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Recent advances in Neuroradiology and their impact on Anesthesia providers

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Learning Objectives

1. Review the evolution, advances and likely changes in neuro-interventional and anesthetic management of patients with cerebrovascular disease; aneurysm, arteriovenous malformation and acute stroke

2. Discuss the anesthetic management of the patient with acute ischemic stroke

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Disclosures

None

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Acknowledgements

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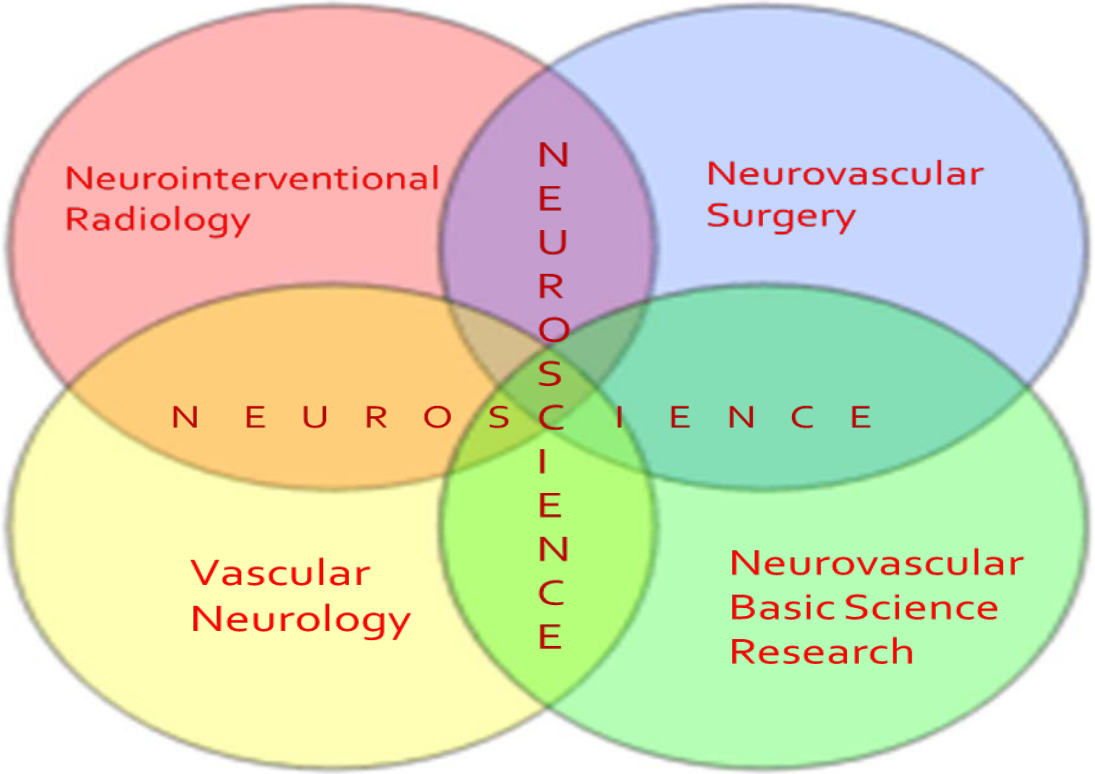
Michigan Medicine

Dr. Joseph Gemmette
Professor of Neuro-interventional Radiology
Michigan Medicine

Dr. Aditya Pandey
Associate Professor, Neurological Surgery
Associate Professor, Otolaryngology – Head and Neck Surgery
Michigan Medicine



University of Michigan
Comprehensive Stroke Center
Neurointerventional Team

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Presentation structure

Aneurysm

Arterio venous malformation

Acute Ischemic Stroke

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Aneurysms

NIR History

Guido Guglielmi 1948-

Neurosurgeon / Engineer
University of Rome 1979

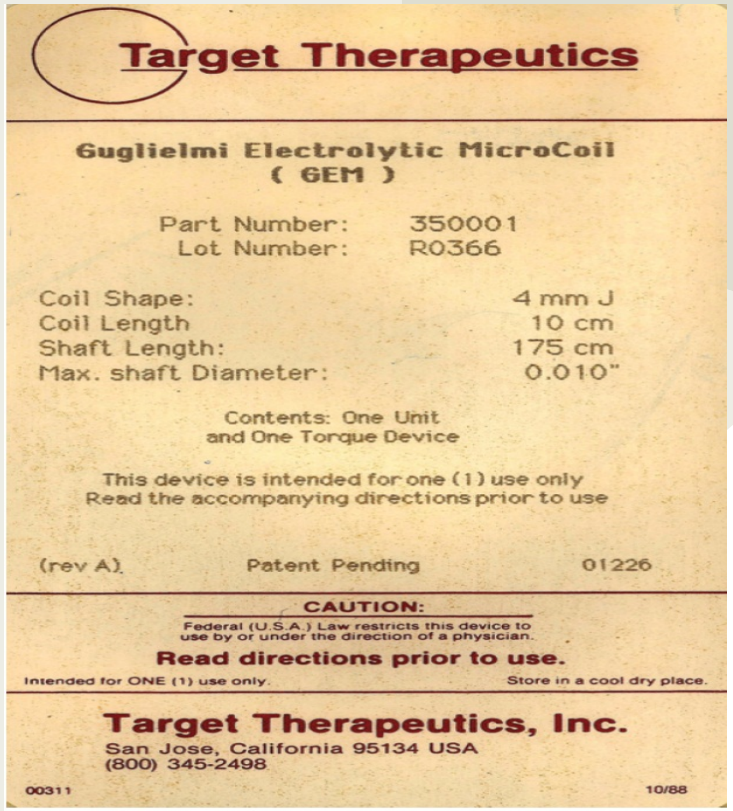
Fernando Vinuela U W.O. then UCLA 1983 - 1989 Research project

Target Therapeutics

March 6th 1990 – Human application

Jan 1991 – First Human aneurysm application GDC

Sep 8th 1995 FDA approval



Target Therapeutics

Guglielmi Electrolytic MicroCoil
(GEM)

Part Number: 350001
Lot Number: R0366

Coil Shape: 4 mm J
Coil Length 10 cm
Shaft Length: 175 cm
Max. shaft Diameter: 0.010"

Contents: One Unit
and One Torque Device

This device is intended for one (1) use only
Read the accompanying directions prior to use

(rev A) Patent Pending 01226

CAUTION:
Federal (U.S.A.) Law restricts this device to use by or under the direction of a physician.
Read directions prior to use.
Intended for ONE (1) use only. Store in a cool dry place.

Target Therapeutics, Inc.
San Jose, California 95134 USA
(800) 345-2498

00311 10/88

FIG. 7. Historic photograph showing the first label on the package of a detachable coil. It was prepared in 1989, when the detachable coils were still called GEMs. The name was then changed to GDCs.

FIG. 8. Historic photograph of the first (handmade) current generator used to detach the coils in 1989.

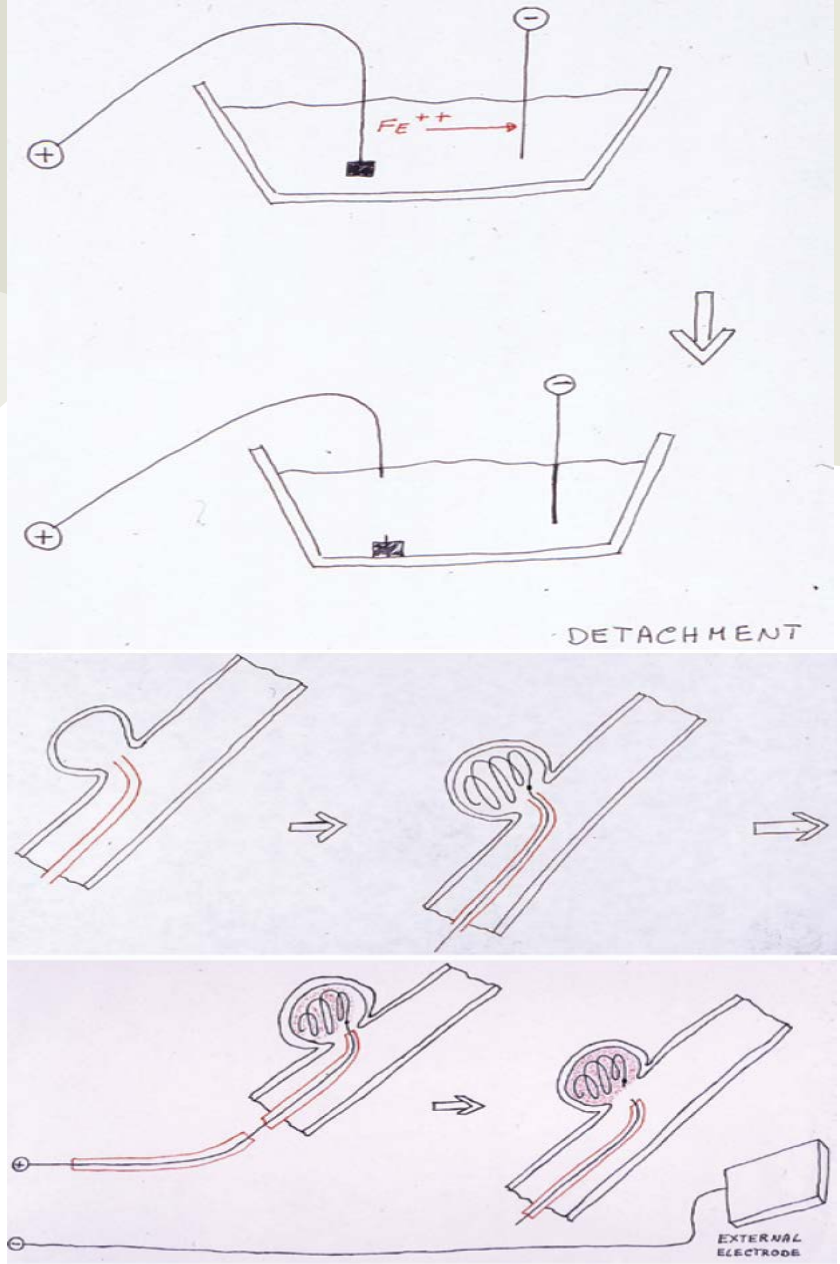


FIG 6. Historic diagrammatic representations drawn in 1989 show the first two *(upper)* and remaining two *(lower)* steps of the detachable coil technique.

J Neurosurg 111:1–8, 2009

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International Subarachnoid Aneurysm Trial (ISAT)

Lancet 2002

2143 SAH patients (WFNS I and II) randomly assigned to coiling vs. open clipping

7.4% risk reduction (death and dependency) in coiling group

Survival benefit extended to at least 7 years

High risk of re-rupture in coiled aneurysms

Molyneux AJ, Kerr RSC, Birks J, et al. Risk of recurrent subarachnoid hemorrhage, death, or dependence and standardized mortality ratios after clipping or coiling of an intracranial aneurysm in the international subarachnoid aneurysm trial (ISAT): long-term follow-up. *Lancet Neurol*. 2009;8(5):427-433

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Anesthesia for aneurysm coiling

GA ETT usually with muscle relaxation

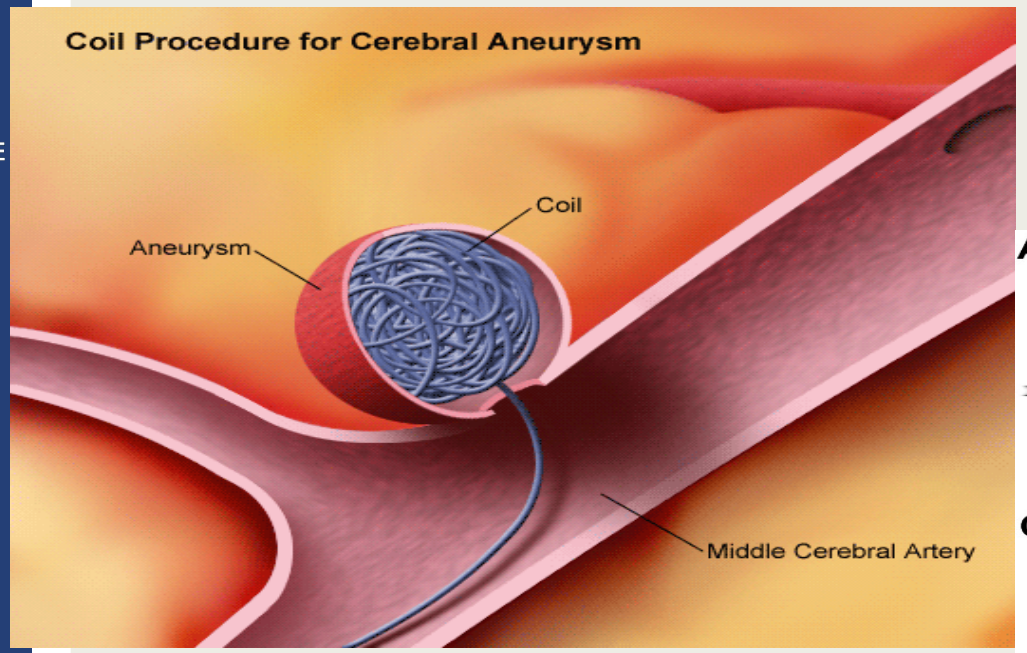
Neuromonitoring common – SSEP

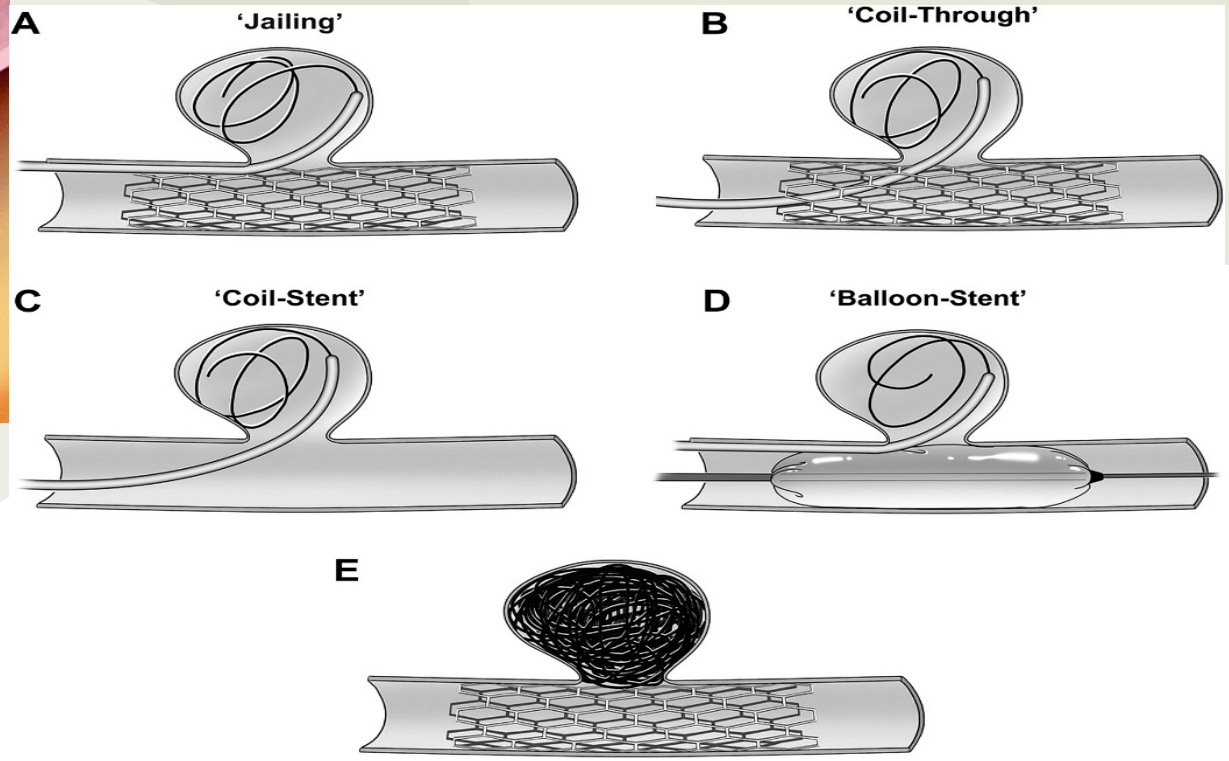
TIVA considered

Access to patient remains major obstacle – local variation

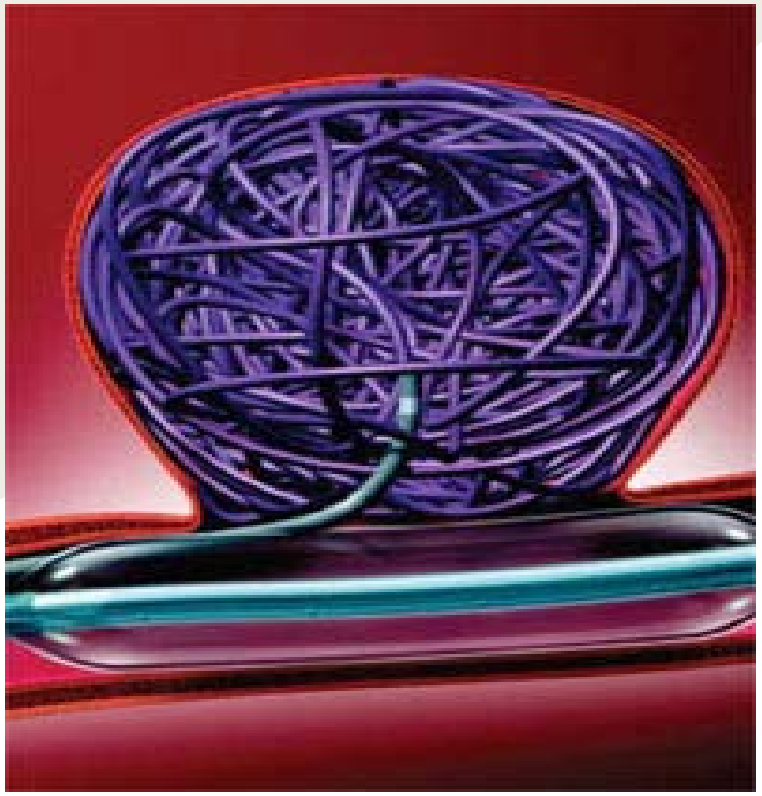
Arterial invasive monitoring essential; may not be able to share femoral access

Coil Embolization Techniques





Balloon Assisted Coiling (or “remodeling balloon technique”, BAC)



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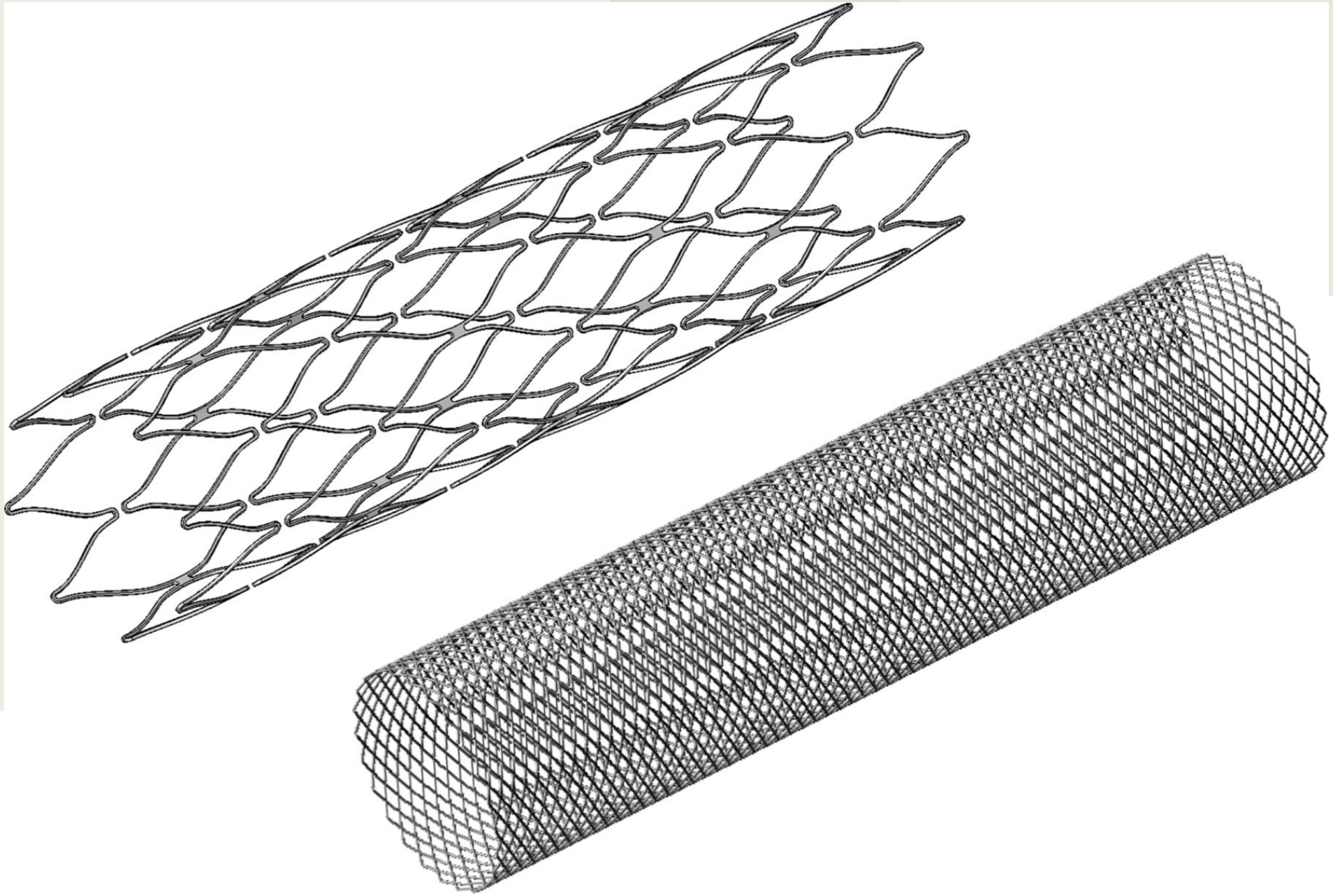
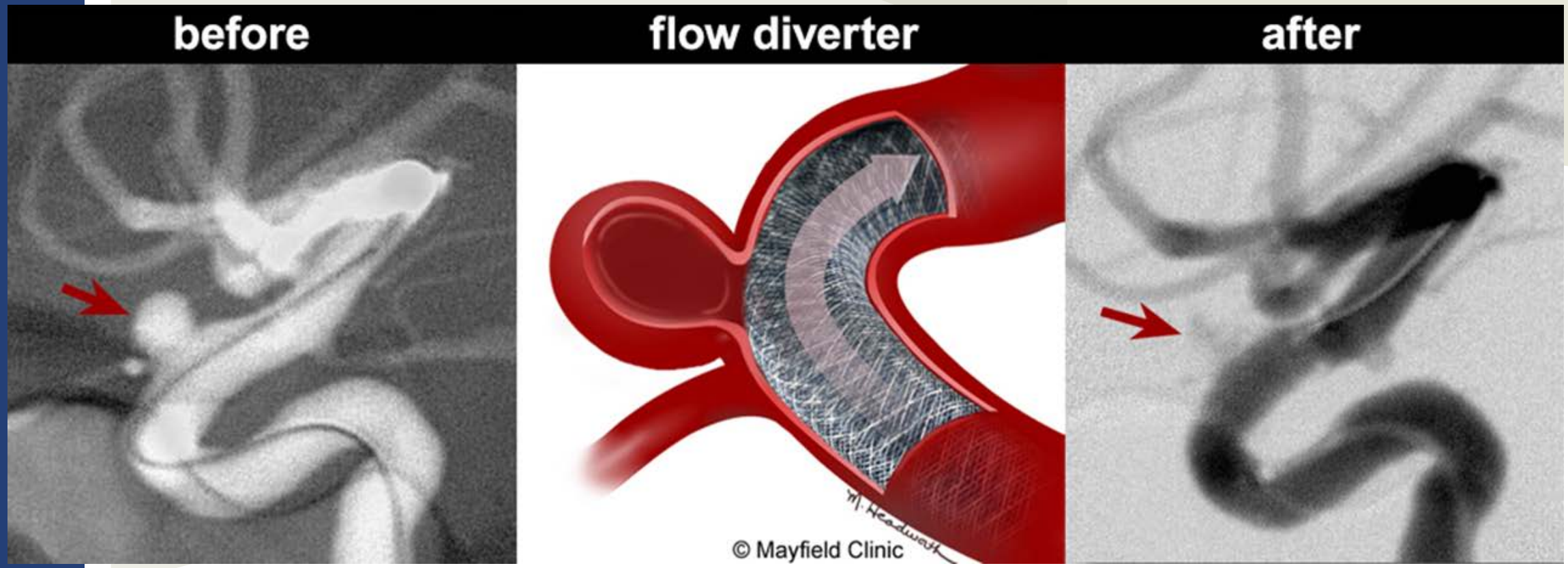


Pipeline™ stents – flow diverter



Pipeline embolization device (Covidien/ev3 Neurovascular, Irvine, California, USA)

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Pipeline for Uncoilable or Failed Aneurysms: Results from a Multicenter Clinical Trial[1]

radiology.rsna.org ▪ ***Radiology:*** Volume 267: Number 3—June 2013

Figure 2

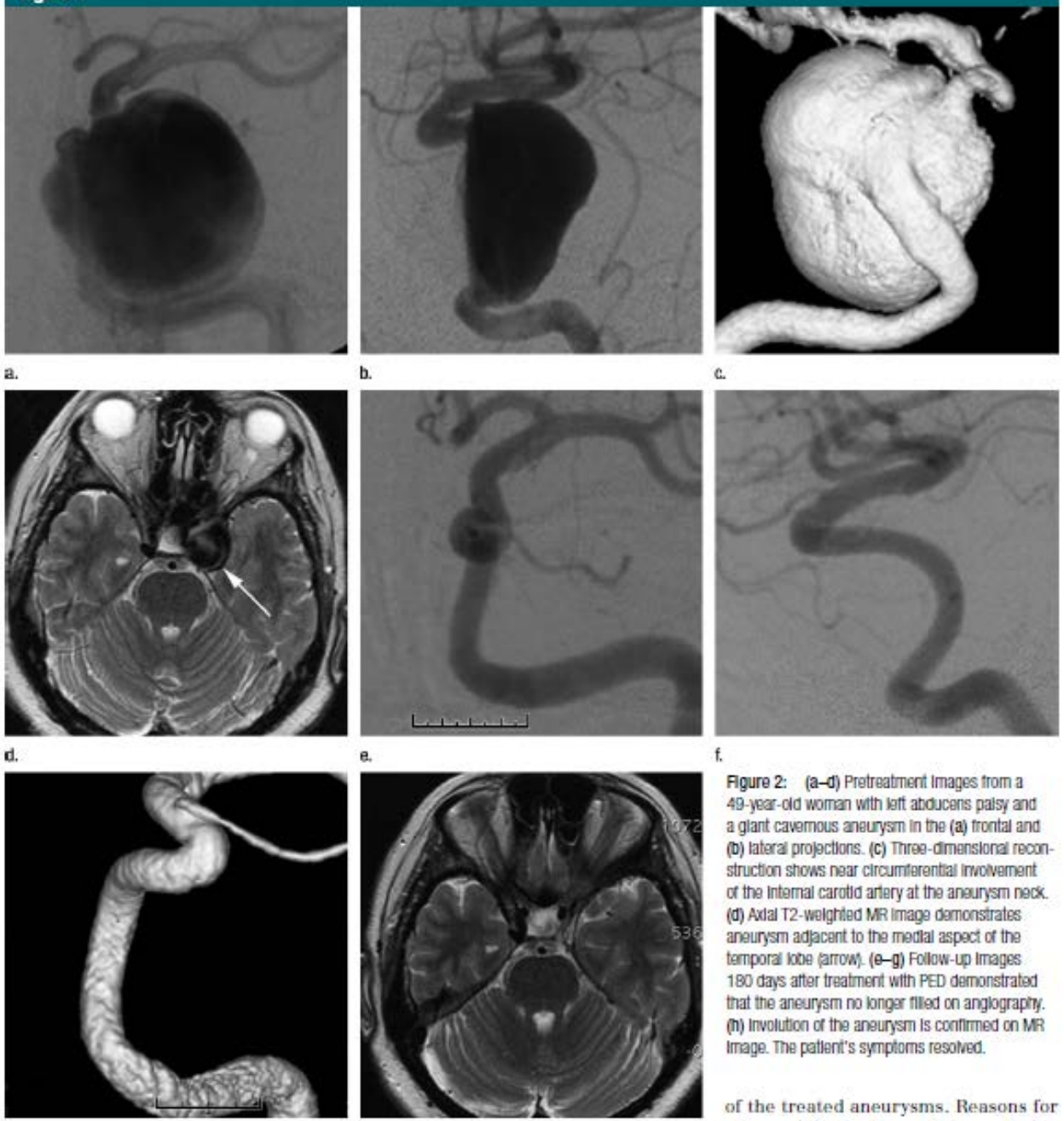

Figure 2: (a–d) Pretreatment images from a 49-year-old woman with left abducens palsy and a giant cavernous aneurysm in the (a) frontal and (b) lateral projections. (c) Three-dimensional reconstruction shows near circumferential involvement of the internal carotid artery at the aneurysm neck. (d) Axial T2-weighted MR image demonstrates aneurysm adjacent to the medial aspect of the temporal lobe (arrow). (e–g) Follow-up images 180 days after treatment with PED demonstrated that the aneurysm no longer filled on angiography. (h) Involution of the aneurysm is confirmed on MR image. The patient's symptoms resolved.

of the treated aneurysms. Reasons for

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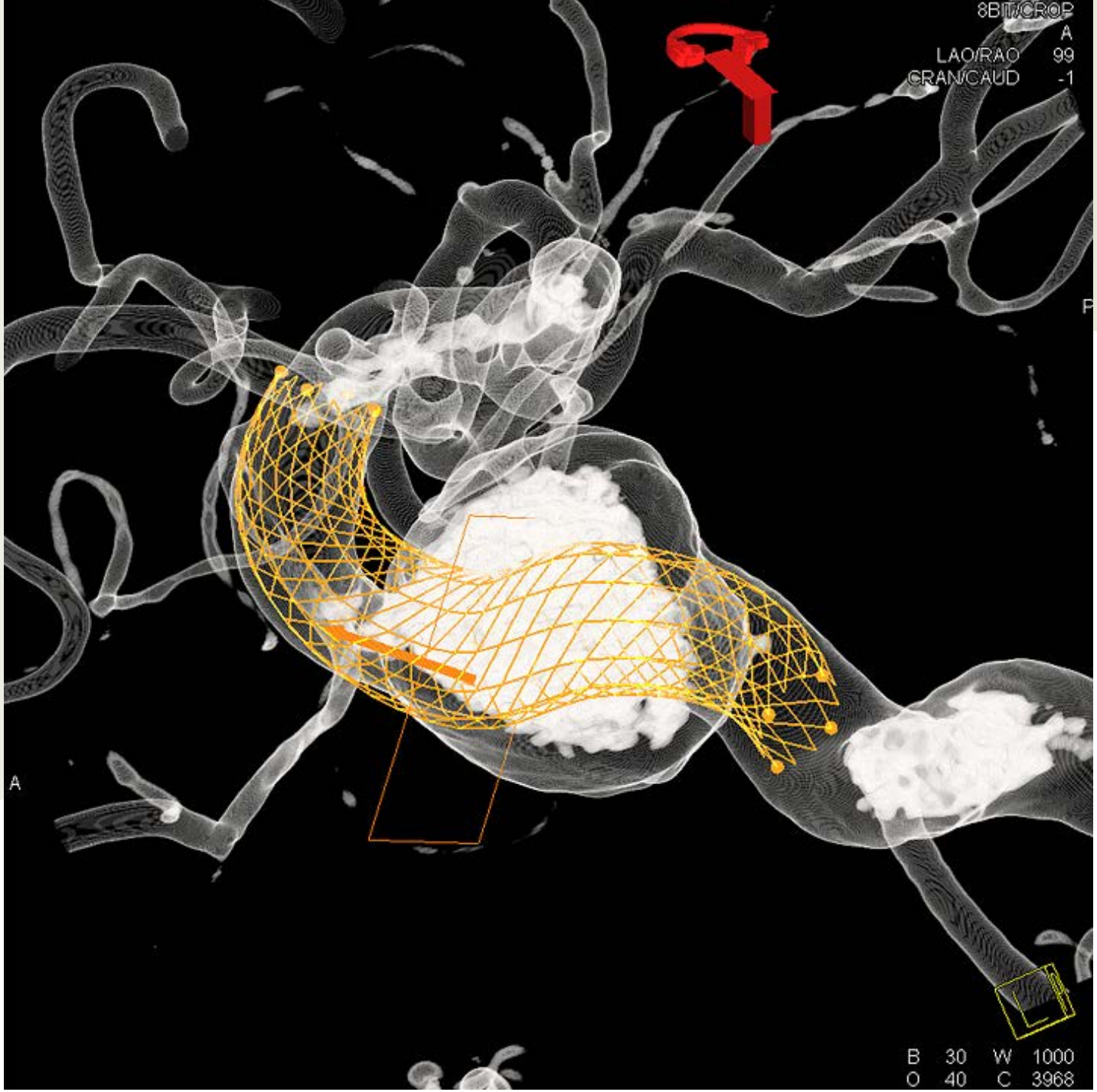

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What is different about Pipeline™?

Do not "cure" the aneurysm

Promote stasis and thrombosis in the sac

Patient placed onto systemic dual anti-platelet agents to prevent IN STENT thrombosis

At least one antiplatelet lifelong

Usually aspirin & clopidogrel minimum 3 months

Platelet function assays necessary and may need to re-dose intra-op – check pre-op & put in an NG

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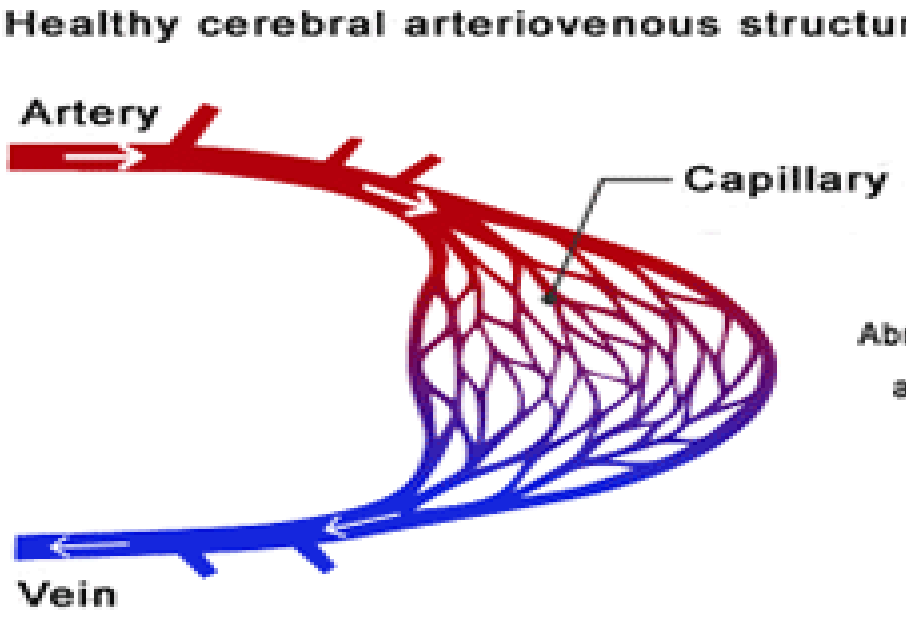
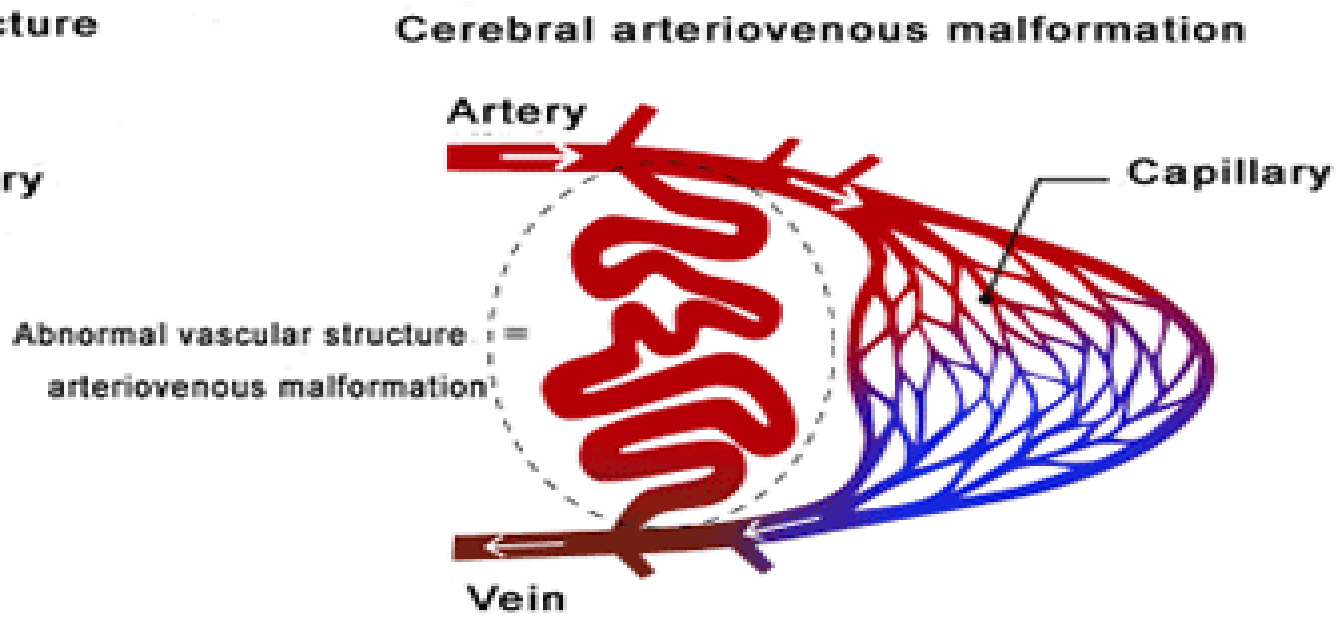
Evolution of Neuro-interventional Arterio-venous malformation therapies

Cerebral arterio-venous malformation





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Onyx™

First described by Takei 1990

FDA 2010

Elastic copolymer (ethylene vinyl alcohol copolymer (EVOH)), dissolved in dimethyl-sulfoxide (DMSO)

“Slow superglue” – up to 90 minutes procedure

Makes the patient smell of fish / old cornflakes!

Taki W, Yonekawa Y, Iwata H et-al. A new liquid material for embolization of arteriovenous malformations. AJNR Am J Neuroradiology. 1990;11 (1): 163-8

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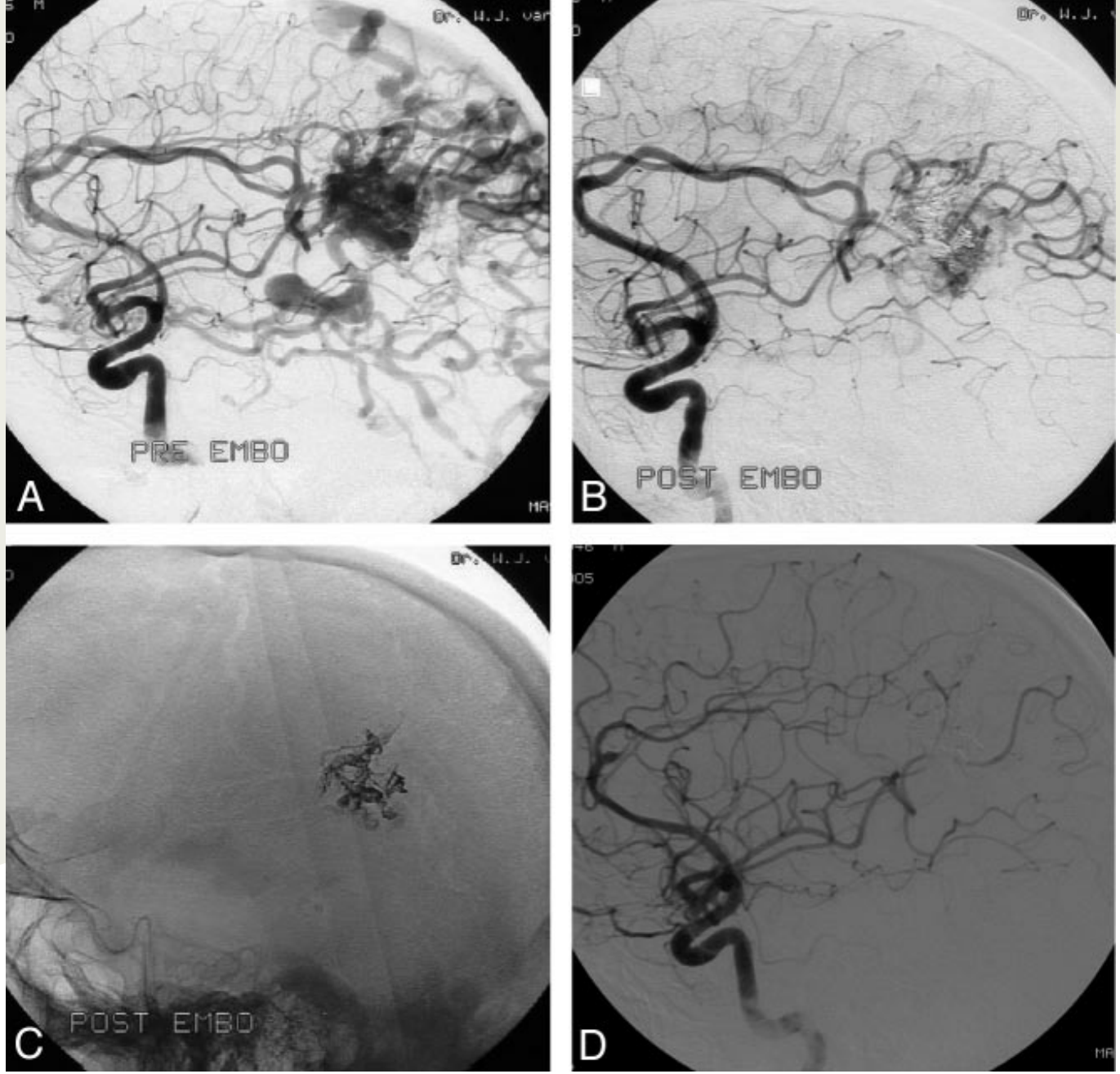

Brain AVM Embolization with Onyx

van Rooij | AJNR 28 | Jan 2007 | www.ajnr.org

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Anesthesia for Onyx™

GA ETT

May require neuromonitoring for SSEP or similar: consider TIVA to improve signals

Usually with muscle relaxation

Heparinized patient: have protamine on hand

Consider circulatory arrest with Adenosine

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Complications of AVM / Onynx

Unintended distal embolization

Normal perfusion pressure breakthrough after procedure

Most delicate of NIR procedures – beware!

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Evolution of Neuro-interventional therapies for Stroke

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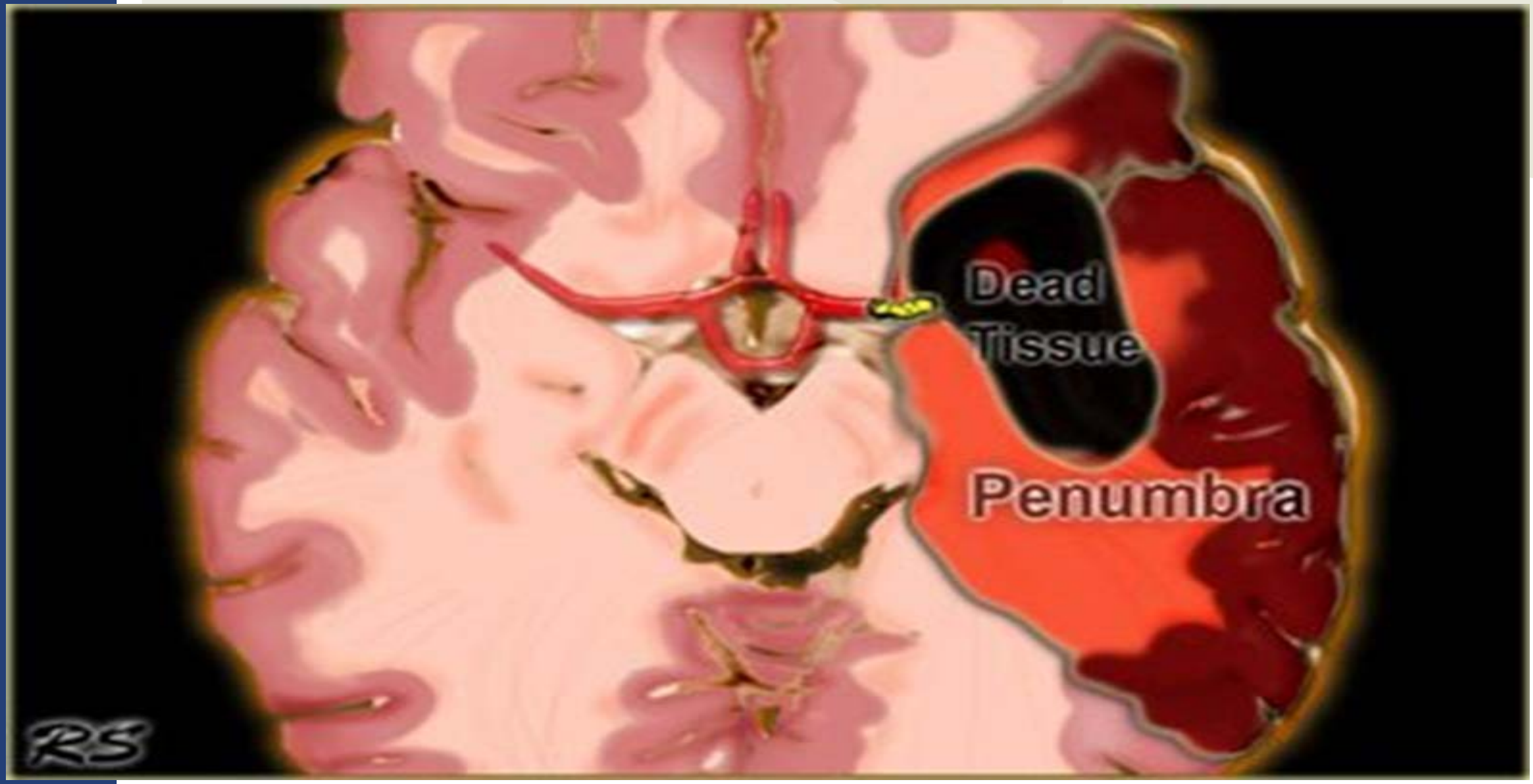
Saving the Penumbra



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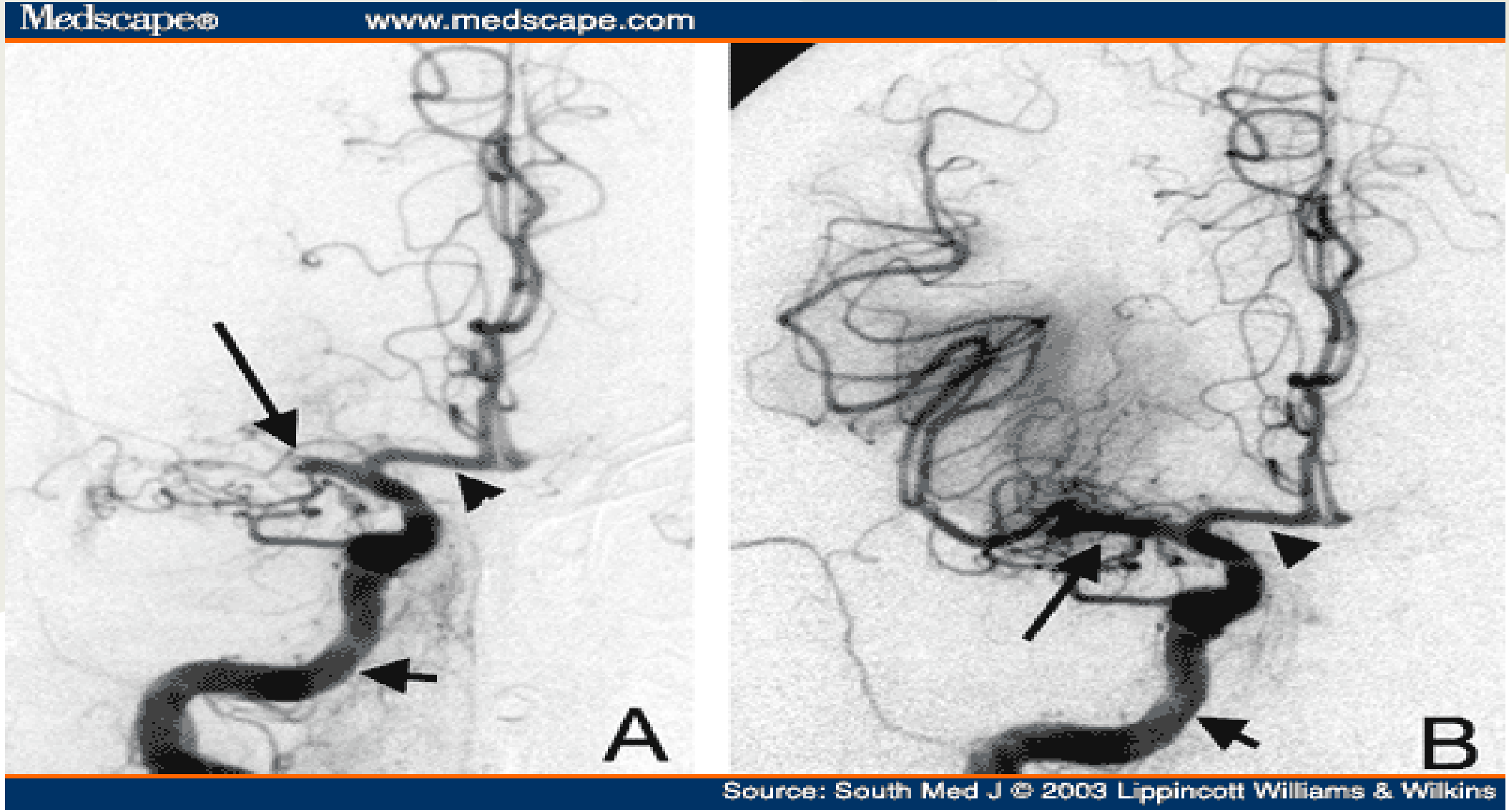
Acute Ischemic Stroke (AIS)



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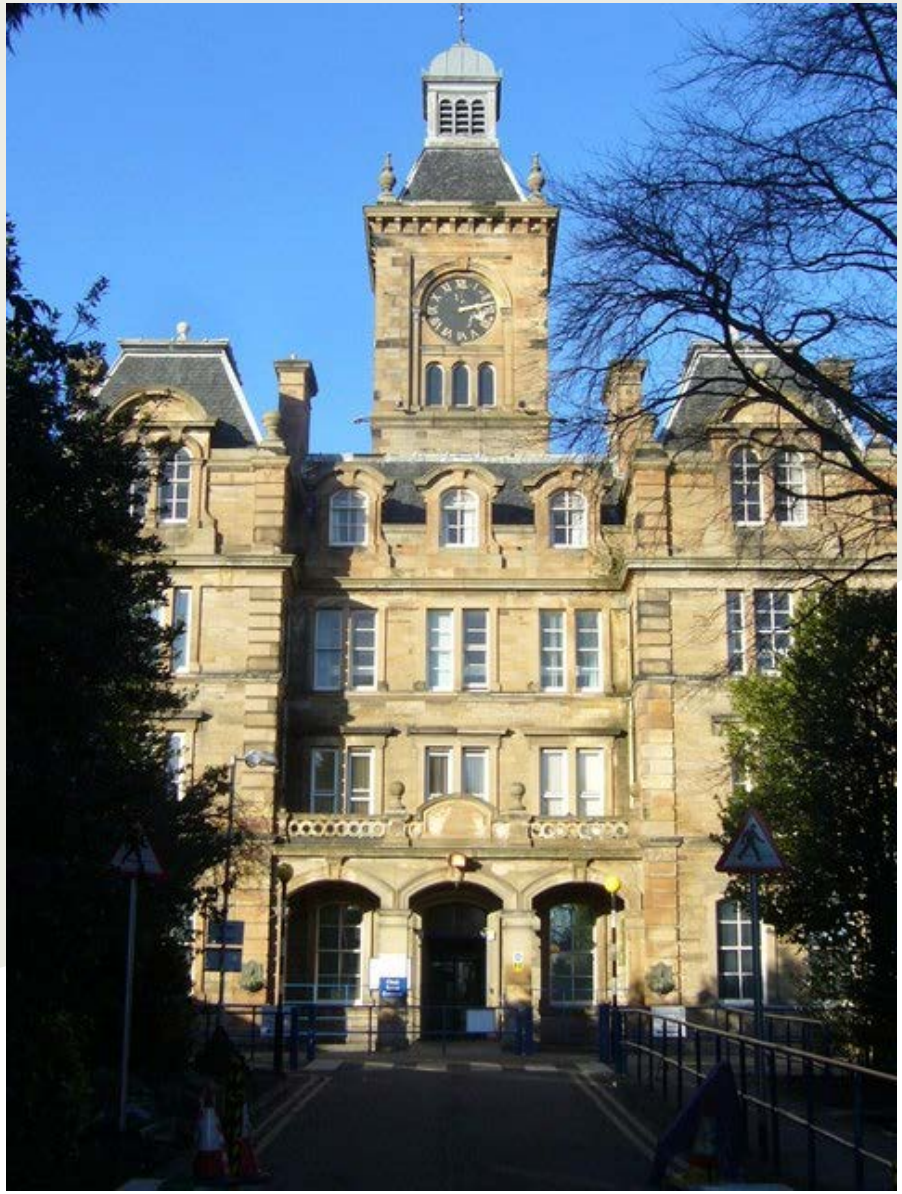

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"New research has found that **97.5%** of Scots are likely to be either cigarette smokers, heavy drinkers, fat, have a bad diet, and never do any exercise." *The Telegraph* 2010

http://www.telegraph.co.uk/news/health/news/7817675/Scottish-people-leading-dangerously-unhealthy-lives.html

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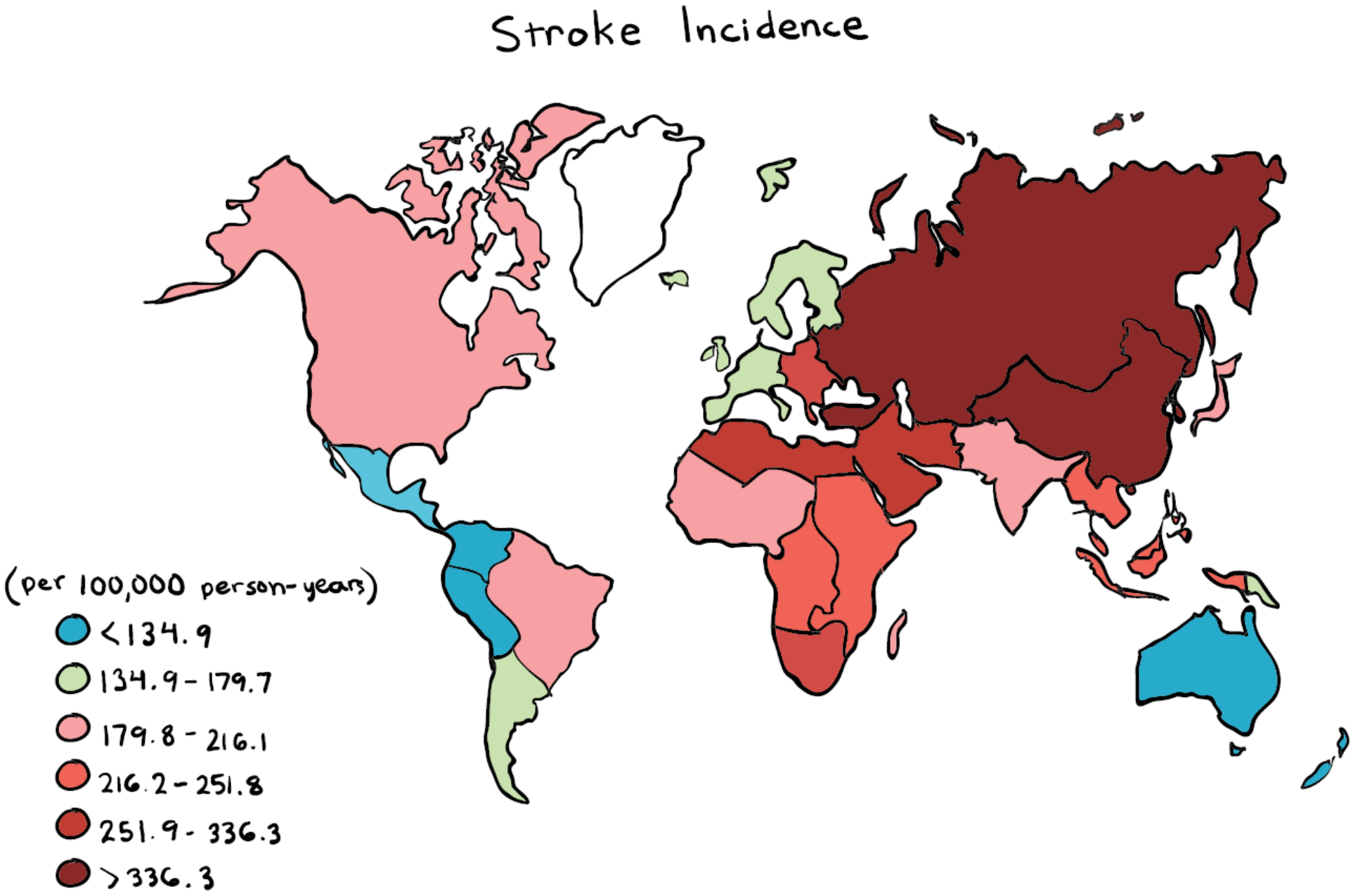

https://www.khanacademy.org/science/health-and-medicine/circulatory-system-diseases/stroke/a/what-is-a-stroke

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Recognizing Stroke

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Pathway to reperfusion

Recognize stroke – public education

Present to hospital

Urgent Imaging – CT / CT angiography

Recognition of target thrombus

TRANSFER TO STROKE CENTRE

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What can be done for stroke?

1. Nothing
2. Thrombolysis
3. Thrombectomy

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Nothing – happens a lot

American Heart Association | American Stroke Association

National Inpatient Sample of 563,087 patients (median age 74) 2005 and 2011 – **ONLY 3.8% receive tPA**

Stroke belt phenomenon

African-Americans 38% ↓ vs Whites to receive tPA

Hispanics 25% ↓ vs Whites to receive tPA

Women 6% ↓ vs Men to receive tPA

Private insurance 29% ↑ more likely to receive tPA vs Medicare

http://newsroom.heart.org/news/many-stroke-patients-do-not-receive-life-saving-therapy

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Lexicon of Acute Ischemic Stroke

Severity – NIHSS

Timing – history

Co-morbidity and resource implications

Outcome - modified Rankin Scale

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National Institutes of Health Stroke Scale

Score = 0 No stroke
Score = 1-4 Minor stroke
Score = 5-15 Moderate stroke
Score = 15-20 Moderate to severe stroke
Score = 21-42 Severe stroke

National Institutes of Health Stroke Scale score	
1a. Level of consciousness	0 = Alert; keenly responsive 1 = Not alert, but arousable by minor stimulation 2 = Not alert; requires repeated stimulation 3 = Unresponsive or responds only with reflex
1b. Level of consciousness questions: What is the month? What is your age?	0 = Answers two questions correctly 1 = Answers one question correctly 2 = Answers neither question correctly
1c. Level of consciousness commands: Open and close your eyes. Grip and release your hand.	0 = Performs both tasks correctly 1 = Performs one task correctly 2 = Performs neither task correctly
2. Best gaze	0 = Normal 1 = Partial gaze palsy 2 = Forced deviation
3. Visual	0 = No visual loss 1 = Partial hemianopia 2 = Complete hemianopia 3 = Bilateral hemianopia
4. Facial palsy	0 = Normal symmetric movements 1 = Minor paralysis 2 = Partial paralysis 3 = Complete paralysis of one or both sides
5. Motor arm 5a. Left arm 5b. Right arm	0 = No drift 1 = Drift 2 = Some effort against gravity 3 = No effort against gravity; limb falls 4 = No movement
6. Motor leg 6a. Left leg 6b. Right leg	0 = No drift 1 = Drift 2 = Some effort against gravity 3 = No effort against gravity 4 = No movement
7. Limb ataxia	0 = Absent 1 = Present in one limb 2 = Present in two limbs
8. Sensory	0 = Normal; no sensory loss 1 = Mild-to-moderate sensory loss 2 = Severe to total sensory loss
9. Best language	0 = No aphasia; normal 1 = Mild to moderate aphasia 2 = Severe aphasia 3 = Mute, global aphasia
10. Dysarthria	0 = Normal 1 = Mild to moderate dysarthria 2 = Severe dysarthria
11. Extinction and inattention	0 = No abnormality 1 = Visual, tactile, auditory, spatial, or personal inattention 2 = Profound hemi-inattention or extinction
Total score = 0–42.	

ALiEM Academic Life in Emergency Medicine

10 minute time burden

0 – 42 score

>15 = bad

>20 = very bad

Treatment threshold based on likely impact rather than an absolute number

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MODIFIED RANKIN SCALE (MRS)

Patient Name: _____

Rater Name: _____

Date: _____

Score	Description
0	No symptoms at all
1	No significant disability despite symptoms; able to carry out all usual duties and activities
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Dead

TOTAL (0–6): _____

Rankin J. "Cerebral vascular accidents in patients over the age of 60."
Scott Med J 1957;2:200-15

Bonita R, Beaglehole R. "Modification of Rankin Scale: Recovery of motor function after stroke."
Stroke **1988 Dec;19(12):1497-1500**

Van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J. "Interobserver agreement for the assessment o handicap in stroke patients."
Stroke **1988;19(5):604-7**

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History of Neuro-intervention for Acute Ischemic Stroke

Systemic IV tPA - 1995

Then targeted intra-arterial tPA - 1998

Thrombectomy devices invented and developed – 2004 onwards

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The beginning: Thrombolysis

IV r-tPA 0.9 mg/kg – up to 4.5 hours post onset

259/787 good outcome versus 176/762

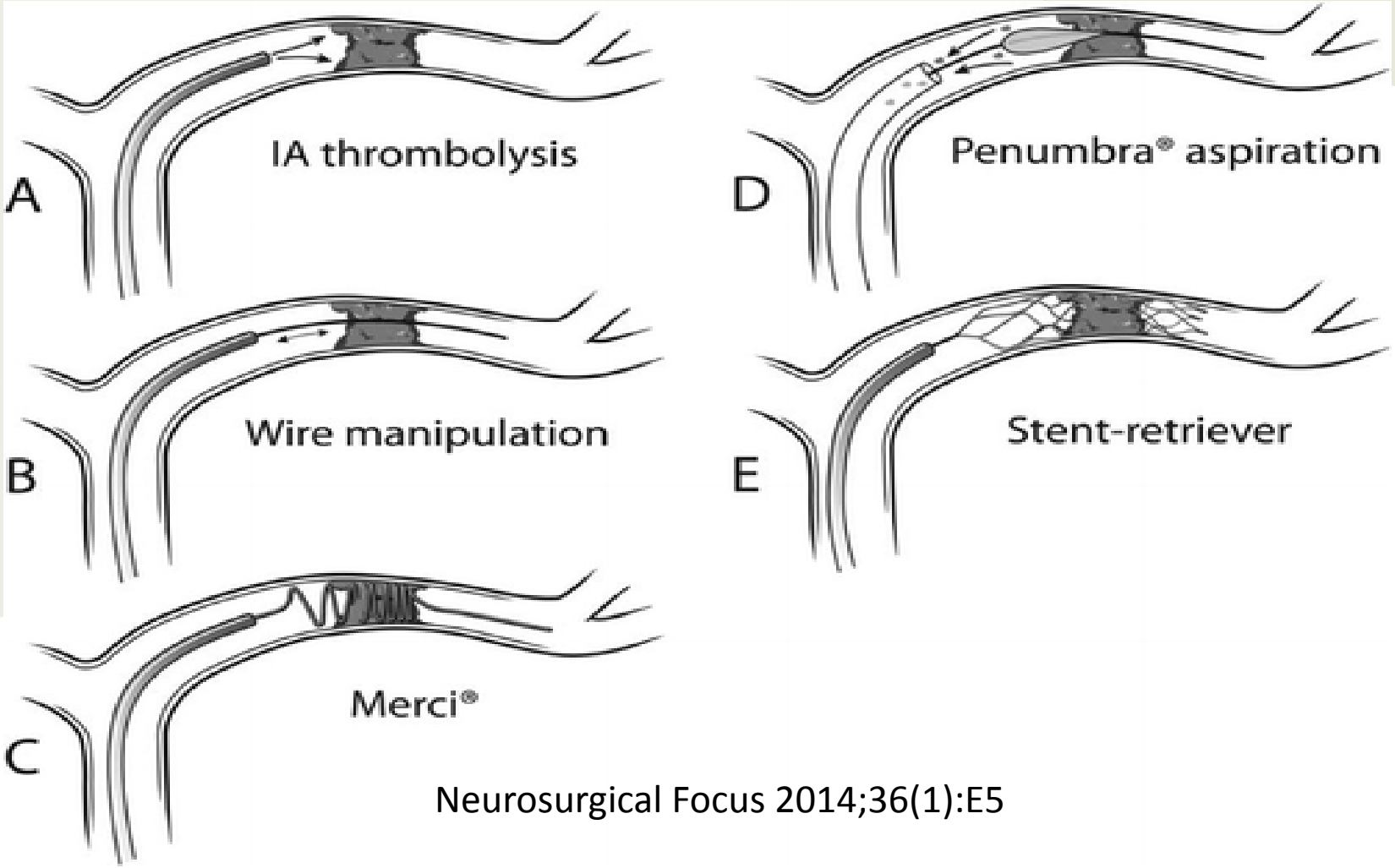
32.9% versus 23.1%

Number Needed to Treat (NNT) 5 at <90 minutes

NNT 9 at 3 to 4.5 hours

Davis SM et al. Effects of alteplase beyond 3 h after stroke in the Echoplanar Imaging Thrombolytic Evaluation Trial (EPITHET): a placebo-controlled randomised trial. Lancet Neurol. 2008 Apr;7(4):299-309.

Evolution of endovascular thrombolysis techniques



Neurosurgical Focus 2014;36(1):E5

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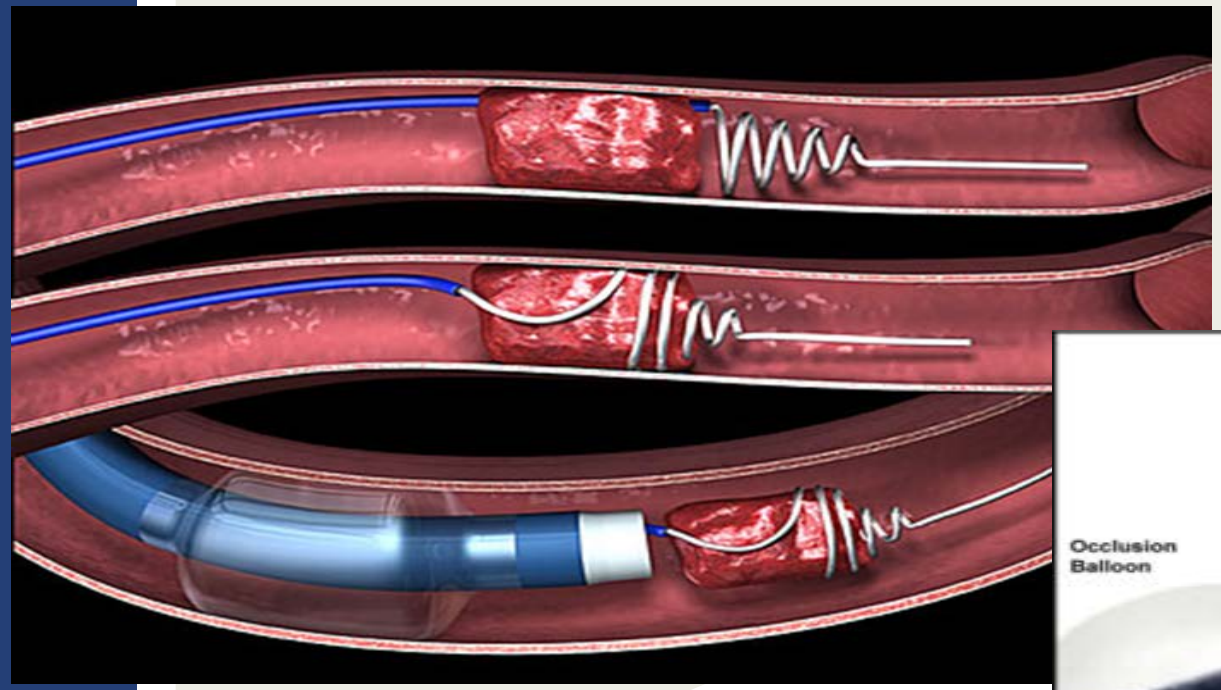
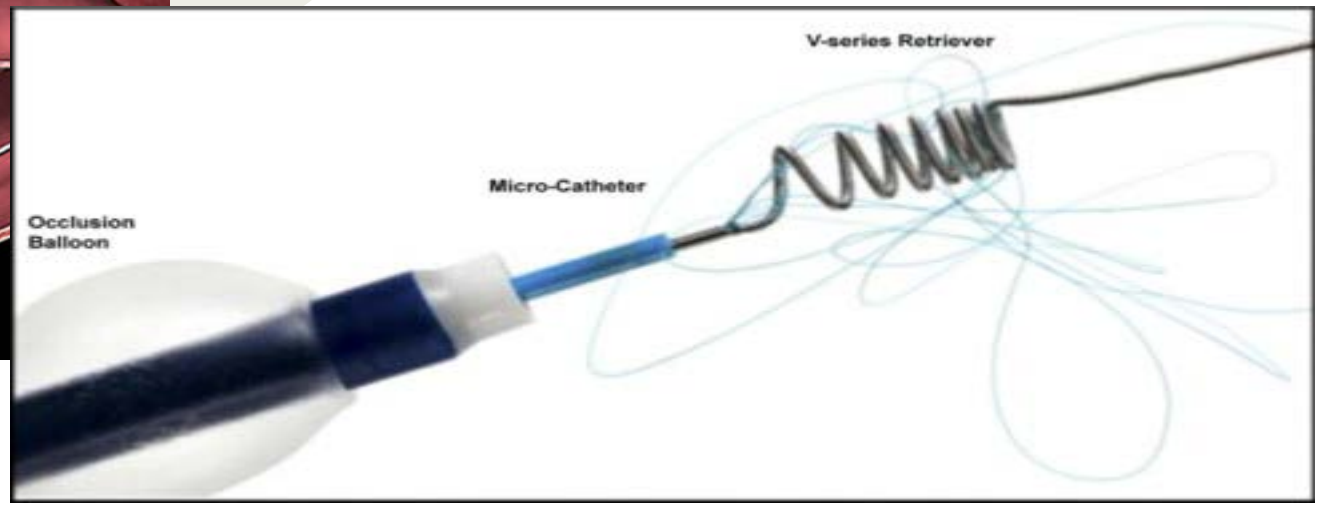
MERCI Device - 2004





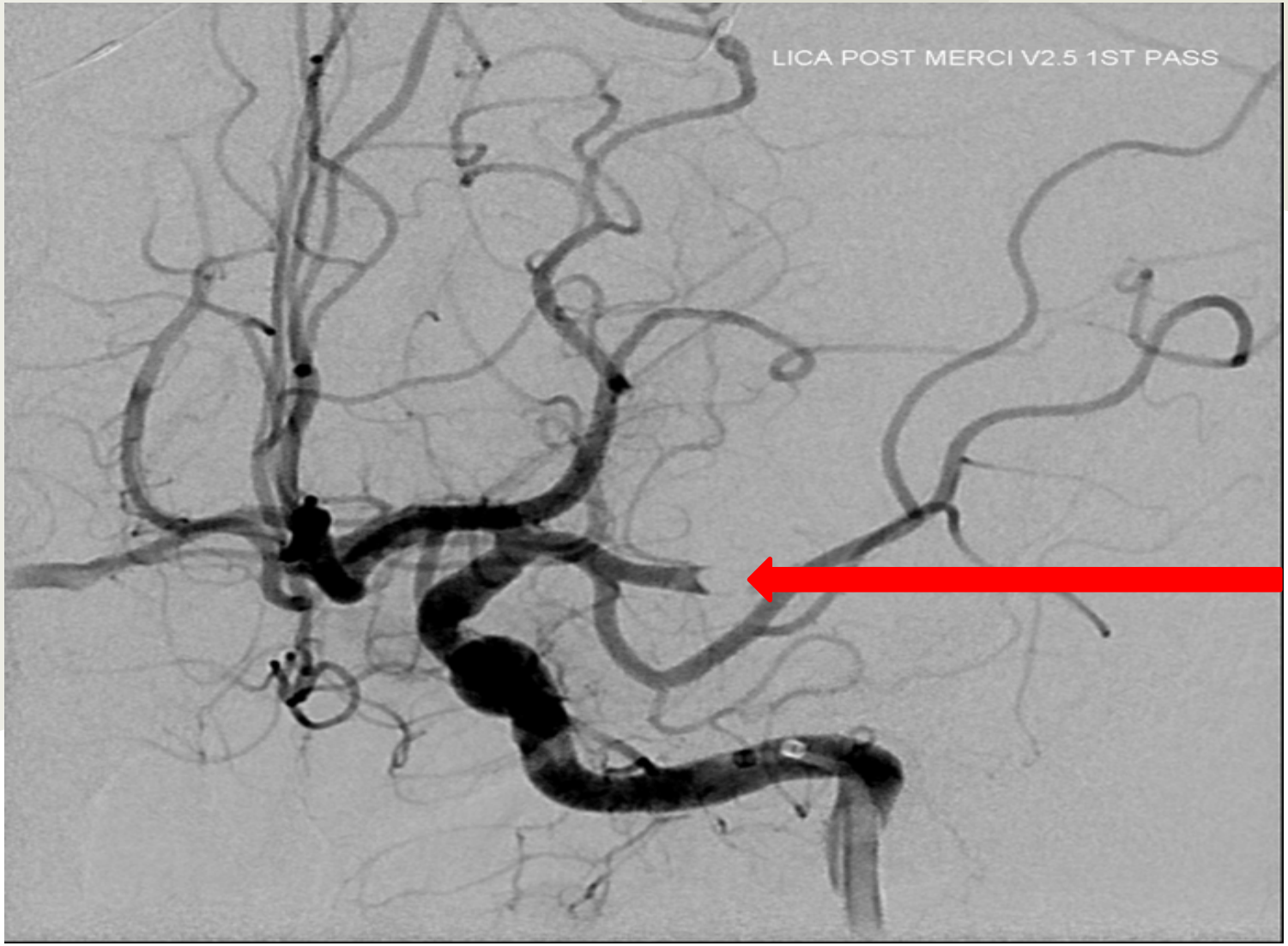
Mechanical Embolus Removal in Cerebral Ischemia

46% success at opening vessel

Acute M1 occlusion

Courtesy of Dr. Aditya Pandey

M1 Occlusion

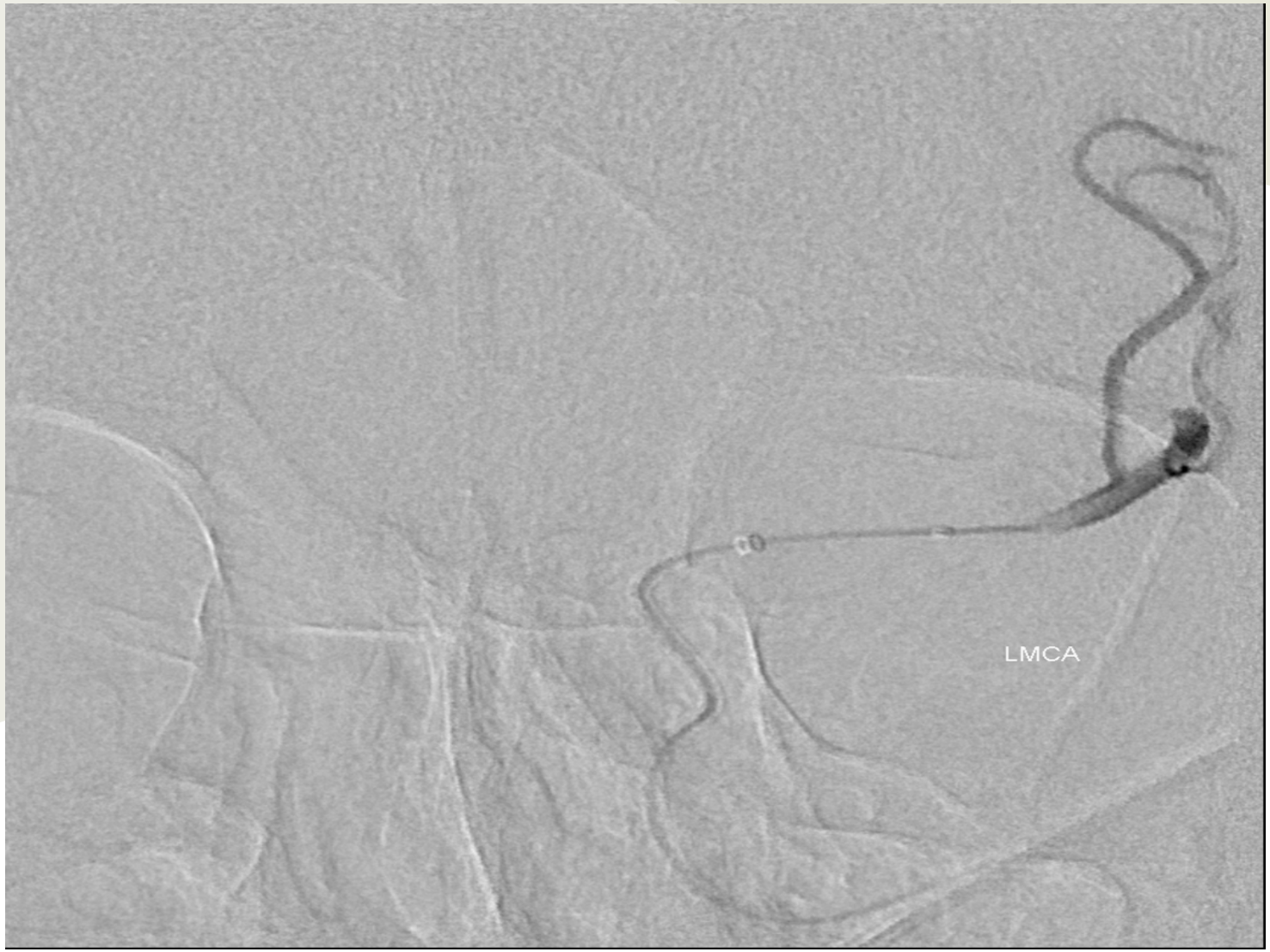


Courtesy of Dr. Aditya Pandey

Catheter advanced past clot

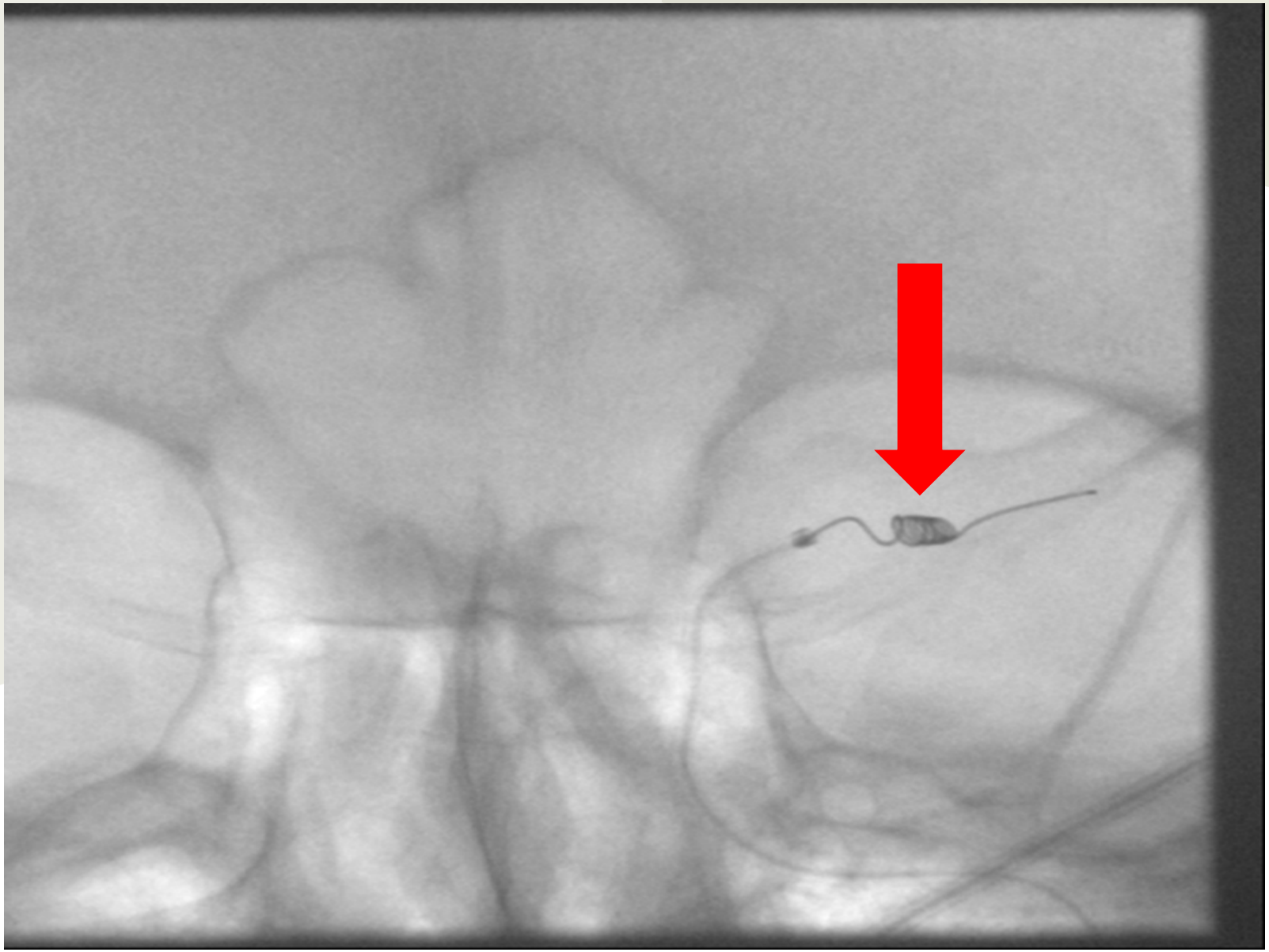
Courtesy of Dr. Aditya Pandey

Injection past clot



Courtesy of Dr. Aditya Pandey

MERCI retrieval catheter in place



Courtesy of Dr. Aditya Pandey

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Recanalization of middle cerebral artery

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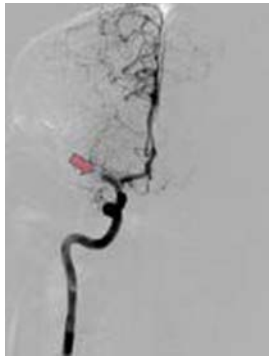
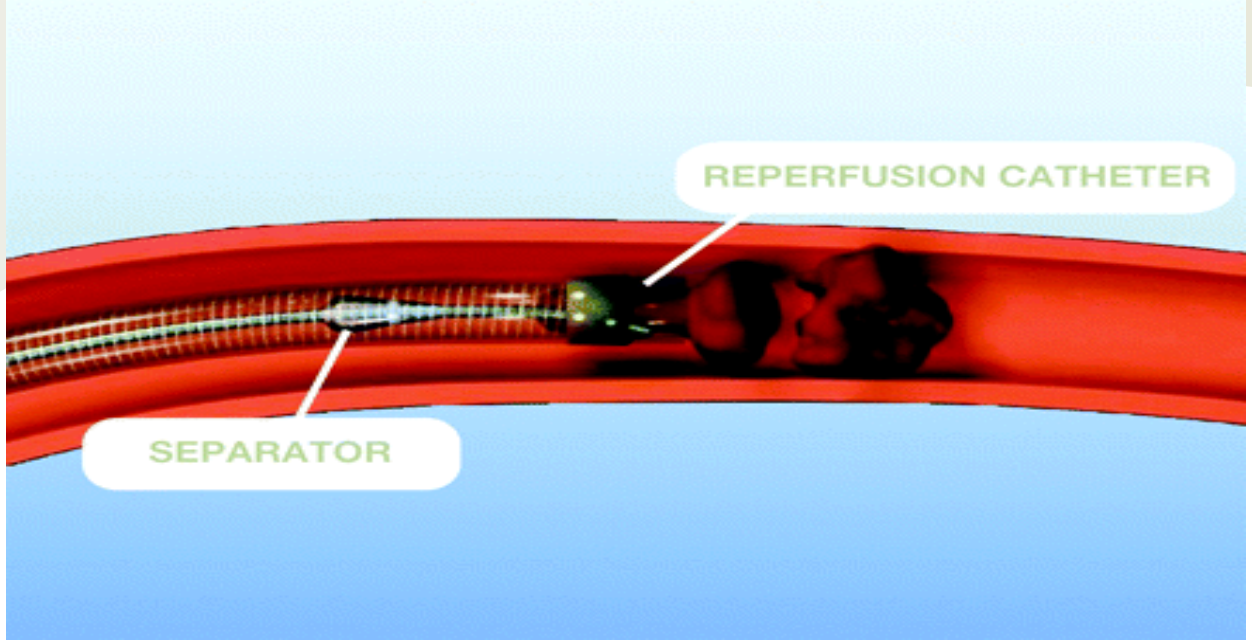
TICI Score (Thrombectomy In Cerebral Infarction)

0: No perfusion
1: Perfusion past the initial obstruction but limited distal branch filling with little or slow distal perfusion
2a: Perfusion of less than half of the vascular distribution of the occluded artery
2b: Perfusion of half or greater of the vascular distribution of the occluded artery
3: Full perfusion with filling of all distal branches



PENUMBRA - 2007

Penumbra Max System



Penumbra Aspiration catheter

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PENUMBRA - Evidence

The Penumbra Pivotal Stroke Trial

Safety and Effectiveness of a New Generation of Mechanical Devices for Clot Removal in Intracranial Large Vessel Occlusive Disease

The Penumbra Pivotal Stroke Trial Investigators

Background and Purpose—The purpose of this clinical evaluation was to assess the safety and effectiveness of the Penumbra System in the revascularization of patients presenting with acute ischemic stroke secondary to intracranial large vessel occlusive disease.

Methods—In this prospective, multicenter, single-arm study, 125 patients with neurological deficits as defined by a National Institutes of Health Stroke Scale score ≥8, presented within 8 hours of symptom onset, and an angiographic occlusion (Thrombolysis In Myocardial Infarction [TIMI] Grade 0 or 1) of a treatable large intracranial vessel were enrolled. Patients who presented within 3 hours from symptom onset had to be ineligible or refractory to recombinant tissue plasminogen activator therapy. All patients were followed clinically for 90 days postprocedure.

Results—A total of 125 target vessels in 125 patients were treated by the Penumbra System. Postprocedure, 81.6% of the treated vessels were successfully revascularized to TIMI 2 to 3. There were 18 procedural events reported in 16 patients (12.8%), 3 patients (2.4%) had events that were considered serious. A total of 35 patients (28%) were found to have intracranial hemorrhage on 24-hour CT of which 14 (11.2%) were symptomatic. All cause mortality was 32.8% at 90 days with 25% of the patients achieving a modified Rankin Scale score of ≤2.

Conclusions—These results suggest the Penumbra System allows safe and effective revascularization in patients experiencing ischemic stroke secondary to large vessel occlusive disease who present within 8 hours from symptom onset. (***Stroke*. 2009;40:2761-2768.**)

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2013 – not a great year for NIR

Interventional Management of Stroke (IMS III)

Mechanical Retrieval and Canalization of Stroke Clots Using Embolectomy (MR RESCUE)

Synthesis Expansion: A Randomized Controlled Trial on Intra-Arterial Versus Intravenous Thrombolysis in Acute Ischemic Stroke (SYNTHESIS Expansion) Mayo Clin Proc 88(10):1056

ALL 3 SUGGESTED THROMBECTOMY WAS NOT SUPERIOR TO THROMBOLYSIS

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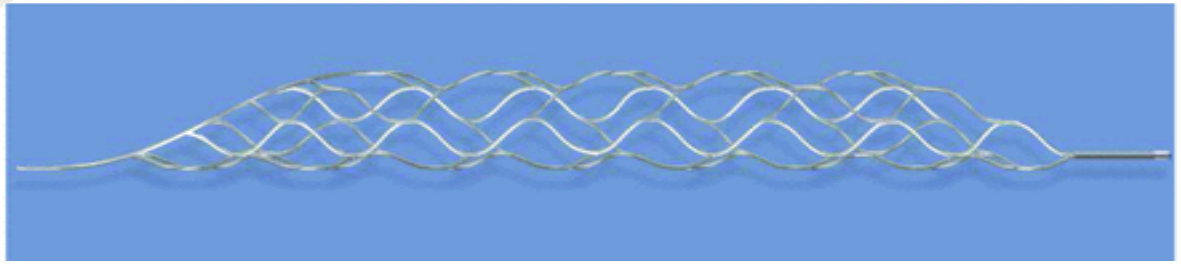
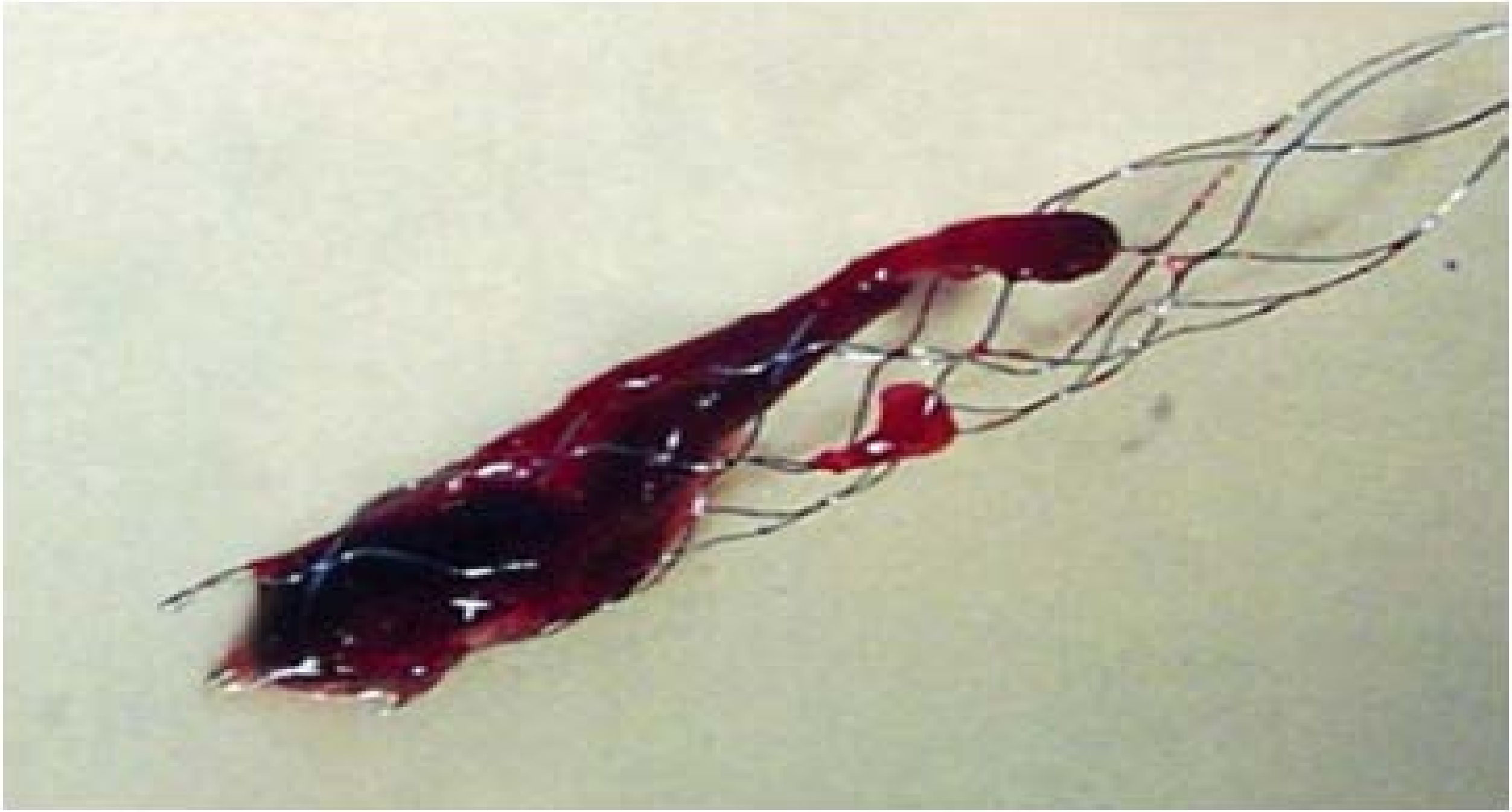
Stentrievers

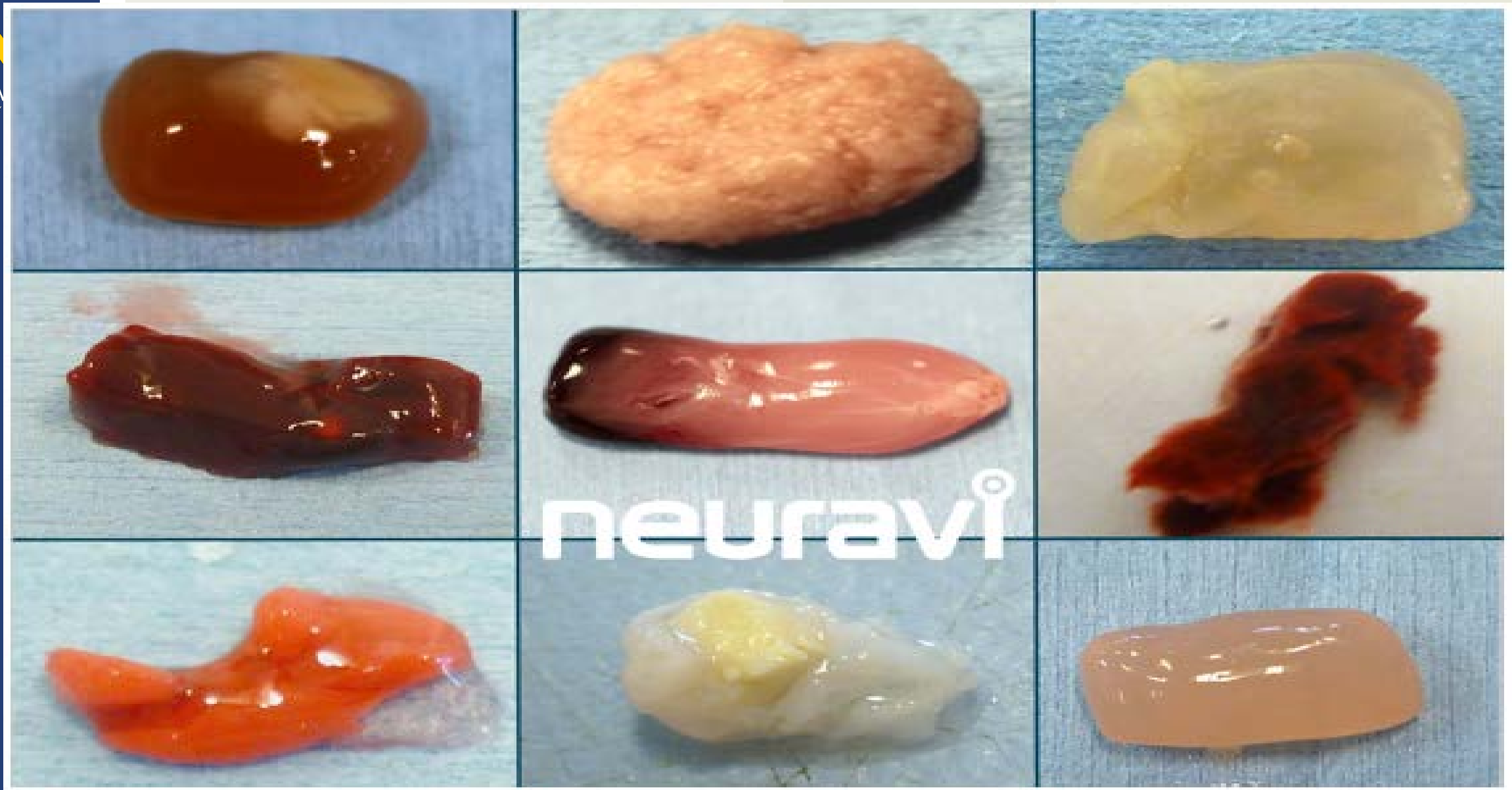
Solitaire™ FR - 2012

The Incredibles Disney ©



Trevo® device - 2012





Evans MRB, *et al*. *Pract Neurol* 2017;**17**:252–265. doi:10.1136/practneurol-2017-001685

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MR CLEAN, SWIFTPRIME & REVASCAT 2015

2015: 1st time Thrombectomy is superior to Tpa

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The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JANUARY 1, 2015 VOL. 372 NO. 1

A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke

O.A. Berkhemer, P.S. Fransen, D. Beumer, L.A. van den Berg, H.F. Lingsma, A.J. Yoo, W.J. Schonewille, J.A. Vos, P.J. Nederkoorn, M.J.H. Wermer, M.A.A. van Walderveen, J. Staals, J. Hofmeijer, J.A. van Oostayen, G.J. Lycklama à Nijeholt, J. Boiten, P.A. Brouwer, B.J. Emmer, S.F. de Bruijn, L.C. van Dijk, L.J. Kappelle, R.H. Lo, E.J. van Dijk, J. de Vries, P.J.M. de Kort, W.J.J. van Rooij, J.S.P. van den Berg, B.A.A.M. van Hasselt, L.A.M. Aerden, R.J. Dallinga, M.C. Visser, J.C. Bot, P.C. Vroomen, O. Eshghi, T.H.C.M. Schreuder, R.J.J. Heijboer, K. Keizer, A.V. Tielbeek, H.M. den Hertog, D.G. Gerrits, R.M. van den Berg-Vos, G.B. Karas, E.W. Steyerberg, H.Z. Flach, H.A. Marquering, M.E.S. Sprengers, S.F.M. Jenniskens, L.F.M. Beenen, R. van den Berg, P.J. Koudstaal, W.H. van Zwam, Y.B.W.E.M. Roos, A. van der Lugt, R.J. van Oostenbrugge, C.B.L.M. Majoie, and D.W.J. Dippel, for the MR CLEAN Investigators*

1 in 3 can live independently versus 1 in 5

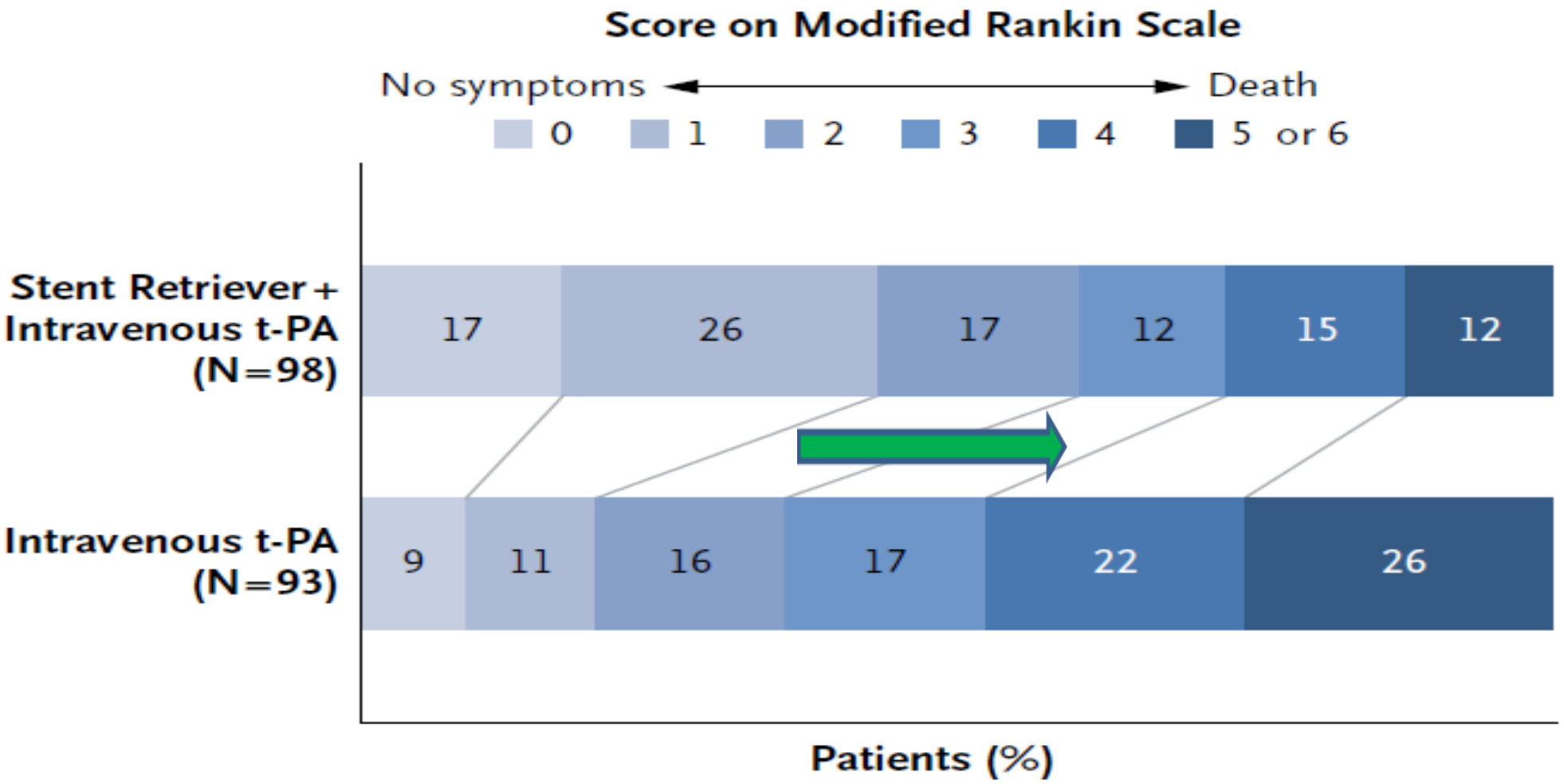
The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JUNE 11, 2015 VOL. 372 NO. 24

Stent-Retriever Thrombectomy after Intravenous t-PA vs. t-PA Alone in Stroke

Jeffrey L. Saver, M.D., Mayank Goyal, M.D., Alain Bonafe, M.D., Hans-Christoph Diener, M.D., Ph.D., Elad I. Levy, M.D., Vitor M. Pereira, M.D., Gregory W. Albers, M.D., Christophe Cognard, M.D., David J. Cohen, M.D., Werner Hacke, M.D., Ph.D., Olav Jansen, M.D., Ph.D., Tudor G. Jovin, M.D., Heinrich P. Mattle, M.D., Raul G. Nogueira, M.D., Adnan H. Siddiqui, M.D., Ph.D., Dileep R. Yavagal, M.D., Blaise W. Baxter, M.D., Thomas G. Devlin, M.D., Ph.D., Demetrius K. Lopes, M.D., Vivek K. Reddy, M.D., Richard du Mesnil de Rochemont, M.D., Oliver C. Singer, M.D., and Reza Jahan, M.D., for the SWIFT PRIME Investigators*

NEJM 2015; 372: 2285 - 95



59% independent versus 33%

NEJM 2015; 372: 2285 - 95

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ORIGINAL ARTICLE

Thrombectomy within 8 Hours after Symptom Onset in Ischemic Stroke

T.G. Jovin, A. Chamorro, E. Cobo, M.A. de Miquel, C.A. Molina, A. Rovira, L. San Román, J. Serena, S. Abilleira, M. Ribó, M. Millán, X. Urra, P. Cardona, E. López-Cancio, A. Tomasello, C. Castaño, J. Blasco, L. Aja, L. Dorado, H. Quesada, M. Rubiera, M. Hernández-Pérez, M. Goyal, A.M. Demchuk, R. von Kummer, M. Gallofré, and A. Dávalos, for the REVASCAT Trial Investigators*

NEJM 2015; 372: 2296 - 306

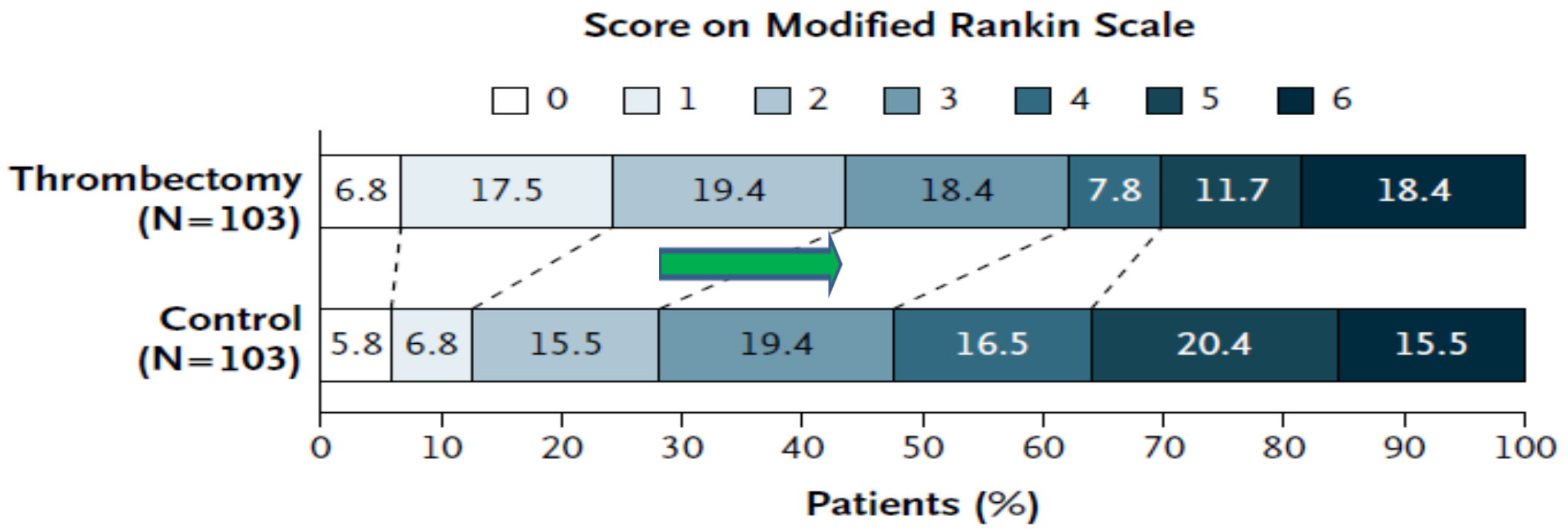

Figure 1. Distribution of Functional Scores at 90 Days (Intention-to-Treat Population).

45% independent versus 29%

NEJM 2015; 372: 2296 - 306

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AHA/ASA guidelines 2015

2015 AHA/ASA Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment

A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association

The American Academy of Neurology affirms the value of this guideline as an educational tool for neurologists.

Endorsed by the American Association of Neurological Surgeons (AANS); Congress of Neurological Surgeons (CNS); AANS/CNS Cerebrovascular Section; American Society of Neuroradiology; and Society of Vascular and Interventional Neurology

2015: WE SHOULD BE PERFORMING THROMBECTOMY ON STROKE PATIENTS WITHIN 6 HOURS OF SYMPTOMS

. Patients should receive endovascular therapy with a stent retriever if they meet all the following criteria (*Class I; Level of Evidence A*). New recommendation:

(a) prestroke mRS score 0 to 1,

(b) acute ischemic stroke receiving intravenous t-PA within 4.5 hours of onset according to guidelines from professional medical societies,

(c) causative occlusion of the internal carotid artery or proximal MCA (M1),

(d) age ≥18 years,

(e) NIHSS score of ≥6,

(f) ASPECTS of ≥6, and

(g) treatment can be initiated (groin puncture) within 6 hours of symptom onset

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Is mechanical thrombectomy cost effective?

One study[76] modelled the hyperacute management of stroke using intravenous thrombolysis and mechanical thrombectomy in the UK (compared with intravenous thrombolysis alone) using Markov simulations of estimated lifetime costs and quality-adjusted life years (QALYs) based on pooled outcome data of three randomised controlled trials. This study found an incremental cost per QALY gained of mechanical thrombectomy over a 20 year period of £11 651 (£7061). A more recent study that modelled the intervention in a US setting found an incremental cost-effectiveness ratio for endovascular treatment (compared with standard care) of $3110/QALY (about £2500 per QALY) in all simulations, although cost effectiveness was lower in more distal (M2) occlusion and with established ischaemic injury (ASPECTS score ≤5). Both

YES!

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Current issues in 2018

1. Making thrombectomy happen

2. Mode of Anesthesia for thrombectomy

3. Service and workforce implications as the indications for thrombectomy expand

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Time is brain

Practicalities dominate proceedings

Protocols may help flow and communication

Larger organizations may have larger protocols!

Role of automatic paging and regular drills

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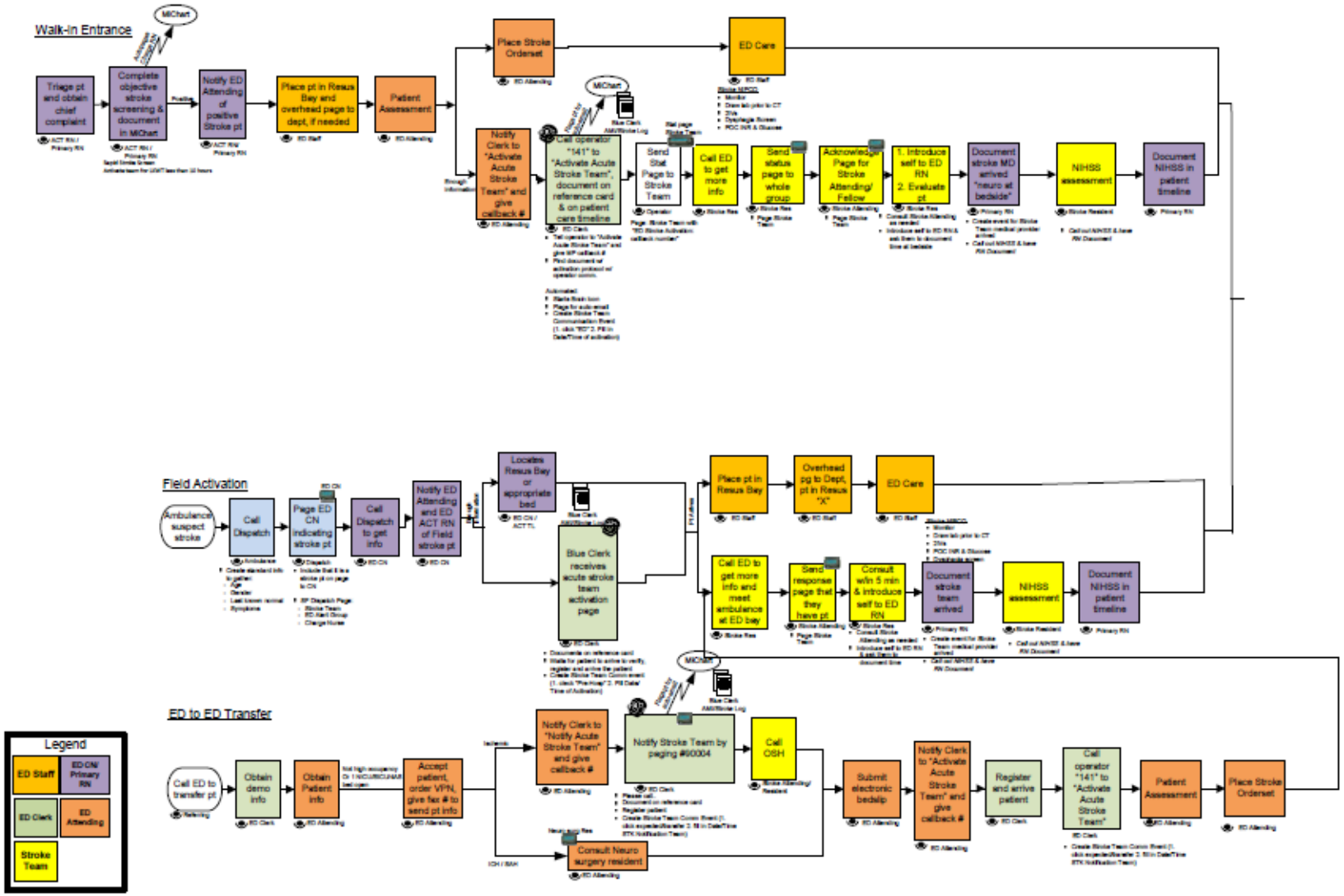
ED Arrival Acute Stroke Patient Flowchart

Stroke Team Page Group
- Stroke Res
- Stroke Attending
- Neuro Reading Room CT
- Rest of Stroke Team
- 4A Charge RN
- NICU Attending
- *Procedure Attending (on-call)
- *ABCC-PFC
- *NICU Charge RN

IR Activation Group
- NIR Tech
- IR RN
- Anesthesia
- Neuro Surg Res
- NIR Procedure Attending (on-call)
- IR Nurse Manager
- IR Nurse Supervisor
- NIR/NIS Fellow

ED Alert Group
- ED Lead/Charge Clerk
- ED WEB Expected
- ED Attending-Main Maize Team
- ED Attending-Main Blue Team
- ED Alert
- ED Charge Nurse



Last Updated: 10/31/2016
Last Reviewed: 03/31/2016

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Evidence of Michigan Medicine tPA protocol success

2014 & 2015

>50% of patients were treated within 45 minutes

>75% of patients were treated within 60 minutes

Last 18 months 100%

State of Michigan <60 minute average is 65%

National average < 60 minute average 86.5%

http://www.uofmhealth.org/conditions-treatments/brain-neurological-conditions/stroke

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How should I anesthetize a stroke patient?

No sedation?

MAC?

General anesthetic?

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Why should we have to anesthetize a stroke patient?

"We are never there for a cardiac cath!"

Risk of airway loss and need for urgent intubation

Risk of catastrophic complications

Because the brain is more important than the heart

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Anesthesia for mechanical thrombectomy

Traditionally used “there there” anesthesia

Perhaps MAC at most

Allows for immediate assessment of neurology

“GA has been associated with worse outcomes”

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Anesthetic Management and Outcome in Patients during Endovascular Therapy for Acute Stroke.

Anesthesiology 2012;116(2):396

Retrospective review: 48 GA/48 LA patients

Primary outcome Rankin Score of 0-2

Independent predictors of good outcome:

- Local anesthesia
- SBP > 140 mmHg
- Low baseline NHSS

Impact of General Anesthesia on Safety and Outcomes in the Endovascular Arm of Interventional Management of Stroke (IMS) III Trial

by Alex Abou-Chebl, Sharon D. Yeatts, Bernard Yan, Kevin Cockroft, Mayank Goyal, Tudor Jovin, Pooja Khatri, Phillip Meyers, Judith Spilker, Rebecca Sugg, Katja E. Wartenberg, Tom Tomsick, Joe Broderick, and Michael D. Hill

Stroke
Volume 46(8):2142-2148
July 27, 2015

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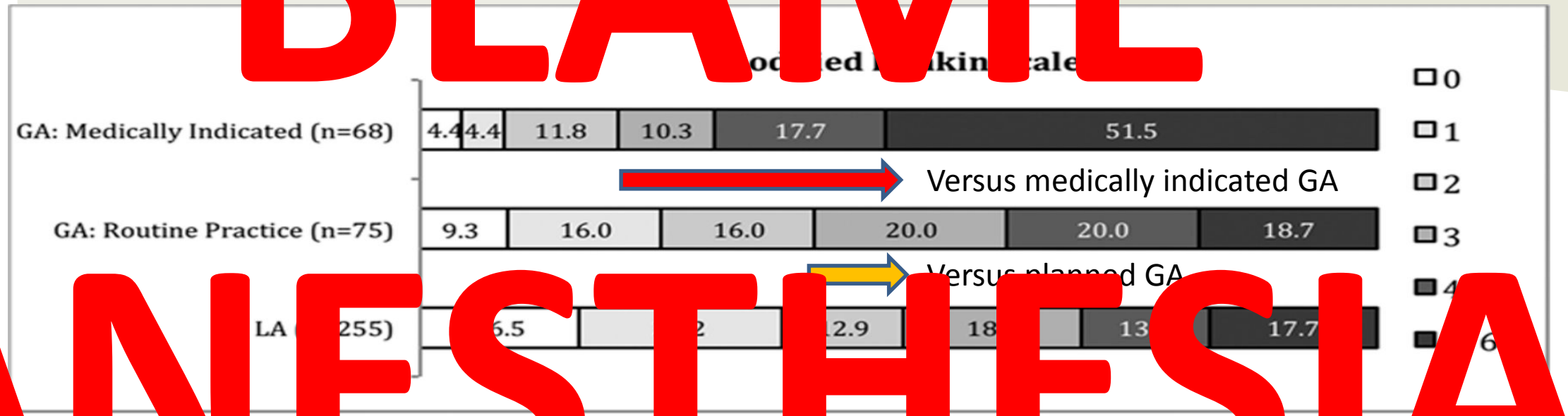
BLAME ANESTHESIA

Distribution of modified Rankin Scale scores of disability at 3 months.



Alex Abou-Chebl et al. Stroke. 2015;46:2142-2148

American Heart Association

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Anesthesia for Embolectomy - 2015

Recommendation: Embolectomy procedures should be performed with conscious sedation or MAC whenever possible. GETA should be reserved for patients who are not considered able to protect their airways for the procedure while supine or who are too uncooperative for the procedure to be performed safely (AHA Class IIb, Level of Evidence C).

McTaggart J Neurointervent Surg 2015

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Questions regarding GA being worse

Biased patient selection?

Greater hypotension associated with GA?

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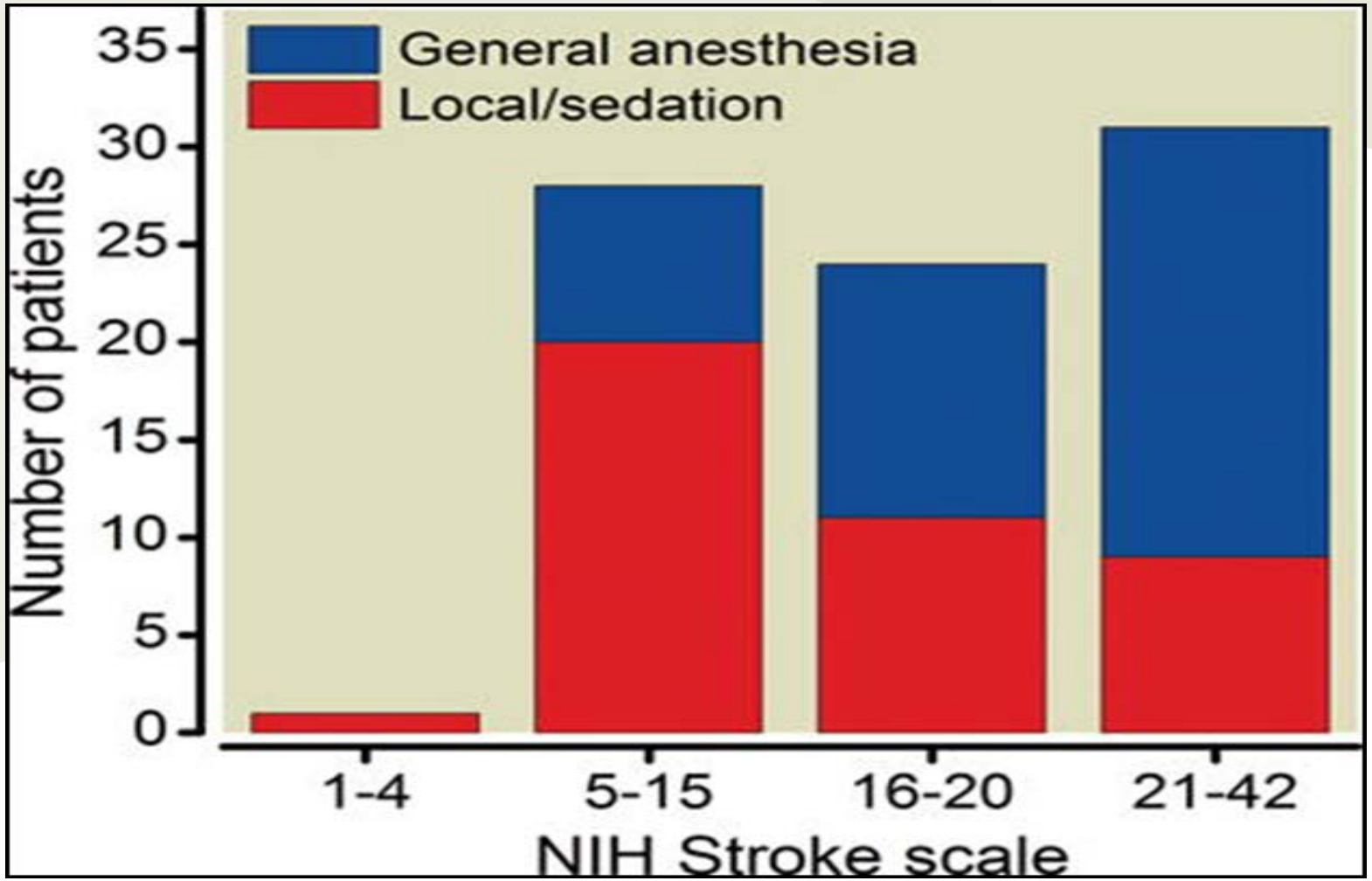
Baseline NHSS and anesthetic technique



Stroke patients undergoing GA are more sick

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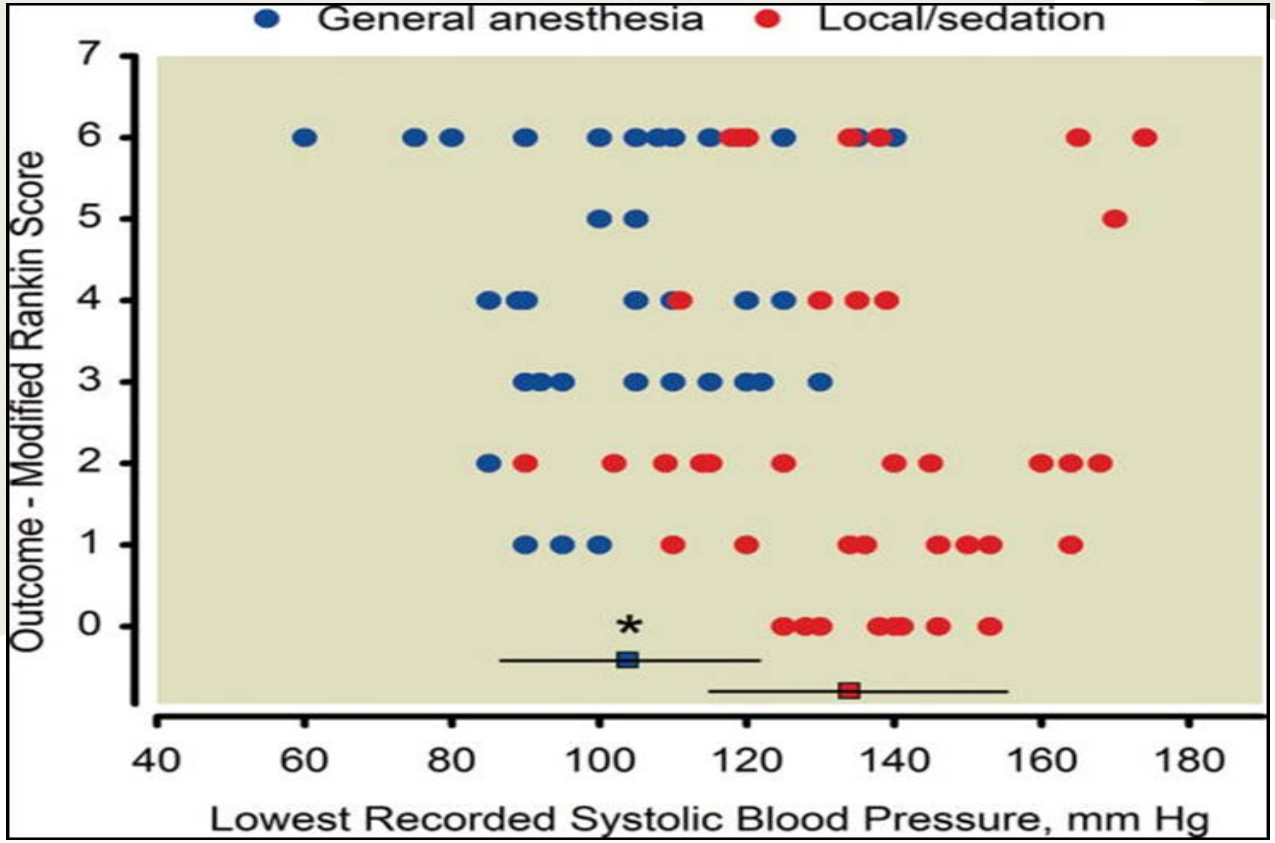
Anesthetic technique, BP and Outcome



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Advantages of General Anesthesia?

Paralyzed patient – easier surgical palette

“Neuroprotection”

Airway protection

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Advantages of Conscious Sedation?

More rapid start

More robust blood pressure

Immediate clinical exam

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3rd European Stroke Organisation Conference (ESOC) 2017

2017 NEW EVIDENCE FOR ANESTHESIA!

ANSTROKE

GOLIATH

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AnStroke

General Anesthesia Versus Conscious Sedation for Endovascular Treatment of Acute Ischemic Stroke: The AnStroke Trial (Anesthesia During Stroke)

Pia Löwhagen Hendén, Alexandros Rentzos, Jan-Erik Karlsson, Lars Rosengren, Birgitta Leiram, Henrik Sundeman, Dennis Dunker, Kunigunde Schnabel, Gunnar Wikholm, Mikael Hellström and Sven-Erik Ricksten

Table 1. Patient Characteristics

	GA	CS
	n=45	n=45
Age, y	73 (65–80)	72 (66–82)
Male sex, n (%)	26 (58)	23 (51)
Comorbidities, n (%)		
Hypertension	27 (60)	22 (49)
Atrial fibrillation	18 (40)	18 (40)
Ischemic heart disease	9 (20)	5 (11)
Diabetes mellitus	9 (20)	7 (16)
Smoker	4 (9)	8 (18)
Hyperlipidemia	5 (11)	7 (16)
Premorbid modified Rankin Scale score ≤2, n (%)	44 (98)	44 (98)

CS indicates conscious sedation; and GA, general anesthesia.

Table 2. Stroke Characteristics

	GA	CS
	n=45	n=45
NIHSS score	20 (15.5–23)	17 (14–20.5)
Intravenous thrombolysis treatment, n (%)	33 (73.3)	36 (80)
Occlusion site, n (%)		
Carotid-T occlusion	15 (33)	9 (20)
Distal ICA	0 (0)	1 (2.2)
First segment of MCA (M1)	26 (58)	26 (58)
First segment of MCA (M1)+distal branches (A2, A3, M2, and M3)	4 (9)	1 (2)
Second segment of MCA (M2)	0 (0)	8 (18)
Left hemisphere, n (%)	26 (58)	17 (38)
ASPECTS score, 1–10	10 (8–10)	10 (9–10)
Collateral circulation, 1–5	2 (1–4)	1 (1–3)

ASPECTS indicates Alberta Stroke Program Early CT score; CS, conscious sedation; GA, general anesthesia; ICA, internal carotid artery; MCA, middle cerebral artery; and NIHSS; National Institutes of Health Stroke Scale.

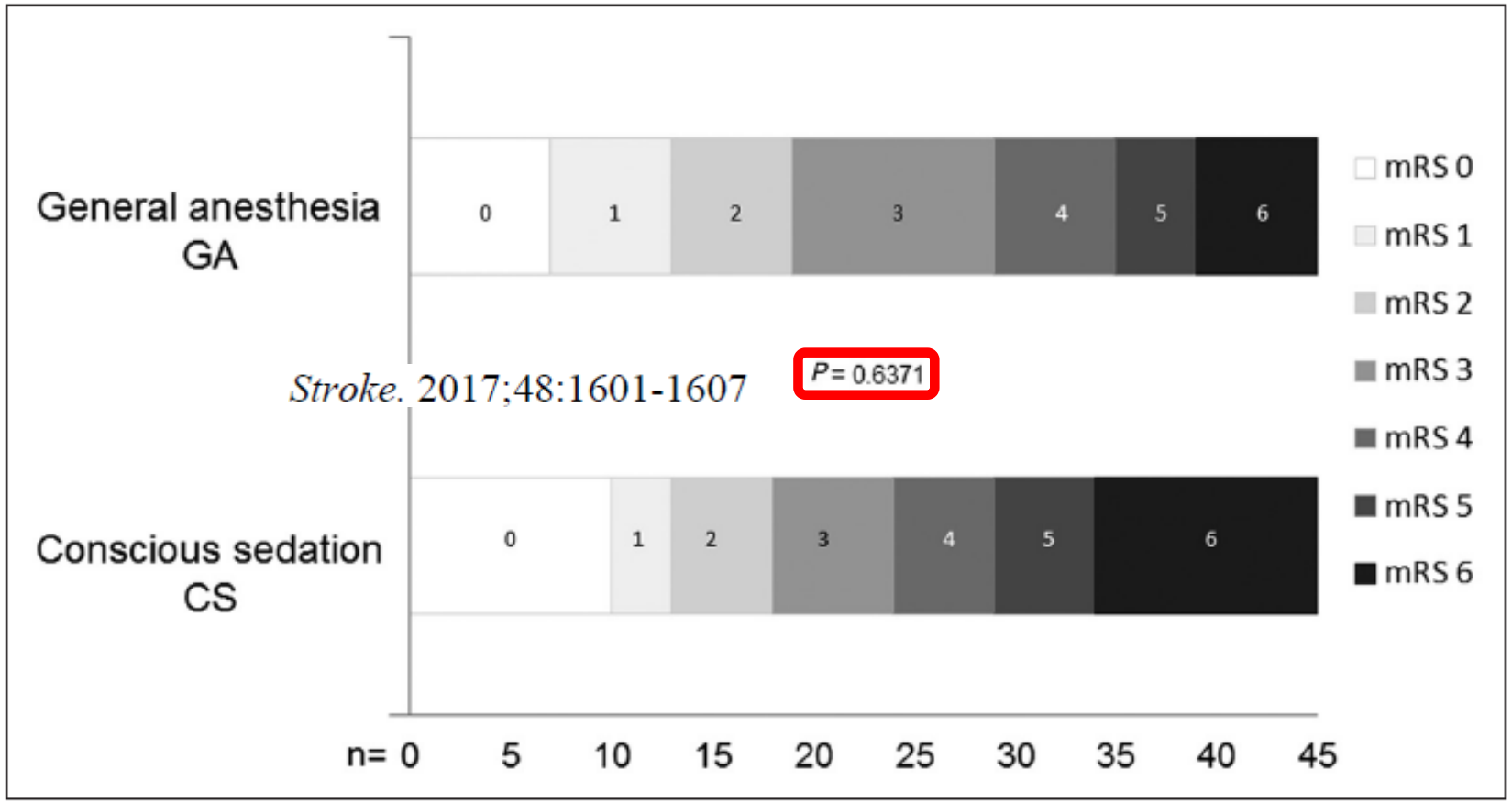
Göteborg

Stroke. 2017;48:1601-1607

AnStroke

General Anesthesia Versus Conscious Sedation for Endovascular Treatment of Acute Ischemic Stroke: The AnStroke Trial (Anesthesia During Stroke)

Pia Löwhagen Hendén, Alexandros Rentzos, Jan-Erik Karlsson, Lars Rosengren, Birgitta Leiram, Henrik Sundeman, Dennis Dunker, Kunigunde Schnabel, Gunnar Wikholm, Mikael Hellström and Sven-Erik Ricksten



Stroke. 2017;48:1601-1607

Figure 2. Neurological outcome expressed as modified Rankin Scale (mRS) score. GA indicates general anesthesia.

Conclusions—In endovascular treatment for acute ischemic stroke, no difference was found between general anesthesia and conscious sedation in neurological outcome 3 months after stroke.

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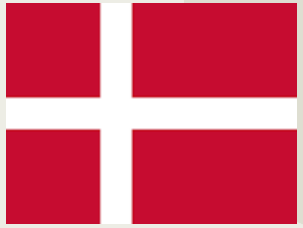
GOLIATH



Anesthetic strategy during endovascular therapy: General anesthesia or conscious sedation? (GOLIATH – General or Local Anesthesia in Intra Arterial Therapy) A single-center randomized trial

Claus Z Simonsen[1], Leif H Sørensen[2], Niels Juul[3], Søren P Johnsen[4], Albert J Yoo[5], Grethe Andersen[1] and Mads Rasmussen[3]

Aarhus. 65 GA, 63 MAC

GA = Propofol /remi vs. MAC Propofol / fentanyl

SBP>140 mmHg, MAP >70 mmHg targets

MAP drop >20% higher in GA group

Infarct GROWTH 8.2mls GA vs 19.4mls MAC (p 0.10)

Modified Rankin was better scores in GA group

Signal in favor of GA (starting infarct <70mls)

International Journal of Stroke
2016, Vol. 11(9) 1045–1052

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So GA is now OK for thrombectomy?

YES!

Patient factors more important than GA vs MAC

Local preference shapes practice

GA lengthens start by 9 minutes (p=0.0555)

BUT GA related with **faster revascularization** by 19 minutes (p=0.6572)

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AHA/ASA Guideline

2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

16. It is reasonable to select an anesthetic technique during endovascular therapy for AIS on the basis of individualized assessment of patient risk factors, technical performance of the procedure, and other clinical characteristics. Further randomized trial data are needed.	**IIa**	**B-R**

Conscious sedation (CS) was widely used in the recent endovascular trials (90.9% of ESCAPE, 63% of SWIFT PRIME) with no clear positive or negative impact on outcome. In MR CLEAN, post hoc analysis showed a 51% (95% CI, 31–86) decrease in treatment effect of general anesthesia (GA) compared with CS.[180] In THRACE, 51 of 67 patients receiving GA and 43 of 69 patients receiving CS achieved TICI 2b/3 (P=0.059) with no impact on outcome.[106] Thirty-five of 67 patients with GA and 36 of 74 with CS had mRS scores of 0 to 2 at 90 days. Although several retrospective studies suggest that GA produces worsening of functional outcomes, there are limited prospective randomized data. Two small (≤150 participants) single-center RCTs have compared GA with CS. Both failed to show superiority of either treatment for the primary clinical end point.[181,182] Until further data are available, either method of procedural sedation is reasonable.

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Workforce implications of an acute stroke thrombectomy service

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Increasing numbers of cases

Michigan 12 cases annually 2014

Michigan 58 cases in 2016

Michigan 68 cases in 2017; 75 stroke team activations

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Urgency and acuity of cases

Time expectations as part of stroke service

60 minutes "door to groin" target

(30 minutes for TpA for comparison)

Current Michigan Medicine metrics

OSH transfer 38 minutes arrival to arterial access

ED presentation 104 minutes arrival to arterial access

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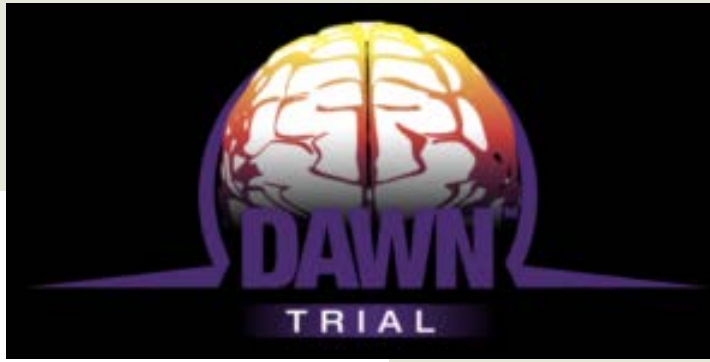
DAWN – WAKE UP STROKE



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct

R.G. Nogueira, A.P. Jadhav, D.C. Haussen, A. Bonafe, R.F. Budzik, P. Bhuva, D.R. Yavagal, M. Ribo, C. Cognard, R.A. Hanel, C.A. Sila, A.E. Hassan, M. Millan, E.I. Levy, P. Mitchell, M. Chen, J.D. English, Q.A. Shah, F.L. Silver, V.M. Pereira, B.P. Mehta, B.W. Baxter, M.G. Abraham, P. Cardona, E. Veznedaroglu, F.R. Hellinger, L. Feng, J.F. Kirmani, D.K. Lopes, B.T. Jankowitz, M.R. Frankel, V. Costalat, N.A. Vora, A.J. Yoo, A.M. Malik, A.J. Furlan, M. Rubiera, A. Aghaebrahim, J.-M. Olivot, W.G. Tekle, R. Shields, T. Graves, R.J. Lewis, W.S. Smith, D.S. Liebeskind, J.L. Saver, and T.G. Jovin, for the DAWN Trial Investigators*

DOI: 10.1056/NEJMoa1706442

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Table 2. Efficacy Outcomes.*

Outcome	Thrombectomy Group (N=107)	Control Group (N=99)	Absolute Difference (95% CI)†	Adjusted Difference (95% Credible Interval)‡	Posterior Probability of Superiority
Primary end points					
Score on utility-weighted modified Rankin scale at 90 days§	5.5±3.8	3.4±3.1	2.1 (1.2–3.1)	2.0 (1.1–3.0)	>0.999
Functional independence at 90 days — no. (%)¶	52 (49)	13 (13)	36 (24–47)	33 (21–44)	>0.999
				Risk Ratio (95% CI)	P Value
Secondary end points					
Early response — no. (%)	51 (48)	4 (1[illegible])	25 (16–[illegible])	[illegible]	<0.001**
Recanalization at 24 hr — no. (%)††	8[illegible] (77)	[illegible] (39)	40 (27–[illegible])	2[illegible]	0.001**
Change from baseline in infarct volume at 24 hr — ml††					0.003‡‡
Median	1	13			
Interquartile range	0–28	0–42			
Infarct volume at 24 hour — ml††					<0.001‡‡
Median	8	22			
Interquartile range	[illegible]–48	8–68			
Grade of 2b or 3 on mTICI scale — no. (%)§§	90 (84)	NA			

52%

independent vs

13%

Trevo® device

NIHSS 17 in both groups

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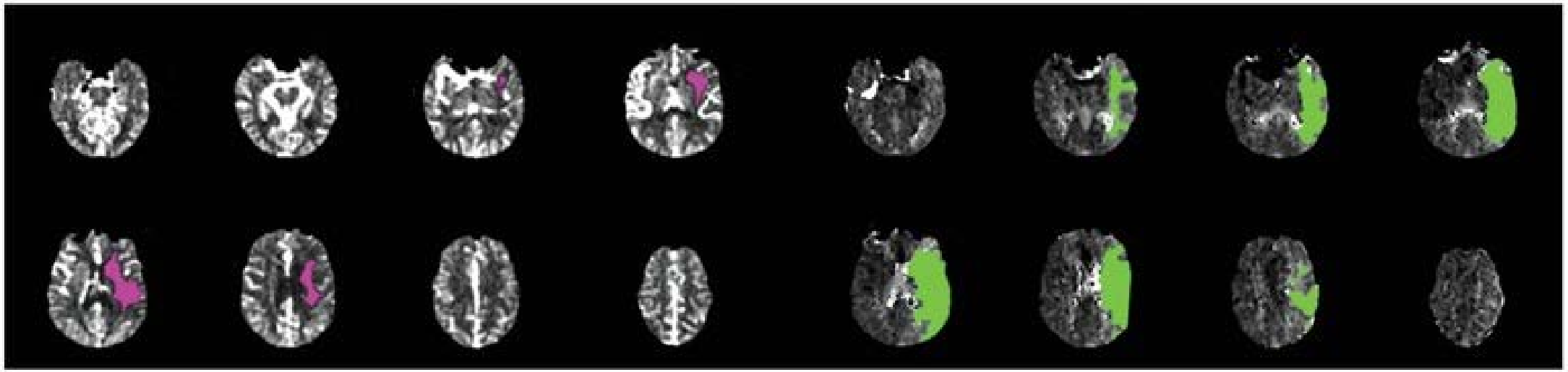
1/24/2018

defuse·3



Volume of Ischemic Core, 23 ml

Volume of Perfusion Lesion, 128 ml

Mismatch volume, 105 ml
Mismatch ratio, 5.6

38 US hospitals
Including Michigan Medicine
Diffusion mismatch, 6-24 hours post stroke >15mls penumbra, <70mls infarct

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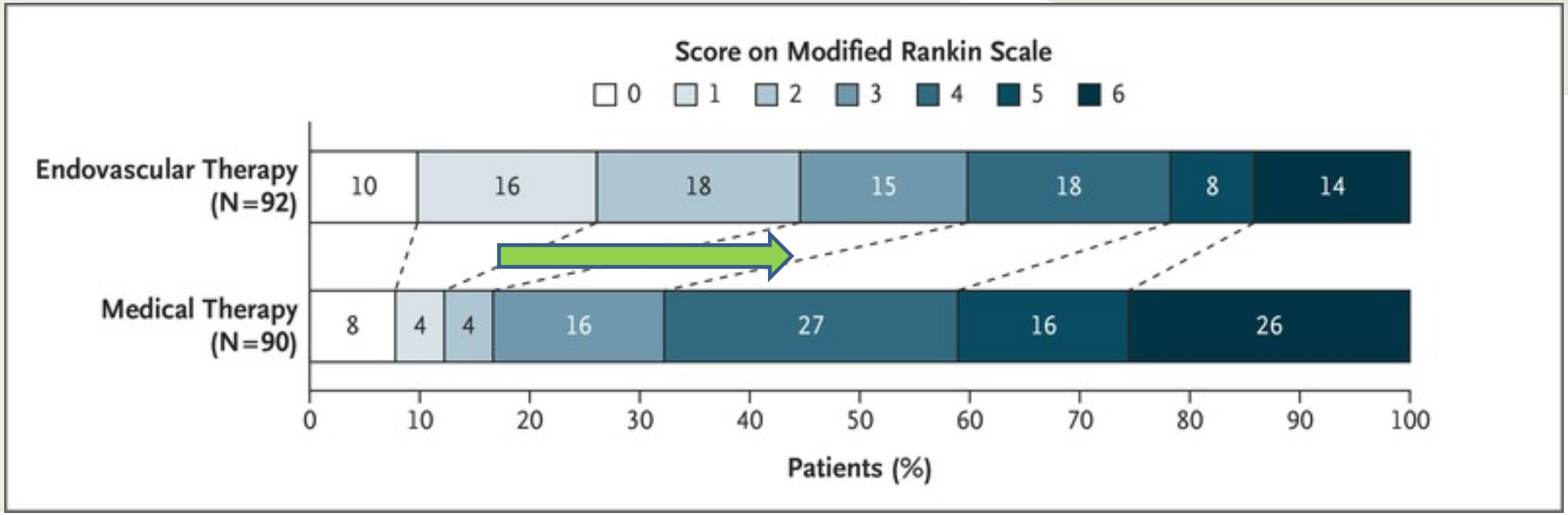
45% functional independence vs 17%



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1/24/2018

AHA/ASA Guideline

2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Consider thrombectomy up to 24 hours

2.2. Brain Imaging (Continued)	COR	LOE	New, Revised, or Unchanged
12. In selected patients with LKN within 6 to 24 hours who are functionally independent and neurologically normal who have LVO in the anterior circulation, obtaining CTP, DW-MRI, or MRI perfusion is recommended to aid in patient selection for mechanical thrombectomy, but only when imaging and other eligibility criteria from RCTs showing benefit are being strictly applied in selecting patients for mechanical thrombectomy.	I	A	New recommendation.
The DAWN trial (Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurovascular Intervention With Trevo) used clinical-imaging mismatch combination of NIHSS and imaging findings (CTP or DW-MRI) as an eligibility criterion to select patients with large anterior circulation vessel occlusion for mechanical thrombectomy between 6 and 24 hours from last known normal. This trial demonstrated an overall benefit in functional outcome at 90 days in the treatment group (mRS score 0–2, 49% versus 13%; adjusted difference, 33%; 95% CI, 21–44; posterior probability of superiority >0.999).[108] The DEFUSE 3 trial (Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution) used perfusion-core mismatch and maximum core size as imaging criteria to select patients with large anterior circulation occlusion 6 to 16 hours from last seen well for mechanical thrombectomy. The trial showed a benefit in functional outcome 90 days in treated group (mRS score 0–2, 44.6% versus 26.7%; RR, 2.[illegible] 95% CI, 1.6[illegible]–4.48; *P*<0.001). Benefit was independently demonstrated for the subgroup of patients who met DAWN eligibility criteria and for the subgroup who did not. DAWN and DEFUSE 3 are the only RCTs showing benefit of mechanical thrombectomy >6 hours from onset. Therefore, only the eligibility criteria from these trials should be used for patient selection. Although future RCTs may demonstrate that additional eligibility criteria can be used to select patients who benefit from mechanical thrombectomy, at this time, the DAWN and DEFUSE 3 eligibility should be strictly adhered to in clinical practice.			See Table XX in Online Data Supplement 1.

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Summary of the future state

Robust protocols are vital to success

More cases:

1. Underserved population
2. Time window enlarging x4 to **24 hours**

General anesthesia ≈ MAC

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Learning Objectives

1. Review the evolution, advances and likely changes in neuro-interventional and anesthetic management of patients with cerebrovascular disease; aneurysm, arteriovenous malformation and acute stroke

2. Discuss the anesthetic management of the patient with acute ischemic stroke

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Questions?