

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

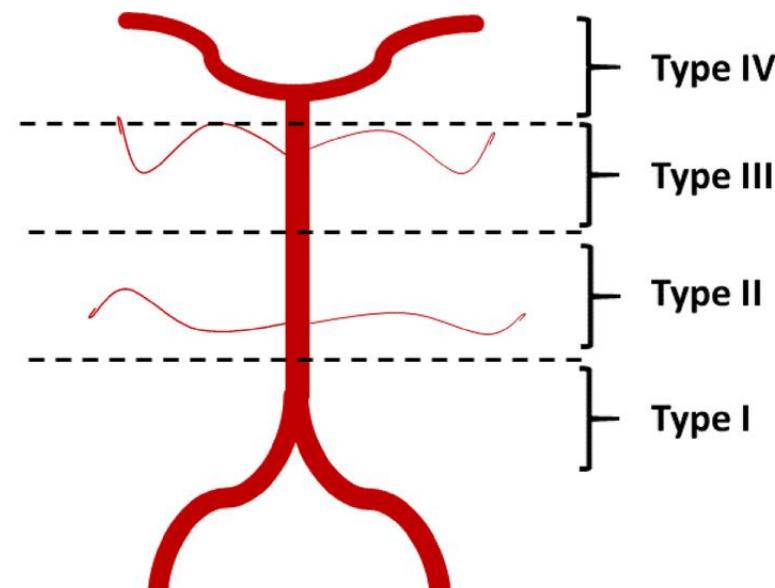
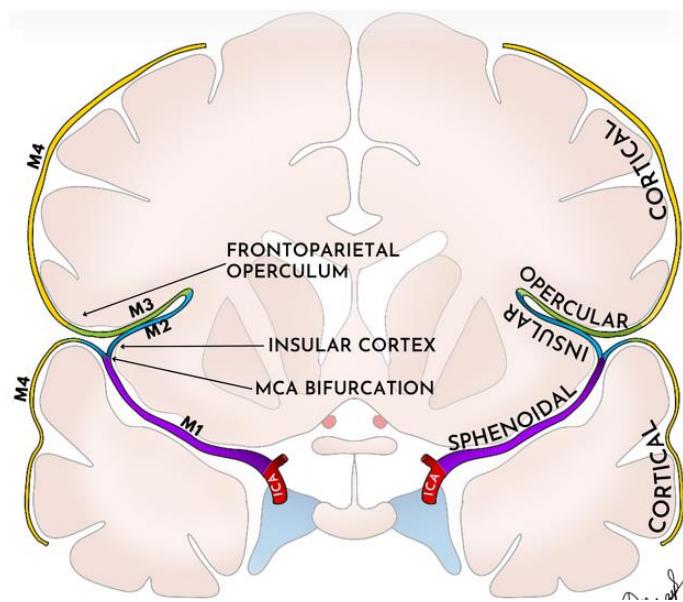
- **Disclosure of Affiliations & Financial Support**
- **Speaker Name:** Alonso Alvarado Bolanos
- **Affiliations:** I have no relationships with for-profit or not-for-profit organizations
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Agenda

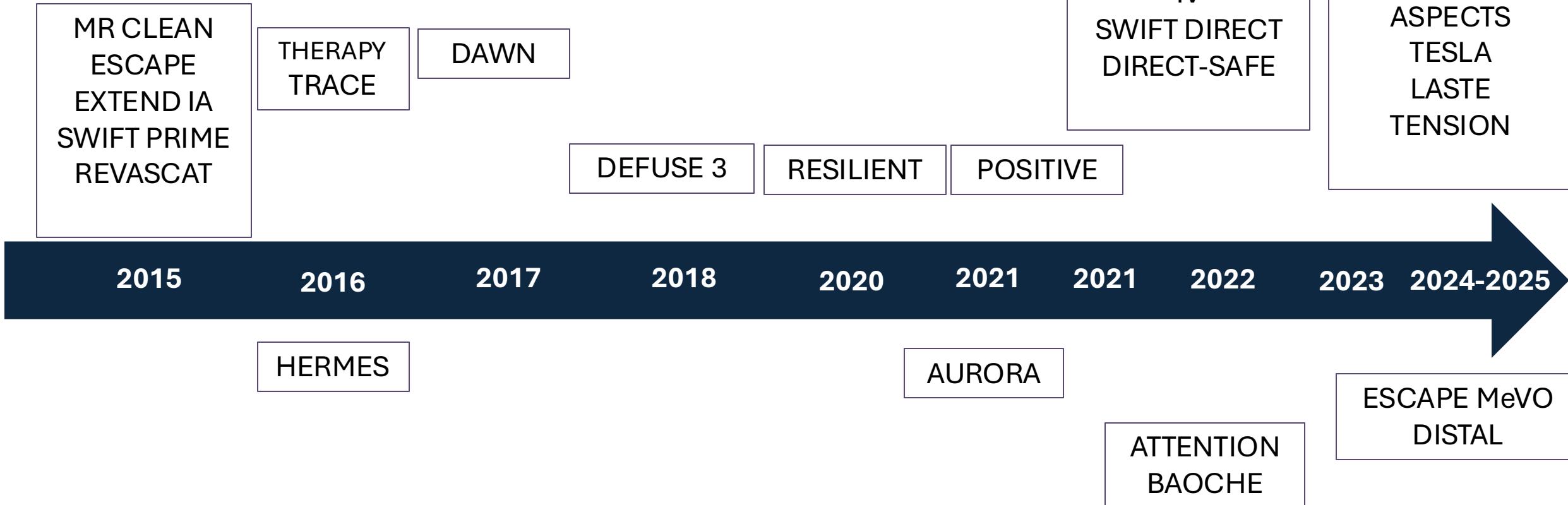
- Evolution of EVT - we are treating more patients
- Post EVT patients belong to ICU
- Factors influencing post EVT care
- Procedural complications
- Blood pressure target after EVT
- Monitoring after EVT

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

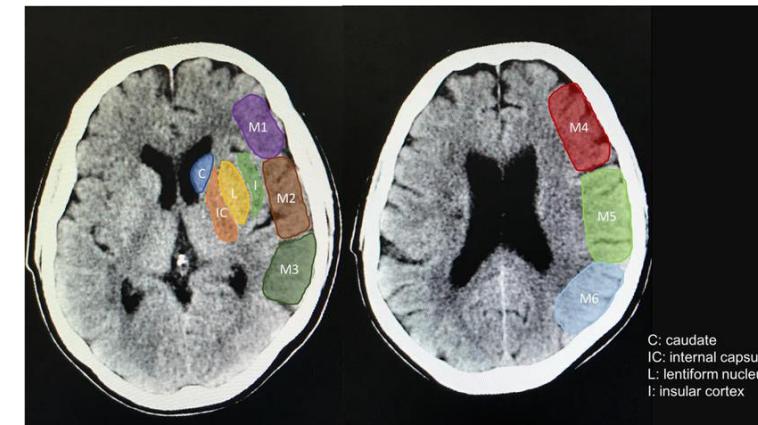
2023

2024-2025

HERMES



<6 hrs



We've come a long way

DAWN

DEFUSE 3

RESILIENT

POSITIVE

2015

2016

2017

2018

2020

2021

2021

2022

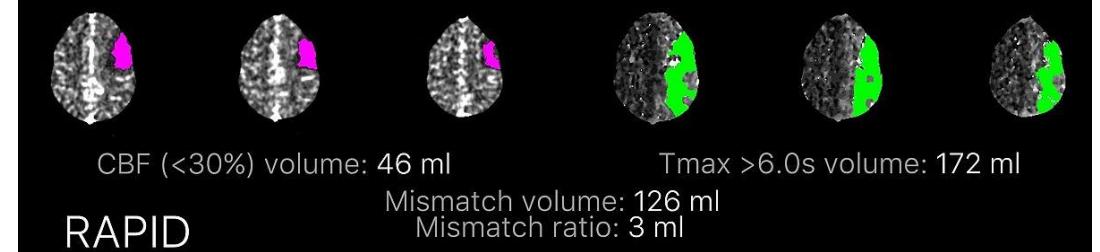
2023

2024-2025



<24 hrs

AURORA



We've come a long way

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



2015

2016

2017

2018

2020

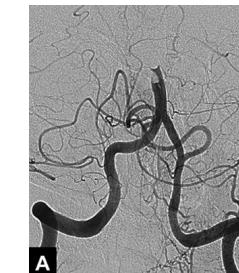
2021

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

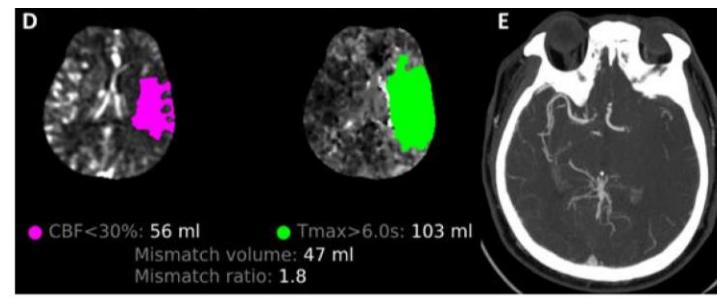
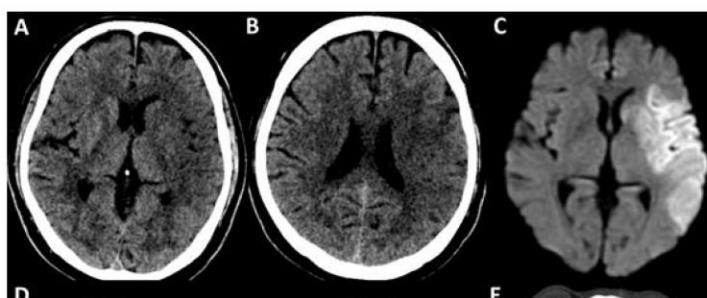
2022

2023

2024-2025

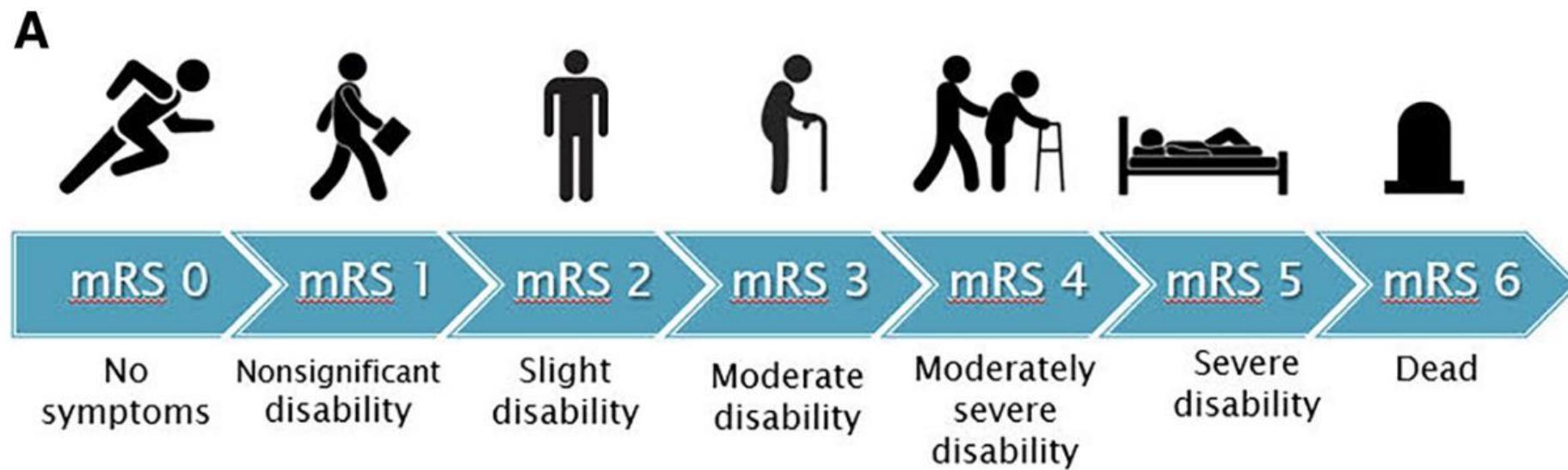


<24 hrs



Endovascular thrombectomy is among the most powerful interventions in medicine

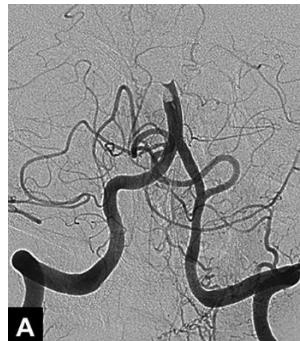
NNT to reduce disability 1 point: 2.6



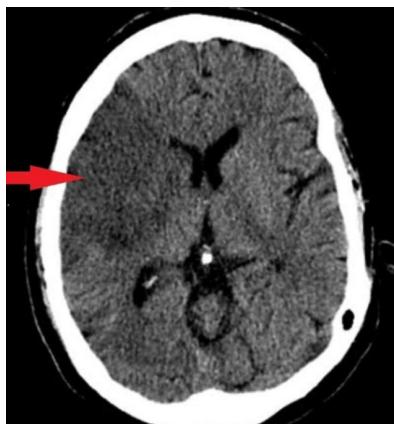
We are bringing more patients for EVT



Late window: >6 hrs



Posterior circulation

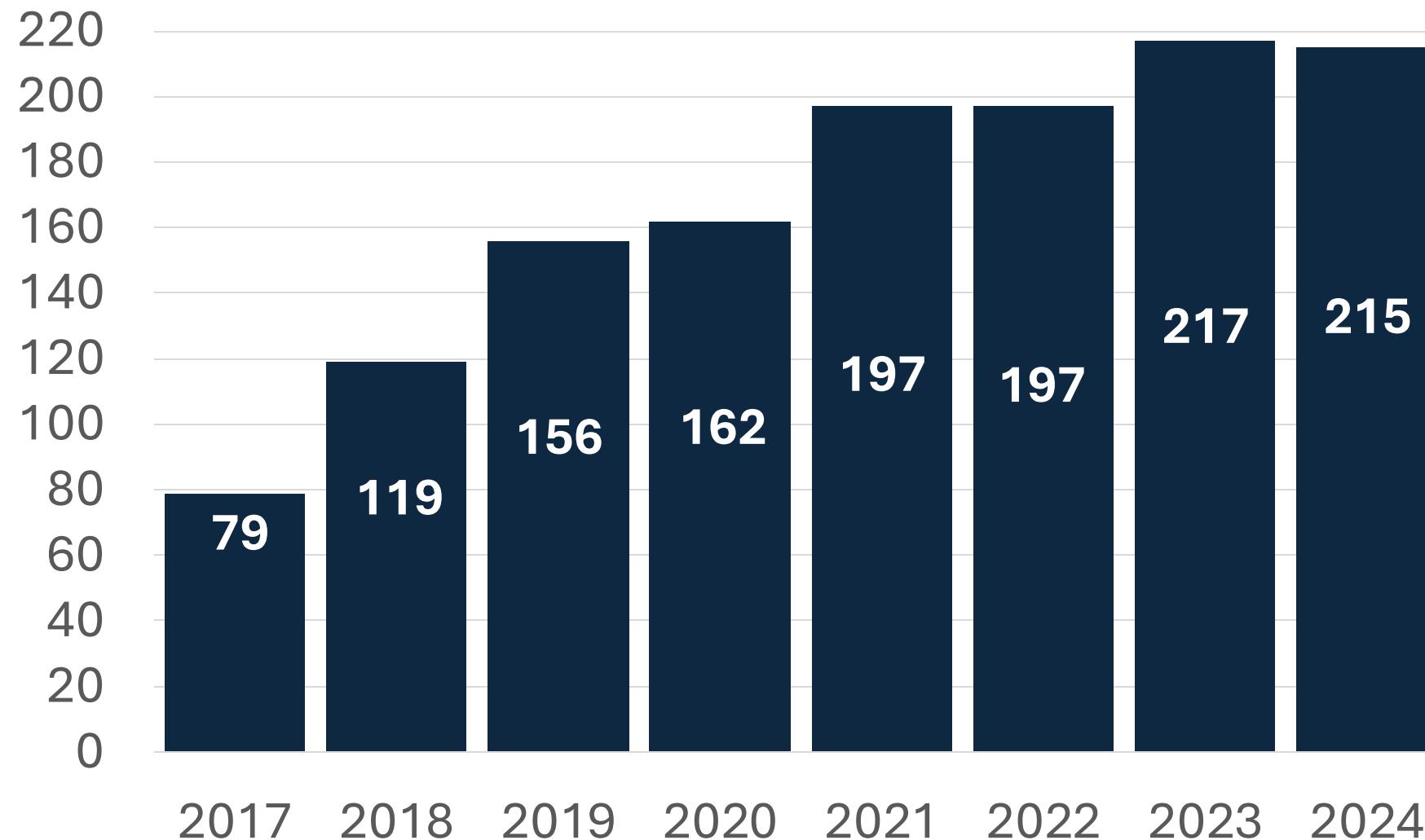


Low ASPECTS



Medium vessel
occlusions

EVT at LHSC

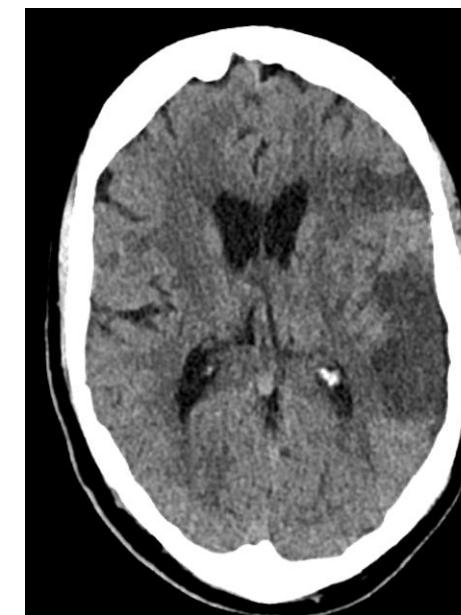


Same procedure, 2 very different tales

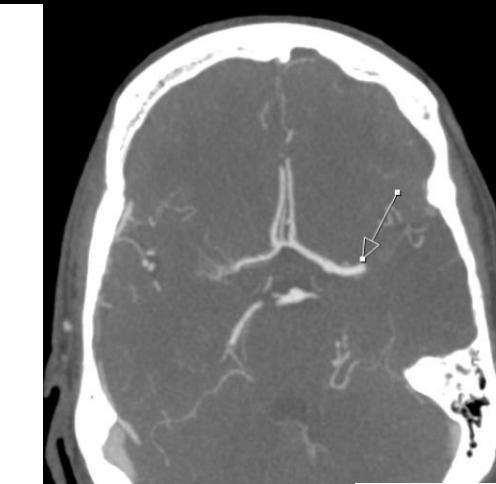
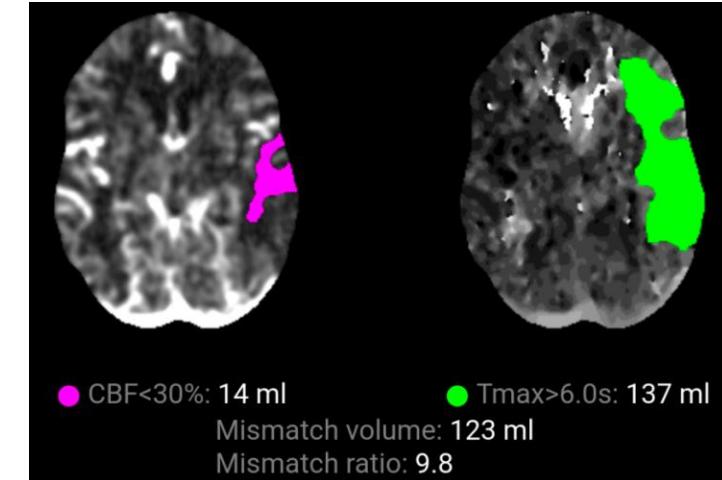
- 57-year-old-woman
- LSW: 1200 while doing PT
- 1 week before left knee injury, meniscus?
- NIHSS: 19, right MCA syndrome
- TNK 13:12 (72 min after LSW)
- PMH: left knee injury, fall and left leg pain
- 67-year-old-male
- LSW? Lives alone, son talked to him 2 days ago. Neighbors had not seen him for 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

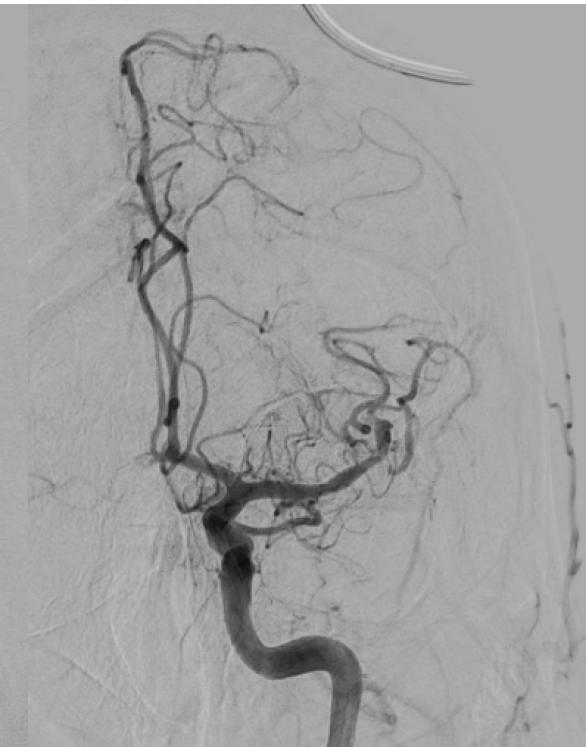
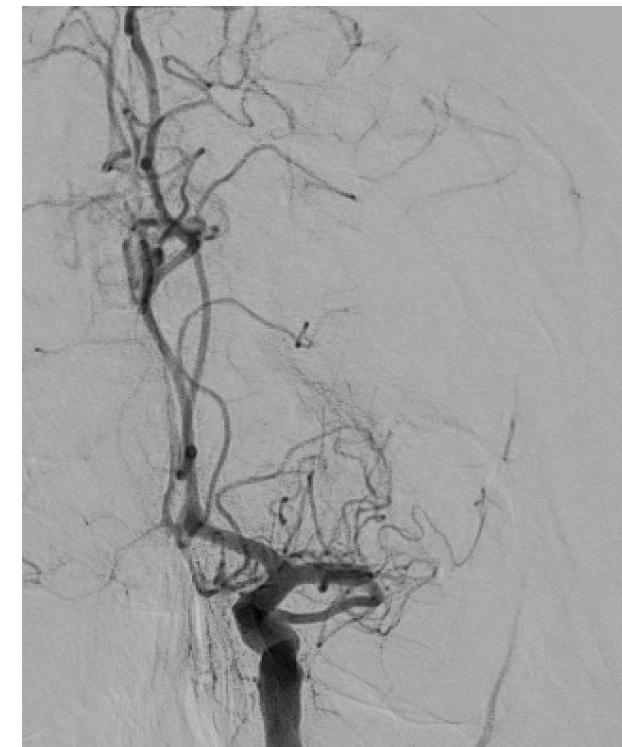
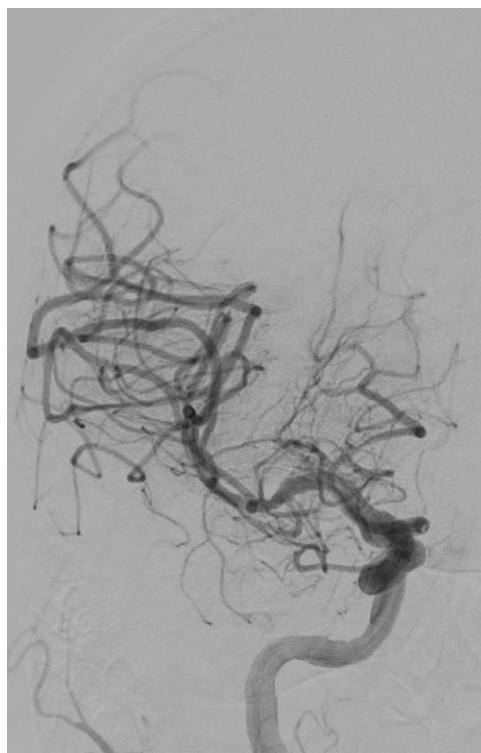
- NIHSS 19 points
- NIHSS 16 points
- Very agitated



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

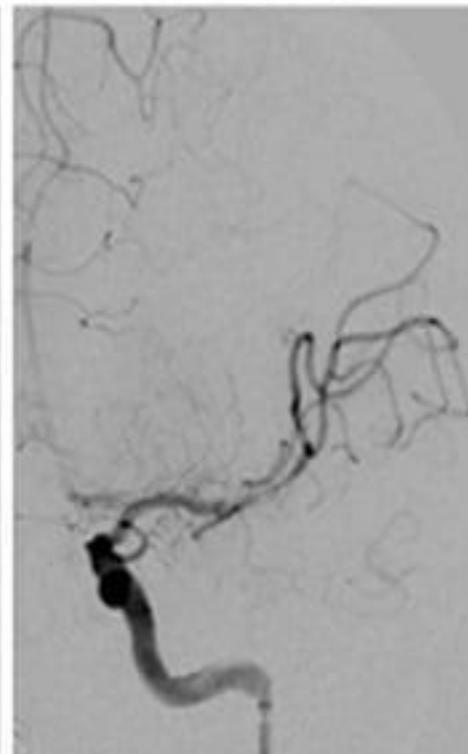
mTICI 0



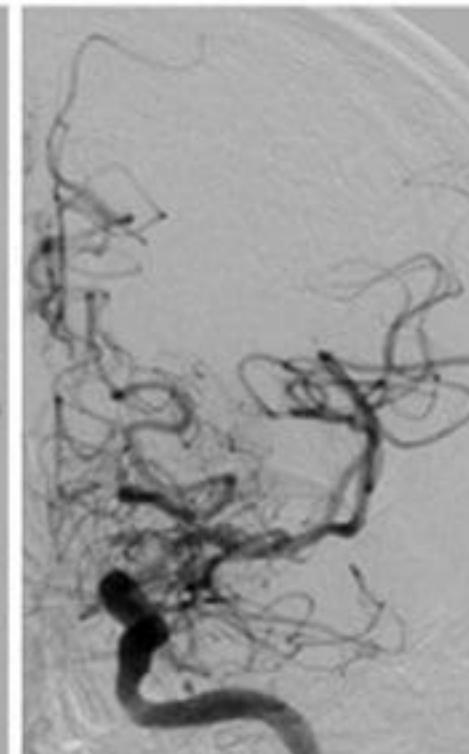
mTICI 1



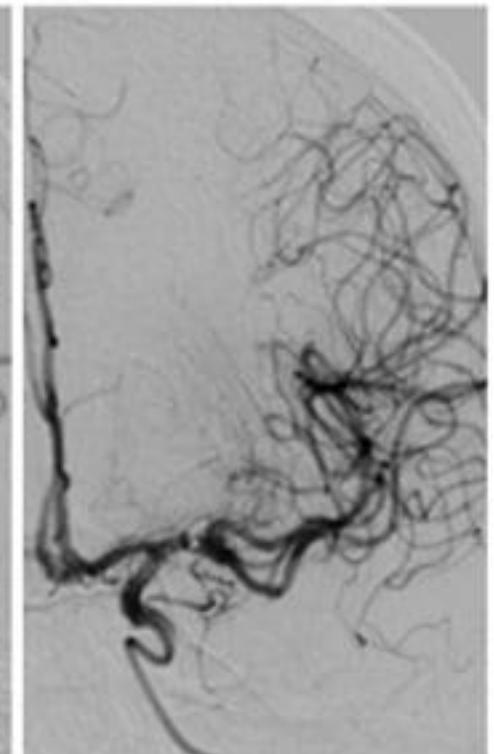
mTICI 2a



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

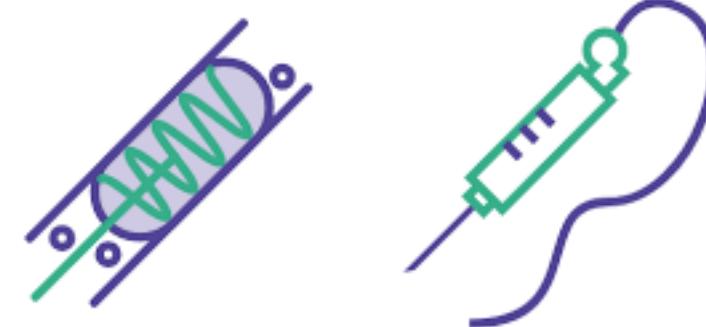


1. Comorbidities
2. Site of occlusion (anterior vs posterior circulation)
3. Severity/large core
4. Mechanism of stroke

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

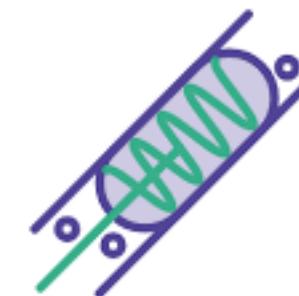
Patient



Other therapies



Procedural information



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

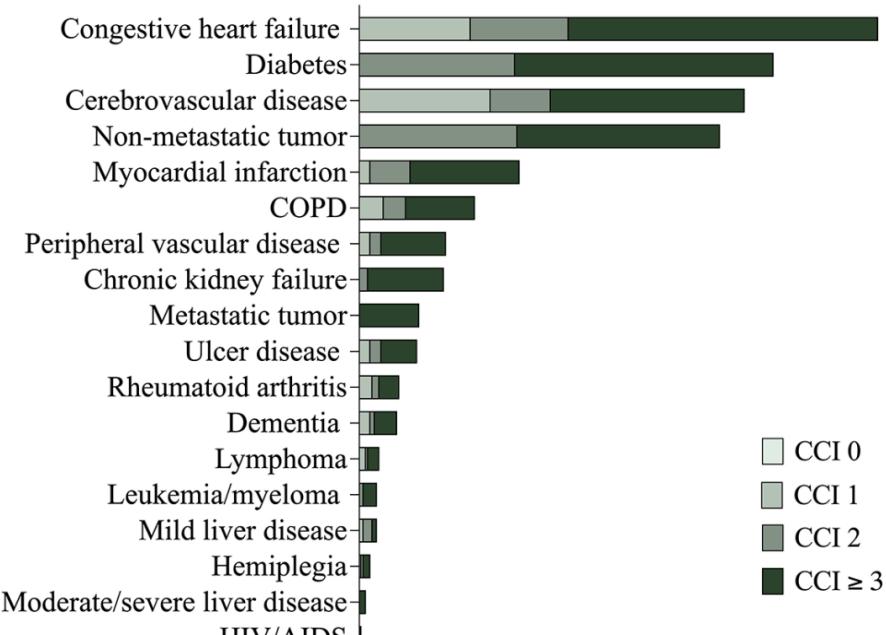
We are bringing more patients for EVT

Patient

But patients are sicker

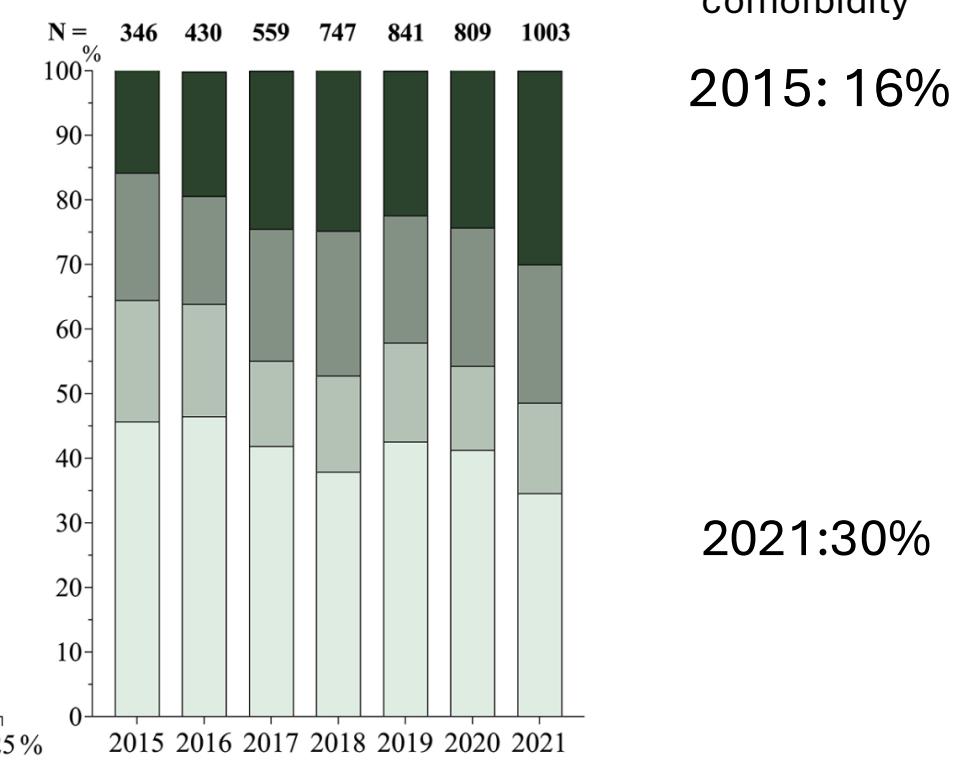
(a)

Prevalence of comorbidities and their association with CCI burden group



(b)

Annual number of EVTs

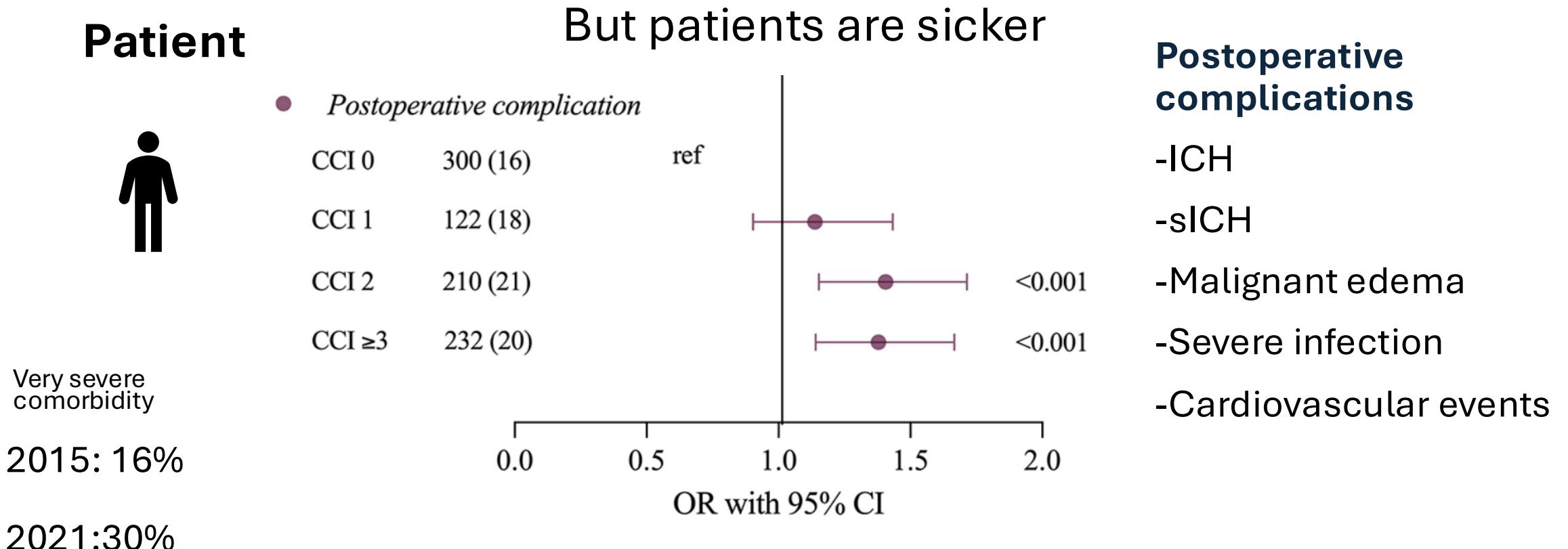


Very severe comorbidity

2015: 16%

2021: 30%

We are bringing more patients for EVT



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

We are bringing more patients for EVT

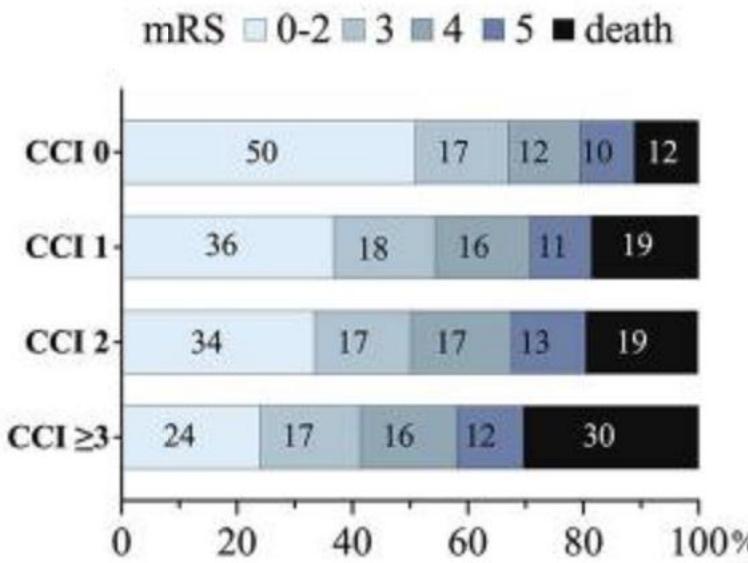
Patient



But patients are sicker

(b) **Functional outcome after 90 days**

P-value



Very severe comorbidity

<0.001

2015: 16%

<0.001

2021:30%

<0.001

<0.001

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
HERMES (<6hrs)	2.7	50%	4.4%	15.3%
Extended window (6-24 hrs)	3.0	40%	5.3%	16.5%
Posterior circulation	3.0	<10%	5.0%	36%
Large core	4.7	30%	5.5%	31.5%

*NNT to
reduce
disability
1 point

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

Intravenous Thrombolysis

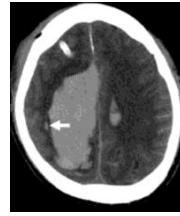
Does thrombolysis really make things more dangerous? (Patients with LVO <4.5hrs otherwise eligible for thrombolysis)



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%

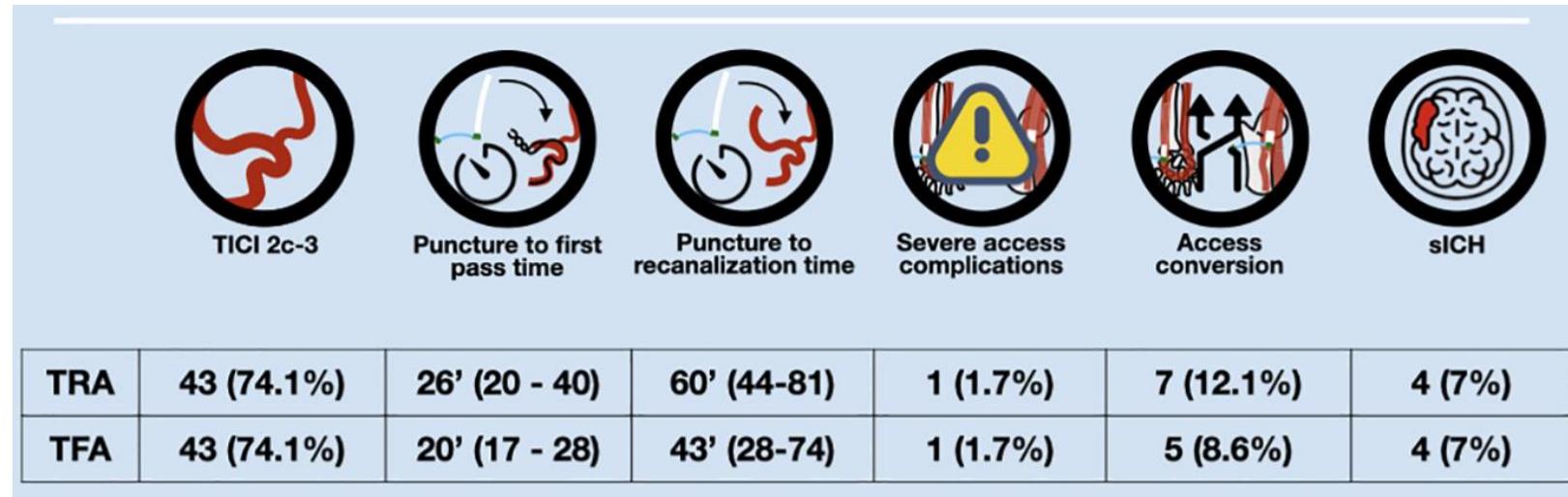
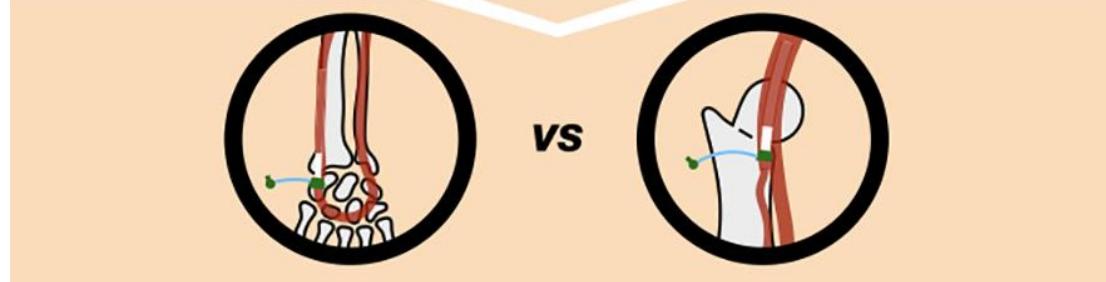
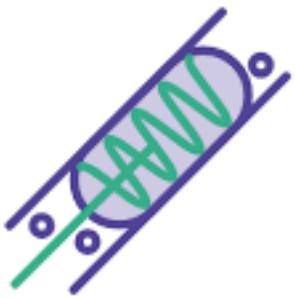
Intravenous Thrombolysis

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
				
EVT + Thrombolysis	45%	36.3%	5.8%	16.5%
Large core	19.4%	35%	5.5%	31.5%

Access – Radial vs Femoral

Procedural information



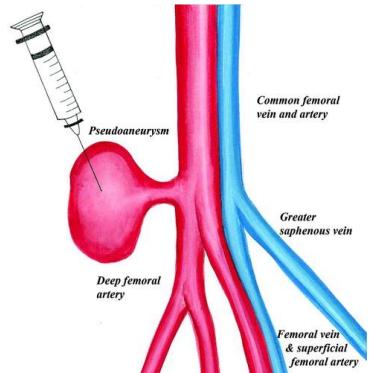
n=296

Femoral access complications



Groin hematoma
3.8%

Retroperitoneal bleeding
1.3%



Pseudoaneurysm
1.3%

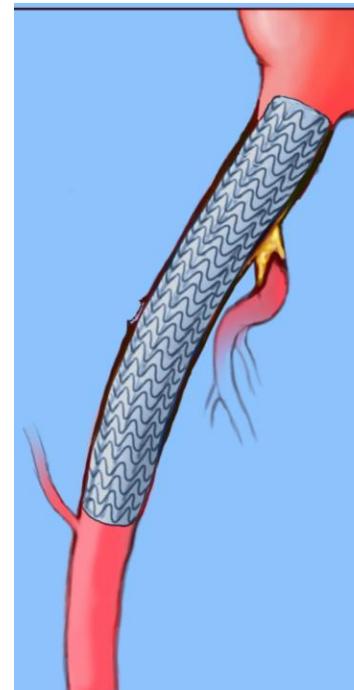
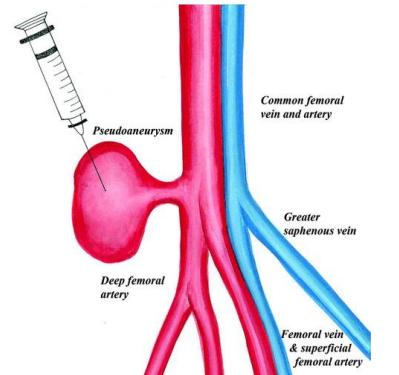
Limb ischemia
3.8%



n=296

Femoral access complications

**Any
complication:
7.8%**



**Complications
requiring
intervention:
2.0%**

Table 2: Access-site complication rates

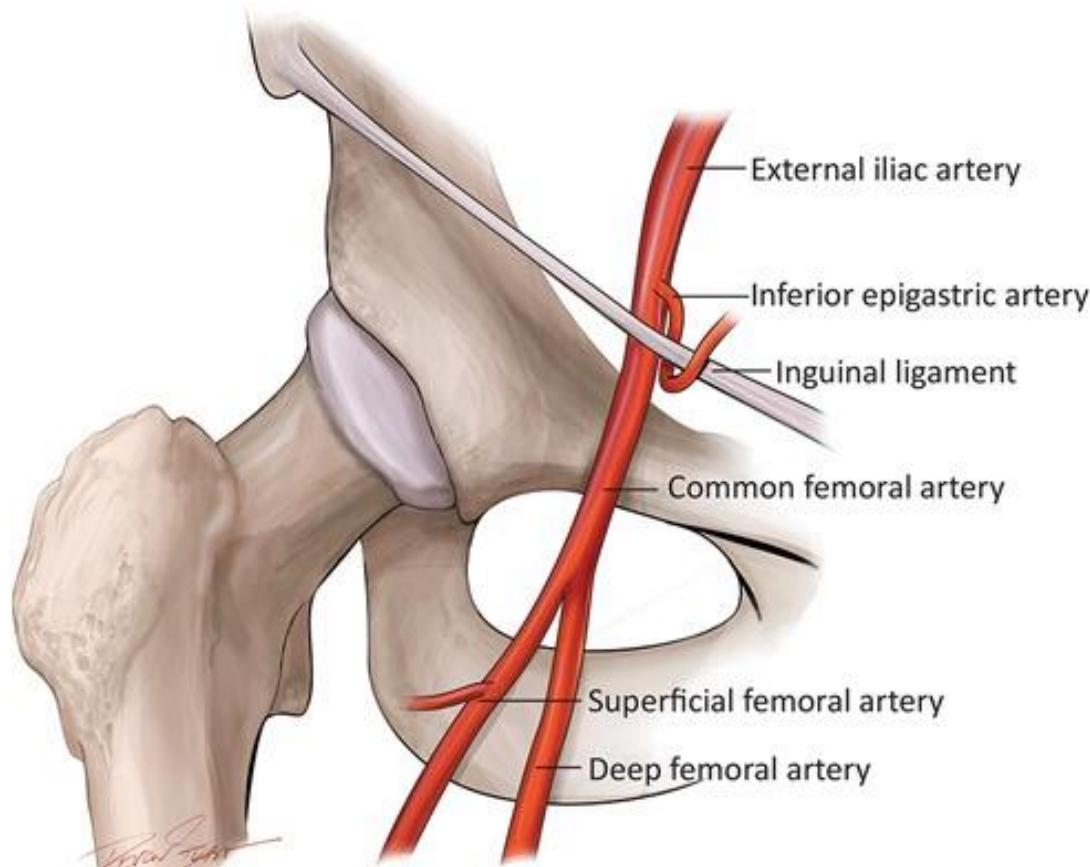
Trial	Non-Major AEs	Serious AEs	TAEs
SWIFT ^a	NA	4/144 (2.78%)	NA
ESCAPE ^b	12/165 (7.27%)	2/165 (1.21%)	14/165 (8.48%)
REVASCAT ^c	NA	NA	12/103 (11.65%)
EXTEND-IA ^d	NA	1/35 (2.86%)	NA
DAWN ^e	NA	1/107 (0.93%)	NA
MR RESCUE ^f	NA	0/64 (0%)	NA
THRACE ^g	NA	3/145 (2.07%)	NA

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

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

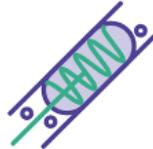
^b Serious adverse events resulted in death, prolonged hospital stays, re-admission, or were severe or life-threatening. All minor events consisted of femoral hematomas.

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

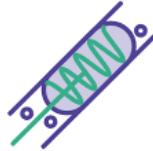


Procedural complications

	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

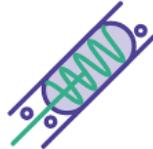


- Antiplatelets
- Stent

Unstandardized antiplatelet regimen

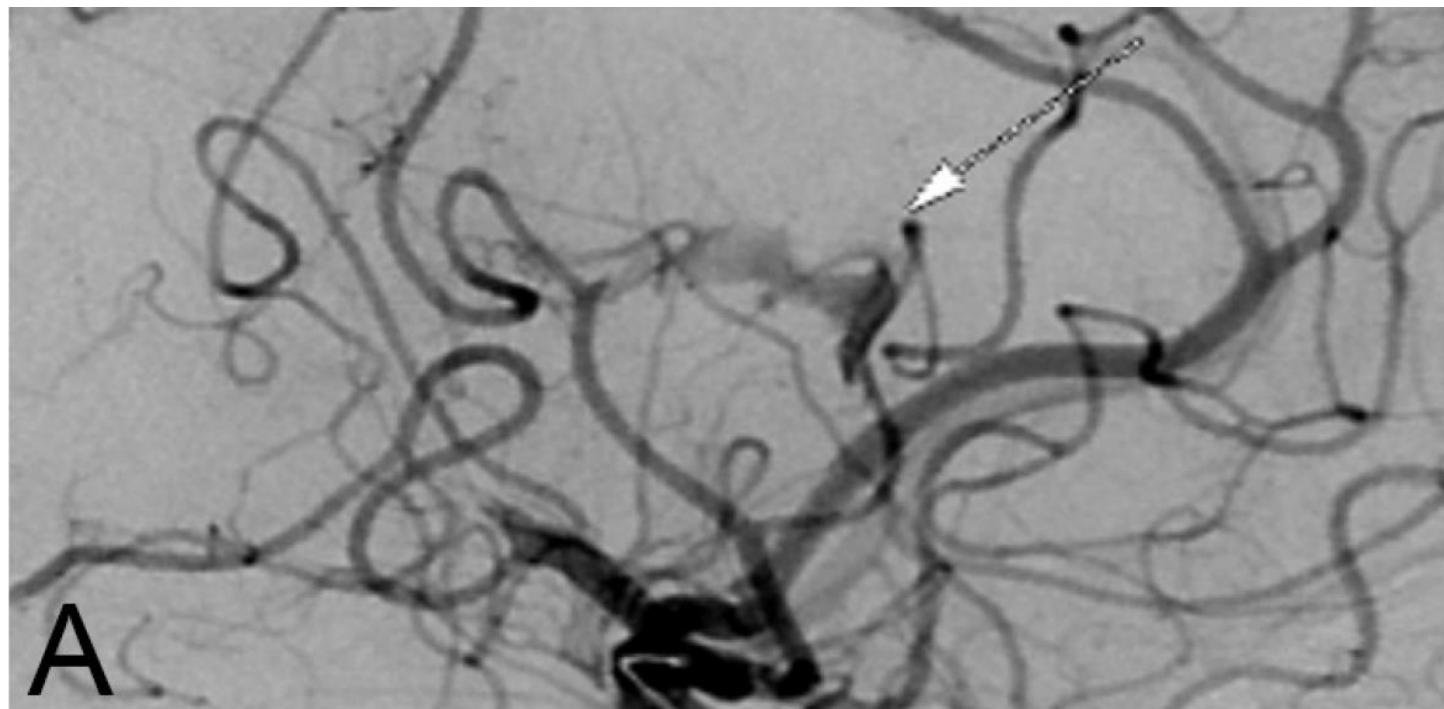
GPIIbIIIa infusion for 4-6 hrs + DAPT



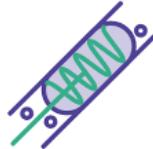


Procedural complications

Vessel perforation



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

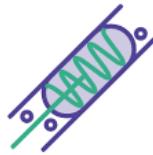


Procedural complications

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-EO
	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**

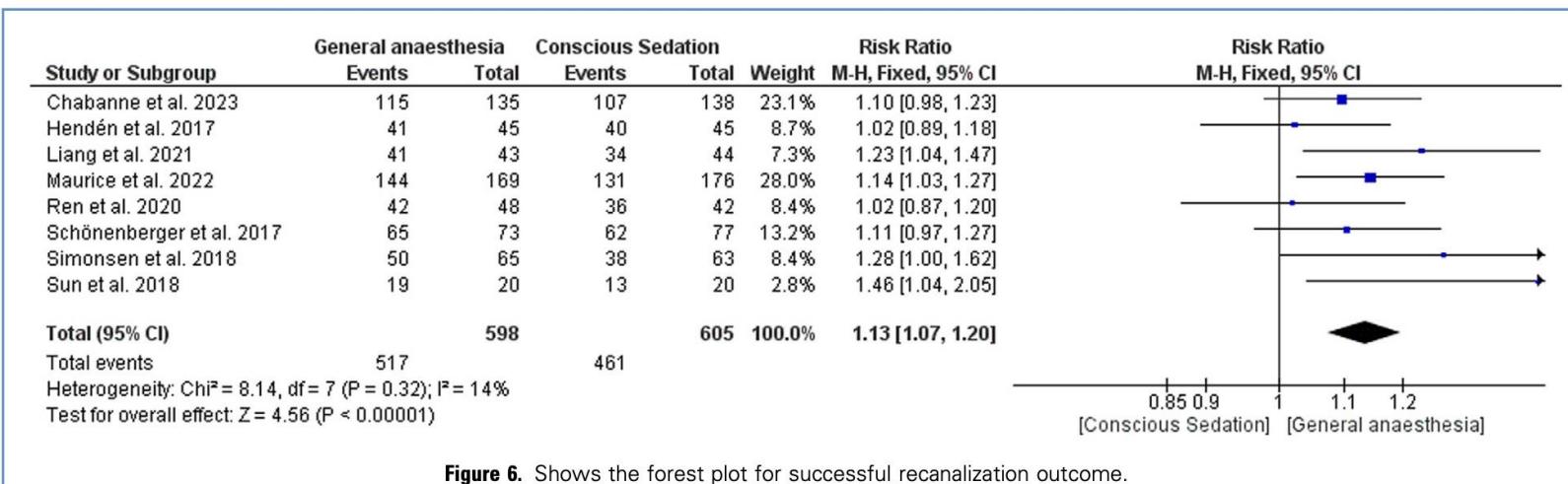
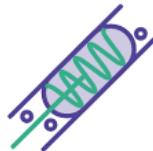
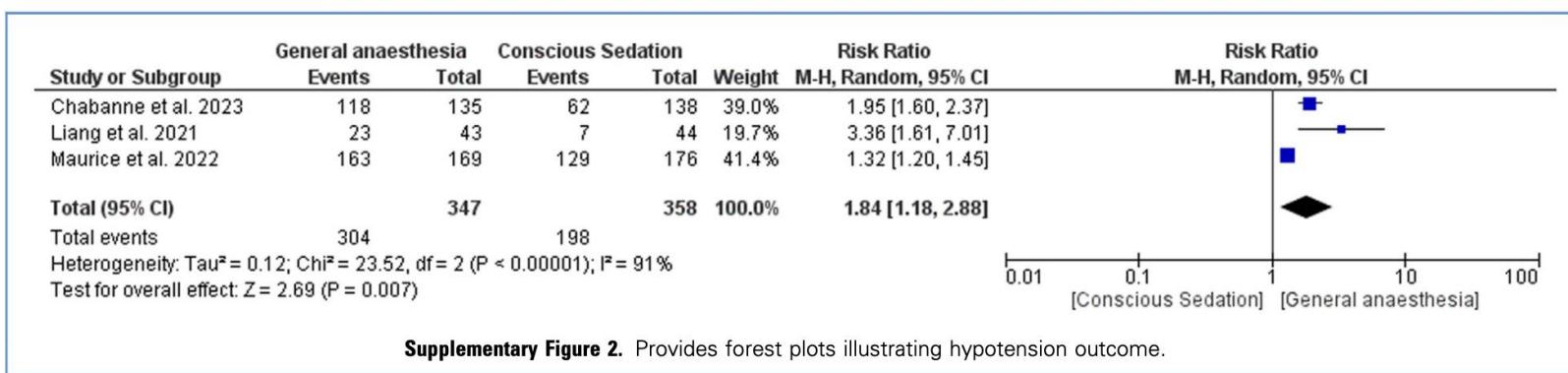


Figure 6. Shows the forest plot for successful recanalization outcome.



General anesthesia vs conscious sedation

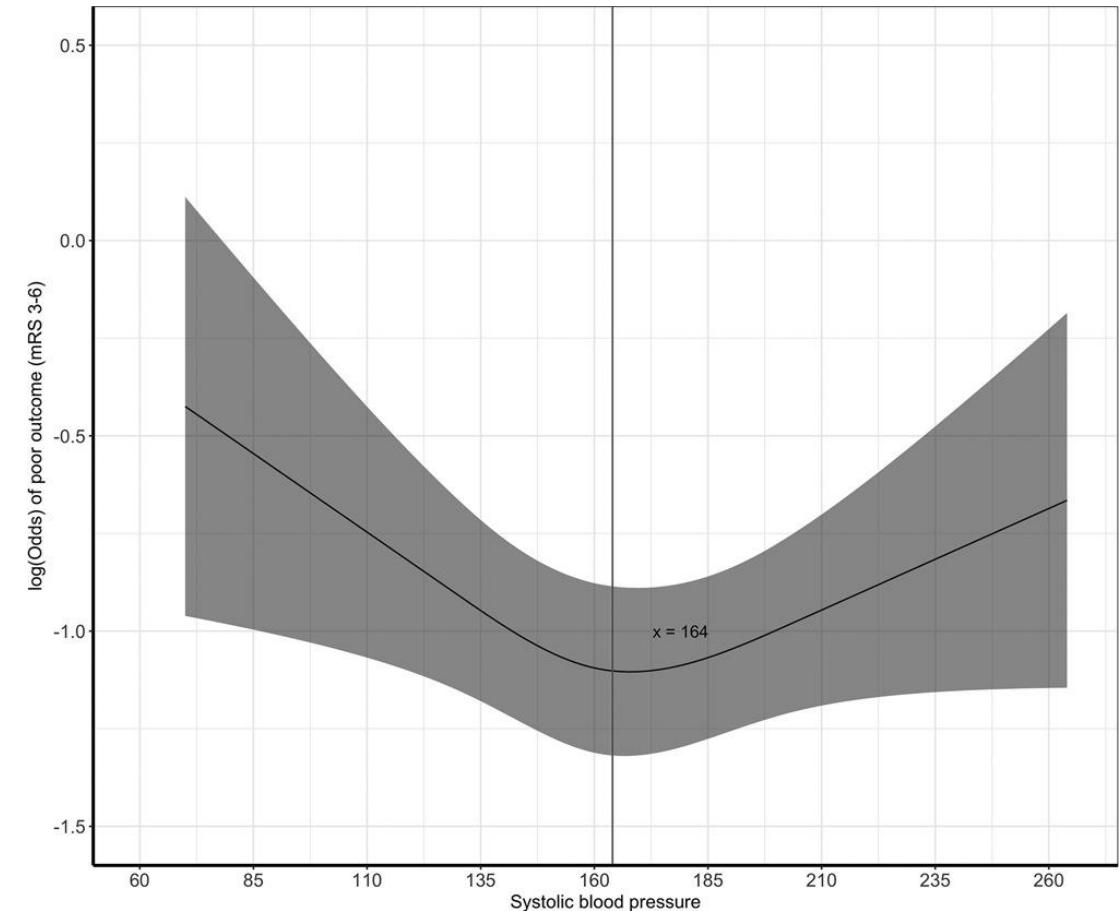
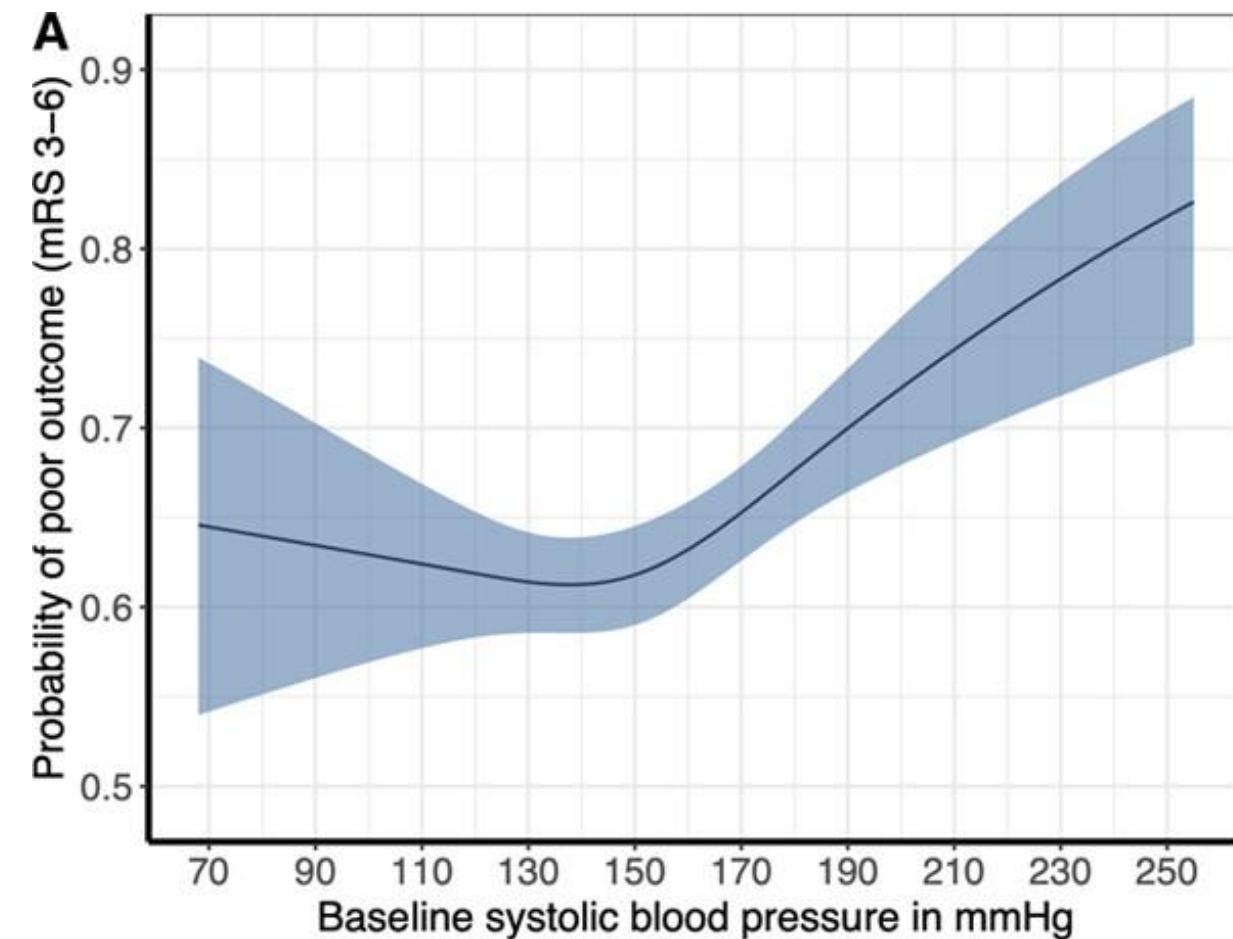
- At least 8 RCTs looking to answer this question
- Inconsistent results
- Largest meta-analysis suggests: **Higher risk of hypotension with GA**



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

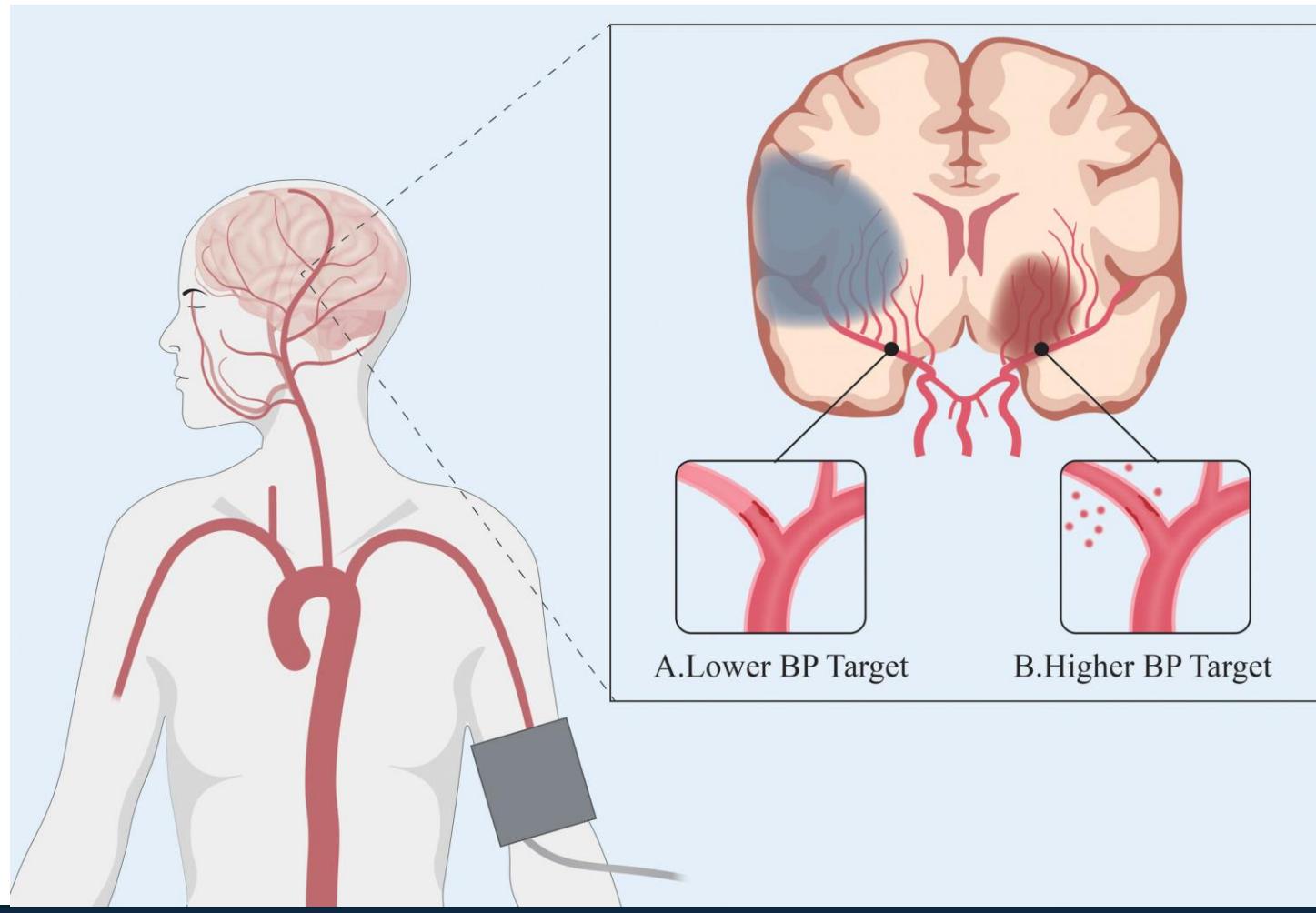
Favors SBP <140 mmHg

- 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 [#]	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

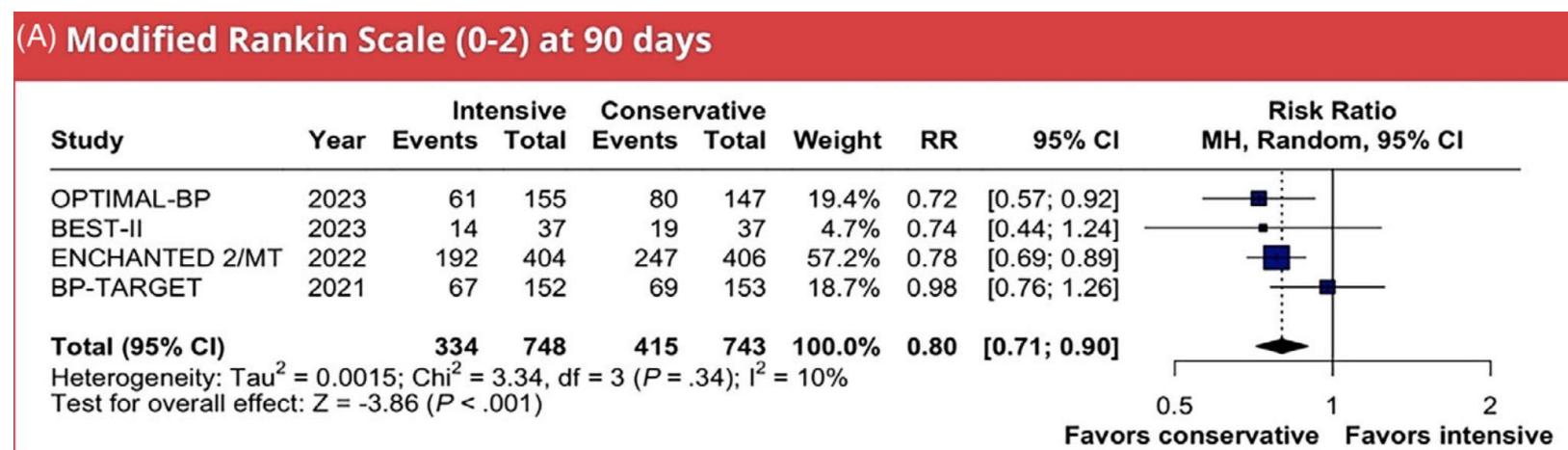
[#]The number of patient who finished the study and data was available

^{*} Intensive systolic blood pressure target group VS. Standard systolic blood pressure target group

*a*Favorable outcome at 90-day (mRS score =0~2), *b* 90-day mortality, *c* sICH, *d* 7-day mortality

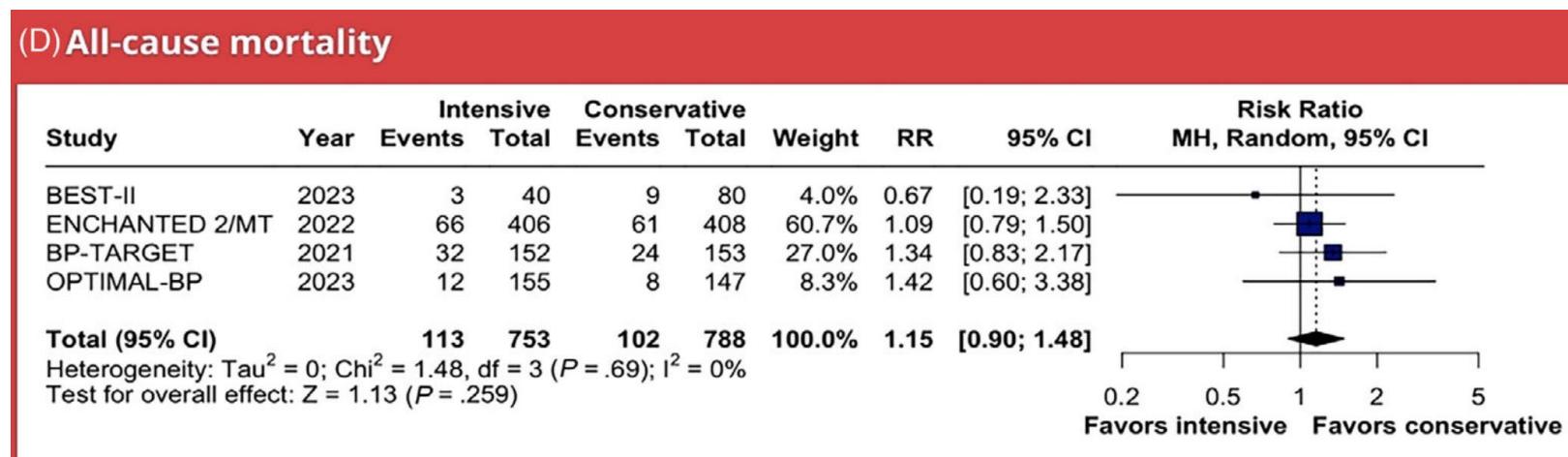
Blood pressure target

Functional outcome



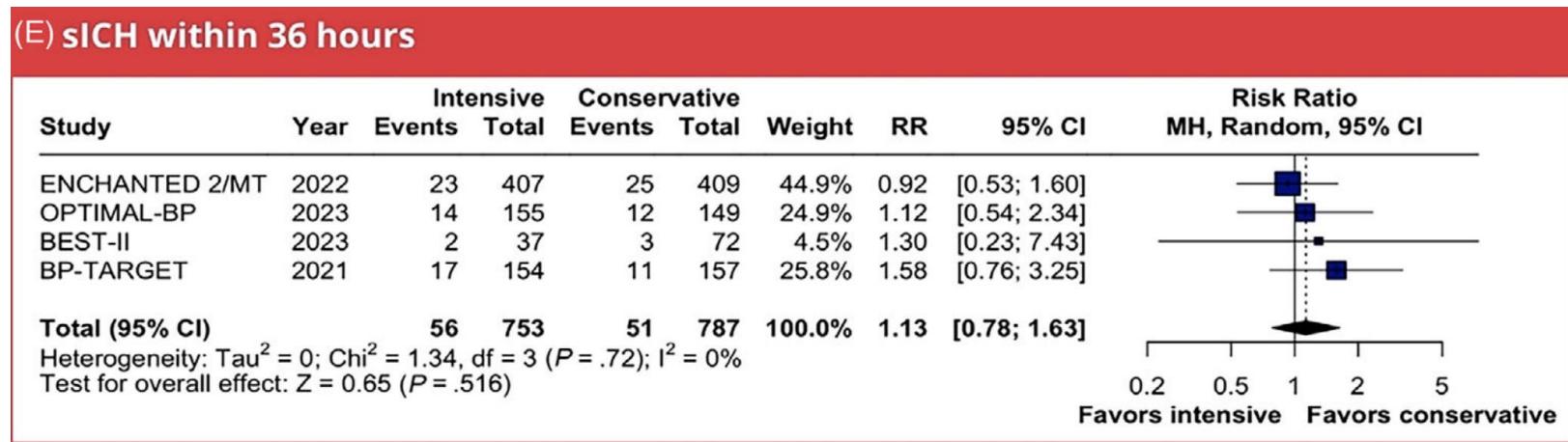
Blood pressure target

Mortality



Blood pressure target

Symptomatic ICH

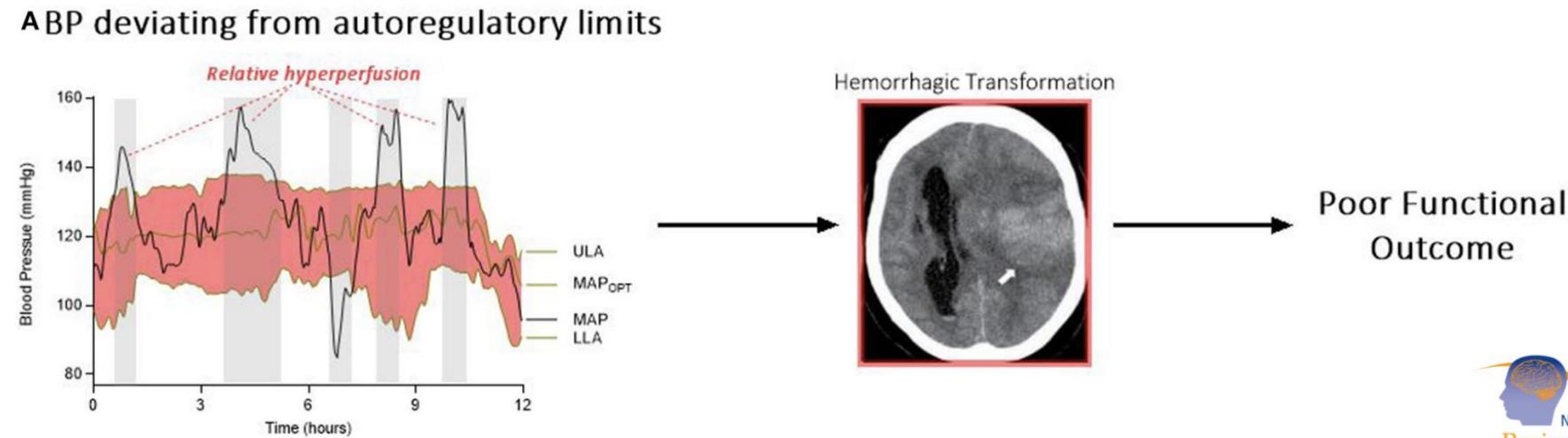


Blood pressure target

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. ¹⁴⁻¹⁷
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. ¹⁸⁻²¹

Blood pressure target

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



Blood pressure target

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

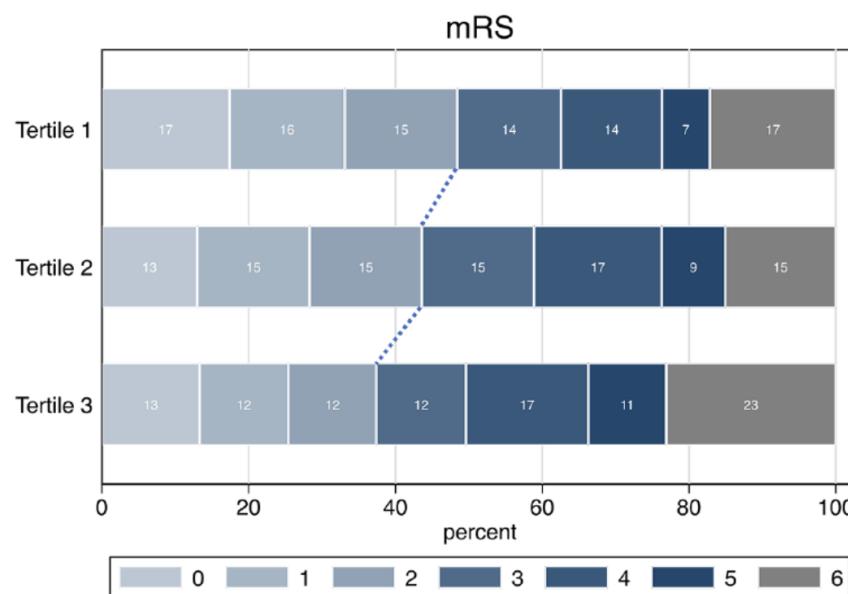


Figure 1. Distribution of mRS-scores at 90 days among different SBP SD tertiles.

mRS: modified Rankin Scale; SBP SD: systolic blood pressure standard deviation.

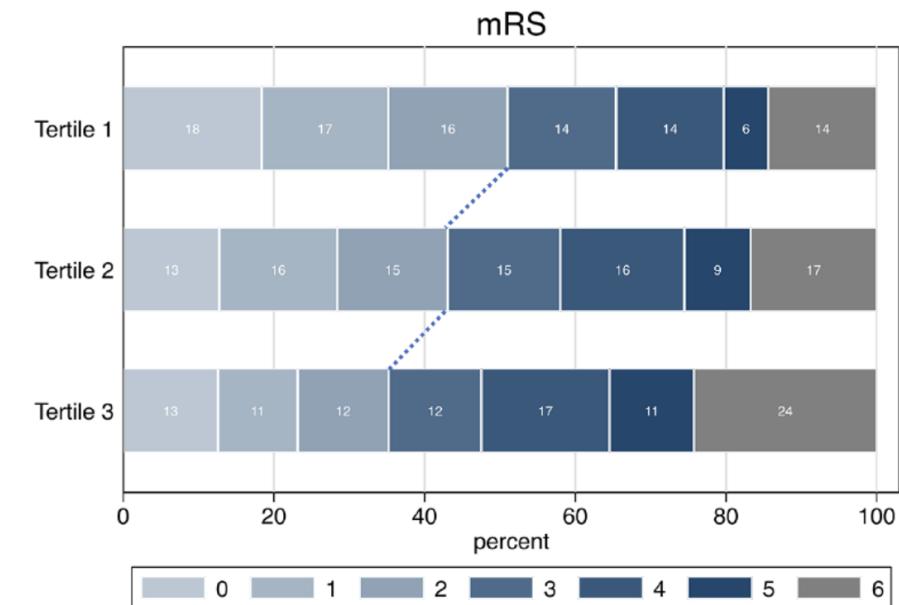


Figure 3. Distribution of mRS-scores at 90 days among different SBP CV tertiles.

mRS: modified Rankin Scale; SBP CV: systolic blood pressure coefficient of variation.

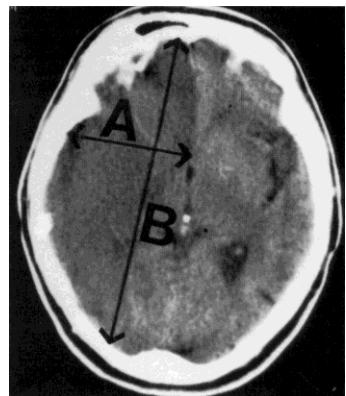
Close neuromonitoring



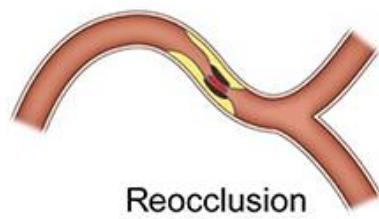
Frequent neurological assessment (Logic behind it)

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

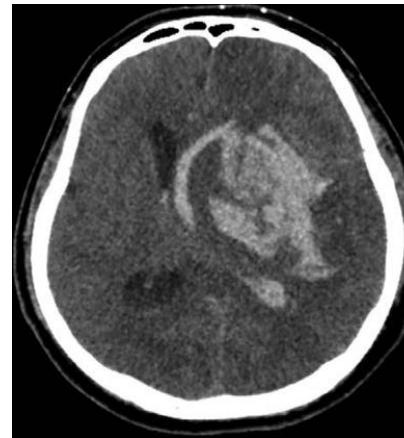
1



2



3



4

Other causes of fluctuations:

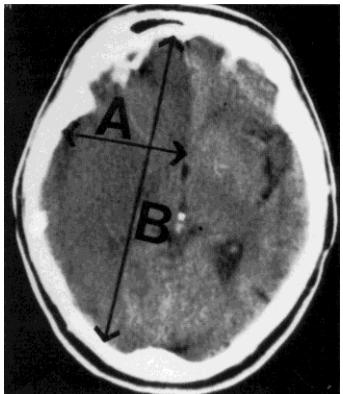
- Seizures
- Metabolic/infectious encephalopathy

Close neuromonitoring



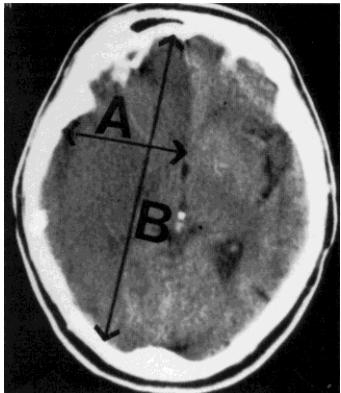
- Frequent neurological assessment (Challenges)
 - Incomplete recovery
 - Difficult neurological exam
 - Bedrest
 - Agitated/confused/uncooperative patients

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

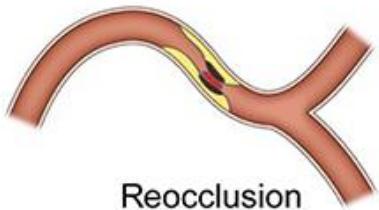
Mass effect



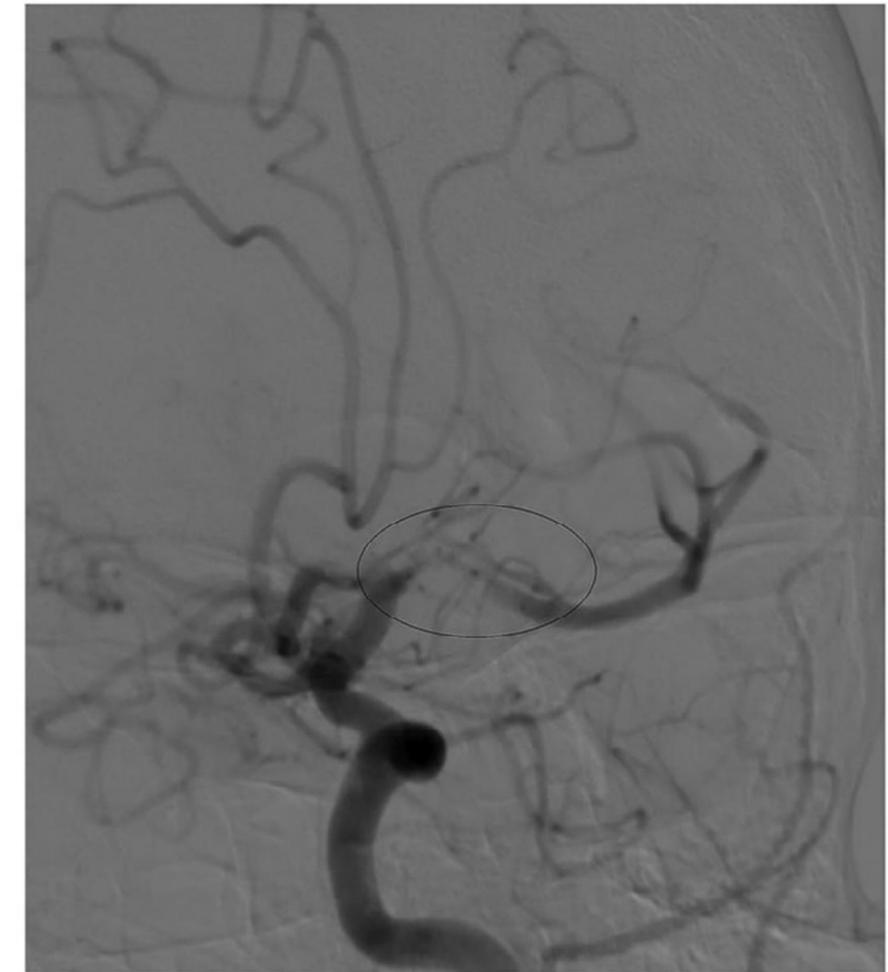
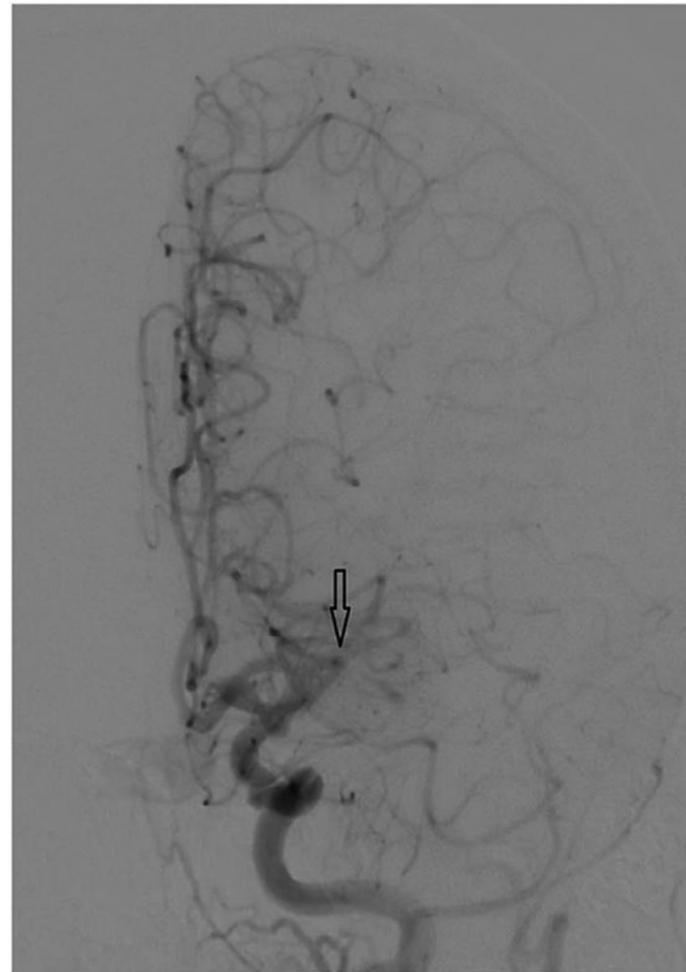
- Osmotic therapy can be considered as a bridge therapy to a surgical intervention (2a recommendation)
- Evidence of harm: hypothermia, barbiturates and corticosteroids
- No benefit: IV glibenclamide

2

Ischemic stroke recurrence



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

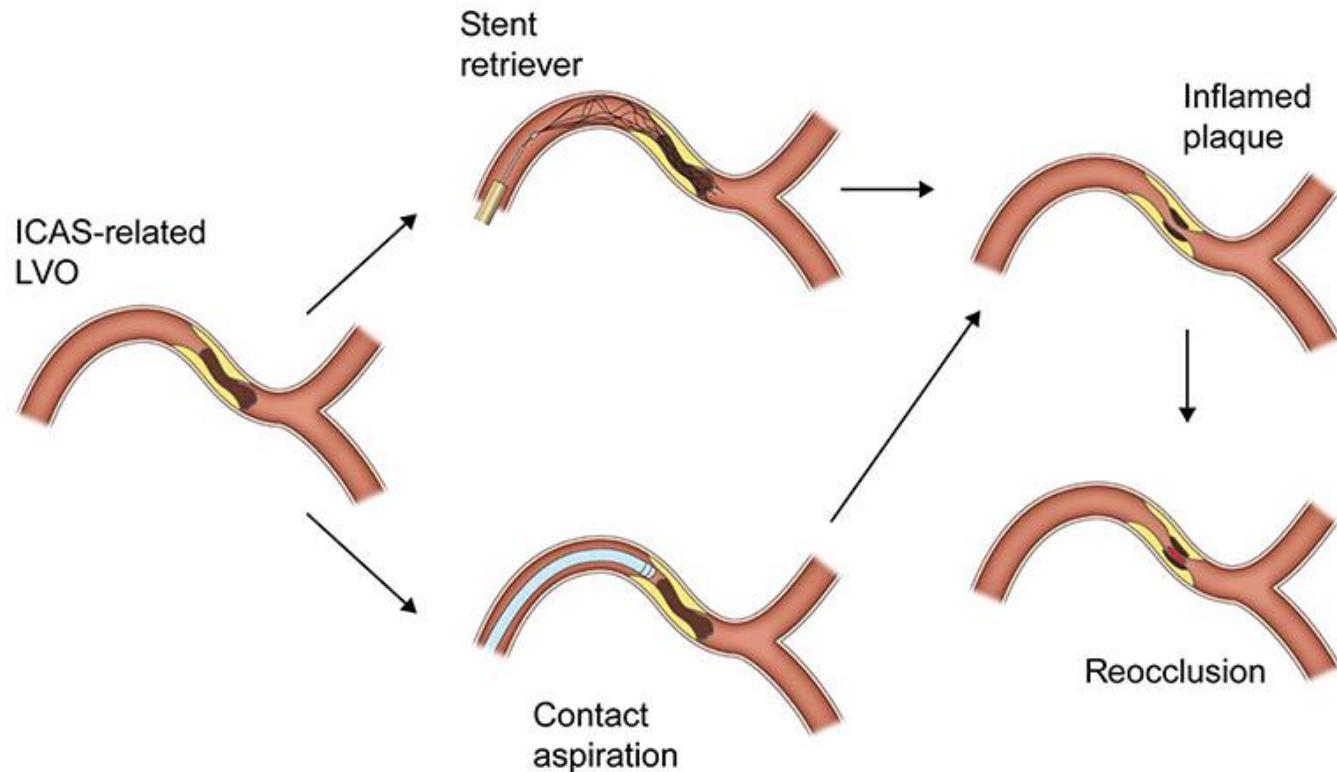


Ischemic stroke recurrence

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

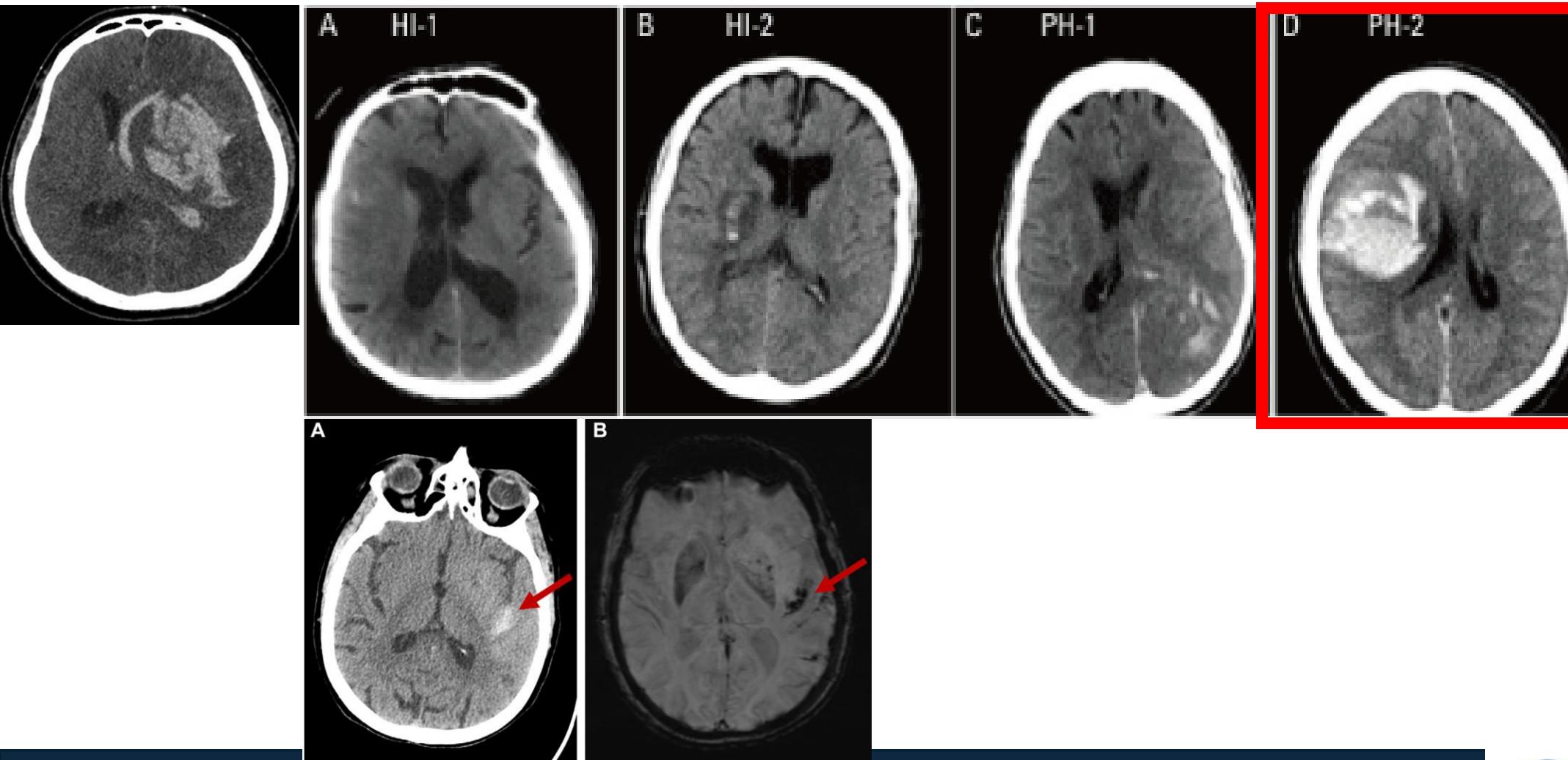
Options:

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



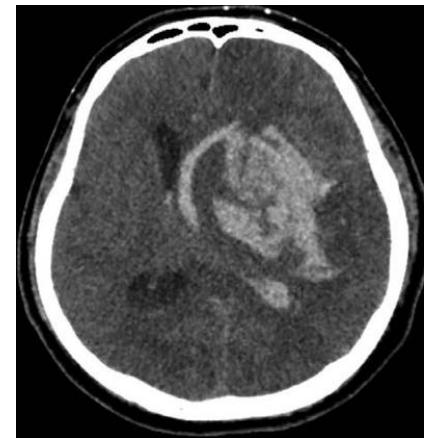
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Hemorrhagic Transformation



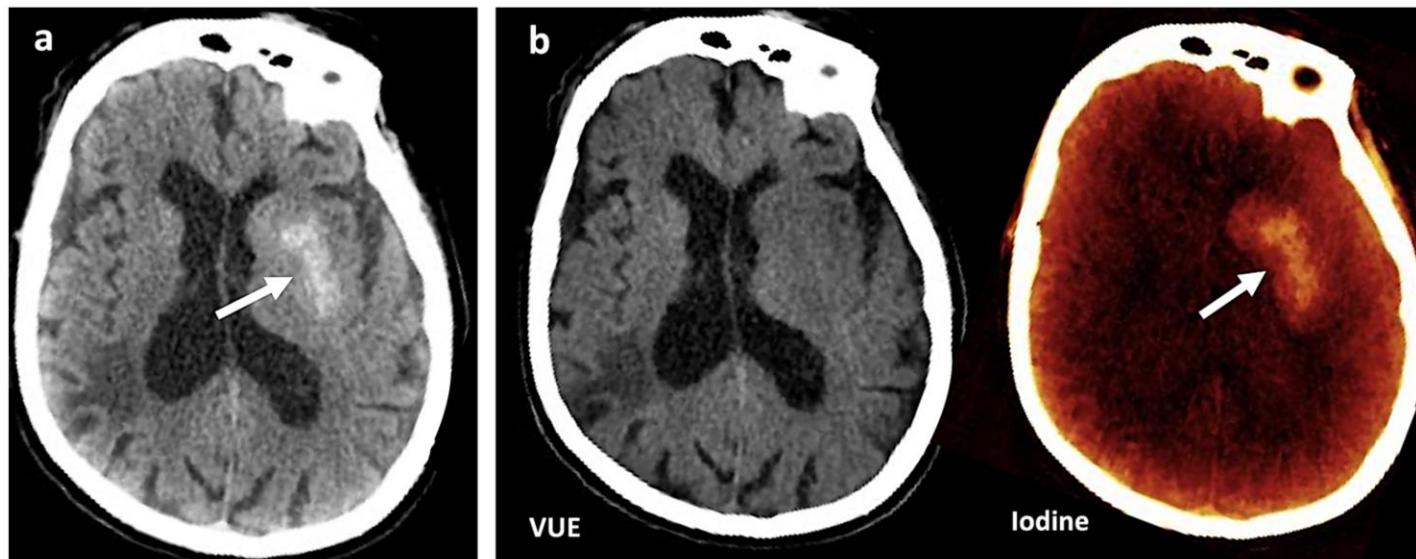
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Hemorrhagic Transformation



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

Dual energy CT can help

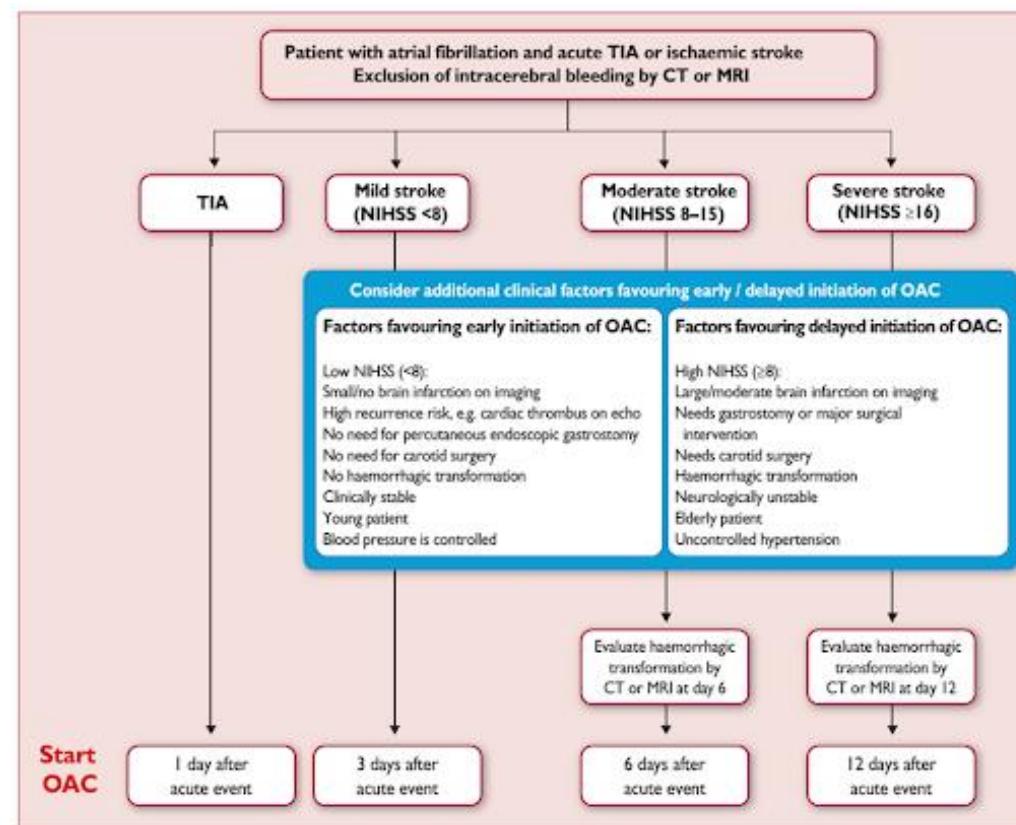


Antithrombotics

- 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

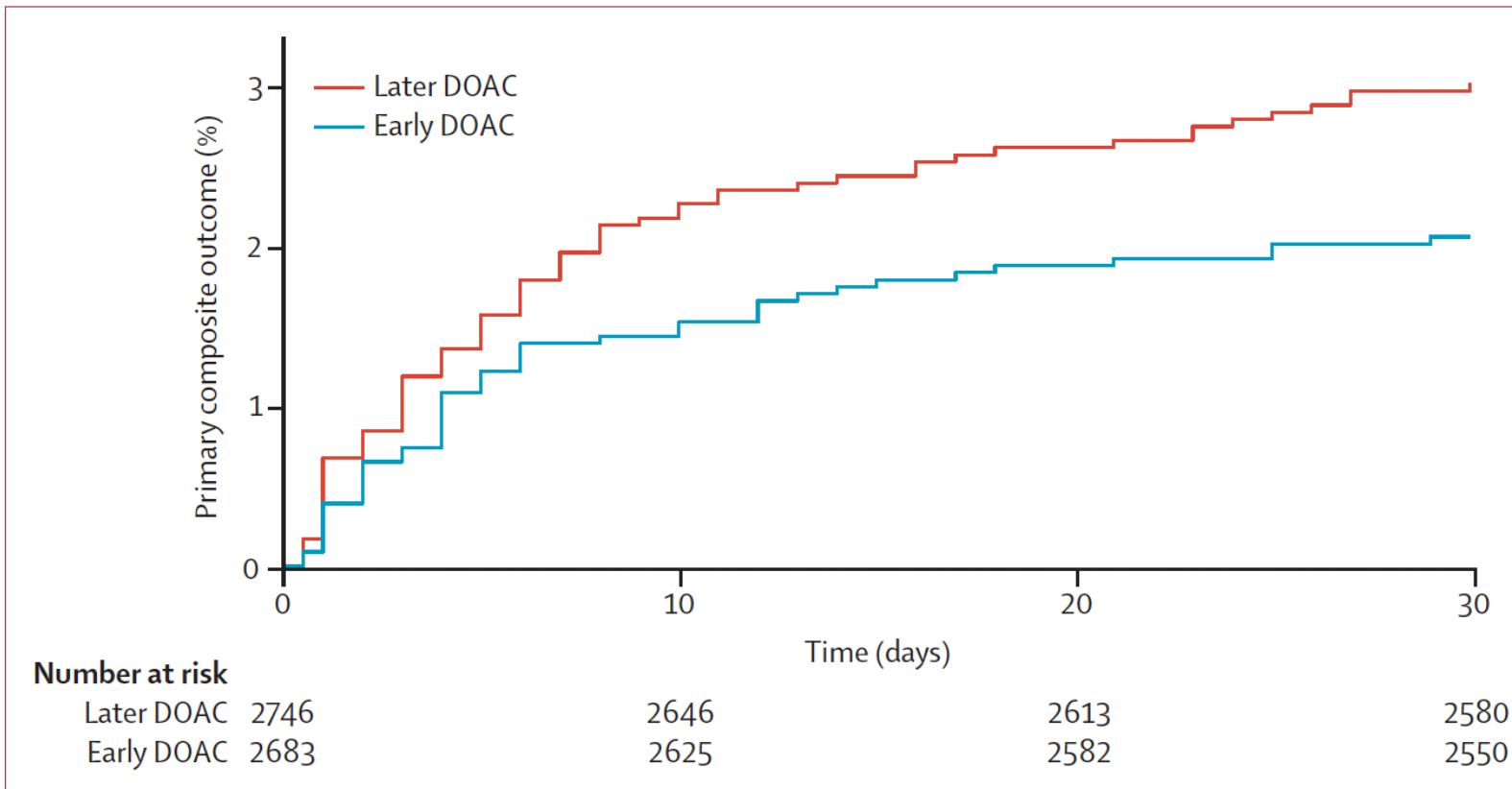


Figure 2: Primary composite outcome at 30 days by DOAC initiation timing (cumulative hazard)
Log-rank p value: 0.034. DOAC=direct oral anticoagulant.

Antithrombotics

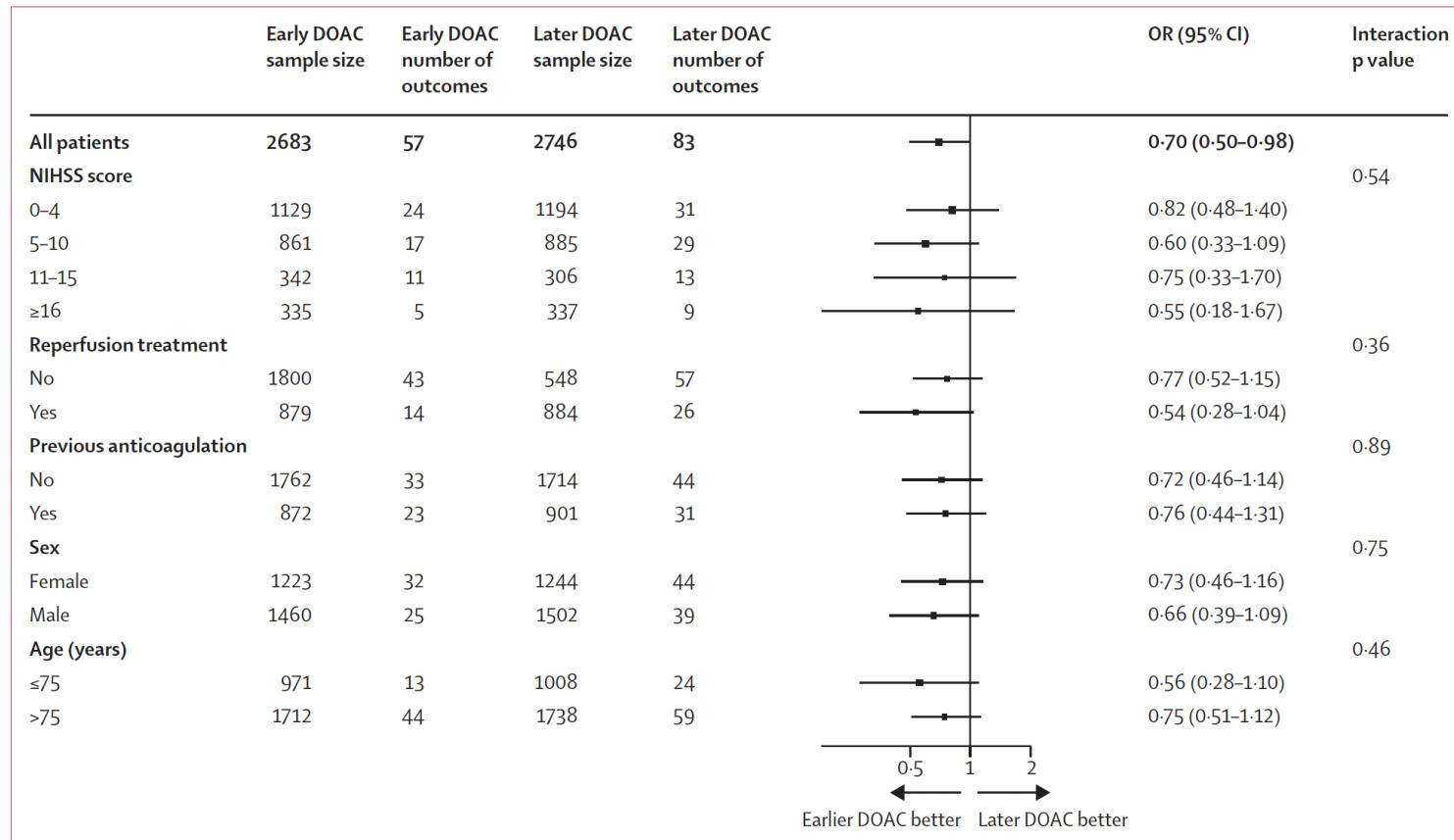


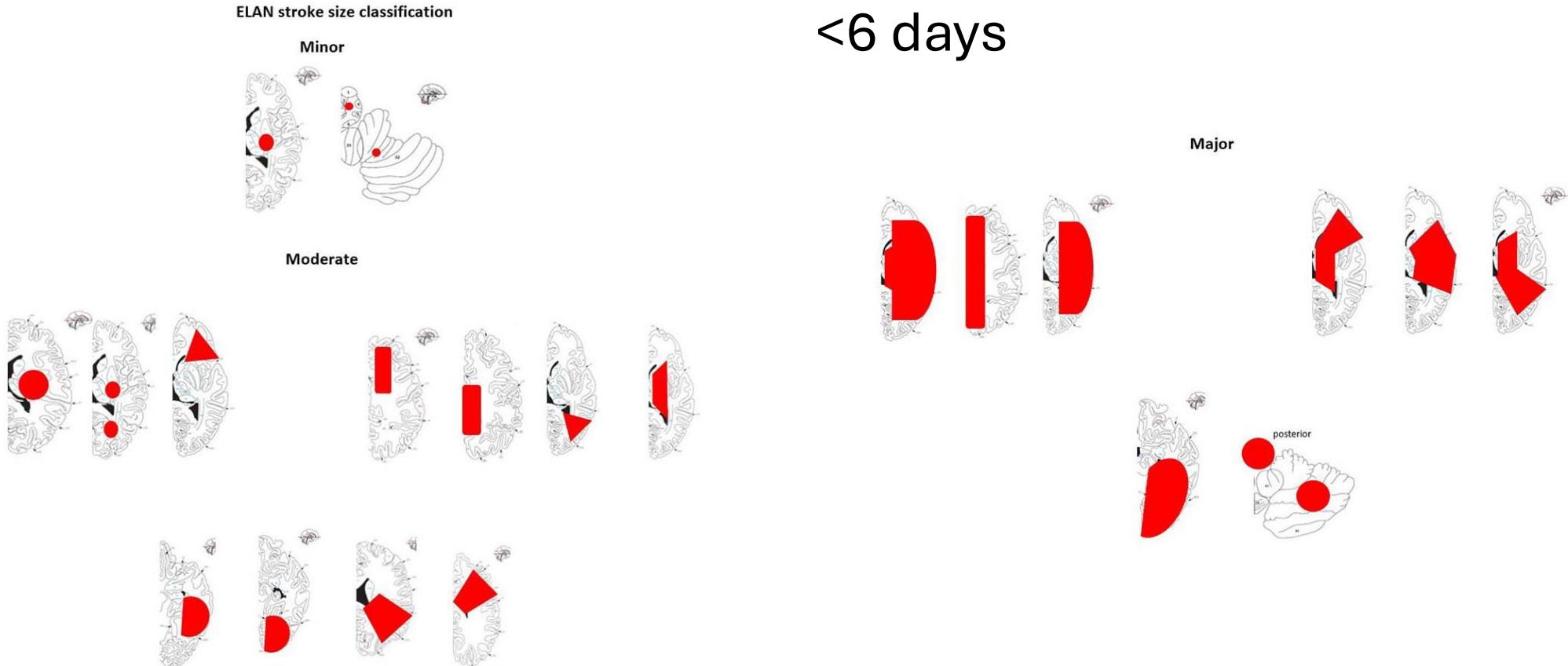
Figure 3: Primary outcome overall and by subgroups of interest

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



Complications in any ischemic stroke

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

Other important interventions

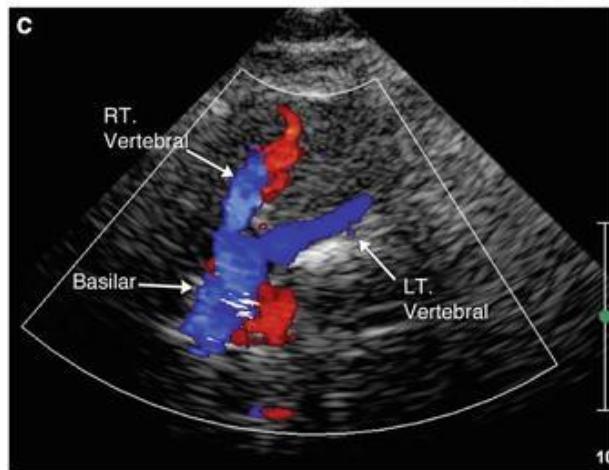
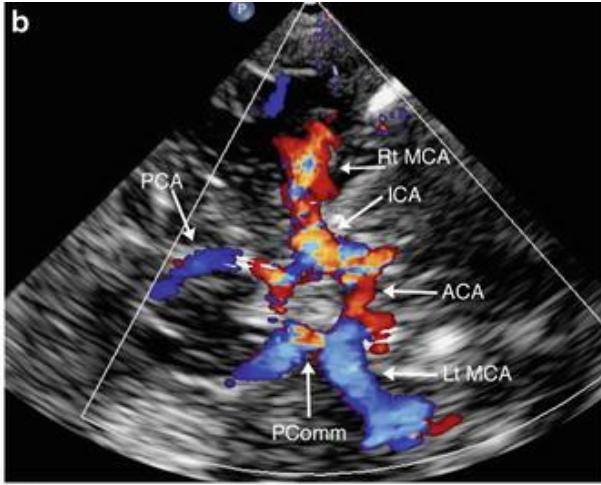
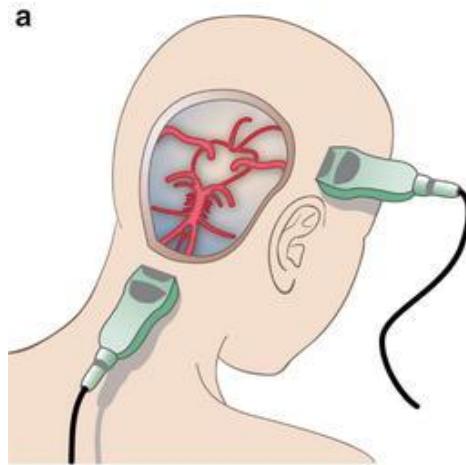
Clear benefit

- 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?

