Radiologic evaluation of the young patient with stroke

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Outline

- Menu of tests for a young patient with stroke
- Normal brain anatomy on axial magnetic resonance imaging (MRI)
- Imaging for index case
- Differential diagnosis (DDx) of a young adult with stroke
  - Imaging to narrow the DDx
  - Back to the patient!
  - Companion patients

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Our patient: clinical presentation

- Mr. S is a 37 year old man

History of present illness (HPI):

- new onset weakness in his left arm and leg
- new onset psychosis
- fell while trying to change a lightbulb and was unable to stand back up

Past medical history (PMH):

- remote intravenous drug use (IVDU) and bipolar disorder treated with lithium.

Normal workup of suspected stroke in a young adult

- Computed tomography (CT) without contrast to evaluate for hemorrhagic stroke
- MRI with diffusion to rule out other possible etiologies and evaluate the extent of the lesion(s)
- Further imaging evaluation to determine the etiology of the stroke

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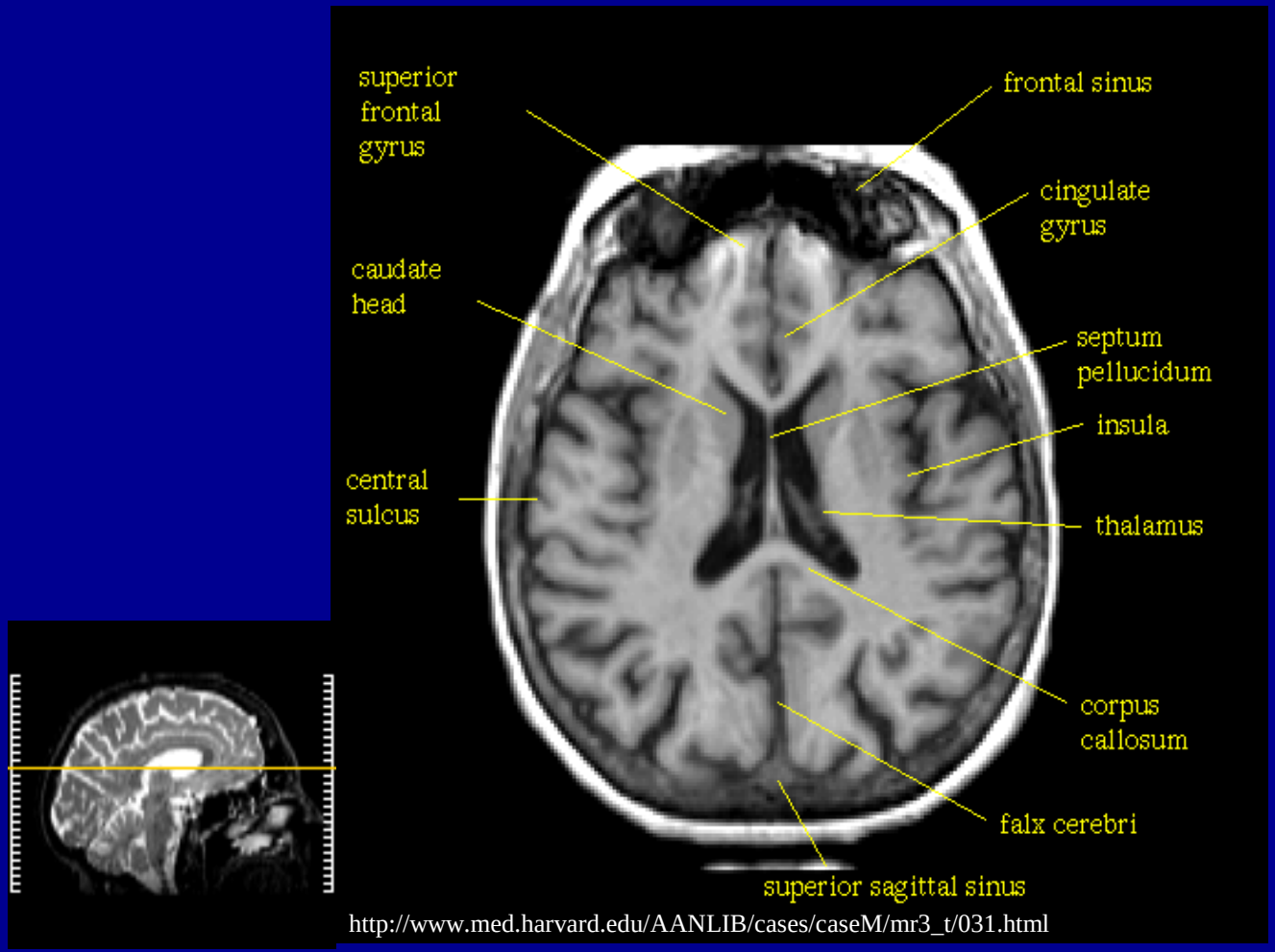
Neuroanatomy on MRI – midaxial plane



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AXIAL MRI T1

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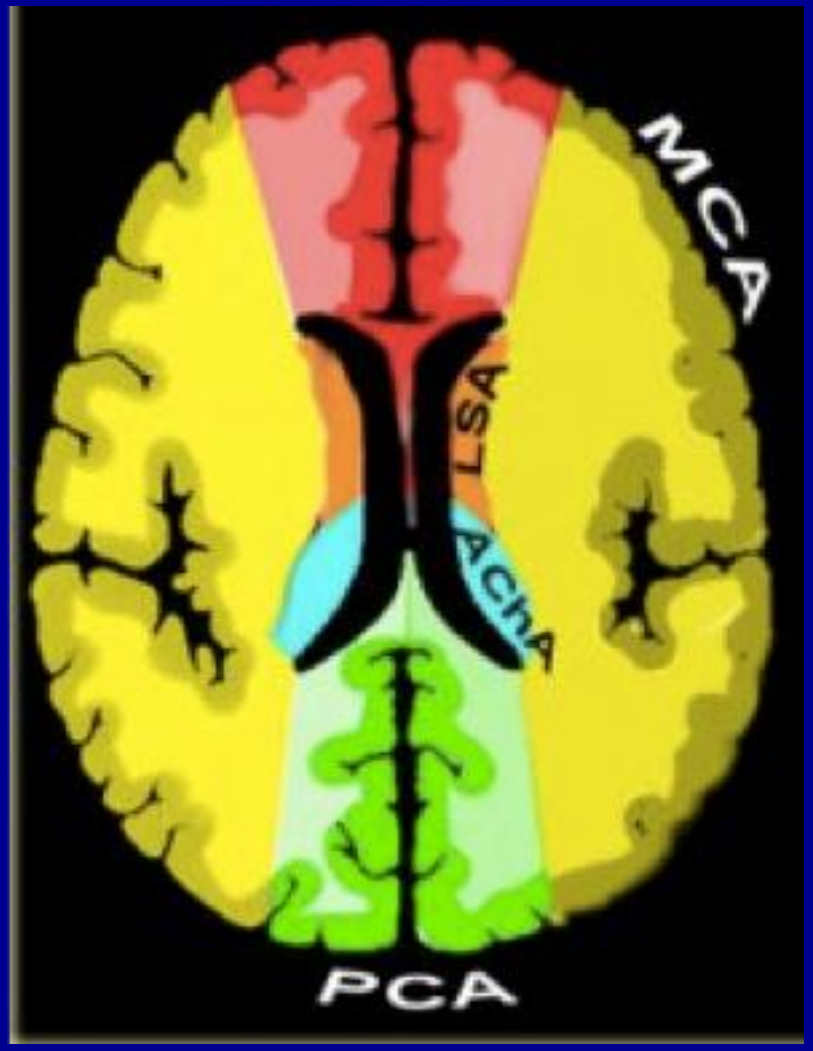
Vascular territories diagram – midaxial plane

ACA = anterior cerebral artery
LSA = lenticulostriate artery
AChA = anterior choroidal artery
MCA = middle cerebral artery
PCA = posterior cerebral artery



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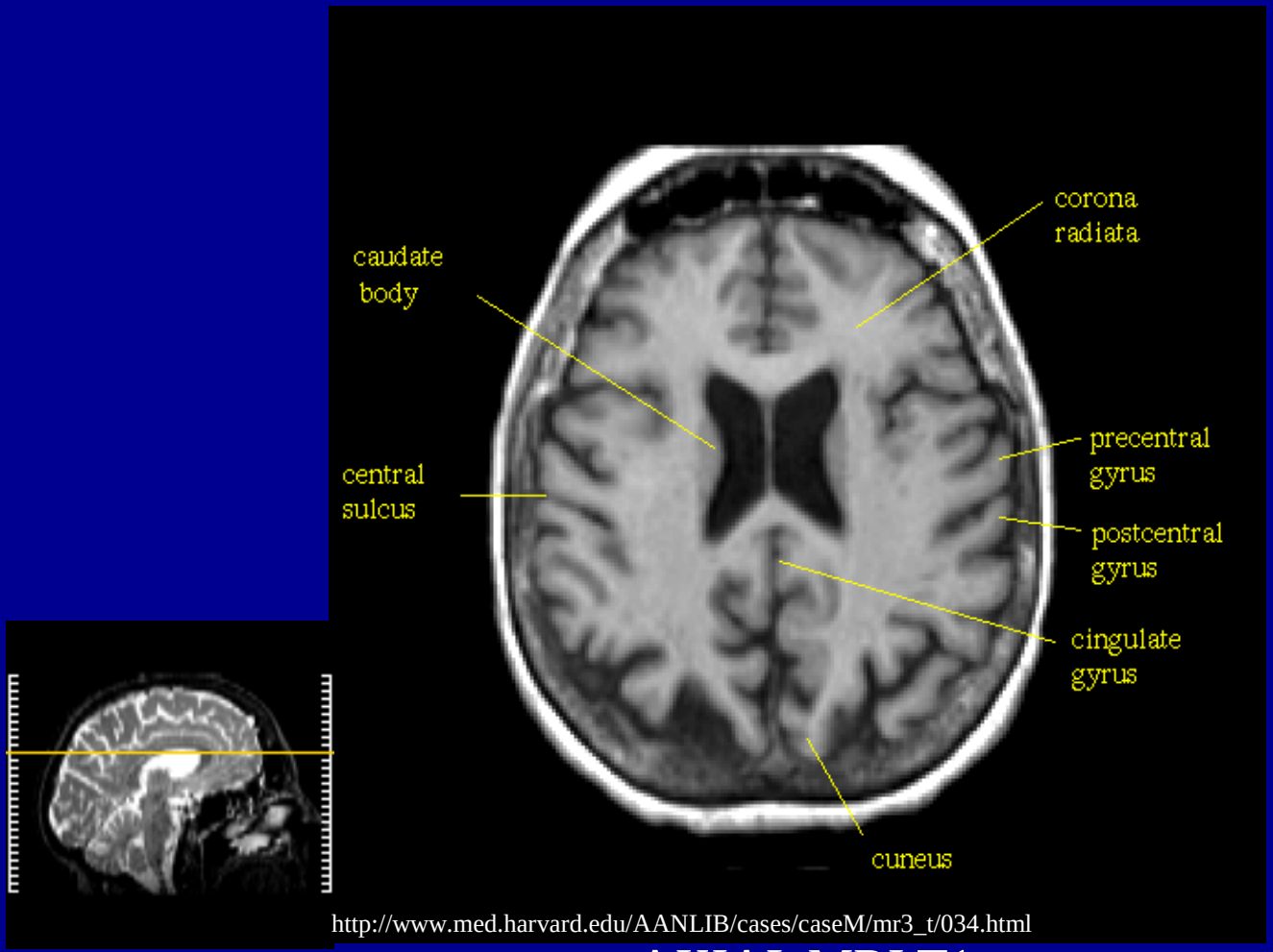
Neuroanatomy on MRI – just above midaxial



http://www.med.harvard.edu/AANLIB/cases/caseM/mr3_t/034.html

AXIAL MRI T1

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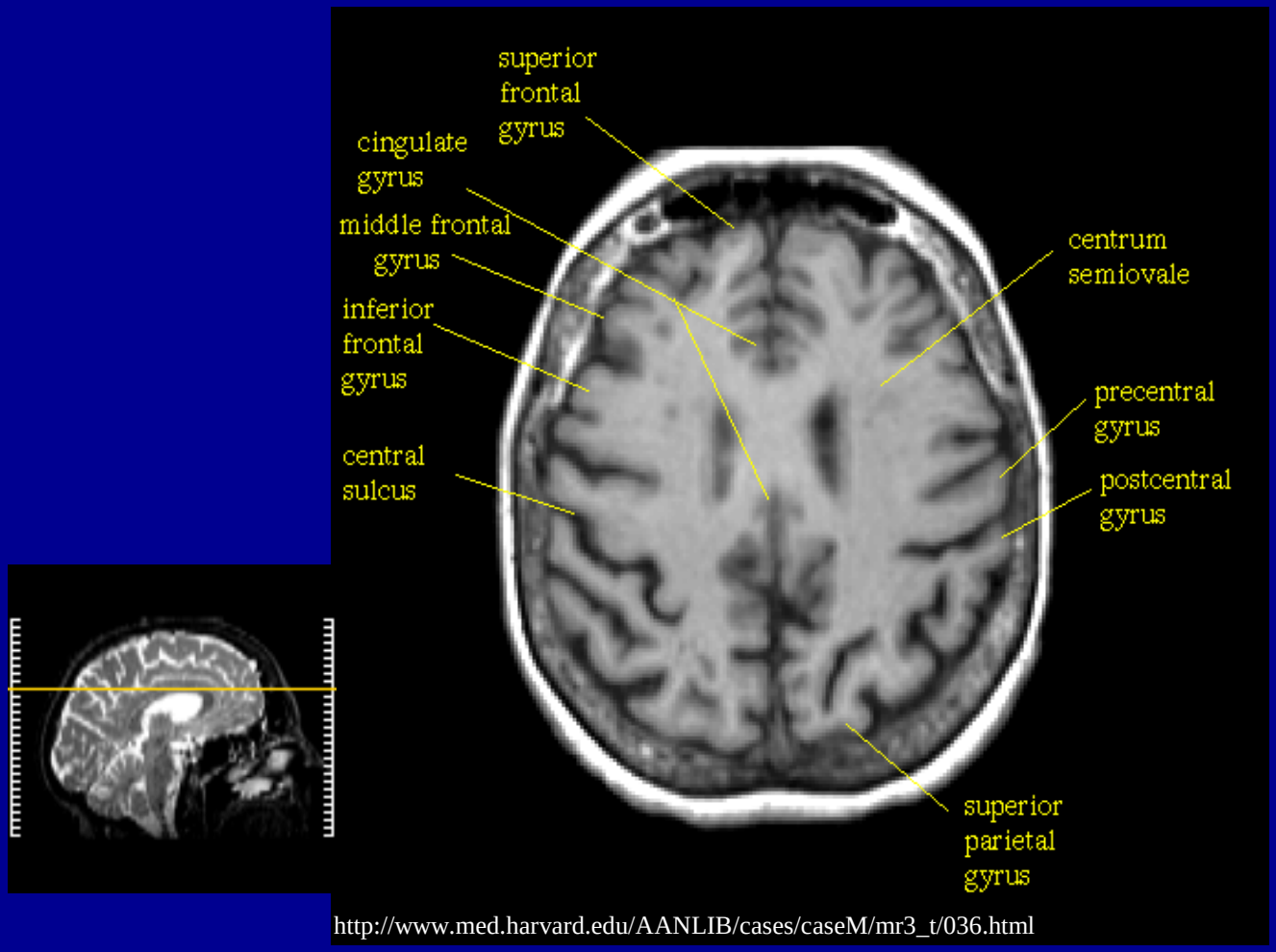
Neuroanatomy on MRI – superior poles of the lateral ventricles



AXIAL MRI T1

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Vascular territories diagram – superior poles of the lateral ventricles

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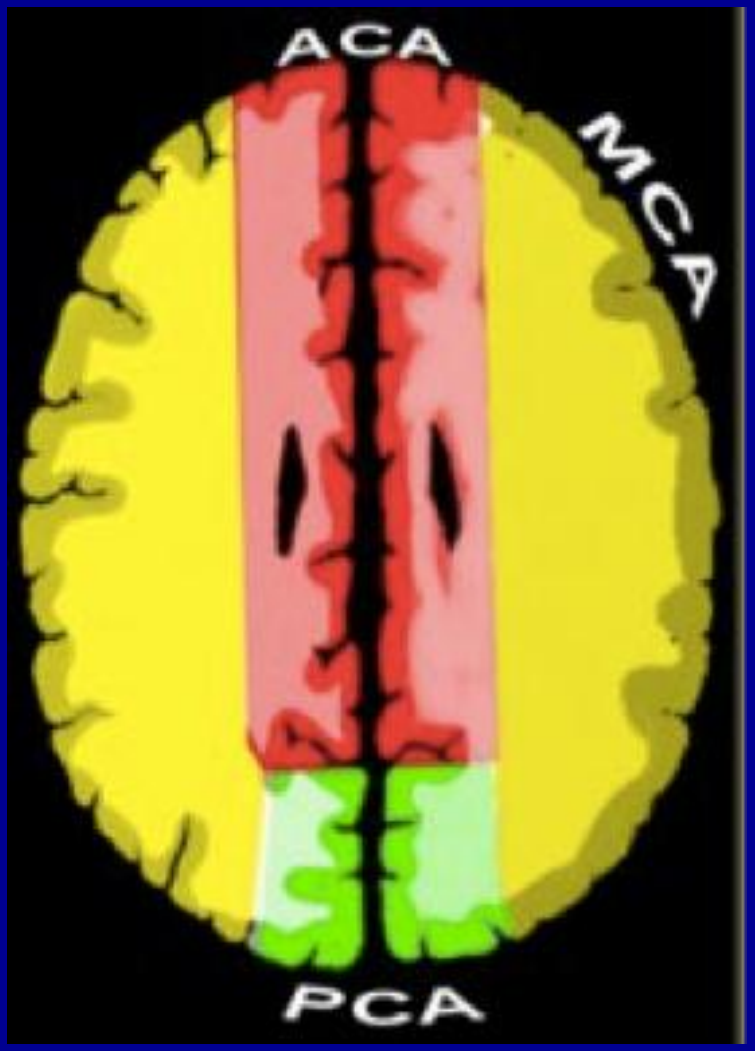

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Our patient: initial imaging

- Head CT without contrast
- Diffusion-weighted MRI (DW-MRI) with apparent diffusion coefficient (ADC) map

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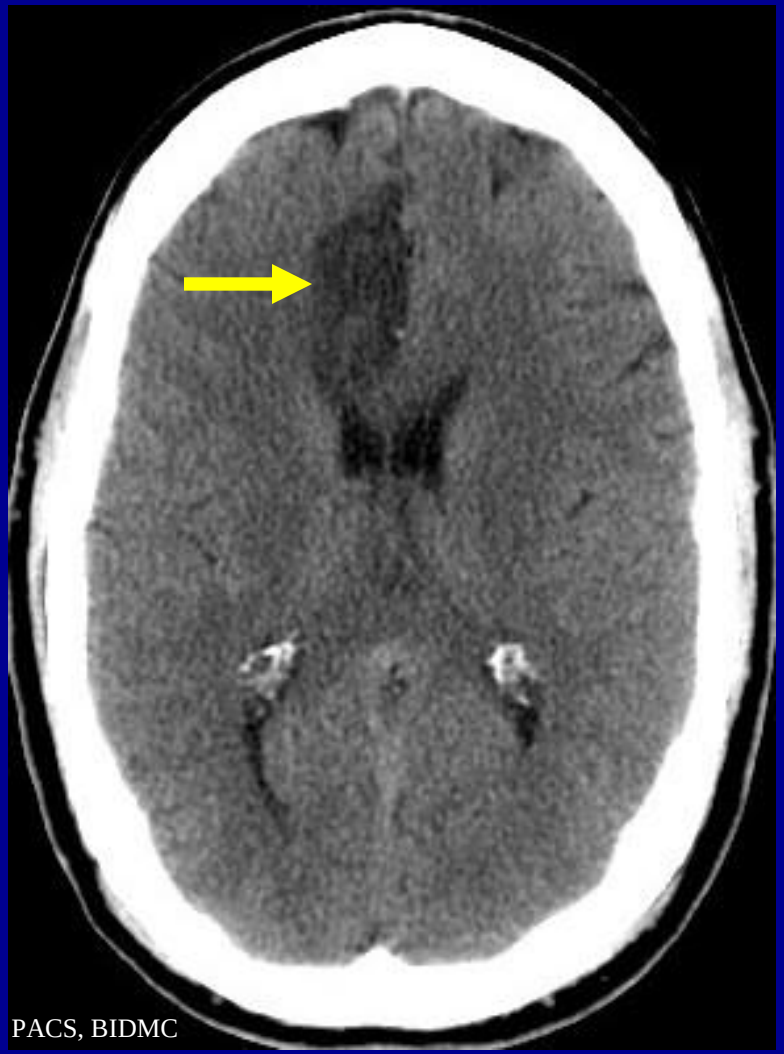
Our patient: head CT – midaxial plane

Cingulate gyrus (ACA)



C- AXIAL CT

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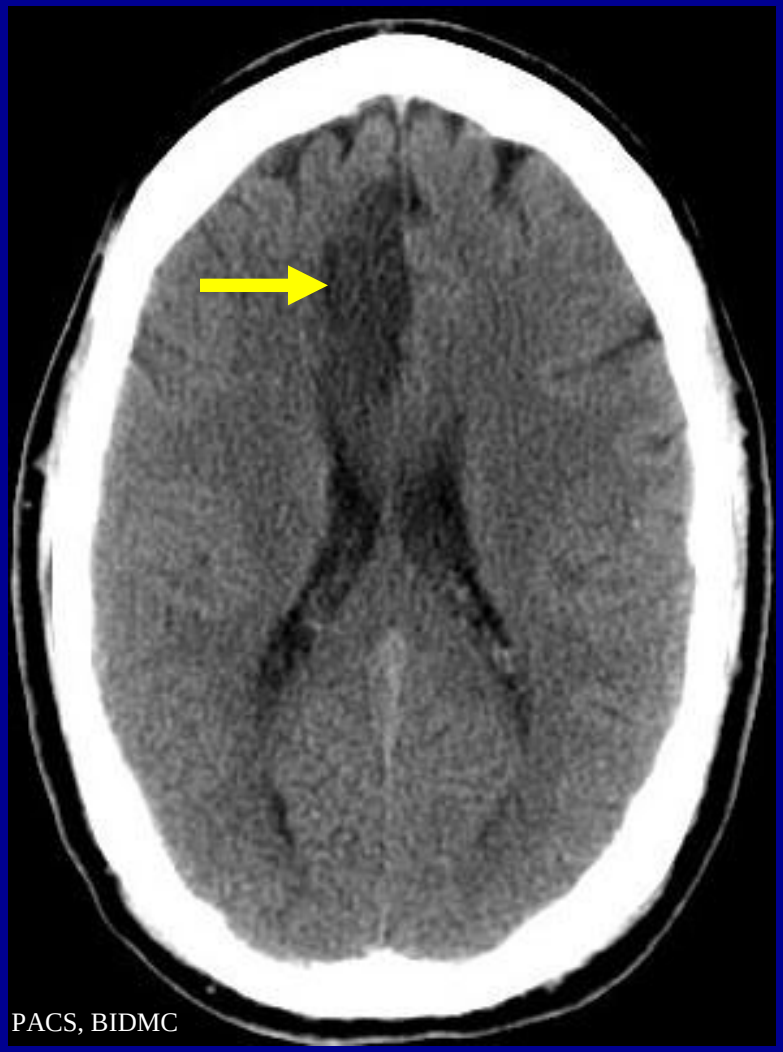
Our patient: head CT – just above midaxial

Cingulate gyrus (ACA)



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C- AXIAL CT

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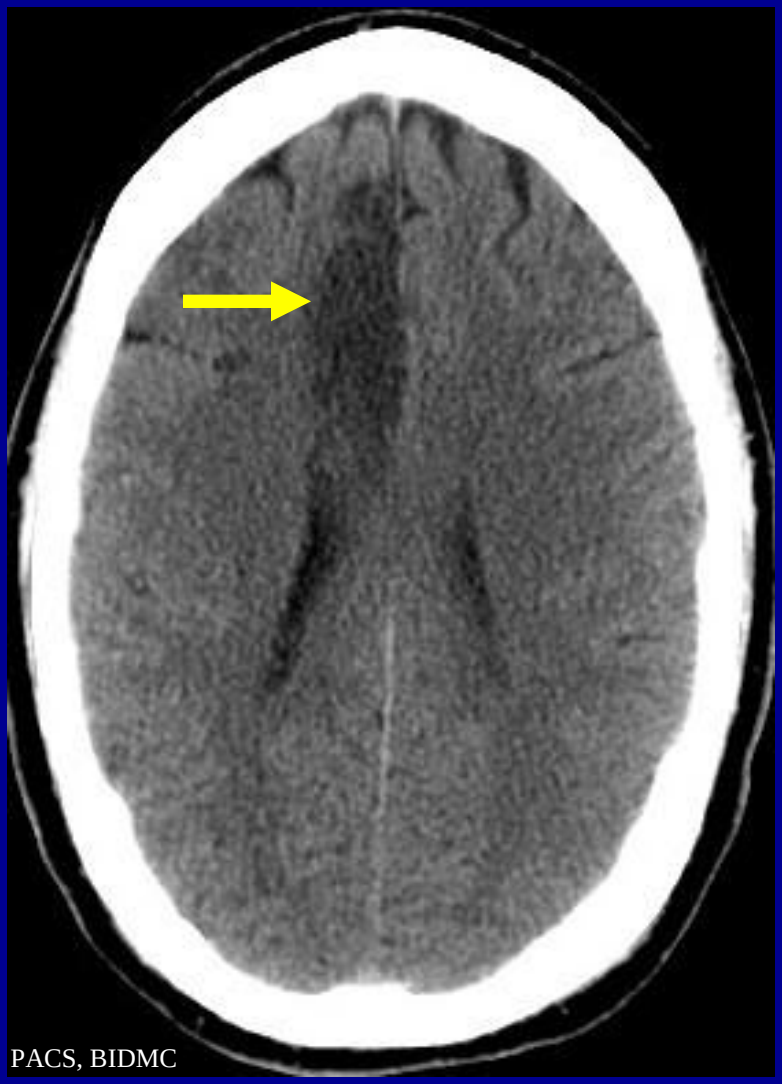
Our patient: head CT – superior poles of the lateral ventricles

Cingulate gyrus (ACA)



C- AXIAL CT

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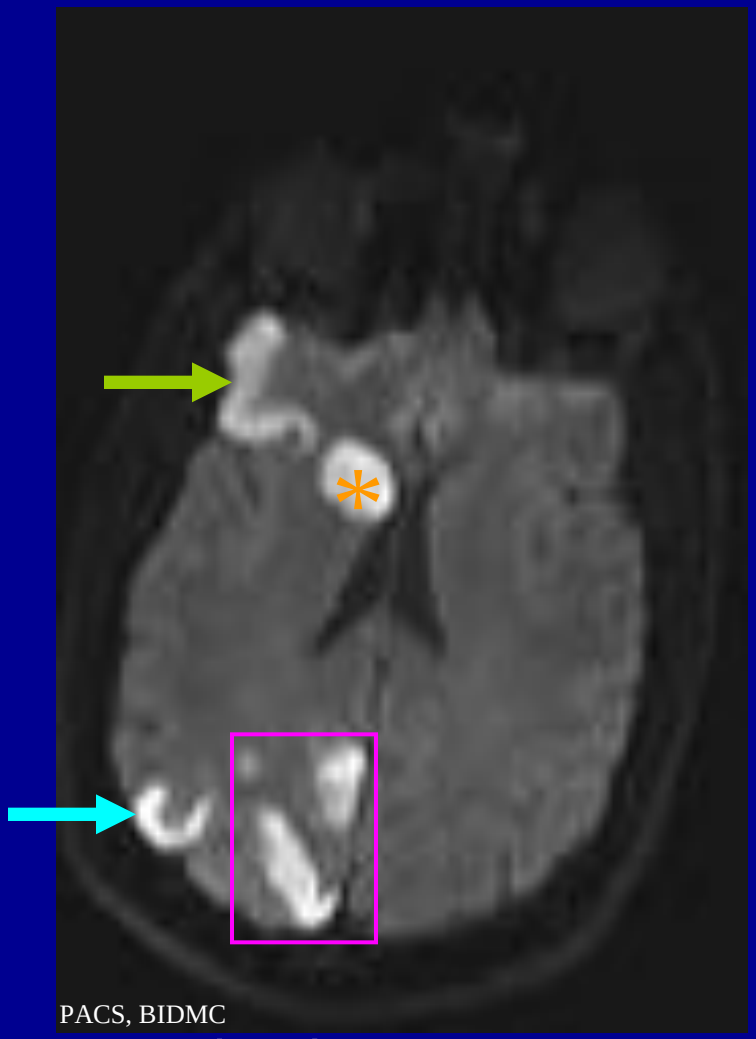
Our patient: brain DW-MRI – midaxial plane

Frontal lobe (MCA)
Caudate (LSA)
Parietal lobe (MCA)
Occipital lobe (PCA)



AXIAL DW-MRI

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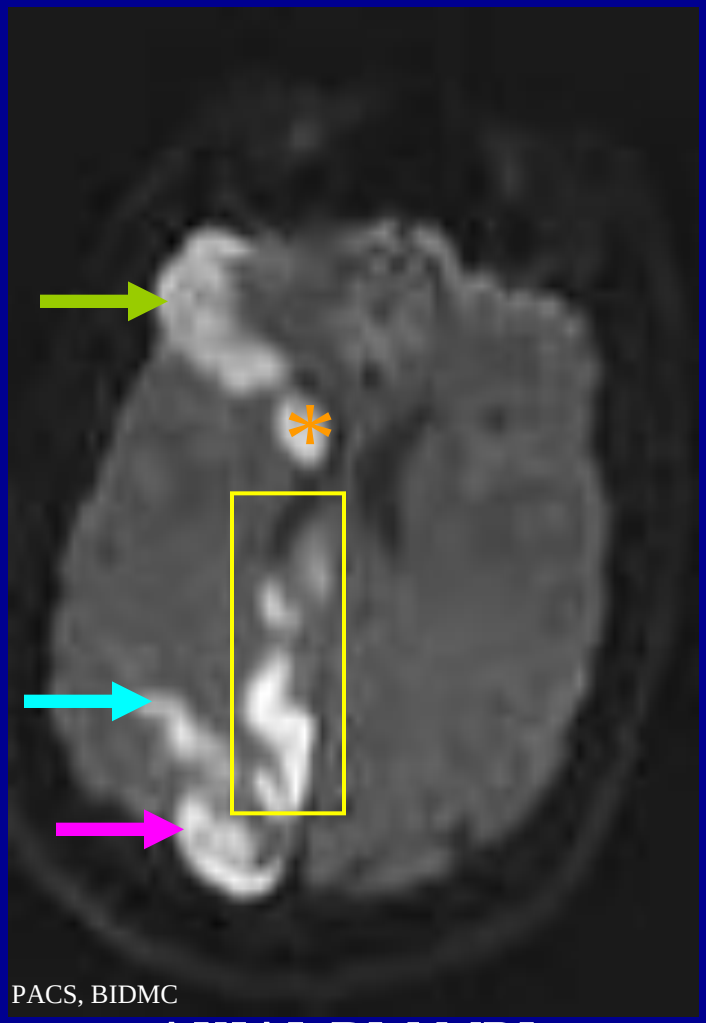
Our patient: brain DW-MRI – just above midaxial

Frontal lobe (MCA)
Caudate (LSA)
Cingulate gyrus (ACA)
Parietal lobe (MCA)
Occipital lobe (PCA)



AXIAL DW-MRI

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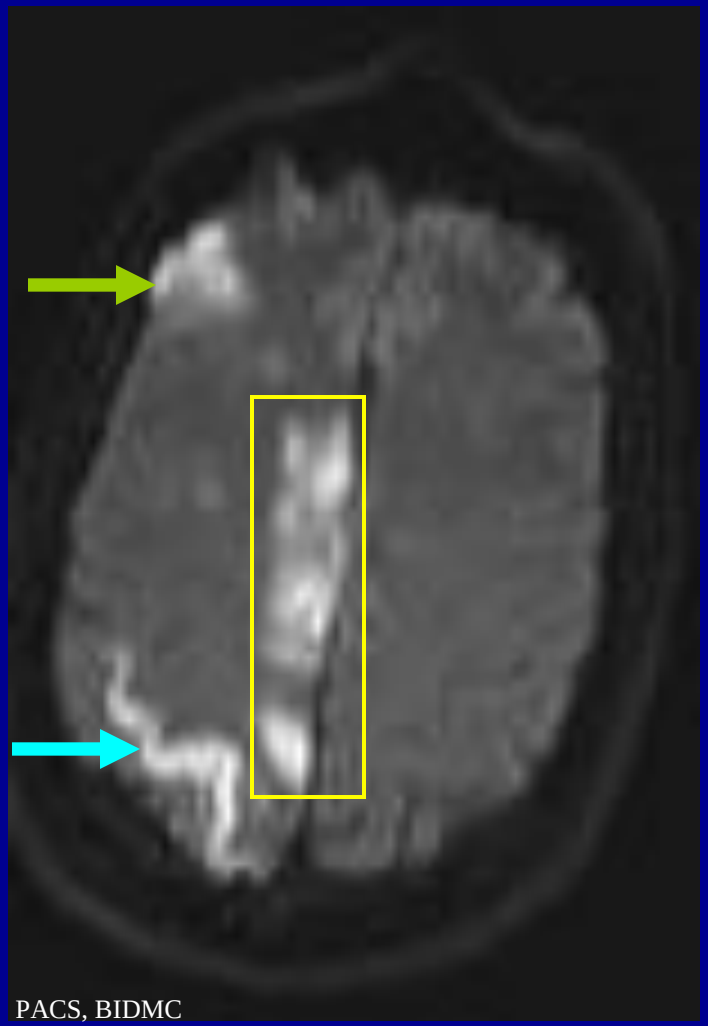
Our patient: brain DW-MRI – superior to the lateral ventricles

Frontal lobe (MCA)
Cingulate gyrus (ACA)
Parietal lobe (MCA)



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AXIAL DW-MRI

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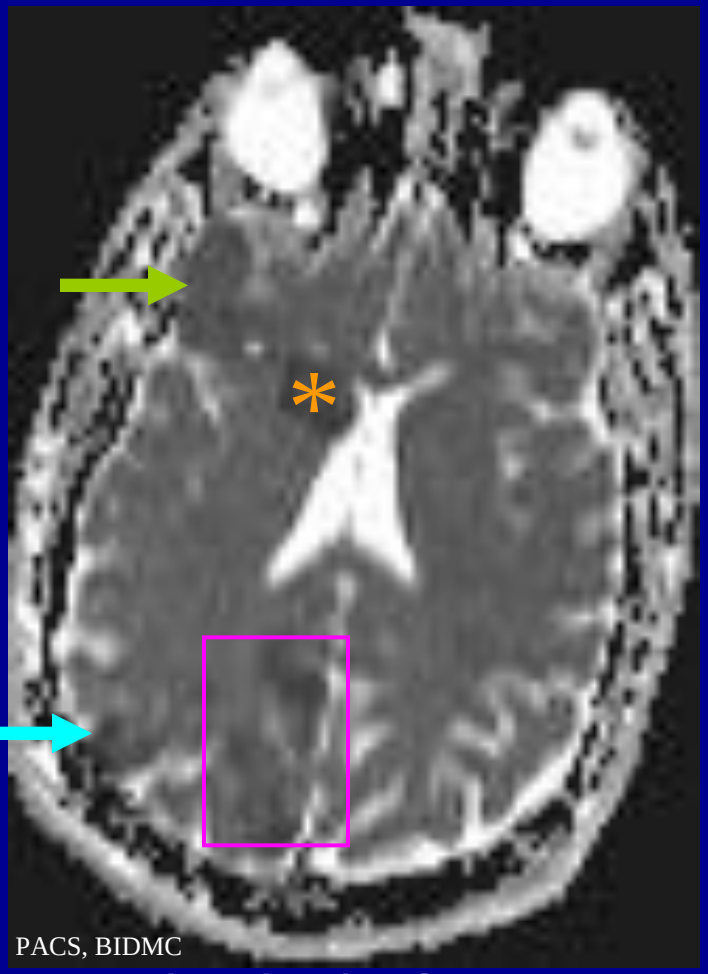
Our patient: brain ADC map – midaxial plane

Frontal lobe (MCA)
Caudate (LSA)
Parietal lobe (MCA)
Occipital lobe (PCA)



AXIAL ADC map

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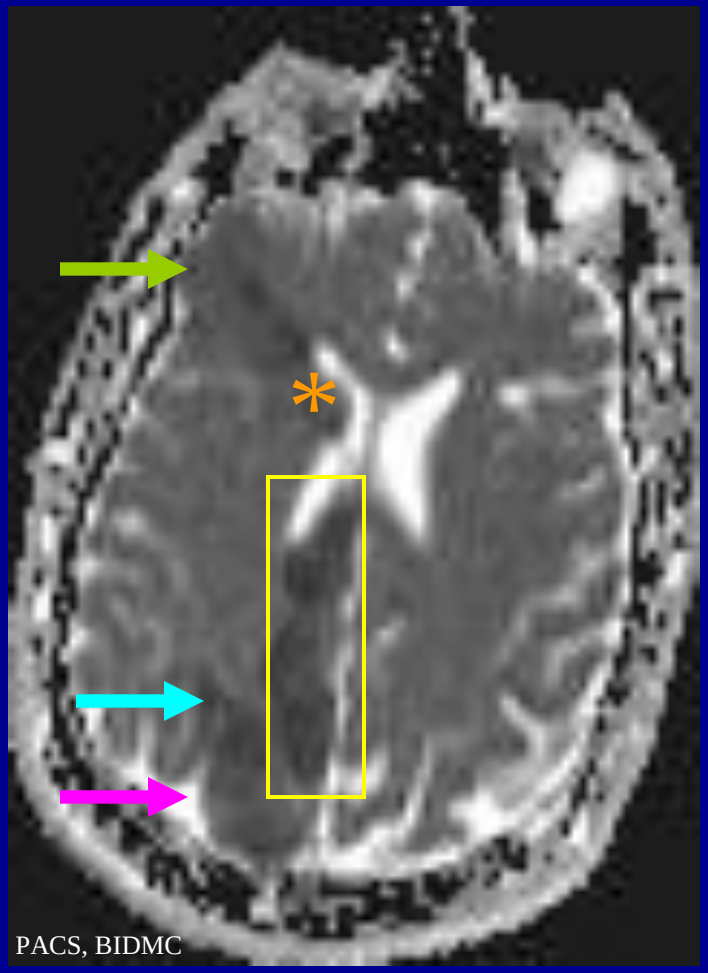
Our patient: brain ADC map – just above midaxial

Frontal lobe (MCA)
Caudate (LSA)
Cingulate gyrus (ACA)
Parietal lobe (MCA)
Occipital lobe (PCA)



AXIAL ADC map

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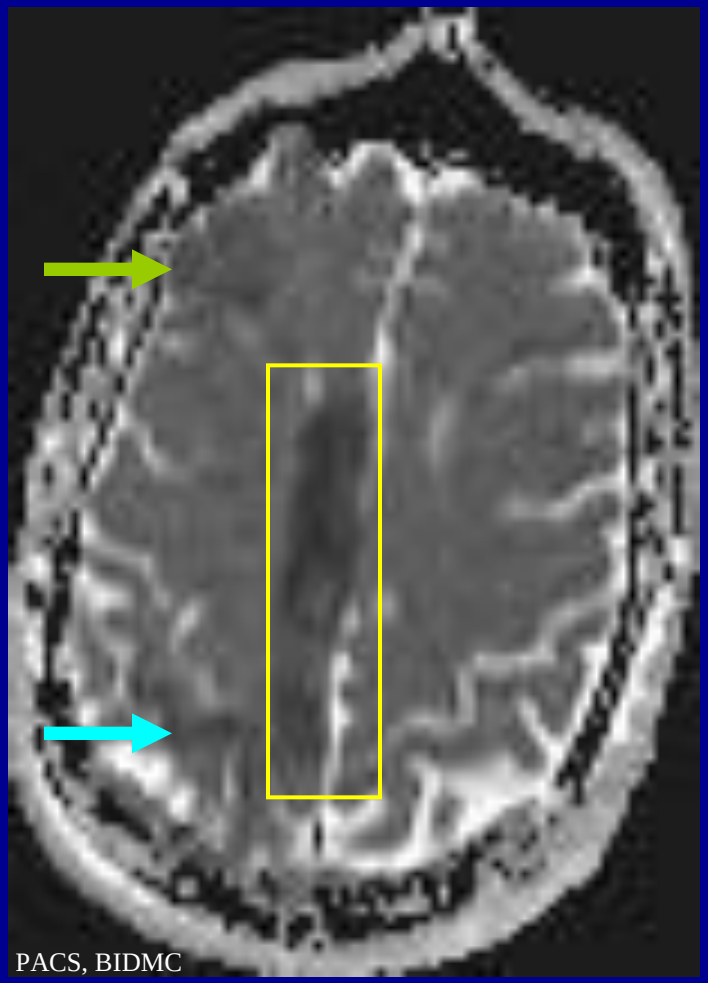
Our patient: brain ADC map – superior to lateral ventricles

Frontal lobe (MCA)
Cingulate gyrus (ACA)
Parietal lobe (MCA)



AXIAL ADC map

Our patient: interpretation of initial imaging

- Head CT and DW-MRI showed multiple regions of likely ischemic stroke
  - ACA, MCA, and PCA vascular territories involved
- Hyperenhancement on DW-MRI with hypoenhancement on ADC strongly suggestive of ischemic stroke

Causes of ischemic stroke in a young patient:

- Atherosclerotic large vessel disease
- Small vessel disease
- Cervical arterial dissection
- Patent foramen ovale (PFO)
- Hypercoagulability
- Primary CNS vasculitis

Note: disease entities may overlap or coexist

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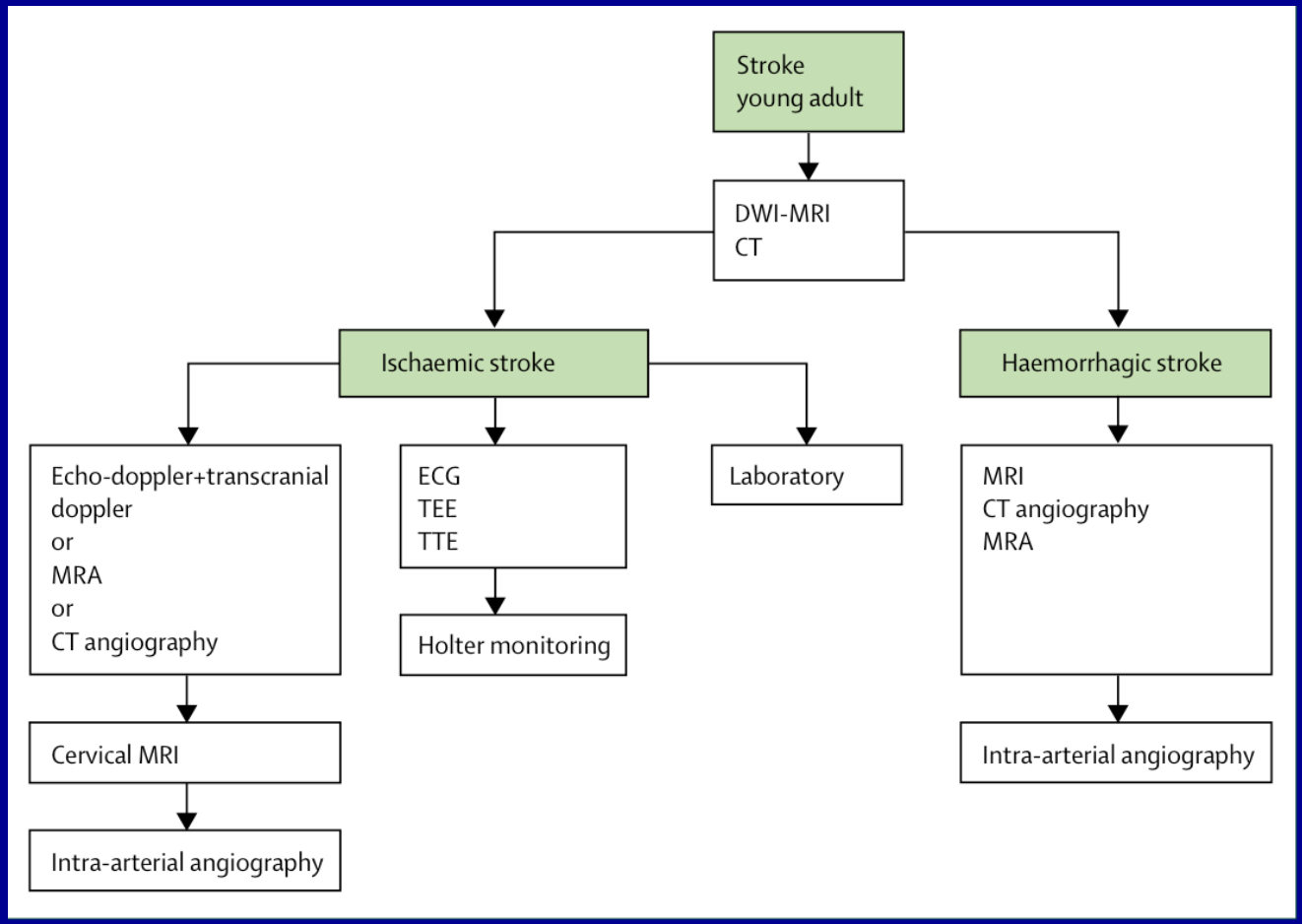
Risk factors in a study of 203 young adults with ischemic stroke

Characteristic	n (%)
Men	108 (53)
Hypertension	38 (19)
Diabetes mellitus	4 (2)
Smoking	94 (46)
Hypercholesterolaemia	79 (39)
Coronary artery disease	3 (1)
History of transient ischaemic attacks	24 (12)
History of ischaemic stroke	8 (4)
History of amaurosis fugax	6 (3)
History of migraine without aura	37 (18)
C reactive protein level >5 mg/l	73 (36)
Oral contraceptives	21 (22*)

*Per cent of the women.

Nedeltchev K, *et al.* Ischaemic stroke in young adults: predictors of outcome and recurrence. *J Neurol Neurosurg Psychiatry* 2005; 76: 191-5.

Imaging workup of suspected stroke in a young adult



Ferro JM, Massaro AR, Mas JL. Aetiological diagnosis of ischaemic stroke in young adults. *Lancet Neurol* 2010; 9: 1085-96.

Stroke etiology in a study of 203 young adults

Aetiology	n (%)
Large artery atherosclerosis	8 (4)
Cardiac embolism	48 (24)
Small vessel disease	18 (9)
Other determined aetiology	61 (30)
Cervical artery dissection	48 (24)
Migrainous infarction	2 (0.9)
Essential thrombocythemia	2 (0.9)
Factor V Leiden deficiency	2 (0.9)
Complication of catheter coronary angiography	2 (0.9)
Systemic lupus erythematosus	1 (0.5)
Cocaine use	1 (0.5)
Protein C deficiency	1 (0.5)
Fabry's disease	1 (0.5)
Eclampsia	1 (0.5)
Undetermined aetiology	68 (33)

Nedeltchev K, *et al.* Ischaemic stroke in young adults: predictors of outcome and recurrence. *J Neurol Neurosurg Psychiatry* 2005; 76: 191-5.

Our patient: further workup

- MR angiography (MRA) of the head and neck to assess for dissection
- Transthoracic echocardiogram (TTE) and transesophageal echocardiogram (TEE) to assess for patent foramen ovale (PFO)
- Ultrasound (U/S) of the upper extremity and lower extremity and MR venogram (MRV) of the pelvis to assess for deep vein thrombosis (DVT)
- Cerebrospinal fluid (CSF) immunophenotyping to look for underlying malignancy

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Our patient: Head and Neck MRA

Normal MR angiography with patent internal carotid and Circle of Willis arteries bilaterally

CORONAL MRA

Our patient: findings on workup

- All negative except for TEE, which showed PFO.

- Suspected etiology:

  - Hypercoagulable state after his fall led to paradoxical embolization through his PFO

  - He showed significant improvement with physical therapy, suggesting a possible lesion in the premotor cortex

  - He was sent home on 81 mg aspirin therapy

Companion patients:

Companion patient #1

- 45 yo F with IVDU and endocarditis

Companion patient #2

- 47 yo F with Moyamoya disease

Companion patient #3

- 48 yo F with left-sided facial droop and ataxia

Companion patient #1: Head CT

Cerebellum (posterior inferior cerebellar artery (PICA) or anterior inferior cerebellar artery (AICA))

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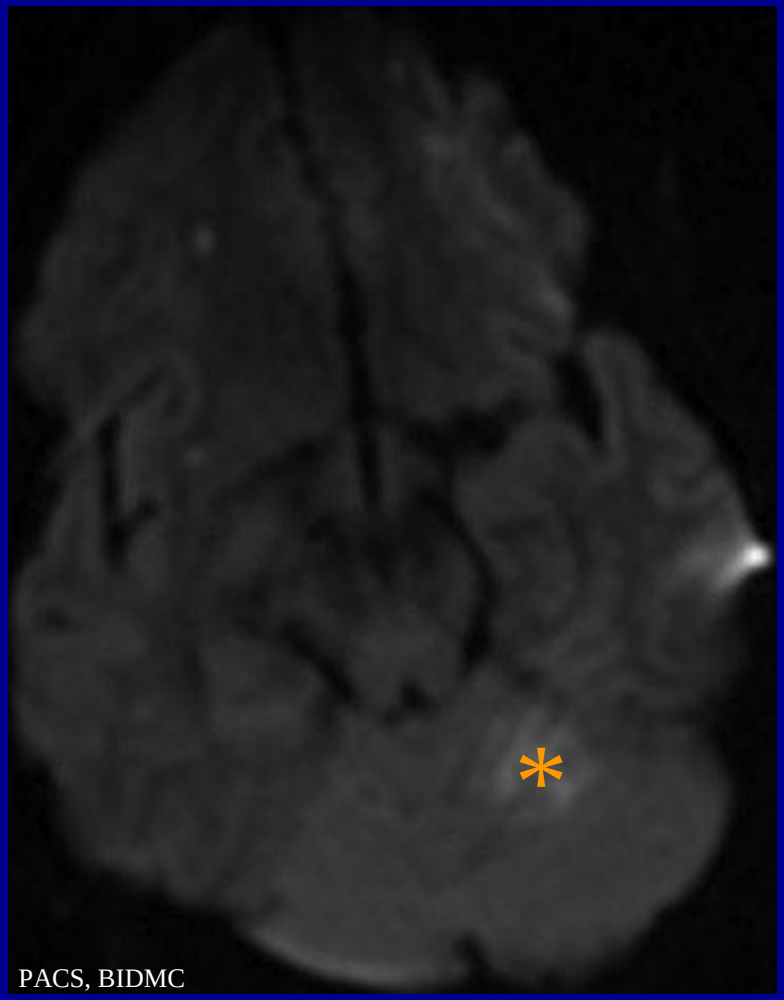
C- AXIAL HEAD CT

Companion patient #1: brain DW-MRI

Cerebellum (PICA or AICA)

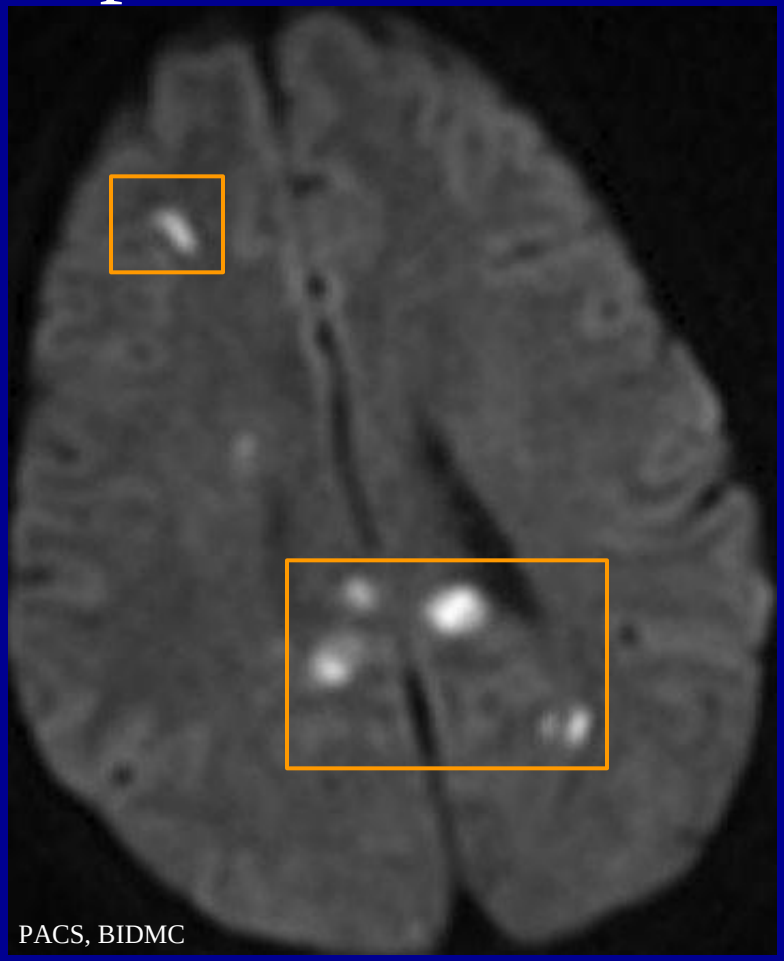


AXIAL DW-MRI

Companion patient #1: brain DW-MRI - a more superior slice

Multiple cerebral infarcts

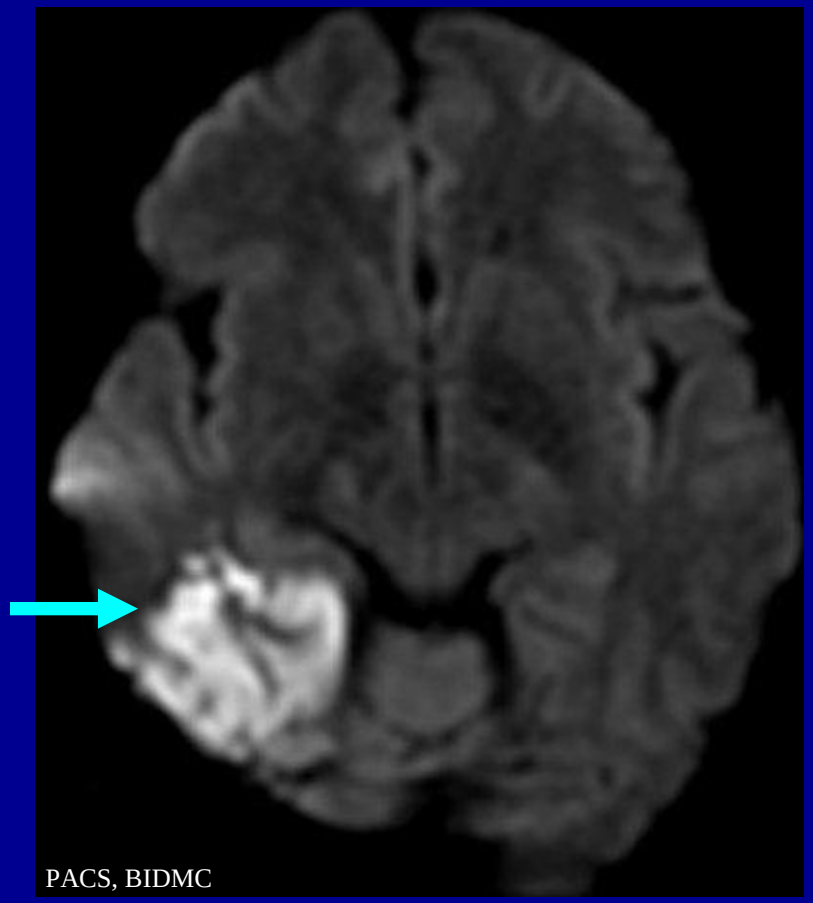
Etiology: repeated infarctions due to septic emboli from endocarditis



AXIAL DW-MRI

Companion patient #2: brain DW-MRI

Parietal and occipital lobes (MCA / PCA watershed)

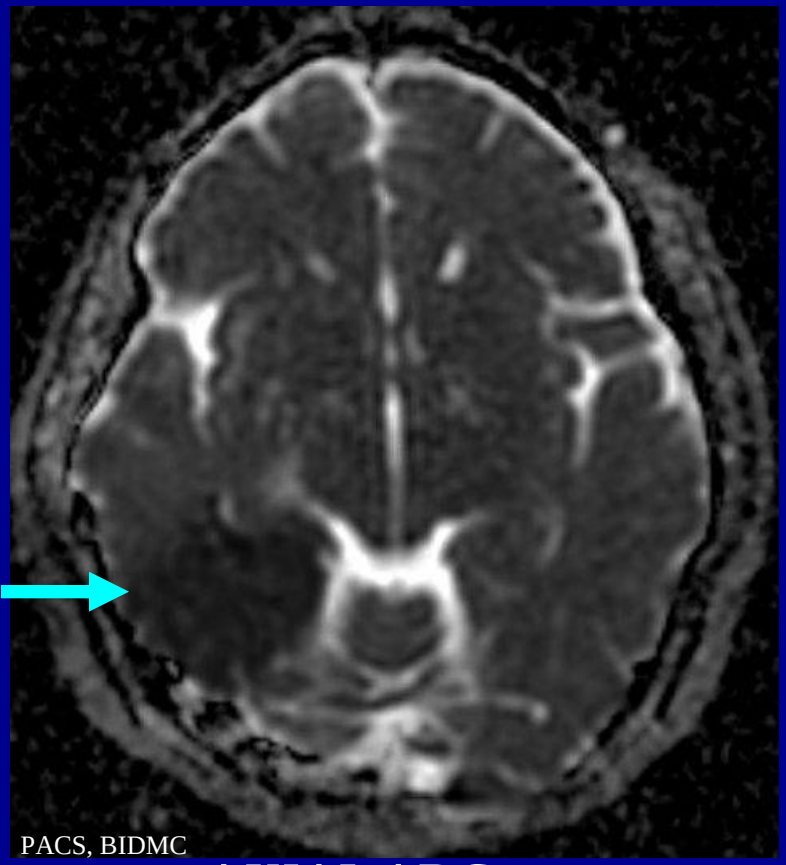


AXIAL DW-MRI

Companion patient #2: brain ADC map

Parietal and occipital lobes (MCA / PCA watershed)

Etiology: watershed infarction due to Moyamoya disease

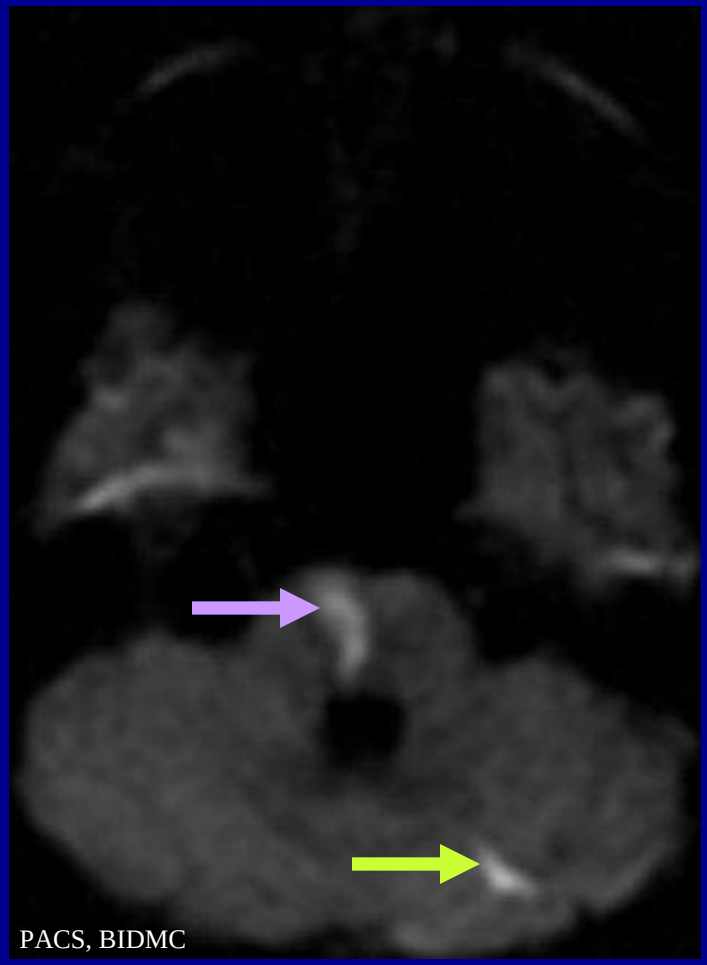


AXIAL ADC map

Companion patient #3: DW-MRI

Pons (Basilar)
Cerebellum (PICA or AICA)

Multiple infarctions due to hypercoagulability with PFO



AXIAL DW-MRI

Conclusion: approach to stroke in a young adult

- Perform stroke workup with imaging
- Develop a DDx based on history and imaging findings
- Use imaging and labs to determine underlying etiology
- Treat!

Acknowledgements

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-Gillian Lieberman, MD

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