Ischemic Stroke

Objectives:

- **(Not Given)**

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Resources: 435 team + Davidson

- Editing file
- Feedback

Before reading the lecture check out this link to revise the neuroanatomy

مراجعة للبيسك لتسهيل مذاكرة المحاضرة؛ روان الضويحي 435

★ Introduction to Stroke lecture Overview

➢ Morbidity and Mortality:

- A leading cause of serious, long term disability #1 cause of disability
- A second to only heart disease in causing death world-wide
- According to the WHO, 15 million people worldwide suffer a stroke each year
- 30-day mortality is 8-12%
- Stroke risk and mortality increase with age because of atherosclerosis which takes 20-30 years to form
- For survivors aged > 65 years:
    - 50% have hemiparesis paralysis on one side , 30% are unable to ambulate walk , 19% are aphasic can't talk or communicate , 35% are depressed, 26% resides in nursing home.
- The increase in life expectancy will increase the incidence of stroke.

➢ Stroke Impact:

- The economic, social, and psychological costs of stroke are enormous.
- Many important leaders in science, medicine, and politics had their productivity end prematurely short by stroke .
- In the US, total direct and indirect costs are $56.8 billion annually.
- The mean lifetime cost of ischemic stroke is estimated at $140,048.

➢ Definitions:

Stroke: is defined as a syndrome of rapid onset of cerebral deficit (usually focal) lasting >24 h or leading to death, with no cause apparent other than a vascular one.

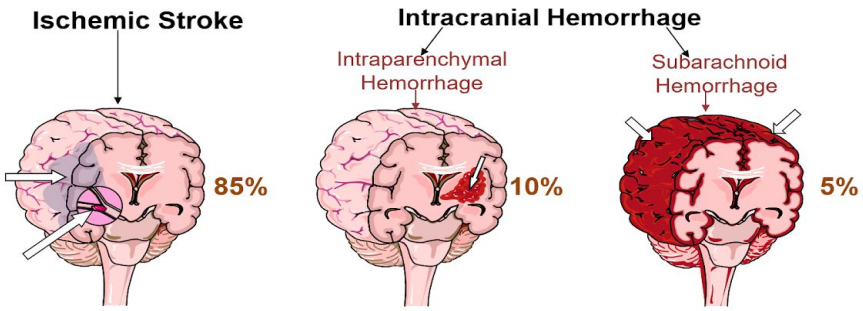
Stroke onset: Timing of FIRST neurological deficit OR last time patient was seen well.

Stroke in evolution: Is when the symptoms and signs are getting worse(usually within 24 hours of onset).

Transient ischaemic attack (TIA): Means a brief episode of neurological dysfunction due to focal ischaemia without infarction, usually lasting seconds or minutes **with COMPLETE recovery.**

- Reversible focal dysfunction, usually lasts minutes less than 24 hours and should have normal MRI , but most of the time it turns out that they have small strokes by MRI .
- Among TIA pts who go to ED:
  (5% have stroke in next 2 days) (25% have recurrent event in next 3 months).
- Stroke risk decreased with proper therapy.

★ Types of Stroke:



★ Common Stroke Presentation:

Any SUDDEN neurological deficit:

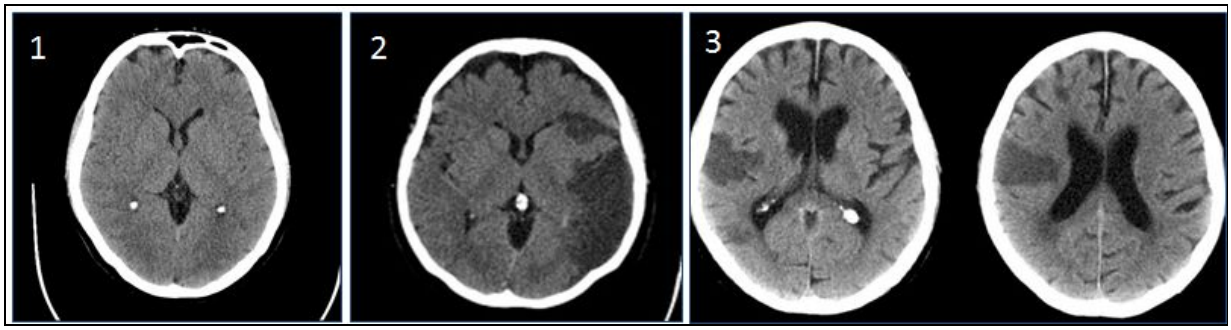
- SUDDEN sensory loss/ visual loss.
- SUDDEN loss of coordination.
- SUDDEN aphasia.
- SUDDEN slurred speech.
- SUDDEN loss of consciousness.
- SUDDEN headache characteristically with hemorrhagic stroke.
- Others it depends on which vessel will be affected the symptoms will differ .

★ Five Major Stroke Syndromes for Rapid Recognition in the ED: any patient with neurological symptoms the first thing you have to exclude is STROKE . so basically any neurological deficit is a stroke until proven otherwise .

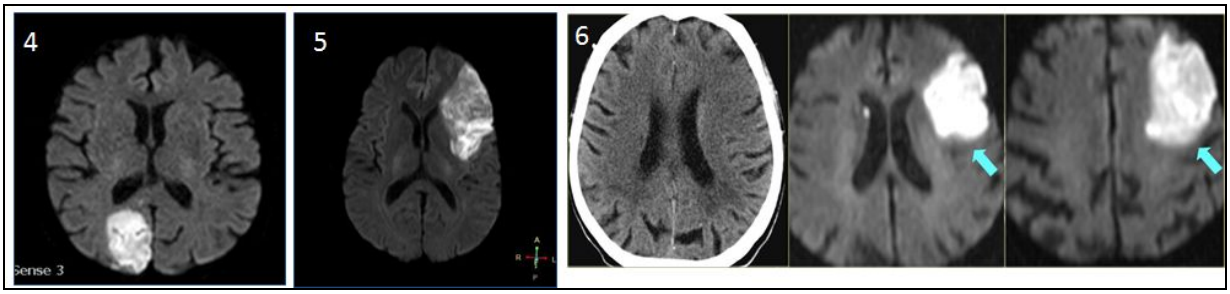
Left (dominant[1]) cerebral hemisphere	• Aphasia (Broca's and wernicke's areas) • L gaze preference[2] • R visual field deficit • R hemiparesis • R hemisensory loss
Right (nondominant) cerebral hemisphere	• **Neglect = (L hemi-inattention)** they neglect their left side of everything • R gaze preference • L visual field deficit • L hemiparesis • L hemisensory loss
Brainstem because it contains the cardio respiratory symptoms they may present with tachycardia	• Hemi or quadriparesis (if both sides of brain stem affected) • Sensory loss in hemibody or all 4 limbs • Crossed signs[3] (face 1 side, body other side)facial weakness and numbness • Diplopia, dysconjugate gaze, gaze palsy[4] • Vertigo, tinnitus • Nausea, vomiting • Hiccups, abnormal respirations • Decreased consciousness
Cerebellum	• Truncal = gait ataxia, • Limb ataxia.

[1] The dominant cerebral hemisphere is the side that controls language function.
[2] Acute inability to produce gaze contralateral to the side of the lesion .
[3] The presence of ipsilateral motor and sensory cranial nerve signs and symptoms , and contralateral long tract dysfunction like hemiplegia .
[4] failure of coordinated movements of the eyes

Hemorrhage	



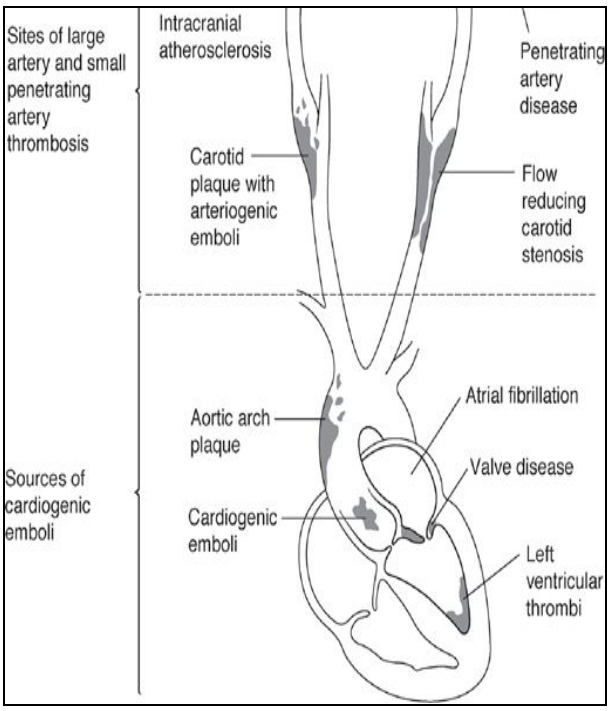
1:X-ray shows calcification in the ventricles bilaterally . Always compare both sides .
2:X-ray shows typical stroke . wedge-shaped lesion “dead tissue” in the left temporal , parietal and frontal area .
3:wedge-shaped hypodense area indicating stroke “dead tissue”



4:MRI showing the medial occipital area . He will come with vision symptoms on the Lt side . Would you treat him ? NO , because it’s a dead tissue and TPA would only cause bleeding .
5:MRI showing the left frontal temporal area , He will come with aphasia . It’s a dead tissue so we don’t treat him . And if you treat him he will bleed to death .

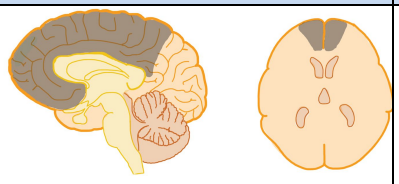
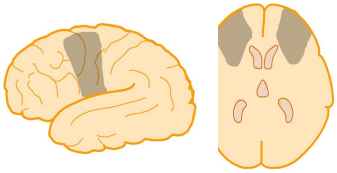
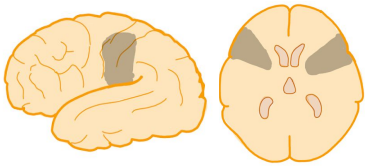
★ Ischemic Stroke Major sites and sources of ischemic stroke:

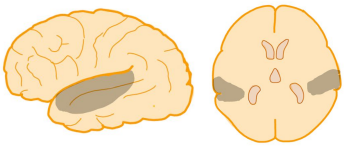
-put this picture in the back of your head ,all the causes of stroke are demonstrated there .
Knowing the Etiology of the stroke will dictate the prevention . If the blood supply to the brain is cut , it will die immediately ; why ? because neurons don’t have energy storages like ATP .
-If a young man/lady comes with a stroke you will think of hypercoagulable states , may be they were born with it , ex: Thrombophilia , protein C deficiency .
-You will also investigate medications in young ladies presenting with strokes, why ? because Oral contraceptive pills causes hypercoagulable state .
-But if an elderly present with a stroke and all other comorbidities like HTN and DM , you will think of atherosclerosis because it takes 20-30 years to form .
-In elderly you would also think of embolism caused by Afib .

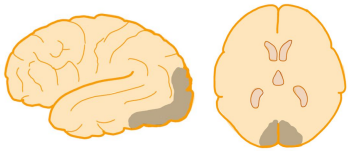


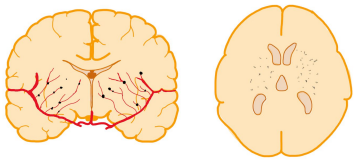
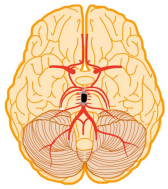
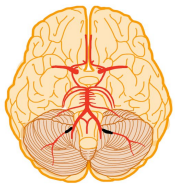
★ What is the typical presentation of the following arterial strokes? Long time ago we didn't have technology and we used to localize the lesion based on the symptoms . You have to know the anatomy and the function of each area to know where the occlusion is .

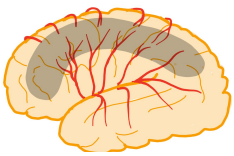
-This table is from 435 , don't skip it please .

Artery occluded	Infarct Surface	Dominant Hemisphere	Nondominant Hemisphere
ACA	 Frontal lobe	• Contralateral lower extremities weakness.Why? Because the motor area medial aspect is supplied by it. Why Leg? according to motor homunculus. • Abulia. (lack of initiation ,lack of interest). • #cognitive dysfunction:will include a change in personality, withdrawal, any frontal lobe dysfunction, both can happen.	
MCA (ant. division)	 Frontal lobe	• Expressive aphasia (broca's Area) "Video"	• Aprosodia You can't know the person emotional status from his speech تصير نبرة صوته وحده سواء حزين سعيد خايف.
		• #Contralateral hemiparesis(in Arm and leg) • #Ipsilateral gaze deviation"Inability to move both eyes in the same direction" **Due to defect of frontal eye field.** مثلاً يقرأ كتاب أو يتابع فلم بدال ما يحرك عيونه وراسه ثابت, لا يحرك راسه كامل	
MCA (post. division)	 Parietal lobe	• Conduction aphasia *"Video"* • Gerstmann's syndrome: Gerstmann's syndrome Is characterized by four primary symptoms: 1)Dysgraphia/agraphia: deficiency in the ability to write. 2)Dyscalculia/acalculia 3)Finger agnosia: inability to distinguish the fingers on the hand. 4)Left-right disorientation.	• Anosognosia(not imp) Lack of recognition of sickness • Apraxia inability to perform a motor task that u used to do,NOT related to muscle weakness, however they respond to noxious stimuli • Contralateral Neglect (Doesn't pay attention to his/her left side & the left side of surrounded environment)يحلق شنبه! اليمين بس يطنش اليسار, يكلم الشخص الي يمينه بس يطنش التي بيساره,جدا صعبين بالتأهيل **يمكن يجيكم سؤال مين أصعب بالتأهيل L MCA او R MCA؟** أكيد اليمين.الناس تظن الليفت اصعب عشان الافيزيا!بس لا النيقلكت(التطنيش) اصعب
		• Contralateral hypoesthesia.Reduced sense of touch or sensation. "Parietal lobe"	

<table>
<tr><td>MCA
(post. division)</td><td> 
Temporal lobe</td><td>Receptive aphasia (wernicke's Area)
"Video" مايفهم الكلام ويجاوبك شي ثاني ماله دخل باللي سألته وما يسكت كثير كلام

• Contralateral homonymous hemianopia.'Due damage to optic tract which supplied by MCA'</td><td>-</td></tr>
<tr><td>PCA</td><td> 
Occipital Lobe</td><td>• Alexia without agraphia
The patients are unable to read at all However,they are able to write. This is example of a disconnect syndrome in which information from the occipital lobe is not available to the parietal or frontal lobes to either understand or express what has been seen.

• Contralateral homonymous hemianopia
• Contralateral weakness. Why there's weakness?!! bc the P1 branch of PCA goes to cross cerbi,supplying the corticospinal tract. Why contra? bc it happens above the medulla where decussation happened)</td><td>-</td></tr>
<tr><td>Subcortical lacunar الجلطة النقطية</td><td>  </td><td>Lacunes are SMALL infarcts seen on MRI or at autopsy. Hypertension is commonly present. Lacunar infarction is often symptomless,or with Minor stroke .</td><td></td></tr>
<tr><td>Basilar artery</td><td>  </td><td>THE MOST IMPORTANT presentation is loss of consciousness.
Since it SUPPLIES the majority of the brainstem (which contains the reticular formation system 'the center of consciousness').</td><td></td></tr>
<tr><td>PICA
"Posterior inferior cerebellar artery"</td><td> 
PICA supplies the lateral medullary and inferior cerebellum.</td><td>Lateral medullary syndrome (wallenberg syndrome):Sensory deficit in opposite side + Ipsilateral ataxia.

ischemia in the lateral part of the medulla→contralateral Sensory deficit
ischemia in inferior cerebellum→ Ipsilateral ataxia</td><td></td></tr>
<tr><td>Watershed Ischemia</td><td> 
Between ACA-MCA</td><td>-Depends on the areas with distal branches, which are the first parts get affected by Hypoperfusion.
-so if there was "strong or even moderate"hypoperfusion due to any cause (hypotension) will give you watershed ischemia. Most common is between MCA & ACA, and between MCA & PCA. there will be <u>PROXIMAL</u> muscle weakness in the arm and leg more than distal(<u>called</u> man in the barrel syndrome).</td><td></td></tr>
</table>

★ Diagnosis

- CT scan of the head (without contrast)
- MRI of the brain (more sensitive than CT)
- ECG
- Carotid duplex US
- Magnetic Resonance Arteriogram (MRA)

-if he was an elderly we should do an echo + 24 hrs. holter monitoring for Afib and if he has Afib we anticoagulate . then we do Routine MRI of the brain to look at the vessels .
-it takes half an hour for the stroke to show in MRI , and 24-28 hrs. to show on CT .

-First we have to do CT because it's fast and it excludes hemorrhagic stroke .
as we know stroke is a **clinical diagnosis** , so if we excluded hemorrhagic stroke and the patient has symptoms and the clinical picture of stroke , we immediately treat him as an ischemic stroke . MRI shows if it was ischemic or not , but we don't have time , TIME IS BRAIN !

★ Treatment of Acute Ischemic Stroke

I. Primary Stroke Prevention : Whenever we talk about stroke treatment, we mention the primary prevention, what does it mean? Preventing a stroke in a patient who has never had a CVA (neither TIA nor stroke)
II. Acute Stroke Treatment : Intervene within a few hours for clot lysis to ensure re-gain of function/recanalization/prevent necrosis
III. Secondary Stroke Prevention[5] : Prevent stroke recurrence or prevent stroke after TIA .
IV. Stroke Rehabilitation : To minimize stroke physiological and psychological impact.

- Prior to two decades ago , no treatment was offered for acute stroke victims because of the misconception that arterial occlusion in the brain leads to irreversible necrosis and dead tissue within minutes .
- Stroke was wrongly name Cerebrovascular accidents (CVA)
- Stroke care was focused on supportive care , stroke prevention and rehabilitation .

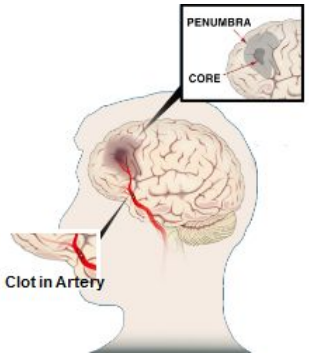
-A Study showed that : "Randomized trial"
Afib pts. were randomized and given 1)Aspirin VS 2)Warfarin , significant reduction in recurrence of stroke on pts. with anticoagulant (warfarin) , it prevents further clot formation . But nowadays we give them NOAC .
-Another Study showed : Pts who have stenosis were randomized to either surgery VS aspirin and they found with surgery more than 50% reduction in recurrence of stroke
- Another study showed that : pts.with stenosis were randomized to Surgery VS stent , and the results were similar , so if surgery was indicated we do STENTING .

[5] Secondary prevention depends on source of thromboembolism

At ER:

Sudden Neurological deficit = Acute stroke!

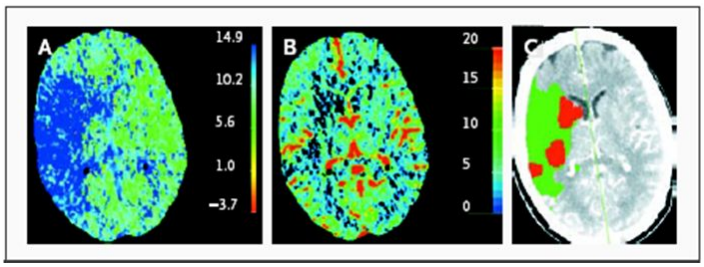
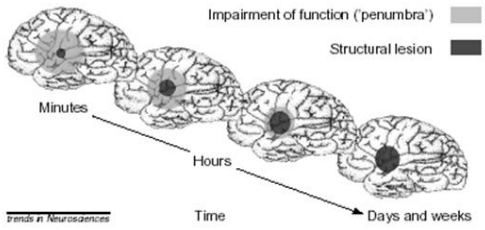
- First ABC!
- Activate Stroke Code
- HISTORY: Stroke Onset, progression, fluctuation,..
- Check inclusion and exclusion criteria
- Blood work up include: CBC, INR, PTT, lytes, Cr, Glucose, Troponin & 12 lead ECG
- 2 Peripheral IV lines and Foley's catheter
- Urgent CT/ CTA brain[6]



★ Stroke Penumbra: "Time is Brain"

- **Penumbra** is zone of **reversible** ischemia around core of irreversible infarction.
- In every ischemic stroke there is ischemic core which dies within few minute and penumbra.
- Penumbra salvageable in the first few hours after ischemic stroke onset due to the **collateral arteries** that supply the penumbral zone. but eventually the penumbra will die if you don't save it , why ? because if any time the pt goes to sleep and the BP goes down , blood will not go through the collaterals and necrosis will happen .
- Penumbra is the region of tissue at risk of being recruited into the ischemic core.
- Ischemic Penumbra presents a **Window of Opportunity.**

-Perfusion means **Ischemia** and diffusion means **Necrosis .**
So if you see on perfusion CT A (large perfusion area and a small diffusion area) , that means you still can save the penumbra , INTERVENE !

	
Perfusion CT Scans Obtained 1 Hour 45 Minutes after the Onset of Ischemia in the Territory of the Right Middle Cerebral Artery. In (Panel C) the map suggest a large penumbra and a small infarct core , with the penumbra shown in green and the suggested infarct core in red.	" Penumbra is The Target of Acute Ischemic Stroke Treatment → TIME IS BRAIN: SAVE THE PENUMBRA"

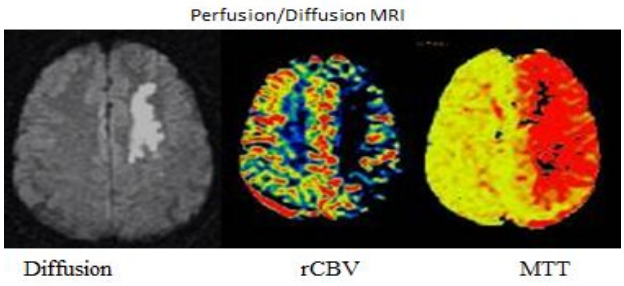
[6] Caution for renal pts

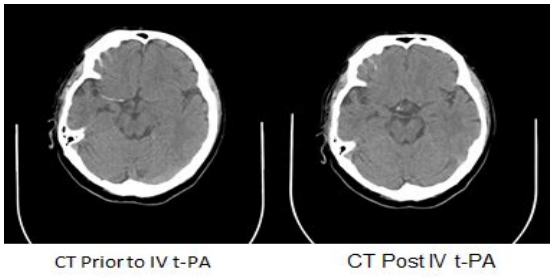
★ Modalities of Acute Stroke Treatment:

I. IV t-PA[7] "Standard"

-A study called "NINDS" showed : stroke pts were randomized to either placebo or tPA within 3 hrs. of stroke onset . Those treated with tPA were 30% more likely to have no or only minor disability at 3 months post stroke .
Despite the probability of hemorrhage the outcome is better !
-They tried to give tPA 6 hrs. after the onset of stroke , but the result was intracerebral hemorrhage .
-Every minute delay in administering tPA counts . the outcome of treating the pt. in the first 90 minutes will for sure be better than the outcome of treating him in the next 90 minutes .

Inclusion criteria	Exclusion criteria
• Clinical Dx of stroke • Stroke onset < 270 minutes • Age is > or = 18	• Intracranial Hge in imaging or clinical • presentation suggests SAH • Active/ recent internal bleeding or on warfarin with INR > 1.7 or platelets < 100K • Serum Glucose <50 or > 400 • Systolic BP > 185 or diastolic >110 • Recent MI (3/52) • Recent (2/52) major surgery or trauma • Recent arterial puncture at non-compressible site.



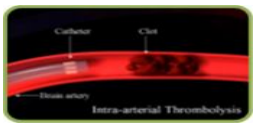


Diffusion MRI shows a large area of necrosis that can't be treated , because it's dead tissue already .

Occluded MCA , dense .
after the tPA it disappeared and the pt. is normal now .

II. Intra Arterial t-PA

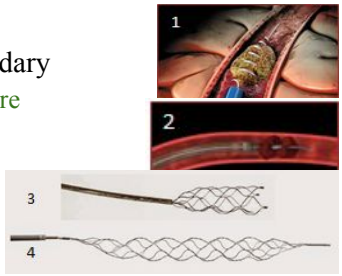
- Increased risk of hemorrhagic transformation



III. Mechanical Disruption "standard"

- Endoarterial Mechanical Disruption devices:

1. Merci Retriever "Approved": Increased recanalization rate and secondary clinical outcome when used for large cerebral arteries. not used anymore
2. Penumbra Microcatheters "Approved"
3. Solitaire Device
4. Trevo Stent-retriever



IV. Surgical Rx (old)

[7] Tissue Plasminogen Activator

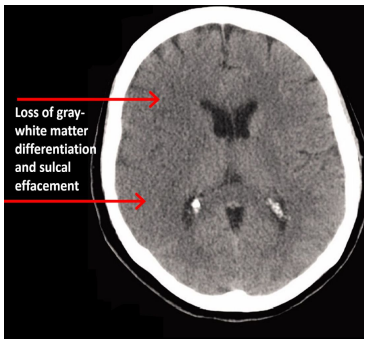
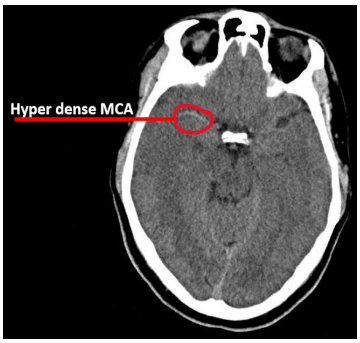
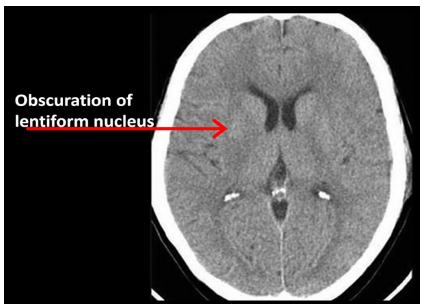
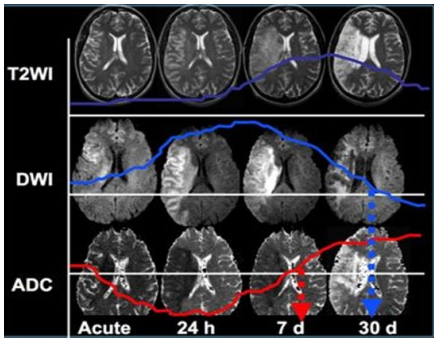
★ Conclusion

- IV t-PA, within **4.5 hours** from the symptoms onset of acute ischemic stroke, is affective and the standard of care.
- Endovascular treatment using stent retriever ± t-PA within **6 hours** from the onset of stroke symptoms, is effective and the standard of care. after the 6 hrs there is nothing you can do

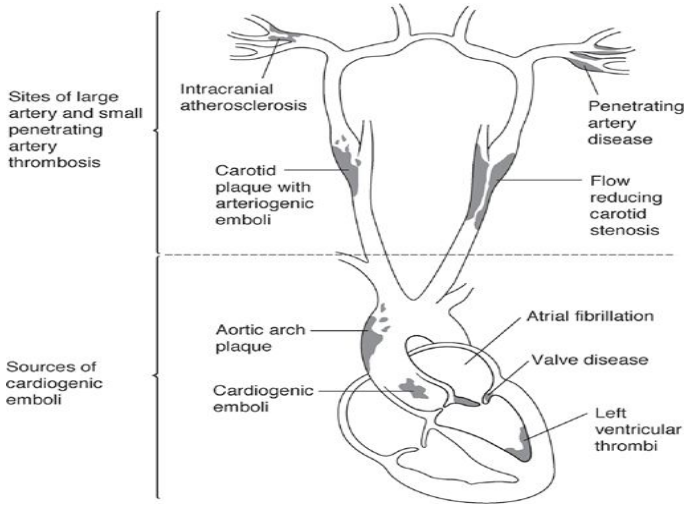
-If you have a small stroke and the 6 hrs have passed , you did MRI and u still can see the penumbra that means you still have the chance to intervene and do stenting .
-DAWN Trial showed that if a stroke last happened 12 hrs. earlier and there is a mismatch (CT shows little effect but clinically he is affected greatly) between clinical deficit and infarct . outcomes for disability and dependency at 90 days were better with thrombectomy .
-lets say that the pt slept at 9 pm and woke up at 6am with symptoms , you are not sure when exactly he got the symptoms right ? So you don't give tPA , but don't forget to document that because if you gave him tPA and he bleeds it will be the end of your career .

★ Barriers for Acute Stroke Therapy

- Late patient presentation to ER (In USA; only 30% present within t-PA window)
- Poor stroke recognition and delayed triage at ER (mainly for unusual stroke presentations)
- Lack of appropriate infrastructure
- Lack of acute stroke expertise
- Presence of a contra-indication
- Difficulty in getting patient's or family's verbal consent

Acute Ischemic Changes in CT		
		 A 45 yr old male with weakness in Lt side for 2 hrs.
Acute Ischemic Changes in MRI		
you have to know that the DWI (diffusion-weighted MRI) will tell you if there was time to save the penumbra or not earlier than the CT or MRI as mentioned up .		

Summary

<table>
<tr><th colspan="2">Ischemic Stroke</th></tr>
<tr><td>Site & Source</td><td> 
</td></tr>
<tr><td>Clinical features</td><td>Any SUDDEN neurological deficit. Specific symptoms depend on which part is affected:
- left dominant hemisphere → Aphasia, L gaze preference, R visual field deficit, R hemiparesis, R hemisensory loss.
- right nondominant hemisphere → Neglect = (L hemi-inattention), R gaze preference, L visual field deficit, L hemiparesis, L hemisensory loss.
- brainstem → Hemi or quadriparesis, Sensory loss in hemibody or all 4 limbs, Crossed signs (face 1 side, body other side), Diplopia, dysconjugate gaze, gaze palsy, Vertigo, tinnitus, Nausea, vomiting, Hiccups, abnormal respirations, Decreased consciousness.
- cerebellum → Truncal = gait ataxia, Limb ataxia.</td></tr>
<tr><td>Investigations</td><td>- Head CT without contrast → can differentiate between hemorrhagic and ischemic, but ischemic changes may take 24 hours to appear.
- MRI of brain → more sensitive (changes may appear as early as 30 minutes).
- ECG
- Carotid duplex US
- Magnetic Resonance Arteriogram (MRA)</td></tr>
<tr><td>Management</td><td>TIME IS BRAIN: SAVE THE PENUMBRA!
Management of acute stroke: At ER (ABC’s + history + blood work up + CT), then
- IV tpA (if pt >/= 18 years and before 270 minutes “4.5 hours” of stroke onset)
- Intra-arterial tpA
DON’T GIVE TPA TO: pt with active or suspected bleeding (Ex: SAH)
- Aspirin
- Mechanical → Endovascular thrombolysis (Merci Retriever, Penumbra Microcatheters, Solitaire Device, Trevo Stent-retrieveer)</td></tr>
</table>

Questions

1. **A 75-years old woman presents to the ED with abrupt onset of left-sided weakness that began 1 hour ago. Assuming all imaging tests are immediately available and there are no contraindications to the following imaging modalities, which test should initially be performed in routine clinical care?**

    A. CT angiogram of the head and neck

    B. CT scan of the head without contrast

    C. Magnetic resonance image (MRI) of the brain

    D. MRI of the brain and magnetic resonance angiogram (MRA) of the head and neck

2. **26 years old female presented with sudden weakness in the right arm and speech difficulty, after taking history and performing physical exam, investigations revealed an ischemic stroke, what of the following information related to her presentation you would expect to get from her medical history?**

    A. That she's Hypertensive

    B. That she has atherosclerosis

    C. That she's on oral contraceptives

    D. Presence of carotid stenosis in CT scan

3. **A 60-years old male with a history of DM & HTN presents with weakness, dizziness and abnormal speech for the past 24 hours. The patient's spouse states that he recently started acting "funny," and his symptoms have been worsening. During the neurological examination, a sensory and motor loss is noted in the right lower leg. What syndrome describes the ischemic stroke this patient suffers from?**

    A. Anterior Cerebral Artery Infarction

    B. Middle Cerebral Artery Infarction

    C. Cerebellar Infarction

    D. Posterior Cerebral Artery Infarction

4. A 64 year old male with a past history of diabetes presents to the ER 3 hours after noticing a dense right sided weakness. His partner also noted him to have eye deviation to the left side. He had surgery 7 months ago to repair an inguinal hernia. Examination reveals expressive aphasia with concomitant right sided dense motor-sensory deficit. A CT brain is reported as normal. Blood tests reveal an INR of 1.6 and platelet count of 142. What is the most appropriate next step in management?

A. start him on TPA

B. Do an MRI

C. Do stenting

D. perform another CT in 24 hours

5. 65 years old Patient presented with difficulty speaking and weakness in the right hand and leg upon examination the patient appears to have aphasia and right hemiplegia , what is the artery affect in this condition?

A. Left MCA
B. Right MCA
C. Right ACA
D. Lift ACA

6.Which ONE of the following complications is associated with thrombolysis for acute stroke?

A. Intracranial Hemorrhage
B. Difficulty to wean off sedation
C. Vascular dissection caused by mechanical thrombectomy
D. Worsening of cytotoxic edema

7.Which ONE of the following brain areas are associated with Broca's aphasia in the event of stroke?

A. Anterior part of superior temporal gyrus
B. Left middle frontal gyrus
C. Posterior part of inferior frontal gyrus in the dominant hemisphere
D. Transcortical motor fibers to middle frontal gyrus in the dominant hemisphere

8.A 21-year-old student developed sudden occipital headache associated with visual disturbance, right side weakness, and difficulty in talking. Three days prior to the event, He was involved in a car accident without head injury. Patient and his mother are known to have recurrent migraine headaches. which ONE of the following is the most appropriate action at ER?

A. Analgesics for migraine, and start prophylactic migraine therapy
B. CT angiogram of the brain and activation of stroke code
C. CT brain and analgesics with clinical observation
D. CT brain and urgent lumbar puncture

Q1. B/ Q2. C/ Q3. A/ Q4. A / Q5.A / Q6.A/Q7.C/Q8.B