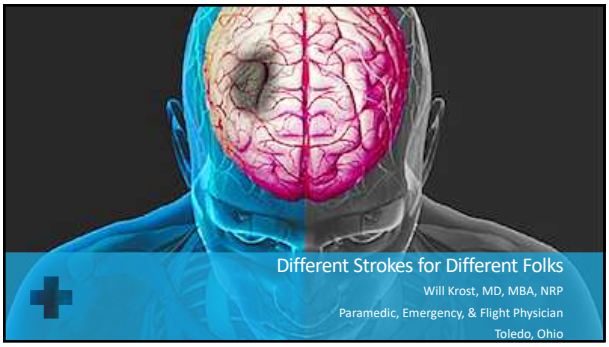
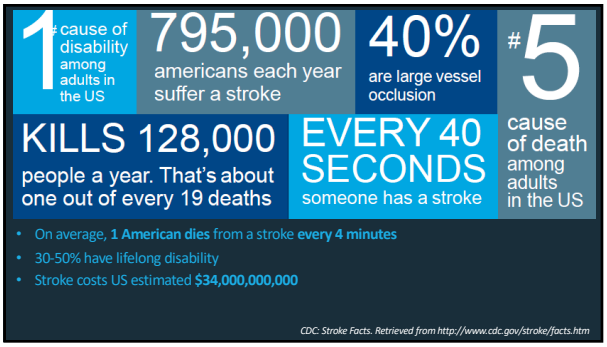
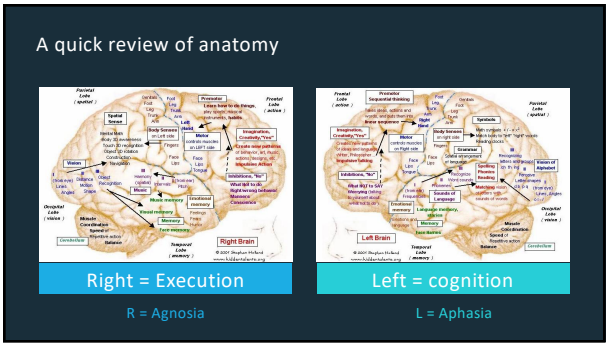

Different Strokes for Different Folks
Will Krost, MD, MBA, NRP
Paramedic, Emergency, & Flight Physician
Toledo, Ohio

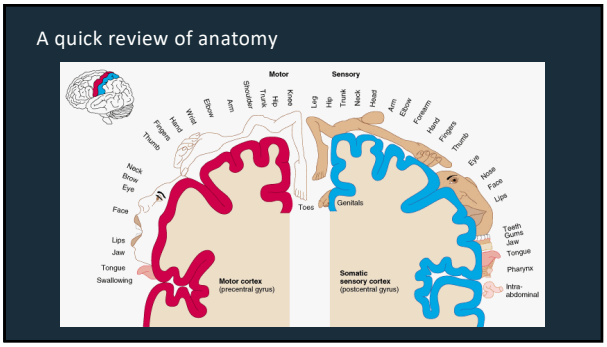
1


1 # cause of disability among adults in the US
795,000 americans each year suffer a stroke
40% are large vessel occlusion
5 cause of death among adults in the US
KILLS 128,000 people a year. That's about one out of every 19 deaths
EVERY 40 SECONDS someone has a stroke
On average, 1 American dies from a stroke every 4 minutes
30-50% have lifelong disability
Stroke costs US estimated $34,000,000,000
CDC: Stroke Facts. Retrieved from http://www.cdc.gov/stroke/facts.htm

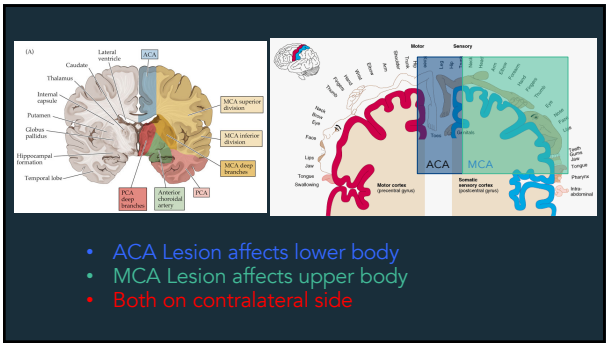
3


A quick review of anatomy
Right Brain
Left Brain
Right = Execution
Left = cognition
R = Agnosia
L = Aphasia

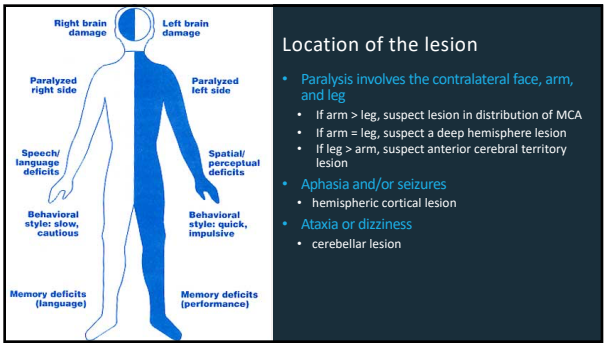
4


A quick review of anatomy
Motor
Sensory
Motor cortex (precentral gyrus)
Somatic sensory cortex (postcentral gyrus)

5

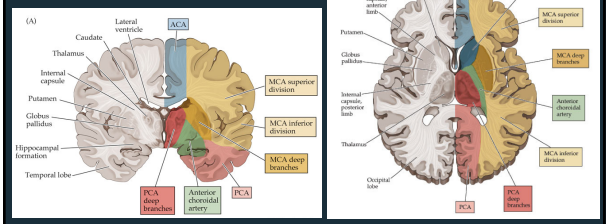

ACA
MCA
• ACA Lesion affects lower body
• MCA Lesion affects upper body
• Both on contralateral side

6


Right brain damage
Left brain damage
Paralyzed right side
Paralyzed left side
Speech/ language deficits
Spatial/ perceptual deficits
Behavioral style: slow, cautious
Behavioral style: quick, impulsive
Memory deficits (language)
Memory deficits (performance)
Location of the lesion
Paralysis involves the contralateral face, arm, and leg
If arm > leg, suspect lesion in distribution of MCA
If arm = leg, suspect a deep hemisphere lesion
If leg > arm, suspect anterior cerebral territory lesion
Aphasia and/or seizures
hemispheric cortical lesion
Ataxia or dizziness
cerebellar lesion

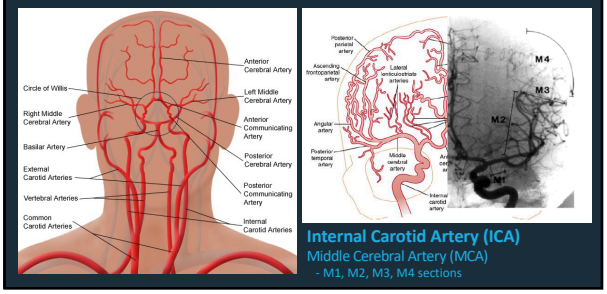
7

A quick review of anatomy



8

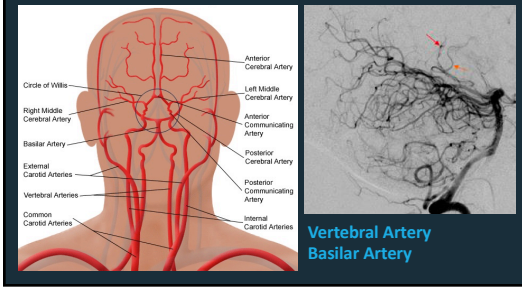
A quick review of anatomy – Anterior Circulation



Internal Carotid Artery (ICA)
Middle Cerebral Artery (MCA)
- M1, M2, M3, M4 sections

9

A quick review of anatomy – Posterior Circulation



Vertebral Artery
Basilar Artery

10

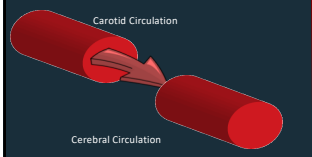
Intrinsic hierarchy

11

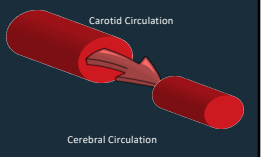
Important Physiology

12

Cerebral Perfusion Pressure



Normal ICP



Elevated ICP

13

Cerebral Perfusion Pressure

- MAP = 1/3(systolic - diastolic) + diastolic
- ICP 0 - 10 torr (20 upper limit)
- CPP 80 - 100 torr
- CPP drops below 60 torr = ischemia
- CPP <30 torr - incompatible with life

CPP = MAP - ICP

14

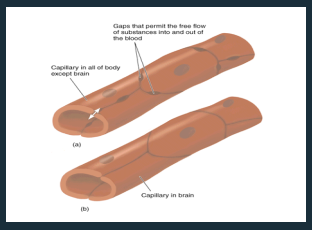
Cerebral Perfusion Pressure

- CPP correlated with CBF
- Decrease in MAP
- Increase in ICP
- Hypotension defined as systolic BP <90 mmHg
- Hypoxia
  - apnea
  - cyanosis
  - SpO2 <90% = PaCo2 of 60 torr

15

Physiology

- CSF - 25 ml/hour
- Blood brain barrier
  - tight capillaries
  - limit movements of solutes and water
  - glucose, oxygen, carbon dioxide, and lipid soluble substances (nicotine, caffeine, narcotics)

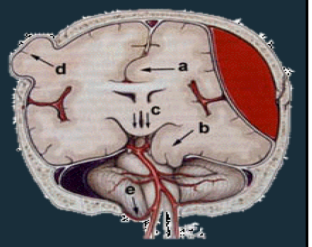


16

Monro-Kelli Doctrine

The volume in the rigid skull is equal to the sum of the brain (90%) + CSF + blood

A change in one compartment must be balanced by a change in another



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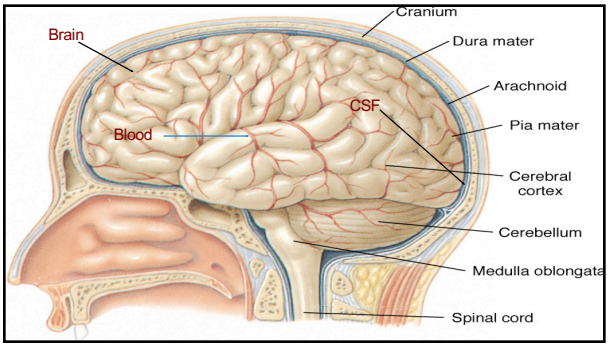

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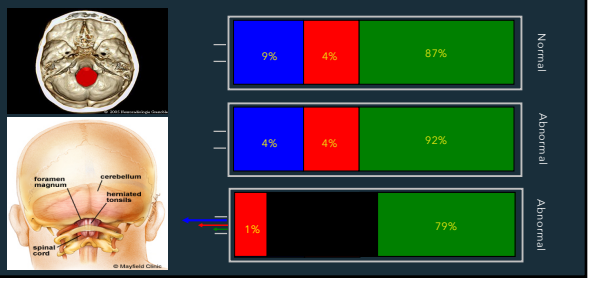
Monro-Kelli Doctrine



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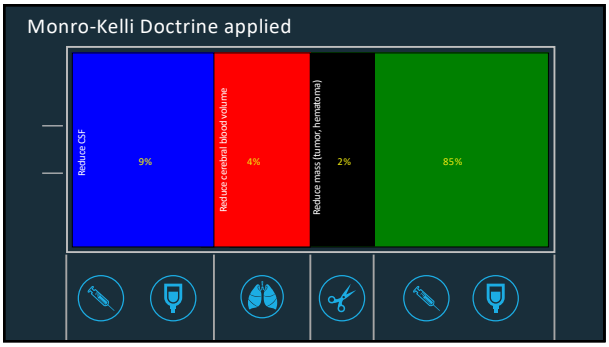

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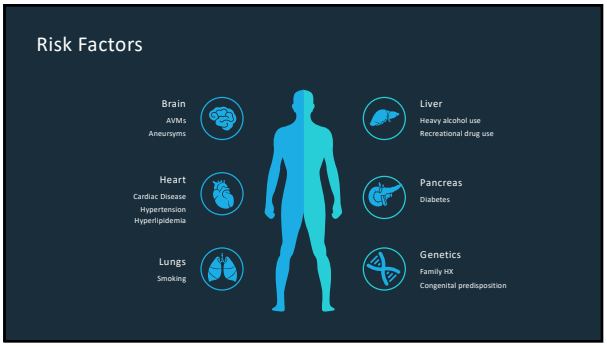

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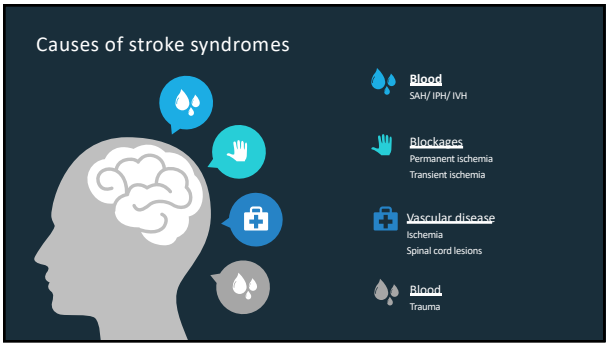

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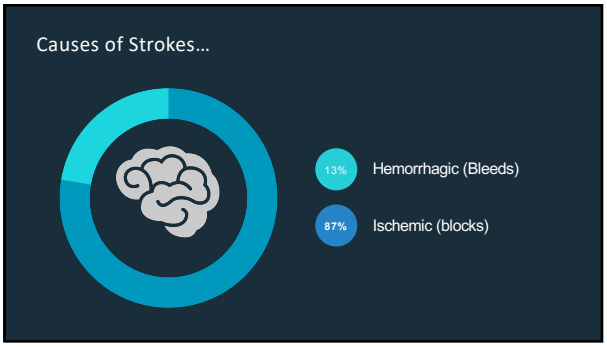

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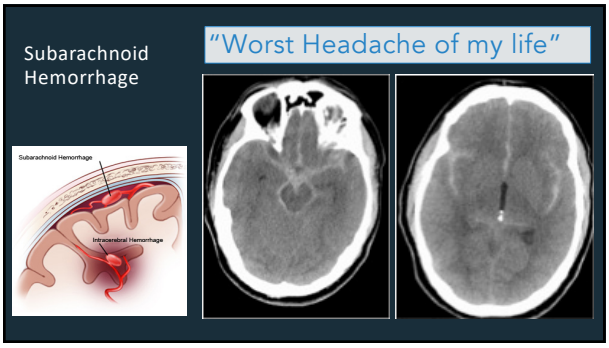

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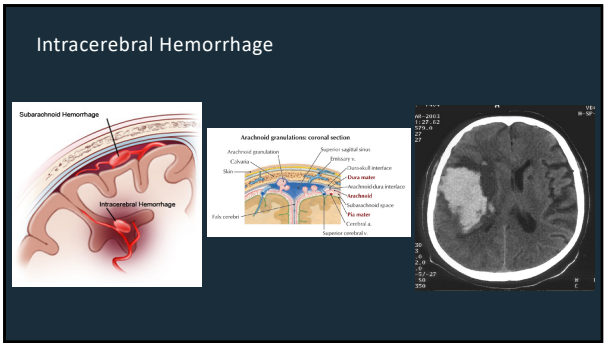
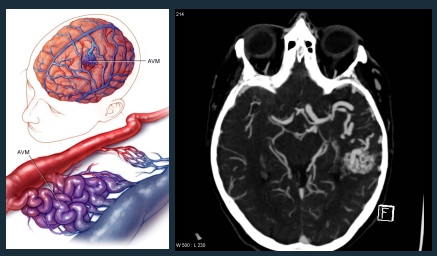


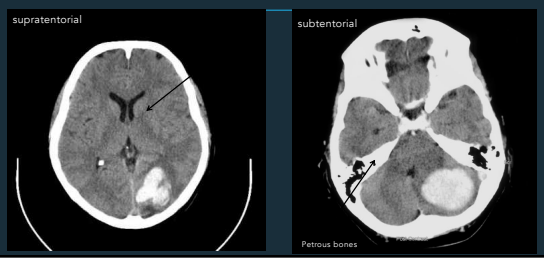
26

A-V Malformation



27

Occipital Bleed vs. Cerebellar Bleed

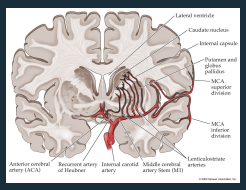


28

Lacunar Infarcts

Small infarctions

- Short penetrating arterioles
- Basal ganglia
- Pons
- Cerebellum
- Anterior limb of internal capsule
- Deep cerebral white matter (rare)

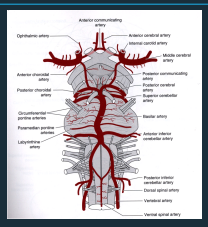


29

Lacunar Infarcts

Small infarctions

- Short penetrating arterioles
- Basal ganglia
- Pons
- Cerebellum
- Anterior limb of internal capsule
- Deep cerebral white matter (rare)



30

Lacunar Infarcts

- Often asymptomatic or very mild symptoms
- Nearly 100% are thought to be caused by blood vessel damage from hypertension or DM
- Usually multiple, bilateral and asymmetric appearance on CT
- More common in Blacks and Asians than in Caucasians
- Prognosis is much better for recovery

31

Clinical Findings

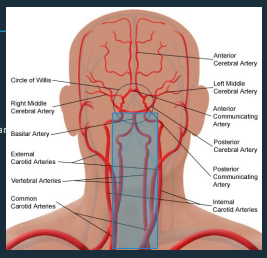
Left MCA	Right MCA	Brainstem
• Aphasia • Lack of comprehension • Left-sided gaze • Right-sided facial droop • Right-sided neglect	• Dsyarthria (slurred) • Left-sided weakness • Right-sided gaze • Left-sided facial droop • Left-sided neglect	• Eye movement deficits • N/V • Ataxia/vertigo • Dysphagia • Dysphasia • AMS • Crossed signs – weakness & facial droop

32

Clinical Findings

Obstruction of Vertebrobasilar Circulation

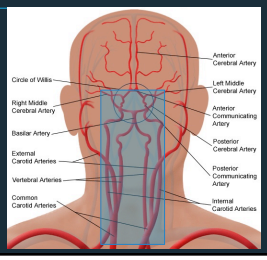
- Supplies:
  - Thalamus
  - Cerebellum
  - Brainstem
- Occlusion of both vertebral arteries or basilar artery:
  - Coma with pinpoint pupils
  - Flaccid quadriplegia
  - Sensory loss
  - Various cranial abnormalities



34

Clinical Findings

- Coma
  - Infarction in either carotid or vertebrobasilar system may cause loss of consciousness



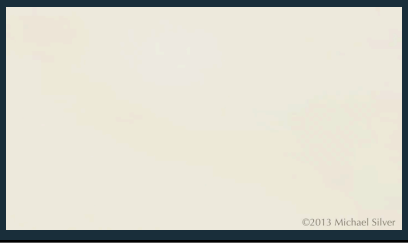
35

Cath Lab no longer means just the Heart

Neurovascular stent retrievers.

first alternative to clot-busting drugs to treat emergency stroke patients

wire-caged device can now be threaded through a patient's blood vessels to catch and remove clots from the bloodstream.



36

Right M1 MCA stroke

37

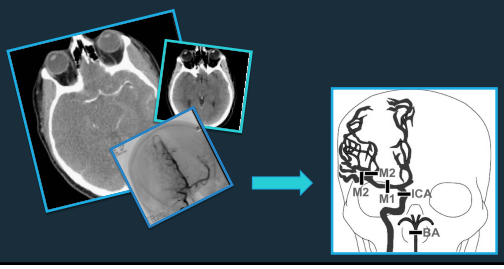
Clinical history

37 yr old woman

- While exercising at the gym, she lost balance and fell without LOC
- Last well 20:40 when she signed in to the Gym
- Developed right gaze preference, left neglect, hemiparesis and facial droop
- NIH 18
- IV tpa given at 2305 after head ct

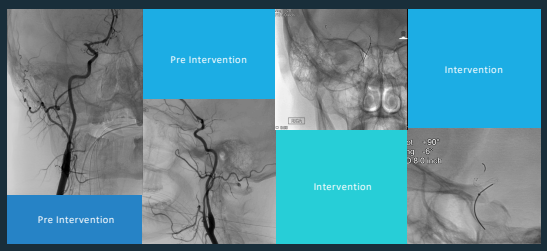
38

Imaging in CVA



39

Interventional Progression



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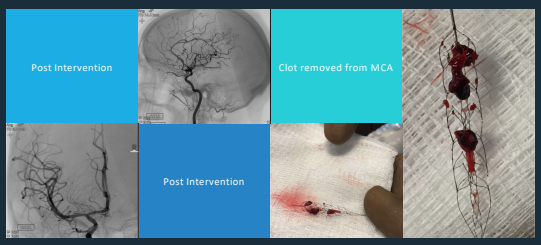
Interventional Progression



41

Basilar artery aneurysm stroke

42

Clinical history

46 year old male with no FH aneurysm

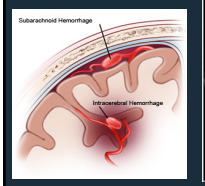
- Current smoker
- Headache the day before
- Thunderclap HA, neck pain and not feeling well prior to presentation at outlying Hospital
- Found down on floor alert with nausea vomiting
- No Focal Neurological Deficit

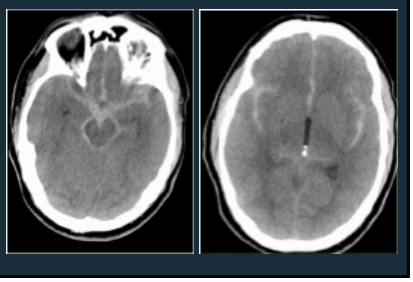
43

Imaging in CVA

"Worst Headache of my life"

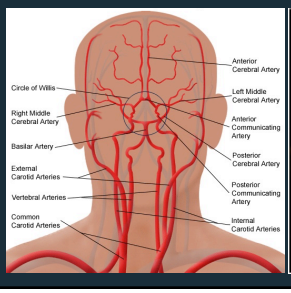
Subarachnoid Hemorrhage

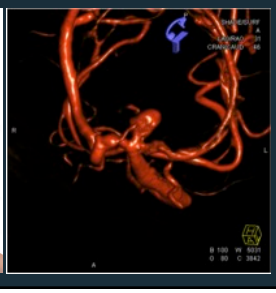




44

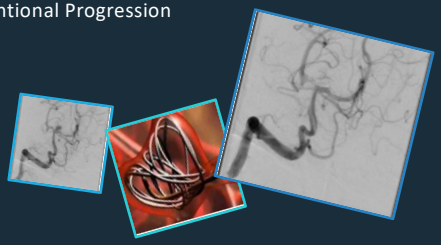
Basilar tip aneurysm





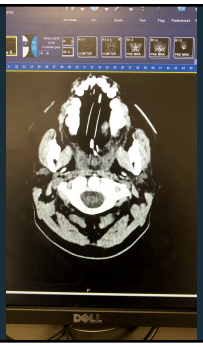
45

Interventional Progression



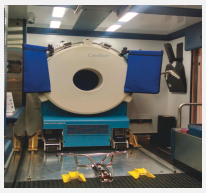
46

Intracerebral Hemorrhage



47

Mercy Health – Toledo, OH
UT Health – Houston, TX
UT Health – Memphis, TN
Cleveland Clinic – Cleveland, OH
NY Presbyterian – Brooklyn, NY



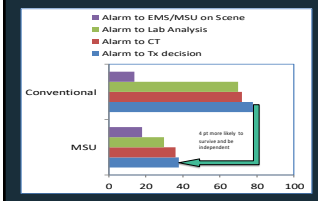
Mobile Stroke Unit

48

Comparative analysis - Toledo

49

Benefits of Stroke Treatment Delivered Using a Mobile Stroke Unit



50% reduction of the alarm-to therapy decision and stroke management subintervals by MSU based stroke care

S. Walter, et al. Diagnosis and treatment of patients with stroke in a mobile stroke unit versus in hospital: a randomized controlled trial

Lancet Neurology 2012;11:397-404

50

Hemorrhagic Stroke – ICH Stroke Scale

Feature	Finding	Points
GCS	3-4	2
	5-12	1
	13-15	0
Age	≥ 80	1
	< 80	0
Location	Infratentorial	1
	Supratentorial	0
ICH volume	≥ 30 mL	1
	< 30 mL	0
Intraventricular Bleed	Yes	1
	No	0
ICH SCORE		0-6 points

ICH Score	30 Day Mortality
0	0%
1	13%
2	26%
3	72%
4	97%
5	100%
6	100%

51

DDx of Ischemic Stroke

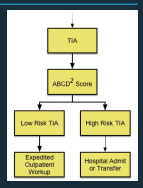
- The most important is **intracranial hemorrhage**
  - If a patient is comatose and no history is available, other diagnoses include:
    - Hypoglycemia
    - Drug overdose
    - Seizures
    - Craniocerebral trauma

52

Evaluation of Suspected Stroke

ABCD² Score

ABCD² Criteria	Points
Age ≥ 60 years (add 1 point)	1
BP ≥ 140/90 mmHg at initial evaluation (add 1 point)	1
Clinical Features of the TIA: • Speech Disturbance without Weakness, or • Unilateral weakness	 1 2
Duration of Symptoms: • 10-59 minutes, or • ≥ 60 minutes	 1 2
Diabetes Mellitus in Patient's History	1



1-3 is low risk
4-5 is moderate risk
>6 is high risk

53

An EMS favorite... Rapid Arterial Occlusion Evaluation

Test Item	0	1	2
Facial Palsy	Absent	Mild	Moderate/Severe
Arm motor	Normal/mild	Moderate	Severe
Leg motor	Normal/mild	Moderate	Severe
Head/Gaze deviation	Absent	Present	N/A
Aphasia (R hemiparesis – L injury)	Performs both tasks	Performs 1 task	Performs neither tasks
Agnosia (L hemiparesis – R injury)	Patient recognizes arm & impairment	Unable to recognize arm or impairment	Unable to recognize arm or impairment
RACE SCORE			**0-9 points**

Aphasia:
1. Ask patient to close eyes
2. Ask patient to make a fist

Agnosia:
1. Ask patient, after lifting paretic arm, who's arm is this?
2. Ask patient to lift both hands and clap

>4 ~ LVO

54

RACE (Rapid Arterial oCclusion Evaluation

Item	Instruction		RACE score	NIHSS score equivalence
Facial palsy	Ask the patient to show teeth	Absent (symmetrical movement)	0	0
		Mild (slightly asymmetrical)	1	1
		Moderate to severe (completely asymmetrical)	2	2-3
Arm motor function	Extending the arm of the patient 90 degrees (if sitting) or 45 degrees (if supine)	Normal to mild (limb upheld more than 10 seconds)	0	0-1
		Moderate (limb upheld less than 10 seconds)	1	2
		Severe (patient do not rise the arm against gravity)	2	3-4
Leg motor function	Extending the leg of the patient 30 degrees (in supine)	Normal to mild (limb upheld more than 5 seconds)	0	0-1
		Moderate (limb upheld less than 5 seconds)	1	2
		Severe (patient do not rise the leg against gravity)	2	3-4
Head and gaze deviation	Observe eyes and cephalic deviation to one side	Absent (eye movements to both sides were possible and no cephalic deviation was observed)	0	0
		Present (eyes and cephalic deviation to one side was observed)	1	1-2
Aphasia (if right hemiparesis)	Ask the patient two verbal orders - "close your eyes" - "make a fist"	Normal (performs both tasks correctly)	0	0
		Moderate (performs one task correctly)	1	1
		Severe (performs neither tasks)	2	2
Agnosia (if left hemiparesis)	Asking: - "Who is this arm" while showing him/her the paretic arm (asomatognosia) - "Can you move well this arm?" (anosognosia)	Normal (no asomatognosia nor anosognosia)	0	0
		Moderate (asomatognosia or anosognosia)	1	1
		Severe (both of them)	2	2
RACE Score total			0-9	

Stroke is likely with a score above 1

Emergent Large Vessel Occlusion is likely if the cumulative score is > 4

with a sensitivity of 85% and specificity of 69%.

The Accuracy of Large Vessel Occlusion Recognition Scales in Telestroke Setting. Mohammad Anadani, Eyad Almallouhi, Amy E. Wahlquist, Ellen Debenham, Christine A. Holmstedt. Telemed J E Health. 2019 Nov 1; 25(11): 1073–1076. Published online 2019 Nov 6.

55

Evaluation of Suspected Stroke

NIH Stroke Scale – the GOLD STANDARD

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.

MAMA
TIP – TOP
FIFTY – FIFTY
THANKS
HUCKLEBERRY
BASEBALL PLAYER

1. **Level of consciousness**
   0 alert
   1 drowsy
   2 stuporous
   3 coma
2. **LOC questions (month, age)**
   0 both correct
   1 one correct
   2 incorrect
3. **LOC commands (close eyes, make a fist)**
   0 both correct
   1 one correct
   2 incorrect
4. **Best gaze**
   0 normal
   1 partial gaze palsy
   2 forced deviation
5. **Visual fields**
   0 no visual loss
   1 partial hemi
   2 complete hemi
   3 bilateral hemi
6. **Facial palsy**
   0 normal
   1 minor
   2 partial
   3 complete

7-10. **Motor (L/R arm + leg)**
   0 no drift
   1 drift
   2 can't resist gravity
   3 no effort against gravity
   4 no movement
   UN amputation/joint fusion
11. **Limb ataxia (Finger-Nose, Heel-Knee-Shin)**
   0 absent
   1 present in 1 limb
   2 present in 2 limbs
12. **Sensation (pinprick)**
   0 normal
   1 partial loss
   2 severe loss
13. **Best language**
   0 no aphasia
   1 mild-mod aphasia
   2 severe aphasia
   3 mute
14. **Dysarthria**
   0 none
   1 mild-mod
   2 near to unintelligible or worse
   UN intubated/barrier
15. **Extinction and inattention**
   0 no neglect
   1 partial neglect
   2 complete neglect

56

BIG thanks to…

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57