# Endovascular treatment of Acute Stroke

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WVES, 4th April 2025, 10-10.15 am

# Disclosures

- PI for INDEx study- CIHR funded
- PI for ACT-TBI study- CIHR funded
- PI for CANCCAP Study- MMSF funded

- PI for EMMA Can randomized control trial- Medtronic Canada funded
- Consultant- Medtronic
- Consultant- Microvention/Terumo

# Objectives

- Background for stroke and EVT
- Evolving Evidence
- Neuroprotection

# Acute Ischemic Stroke- Background

- WHO definition-

  Rapid loss of brain function(s) due to disturbance in the blood supply to the brain due to ischemia (lack of blood flow) caused by blockage (thrombosis, arterial embolism)

- 87% of all strokes are ischemic.
- Stroke is
  - the second leading cause of mortality and
  - the third leading cause of disability-adjusted life-years worldwide.[1]

Benjamin EJ, Blaha MJ, Chiuve SE, et al; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics-2017 Update: A Report From the American Heart Association. Circulation 2017;135(10):e146-e603.

# Before 2015

- IV tPA within 3 to 4.5 hrs after symptom onset.
- 30% more likely to have good functional outcome (mRS- 0 or 1) at 3 months

**Time Is Brain**

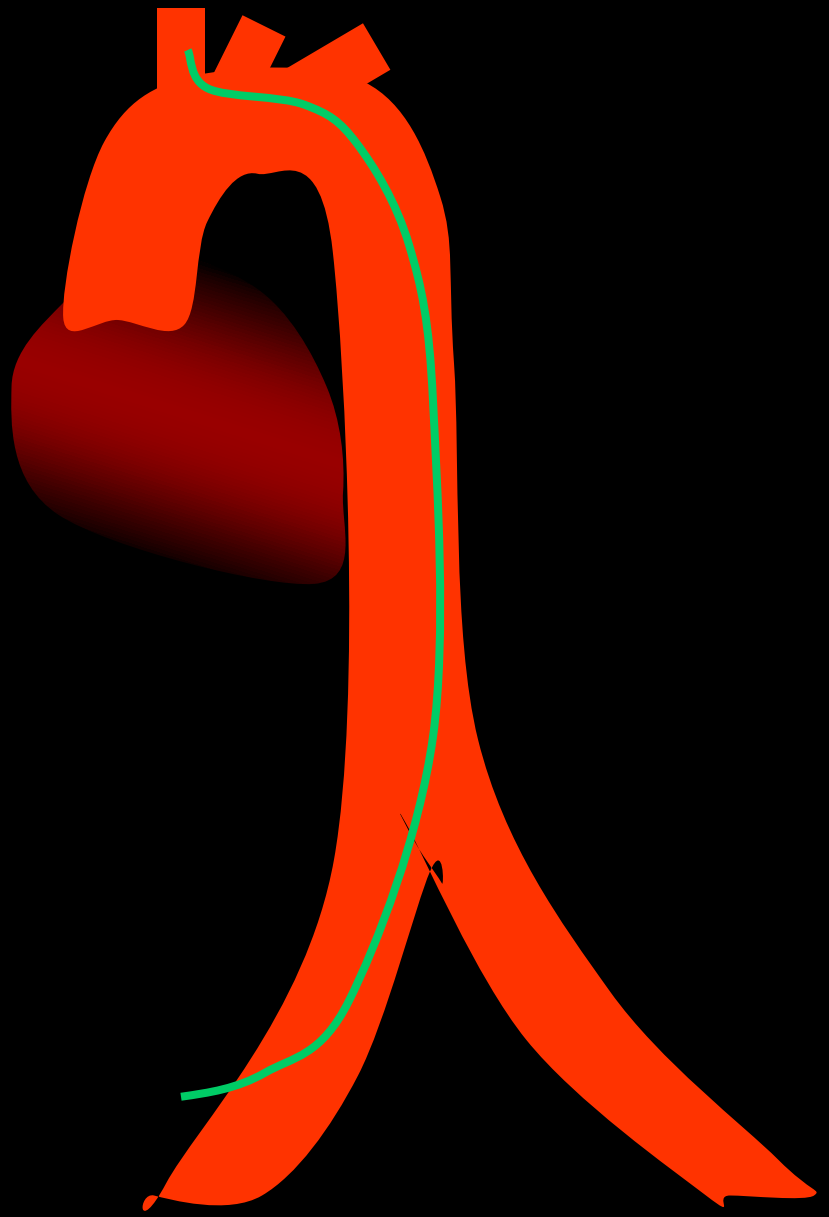
Hacke W, Kaste M, Bluhmki E, et al. Thrombolysis with alteplase 3 to 4.5 hours after acute ischemic stroke. N Engl J Med 2008;359:1317-29.

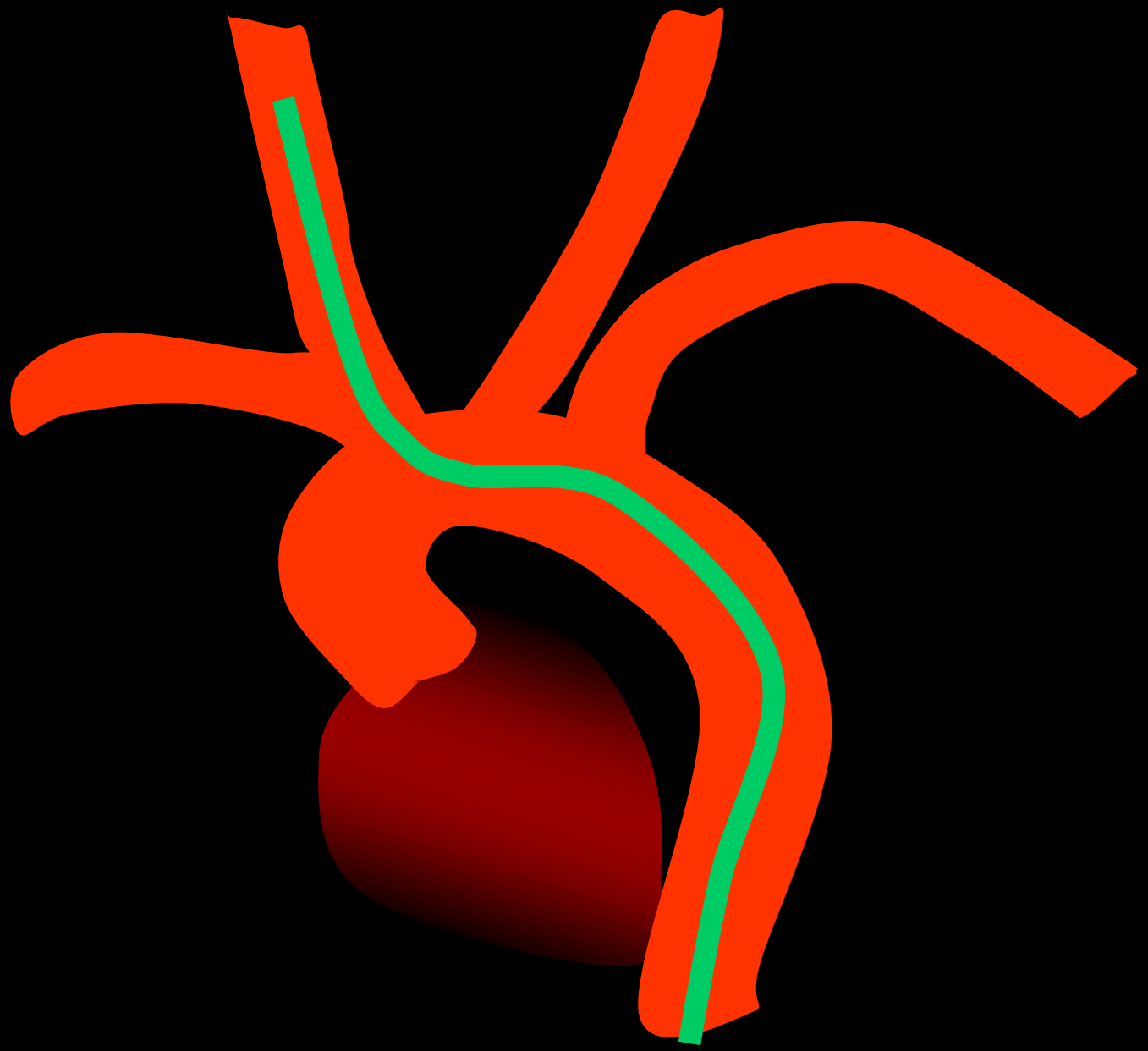
- IV tPA is less effective in patients with the most disabling strokes due to LVO

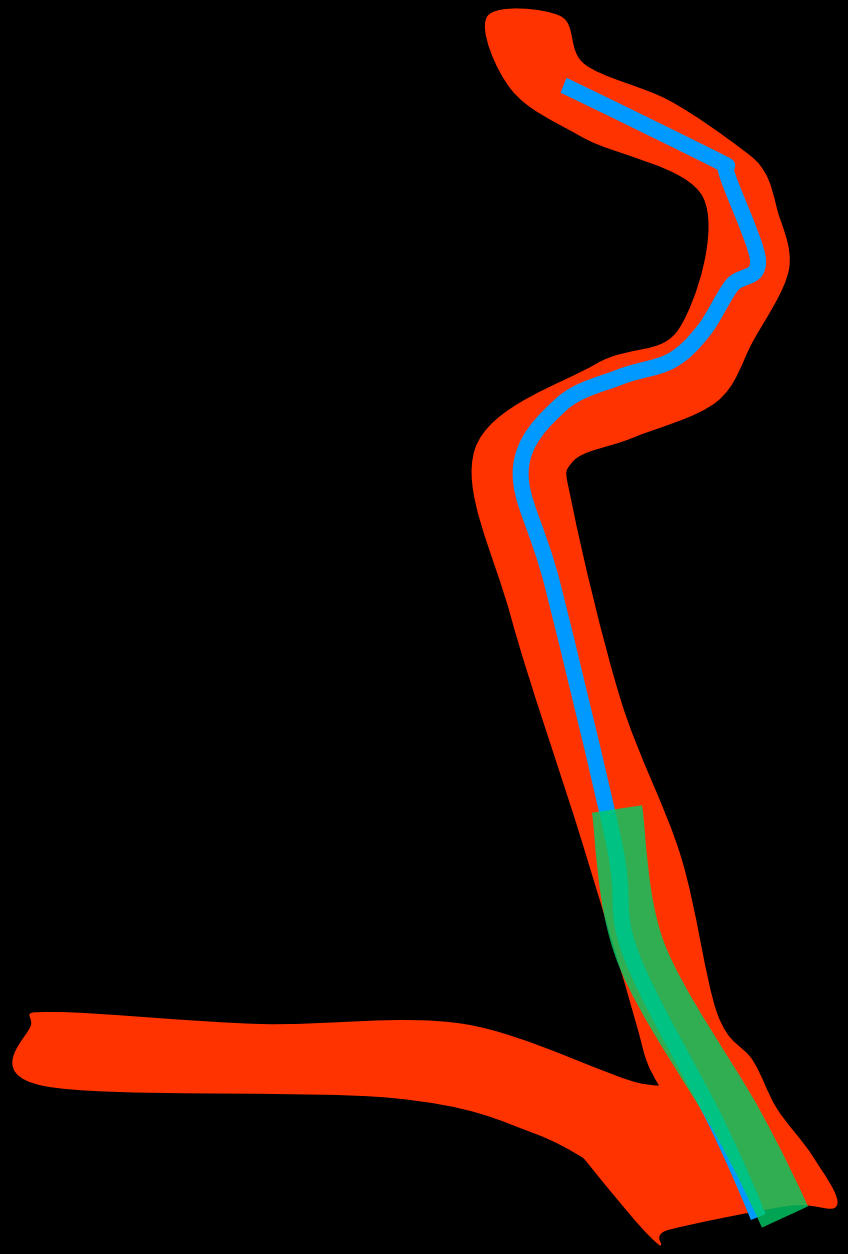
Menon BK, Al-Ajlan FS, Najm M, et al. Association of clinical, imaging, and thrombus characteristics with recanalization of visible intracranial occlusion in patients with acute ischemic stroke. JAMA 2018;320:1017-26.

Koga M, Arihiro S, Miyashita F, et al. Factors associated with early recanalization failure following intravenous rt-PA therapy for ischemic stroke. Cerebrovasc Dis. 2013;36:299-305.

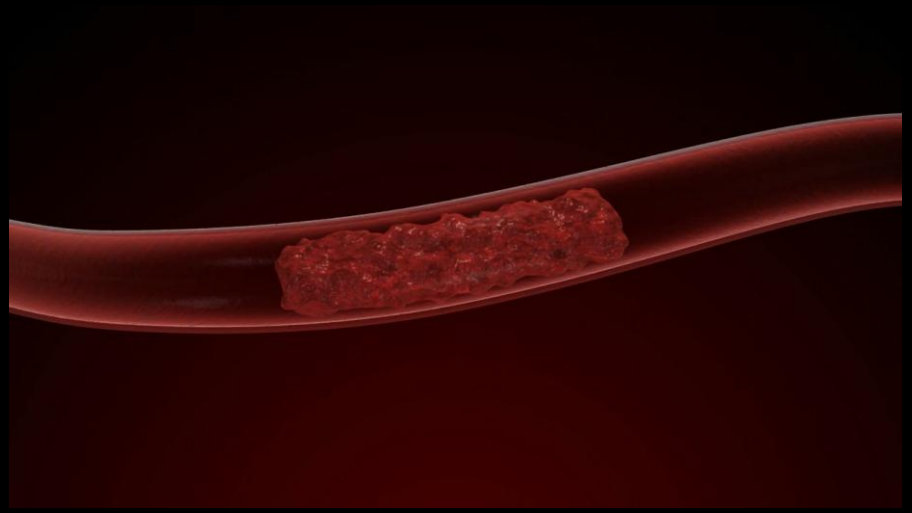
# Other option- Endovascular thrombectomy (EVT)

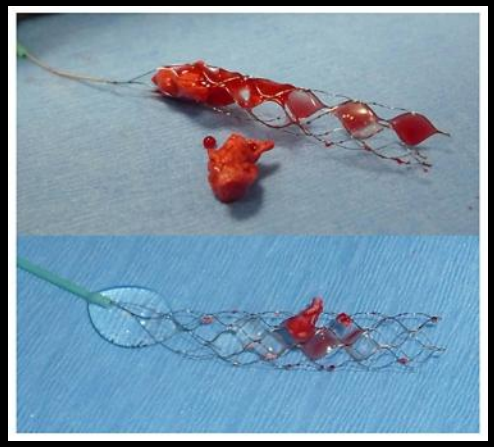






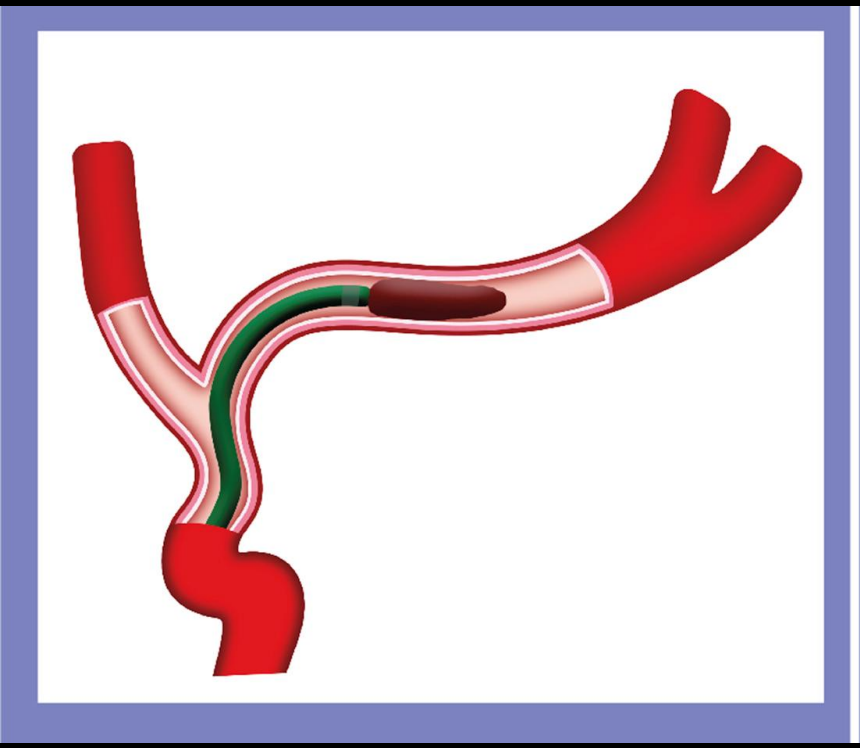
# Endovascular thrombectomy (EVT)



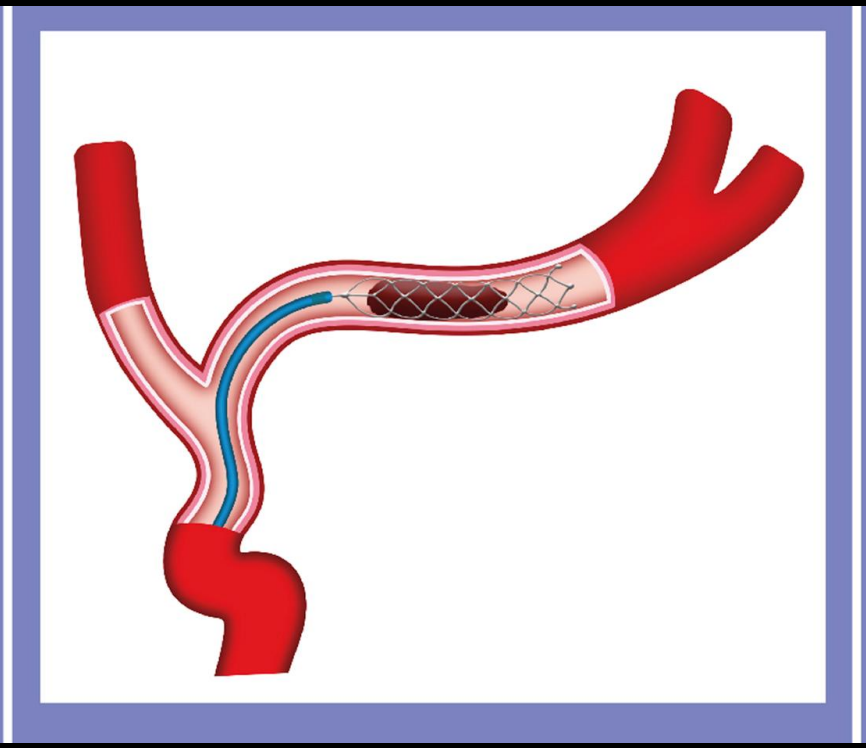


Courtsey Stryker

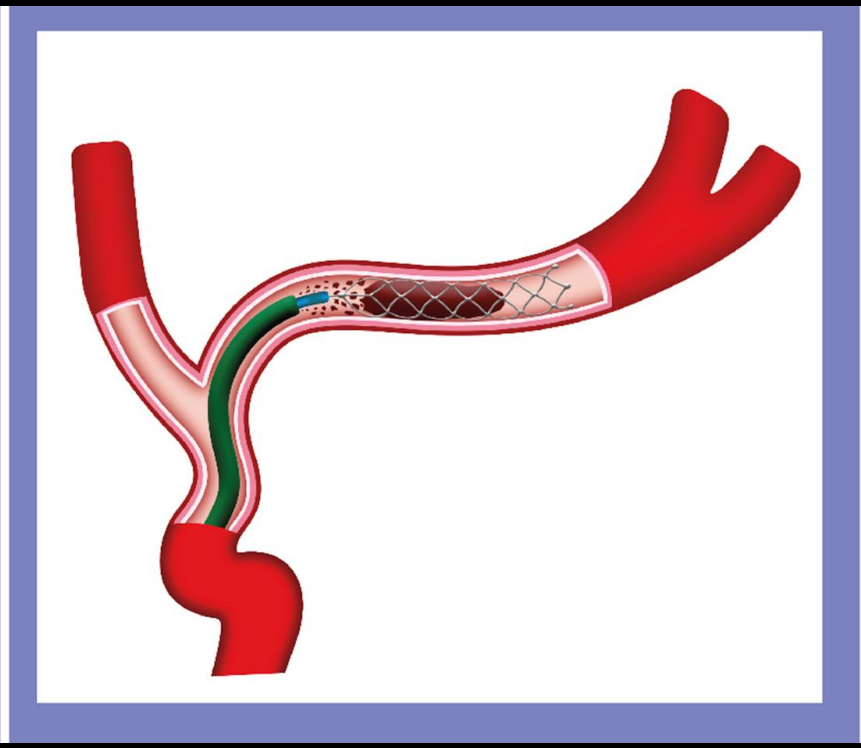
# Thrombectomy techniques



Aspiration alone



Stent Retriever

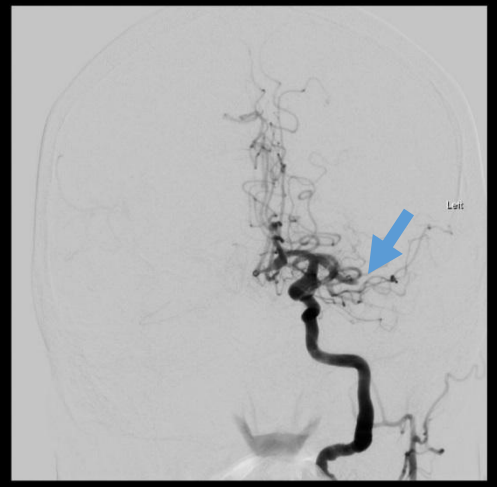


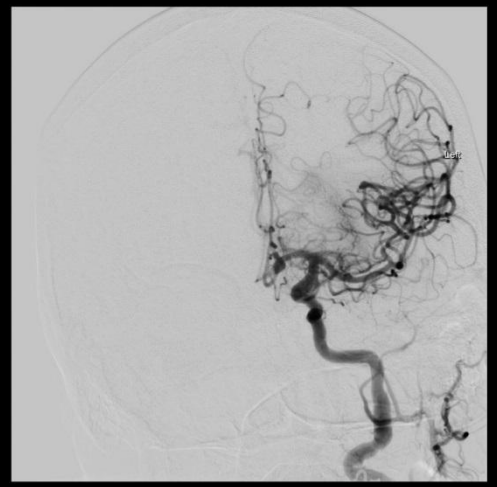
Combination of the two

91 Y F

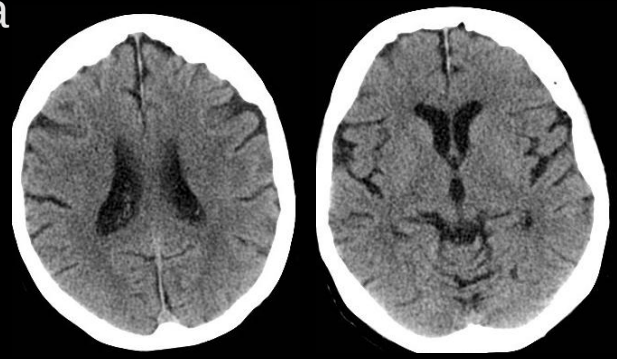
Presentation- complete Rt Hemiplegia and aphasia

Puncture to recanalization time- 25 min





Next day morning



Patient gave consent for use of video for teaching purpose


FAILURE
BEFORE
SUCCESS

# Endovascular treatment (EVT)

- 2013- 3 RCTs published in NEJM- futility of endovascular thrombectomy for acute ischemic stroke
  - SYNTHESIS,
  - MR RESCUE,
  - IMS III.

[8] Ciccone A, Valvassori L, Nichelatti M, Sgoifo A, Ponzio M, et al. for the SYNTHESIS Expansion Investigators. Endovascular treatment for acute ischemic stroke. N Engl J Med 2013;368:904-13.

[9] Kidwell CS, Jahan R, Gornbein J, Alger JR, Nenov V, et al. for the MR RESCUE Investigators. A trial of imaging selection and endovascular treatment for ischemic stroke. N Engl J Med 2013;368:914-23.

[10] Broderick JP, Palesch YY, Demchuk AM, Yeatts SD, Khatri P, Hill MD, et al. for the IMS III Investigators. Endovascular therapy after intravenous t-PA versus t-PA alone for stroke. N Engl J Med 2013;368:893-903.


FAILURE IS NOT AN OPTION!
www.cartoonmotivators.com
RICHARD DUSZCZAK


FAILURE
SUCCESS
ABNORMAL MING

# Endovascular treatment (EVT)

- 2015- 5 RCTs-
  - MR CLEAN,
  - EXTEND IA,
  - ESCAPE,
  - SWIFT PRIME,
  - REVASCAT
- Pts with AIS caused by **large-vessel thrombus occlusion** of the **proximal anterior circulation** had **significantly reduced disability** on mRS at 90 days, when treated with **rapid endovascular thrombectomy and usual stroke care** compared to usual stroke care alone.


[2] Berkhemer OA, Fransen PSS, Beumer D, van den Berg LA, Lingsma HF, Yoo AJ, et al. for the MR CLEAN Trial Investigators. A randomized trial of intraarterial treatment for acute ischemic stroke. N Engl J Med 2015;372:11-20.

[3] Campbell BCV, Mitchell PJ, Kleinig TJ, Dewey HM, Churilov L, Yassi N, et al. for the EXTEND IA Trial Investigators. Endovascular therapy for ischemic stroke with perfusion-imaging selection. N Engl J Med 2015;372:1009-18.

[4] Goyal M, Demchuk AM, Menon BK, Eesa M, Rempel JL, Thornton J, et al. for the ESCAPE Trial Investigators. Randomized assessment of rapid endovascular treatment of ischemic stroke. N Engl J Med 2015;372:1019-30.

[5] Saver JL, Goyal M, Bonafe A, Diener HC, Levy EI, Pereira VM, et al. for the SWIFT PRIME Trial Investigators. Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke. N Engl J Med 2015;372:2285-95.

[6] Jovin TG, Chamorro A, Cobo E, de Miquel MA, Molina CA, Rovira A, et al. for the REVASCAT Trial Investigators. Thrombectomy within 8 hours after symptom onset in ischemic stroke. N Engl J Med 2015;372:2296-306.

# ESCAPE Endovascular treatment for Small Core and Anterior circulation

## Proximal occlusion with Emphasis on minimizing CT to recanalization times

The NEW ENGLAND JOURNAL of MEDICINE

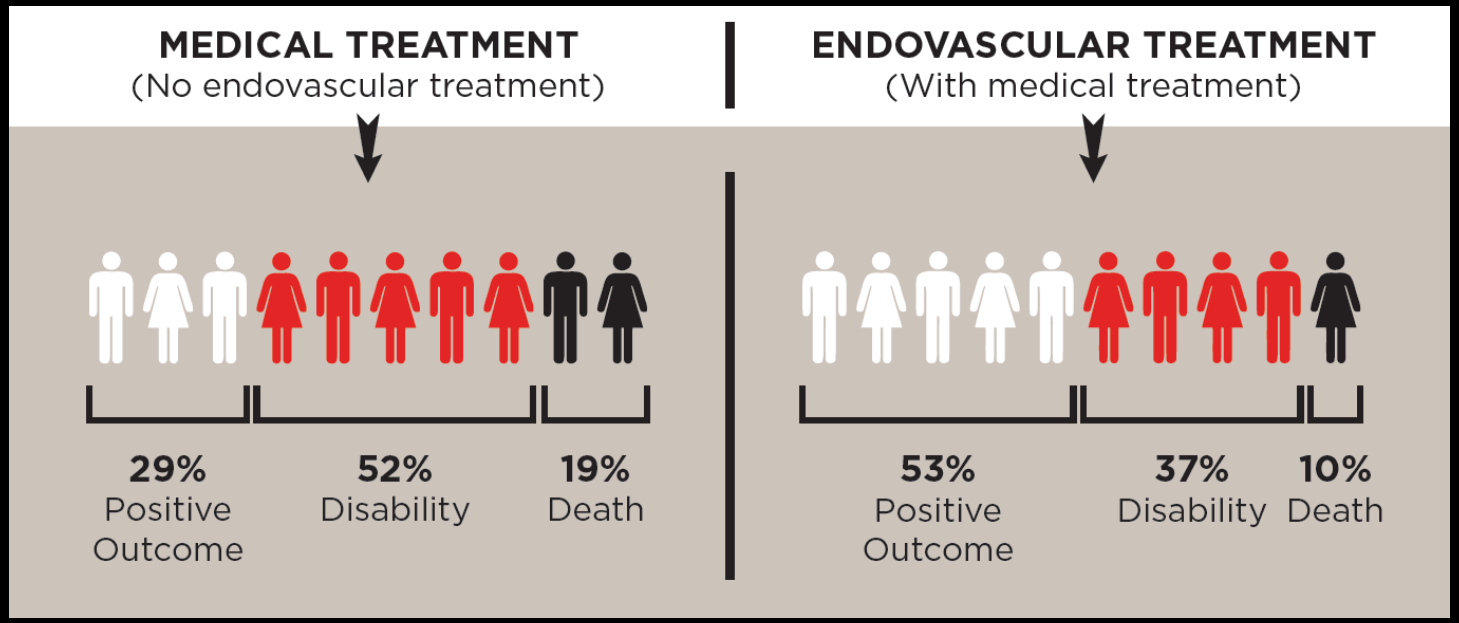
ORIGINAL ARTICLE

# Randomized Assessment of Rapid Endovascular Treatment of Ischemic Stroke

M. Goyal, A.M. Demchuk, B.K. Menon, M. Eesa, J.L. Rempel, J. Thornton, D. Roy, T.G. Jovin, R.A. Willinsky, B.L. Sapkota, D. Dowlatshahi, D.F. Frei, N.R. Kamal, W.J. Montanera, A.Y. Poppe, K.J. Ryckborst, F.L. Silver, A. Shuaib, D. Tampieri, D. Williams, O.Y. Bang, B.W. Baxter, P.A. Burns, H. Choe, J.-H. Heo, C.A. Holmstedt, B. Jankowitz, M. Kelly, G. Linares, J.L. Mandzia, J. Shankar, S.-I. Sohn, R.H. Swartz, P.A. Barber, S.B. Coutts, E.E. Smith, W.F. Morrish, A. Weill, S. Subramaniam, A.P. Mitha, J.H. Wong, M.W. Lowerison, T.T. Sajobi, and M.D. Hill for the ESCAPE Trial Investigators*

N Engl J Med. 2015 Mar 12;372(11):1019-30.

# ESCAPE Outcomes (NNT = 2.5)




| | |
|---|---|
| **Rapid Defibrillation for Cardiac Arrest-** | 2.5 for mortality |
| **Thrombolytics Given for Major Heart Attack (STEMI)-** | 43 for mortality |
| **Aspirin Given Immediately for a Major Heart Attack (STEMI)** | 42 for mortality |
| **Early Antibiotic Use in Open Fractures-** | 16 for infection |
| **Antibiotics for the Treatment of Acute Bronchitis** | 6 were helped |

# Endovascular treatment (EVT)- 6hrs

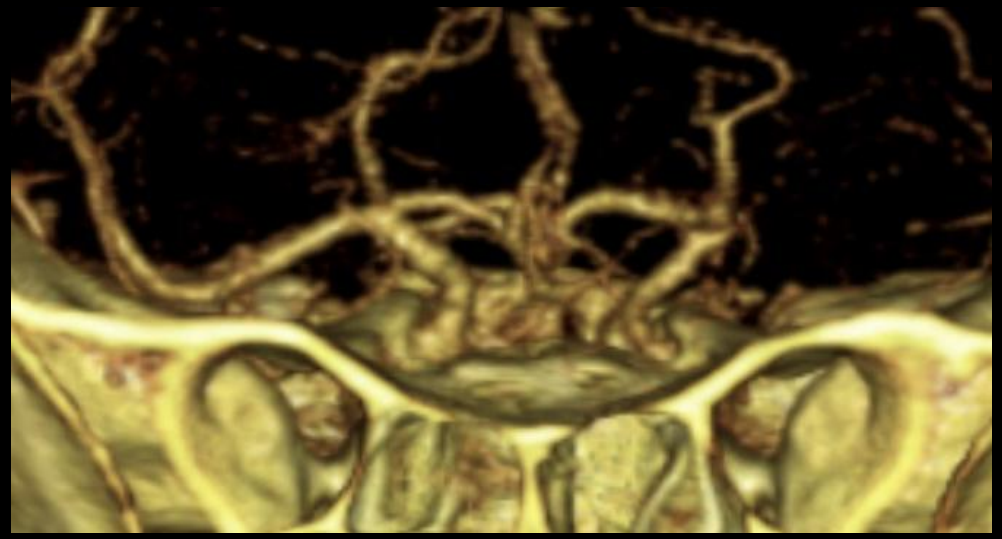
Meta-analysis of 5 clinical trials-1287 patients (634 with EVT + usual stroke care, 653 with usual stroke care alone)

- With EVT
  - NNT- 2.6- to reduce disability by at least one level on the mRS.
  - NNT- 5- for functional independence (mRS 0-2) at 90 days.
- One of the most effective treatments in present-day medicine.
- New North American and European standard of care for suitable patients.

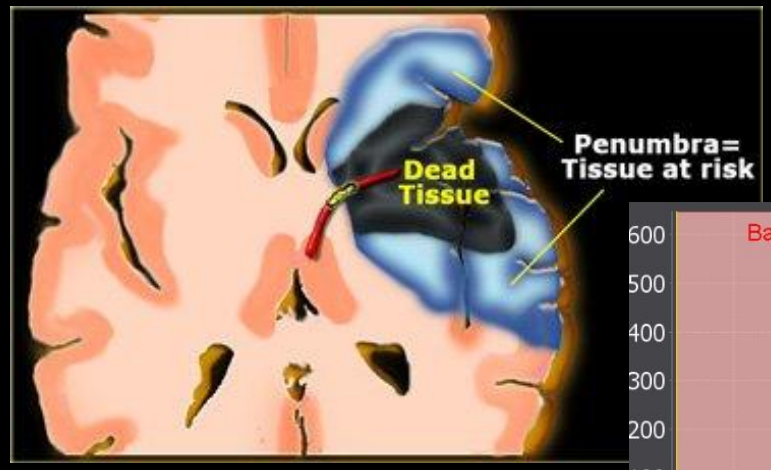
Goyal M, Menon BK, van Zwam WH, Dippel DWJ, Mitchell PJ, Demchuk AM, et al. for the HERMES collaborators. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. Lancet 2016;387:1723-31.

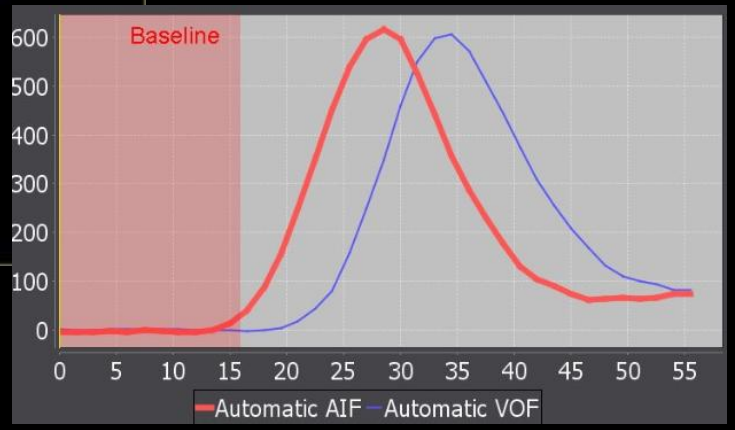
# CT Angiography: Intracranial Occlusion

- EVT is currently recommended for proximal anterior circulation (ICA and M1) occlusions.

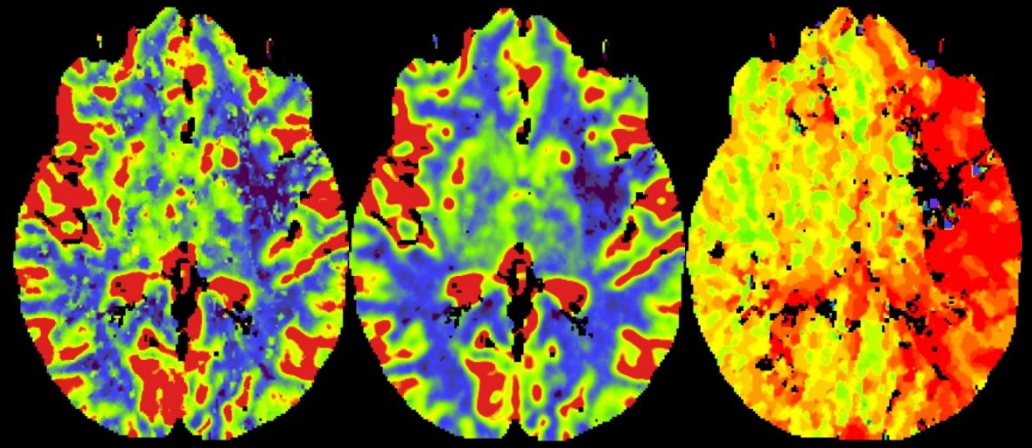


# CT Perfusion




CBF CBV



# Extending Time/Tissue window

- Wake-up strokes,
- Strokes with unclear onset time, and
- Witnessed late presenting strokes (> 6 hours)

- Represent a large proportion of LVOS (~40%)
- No proven treatment options exist for this population.

Du E, **Shankar JJS.** Rapid Endovascular Treatment of Acute Ischemic Stroke: What a General Radiologist Should Know. Can Assoc Radiol J. 2017 May;68(2):154-160.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Geff
"Things are changing a little too fast for my taste."

# DAWN trial (DWI or CTP Assessment with Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurointervention with Trevo)

- 6 to 24 hours after time last known well
- Clinical imaging mismatch (CIM) defined by age, core, and NIHSS
  - A. ≥80 y/o:
    - NIHSS ≥10 + core <21cc
  - B. <80 y/o:
    - NIHSS ≥10 + core <31cc
- Improvement in clinical outcomes across the entire range of utility weighted mRS and with higher rates of functional independence (mRS 0-2) compared to standard medical therapy (48.6% vs 13.1%, probability of superiority >0.999)
- NNT = 2.8

Nogueira RG, Jadhav AP, Haussen DC, et al. Thrombectomy 6 to 24 hours after stroke with a mismatch between deficit and infarct. N Engl J Med 2018;378:11-21

# DEFUSE 3 (Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke)

- 6 to 16 hours after LSN
- a core volume of less than 70 mL on DWI or PWI
- Infarct core <70 mL, mismatch volume >15mL, and mismatch ratio ≥1.8 on CT perfusion
  - rCBF<30% as infarct core
  - Tmax>6 s as penumbra
- Functional independence (mRS 0-2) compared to standard medical therapy (45% vs 17%)

Albers GW, Marks MP, Kemp S, et al. Thrombectomy for stroke at 6 to 16 hours with selection by perfusion imaging. N Engl J Med 2018;378:708-18.

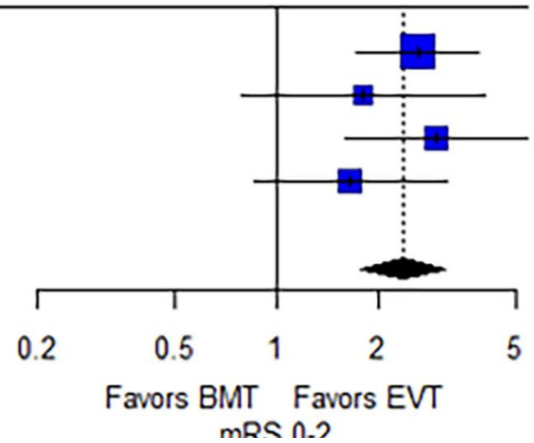
# Large core infarcts-

C

| Study | EVT Events | EVT Total | BMT Events | BMT Total | Weight | Risk Ratio IV, Random, 95% CI |
|---|---|---|---|---|---|---|
| ANGEL-ASPECT | 69 | 230 | 26 | 225 | 47.7% | 2.60 [1.72, 3.92] |
| RESCUE-Japan LIMIT | 14 | 100 | 8 | 102 | 11.9% | 1.79 [0.78, 4.07] |
| SELECT2 | 36 | 178 | 12 | 174 | 21.1% | 2.93 [1.58, 5.45] |
| TESLA | 22 | 152 | 13 | 148 | 19.3% | 1.65 [0.86, 3.15] |
| **Total (95% CI)** | | **660** | | **649** | **100.0%** | **2.33 [1.76, 3.10]** |

Heterogeneity: $Tau^2 = 0$; $Chi^2 = 2.30$, df = 3 (P = .51); $I^2 = 0\%$

Test for overall effect: Z = 5.84 (P < .01)

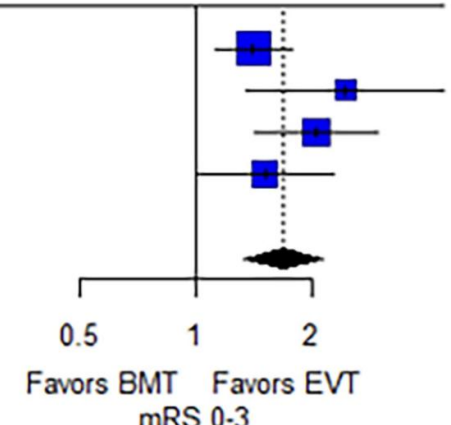



B

| Study | EVT Events | EVT Total | BMT Events | BMT Total | Weight | Risk Ratio IV, Random, 95% CI |
|---|---|---|---|---|---|---|
| ANGEL-ASPECT | 108 | 230 | 75 | 225 | 39.8% | 1.41 [1.12, 1.77] |
| RESCUE-Japan LIMIT | 31 | 100 | 13 | 102 | 13.0% | 2.43 [1.35, 4.37] |
| SELECT2 | 67 | 178 | 32 | 174 | 25.3% | 2.05 [1.42, 2.95] |
| TESLA | 45 | 152 | 29 | 148 | 22.0% | 1.51 [1.00, 2.27] |
| **Total (95% CI)** | | **660** | | **649** | **100.0%** | **1.69 [1.33, 2.14]** |

Heterogeneity: $Tau^2 = 0.023$; $Chi^2 = 4.94$, df = 3 (P = .18); $I^2 = 39\%$

Test for overall effect: Z = 4.34 (P < .01)



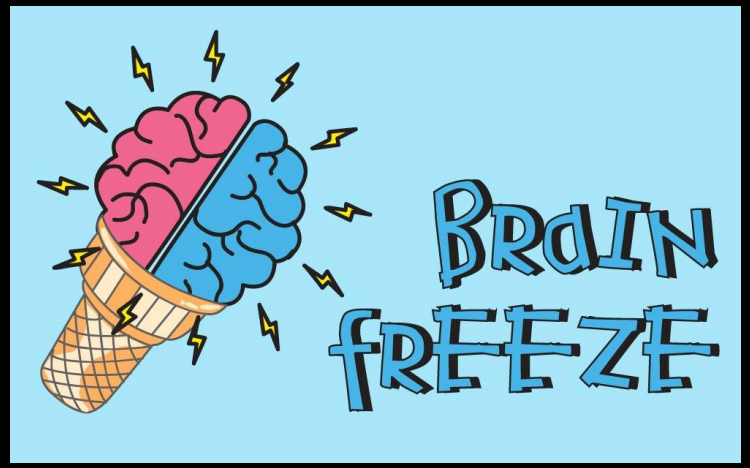
# More trials

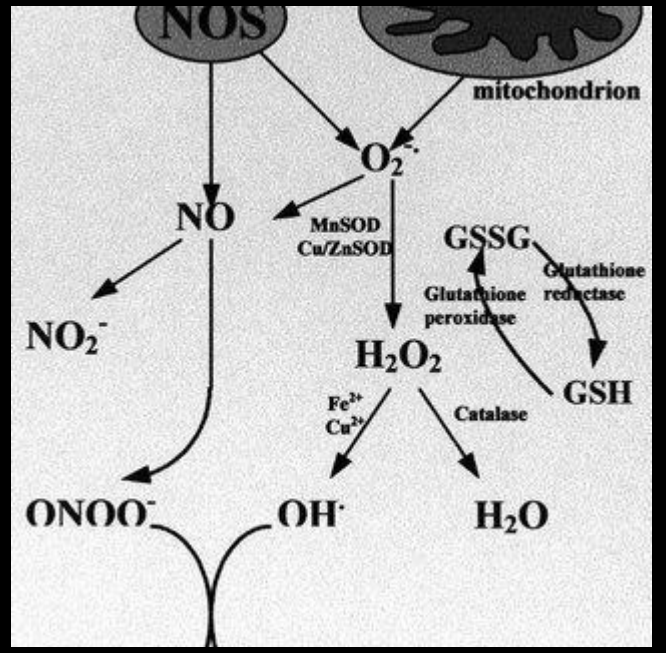
- Distal vessel occlusion- No evidence yet

Goyal M, Ospel JM, Ganesh A, Dowlatshahi D, Volders D, Möhlenbruch MA, Jumaa MA, Nimjee SM, Booth TC, Buck BH, Kennedy J, Shankar JJS, Dorn F, Zhang L, Hametner C, Nardai S, Zafar A, Diprose W, Vatanpour S, Stebner A, Bosshart S, Singh N, Sebastian I, Uchida K, Ryckborst KJ, Fahed R, Hu SX, Vollherbst DF, Zaidi SF, Lee VH, Lynch J, Rempel JL, Teal R, Trivedi A, Bode FJ, Ogungbemi A, Pham M, Orosz P, Abdalkader M, Taschner C, Tarpley J, Poli S, Singh RJ, De Leacy R, Lopez G, Sahlas D, Chen M, Burns P, Schaafsma JD, Marigold R, Reich A, Amole A, Field TS, Swartz RH, Settecase F, Lenzsér G, Ortega-Gutierrez S, Asdaghi N, Lobotesis K, Siddiqui AH, Berrouschot J, Mokin M, Ebersole K, Schneider H, Yoo AJ, Mandzia J, Klostranec J, Jadun C, Patankar T, Sauvageau E, Lenthall R, Peeling L, Huynh T, Budzik R, Lee SK, Makalanda L, Levitt MR, Perry RJ, Hlaing T, Jahromi BS, Singh P, Demchuk AM, Hill MD; ESCAPE-MeVO Investigators. Endovascular Treatment of Stroke Due to Medium-Vessel Occlusion. N Engl J Med. 2025 Feb 5. doi: 10.1056/NEJMoa2411668. Epub ahead of print. PMID: 39908448.

- Role of intra-arterial thrombolytic (tPA or TNK)- No good evidence

# Neuroprotection

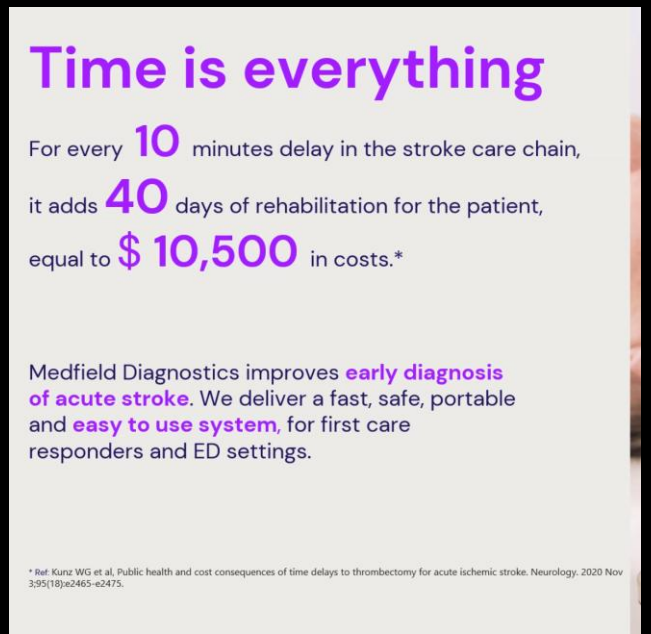



Hill MD, Goyal M, Demchuk AM, Menon BK, Field TS, Guest WC, Berrouschot J, Bormann A, Pham M, Haeusler KG, Dippel DWJ, van Doormaal PJ, Dorn F, Bode FJ, van Adel BA, Sahlas DJ, Swartz RH, Da Costa L, Ospel JM, McDonough RV, Ryckborst KJ, Almekhlafi MA, Heard KJ, Garman DJ, Adams C, Kohli Y, Schoon BA, Buck BH, Muto M, Zafar A, Schneider H, Grossberg JA, Yeo LLL, Tarpley JW, Psychogios MN, Coutinho JM, Limbucci N, Puetz V, Kelly ME, Campbell BCV, Poli S, Poppe AY, Shankar JJS, Chandra R, Dowlatshahi D, Lopez GA, Cirillo L, Moussaddy A, Devlin M, Garcia-Bermejo P, Mandzia JL, Skjelland M, Aamodt AH, Silver FL, Kleinig TJ, Pero G, Minnerup J, McTaggart RA, Puri AS, Chiu AHY, Reimann G, Gubitz GJ, Camden MC, Lee SK, Sauvageau E, Mundiyanapurath S, Frei DF, Choe H, Rocha M, Gralla J, Bailey P, Fischer S, Liebig T, Dimitriadis K, Gandhi D, Chapot R, Jin A, Hassan AE, Zwam WV, Maier IL, Wiesmann M, Niesen WD, Advani R, Eltoft A, Asdaghi N, Murphy C, Remonda L, Ghia D, Jansen O, Holtmannspoetter M, Hellstern V, Witt K, Fromme A, Nimjee SM, Turkel-Parella D, Michalski D, Maegerlein C, Tham CH, Tymianski M; ESCAPE-NEXT Investigators. Efficacy and safety of nerinetide in acute ischaemic stroke in patients undergoing endovascular thrombectomy without previous thrombolysis (ESCAPE-NEXT): a multicentre, double-blind, randomised controlled trial. Lancet. 2025 Feb 15;405(10478):560-570. doi: 10.1016/S0140-6736(25)00194-1. PMID: 39955119.

# Implementation of evidence to practice


- Speed is key- Time is Brain-
  - an estimated 1.9 million brain cells die per min
- Technique- use what you are most comfortable with
- Imaging is key
- Larger the infarct. lesser the chance of good outcome

# Thank You

- Stroke Team-
  - Stroke Neurologists
  - Neuro-interventional radiologists/Surgeons
  - Angio Techs and Nurses