Mahidol University
Faculty of Medicine
Siriraj Hospital

ACUTE STROKE MANAGEMENT

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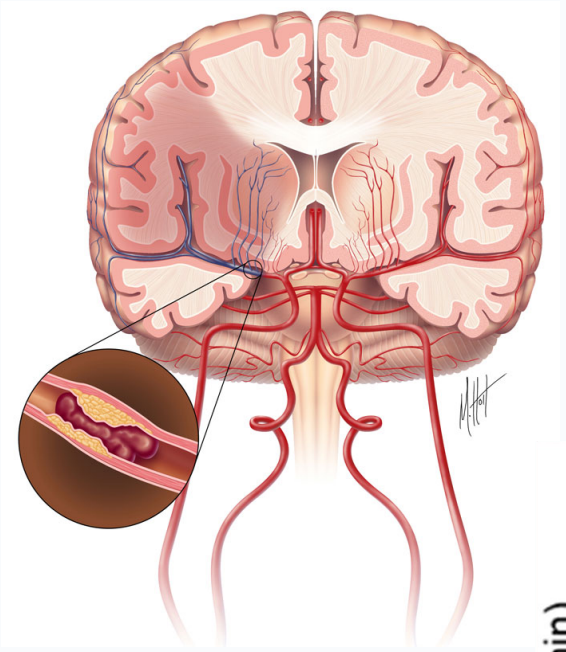
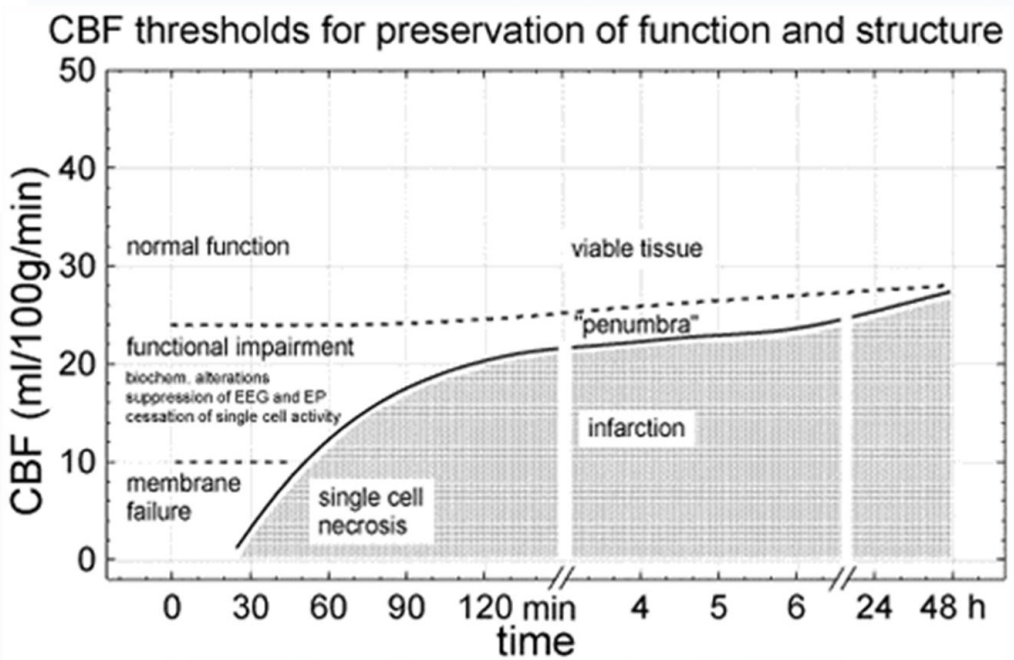
Acute ischemic stroke

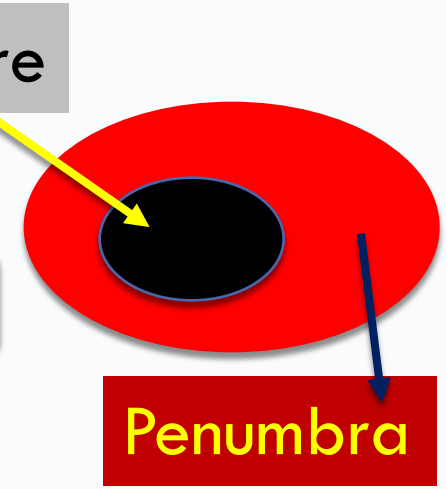
- Stroke is a major cause of death and disablity
- Even if an individual survives a stroke, can lead to permanent impairment
- Early and proper stroke treatment associated with better outcome

Acute ischemic stroke



1. Excitatory neurotransmitter release → Ca^{2+} released
2. Oxidative stress
3. Inflammation





Cell death

Reperfusion
Restoration blood flow
Tissue protection

Reversible ischemia

Acute ischemic stroke

Stroke is treatable
Stroke is preventable

World Stroke Campaign | World Stroke Organization

Time is importance

Time loss is brain loss

How to safe time?

AHA/ASA Guideline

Guidelines for the Early Management of Patients With Acute Ischemic Stroke

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 and Congress of Neurological Surgeons

AHA/ASA guideline 2013

AHA/ASA guideline 2015

AHA/ASA Guideline

2015 American Heart Association/American Stroke Association 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.

AHA/ASA guideline 2016

AHA/ASA Scientific Statement

Scientific Rationale for the Inclusion and Exclusion Criteria for Intravenous Alteplase in Acute Ischemic Stroke

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

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

Endorsed by the American Association of Neurological Surgeons and Congress of Neurological Surgeons

Stroke Chain of Survival

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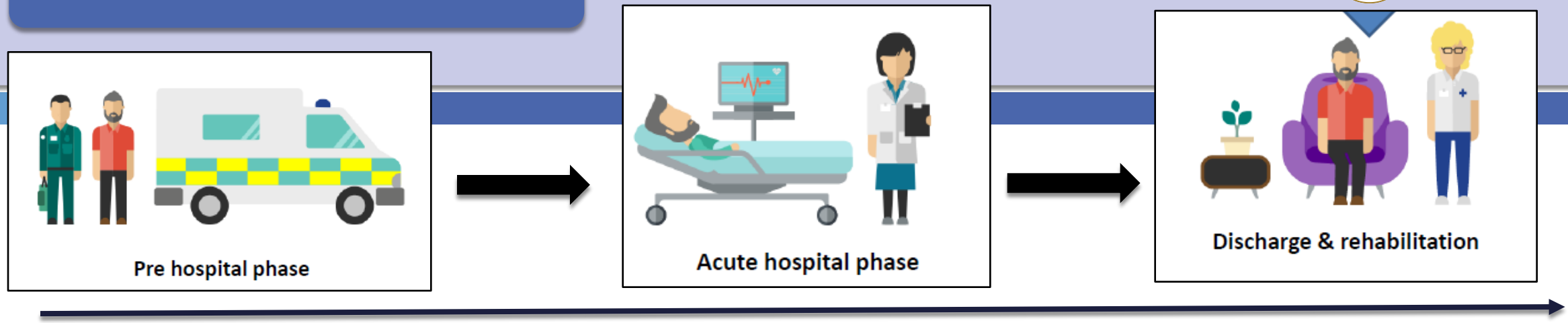

1. Detection
2. Dispatch
3. Delivery
4. Door
5. Data
6. Dicision
7. Drug
8. Disposition

"8D"

AHA stroke system

Advanced cardiac life support stroke chain of survival

Stroke. 2013;44:870-947.

Stroke Chain of Survival

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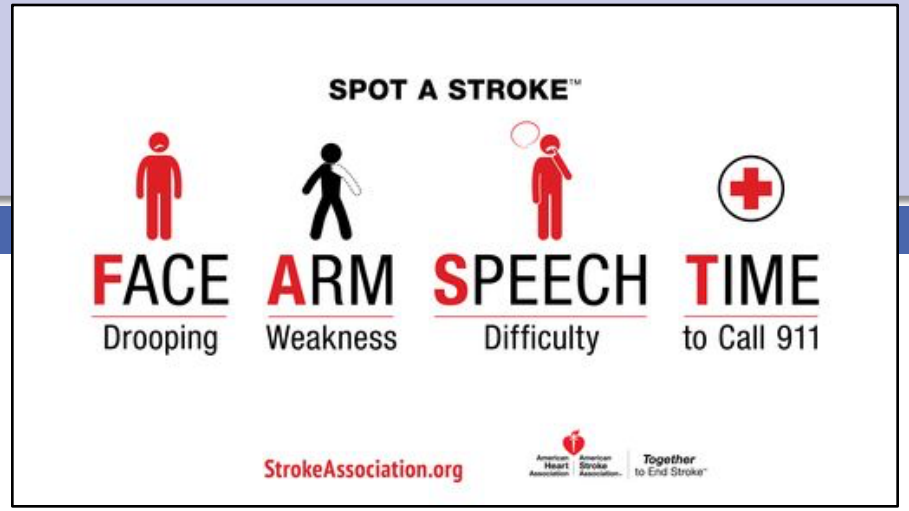
Pre hospital phase



1. **Detection**
2. Dispatch
3. **Delivery**

Recognizing the signs and symptoms of an acute stroke

Activating emergency medical services → **Call 1669**

Pre-arrival informations: Patient's age

- **Last seen normal**
- Medical history and baseline mental status

Stroke. 2013;44:870-947.

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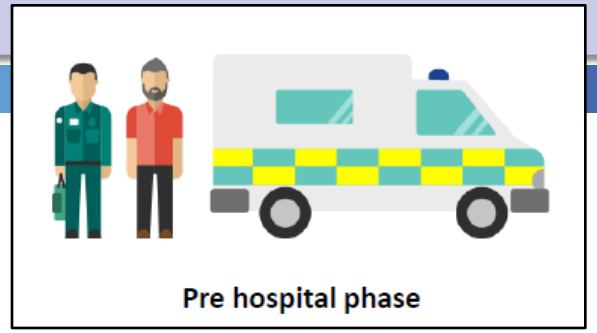
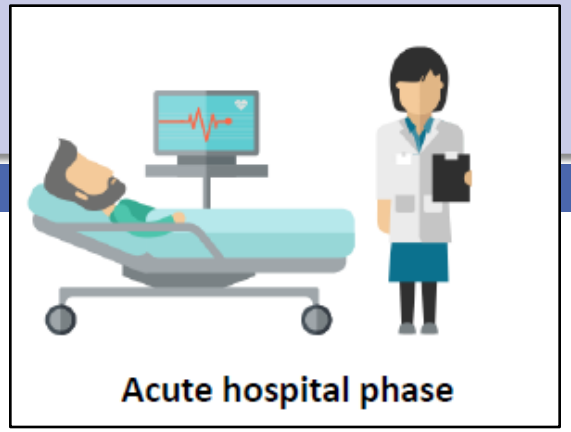


Pre hospital phase



Acute hospital phase

1. Detection
2. Dispatch
3. Delivery

4. Door
5. Data
6. Dicision
7. Drug
8. Disposition

ER physician and stroke team
- Prompt assessment and diagnosis
- Physical and neurological examination
  - Vital signs
  - NIHSS

Protocal
- **Laboratory test: POCT, CBC, coagulogram, blood chemisty**
- **EKG 12 lead**
- **CT brain non contrast**

Rule out stroke mimics

Hypoglycemia
Seizure
Syncope
Migraine
Brain tumor
Toxin
CNS infection

NIHSS

The National Institutes of Health Stroke Scale

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Table 7. National Institutes of Health Stroke Scale

Tested Item	Title	Responses and Scores
IA	Level of consciousness	0—Alert 1—Drowsy 2—Obtunded 3—Coma/unresponsive
1B	Orientation questions (2)	0—Answers both correctly 1—Answers 1 correctly 2—Answers neither correctly
1C	Response to commands (2)	0—Performs both tasks correctly 1—Performs 1 task correctly 2—Performs neither
2	Gaze	0—Normal horizontal movements 1—Partial gaze palsy 2—Complete gaze palsy
3	Visual fields	0—No visual field defect 1—Partial hemianopia 2—Complete hemianopia 3—Bilateral hemianopia
4	Facial movement	0—Normal 1—Minor facial weakness 2—Partial facial weakness 3—Complete unilateral palsy
5	Motor function (arm) a. Left b. Right	0—No drift 1—Drift before 5 seconds 2—Falls before 10 seconds 3—No effort against gravity 4—No movement
6	Motor function (leg) a. Left b. Right	0—No drift 1—Drift before 5 seconds 2—Falls before 5 seconds 3—No effort against gravity 4—No movement
7	Limb ataxia	0—No ataxia 1—Ataxia in 1 limb 2—Ataxia in 2 limbs
8	Sensory	0—No sensory loss 1—Mild sensory loss 2—Severe sensory loss
9	Language	0—Normal 1—Mild aphasia 2—Severe aphasia 3—Mute or global aphasia
10	Articulation	0—Normal 1—Mild dysarthria 2—Severe dysarthria
11	Extinction or inattention	0—Absent 1—Mild (loss 1 sensory modality lost) 2—Severe (loss 2 modalities lost)

Total 42

Tips: **do not coach** patient → 1st thing the patient done
Do not think what patient can or can't do → just **scale by objective test**

Score	Severity
0-4	Minor stroke
5-15	Moderate stroke
16-20	Moderate to severe stroke
21-42	Severe stroke

Stroke. 2013;44:870-947.

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Instructions	Scale Definition	Score
1a. Level of Consciousness: The investigator must choose a response if a full evaluation is prevented by such obstacles as an endotracheal tube, language barrier, orotracheal trauma/bandages. A 3 is scored only if the patient makes no movement (other than reflexive posturing) in response to noxious stimulation.	0 = **Alert**; keenly responsive. 1 = **Not alert**; but arousable by minor stimulation to obey, answer, or respond. 2 = **Not alert**; requires repeated stimulation to attend, or is obtunded and requires strong or painful stimulation to make movements (not stereotyped). 3 = Responds only with reflex motor or autonomic effects or totally unresponsive, flaccid, and areflexic.	_____
1b. LOC Questions: The patient is asked the month and his/her age. The answer must be correct - there is no partial credit for being close. Aphasic and stuporous patients who do not comprehend the questions will score 2. Patients unable to speak because of endotracheal intubation, orotracheal trauma, severe dysarthria from any cause, language barrier, or any other problem not secondary to aphasia are given a 1. It is important that only the initial answer be graded and that the examiner not "help" the patient with verbal or non-verbal cues.	0 = **Answers** both questions correctly. 1 = **Answers** one question correctly. 2 = **Answers** neither question correctly.	_____
1c. LOC Commands: The patient is asked to open and close the eyes and then to grip and release the non-paretic hand. Substitute another one step command if the hands cannot be used. Credit is given if an unequivocal attempt is made but not completed due to weakness. If the patient does not respond to command, the task should be demonstrated to him or her (pantomime), and the result scored (i.e., follows none, one or two commands). Patients with trauma, amputation, or other physical impediments should be given suitable one-step commands. Only the first attempt is scored.	0 = **Performs** both tasks correctly. 1 = **Performs** one task correctly. 2 = **Performs** neither task correctly.	_____

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Tested Item	Title	Response and score	วิธีการตรวจ
IA	Consciousness	0 = Alert 1 = Sleepiness 2 = Stupor 3 = Coma	0 = ตอบสนองปกติ 1 = กระตุ้นได้ง่าย ทำตามคำสั่งและตอบได้ 2 = ต้องกระตุ้นหลายครั้ง หรือ ด้วย painful stimuli 3 = กระตุ้นได้แค่ reflex motor, autonomic หรือไม่สามารถกระตุ้นได้ flaccid areflexia
IB	Question	0 = Answers both question 1 = Answers one question 2 = Answers neither question	ถาม 2 คำถาม: เดือนอะไร อายุเท่าไร 1 = หรือใส่ ETT, mouth barrier, severe dysarthria 2 = หรือหากมี aphasia หรือซึม
IC	Commands	0 = Performs both task 1 = Performs one task 2 = Performs neither task	ให้ หลับตาลืมตา กำมือแบมือ ในข้างที่ไม่อ่อนแรง หากทำไม่ได้ให้ทำท่าตัวอย่างให้ทำตาม

1st answer
Do not count if repeat answer

Tips: ให้ทำท่าไปด้วยพร้อมบอกคนไข้ ให้รับ **sensory input** จากท่าทางด้วย

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2. Best Gaze: Only horizontal eye movements will be tested. Voluntary or reflexive (oculocephalic) eye movements will be scored, but caloric testing is not done. If the patient has a conjugate deviation of the eyes that can be overcome by voluntary or reflexive activity, the score will be 1. If a patient has an isolated peripheral nerve paresis (CN III, IV or VI), score a 1. Gaze is testable in all aphasic patients. Patients with ocular trauma, bandages, pre-existing blindness, or other disorder of visual acuity or fields should be tested with reflexive movements, and a choice made by the investigator. Establishing eye contact and then moving about the patient from side to side will occasionally clarify the presence of a partial gaze palsy.	0 = **Normal.** 1 = **Partial gaze palsy;** gaze is abnormal in one or both eyes, but forced deviation or total gaze paresis is not present. 2 = **Forced deviation,** or total gaze paresis not overcome by the oculocephalic maneuver.	_____

Tip: patient incooperate: use VOR or observe eye movement tracking examiner face

2	Gaze	0 = Normal 1 = Partial gaze palsy 2 = Forced deviation	ทดสอบ horizontal eye movements 1 = การกลอกตาผิดปกติ แต่สามารถทำ VOR ได้ หรือ isolate CN palsy 2 = กลอกตาผิดปกติ VOR ทำไม่ได้

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3. Visual: Visual fields (upper and lower quadrants) are tested by confrontation, using finger counting or visual threat, as appropriate. Patients may be encouraged, but if they look at the side of the moving fingers appropriately, this can be scored as normal. If there is unilateral blindness or enucleation, visual fields in the remaining eye are scored. Score 1 only if a clear-cut asymmetry, including quadrantanopia, is found. If patient is blind from any cause, score 3. Double simultaneous stimulation is performed at this point. If there is extinction, patient receives a 1, and the results are used to respond to item 11.	0 = **No visual loss.** 1 = **Partial hemianopia.** 2 = **Complete hemianopia.** 3 = **Bilateral hemianopia** (blind including cortical blindness).	_____

3	Visual	0 = No visual loss 1 = Partial hemianopia 2 = Complete hemianopia 3 = Bilateral hemianopia	ทดสอบโดย confrontation test 1 = quadrantanopia หรือ impair double visual stimuli 3 = blind เช่น cortical blindness

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4. Facial Palsy: Ask – or use pantomime to encourage – the patient to show teeth or raise eyebrows and close eyes. Score symmetry of grimace in response to noxious stimuli in the poorly responsive or non-comprehending patient. If facial trauma/bandages, orotracheal tube, tape or other physical barriers obscure the face, these should be removed to the extent possible.	0 = **Normal** symmetrical movements. 1 = **Minor paralysis** (flattened nasolabial fold, asymmetry on smiling). 2 = **Partial paralysis** (total or near-total paralysis of lower face). 3 = **Complete paralysis** of one or both sides (absence of facial movement in the upper and lower face).	_____

4	Facial palsy	0 = Normal 1 = Minor paralysis 2 = Partial paralysis 3 = Complete paralysis	ทดสอบให้ ยิงฟัน ยักคิ้ว 1 = Nasolabial fold ลดลง หรือยิ้มแล้ว asymmetry 2 = paralysis of lower face 3 = paralysis upper and lower face *ถ้าซึมให้กระตุ้นด้วย pain

Tip: ต้องทำ 3 ท่า
If not co-operative use noxious stimuli

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5. Motor Arm: The limb is placed in the appropriate position: extend the arms (palms down) 90 degrees (if sitting) or 45 degrees (if supine). Drift is scored if the arm falls before 10 seconds. The aphasic patient is encouraged using urgency in the voice and pantomime, but not noxious stimulation. Each limb is tested in turn, beginning with the non-paretic arm. Only in the case of amputation or joint fusion at the shoulder, the examiner should record the score as untestable (UN), and clearly write the explanation for this choice.

0 = **No drift;** limb holds 90 (or 45) degrees for full 10 seconds.
1 = **Drift;** limb holds 90 (or 45) degrees, but drifts down before full 10 seconds; does not hit bed or other support.
2 = **Some effort against gravity;** limb cannot get to or maintain (if cued) 90 (or 45) degrees, drifts down to bed, but has some effort against gravity.
3 = **No effort against gravity;** limb falls.
4 = **No movement.**
UN = **Amputation** or joint fusion, explain: _____

5a. Left Arm

5b. Right Arm

Tip: Start test with non paralytic arm
Use pantomine ให้ทำท่า จับแขนคนไข้ตั้งได้ นับ 1-10 ให้คนไข้ฟัง

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5	Motor arm 5a) Left arm 5b) Right arm	0 = No drift 1 = Drift 2 = Some effort against gravity 3 = No effort against gravity 4 = No movement UN = amputation, joint fusion	ควำมือ ยืดแขนยกขึ้น 90° (นั่ง) หรือ 45° (นอน) นับ 10 sec. 1 = hold position but แต่ ก่อน 10 sec. 2 = maintain position ไม่ได้ แต่ต้าน gravity ได้บางส่วน 3 = แขนตกยกไม่ได้ 4 = ไม่ขยับ ** ถ้าผู้ป่วย aphasia ให้ทำท่าตาม ไม่กระตุ้นด้วย pain

Tip: Scale3: shoulder movement : OK
** Pt. coma (1A=3 → score 4)

6. Motor Leg: The limb is placed in the appropriate position: hold the leg at 30 degrees (always tested supine). Drift is scored if the leg falls before 5 seconds. The aphasic patient is encouraged using urgency in the voice and pantomime, but not noxious stimulation. Each limb is tested in turn, beginning with the non-paretic leg. Only in the case of amputation or joint fusion at the hip, the examiner should record the score as untestable (UN), and clearly write the explanation for this choice.	0 = **No drift;** leg holds 30-degree position for full 5 seconds. 1 = **Drift;** leg falls by the end of the 5-second period but does not hit bed. 2 = **Some effort against gravity;** leg falls to bed by 5 seconds, but has some effort against gravity. 3 = **No effort against gravity;** leg falls to bed immediately. 4 = **No movement.** UN = **Amputation** or joint fusion, explain: _____ **6a. Left Leg** **6b. Right Leg**

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 UN = amputation, joint fusion	ตรวจในท่านอน ยกขา 30° นับ 5 sec. 1 = hold position ได้ drift ก่อน 5 sec. 2 = maintain position ไม่ได้ แต่ต้าน gravity ได้บางส่วน 3 = ขาตกยกไม่ได้ 4 = ไม่ขยับ ** ถ้าผู้ป่วย aphasia ให้ทำท่าตาม ไม่กระตุ้นด้วย pain

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7. Limb Ataxia: This item is aimed at finding evidence of a unilateral cerebellar lesion. Test with eyes open. In case of visual defect, ensure testing is done in intact visual field. The finger-nose-finger and heel-shin tests are performed on both sides, and ataxia is scored only if present out of proportion to weakness. Ataxia is absent in the patient who cannot understand or is paralyzed. Only in the case of amputation or joint fusion, the examiner should record the score as untestable (UN), and clearly write the explanation for this choice. In case of blindness, test by having the patient touch nose from extended arm position.	0 = **Absent.** 1 = **Present in one limb.** 2 = **Present in two limbs.** UN = **Amputation** or joint fusion, explain: _____

7	Limb ataxia	0 = Absent 1 = Present in one limb 2 = Present in two limb UN = amputation, joint fusion	FTNTF and heel to shin test (เพื่อจะหา unilateral cerebellar sign) * ถ้าผู้ป่วย aphasia หรือ paralysis ให้ score = 0

Tip: score2 (2limb = leg+arm or 2 legs or 2 arms)
** ataxia out of proportion to weakness, patient 1A=3 → score 0 ataxia

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8. Sensory: Sensation or grimace to pinprick when tested, or withdrawal from noxious stimulus in the obtunded or aphasic patient. Only sensory loss attributed to stroke is scored as abnormal and the examiner should test as many body areas (arms [not hands], legs, trunk, face) as needed to accurately check for hemisensory loss. A score of 2, "severe or total sensory loss," should only be given when a severe or total loss of sensation can be clearly demonstrated. Stuporous and aphasic patients will, therefore, probably score 1 or 0. The patient with brainstem stroke who has bilateral loss of sensation is scored 2. If the patient does not respond and is quadriplegic, score 2. Patients in a coma (item 1a=3) are automatically given a 2 on this item.	0 = **Normal;** no sensory loss. 1 = **Mild-to-moderate sensory loss;** patient feels pinprick is less sharp or is dull on the affected side; or there is a loss of superficial pain with pinprick, but patient is aware of being touched. 2 = **Severe to total sensory loss;** patient is not aware of being touched in the face, arm, and leg.

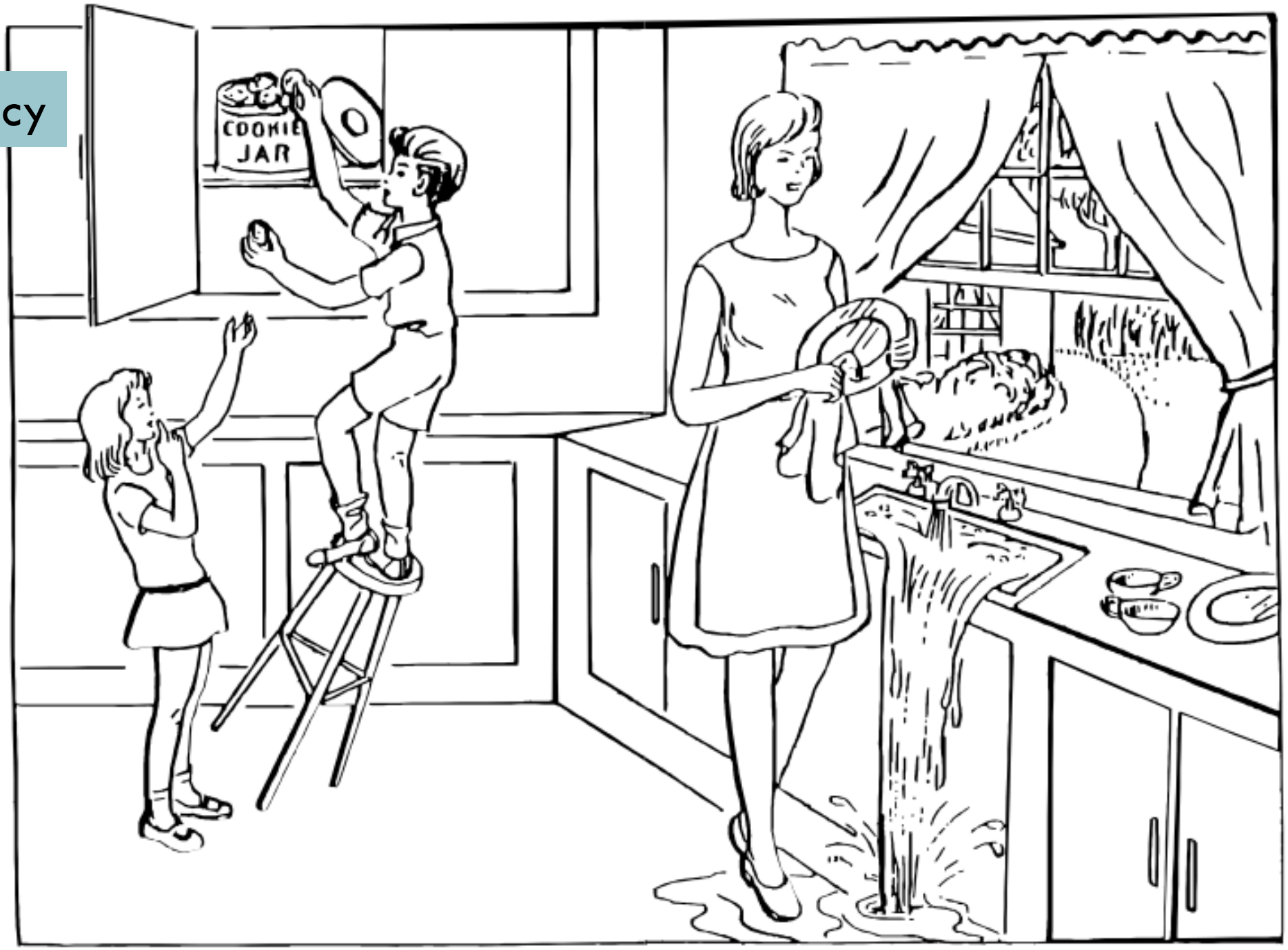
8	Sensory	0 = Normal 1 = Mild to moderate sensory loss 2 = Severe to total sensory loss	ตรวจ sensation: face, arm, leg 1 = ผู้ป่วยรู้สึกลดลง หรือหนา แต่รู้ว่าสัมผัสหรือ stupor หรือ aphasia 2 = ผู้ป่วยไม่รู้ว่าถูกสัมผัส หรือ brainstem stroke ชา 2 ข้าง/ quadriplegia หรือ coma

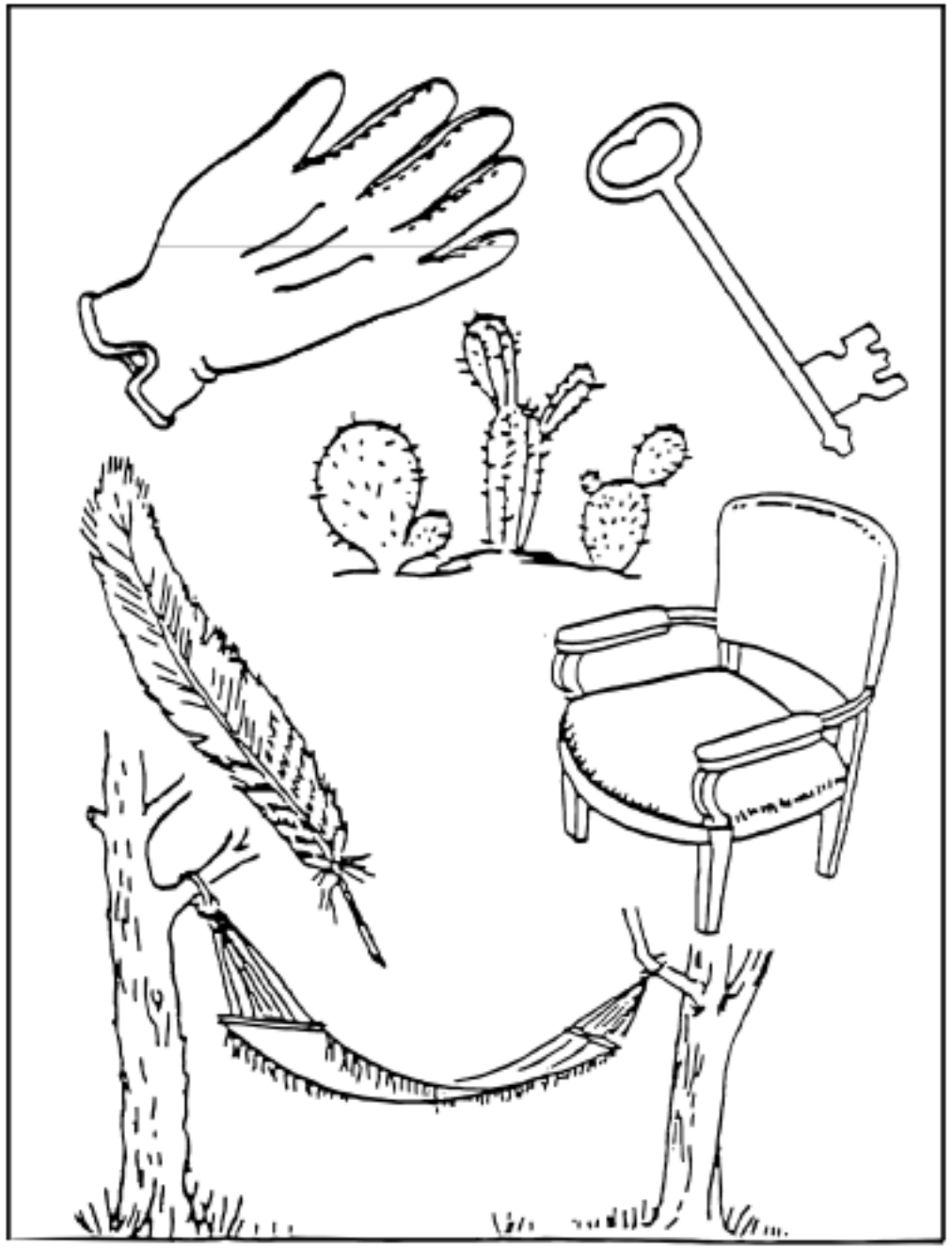
Tip: sensation test pinprick: 3 level (face, arm, leg)
if no feeling → noxious stimuli test (nail bed)

9. Best Language: A great deal of information about comprehension will be obtained during the preceding sections of the examination. For this scale item, the patient is asked to describe what is happening in the attached picture, to name the items on the attached naming sheet and to read from the attached list of sentences. Comprehension is judged from responses here, as well as to all of the commands in the preceding general neurological exam. If visual loss interferes with the tests, ask the patient to identify objects placed in the hand, repeat, and produce speech. The intubated patient should be asked to write. The patient in a coma (item 1a=3) will automatically score 3 on this item. The examiner must choose a score for the patient with stupor or limited cooperation, but a score of 3 should be used only if the patient is mute and follows no one-step commands.	0 = **No aphasia;** normal. 1 = **Mild-to-moderate aphasia;** some obvious loss of fluency or facility of comprehension, without significant limitation on ideas expressed or form of expression. Reduction of speech and/or comprehension, however, makes conversation about provided materials difficult or impossible. For example, in conversation about provided materials, examiner can identify picture or naming card content from patient's response. 2 = **Severe aphasia;** all communication is through fragmentary expression; great need for inference, questioning, and guessing by the listener. Range of information that can be exchanged is limited; listener carries burden of communication. Examiner cannot identify materials provided from patient response. 3 = **Mute, global aphasia;** no usable speech or auditory comprehension.	_____

9	Best language	0 = No aphasia 1 = Mild to moderate aphasia 2 = Severe aphasia 3 = Mute, global aphasia	วิธีตรวจให้บรรยายรูป บอกชื่อสิ่งของ หรือประเมินจากคำสั่งต่างๆ ก่อนหน้านี้ ถ้าคนไข้มองไม่เห็นให้กำของในมือ 1 = มีความผิดปกติเล็กน้อยใน fluency หรือ comprehension 2 = มีปัญหาในการสื่อสาร และผู้ฟังต้องใช้ความพยายามคาดเดา 3 = ไม่พูด ไม่ทำตามสั่ง หรือ coma *ถ้าใส่ ETT ให้เขียน

Describe: fluency





Naming object

Read

You know how.

Down to earth.

I got home from work.

Near the table in the dining room.

They heard him speak on the radio last night.

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10. Dysarthria: If patient is thought to be normal, an adequate sample of speech must be obtained by asking patient to read or repeat words from the attached list. If the patient has severe aphasia, the clarity of articulation of spontaneous speech can be rated. Only if the patient is intubated or has other physical barriers to producing speech, the examiner should record the score as untestable (UN), and clearly write an explanation for this choice. Do not tell the patient why he or she is being tested.	0 = **Normal.** 1 = **Mild-to-moderate dysarthria;** patient slurs at least some words and, at worst, can be understood with some difficulty. 2 = **Severe dysarthria;** patient's speech is so slurred as to be unintelligible in the absence of or out of proportion to any dysphasia, or is mute/anarthric. UN = **Intubated** or other physical barrier, explain:_____

10	Dysarthria	0 = Normal 1 = Mild to moderate dysarthria 2 = Severe dysarthria UN = Intubation, physical barrier	ให้อ่านคำ 1 = พูดฟังยากแต่เข้าใจ 2 = พูดฟังไม่เข้าใจหรือพูดไม่ได้ (mute/anarthria) Tip: patient 1A=3 → score 2 dysarthria

Read

MAMA

TIP – TOP

FIFTY – FIFTY

THANKS

HUCKLEBERRY

BASEBALL PLAYER

Dysarthria

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11. Extinction and Inattention (formerly Neglect): Sufficient information to identify neglect may be obtained during the prior testing. If the patient has a severe visual loss preventing visual double simultaneous stimulation, and the cutaneous stimuli are normal, the score is normal. If the patient has aphasia but does appear to attend to both sides, the score is normal. The presence of visual spatial neglect or anosagnosia may also be taken as evidence of abnormality. Since the abnormality is scored only if present, the item is never untestable.	0 = **No abnormality.** 1 = **Visual, tactile, auditory, spatial, or personal inattention** or extinction to bilateral simultaneous stimulation in one of the sensory modalities. 2 = **Profound hemi-inattention or extinction to more than one modality;** does not recognize own hand or orients to only one side of space.

11	Inattention (Neglect)	0 = No abnormality 1 = Mild inattention 2 = Severe inattention	ตรวจด้วยการทำ bilateral stimuli ด้วย sensory modalities: visual, tactile, auditory, spatial (วาดรูปหรือ line cancellation), personal inattention 1 = มีผิดปกติเพียง 1 modality 2 = ผิดปกติ > 1 modality หรือไม่สนใจส่วนหนึ่งของร่างกาย

Tip: stimuli touch 3 location (face, arm, leg)
Visual or auditory

NIHSS

NIHSS Score and Arteriographic Findings in Acute Ischemic Stroke

Urs Fischer, MD; Marcel Arnold, MD; Krassen Nedeltchev, MD; Caspar Brekenfeld, MD; Pietro Ballinari, MSc; Luca Remonda, MD; Gerhard Schroth, MD; Heinrich P. Mattle, MD

NIHSS Items at Baseline and ORs for ICA, M1, M2, or BA Occlusions on DSA

	ORs for Vessel Occlusion	*P* Value (univariate model)	ORs for Vessel Occlusion	*P* Value (multivariate model)
NIHSS items				
LOC	3.3 (1.7–6.5)	0.001		
LOC alertness	3.0 (1.50.8–5.7)	0.001		
LOC questions	2.7 (1.5–5.1)	0.002	4.0 (1.9–8.4)	<0.001
LOC commands	2.7 (1.4–5.4)	0.005		
Gaze	4.6 (2.3–8.9)	<0.001	2.9 (1.4–6.2)	<0.001
Visual fields	2.8 (1.2–6.5)	0.021		
Facial palsy	2.1 (0.8–5.3)	0.129		
Motor arm	4.5 (1.8–11.5	0.002		
Motor leg	5.2 (2.5–10.9)	<0.001	4.2 (1.8–9.6)	0.001
Ataxia	0.4 (0.2–1.2)	0.1		
Sensation	2.5 (1.3–4.6)	0.005		
Language	1.7 (0.9–3.2)	0.079		
Dysarthria	1.3 (0.7–2.5)	0.4		
Neglect	3.5 (1.6–7.9)	0.002	3.2 (1.3–8.1)	0.013

NIHSS scores = 10 → PPVs occlusions in 97% of carotid and 96% of vertebrobasilar strokes
NIHSS score =12 → PPV to find a central occlusion 91%

Stroke. 2005;36:2121-2125.

Suspected acute stroke
Especially within 8 hr

↓

Tel ศูนย์แพทย์ 99499

Neuro-Med | **Neuro-Radiologist** | **Neuro-Intervention**

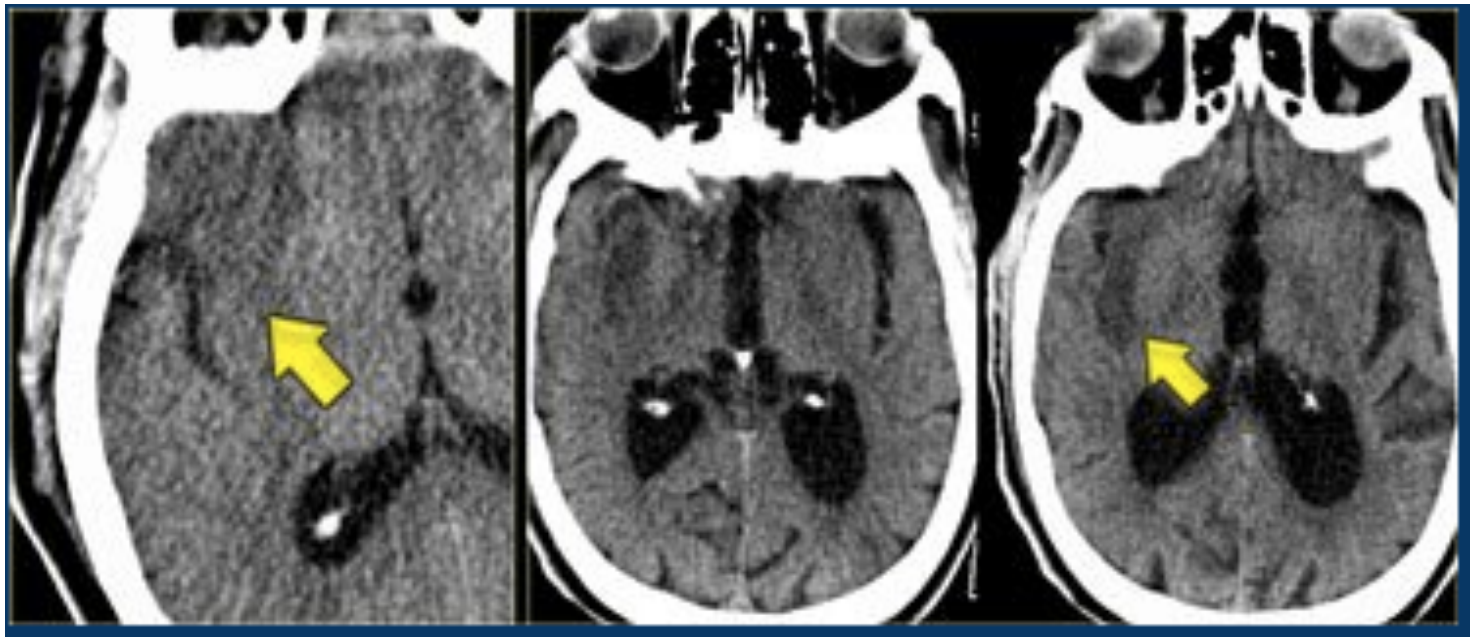
เวรเปล → **หน่วยรักษาความปลอดภัย**

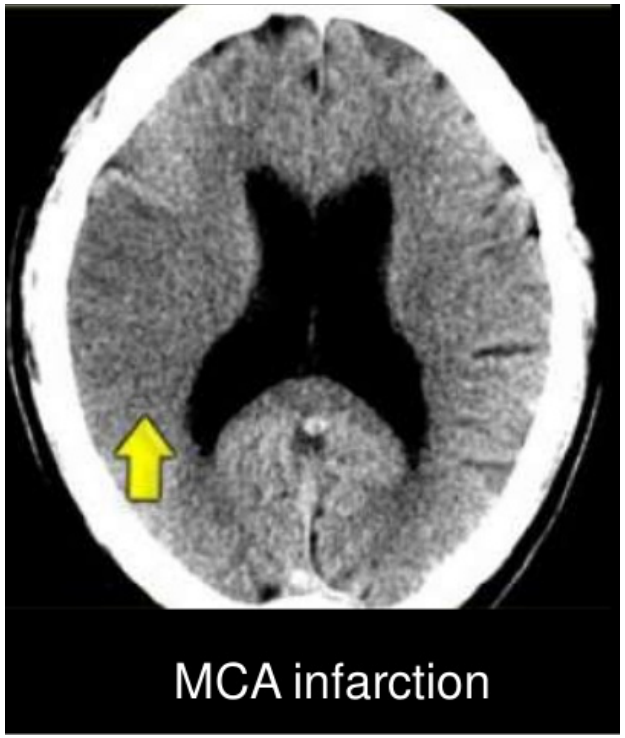
CT brain non contrast
Additional: CTA or CT perfusion
Or MRI

Rule out hemorrhage

CT brain non contrast

Early signs of infarction

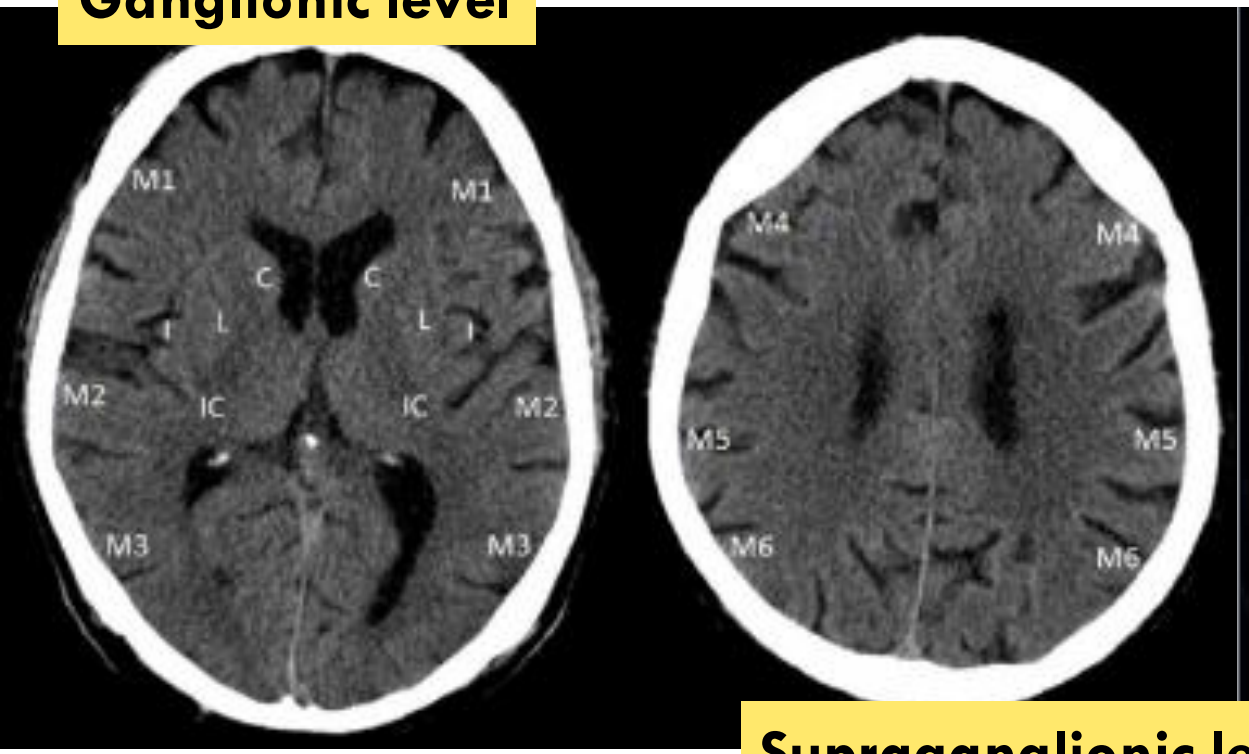




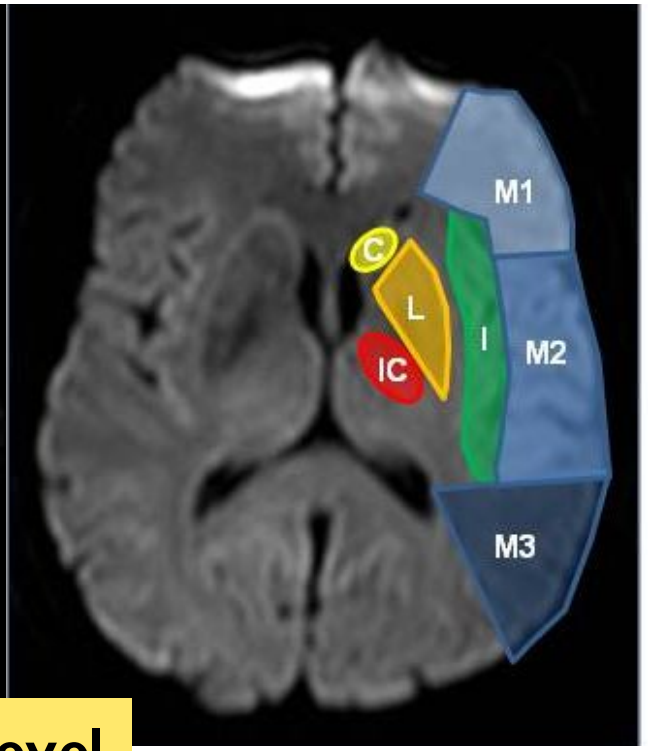
ASPECT score

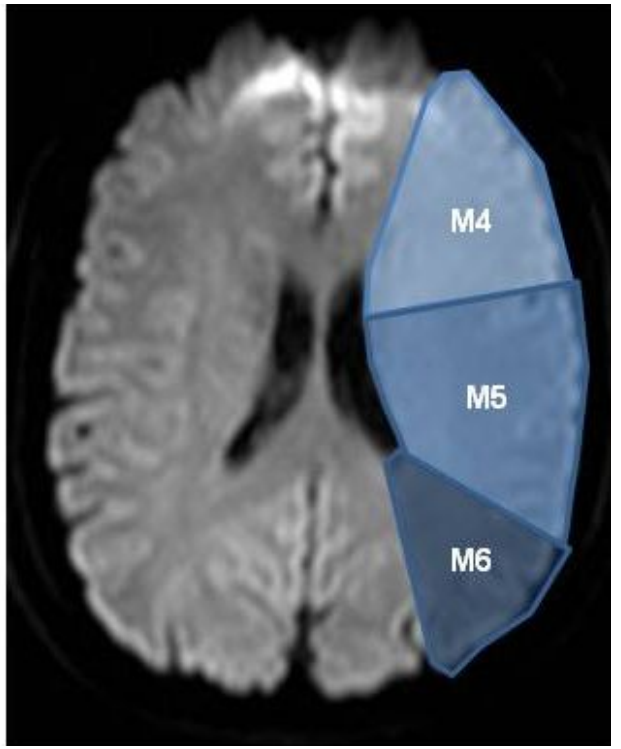
Early detecting signs of ischemia

Ganglionic level



Supraganglionic level





Total score = 10

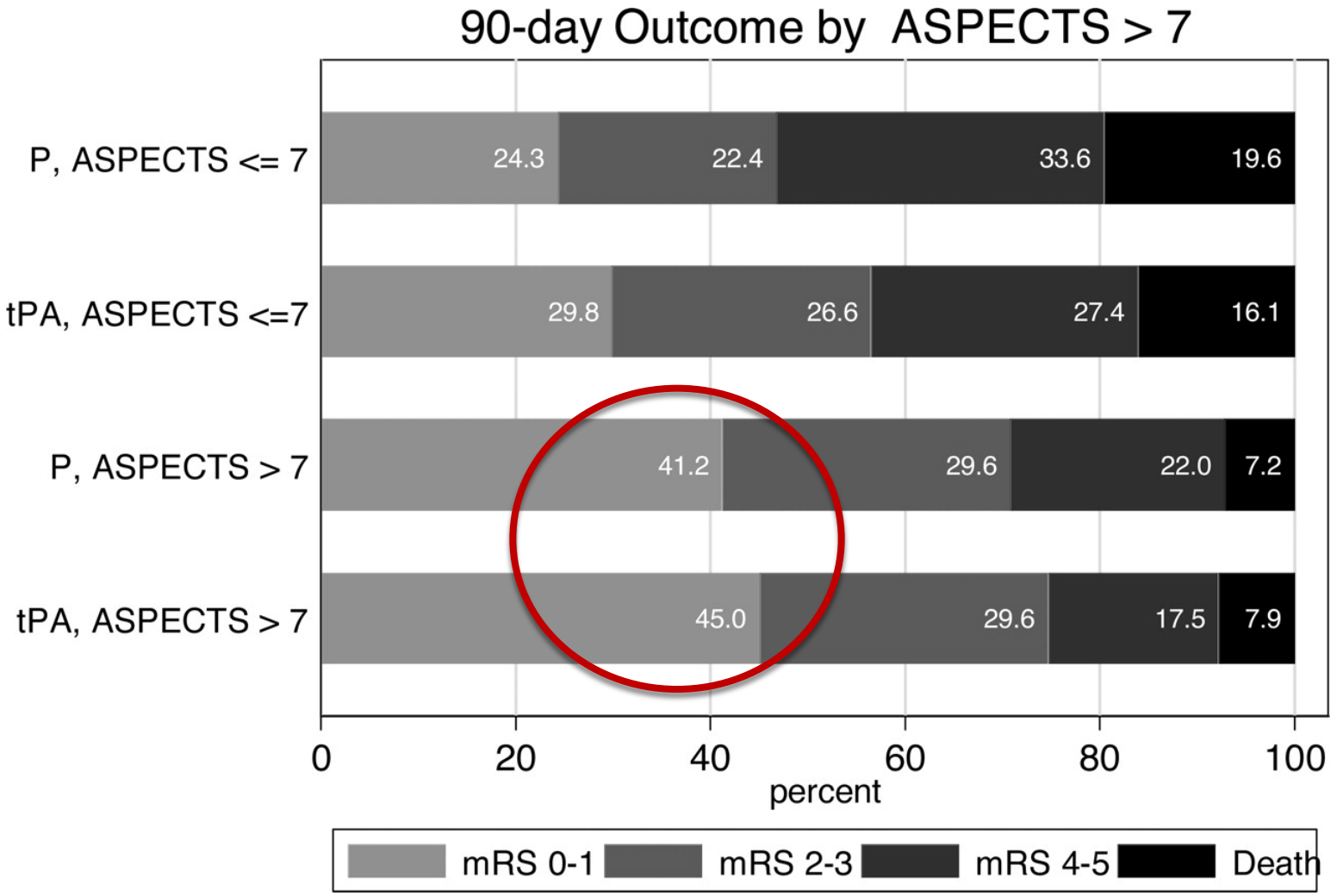
Score 8-10: small core
Score 6-7: moderate core
Score 0-5: large core

Arrange

Subcortical : C, L, IC

Cortical : I, M1-M6

Alberta Stroke Program Early CT score (ASPECTS)

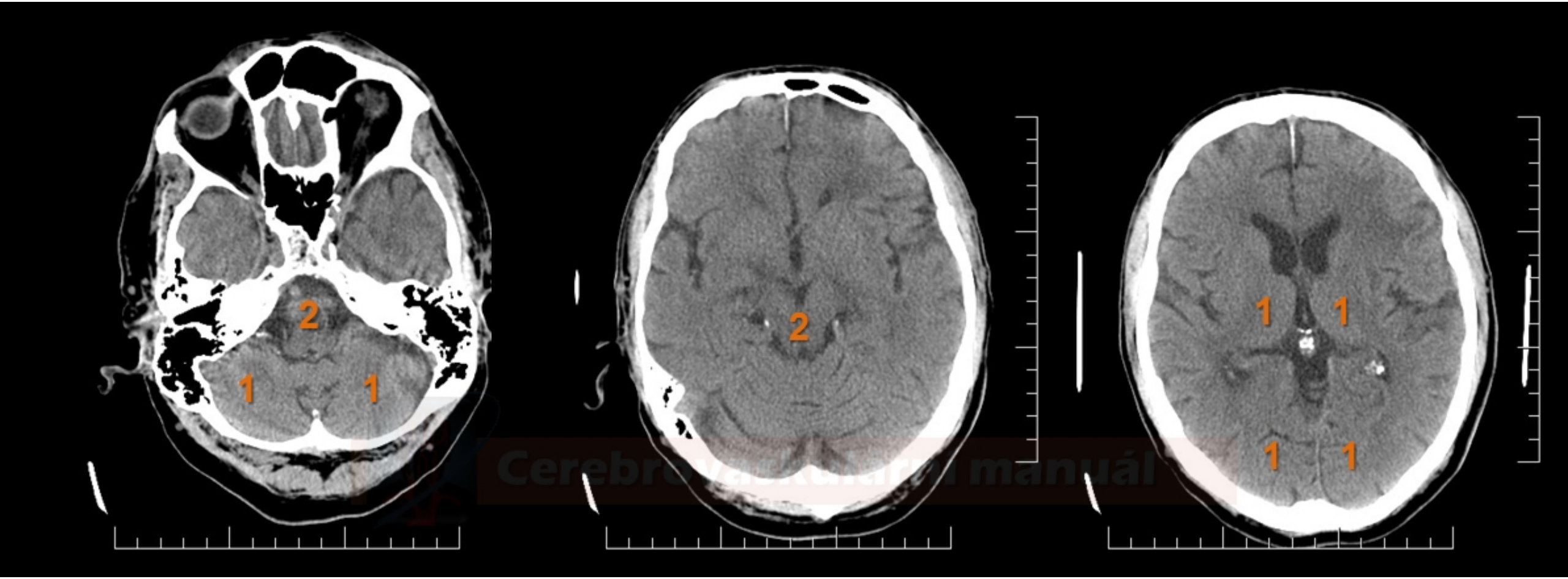


Favorable outcome
ASPECTS > 7

Modify rankin score (mRS)
In stroke patients
Score 0: no symptoms
Score 1: No significant disablility
Score 2: Slight disability
Score 3: Moderate disablitiy
Score 4: Moderately severe disability
Score 5: Severe ability
Death

Imanuel Dzialowski, MD, et al. Stroke. 2006;37:973-978.

ASPECT score



Stroke Chain of Survival

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4. Door
5. Data

6. Dicision

Neuro-Med and Neuro-interventionist

7. Drug

Informed risks and benefit with patient and family

Q1: Reperfusion ?

- **Yes: 1) Thrombolysis**
  2) Endovascular treatment: mechanical thrombectomy
- **No: mild stroke or TIA → Admission**

Reperfusion

Door to needle time < 60 min
(*Class I, Level of Evidence A*)

Thrombolytic: IV r-TPA (Alteplase)

Time

0 — 3 — 4.5 — 6 — 8 — 12 — 24 hr

Two positive randomized trial: NINDS II, IST3 → ECAS III (extend to 4.5hr)
FDA approved indication (*Class I, Level of Evidence A*)

Dose: 0.9 mg/kg (max. 90mg)
10% bolus in 1 min
90% in 60 min

Stroke. 2013;44:870-947.

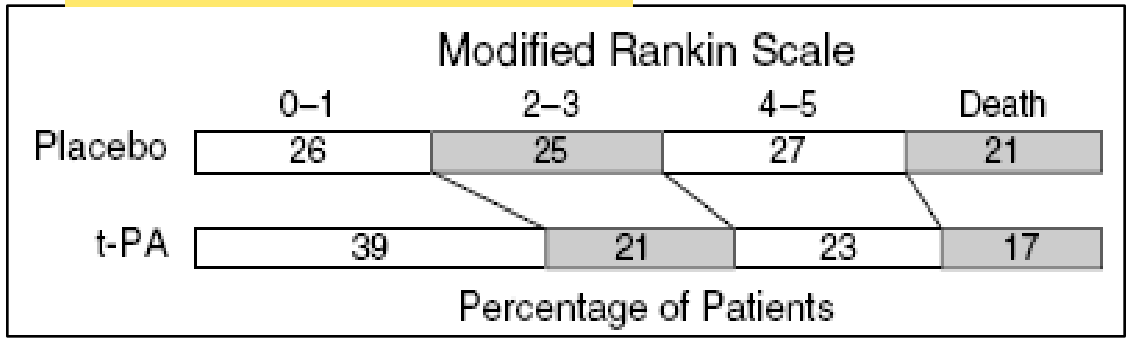
Functional independence thrombolytic vs control group

Study or subgroup	thrombolysis n/N	Control n/N	Peto Odds Ratio Peto,Fixed,95% CI	Weight	Peto Odds Ratio Peto,Fixed,95% CI
Mori 1992	8/19	2/12		0.4 %	3.09 [0.67, 14.12]
NINDS 1995	157/312	120/312		9.6 %	1.62 [1.18, 2.21]
ECASS 1995	142/313	122/307		9.4 %	1.26 [0.92, 1.73]
ECASS II 1998	222/409	180/391		12.4 %	1.39 [1.05, 1.83]
ATLANTIS B 1999	166/307	171/306		9.4 %	0.93 [0.68, 1.28]
ATLANTIS A 2000	7/71	15/71		1.2 %	0.43 [0.17, 1.05]
Wang 2003	53/67	22/33		1.0 %	1.93 [0.74, 5.03]
ECASS 3 2008	278/418	248/403		11.7 %	1.24 [0.93, 1.65]
EPITHET 2008	24/52	20/49		1.6 %	1.24 [0.57, 2.71]
IST3 2012	554/1515	534/1520		43.3 %	1.06 [0.92, 1.23]
Total (95% CI)	**3483**	**3404**		**100.0 %**	**1.17 [1.06, 1.29]**

Total events: 1611 (thrombolysis), 1434 (Control)
Heterogeneity: Chi^2 = 16.85, df = 9 (P = 0.05); I^2 =47%
Test for overall effect: Z = 3.19 (P = 0.0014)
Test for subgroup differences: Not applicable

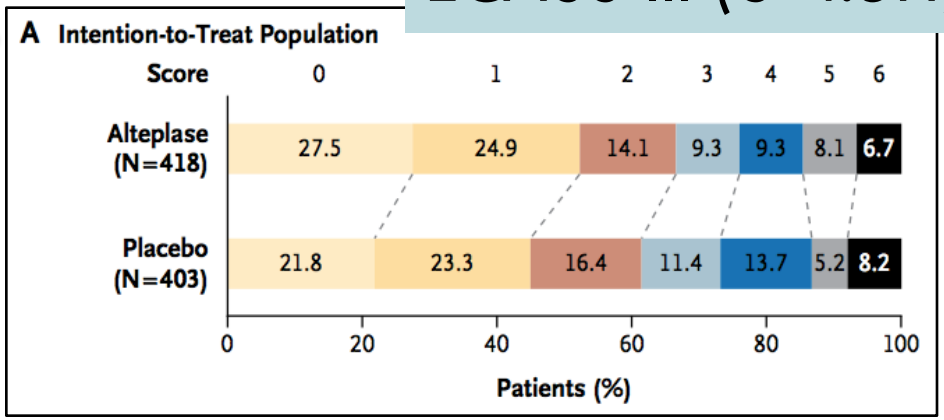
0.1 0.2 0.5 1 2 5 10
Favours control | Favours thrombolysis

NINDS trial 1995



mRS 0-1 at 90d: ↑13%

ECASS III (3-4.5H)

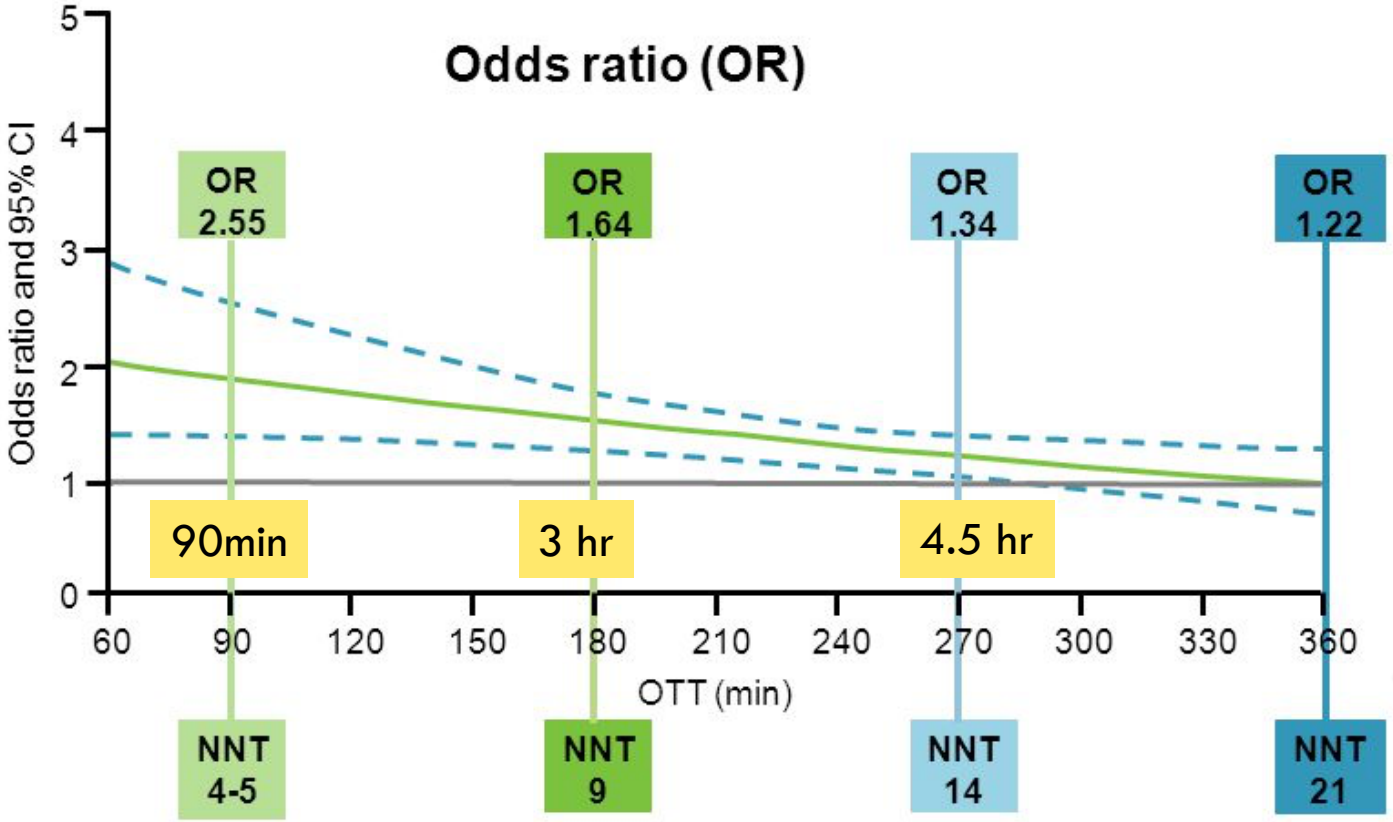


mRS 0-1 at 90d: ↑7.3%

N Engl J Med 1995
N Engl J Med 2008;359:1317-29.
Cochrane Database of Systematic Reviews 2014, Issue 7

Reperfusion

OR and NNT after thrombolytic by time



NNT, Number needed to treat
OTT, Time from stroke onset to start of treatment
mRS, modified Rankin Scale

Lees et al. *Lancet* 2010;375:1695-1703

General bleeding risk
sICH 6.4% (NINDS: 0-3hr)
sICH 2.4% (ECASSIII: 0-4.5hr)

Earlier treatment give the most benefit

POST RTPA BLEEDING: NIHSS AND ASPECT

ASPECT score

ASPECT score and bleeding risk

TABLE 2. Rate of Thrombolysis-Related Hemorrhage for Dichotomized and Trichotomized ASPECTS

	Alteplase % (n)		Placebo % (n)		RR (95% CI)	
	PH	sICH	PH	sICH	PH	sICH
ASPECTS 8–10	9.3 (26/280)	6.4 (18/280)	3.9 (11/277)	2.9 (8/277)	2.3 (1.2–4.6)	2.2 (0.98–5.0)
ASPECTS 0–7	17.7 (22/124)	14.5 (18/124)	0.9 (1/107)	2.8 (3/107)	18.9 (2.6–138)	5.2 (1.6–17.1)
ASPECTS 0–3	40.0 (2/5)	40.0 (2/5)	0.0 (0/3)	0.0 (0/3)	∞	∞
ASPECTS 4–7	16.8 (20/119)	13.5 (16/119)	1.0 (1/104)	2.9 (3/104)	17.5 (2.4–128.0)	4.7 (1.4–15.5)

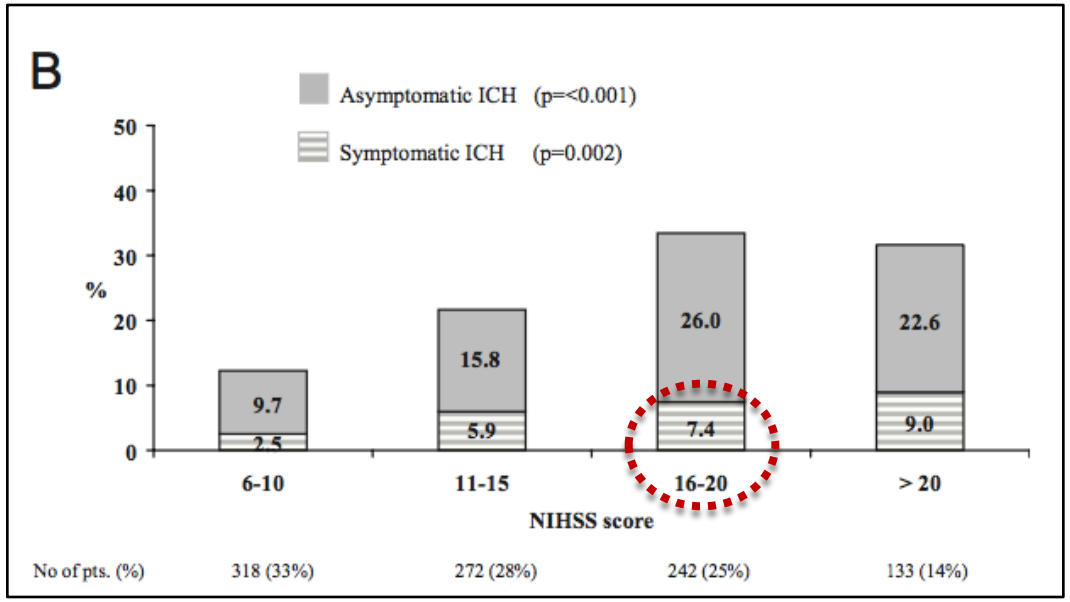
rTPA group ASPECTS ≤ 7: sICH increased 2.8% → 14.5%

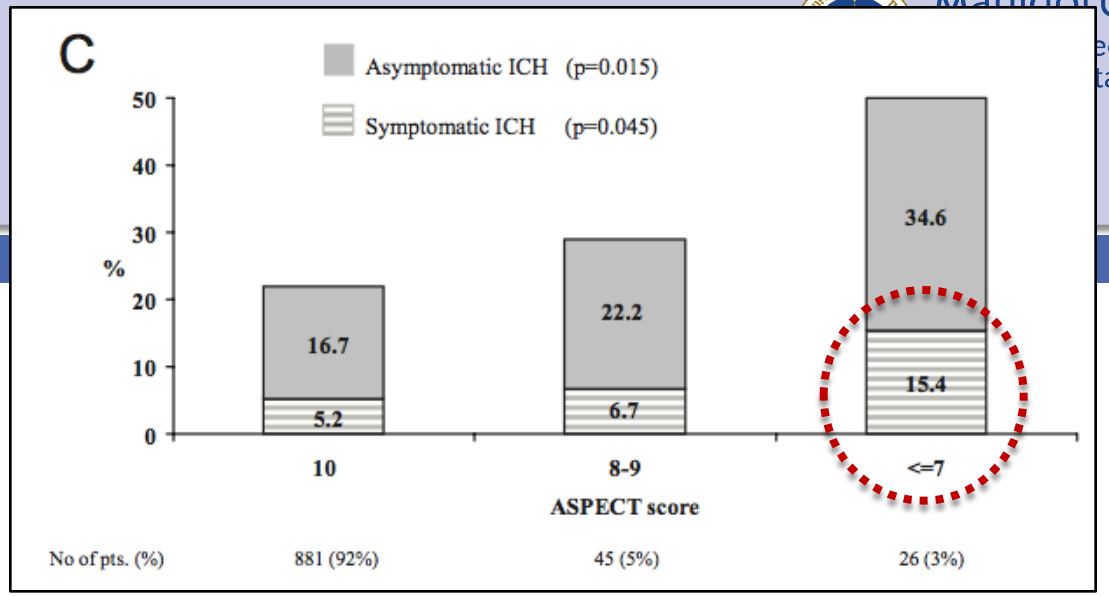
Imanuel Dzialowski, MD, et al. Stroke. 2006;37:973-978.

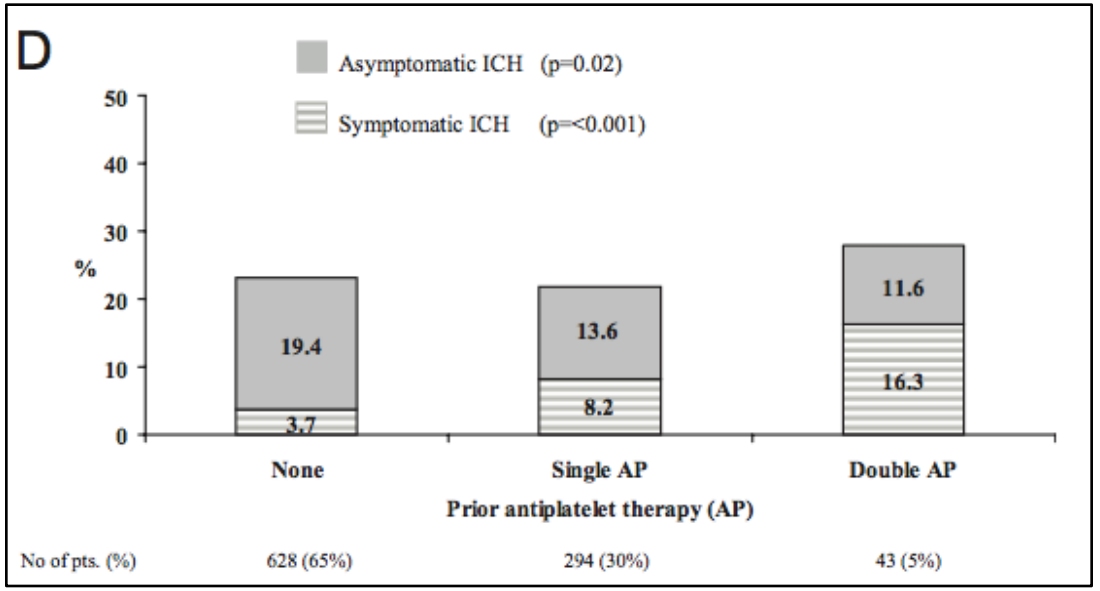
Factors Associated With Intracerebral Hemorrhage After Thrombolytic Therapy for Ischemic Stroke

Pooled Analysis of Placebo Data From the Stroke-Acute Ischemic NXY Treatment (SAINT) I and SAINT II Trials

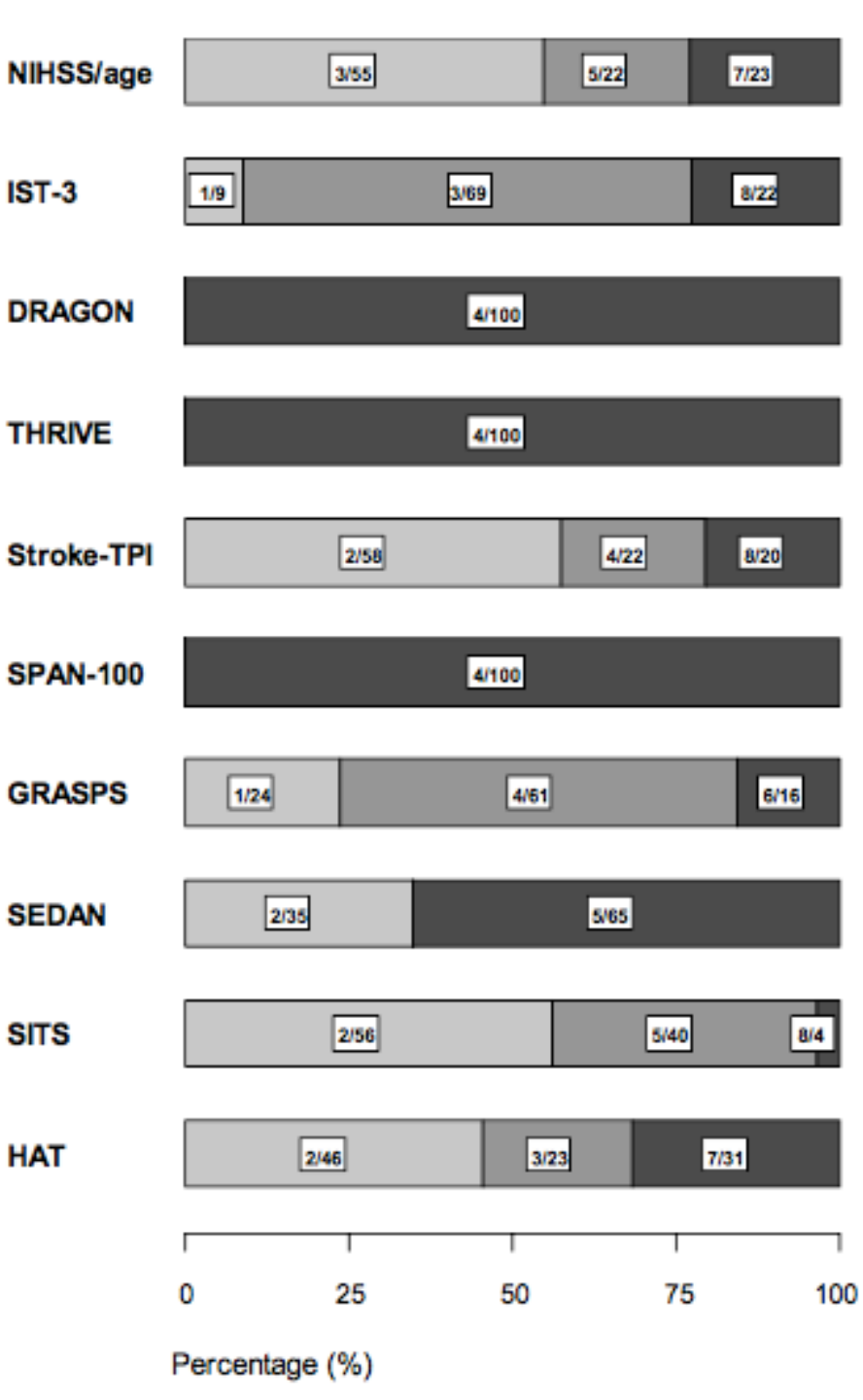
Brett Cucchiara, MD; Scott E. Kasner, MD; David Tanne, MD; Steven R. Levine, MD; Andrew Demchuk, MD; Steven R. Messe, MD; Lauren Sansing, MD; Kennedy R. Lees, MD; Patrick Lyden, MD; for the SAINT Investigators







Stroke. 2009;40:3067-3072.



Targeting Recombinant Tissue-Type Plasminogen Activator in Acute Ischemic Stroke Based on Risk of Intracranial Hemorrhage or Poor Functional Outcome

An Analysis of the Third International Stroke Trial

William N. Whiteley, PhD; Douglas Thompson, BSc; Gordon Murray, PhD; Geoff Cohen, MA; Richard I. Lindley, FRCP; Joanna Wardlaw, FRCR, FRCP; Peter Sandercock, FRCPE; on behalf of the IST-3 Collaborative Group

Stroke. 2014;45:1000-1006.

Functional outcome after rTPA

Table 1 | The SEDAN score

Item	Value	Score
Blood sugar	≤8.0 mmol/l (≤144 mg/dl)	0
	8.1–12.0 mmol/l (145–216 mg/dl)	1
	>12.0 mmol/l (>216 mg/dl)	2
Early ischaemic signs on CT	Absent	0
	Present	1
Hyperdense artery sign	Absent	0
	Present	1
Age	≤75 years	0
	>75 years	1
NIH Stroke Scale score	0–9 points	0
	≥10 points	1

	Points
NIHSS	
≤10	0
11–20	2
≥21	4
Age	
≤59	0
60–79	1
≥80	2
CDS (1 point each for HTN, DM, AFib)	
0	0
1	1
2	2
3	3

THRIVE score = ___ (0–9)

DRAGON Score

Parameter	Scale (Normal to Severe)
(hyper)Dense cerebral artery or early infarct signs in CT head scan on admission	0-2
Modified Rankin scale score >1, prestroke	0 or 1
Age	0-2
Glucose level on admission	0 or 1
Onset-to-treatment time	0 or 1
NIHSS on admission	0-3

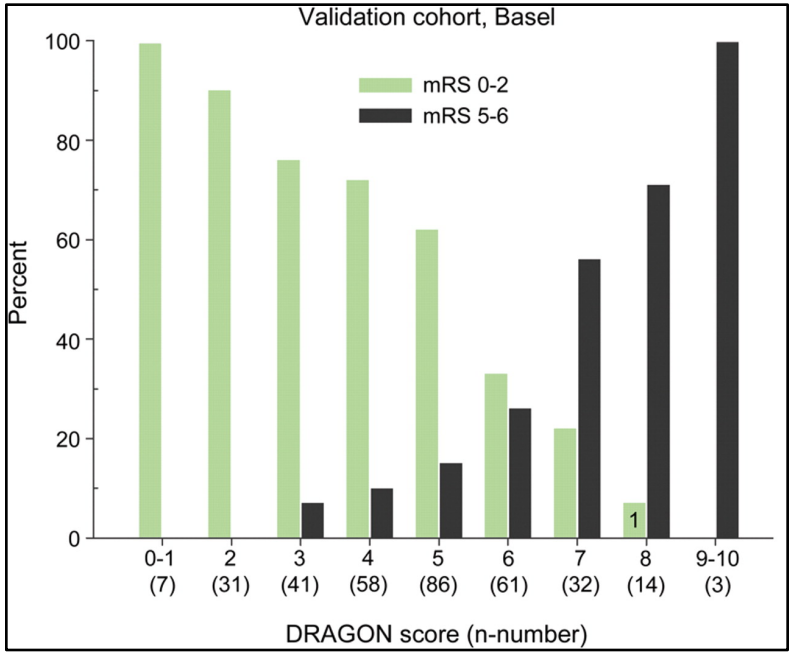
DRAGON score range: 0 – 10

Strbian D, et al. *Stroke*. 2013;44:2718-2721.

Bleeding risk after rTPA

HAT score

Clinical feature	Point value
History of diabetes of blood glucose level >200 mg/dL on admission	1
Pretreatment NIHSS 15-20	1
Pretreatment NIHSS >20	2
Easily visible hypodensity on initial CT scan in <1/3 of MCA territory	1
Easily visible hypodensity on initial CT scan in >1/3 of MCA territory	2



Bleeding risk after rTPA

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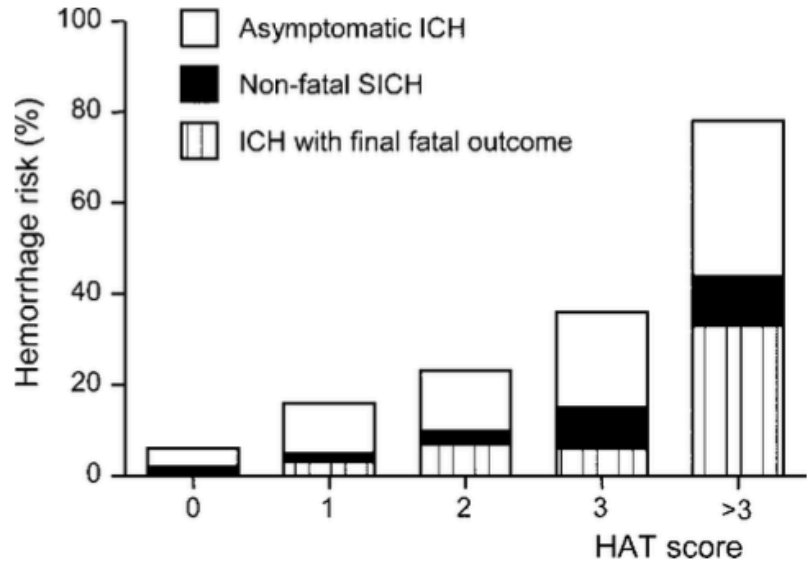
Table 1 Score assignments in the HAT score

Characteristic	Points
History of diabetes mellitus or baseline blood glucose >200 mg/dL upon admission	
No	0
Yes	1
Pretreatment NIHSS score	
<15	0
15-20	1
≥20	2
Presence of easily visible hypodensity on initial head CT scan	
No	0
<1/3 of MCA territory	1
≥1/3 of MCA territory	2

Figure Risk of intracerebral hemorrhage after tissue-plasminogen activator therapy in two cohorts combined (n = 400)



HAT score

Neurology 2008;71:1417–1423

Bleeding risk after rTPA

GWTG storke sICH 'GRASPS'

Points for age	
Class	Points
≤60	8
61-70	11
71-80	15
>80	17
Points for NIHSS	
Class	Points
0-5	25
6-10	27
11-15	34
16-20	40
>20	42
Points for Systolic Blood Pressure (mm Hg)	
Class	Points
<120	10
120-149	14
150-179	18
≥180	21
Points for Blood Glucose (mg/dl)	
Class	Points
<100	2
100-149	6
≥150	8
Points for Ethnicity	
Class	Points
Asian	9
Non-asian	0
Points for Gender	
Class	Points
Male	4
Female	0

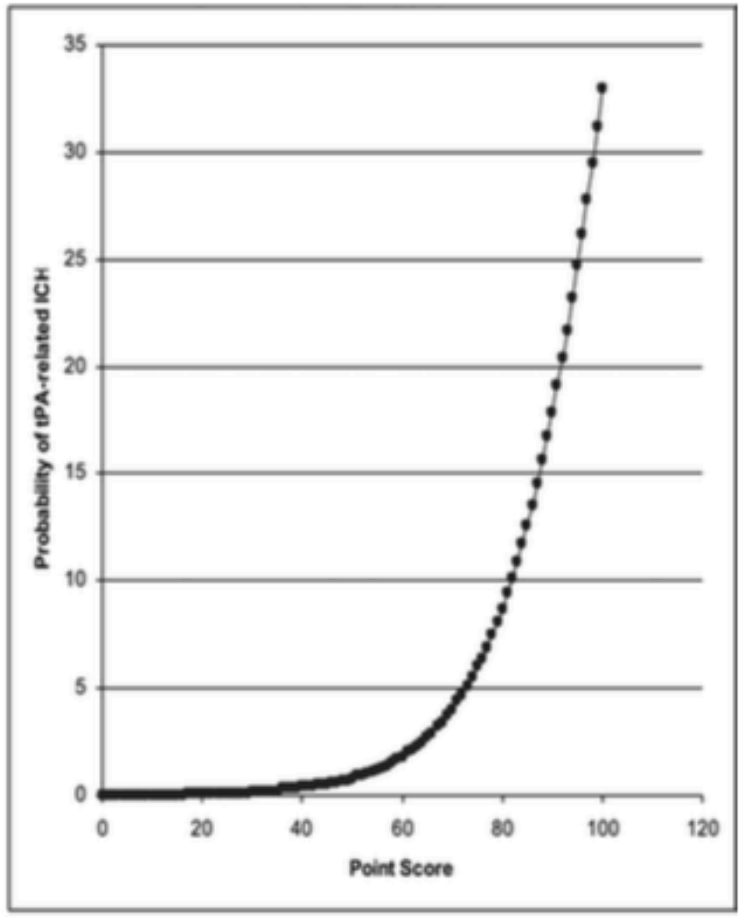


Figure 1. Risk score for symptomatic intracranial hemorrhage after IV tPA. IV tPA indicates intravenous tissue-type plasminogen activator.

Stroke. 2012;43:2293-2299.

Table 10. Inclusion and Exclusion Characteristics of Patients With Ischemic Stroke Who Could Be Treated With IV rtPA Within 3 Hours From Symptom Onset

Inclusion criteria
Diagnosis of ischemic stroke causing measurable neurological deficit
Onset of symptoms <3 hours before beginning treatment
Aged ≥18 years
Exclusion criteria
Significant head trauma or prior stroke in previous 3 months
Symptoms suggest subarachnoid hemorrhage
Arterial puncture at noncompressible site in previous 7 days
History of previous intracranial hemorrhage
Intracranial neoplasm, arteriovenous malformation, or aneurysm
Recent intracranial or intraspinal surgery
Elevated blood pressure (systolic >185 mm Hg or diastolic >110 mm Hg)
Active internal bleeding
Acute bleeding diathesis, including but not limited to
Platelet count <100 000/mm^3
Heparin received within 48 hours, resulting in abnormally elevated aPTT greater than the upper limit of normal
Current use of anticoagulant with INR >1.7 or PT >15 seconds
Current use of direct thrombin inhibitors or direct factor Xa inhibitors with elevated sensitive laboratory tests (such as aPTT, INR, platelet count, and ECT; TT; or appropriate factor Xa activity assays)
Blood glucose concentration <50 mg/dL (2.7 mmol/L)
CT demonstrates multilobar infarction (hypodensity >1/3 cerebral hemisphere)

Contraindications

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Some of these exclusions

- More common than others
- Potentially **treatable, modifiable, or reversible** before alteplase administration

Need individualized evaluations

- Levels of evidence supporting individual exclusion criteria for intravenous alteplase **vary widely**

Relative C/I (3-4.5hr)

- Age > 80y
- Taking oral anticoagulants regardless INR
- NIHSS > 25
- History of stroke and DM

Stroke. 2013;44:870-947.
Stroke. 2016;47:581-641

Contraindications

Mahidol University
Faculty of Medicine
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Exclusion criteria

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- Symptoms suggest subarachnoid hemorrhage
- Arterial puncture at noncompressible site in previous 7 days
- History of previous intracranial hemorrhage
- Intracranial neoplasm, arteriovenous malformation, or aneurysm
- Recent intracranial or intraspinal surgery
- Elevated blood pressure (systolic >185 mm Hg or diastolic >110 mm Hg)
- Active internal bleeding
- Acute bleeding diathesis, including but not limited to
- Platelet count <100 000/mm^3
- Heparin received within 48 hours, resulting in abnormally elevated aPTT greater than the upper limit of normal
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Some of these exclusions

- More common than others
- Potentially **treatable, modifiable, or reversible** before alteplase administration

Need individualized evaluations

- Levels of evidence supporting individual exclusion criteria for intravenous alteplase **vary widely**

Relative exclusion criteria

Recent experience suggests that under some circumstances, with careful consideration and weighting of risk to benefit, patients may receive fibrinolytic therapy despite ≥1 relative contraindications. Consider risk to benefit of intravenous rtPA administration carefully if any of these relative contraindications is present

- Only minor or rapidly improving stroke symptoms (clearing spontaneously)
- Pregnancy
- Seizure at onset with postictal residual neurological impairments
- Major surgery or serious trauma within previous 14 d
- Recent gastrointestinal or urinary tract hemorrhage (within previous 21 d)
- Recent acute myocardial infarction (within previous 3 mo)

Stroke. 2013;44:870-947.
Stroke. 2016;47:581-641

Appendix: Comparison of AHA/ASA Acute Stroke Management Guidelines and Previous and New FDA Prescribing Information for Alteplase (Activase) Treatment in Acute Ischemic Stroke

Criterion	AHA/ASA Acute Stroke Management Guideline 2013[24]	Old Alteplase (Activase) PI (Updated 2009)	New Alteplase (Activase) PI (February 2015)
Prior stroke	Exclusion: prior stroke within 3 mo	Contraindication: recent (within 3 mo) previous stroke	Removed entirely
Seizure at onset	Relative exclusion: seizure at onset with postictal neurological impairments	Contraindication: seizure at the onset of stroke	Removed entirely
Bleeding diathesis/OACs	Exclusion: Platelet count <100 000/mm^3 Heparin received within 48 h, resulting in abnormally elevated aPTT Current use of anticoagulant with INR >1.7 or PT >15 s Current use of direct thrombin inhibitors or direct factor Xa inhibitors with elevated sensitive laboratory tests	Contraindication: known bleeding diathesis including but not limited to: Current use of OACs (eg, warfarin sodium), an INR >I.7, or a PT >15 s Administration of heparin within 48 h preceding the onset of stroke with an elevated aPTT at presentation Platelet count <100 000/mm^3 Warning for all indications: patients currently taking OACs	Bleeding diathesis remains a contraindication, but all laboratory values and specific examples removed
ICH	Exclusion: history of previous ICH	Contraindication: history of ICH	Contraindication removed Warning added for recent ICH
BP	Exclusion: Elevated BP (systolic >85 mm Hg or diastolic >10 mm Hg)	Contraindication: uncontrolled hypertension at the time of treatment (eg, >185 mm Hg systolic or >110 mm Hg diastolic)	Contraindication: current severe uncontrolled hypertension remains, specific BP values removed Warning for BP >175/110 mm Hg remains for all alteplase (Activase) indications

Stroke. 2016;47:581-641

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Criterion	AHA/ASA Acute Stroke Management Guideline 2013[24]	Old Alteplase (Activase) PI (Updated 2009)	New Alteplase (Activase) PI (February 2015)
Blood glucose	Exclusion: blood glucose <50 mg/dL	Warning: because of the increased risk for misdiagnosis of acute ischemic stroke, special diligence is required in making this diagnosis in patients whose blood glucose values are ≈50 or >400 mg/dL	Removed entirely
Severe stroke	Not listed	Warning: patients with severe neurological deficit (NIHSS score >22) at presentation; there is an increased risk of ICH in these patients	Removed entirely
Mild stroke	Relative exclusion: only minor or rapidly improving stroke symptoms (clearing spontaneously)	Warning: safety and efficacy in patients with minor neurological deficit or with rapidly improving symptoms have not been evaluated; therefore, treatment of patients with minor neurological deficit or with rapidly improving symptoms is not recommended	Removed entirely
Neuroimaging findings	Exclusion: CT demonstrates multilobar infarction (hypodensity >1/3 cerebral hemisphere)	Warning: Major early infarct sign (substantial edema, mass effect, or midline shift on CT)	Removed entirely
SAH	Exclusion: symptoms suggest SAH	Contraindication: Suspicion of SAH on pretreatment evaluation	Contraindication: subarachnoid hemorrhage

Stroke. 2016;47:581-641

Appendix: Comparison of AHA/ASA Acute Stroke Management Guidelines and Previous and New FDA Prescribing Information for Alteplase (Activase) Treatment in Acute Ischemic Stroke

Criterion	AHA/ASA Acute Stroke Management Guideline 2013[24]	Old Alteplase (Activase) PI (Updated 2009)	New Alteplase (Activase) PI (February 2015)
Use in specific populations			
Pregnancy	Relative exclusion	Warning: pregnancy Category C	No change
Nursing mothers	Not listed	Not mentioned	Unknown risk
Children	Inclusion: ≥18 y of age	Indicated for adults	Pediatric use not established
Elderly	Not listed	Warning for all indications: advanced age (eg, >75 y) may increase risks	Warning added: age >77 y was 1 of several interrelated baseline characteristics associated with an increased risk of ICH; efficacy results suggest a reduced but still favorable clinical outcome
Gastrointestinal or genitourinary bleeding	Warning: gastrointestinal or genitourinary bleeding within the past 21 d	Warning: gastrointestinal or genitourinary bleeding within the past 21 d	Warning: gastrointestinal or genitourinary bleeding

Stroke. 2016;47:581-641

Table 7. Comparison of Favorable Outcomes at 90 Days Between tPA and Control Among Participants <80 and >80 Years of Age in the NINDS and IST-3 Trials

Study	Age Group, y	tPA, n	Control, n	Favorable Outcome at 3 mo		
				tPA, n (%)	Control, n (%)	OR (95% CI)
NINDS[1]	≤80	272	283	142 (52.2)	102 (36.0)	1.94 (1.38–2.72)
	>80	40	29	9 (22.5)	6 (20.7)	1.11 (0.35–3.37)
IST-3[6]	≤80	698	719	331 (47.4)	346 (48.1)	0.92 (0.67–1.26)
	>80	817	799	223 (27.3)	188 (23.5)	1.35 (0.97–1.88)
Total	≤80	970	1002	473 (48.8)	433 (43.2)	1.25 (1.04–1.50)
	>80	857	828	232 (27.1)	194 (23.4)	1.21 (0.97–1.52)

Predictor for post rTPA bleeding

- Large infarction area (NIHSS, ASPECTS)
- High blood pressure
- Older age
- DM (high blood sugar)

Stroke. 2016;47:581-641
Jonathan Emberson, et al. Lancet 2014; 384: 1929–35

Age: not contraindicate

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Faculty of Medicine
Siriraj Hospital

Age > 80 y
Favorable outcome
mRS 0-2 > control in 3 hr onset

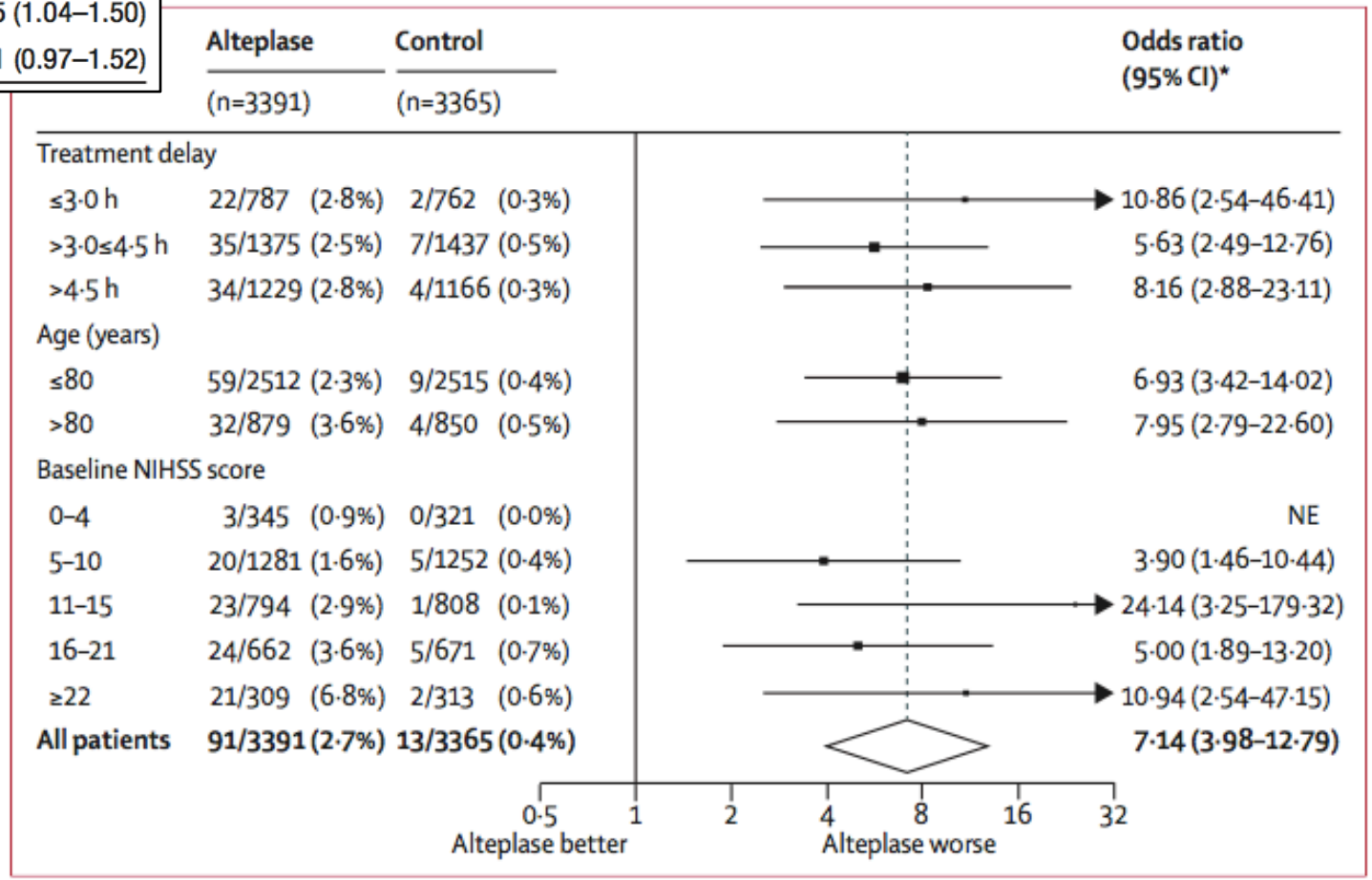


Figure 4: **Effect of alteplase on fatal intracranial haemorrhage within 7 days by treatment delay, age, and stroke severity**

Adverse effect: Alteplase

Orolingual angioedema

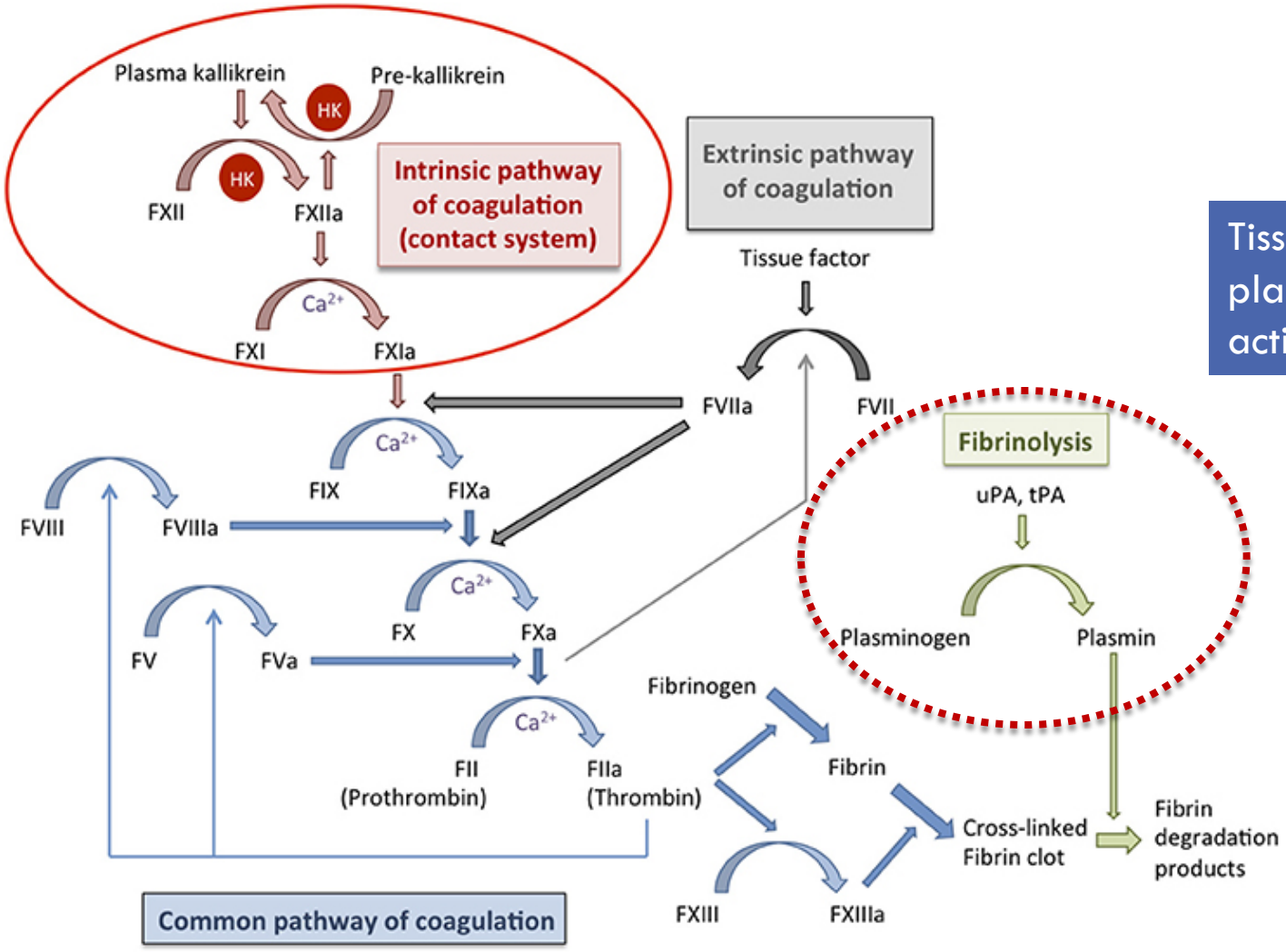
1.3-5.1% swelling of tongue, lips or oropharynx
Typically mild, transient → can be severe airway obstruction
Contralateral to ischemic hemisphere
Associated risk

- ACEI used, insular and frontal cortex infarction

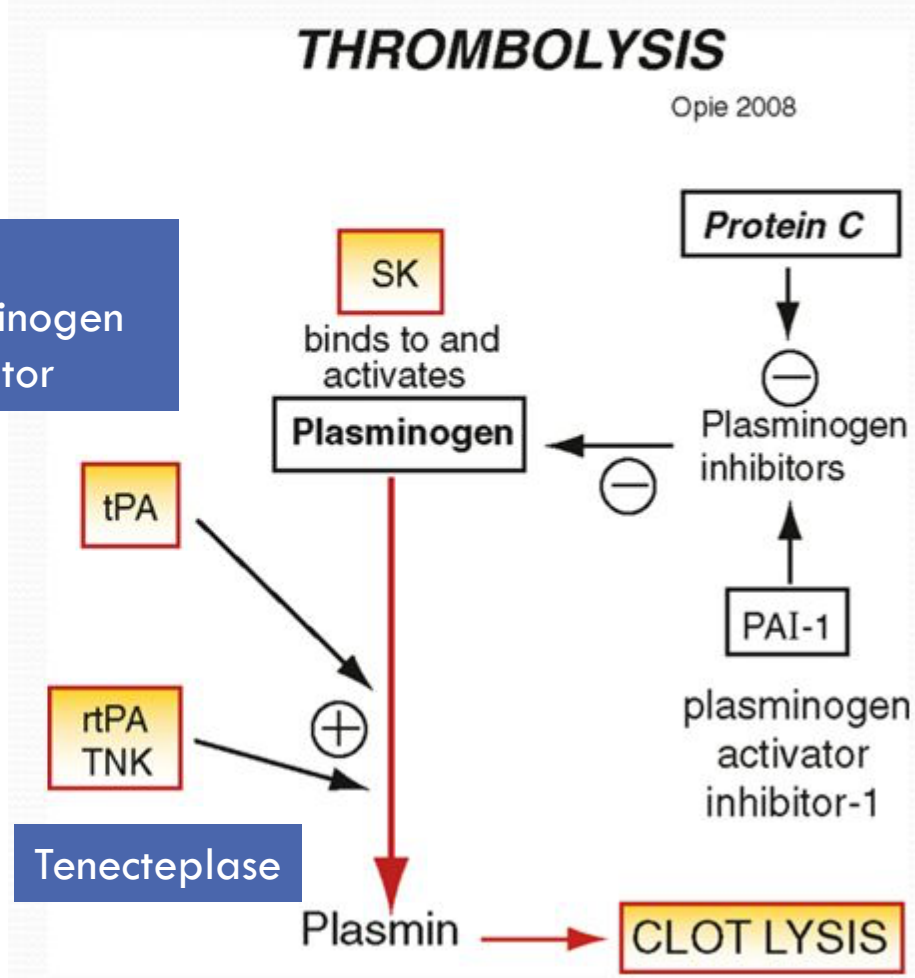
Rx: diphenhydramine, methylprednisolone

Stroke. 2013;44:870-947.

Mechanism of rTPA



Tissue plasminogen activator



Mechanism of rTPA

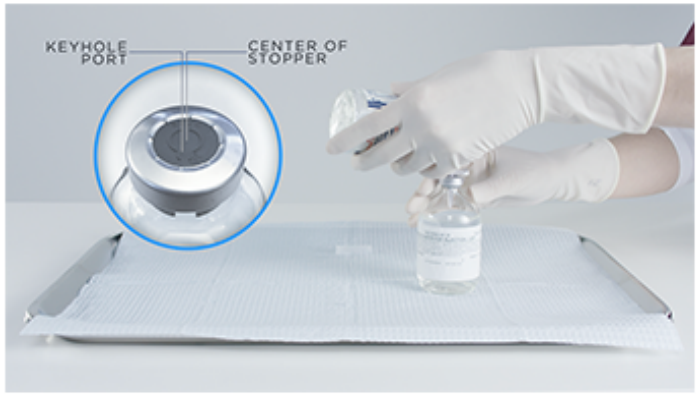
How to give rTPA

REMOVE CAPS

STERILIZE

INSERT TRANSFER PIN IN SWFI VIAL

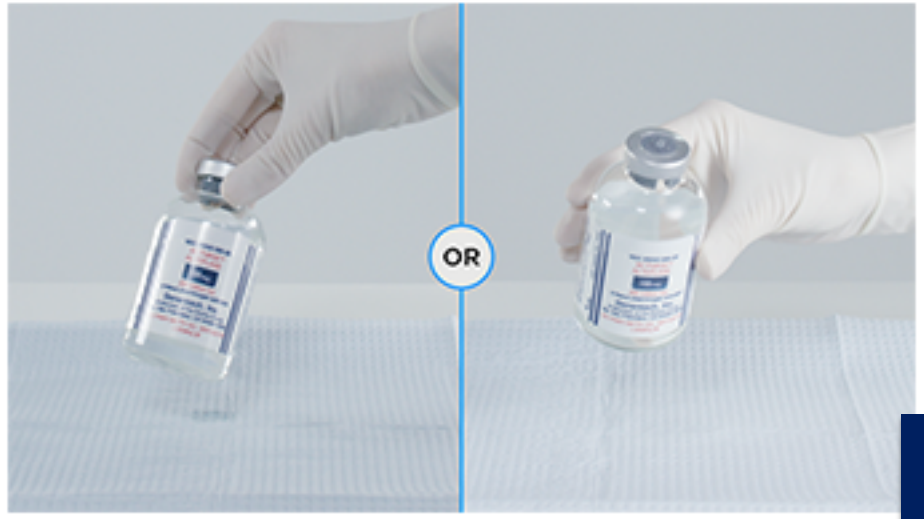
INSERT ACTIVASE VIAL ON OTHER END OF PIN



PUSH DOWN

INVERT VIALS

MIX GENTLY



LET IT SETTLE (SEVERAL MINUTES)

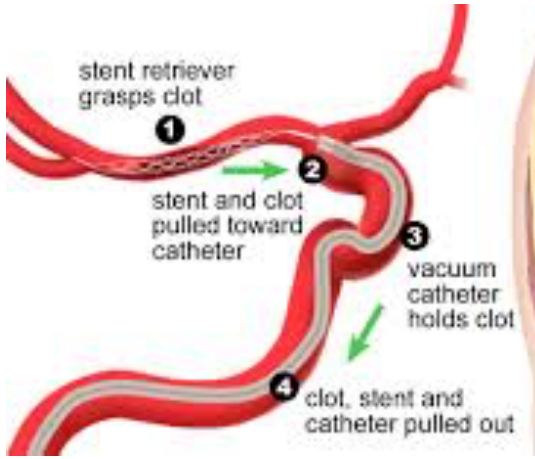
INSPECT SOLUTION

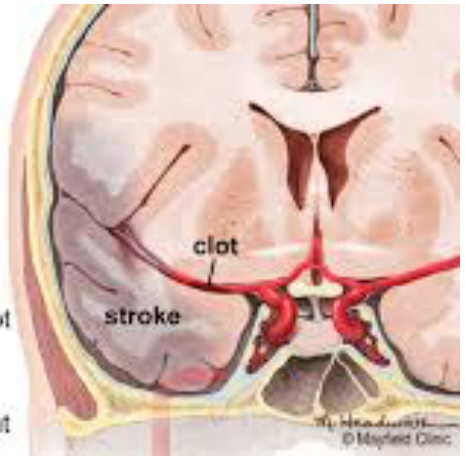
Mechanical thrombectomy

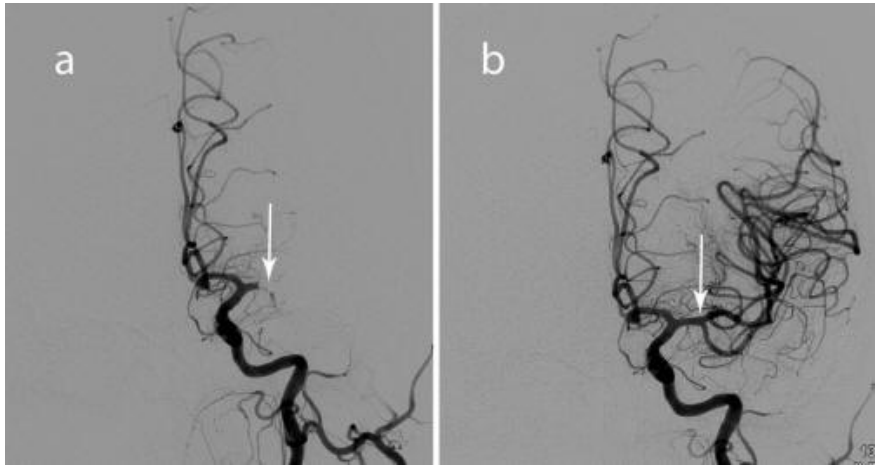
Anterior circulation stroke

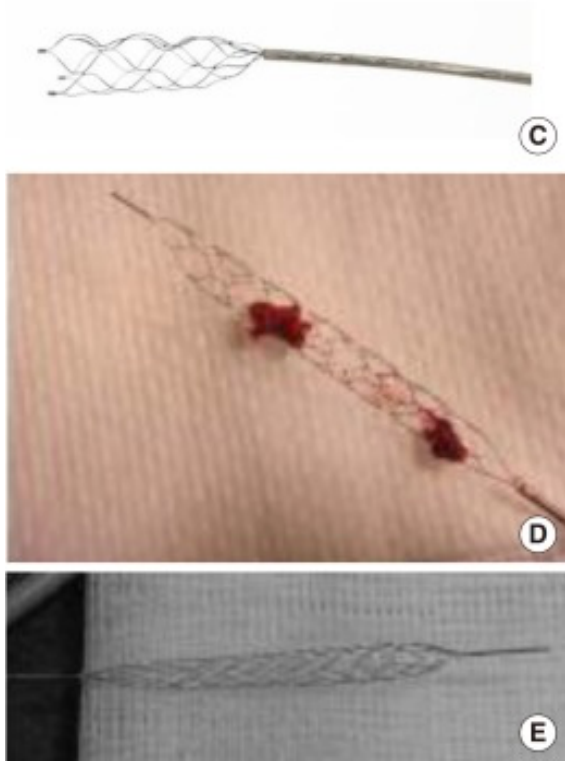
Time

0 — 3 — 4.5 — 6 — 8 — 12 — 24 hr









Large a. occlusion: ICA, MCA (proximal M1)

Mechanical thrombectomy

Anterior circulation stroke

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

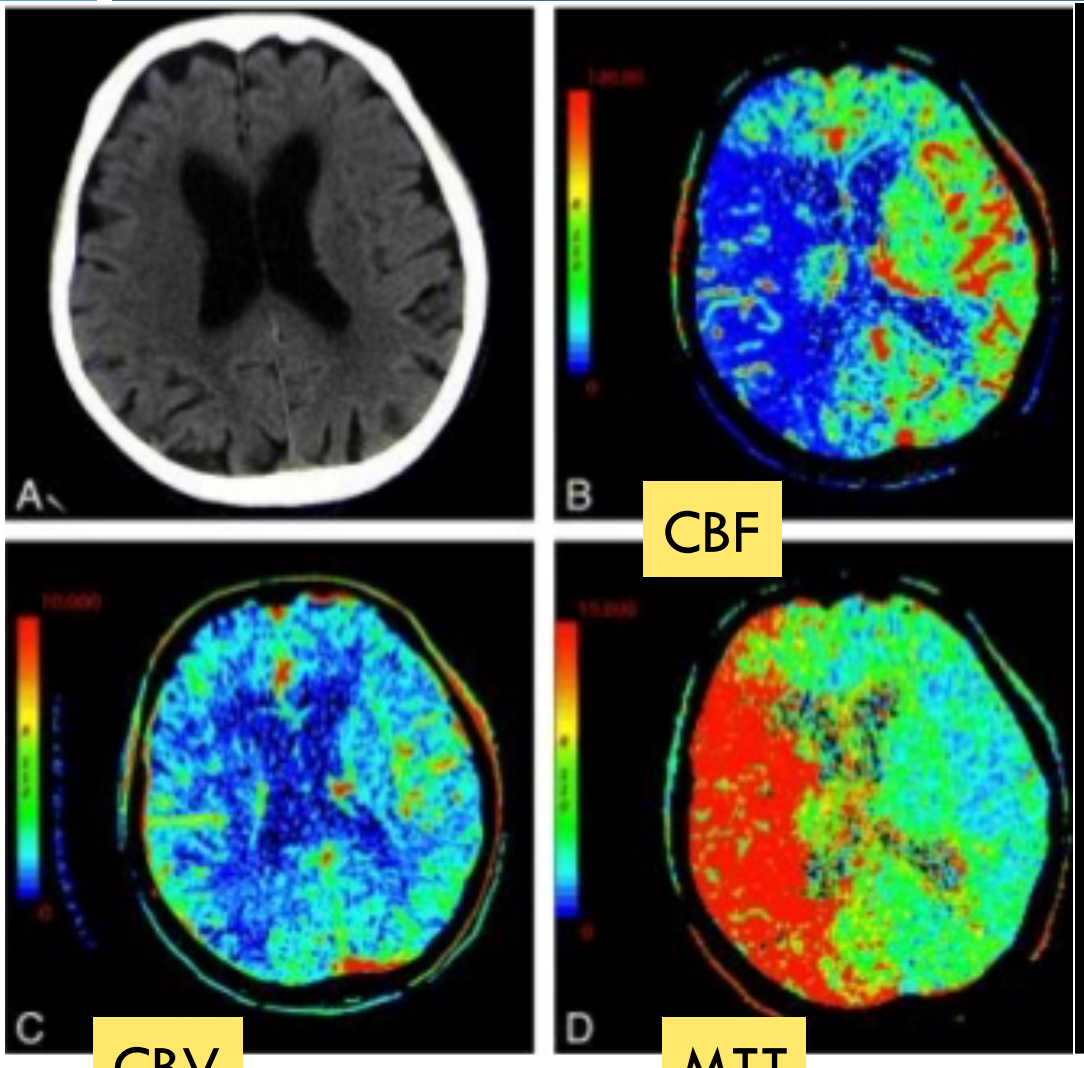
a. Prestroke mRS score 0 to 1,
b. Acute ischemic stroke receiving intravenous r-tPA within 4.5 hours of onset according to guidelines from professional medical societies,
c. Causative occlusion of the ICA or proximal MCA (M1),
d. Age ≥18 years,
e. NIHSS score of ≥6,
f. ASPECTS of ≥6, and
g. Treatment can be initiated (groin puncture) within 6 hours of symptom onset

Siriraj protocal: within 8 hr

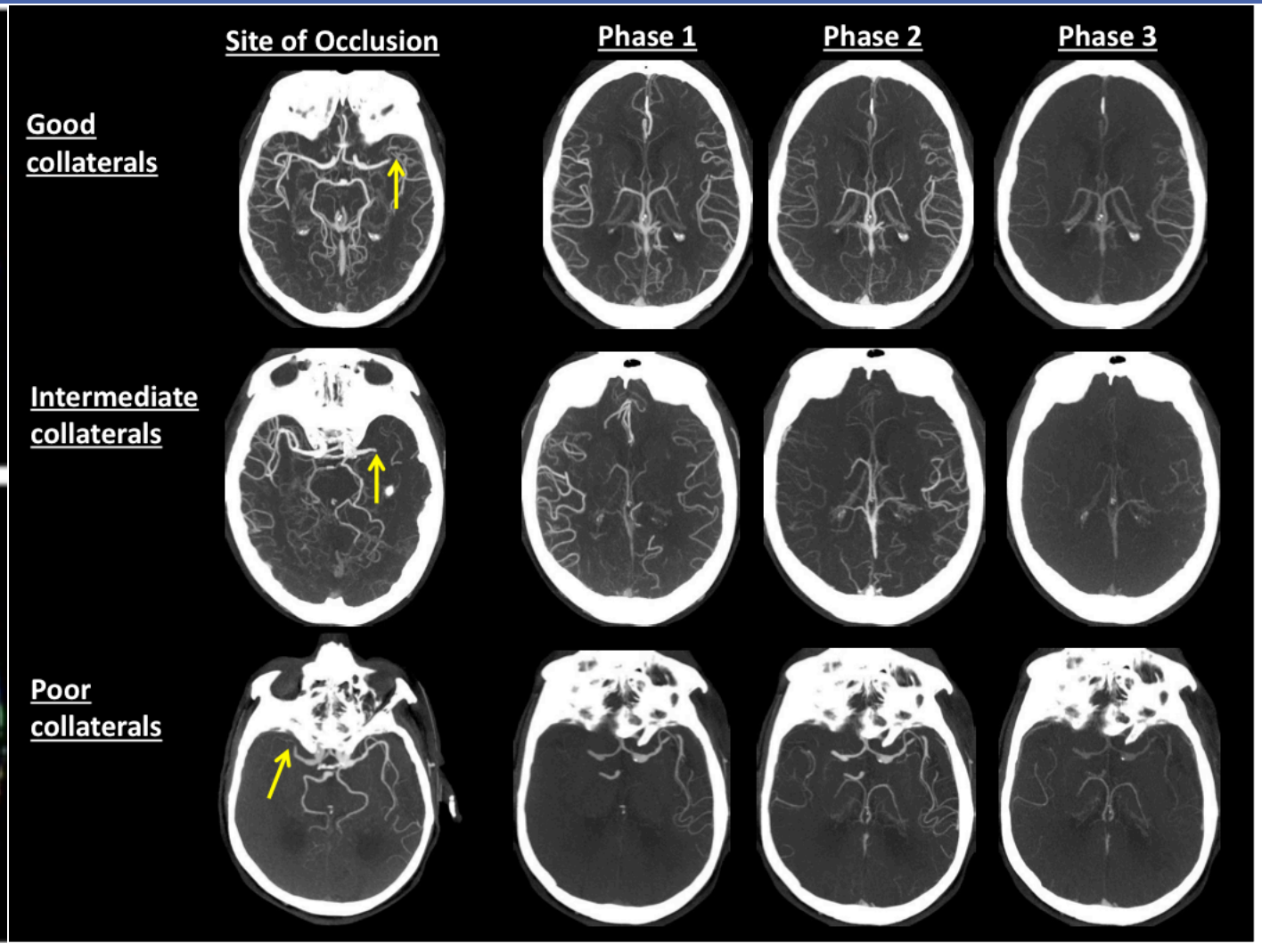
ASPECT score $\geq$ 6 or
Collateral score $\geq$ 3 or
Mismatched area $\geq$ 2/3 of the territory
(Ischemic zone-reversible)

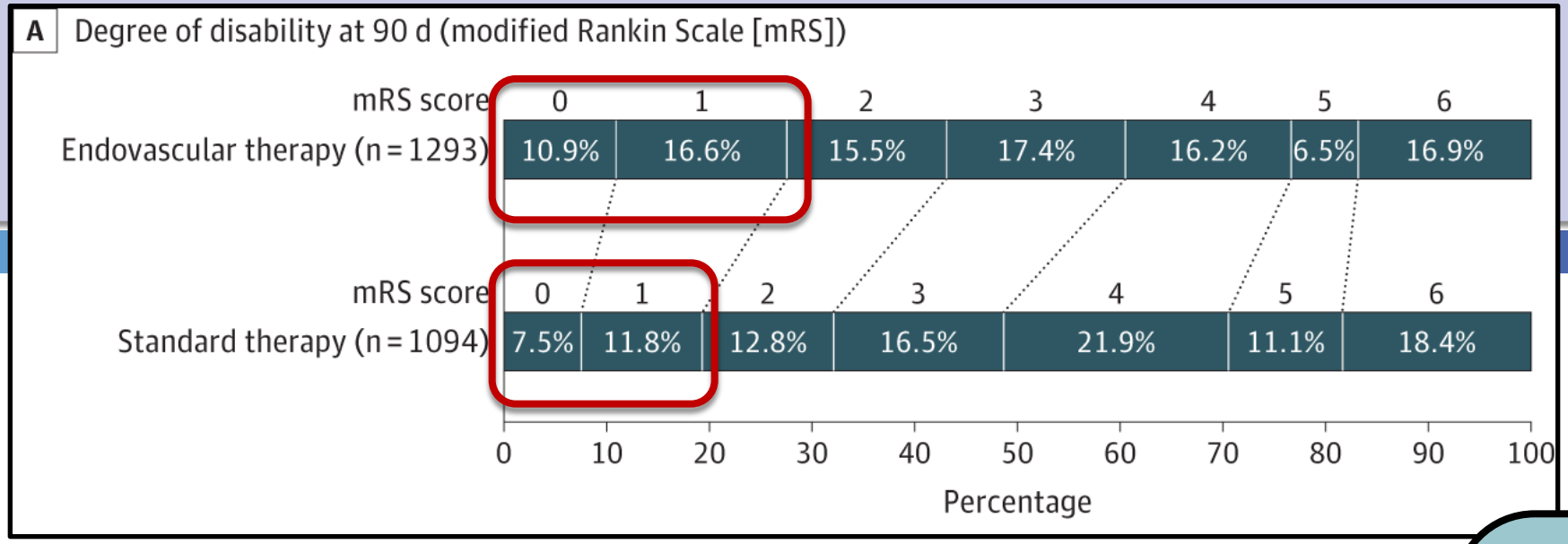
Stroke. 2015;46: 3024-3039.

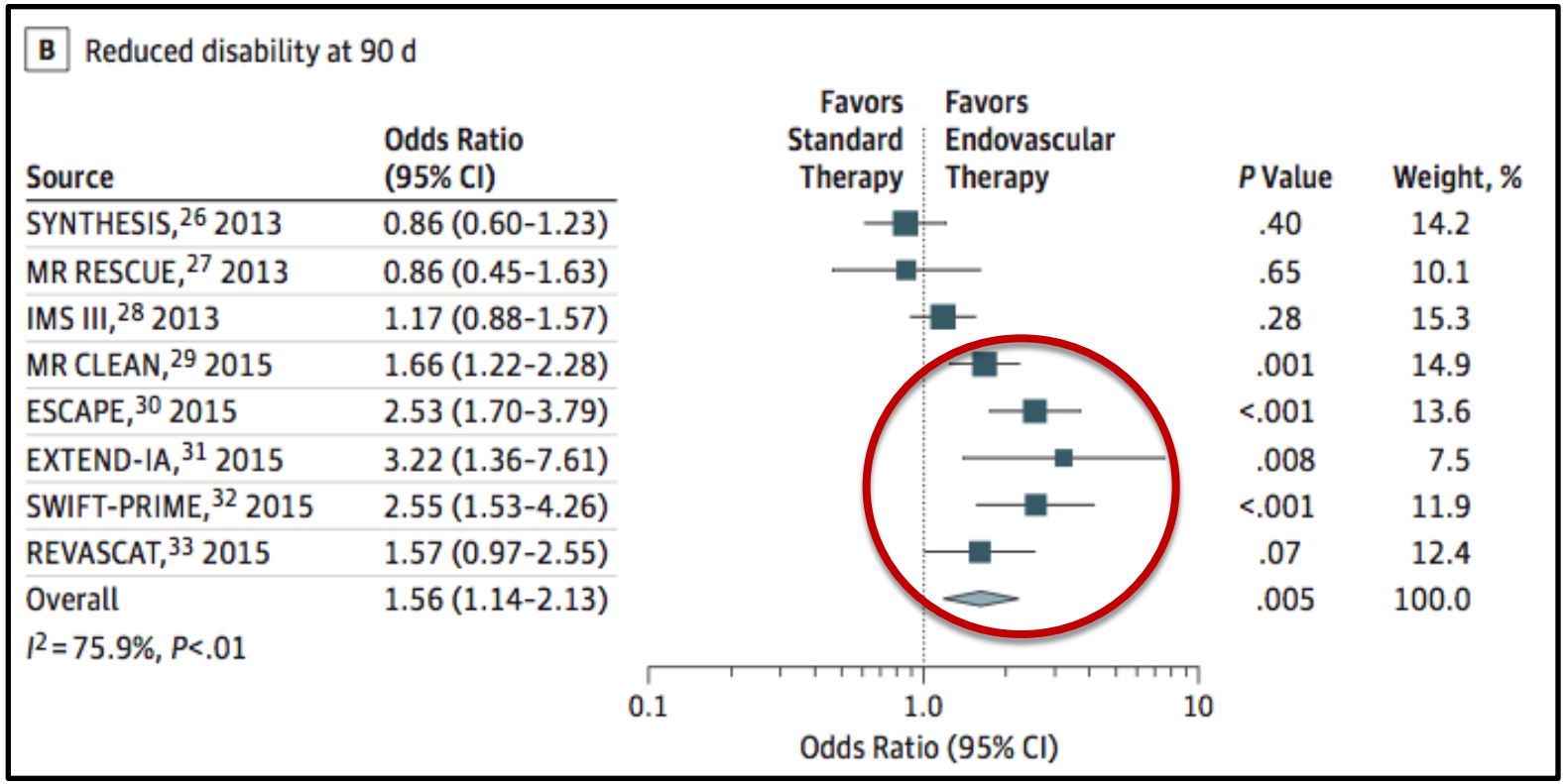
CT perfusion
Penumbra zone (CBV/CBF mismatch)



Multi-phase CTA







Mechanical thrombectomy

- Favorable outcome
- Add on standard therapy: 8.2%

NNT=4
Not differ in sICH

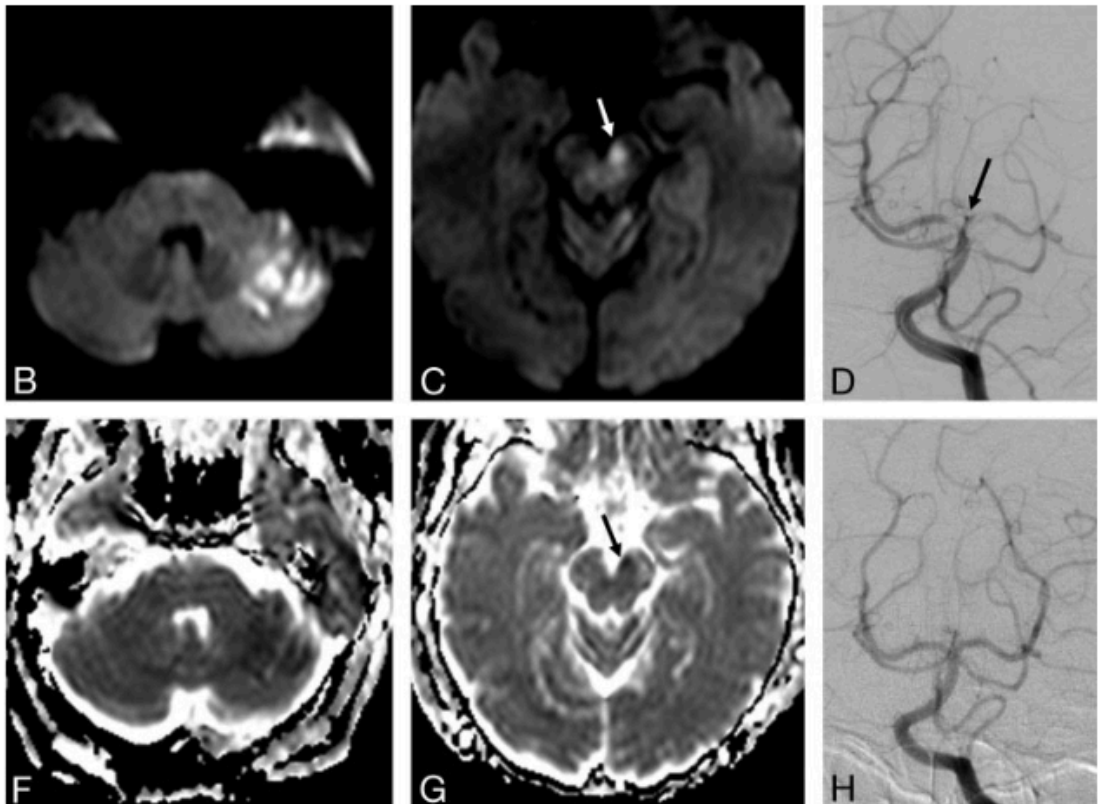
Jeffrey L. Saver, et al. *JAMA*. 2016;316(12)

Mechanical thrombectomy

Posterior circulation stroke

Time

0 3 4.5 6 8 12 24 hr



Without clinical or imaging of brainstem infarction

High mortality and morbidity rates associated with basilar artery occlusion

Lack evidence from RCT for efficacy
45 observational study meta-analysis show decrease in death or dependency

International Journal of Stroke 2016, Vol. 11(1) 134–147

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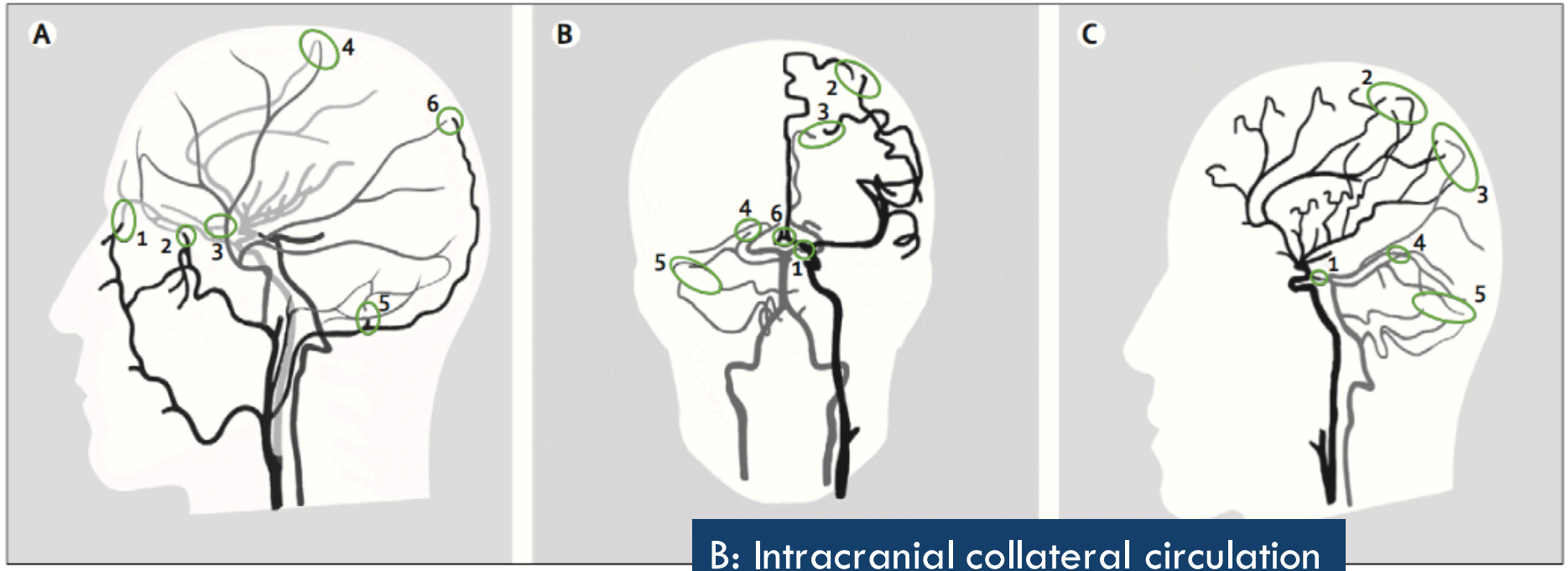
Faculty of Medicine
Siriraj Hospital

Collateral blood vessels in acute stroke

Collateral flow can sustain brain tissue for hours after the occlusion of major arteries to the brain

A: Extra-intracranial circulation

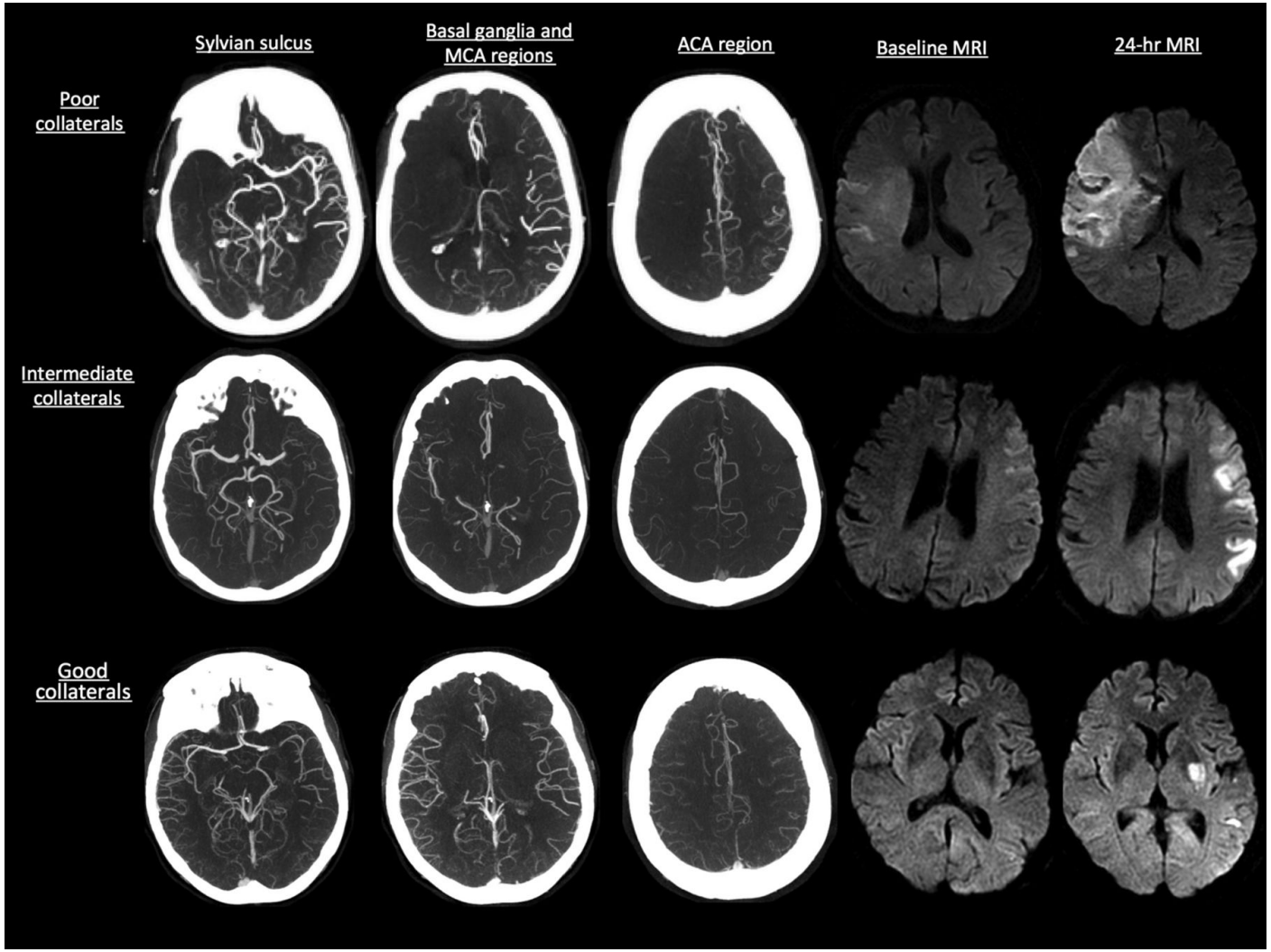


B: Intracranial collateral circulation

Figure 1: **Cerebral arterial circulation**
(A) Extracranial arterial collateral circulation. Shown are anastomoses from the facial (1), maxillary (2), and middle meningeal (3) arteries to the ophthalmic artery, and dural arteriolar anastomoses from the middle meningeal artery (4) and occipital artery through the mastoid foramen (5) and parietal foramen (6). Intracranial arterial collateral circulation in frontal (B) and lateral (C) views. Shown are the posterior communicating artery (1); leptomeningeal anastomoses between anterior and middle cerebral arteries (2) and between posterior and middle cerebral arteries (3); the tectal plexus between posterior cerebral and superior cerebellar arteries (4); anastomoses of distal cerebellar arteries (5); and the anterior communicating artery (6). Reproduced from Liebeskind,[7] by permission of Wolters Kluwer Health.

Lancet Neurol 2011; 10: 909–21

Collateral blood vessels in acute stroke



Collateral blood vessels in acute stroke

***Panel 1:* Conditions that might adversely affect collateral status**

- Congenital lack of collateral anatomy (ie, incomplete circle of Willis)
- Dehydration
- Hyperthermia
- Hyperglycaemia
- Increased blood viscosity
- Systemic infections
- Pulmonary compromise
- Cardiac failure
- Electrolyte and renal dysfunction
- Drugs that inhibit physiological augmentation of blood pressure (ie, high-dose antihypertensives)*
- Widespread cerebral atherosclerosis

*Some vasodilatory antihypertensives, particularly nitric oxide donors, might enable collateral flow.[50]

Maintain good collateral is importance

Good collateral circulation

- Prevent or delay permanent neural damage
- Could restrict the extent of infarction in ischaemic stroke

**effectiveness of collateral flow varies greatly between patients

Lancet Neurol 2011; 10: 909–21

	Modality	Grading system	Comments
Kucinski et al[25]	Cerebral angiography	1 (good): ≥3 MCA branches (retrograde filling) 2 (poor): <3 MCA branches	Small series; scoring system not validated
Higashida et al[59]	Cerebral angiography	0: no collateral vessels filled 1: slow collateral filling to periphery 2: rapid collateral filling to periphery 3: collaterals with slow but complete flow in ischaemic bed 4: rapid and complete flow in entire ischaemic territory	Scoring system not validated
Miteff et al[9]	CT angiography	1 (good): entire MCA distal to occlusion reconstituted with contrast 2 (moderate): some branches of MCA reconstituted in Sylvian fissure 3 (poor): distal superficial branches reconstituted	Large thrombolysis series; excellent outcome in patients with good collaterals

Lancet Neurol 2011; 10: 909–21

	Modality	Grading system	Comments
Maas et al[60]	CT angiography	1: absent 2: less than contralateral side 3: equal to contralateral side 4: greater than contralateral side 5: exuberant	Large series from two centres; scoring system not validated
Tan et al[61]	CT angiography	0: absent 1: <50% collateral MCA filling 2: >51–99% 3: 100%	Small series; clot volume also calculated; scoring system not validated
Lee et al[62]	MRI, magnetic resonance angiography	Distal hyperintense vessels on FLAIR MRI 1: absent 2: subtle 3: prominent	Small series; all patients had proximal MCA occlusion; prominent hyperintense vessels predicted good outcome; scoring system not validated

	Modality	Grading system	Comments
Silvestrini et al[63]	Transcranial doppler	Collateral supply inferred by direction of flow in ophthalmic artery, anterior cerebral artery, and posterior cerebral artery Good: ≥2 vessels insonated Poor: ≤1 vessel insonated	Carotid dissection case series; good collateral flow associated with good prognosis; no validation study

MCA=middle cerebral artery. FLAIR=fluid-attenuated inversion recovery.

Table: **Collateral vessel grading systems by study**

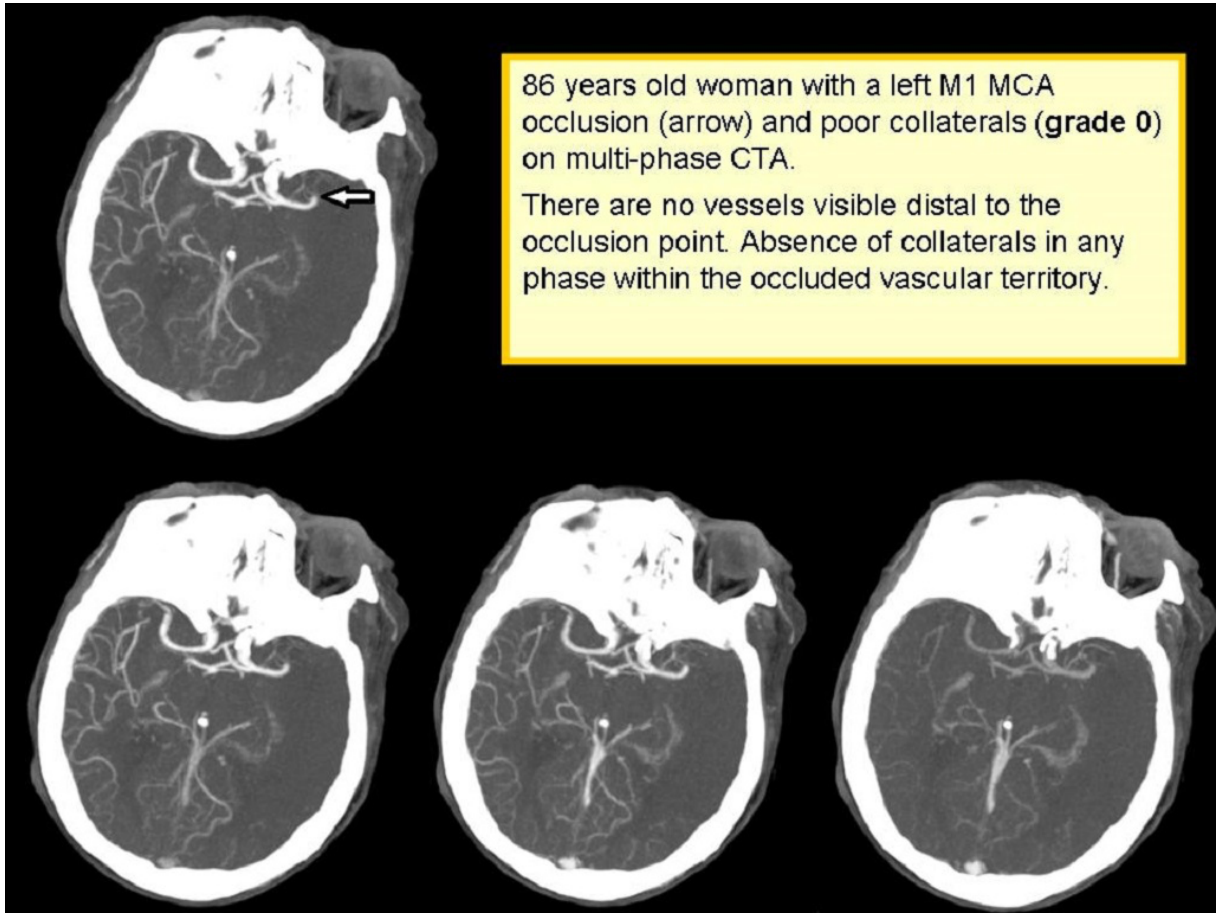
Multiphase CTA (MCTA) collateral score

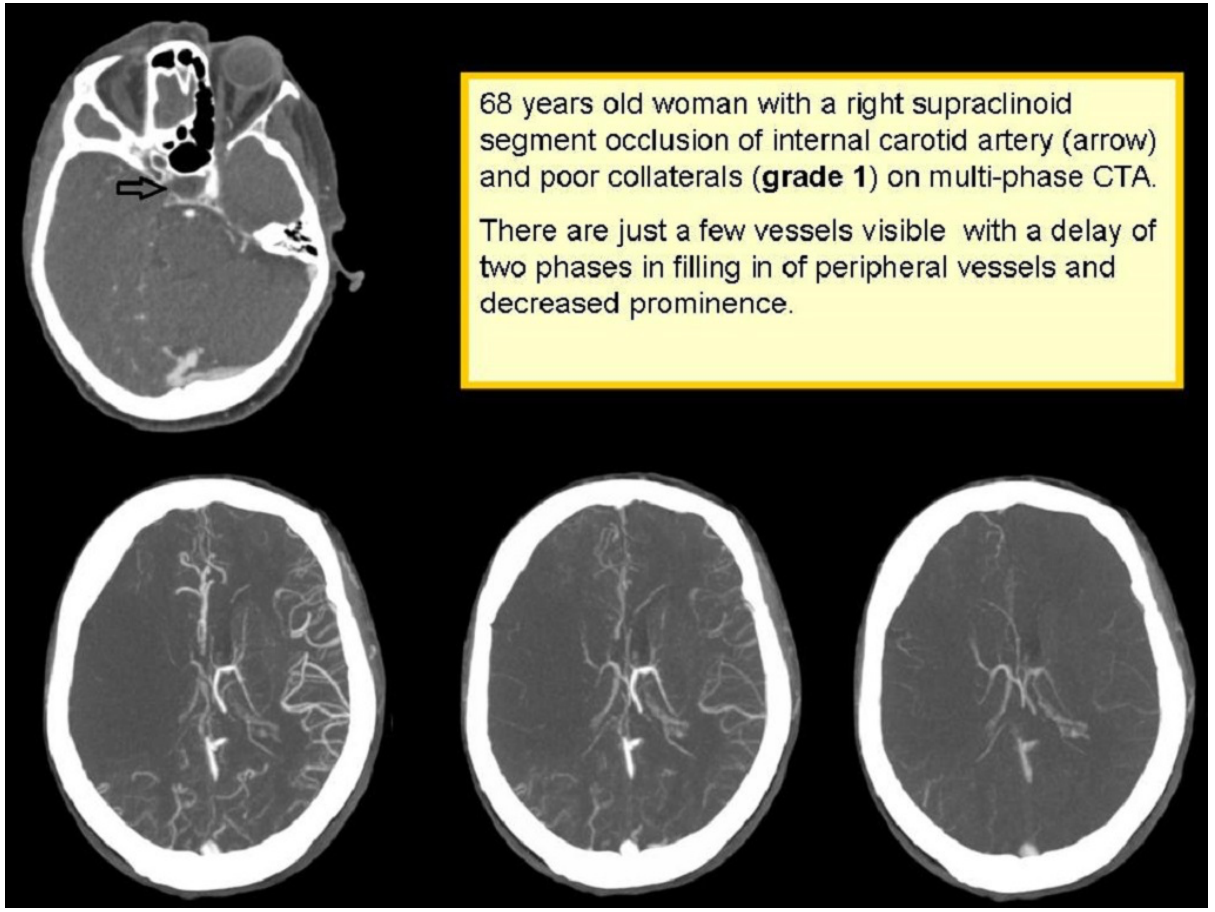
Category	Score	Findings
Poor	0	Compared to asymptomatic contralateral hemisphere: ▪There are no vessels visible in any phase within the occluded vascular territory.
	1	Compared to asymptomatic contralateral hemisphere: ▪There are just a few vessels visible in any phase within the occluded vascular territory.
Intermediate	2	Compared to asymptomatic contralateral hemisphere ther is : ▪ A delay of two phases in filling in of peripheral vessels and decreased prominence (thinner vessels) and extent. or ▪ A one-phase delay and some regions with no vessels in some part of the territory occluded.
	3	Compared to asymptomatic contralateral hemisphere there is: ▪A delay of two phases in filling in of peripheral vessels but prominence and extent is the same. or ▪A one phase delay and decreased prominence and reduced number of vessels in some part of the territory occluded.
Good	4	Compared to asymptomatic contralateral hemisphere: ▪There is a delay of one phase in filling in of peripheral vessels but prominence and extent are the same.
	5	Compared to asymptomatic contralateral hemisphere, there is: ▪No delay, normal or increased prominence and normal extent of peripheral vessels.

Collateral scores of 4 and 5 have over 80% rate of inclusion for thrombectomy in the setting of a large vessel occlusion

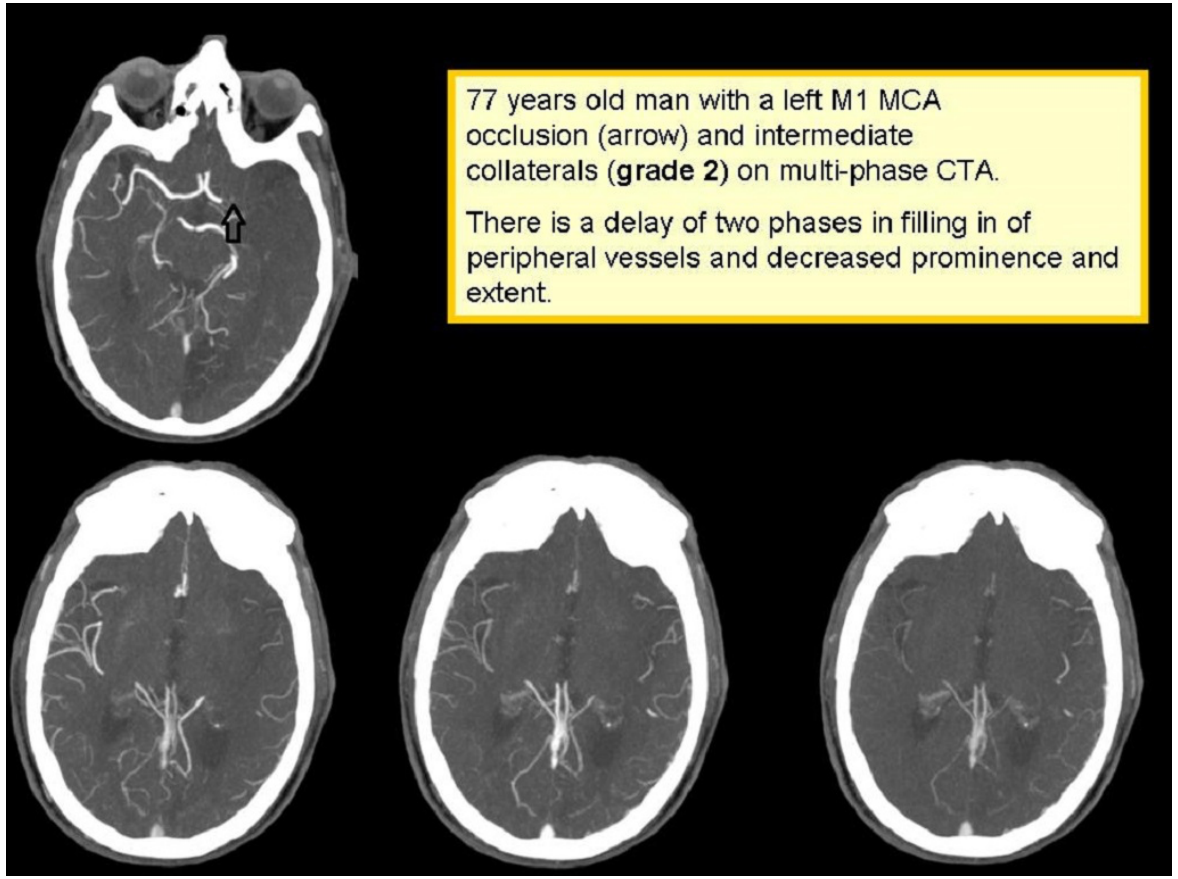
G. Bennett, et al. BMJ Volume 9, Issue Suppl 1

Multiphase CTA (MCTA) collateral score



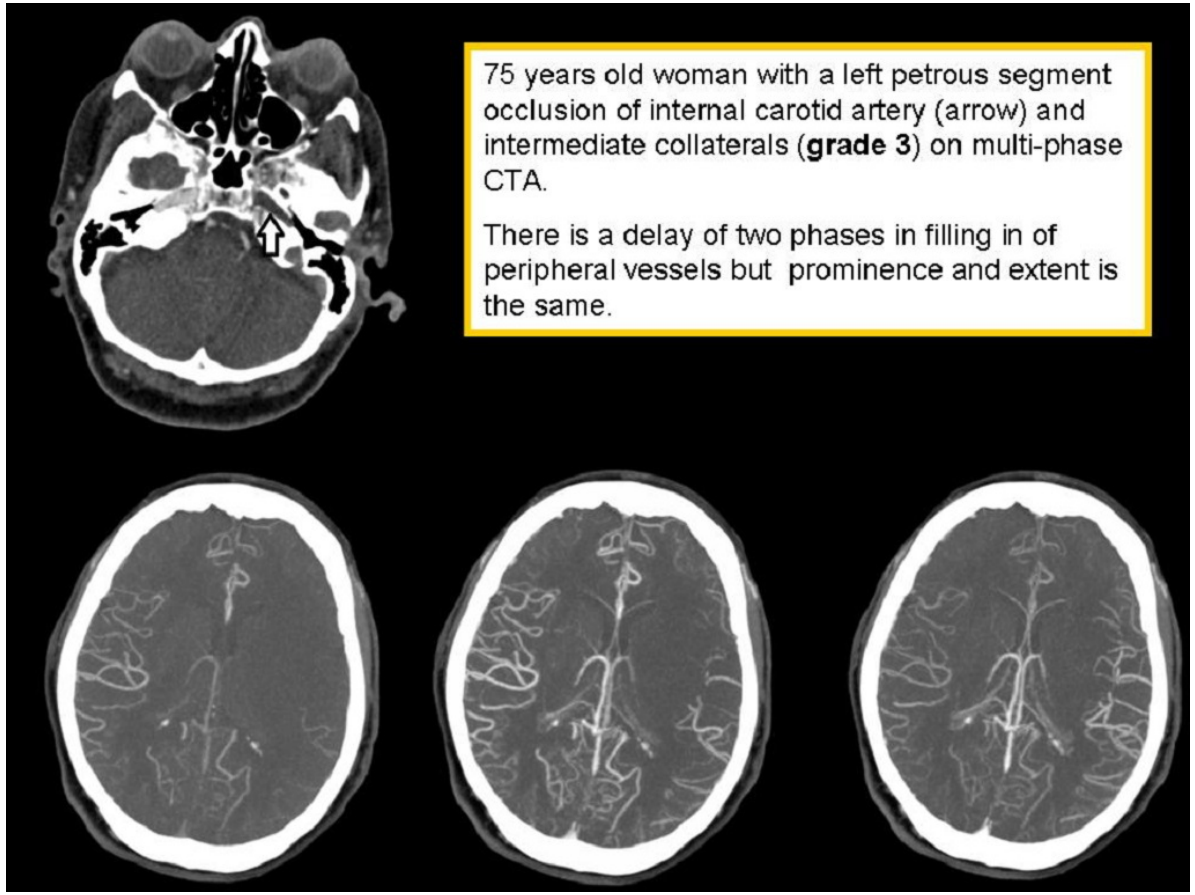


Multiphase CTA (MCTA) collateral score



77 years old man with a left M1 MCA occlusion (arrow) and intermediate collaterals (**grade 2**) on multi-phase CTA.

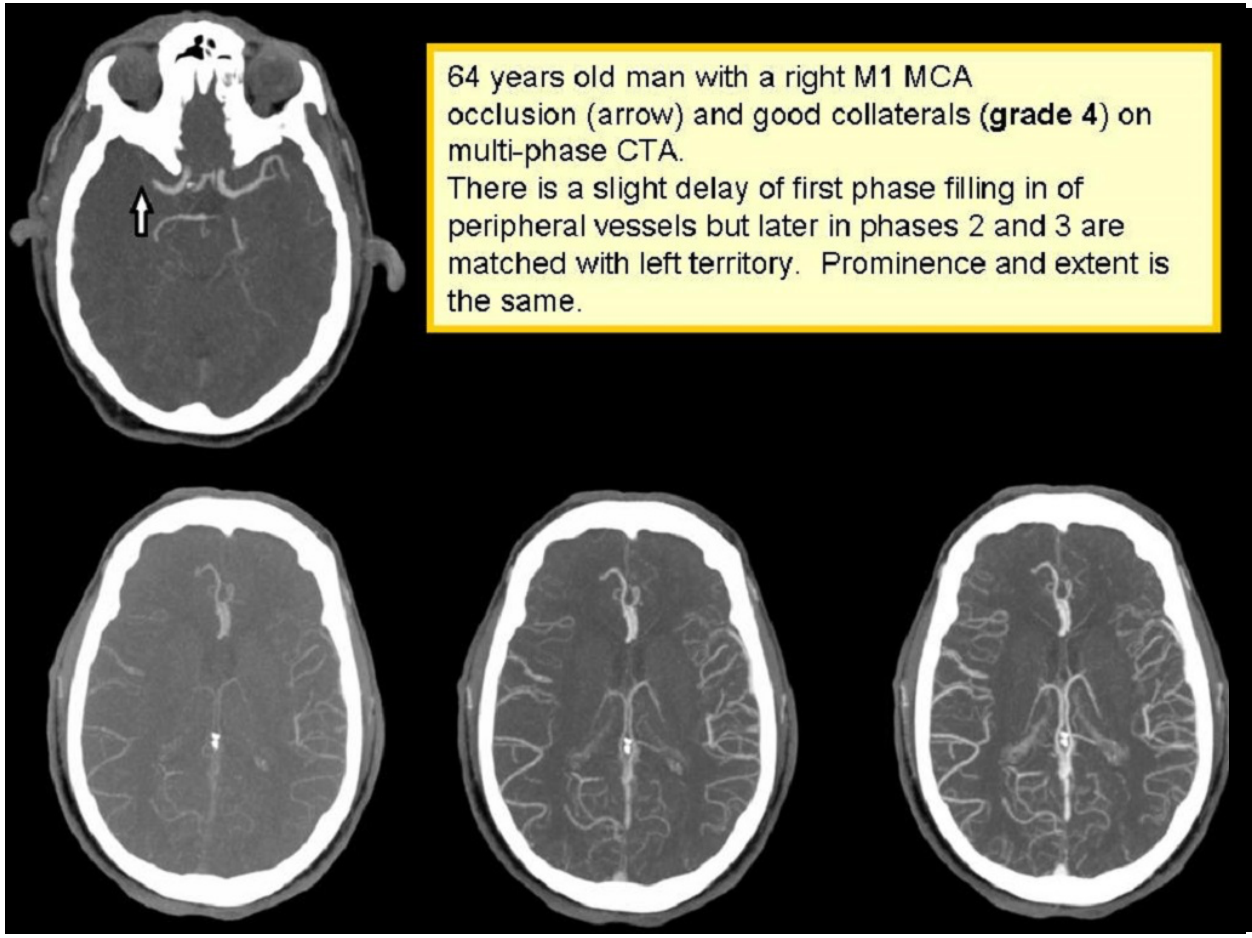
There is a delay of two phases in filling in of peripheral vessels and decreased prominence and extent.



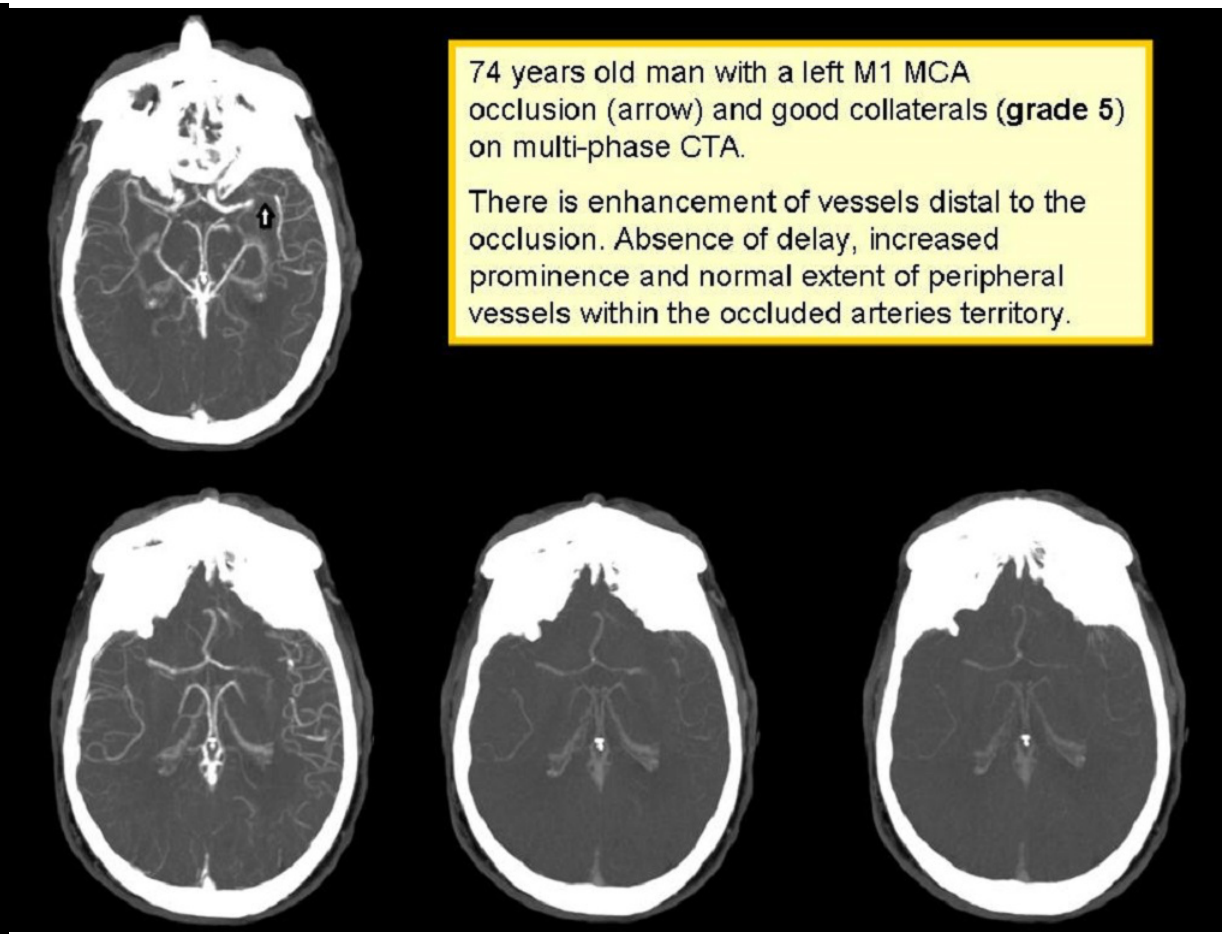
75 years old woman with a left petrous segment occlusion of internal carotid artery (arrow) and intermediate collaterals (**grade 3**) on multi-phase CTA.

There is a delay of two phases in filling in of peripheral vessels but prominence and extent is the same.

Multiphase CTA (MCTA) collateral score

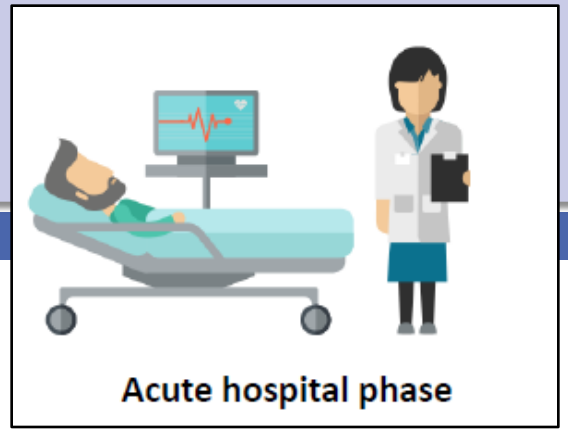


64 years old man with a right M1 MCA occlusion (arrow) and good collaterals (**grade 4**) on multi-phase CTA.
There is a slight delay of first phase filling in of peripheral vessels but later in phases 2 and 3 are matched with left territory. Prominence and extent is the same.



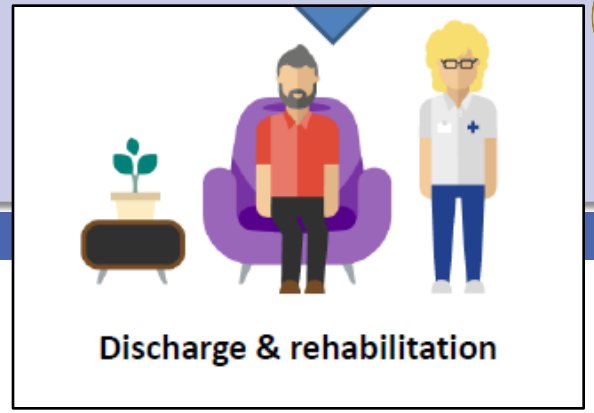
74 years old man with a left M1 MCA occlusion (arrow) and good collaterals (**grade 5**) on multi-phase CTA.

There is enhancement of vessels distal to the occlusion. Absence of delay, increased prominence and normal extent of peripheral vessels within the occluded arteries territory.



Post stroke care

Admit stroke unit



Lower overall 30day mortality *(Class I; Level of Evidence A)*

General management

- Airway, Ventilatory Support, and Supplemental Oxygen (if SpO2 < 94%)
- Treatment of hyperthermia (T>37.6 °C)
- Correction of hypovolemia, avoid hypervolemia

Class I; Level of Evidence C

- **BP management** — *Class I; Level of Evidence B*
- Normoglycemia, avoid hypoglycemia
  - ADA recommended: 140-180 mg/dl — *Class IIa; Level of Evidence C*
- Cardiac monitoring at least 24 hr — *Class I; Level of Evidence B*

Stroke. 2013;44:870-947.

Table 9. Potential Approaches to Arterial Hypertension in Acute Ischemic Stroke Patients Who Are Candidates for Acute Reperfusion Therapy

Patient otherwise eligible for acute reperfusion therapy except that BP is >185/110 mm Hg:

- Labetalol 10–20 mg IV over 1–2 minutes, may repeat 1 time; or
- Nicardipine 5 mg/h IV, titrate up by 2.5 mg/h every 5–15 minutes, maximum 15 mg/h; when desired BP reached, adjust to maintain proper BP limits; or
- Other agents (hydralazine, enalaprilat, etc) may be considered when appropriate

If BP is not maintained at or below 185/110 mm Hg, do not administer rtPA

Management of BP during and after rtPA or other acute reperfusion therapy to maintain BP at or below 180/105 mm Hg:

- Monitor BP every 15 minutes for 2 hours from the start of rtPA therapy, then every 30 minutes for 6 hours, and then every hour for 16 hours

If systolic BP >180–230 mm Hg or diastolic BP >105–120 mm Hg:

- Labetalol 10 mg IV followed by continuous IV infusion 2–8 mg/min; or
- Nicardipine 5 mg/h IV, titrate up to desired effect by 2.5 mg/h every 5–15 minutes, maximum 15 mg/h

If BP not controlled or diastolic BP >140 mm Hg, consider IV sodium nitroprusside

Blood pressure management

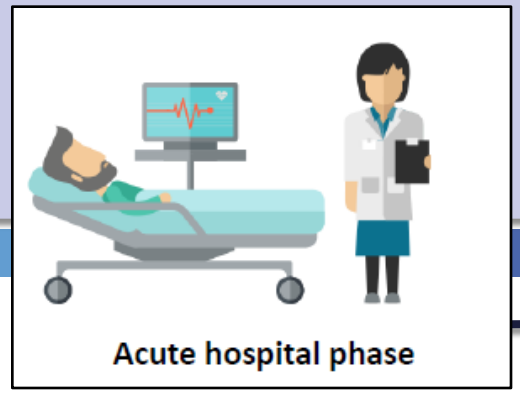
1. Acute reperfusion therapy
   BP < 185/110 mmHg
2. During and after reperfusion
   BP < 180/105 mmHg

- **Labetalol IV**
- **Nicardipine IV**

Non reperfusion group
BP < 220/120 mmHg in first 24 hr

Stroke. 2013;44:870-947.

Post acute stroke care



Medication management

- **Antiplatelets for non cardioembolic stroke**
  - **Aspirin in 48 hr of stroke onset**

Class I; Level of Evidence A

Initial 325 mg (range 160-300mg from 2RCT)
Reduction in early recurrent stroke in 14 day
Reduced mortality and unfavorable outcome

Not recommend aspirin in 24 hr after thrombolytic

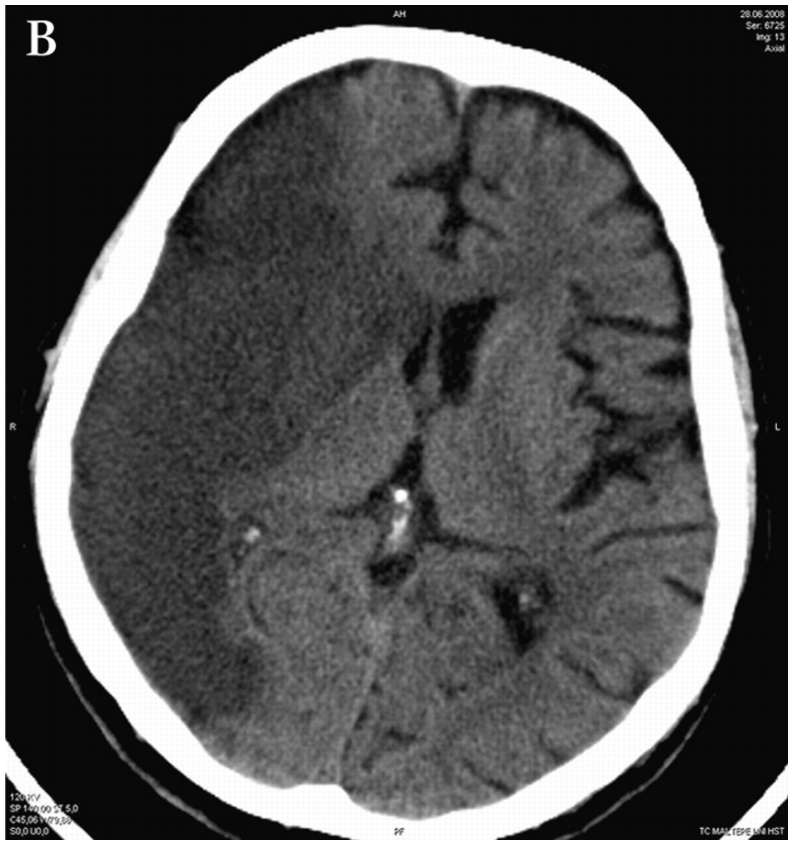
Class III; Level of Evidence C

- Other antiplatelets: selection individualized on patient risk factors (ex. combination aspirin and clopidogrel or dipyridamole)

Class IIa; Level of Evidence B

Stroke. 2013;44:870-947.

Complications after acute ischemic stroke



Cytotoxic edema normally peaks 3 to 4 days after injury
Early reperfusion of large necrotic volume accellerate edema
→ **"Malignant edema"** within first 24 hr

High mortality rate upto 80%

Intensive medical management for lowering ICP

- Temporary: Mannitol, hyperventilation
- Before definitive treatment

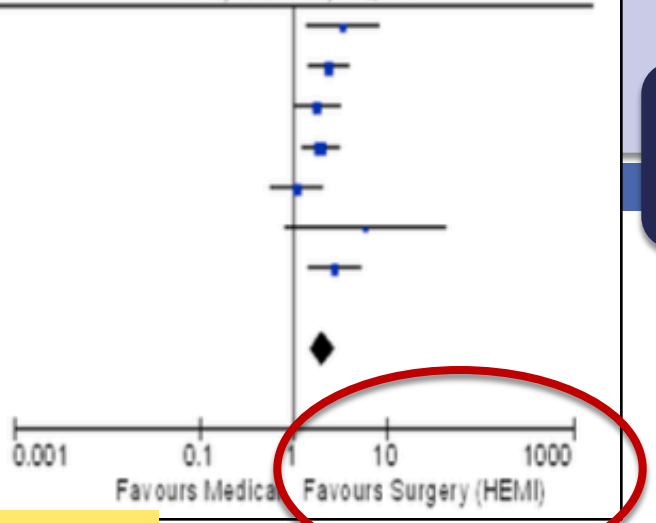
Decompressive surgery for malignant edema of the cerebral hemisphere is effective and potentially **lifesaving** *(Class I; Level of Evidence B)*

Mahidol University
Faculty of Medicine
Siriraj Hospital

mRS 0-5 vs death at 12 months

Study or Subgroup	ALIVE (mRS=0-5) Surgery Events	Total	ALIVE (mRS=0-5) Medical Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
DECIMAL_Vahedi_2007	15	20	4	18	8.5%	3.38 [1.37, 8.31]
DESTINY II_Jüttler_2014	27	47	15	62	20.4%	2.37 [1.43, 3.93]
DESTINY_Jüttler_2007	14	17	7	15	16.8%	1.76 [0.98, 3.16]
HAMLET_Hofmeijer_2009	25	32	13	32	23.1%	1.92 [1.22, 3.04]
HeADDFIRST Pilot_FRANK_2014	9	14	6	10	14.7%	1.07 [0.57, 2.03]
Slezins_Decompressive_2012	5	11	1	13	2.0%	5.91 [0.81, 43.28]
ZHAO_Decompressive_2012	20	24	7	23	14.6%	2.74 [1.44, 5.21]
Total (95% CI)		**165**		**173**	**100.0%**	**2.05 [1.54, 2.72]**
Total events	115		53			

Heterogeneity: $Tau^2 = 0.04$; $Chi^2 = 8.07$, $df = 6$ ($P = 0.23$); $I^2 = 26\%$
Test for overall effect: $Z = 4.95$ ($P < 0.00001$)

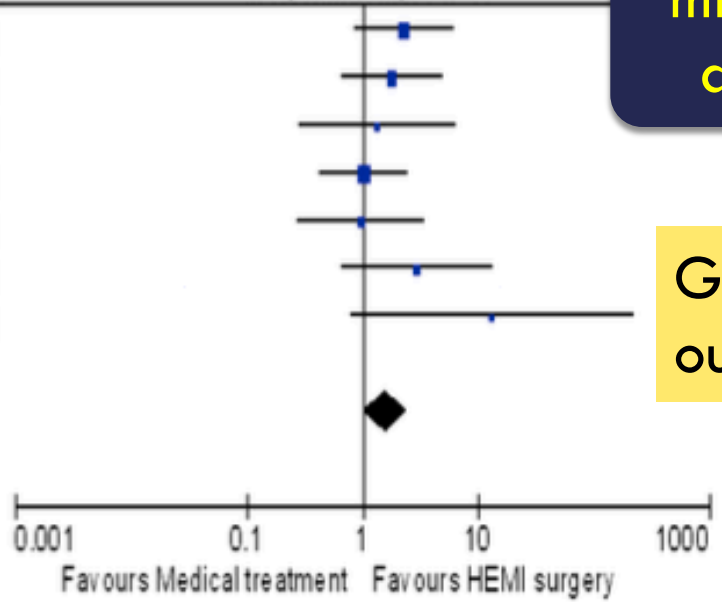


Reduced death from best medical 69% → 30%

mRS 0-3 vs 4-6 at 12 months

Study or Subgroup	mRS 0-3 v 4-6 HEMI sur Events	Total	mRS 0-3 v 4-6 medical Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
DECIMAL_Vahedi_2007	10	20	4	18	20.8%	2.25 [0.85, 5.93]
DESTINY_Jüttler_2007	8	17	4	15	20.4%	1.76 [0.66, 4.70]
DESTINY II_Jüttler_2014	3	47	3	62	8.1%	1.32 [0.28, 6.24]
HAMLET_Hofmeijer_2009	8	32	8	32	27.1%	1.00 [0.43, 2.34]
HeADDFIRST Pilot_FRANK_2014	4	14	3	10	12.3%	0.95 [0.27, 3.35]
ZHAO_Decompressive_2012	6	24	2	23	8.7%	2.88 [0.64, 12.82]
Slezins_Decompressive_2012	5	11	0	13	2.5%	12.83 [0.79, 209.04]
Total (95% CI)		**165**		**173**	**100.0%**	**1.58 [1.02, 2.46]**
Total events	44		24			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 5.31$, $df = 6$ ($P = 0.50$); $I^2 = 0\%$
Test for overall effect: $Z = 2.03$ ($P = 0.04$)

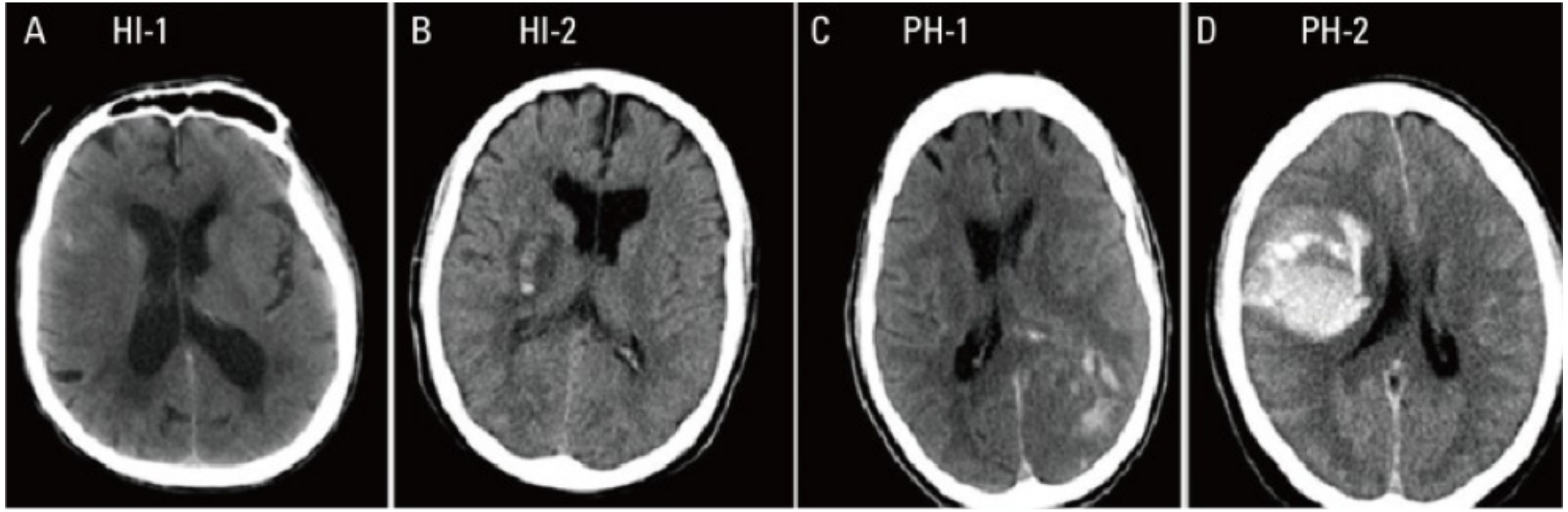


Good functional outcome ↑13%

Alexander P, et al. BMJ Open 2016

Complications after acute ischemic stroke

Radiographic classification of the spectrum of hemorrhagic transformation

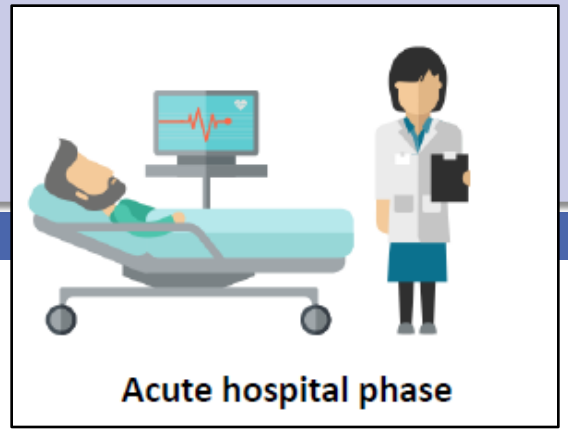


PH-2: 1.9-2.9%
(ECASIII, SIST-MOST)

Hemorrhagic infarction

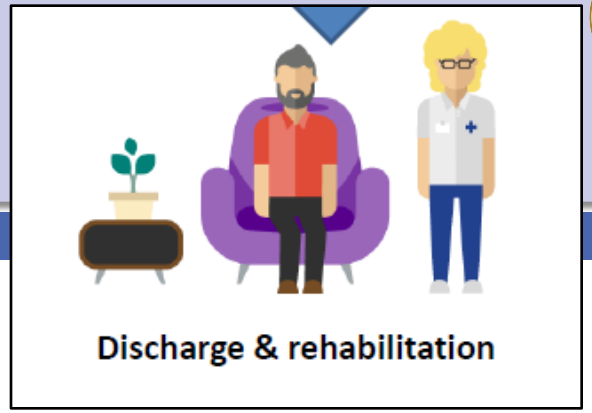
Parenchymal hemorrhage

Criteria proposed by Fiorelli et al. (1999).



Post stroke care

Admit stroke unit

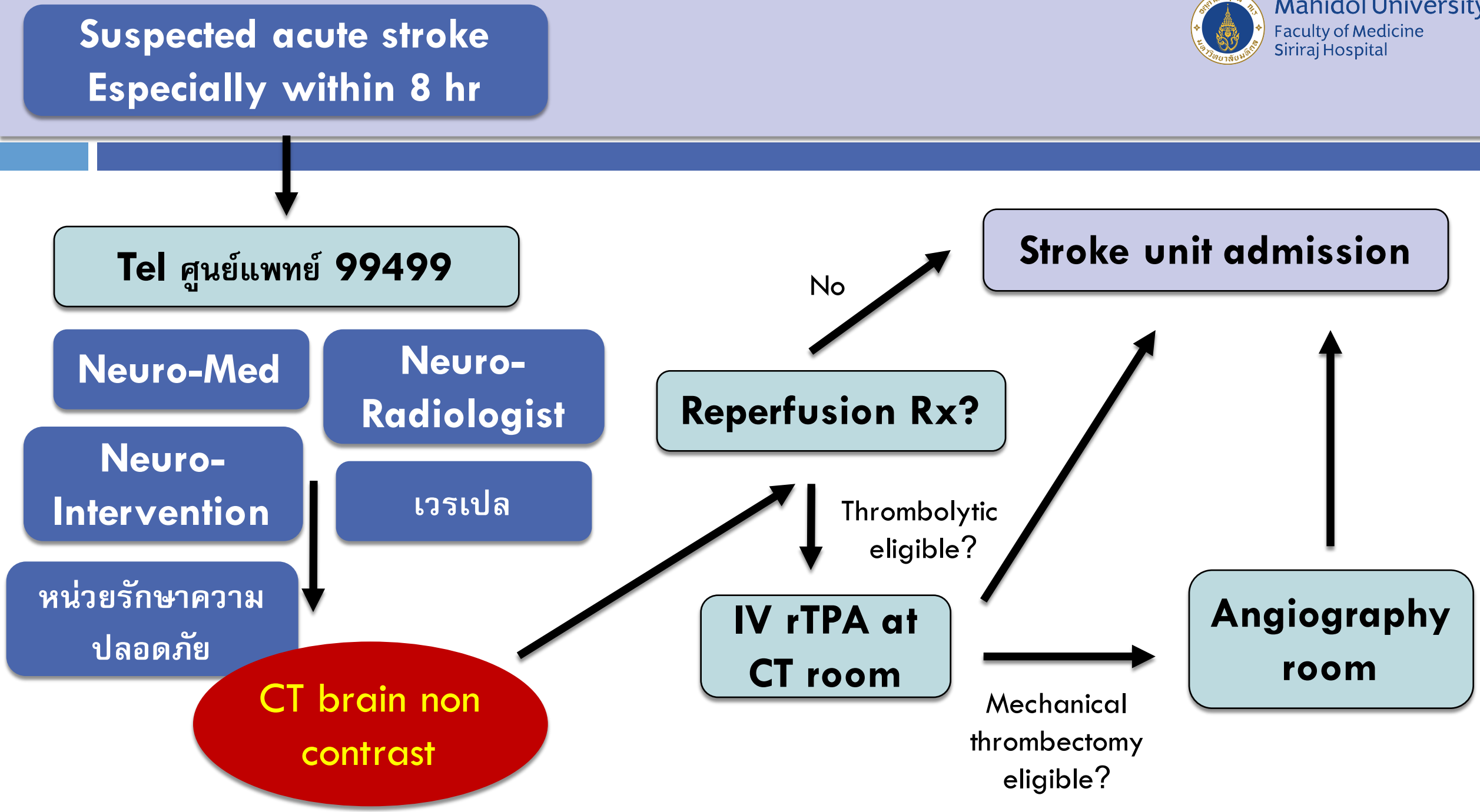


General management

- Assessment of swallowing — *Class I; Level of Evidence B*
- Maintain nutrition and hydration
- Early mobilization of less severely affected patients — *Class I; Level of Evidence C*

Individualized secondary prevention

Stroke. 2013;44:870-947.


Suspected acute stroke
Especially within 8 hr
Tel ศูนย์แพทย์ 99499
Neuro-Med
Neuro-Radiologist
Neuro-Intervention
เวรเปล
หน่วยรักษาความปลอดภัย
CT brain non contrast
Reperfusion Rx?
No
Stroke unit admission
Thrombolytic eligible?
IV rTPA at CT room
Mechanical thrombectomy eligible?
Angiography room

Mahidol University
Faculty of Medicine
Siriraj Hospital

Good multidisciplinary team working

“Better patient outcome and quality of life”

THANK YOU

Complications after acute ischemic stroke

Table 2 | Summary of hemorrhagic transformation data from major clinical trials of AIS intervention.

Clinical trial	Sample size	Duration of radiographic follow up	Asymptomatic hemorrhagic transformation rate	Symptomatic hemorrhagic transformation rate	Parenchymal hemorrhage type 2 rate	Time to treatment+
IV FIBRINOLYSIS						
NINDS	312	7–10 days	4.5% (14/312)	6.4% (20/312)	N/A	1.5 h[p]
ECASS-II	409	7 days	39.6% (161/407)	8.8% (36/407)	8.1% (33/407)	N/A
ATLANTIS	272	18–30 h	11.4% (31/272)	7.0% (19/272)	N/A	4.36 h[p]
SITS-MOST	6483	22–36 h	9.6% (617/6438)	7.3% (468/6483)	2.9% (184/6352)	2.3 h[p]
ECASS-III	418	36 h	27% (113/418)	2.4% (10/418)	1.9% (8/418)	3.98 h[p]
IST-III	1515	7 days	N/A	6.9% (104/1515)	N/A	4.2 h[p]

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