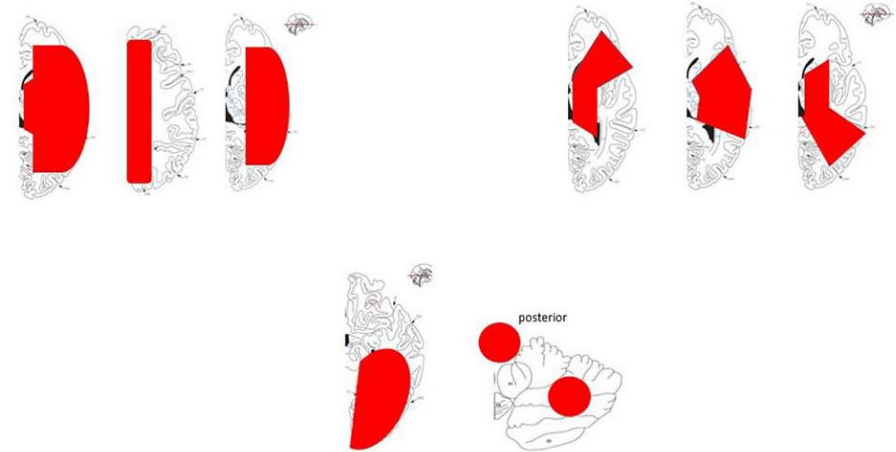


Moderate



<6 days

Major



# Complications in any ischemic stroke

- Hyperglycemia/Hypoglycemia
- Temperature dysregulation
- Arrhythmias
- Hemodynamic instability
- Aspiration
- Respiratory failure
- Infection
- Thromboembolic complications

# Other important interventions

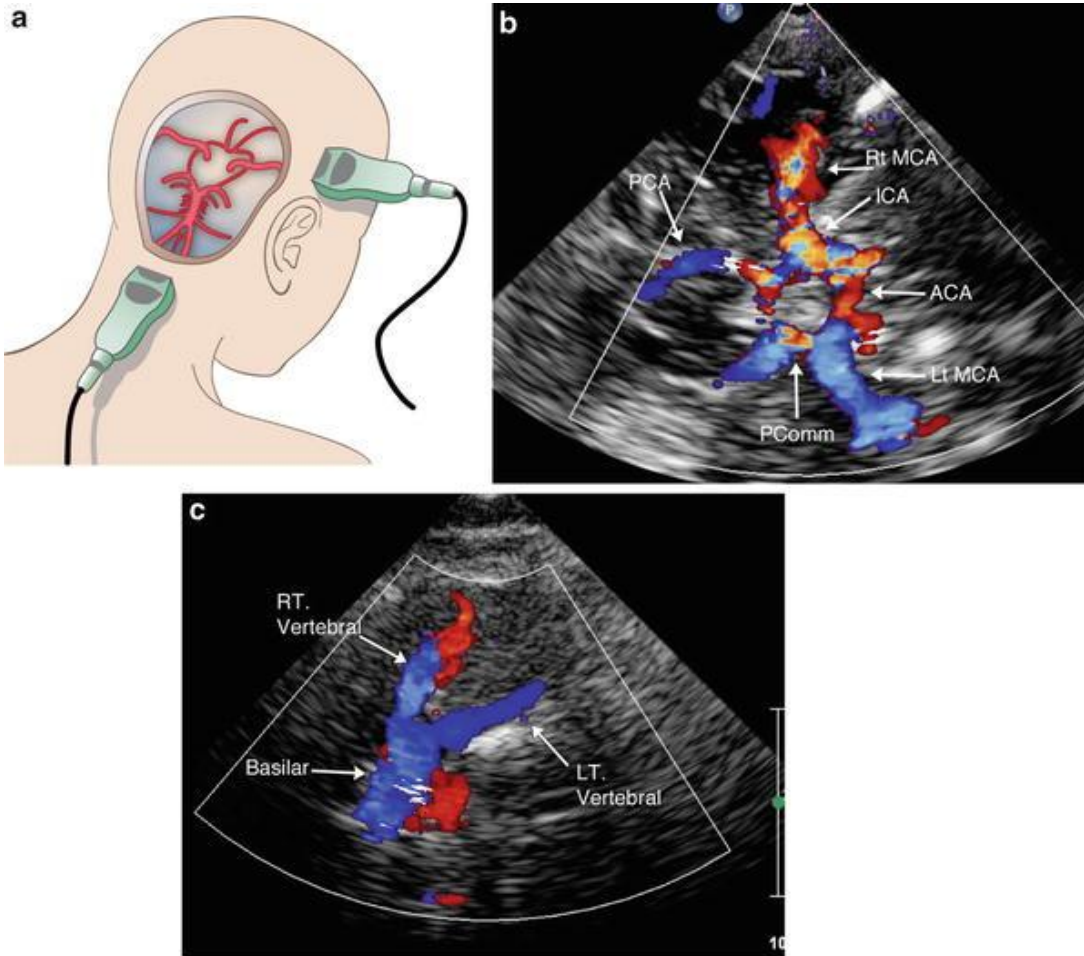
## Clear benefit

- Dysphagia screening
- Avoiding hypoglycemia
- Treat hyperthermia early
- Enteral nutrition first 7 days
- Early DVT prophylaxis , IPC and LMWH
- Early rehabilitation

## Harm or no benefit

- Heparin during procedure
- Steroids
- Hemodilution, volume expansion or BP augmentation
- Prophylactic AED

# Novel post EVT monitoring



TCD to monitor

- Re-occlusion
- Hyperperfusion
- Hemorrhagic transformation
- Guide BP management

# Take home messages

1. More patients benefit from EVT, Time and tissue are no longer barriers
2. Patients undergoing EVT are increasingly more complicated and comorbid
3. Same procedure, very different post EVT results
4. Key things to ask:
  1. Access
  2. Procedural data/complications
5. BP is still a moving target, but for now let it ride, only treat if  $>180$  mmHg and avoid variability
6. Even after successful EVT patients might still have re-occlusion, mass effect or hemorrhagic transformation
7. Earlier initiation of anticoagulation

# Evaluation

For the **Provincial Stroke Rounds Planning Committee**:

- To plan future programs
- For quality assurance and improvement
- For **You**: Reflecting on what you've learned and how you plan to apply it can help you enact change as you return to your professional duties
- For **Speakers**: The responses help understand participant learning needs, teaching outcomes and opportunities for improvement.

Please take 2 minutes to fill the evaluation form out. Thank you!



# Questions?

