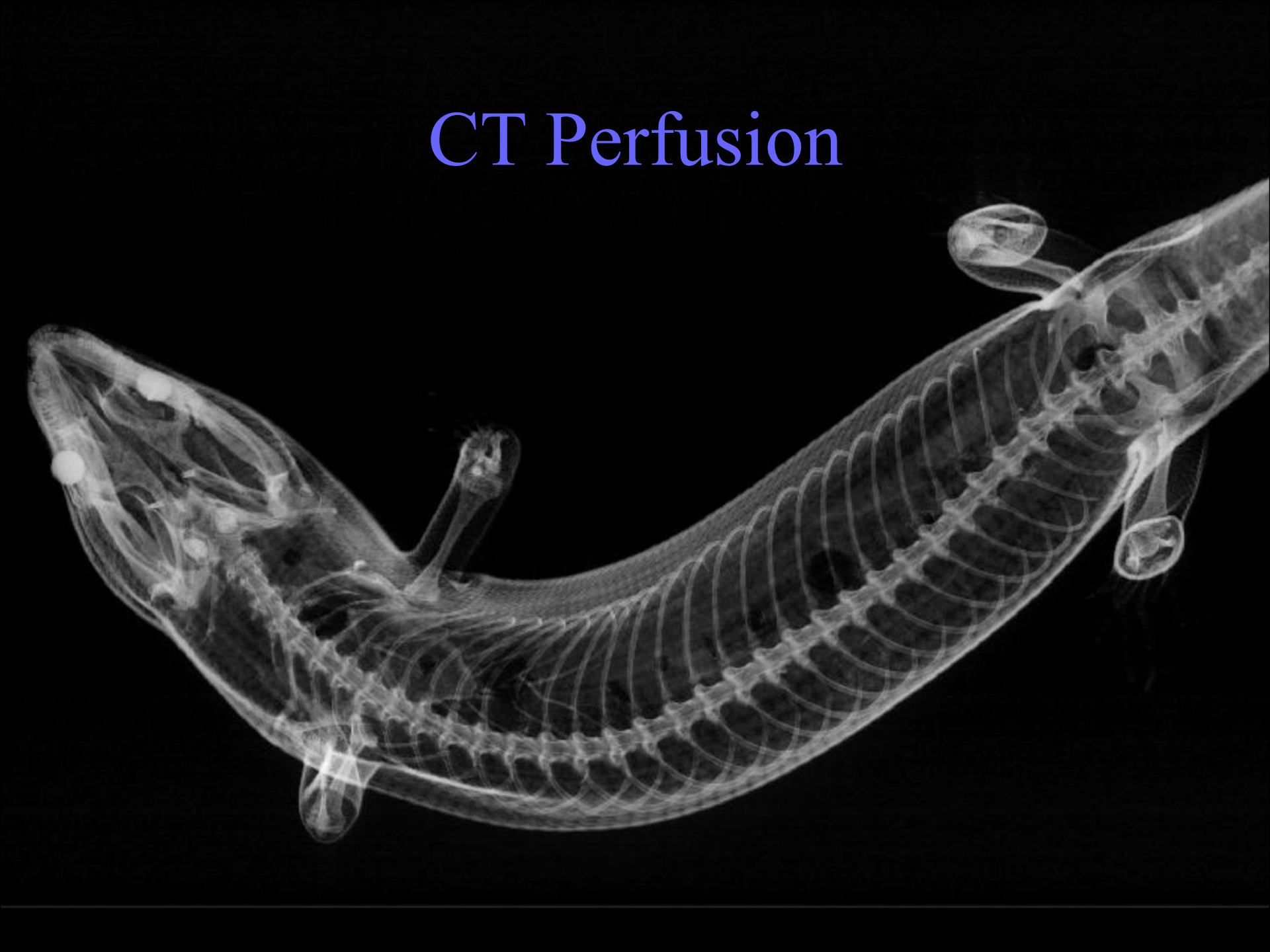
CT Perfusion



Acute Stroke Intervention Criteria

A. NIHSS ≥ 10 or VAN positive right before procedure **AND**

B. CTA showing M1 And/ OR intracranial ICA occlusion **AND**

C. CT Perfusion criteria

- Ischemic penumbra >15 cc **AND**
- Mismatch ratio >1.8 **AND**

B1: Less than 6 hours (based on SWIFT-PRIME)

- Infarct lesion < 50 cc

B2: 6-24 hours (based on DAWN)

- 0-<21 cc core infarct and NIHSS ≥ 10 (and age ≥ 80 years old)
- 0-<31 cc core infarct and NIHSS ≥ 10 (and age < 80 years old)
- 31 cc to <51 cc core infarct and NIHSS ≥ 20 (and age < 80 years old)

Acute Stroke Intervention Checklist (If answer is No to any of these then STOP)

1. **NIHSS ≥ 10 or VAN positive right before procedure** **Yes**
2. **CTA showing M1 And/ OR intracranial ICA occlusion** **Yes**
3. **CT perfusion showing:**
   - Ischemic penumbra >15 cc **AND** Mismatch ratio >1.8 **Yes**
4. **< 6 hours (based on SWIFT-PRIME):** Infarct lesion < 50 cc **Yes**
5. **6-24 hours (based on DAWN)** **Yes**
   A. 0-<21 cc core infarct **and** NIHSS ≥ 10 (**and** age ≥ 80 years old)
   B. 0-<31 cc core infarct **and** NIHSS ≥ 10 (**and** age < 80 years old)
   C. 31 cc to <51 cc core infarct **and** NIHSS ≥ 20 (**and** age < 80 years old)

*If patient meet criteria then call neuro IR on call

*If the answer to NO then contact stroke neurologist OR neurointensivist OR neurologist on call to discuss the case

NATIONAL INSTITUTES OF HEALTH
stroke scale

CATEGORY	STROKE SCALE	SCORE
1a. Level of consciousness Alert, Drowsy, etc	0 Alert 1 Drowsy 2 Stuporous 3 Coma	
1b. LOC Questions Month, age	0 Answers both correctly 1 Answers one correctly 2 Incorrect	
1c. LOC Commands Open/close eyes, make a fist & let go	0 Obeys both correctly 1 Obeys one correctly 2 Incorrect	
2. Best Gaze Eyes open - pt follows examiner's fingers or face.	0 Normal 1 Partial gaze palsy 2 Forced deviation	
3. Visual Introduce visual stimulus/threat to pt's visual field quadrants. Cover 1 eye and hold up fingers in all 4 quadrants.	0 No visual loss 1 Partial hemianopsia 2 Complete hemianopsia 3 Bilateral hemianopsia	

4. Facial Palsy

Show teeth, raise eyebrows and squeeze eyes tightly shut.

0	1	2	3
Normal	Minor	Partial	Complete

5.a Motor Arm - Left

Elevate extremity to 90 degrees and score drift/movement. Count to 10 out loud and use fingers for visual cue.

0	1	2	3	4
No Drift	Drift	Can't resist gravity	No effort against gravity	No Movement

NT = Amputation, joint fusion

5.b Motor Arm - Right

Elevate extremity to 90 degrees and score drift/movement. Count to 10 out loud and use fingers for visual cue.

0	1	2	3	4
No Drift	Drift	Can't resist gravity	No effort against gravity	No Movement

NT = Amputation, joint fusion

6.a Motor Leg - Left

Elevate extremity to 30 degrees and score drift/movement. Count to 5 out loud and use fingers for visual cue.

0	1	2	3	4
No Drift	Drift	Can't resist gravity	No effort against gravity	No Movement

NT = Amputation, joint fusion

6.b Motor Leg - Right

Elevate extremity to 30 degrees and score drift/movement. Count to 5 out loud and use fingers for visual cue.

0	1	2	3	4
No Drift	Drift	Can't resist gravity	No effort against gravity	No Movement

NT = Amputation, joint fusion

7. Limb Ataxia

Finger to nose, heal down shin

0	1	2
Absent	Present in one limb	Present in two limbs

8. Sensory

Pin prick to face, arms, trunk, and legs - compare sharpness side to side

0	1	2
Normal	Partial loss	Severe Loss

9. Best Language

Name items, describe picture, and read sentences. Don't forget glasses if they normally wear them.

0	1	2	3
No aphasia	Mild to moderate aphasia	Severe aphasia	Mute

10. Dysarthria

Evaluate speech clarity by pt reading or repeating words on list.

0	1	2
Normal articulation	Mild to moderate dysarthria	Near to unintelligible or worse

NT = Intubated or other physical barrier

11. Extinction and Inattention

Use information from prior testing or double simultaneous stimuli testing to identify neglect. Face, arms, legs, and visual fields.

0	1	2
No neglect	Partial neglect	Complete neglect

11. Extinction and Inattention

Use information from prior testing or double simultaneous stimuli testing to identify neglect. Face, arms, legs, and visual fields.

0	1	2
No neglect	Partial neglect	Complete neglect

NT = Not Testable acceptable as noted above

Score	Stroke Severity
0	No stroke symptoms
1-4	Minor stroke
5-15	Moderate stroke
16-20	Moderate to severe stroke
21-42	Severe stroke

TOTAL =

Saebo

Alberta stroke program early CT score (ASPECTS)

A.Prof Frank Gaillard and Dr Haris Sair et al.

The **Alberta stroke programme early CT score (ASPECTS)** [1] is a 10-point quantitative topographic CT scan score used in patients with middle cerebral artery stroke. It has also been adapted for the posterior circulation (see below).

Scoring system

Segmental assessment of the MCA vascular territory is made and 1 point is deducted from the initial score of 10 for every region involved:

- caudate
- putamen
- internal capsule
- insular cortex
- M1: "anterior MCA cortex," corresponding to frontal operculum
- M2: "MCA cortex lateral to insular ribbon" corresponding to anterior temporal lobe
- M3: "posterior MCA cortex" corresponding to posterior temporal lobe
- M4: "anterior MCA territory immediately superior to M1"
- M5: "lateral MCA territory immediately superior to M2"
- M6: "posterior MCA territory immediately superior to M3"

Acute Stroke Intervention Criteria

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C. CT Perfusion criteria

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Important points

1. the initial paper [1] specifically referred to the internal capsule only involving the posterior limb, however, subsequent articles indicate any portion of the internal capsule may be included
2. M1 to M3 are at the level of the basal ganglia
3. M4 to M6 is at the level of the ventricles immediately above the basal ganglia

Clinical use

An ASPECTS score less than or equal to 7 predicts a worse functional outcome at 3 months as well as symptomatic hemorrhage.

According to the study performed by R. I. Aviv et al., patients with ASPECTS score less than 8 treated with thrombolysis did not have a good clinical outcome [3].

Posterior circulation

Variations of the ASPECT scoring system have been described for use in the posterior circulation and referred to as pc-ASPECTS [5].

As is the case for the anterior circulation, the pc-ASPECTS is a 10 point scale, where points are lost for each region affected. Unlike ASPECTS, the pons and the midbrain are worth 2 points each (regardless of whether or not the changes are bilateral; any involvement of the pons, for example, deducted 2 points).

- thalami (1 point each)
- occipital lobes (1 point each)
- midbrain (2 points)
- pons (2 points)
- cerebellar hemispheres (1 point each)

The Central Volume Principle

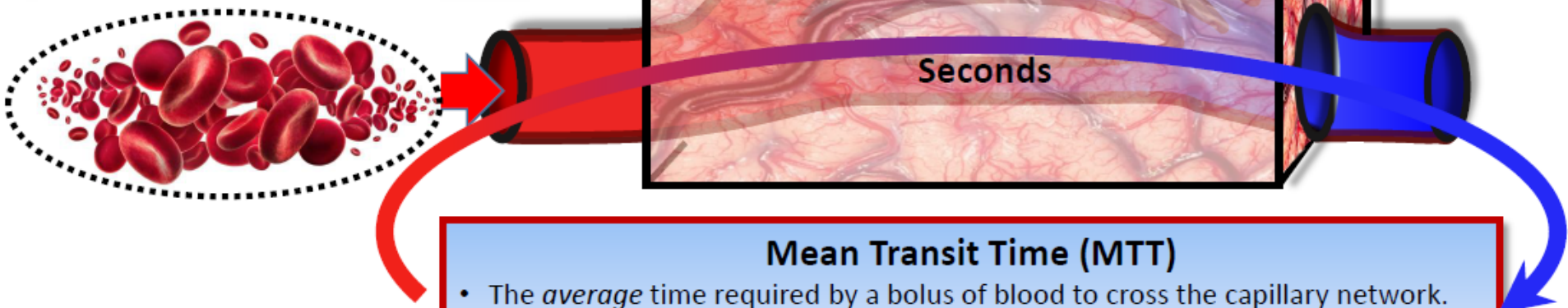
Cerebral Blood Flow = Cerebral Blood Volume/Mean Transit Time*

Cerebral Blood Volume (CBV)

- The total volume of blood in a given unit volume of the brain (including parenchyma, arteries, arterioles, capillaries, venules, and veins).
- Normal CBV is 4–6 mL/100g in gray matter.
- Measure of collaterization and autoregulation.

Cerebral Blood Flow (CBF)

- The volume of blood moving through a given unit volume of brain per unit time.
- Normal CBV is 50–60 mL/100 g/min

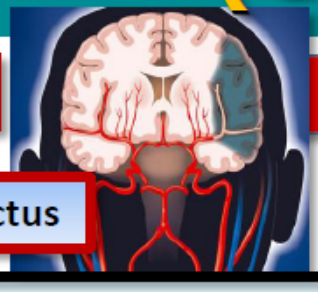


Mean Transit Time (MTT)

- The *average* time required by a bolus of blood to cross the capillary network.
- Depends on the distance between arterial inflow and venous outflow.
- Normal MTT is 4 seconds in gray matter.

*MTT = CBV/CBF

Stroke Pathophysiology (CBF=CBV/MTT)



Normal

Ictus

Time (Minutes to Hours)
Duration and severity matter

Stroke Symptoms Appear,
Loss of Function, Δ EEG

Infarct Core

Benign Oligemia (viable tissue)

CBF (mL/100g/min)

75 60 45 30 15 0

Compensated Low Cerebral Perfusion Pressure

Under perfusion

17-20

Cytotoxic Edema

10-15

Vasogenic Edema

<10

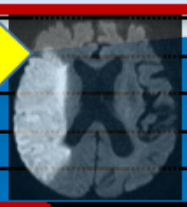
CBV (mL/100g)

10 8 6 4 2 0

Compensation for ↓CBF

Autoregulatory vasodilatation/collaterals

Neuronal Failure, +DWI



MTT (Sec)

50 40 30 20 10 0

↑Lactate, ↓ATP
↑ Glu, ↑ ic CA^{+2}

Oxygen Extraction Fraction >80%

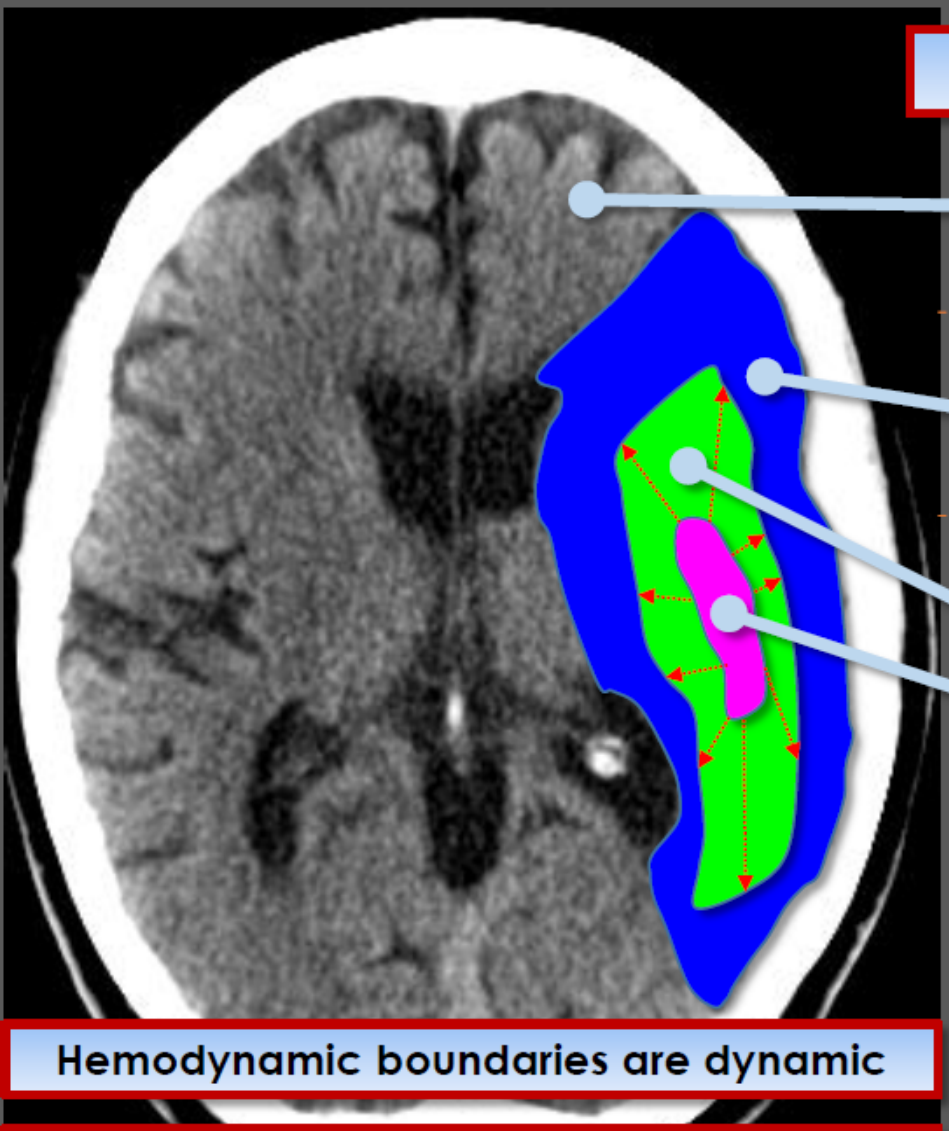
$CMRO_2$ <160mmol/100g/min

Loss of autoregulation

REVERSIBLE ISCHEMIA ("At Risk" PENUMBRA)

IRREVERSIBLE INFARCTION

After González et al., J NeuroIntervent Surg 2013;5:i7-i12



Hemodynamic boundaries are dynamic

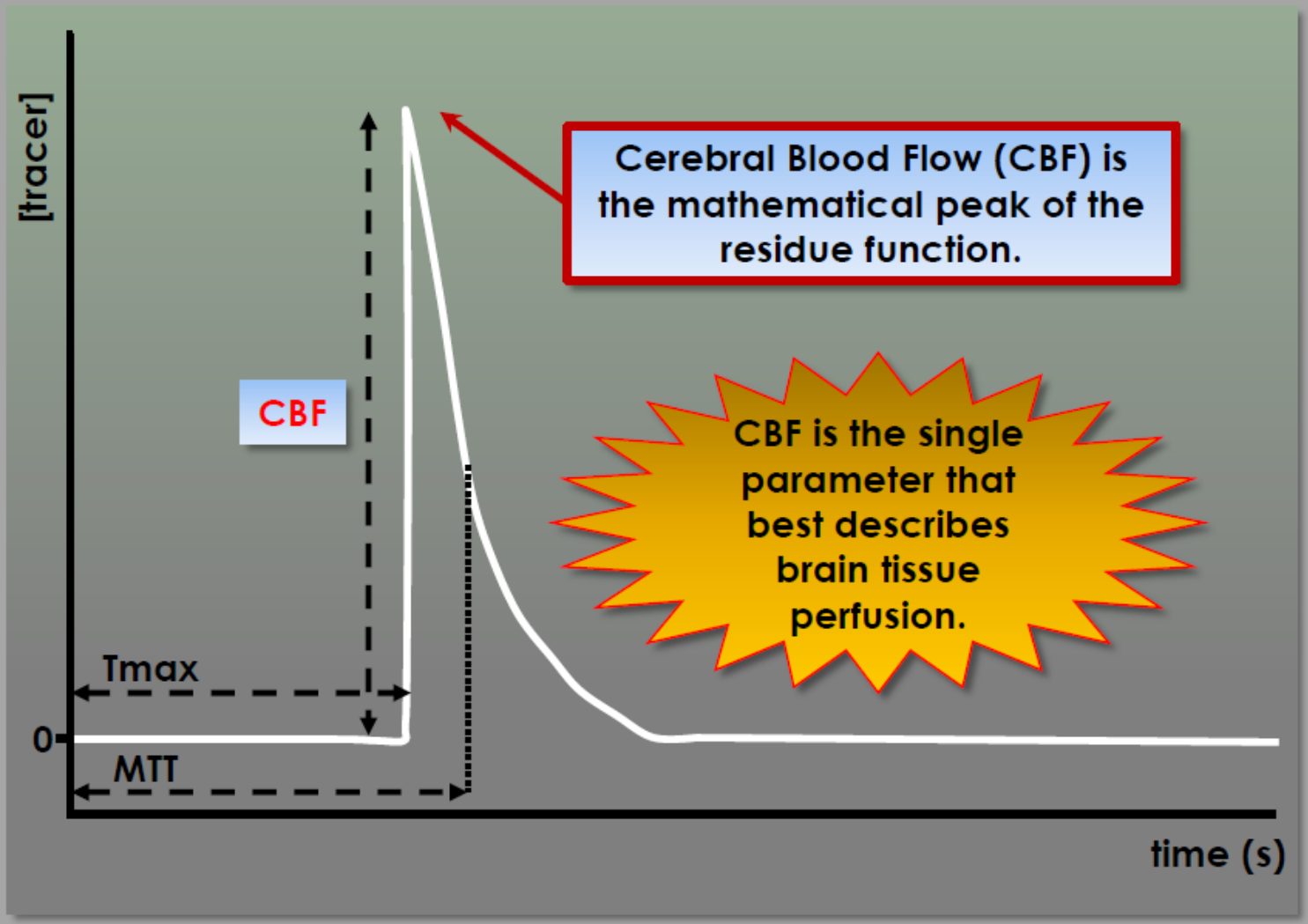
Mismatch = Penumbra Volume (MTT or CBF) minus Core Volume (CBV)

CBF Thresholds (mL/100 g/min)

- Normal Brain: 60-100 mL/100 g/min
- Hypoxia Threshold
- Oligemia: 40-60 mL/100 g/min
- Ischemia Threshold
- Ischemic Penumbra: 10-40 mL/100 g/min
- Infarct Core: <20 mL/100 g/min

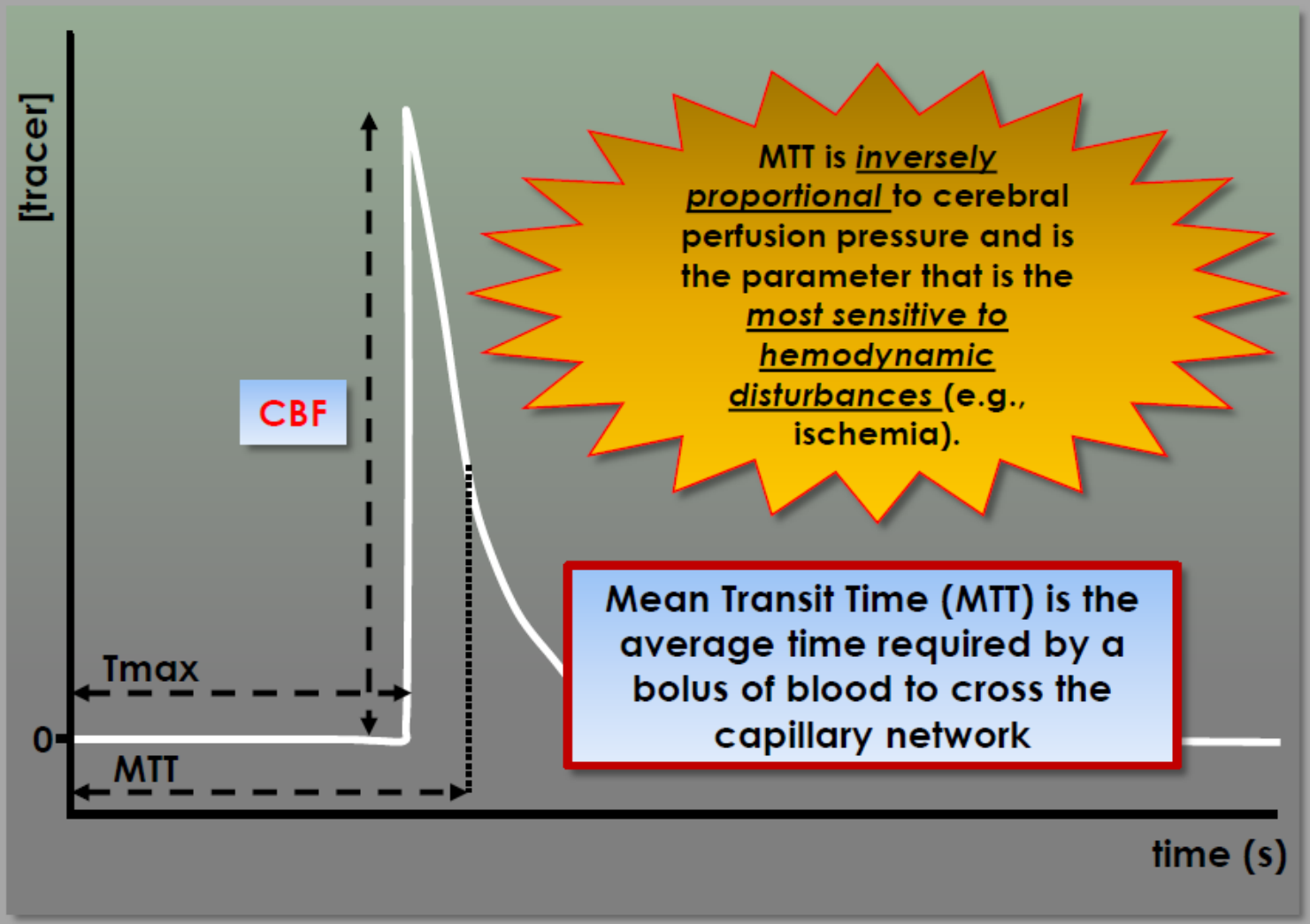
Imaging is used to define the boundaries between normal, hypoxic, and reversible/irreversible ischemic CBF thresholds

Cerebral Blood Flow (CBF)



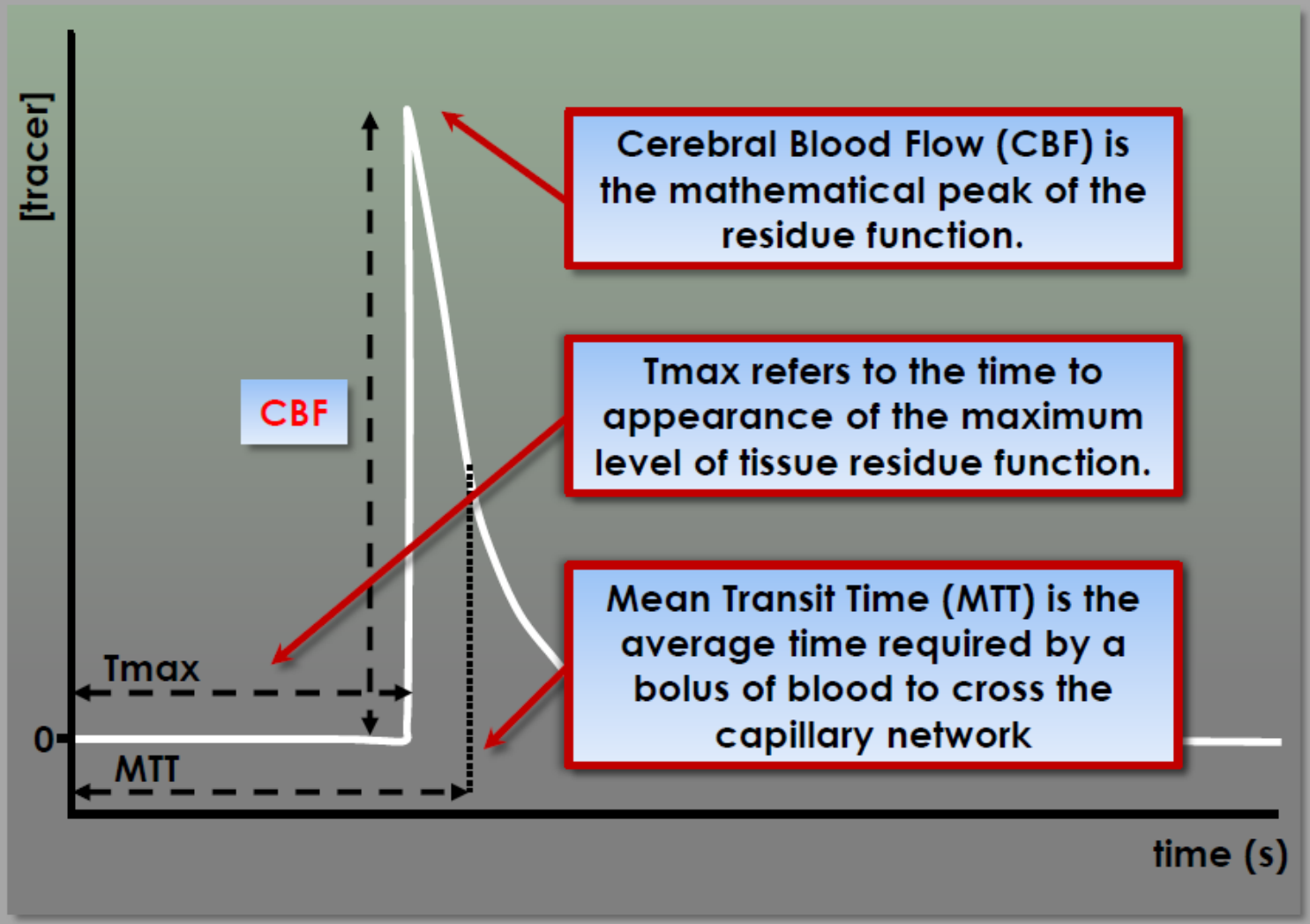
(adapted from Leiva-Salinas et al., Neuroradiology 2002. 54:907-918)

Mean Transit Time (MTT)



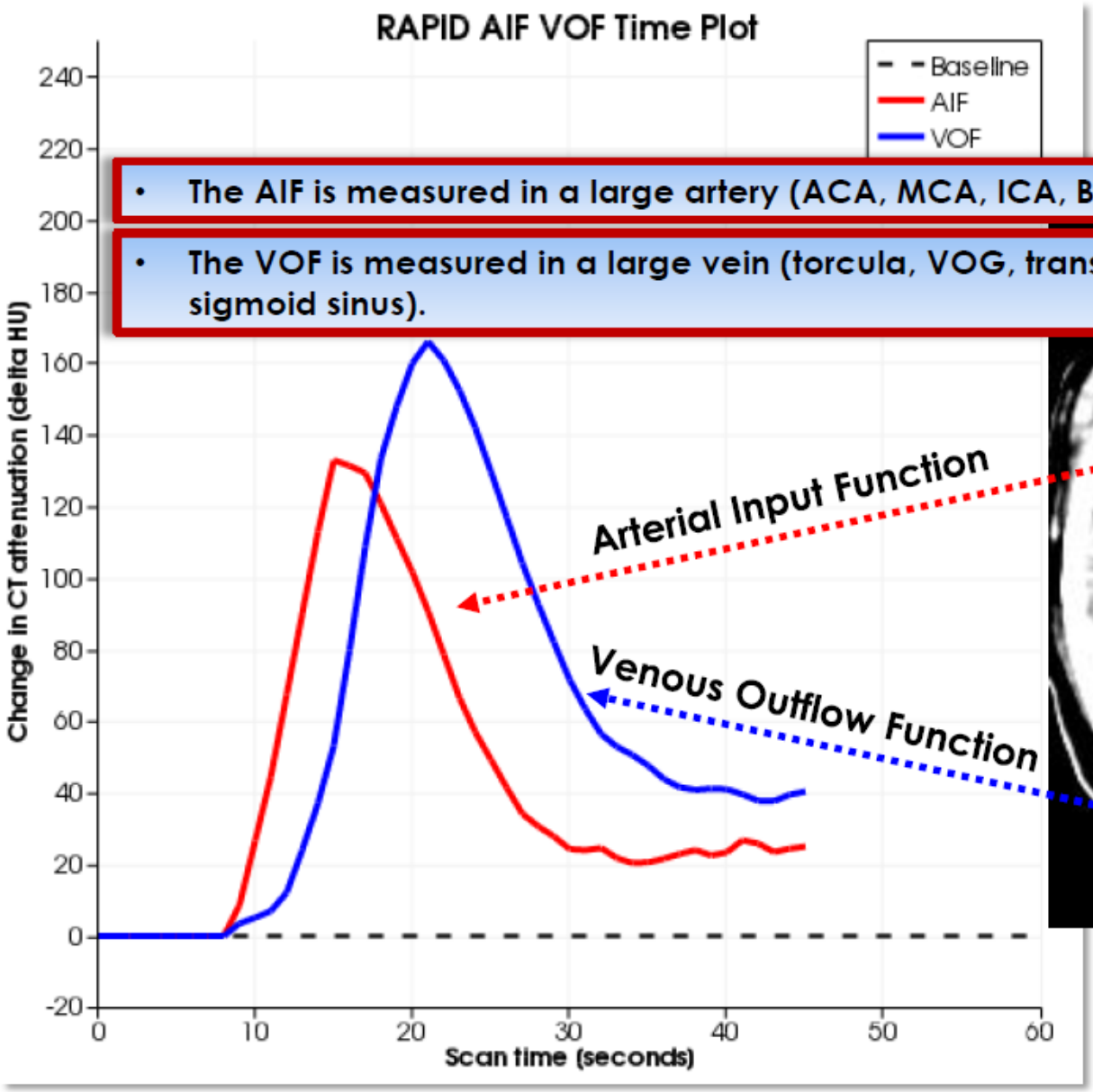
(adapted from Leiva-Salinas et al., Neuroradiology 2002. 54:907-918)

Time-To-Maximum (Tmax)

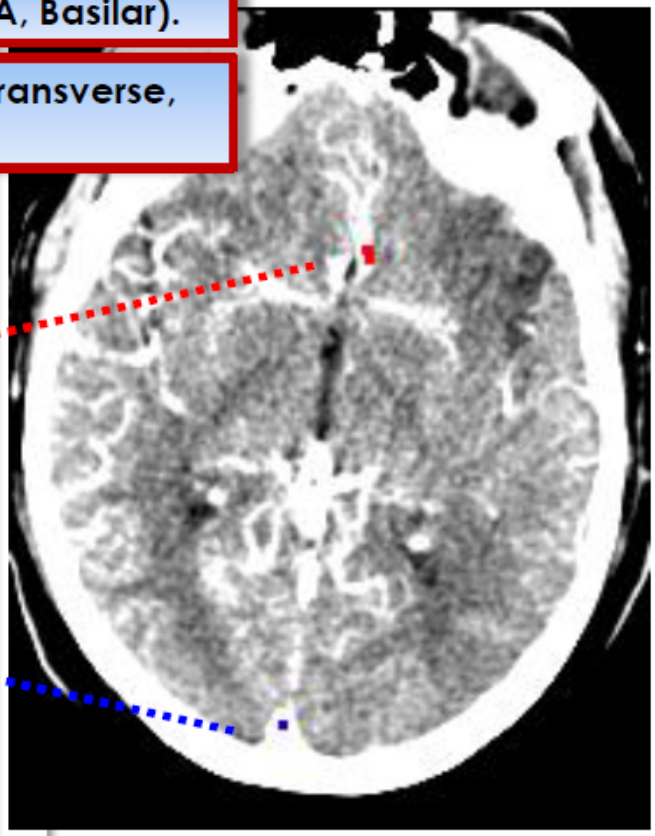


(adapted from Leiva-Salinas et al., Neuroradiology 2002. 54:907-918)

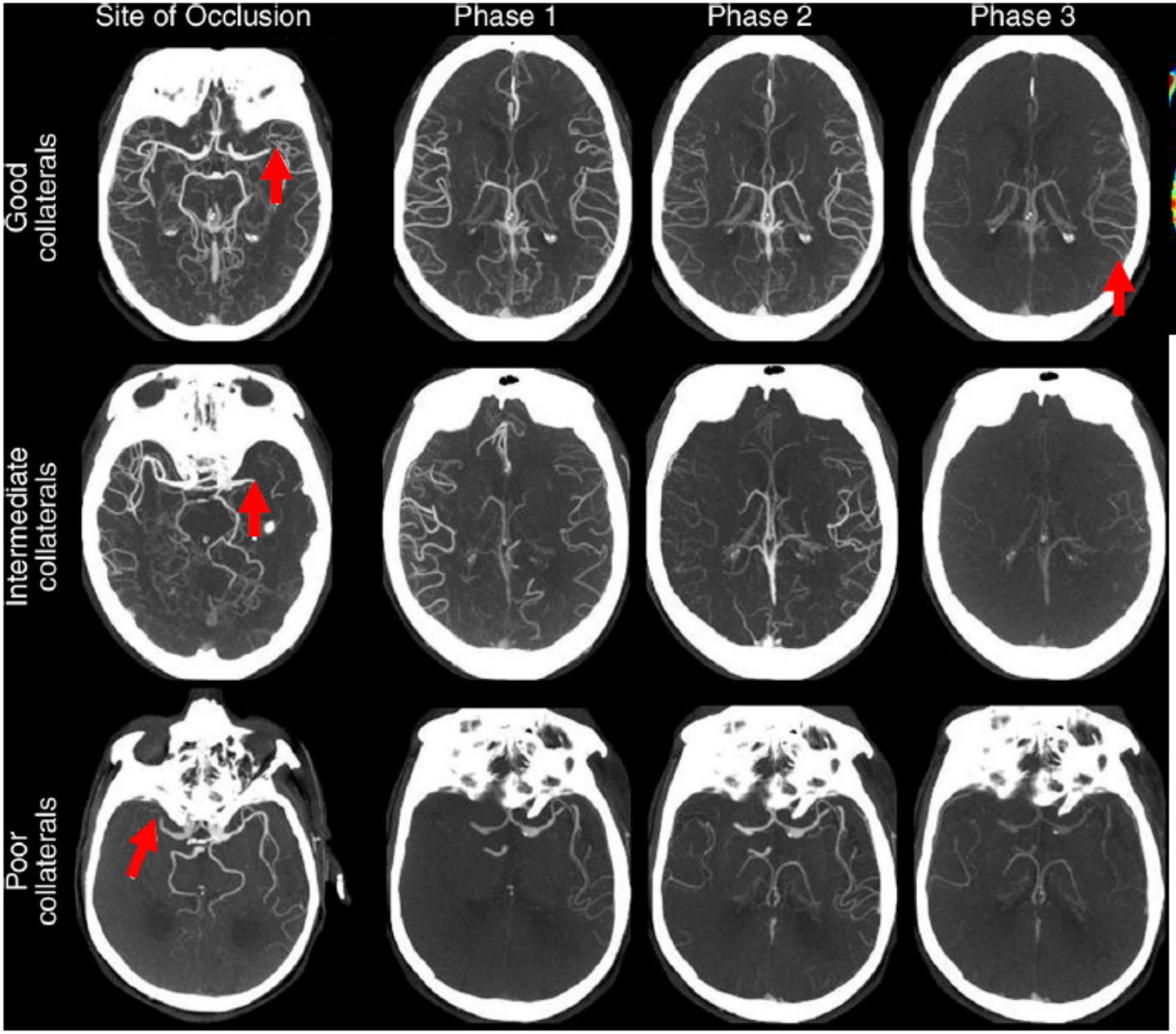
Time Density Curves

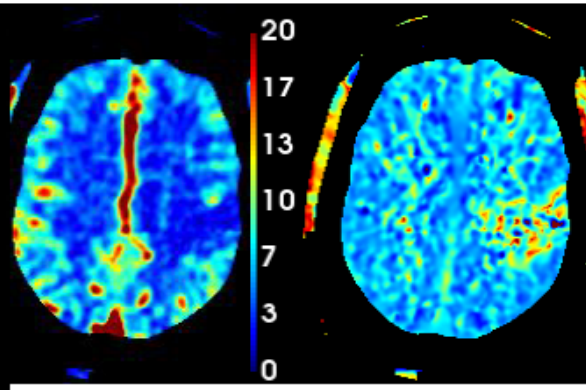


- The AIF is measured in a large artery (ACA, MCA, ICA, Basilar).
- The VOF is measured in a large vein (torcula, VOG, transverse, sigmoid sinus).



Not all LVOs are created equal!





In the setting of LVO and good collateral flow, MTT may be over-estimated and CBF under-estimated in the affected tissue.

Blood has to travel a longer path through collaterals to perfuse viable tissue.

Menon et al. Radiology 2015, 275, 510-520

RAPID output to email and PACS

iSchemaViewRAPID

RAPID processing: finished successfully

CBF<30.0% volume = 146 ml

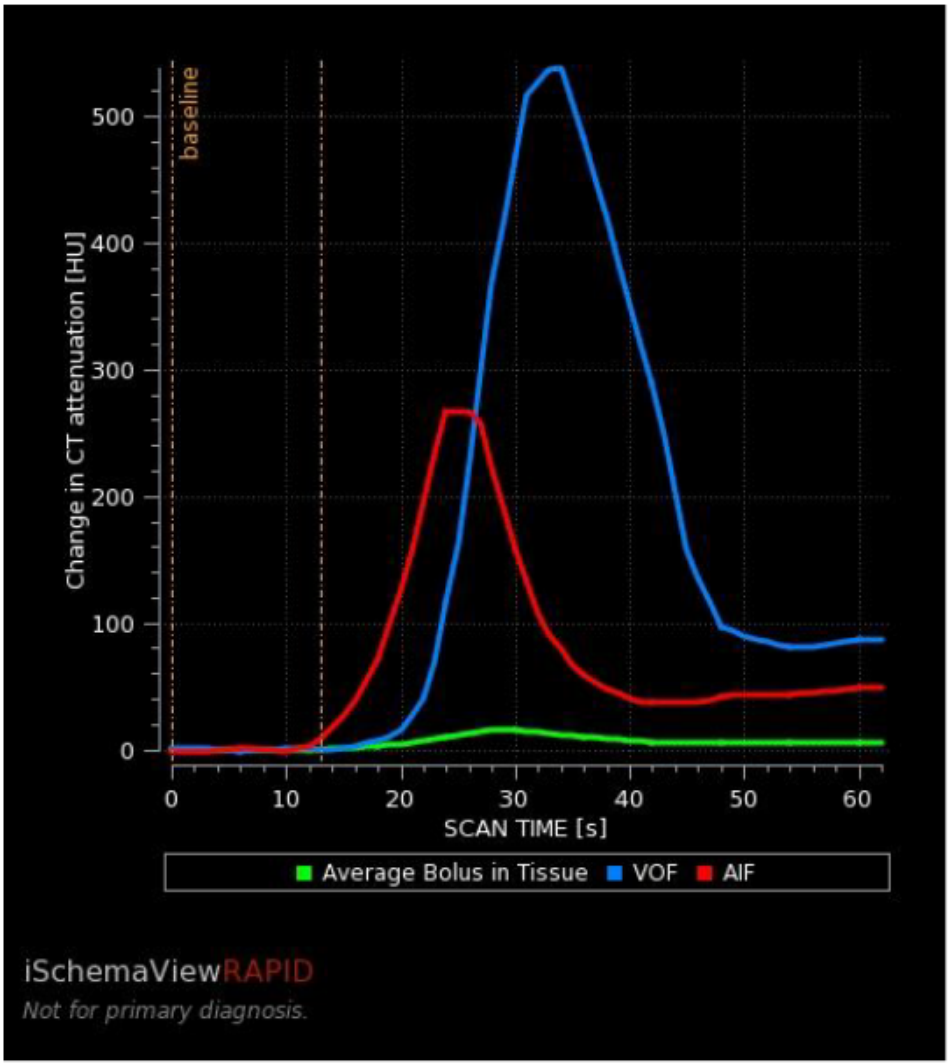
Tmax>6.0s volume = 211 ml

Review results on the RAPID server

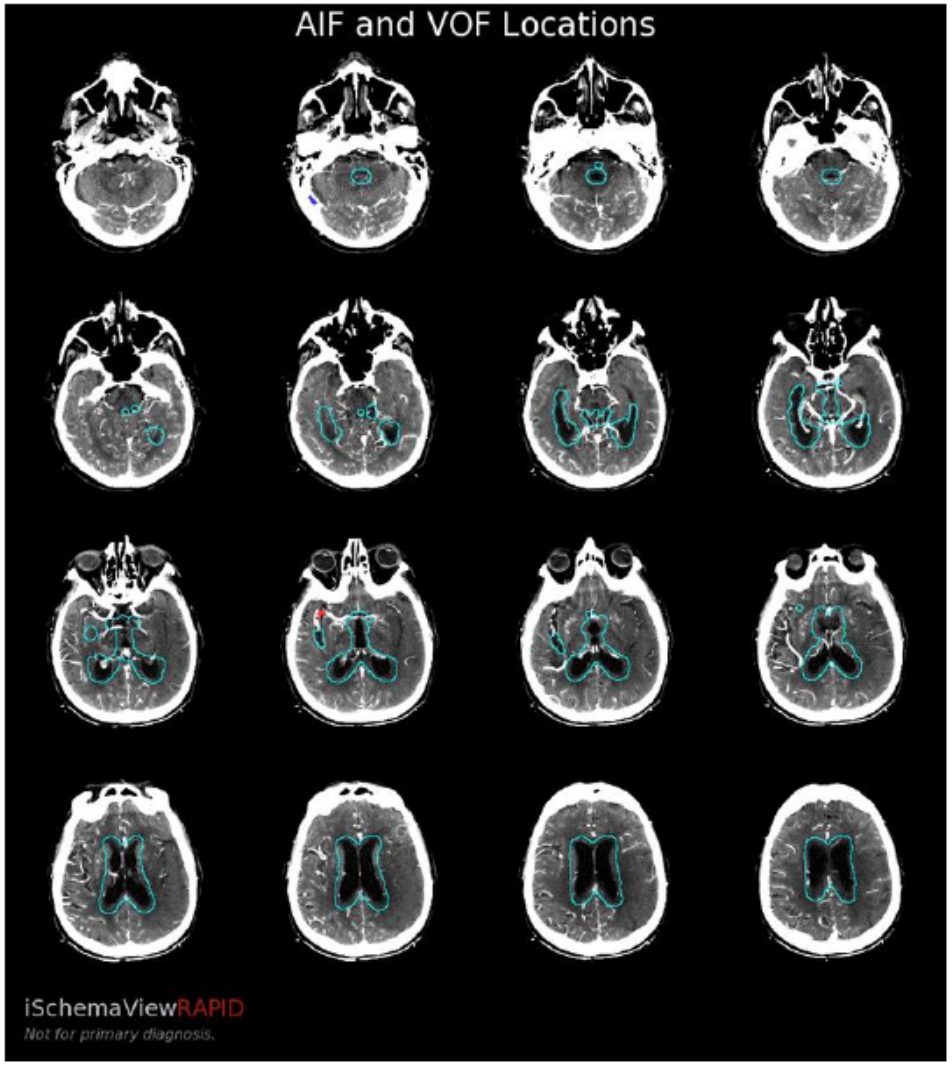
Institution:	[redacted] Medical Center VCT
RAPID AnonID:	964_184
Patient Gender:	Male
Patient Age:	Above 89
Perfusion series:	#2 PERFUSION 50ml 4cc/sec, 2018/02/08 13:25:50 (368 files)
Station:	GE MEDICAL SYSTEMS, LightSpeed VCT

RAPID output to email and PACS

AIF/VOF Curves

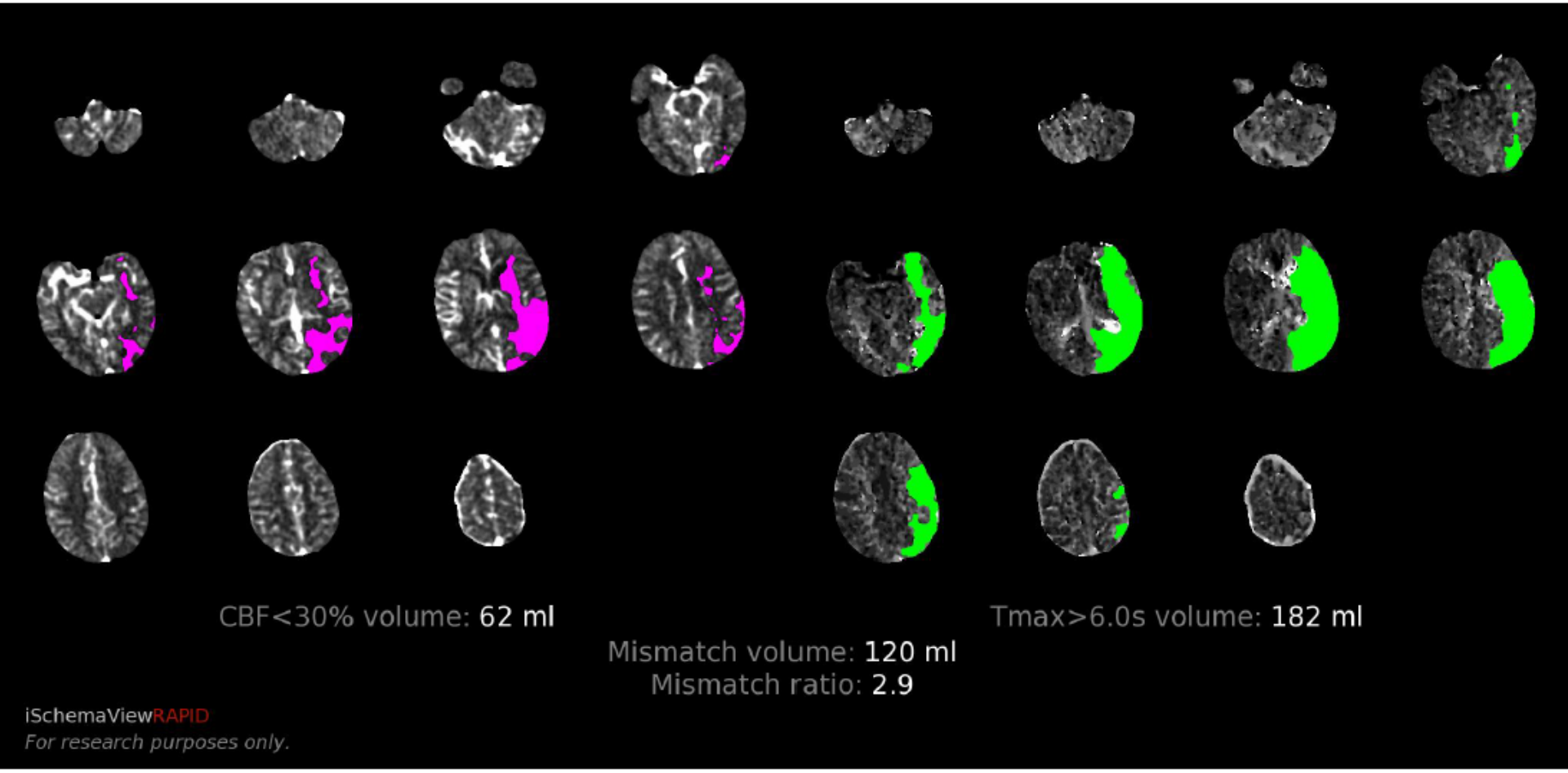


AIF/VOF Locations



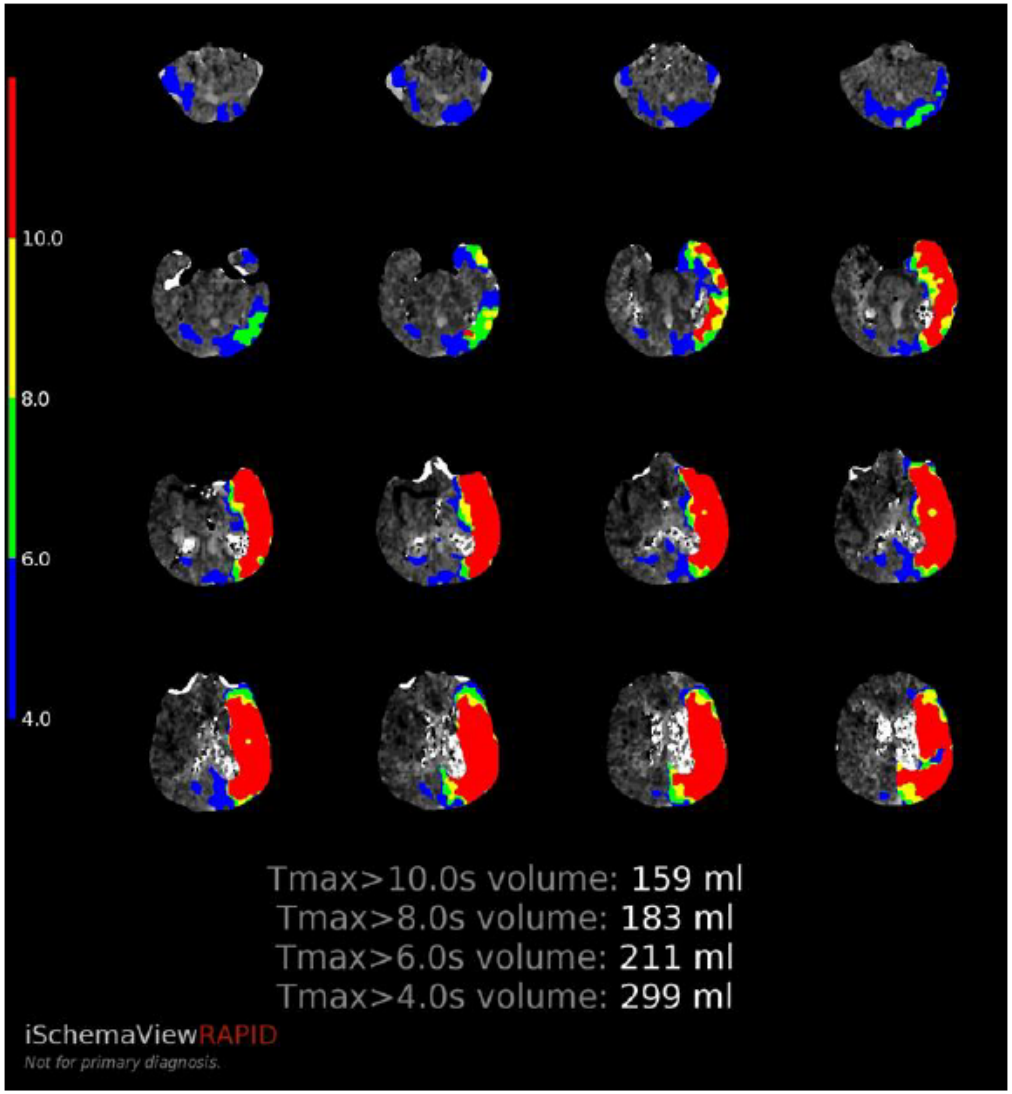
RAPID output to email and PACS

CBF/Tmax Mismatch



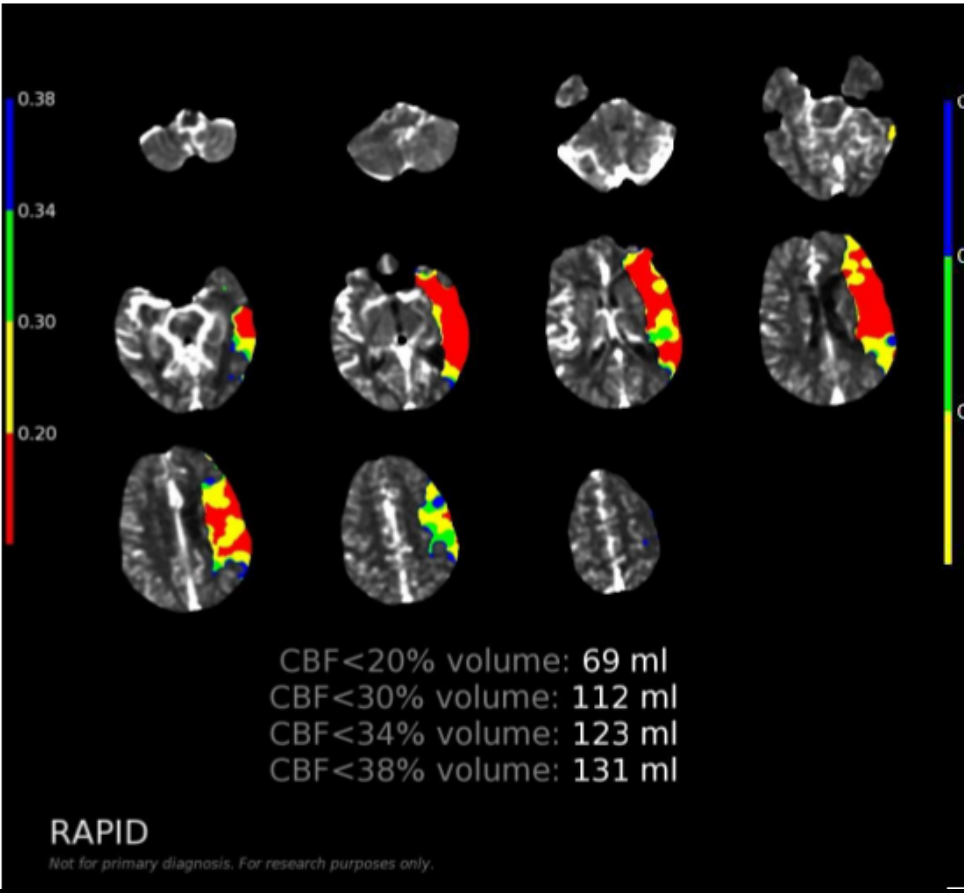
RAPID output to email and PACS

Tmax Thresholds

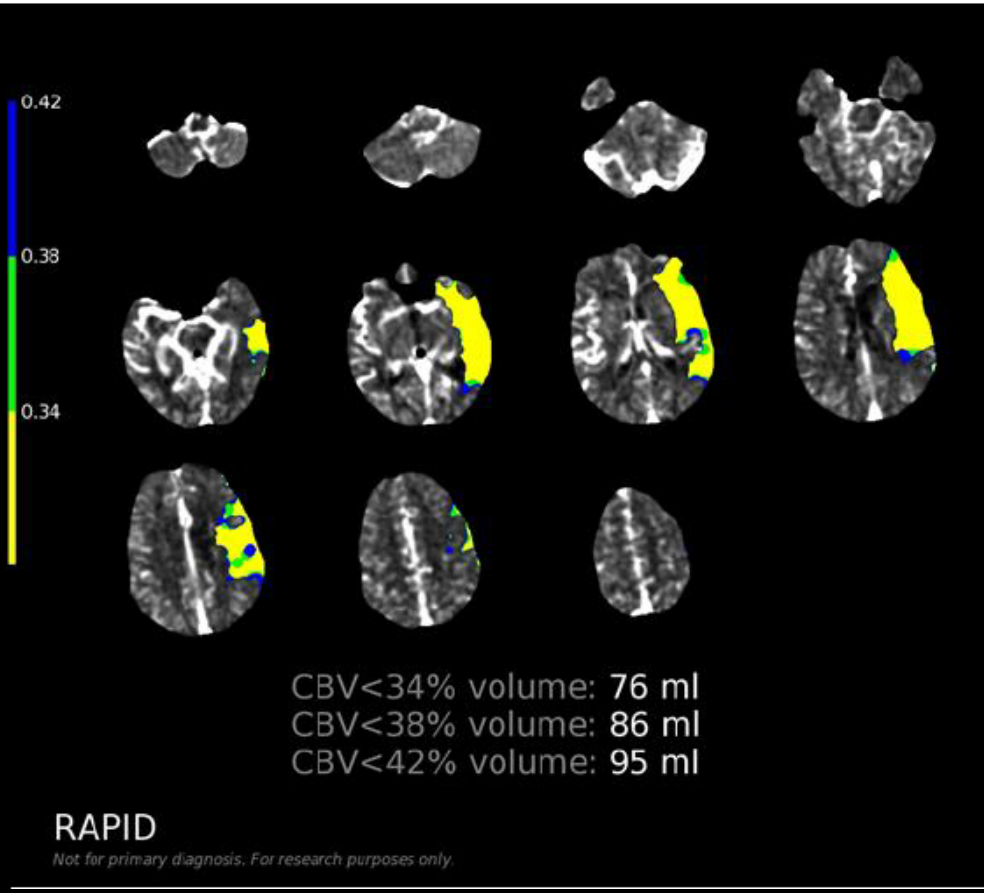


RAPID output to email and PACS

CBF Thresholds



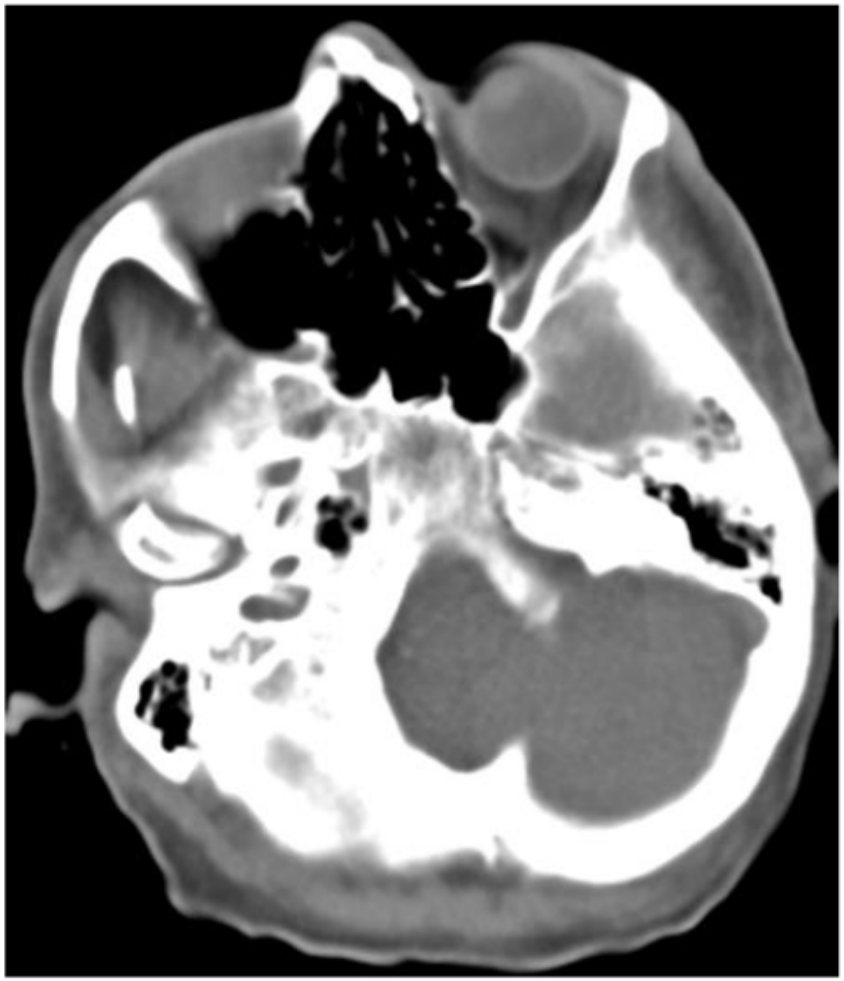
CBV Thresholds



Always Perform QC Check First

Check positioning of patient's head - should be perfectly straight

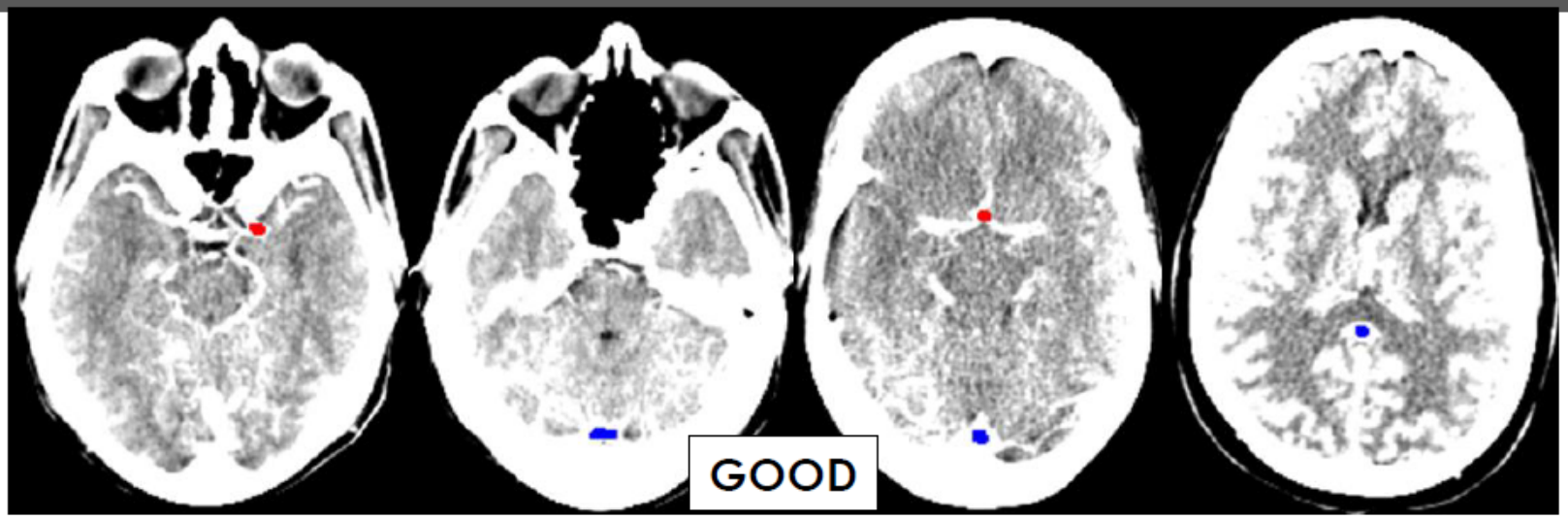
GOOD

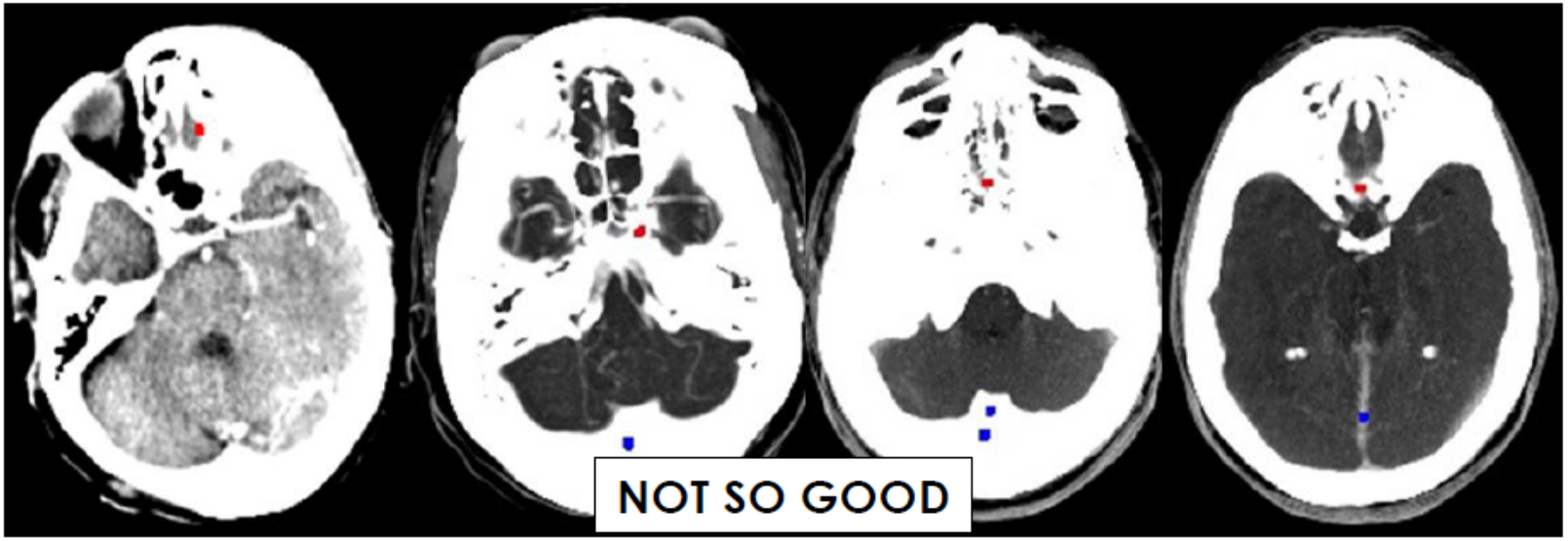


NOT SO GOOD

Always Perform QC Check First

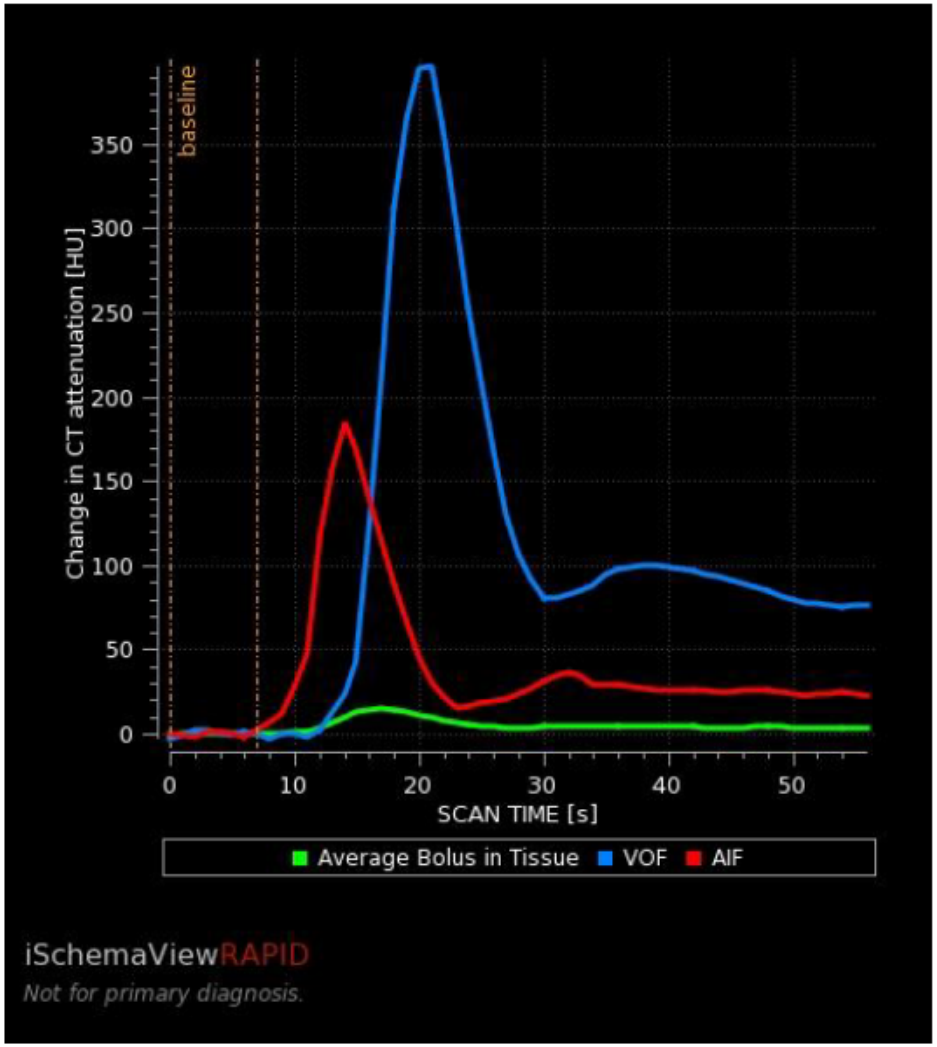
Check RAPID selection of AIF and VOF (ICA, ACA, MCA/Torcula, VoGa, SS)

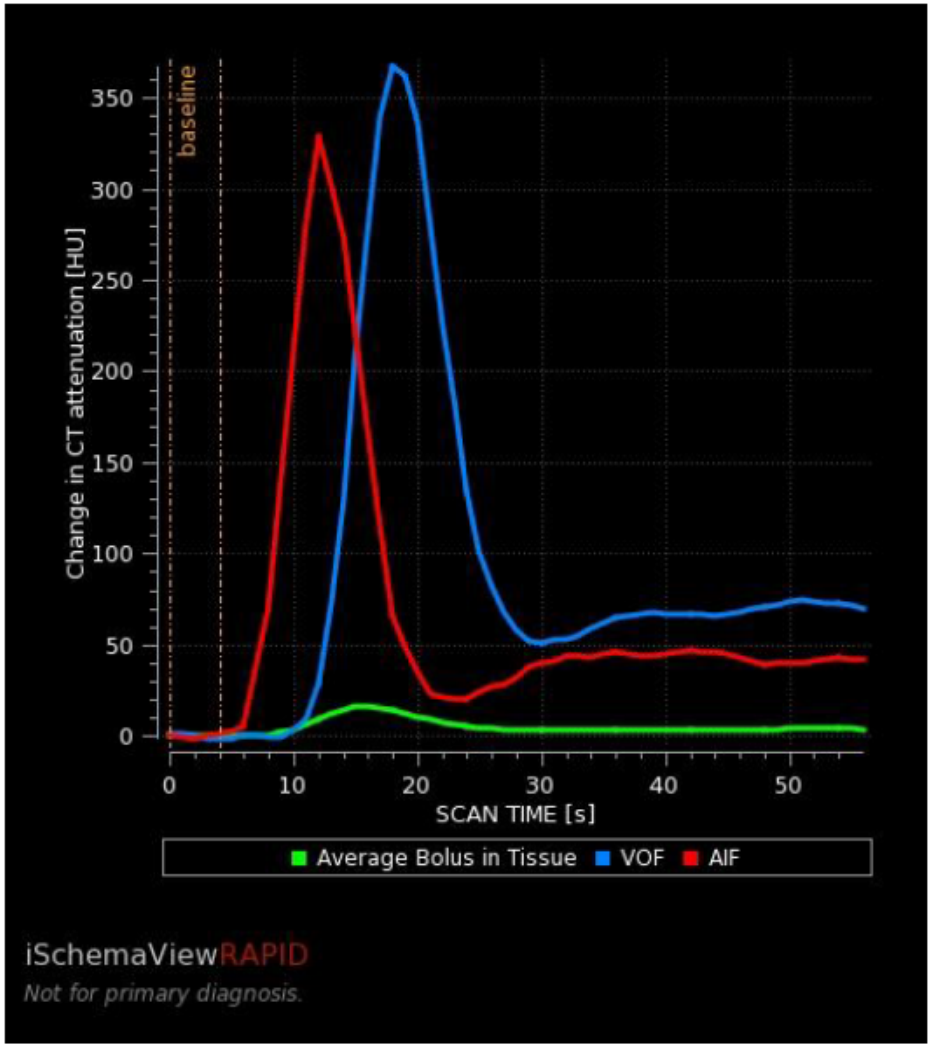




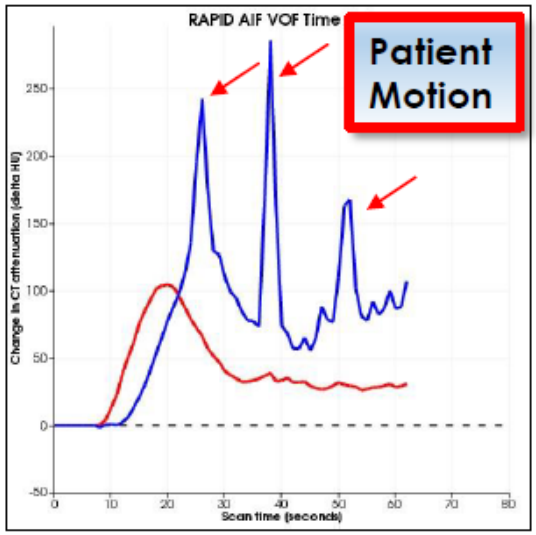
Always Perform QC Check First

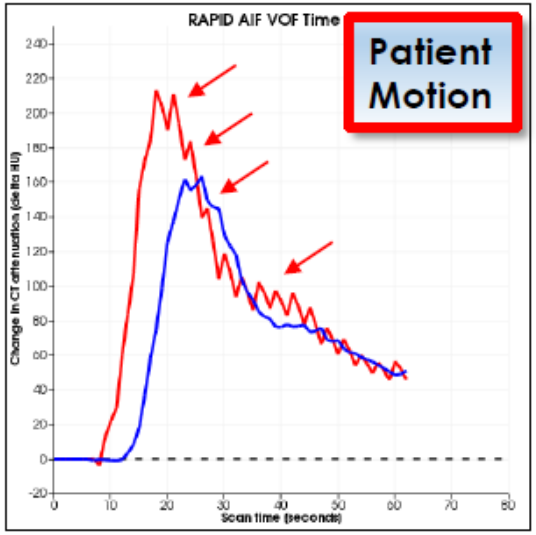
Check RAPID AIF VOF Time Plot

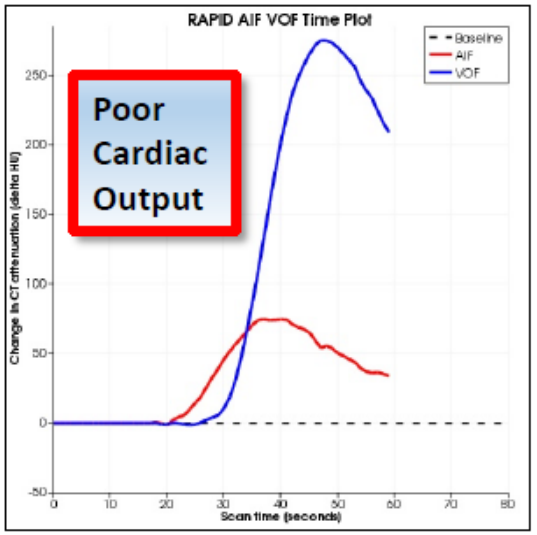


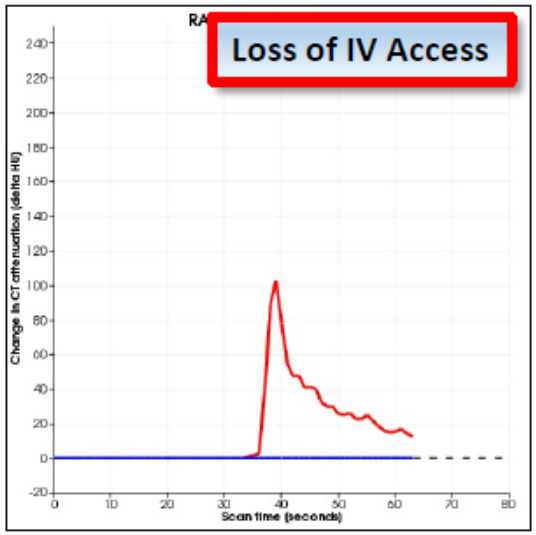


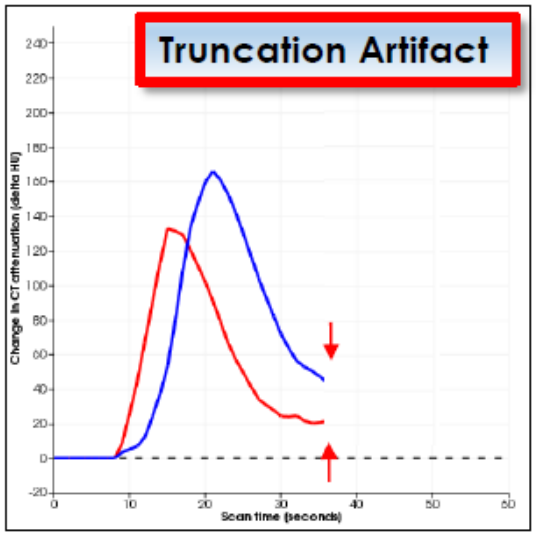
Common Causes of a Non-Diagnostic CT Perfusion Study

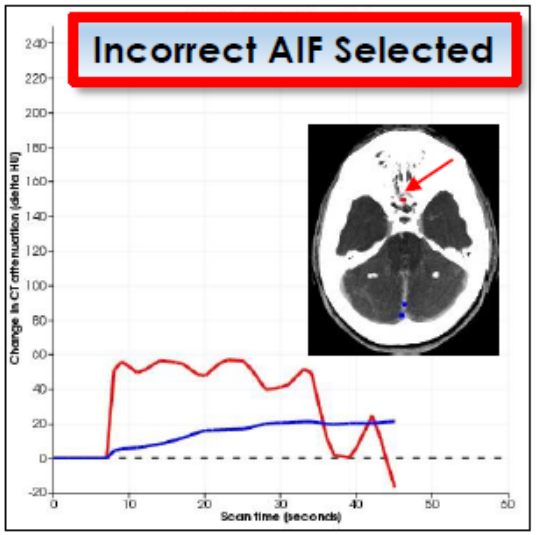






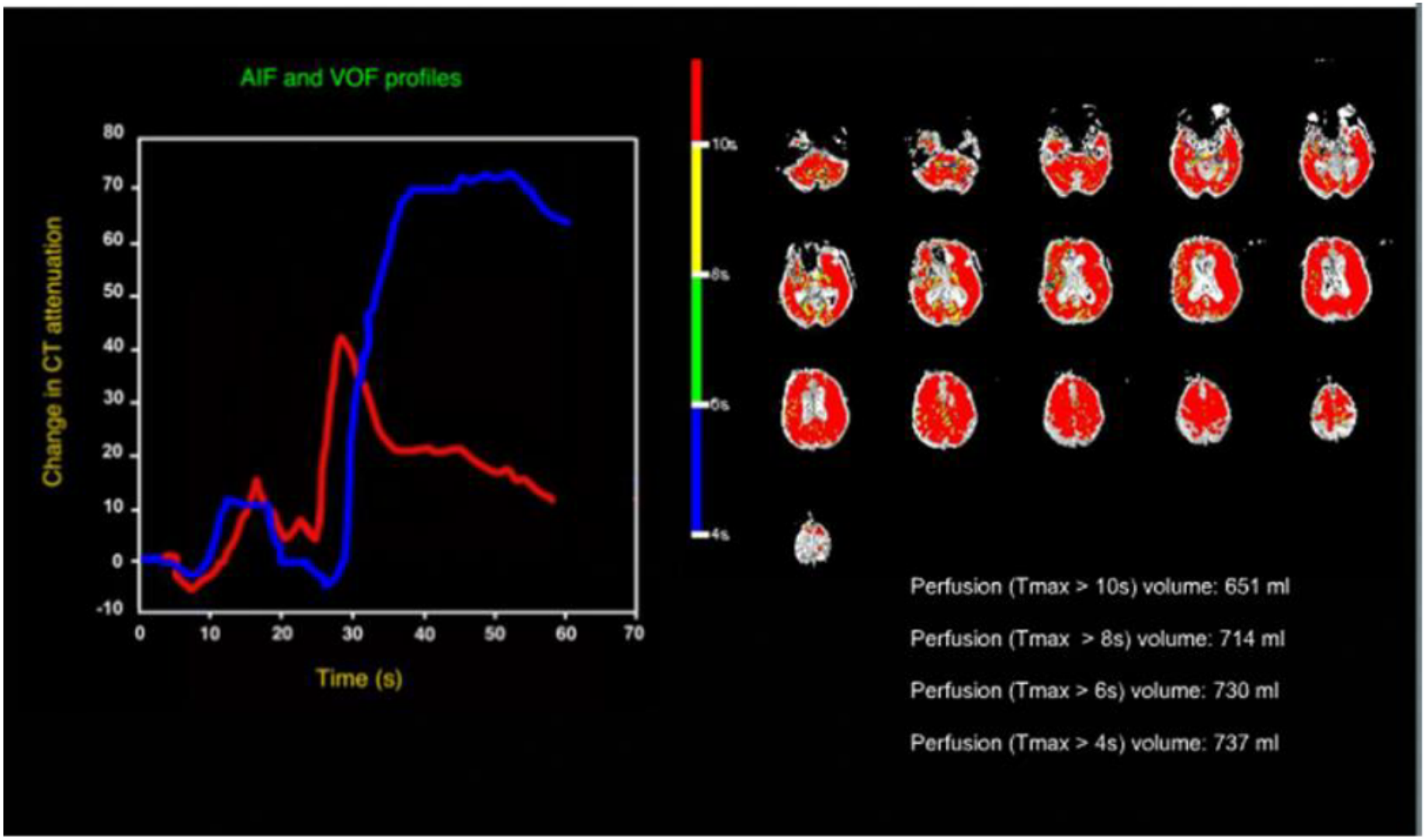




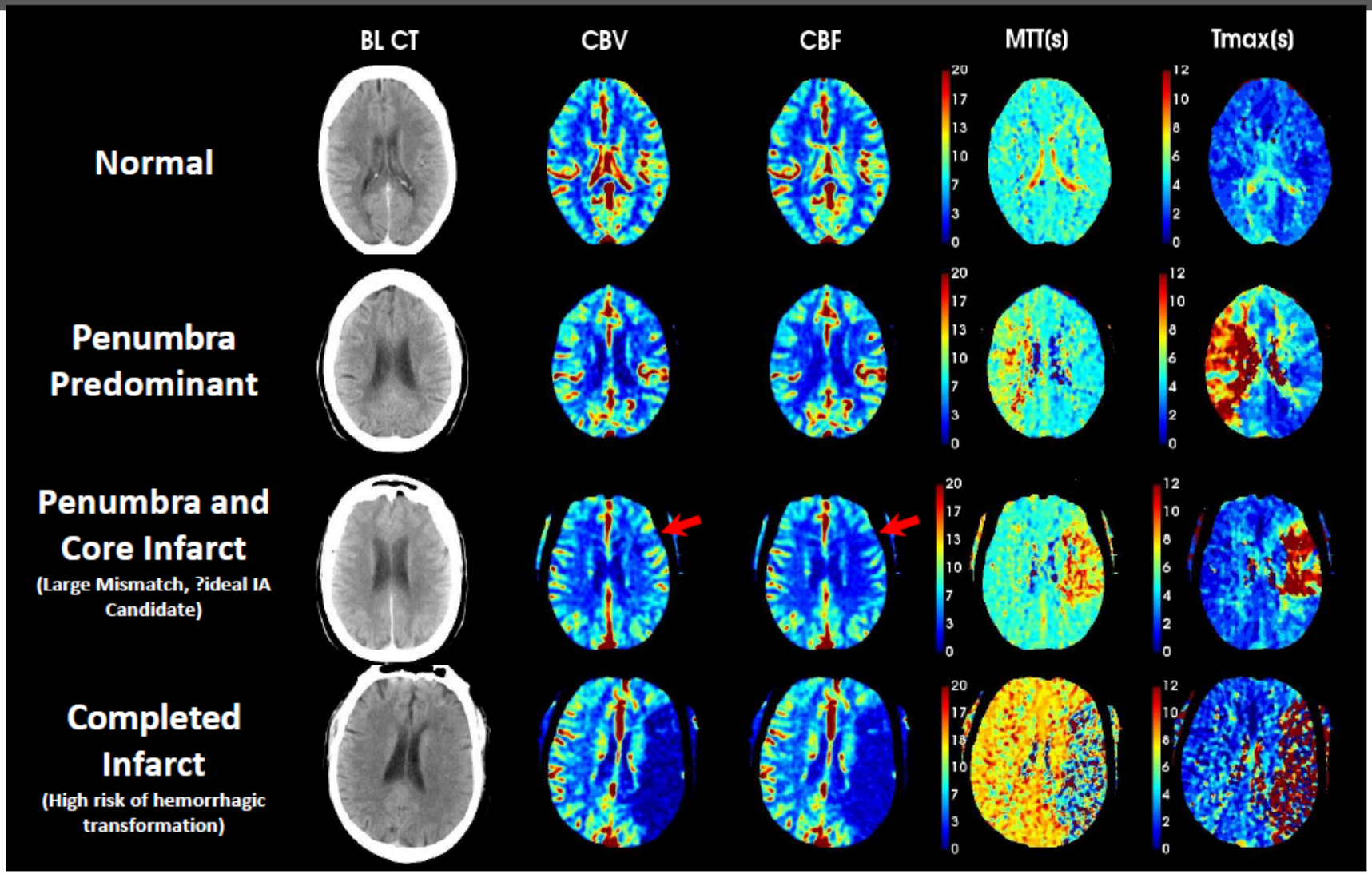


Motion artifact with non-diagnostic perfusion maps

Spikes are present in both AIF and VOF

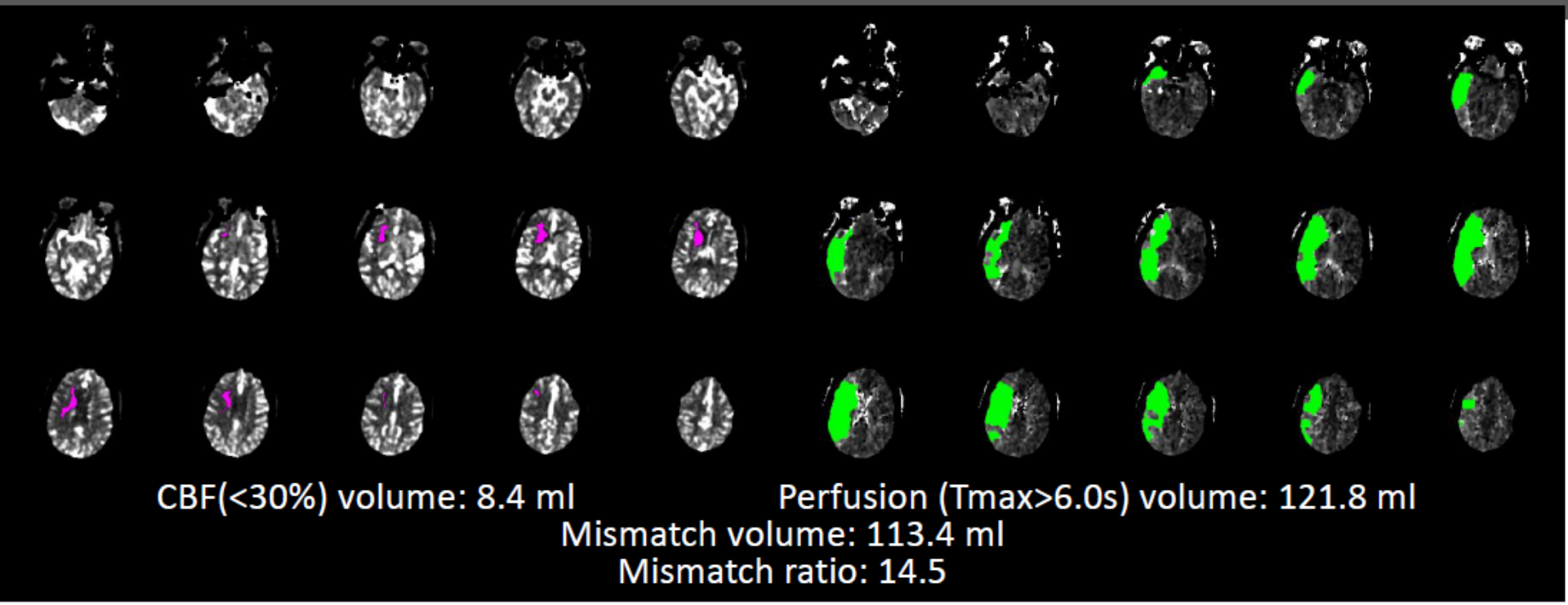


Prototypical CTP Color Parametric Map Patterns



Albers GW et al., Ann Neurol 2006;60:508–517

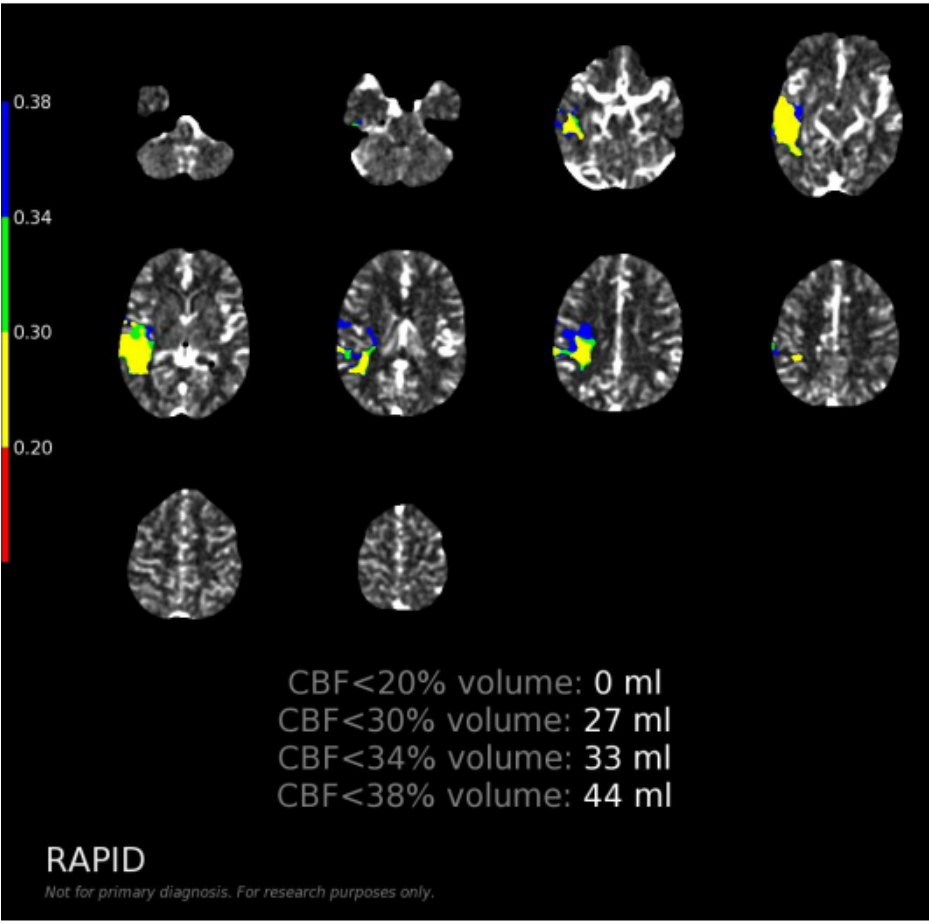
iSchemaView RAPID Automated Output

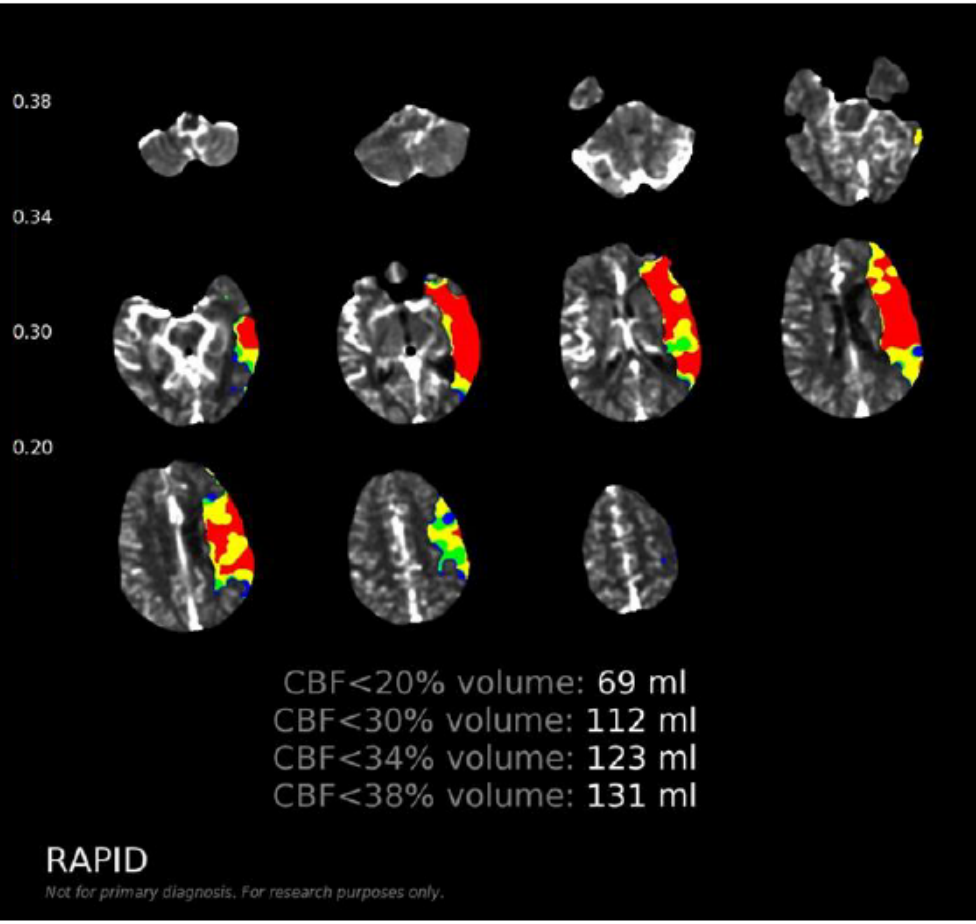


- **CBF (<30%) Volume:** The *ischemic core lesion* is defined by a cerebral blood flow (CBF) reduction to <30% of the corresponding contralateral territory. (i.e., flow in affected area is 70 percent less than normal areas)
- **Tmax>6.0s Volume:** The *total hypoperfused volume* is defined by a >6-second delay for the maximum of the tissue residue function.

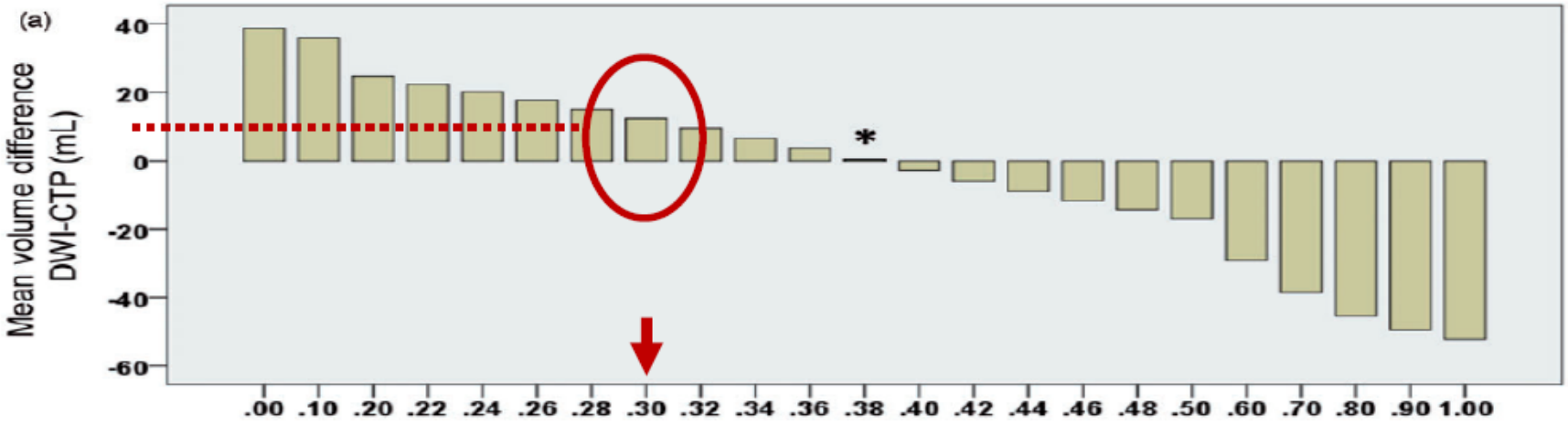
Albers GW et al., Ann Neurol. 2016 Jan;79(1):76-89.

Which CBF threshold is most accurate for estimating the ischemic core?





rCBF <30% typically underestimates DWI core infarct volume by 10-15 ml

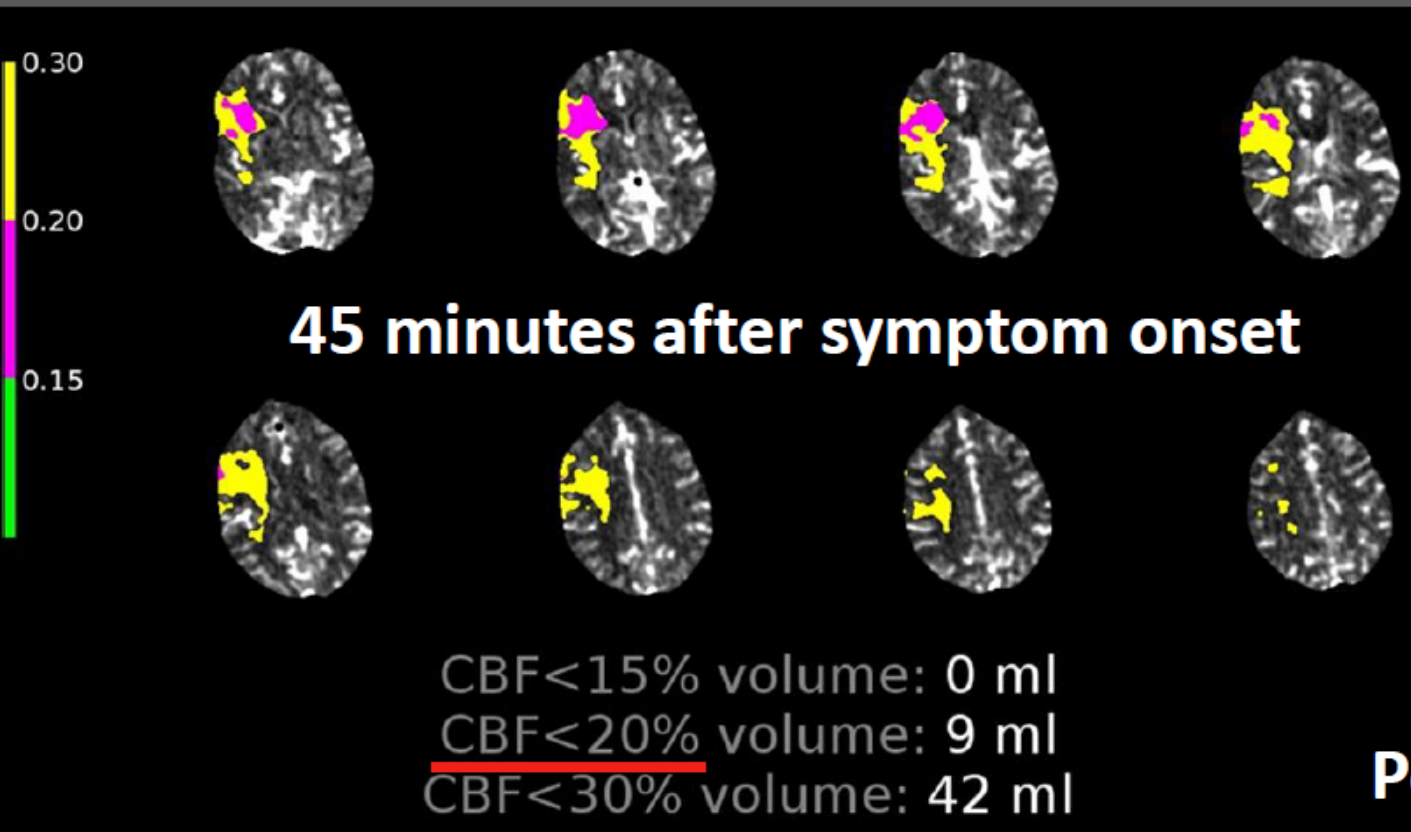


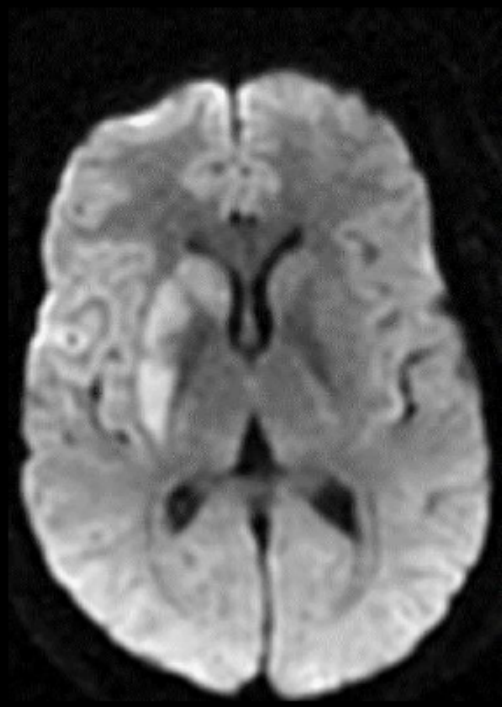
Most studies have suggested that CBF thresholds <30-35% are optimal.

Cereda C et al., *JCBFM*, 2016;36(10):1780-1789

CTP During the Golden Hour

Consider using CBF<20% in patients with hyperacute symptoms

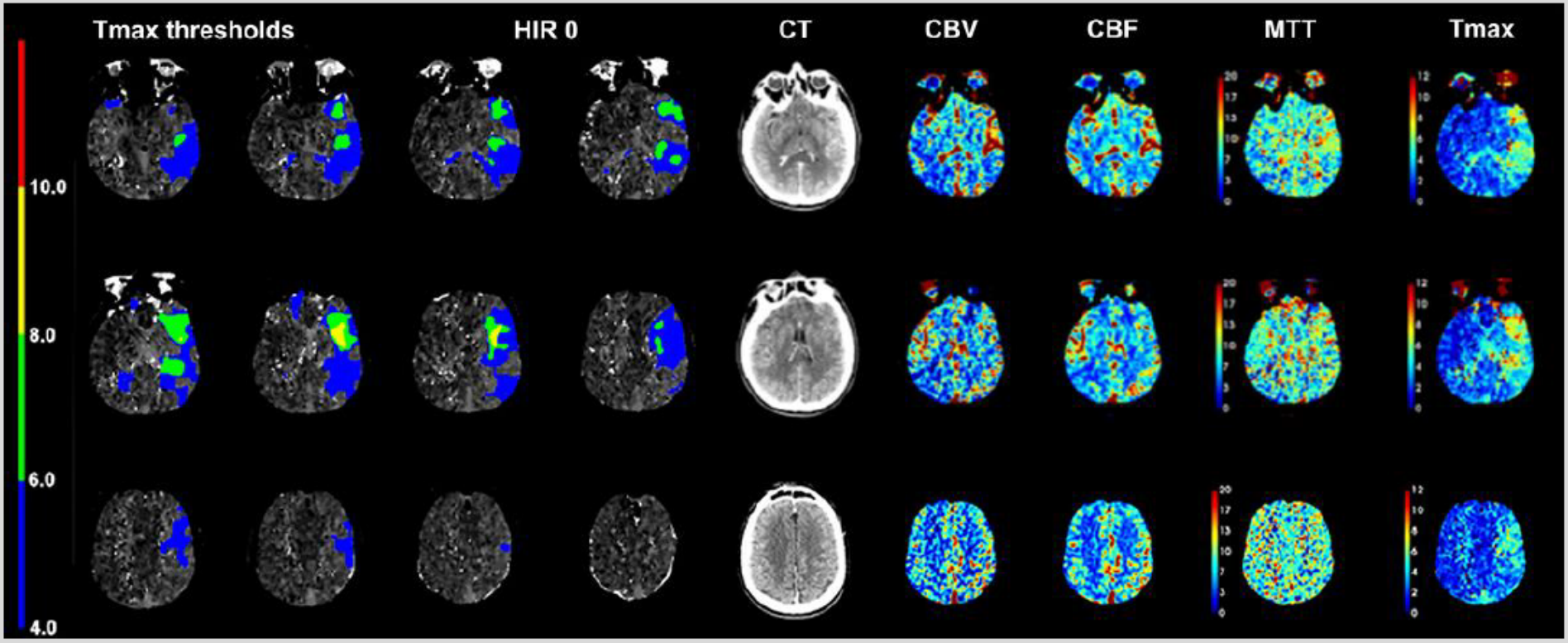




Post reperfusion

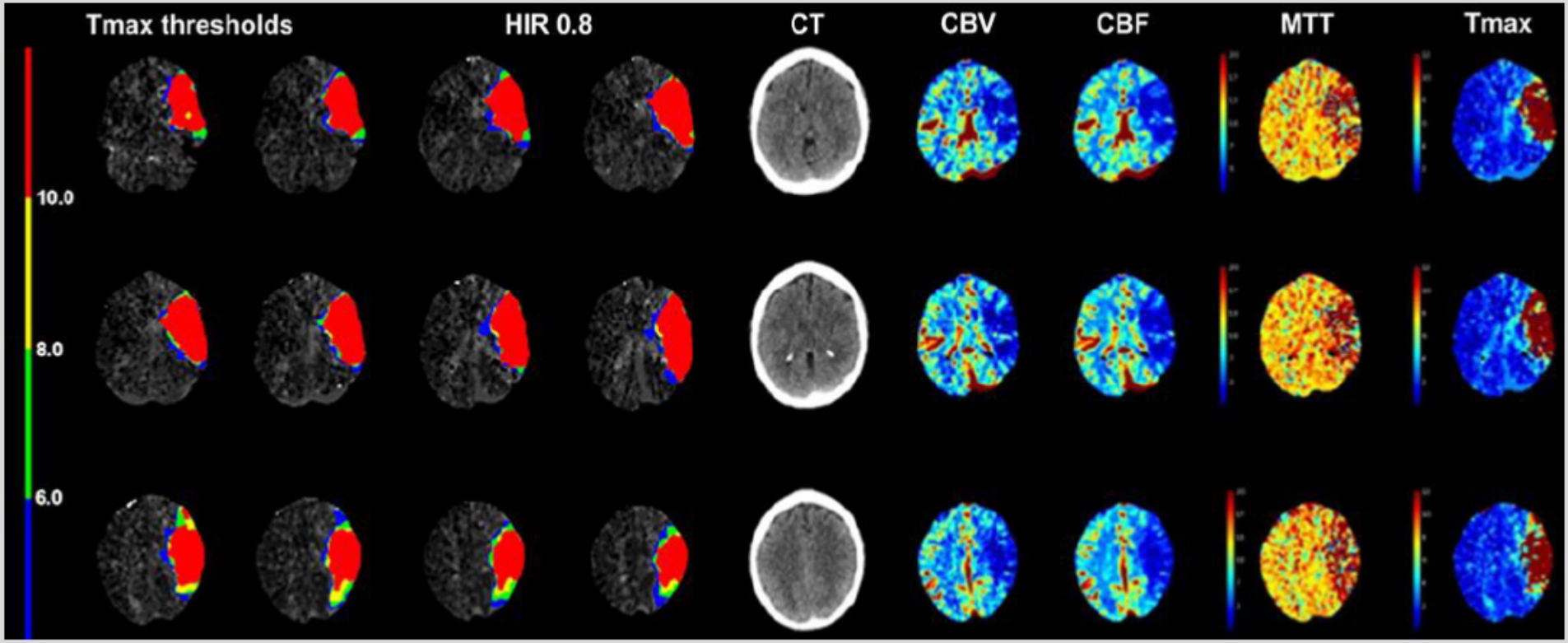
- For patients who present <u><60 minutes</u> after symptom onset, a stricter CBF threshold of <20% may be a more accurate predicter of core infarct volume than CBF <38%.
- Regions with very low CBF will <u>not yet be irreversibly injured</u> and early reperfusion can result in a transient ischemic attack.

Good Collaterals



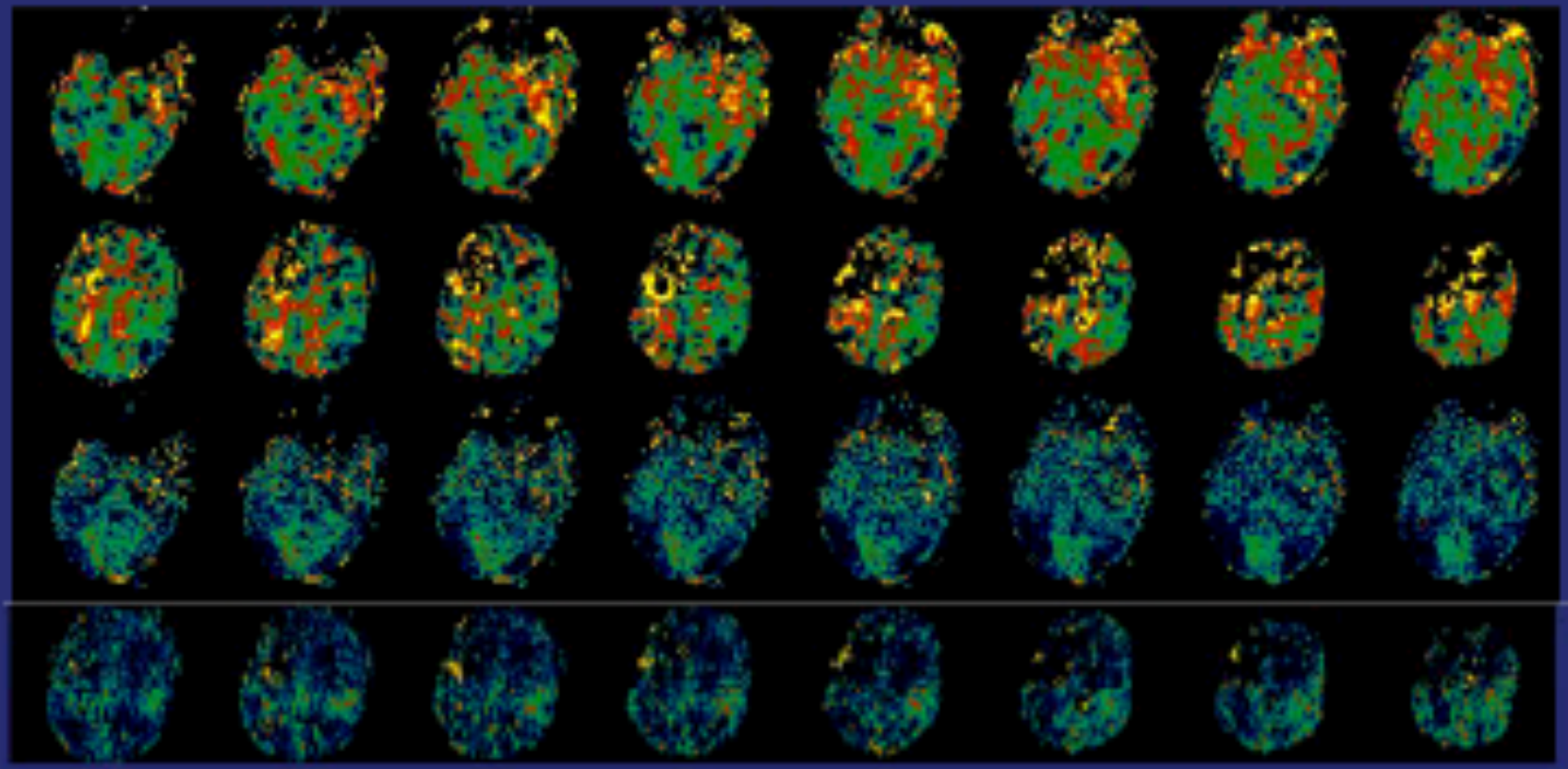
- Left MCA occlusion with good collateral circulation.
- Mild Tmax delay in the left MCA territory with a Hypoperfusion Intensity Ratio of 0, indicating that there is no tissue with a Tmax delay >10 seconds.
- Preserved CBV in the left hemisphere.

Poor Collaterals



- Left MCA occlusion with poor collateral circulation.
- Severe Tmax delay in the left MCA territory with a Hypoperfusion Intensity Ratio of 0.8, indicating that a lot of the lesion has Tmax delay >10 seconds.
- Very low CBV in the left hemisphere.

Emergency Stroke Triage



Jalal B. Andre, MD
Director of Neurological MRI. Harborview Medical Center
Associate Professor, Neuroradiology • UW Dept. of Radiology

Stroke protocol

- Soon to be updated on HMC ED website

- Called to scanner to check CT head for bleed.
  - If bleed => CTA head
  - If no bleed => CT Perfusion, CTA head and neck

RIS: How to protocol

- RIS protocol:
  - A combined stroke protocol (called "Code Stroke") including CT perfusion followed by CTA is the eventual goal
  - For now, a stroke CT head perfusion and CTA head/neck are two separate protocols.
  - CT head perfusion protocol:
    - Select any CT head Perf protocol and type "Code Stroke" in the comments section. Ask for "0 sec" injector delay.

CT Perfusion: Theory

- RAPID software transforms CT perfusion data into quantifiable measures of infarct core and penumbra, which serve as a guide for neurointerventional therapies.

- CBF less than 30% volume ~ Acute infarct core

- Tmax >= 6.0 s volume ~ Penumbra

Details on where these thresholds originate:

1. http://pubs.rsna.org/doi/pdf/10.1148/radiol.1212097
2. http://pubs.rsna.org/doi/pdf/10.1148/radiol.2015150319

Acute Stroke Intervention Criteria

A. NIHSS ≥ 10 or VAN positive right before procedure **AND**

B. CTA showing M1 And/ OR intracranial ICA occlusion **AND**

C. CT Perfusion criteria

- Ischemic penumbra >15 cc **AND**
- Mismatch ratio >1.8 **AND**

B1: Less than 6 hours (based on SWIFT-PRIME)

- Infarct lesion < 50 cc

B2: 6-24 hours (based on DAWN)

- 0-<21 cc core infarct and NIHSS ≥ 10 (and age ≥ 80 years old)
- 0-<31 cc core infarct and NIHSS ≥ 10 (and age < 80 years old)
- 31 cc to <51 cc core infarct and NIHSS ≥ 20 (and age < 80 years old)

Acute Stroke Intervention Checklist (If answer is No to any of these then STOP)

1. **NIHSS ≥ 10 or VAN positive right before procedure** **Yes**
2. **CTA showing M1 And/ OR intracranial ICA occlusion** **Yes**
3. **CT perfusion showing:**
   - Ischemic penumbra >15 cc **AND** Mismatch ratio >1.8 **Yes**
4. **< 6 hours (based on SWIFT-PRIME):** Infarct lesion < 50 cc **Yes**
5. **6-24 hours (based on DAWN)** **Yes**
   A. 0-<21 cc core infarct **and** NIHSS ≥ 10 (**and** age ≥ 80 years old)
   B. 0-<31 cc core infarct **and** NIHSS ≥ 10 (**and** age < 80 years old)
   C. 31 cc to <51 cc core infarct **and** NIHSS ≥ 20 (**and** age < 80 years old)

*If patient meet criteria then call neuro IR on call

*If the answer to NO then contact stroke neurologist OR neurointensivist OR neurologist on call to discuss the case

CT perfusion: Report

- CT perfusion and CTA stroke should be associated exams

- A standardized reporting template is currently pending.

- For now, an example of all you need to include in the report is provided below.

CT perfusion:
Arterial and venous and input function appears normal.

CBF less than 30% volume: 175 mL
Tmax >6.0 s volume: 241 mL
Mismatch volume 66 mL
Mismatch ratio: 1.4 mL

CT Perfusion

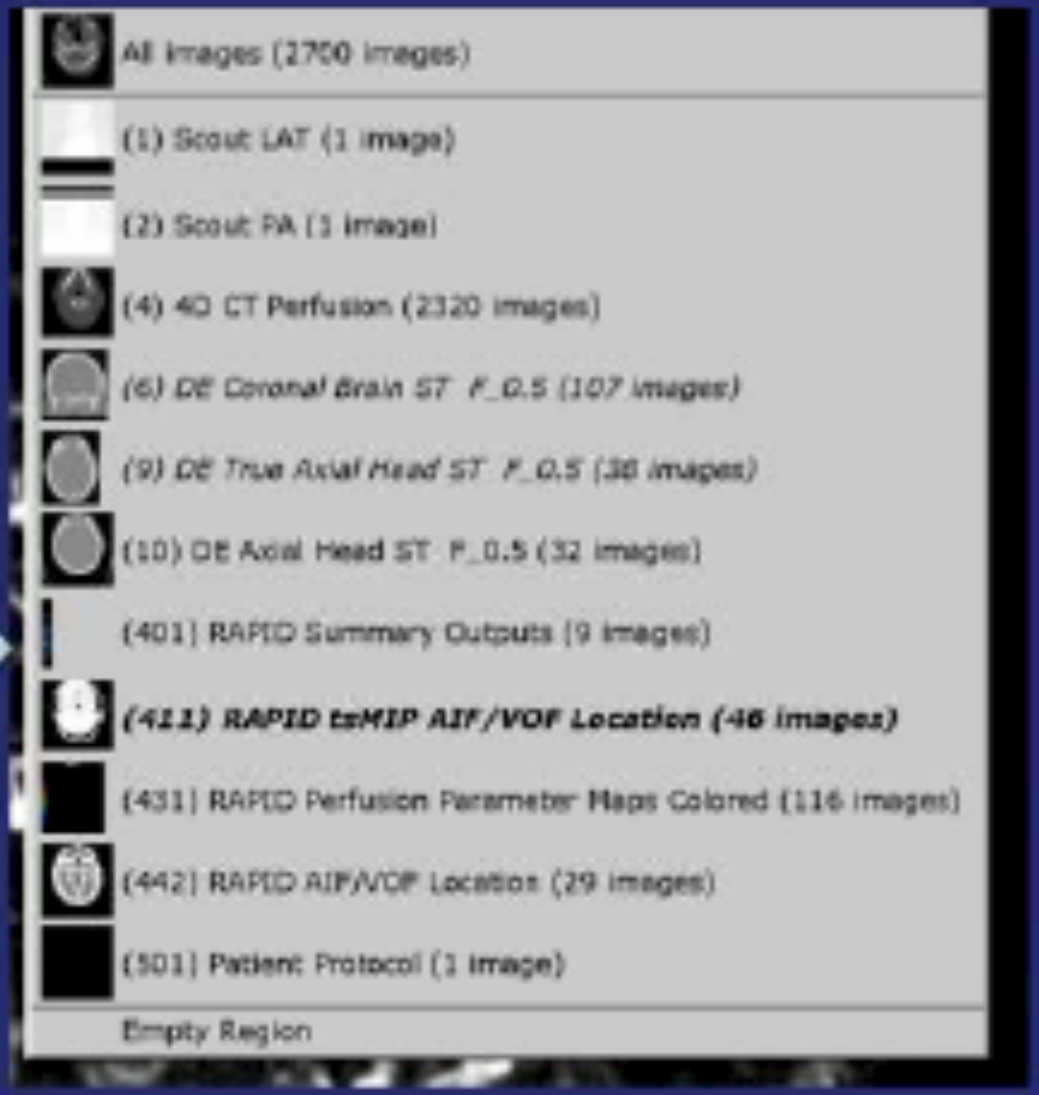
- Report is easy

- Penumbra and infarct core volumes are generated from raw data

- Your role is to make sure that this data is trustable after verifying no bleed.

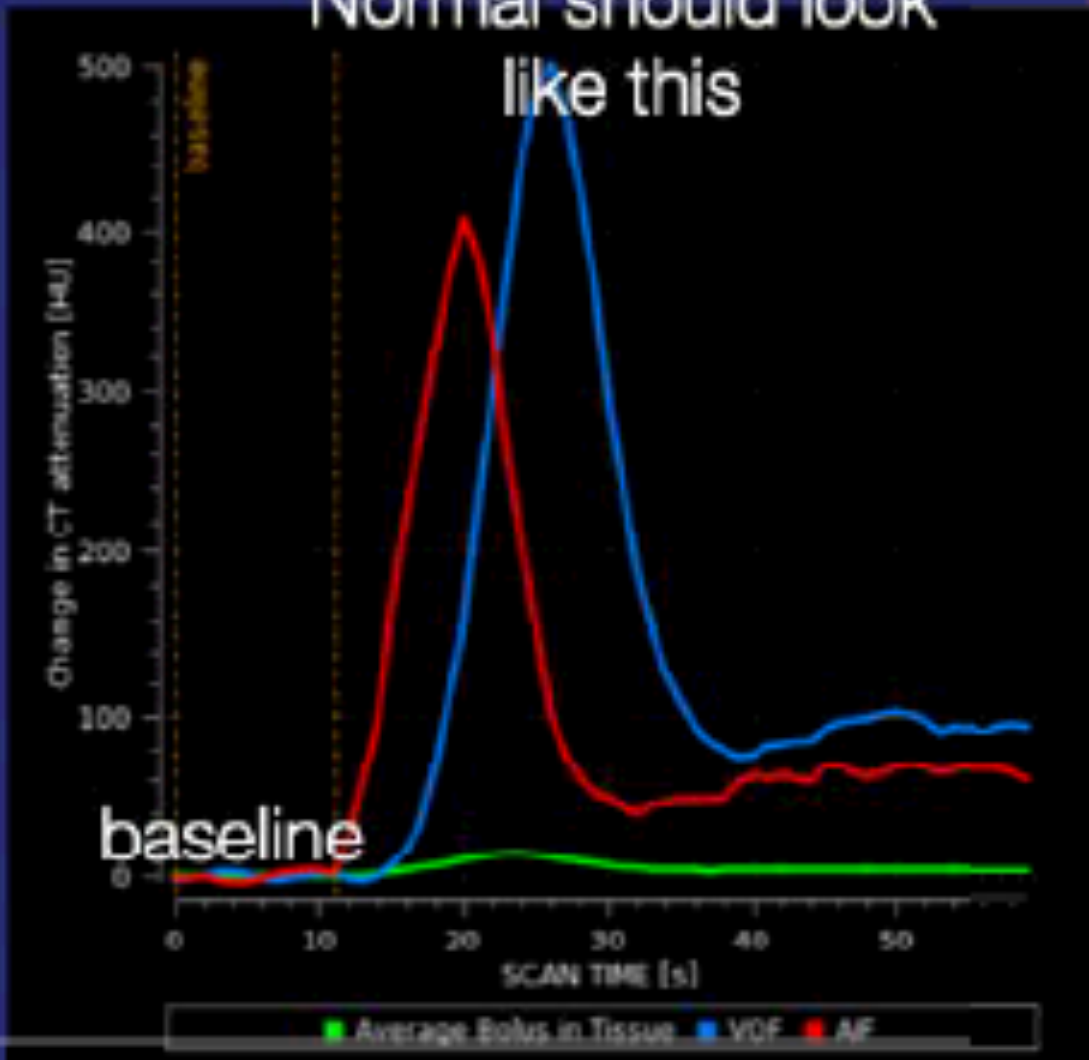
Start

Rapid summary outputs has all the quality metrics you should be looking at

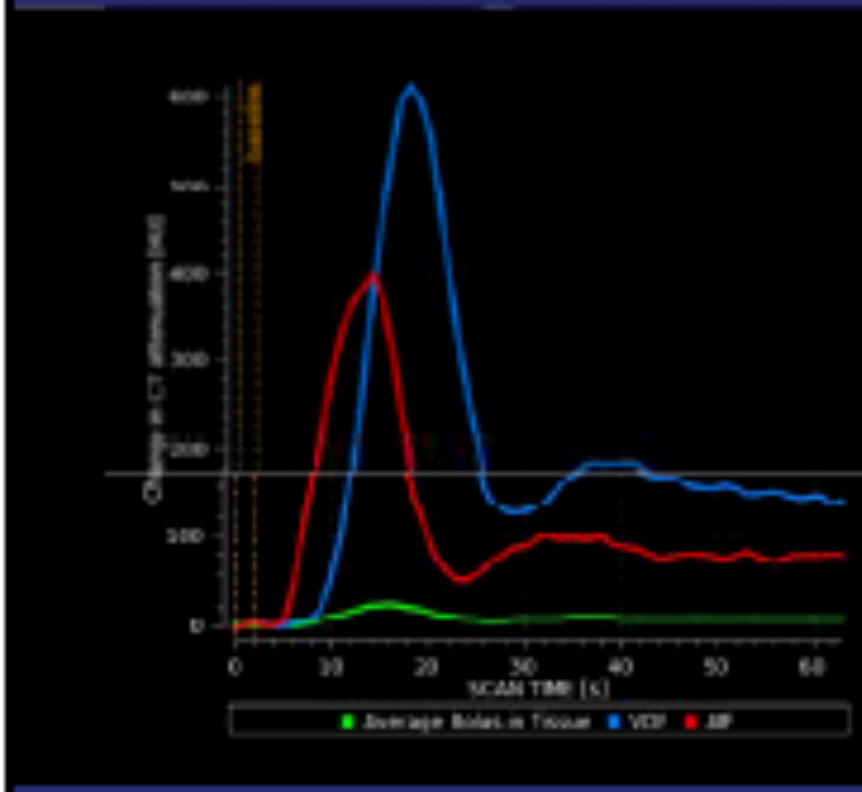


Step 1: Curve Quality

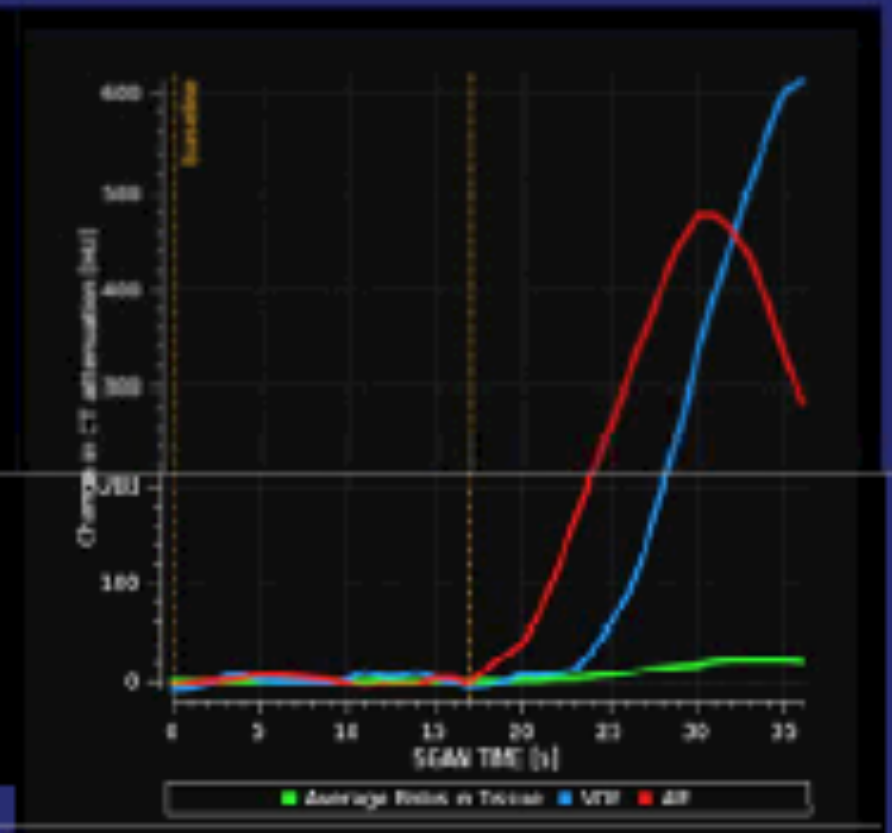
- Arterial input function (AIF; red curve) should be before venous outflow function (VOF; blue curve).
- Ensure baseline (dotted vertical lines) is longer >= 8 sec.
- AIF and VOF curves are not truncated
- Scan time ~65 seconds
- "quick upstroke" for both curves



Abnormal Curves



Baseline to short (~2 sec.)



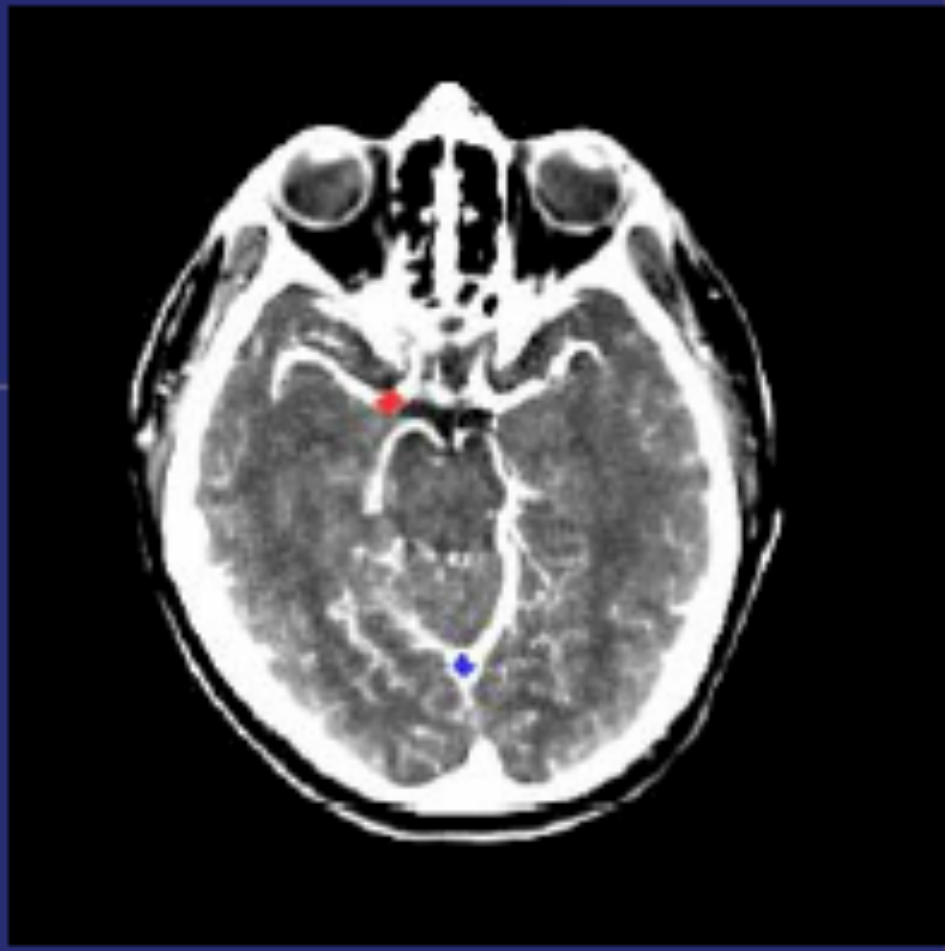
Baseline too long, truncated curves, scan time wrong

What to do?

-Report that curves are suboptimal and limits data interpretation.

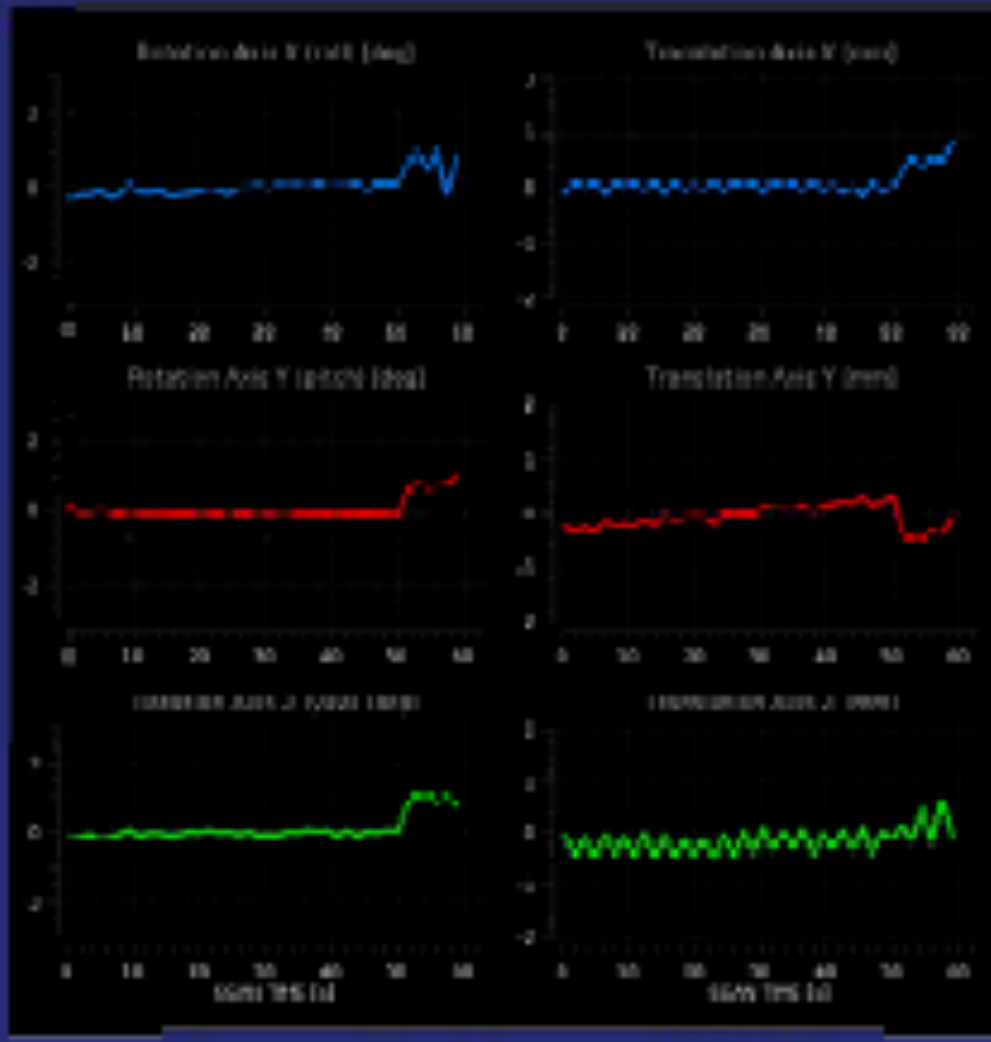
Step 2: AIF and VOF selection

- AIF (red diamond):
  - Over an artery
  - Contralateral to thrombus, symptoms, side of decreased perfusion
- VOF (blue diamond):
  - Over dural venous sinus
- Area of interest should be in the middle of the vessel (for CTP)



Step 3: Motion

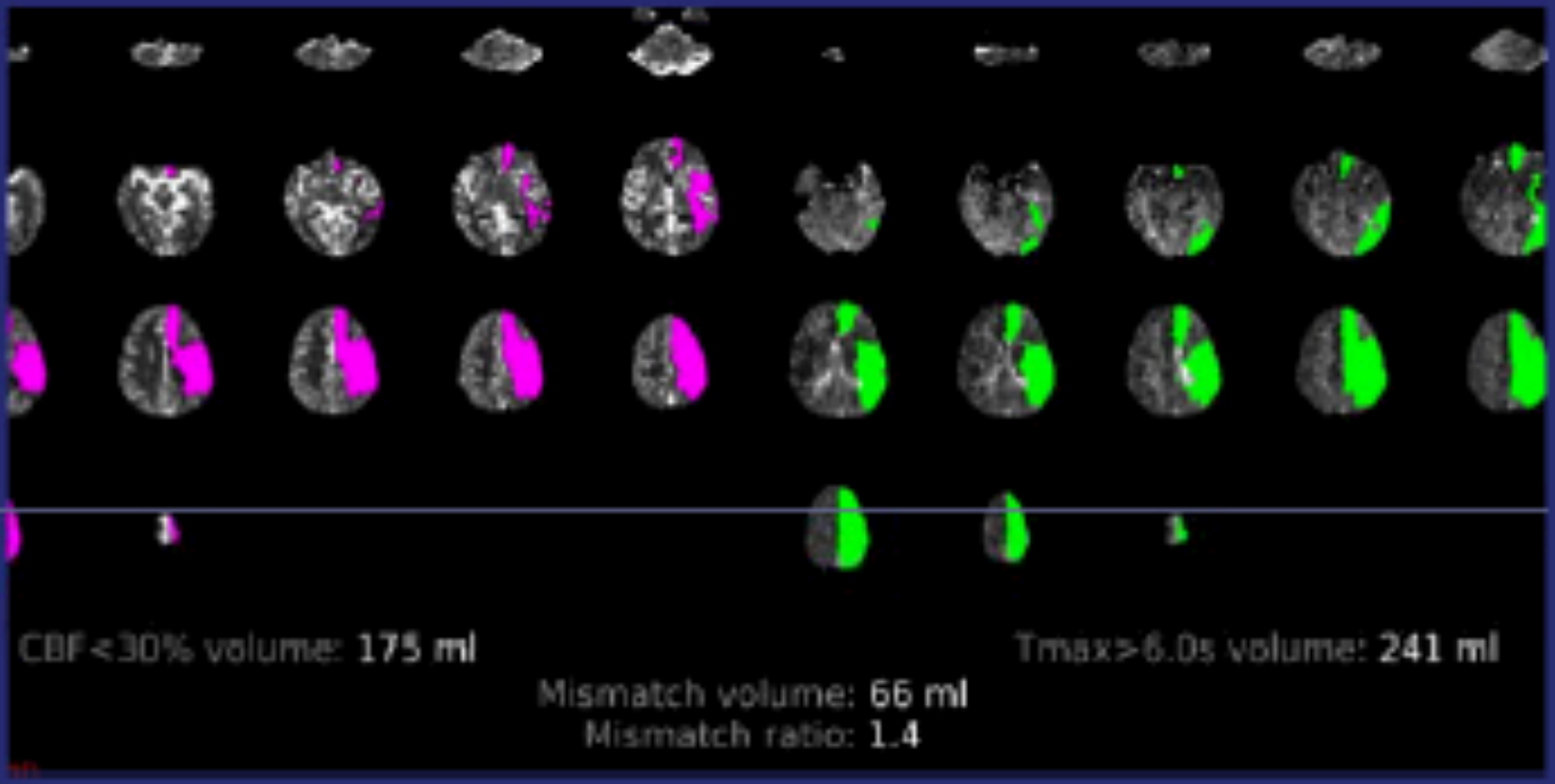
- Rough qualitative assessment of motion



Acceptable variability

Step 4: Report

Report the four metrics (All provided on this image):



Last points

- Neuro-interventionalist (in consult with others in the neuro critical care team) may ultimately interpret numbers and decide on treatment.

HMC AIS Neuro protocol (WIP)*

- Overview of protocol:
- 1. Acute Stroke pt. presents to ED
- 2. Non-contrast Head CT shows no blood
- 3. And could puncture by 24 hours
- 4. Do (as default) CTP then CTA ("Code Stroke") protocol

* Provided for your reference only!

HMC AIS Neuro protocol (WIP)*

- Imaging Criteria for good anterior circulation thrombectomy candidates:
- <6 hrs to puncture (current state)
- ASPECTS >=6
- ICA, M1, select M2 occlusions
- Consider using CTP to exclude patients with large core and little mismatch (new twist, case by case basis)

* Provided for your reference only!

HMC AIS Neuro protocol (WIP)*

- 6-16 hours (DEFUSE trial imaging criteria)
- ASPECTS >=6
- ICA, M1, select M2 occlusions
- Target Mismatch Profile on CT perfusion
- ischemic core volume is < 70 ml
- mismatch ratio is >/= 1.8 and
- mismatch volume is >/= 15 ml)
- (all key info is typically provided on first few images from RAPID software and in text)

* Provided for your reference only!

HMC AIS Neuro protocol (WIP)*

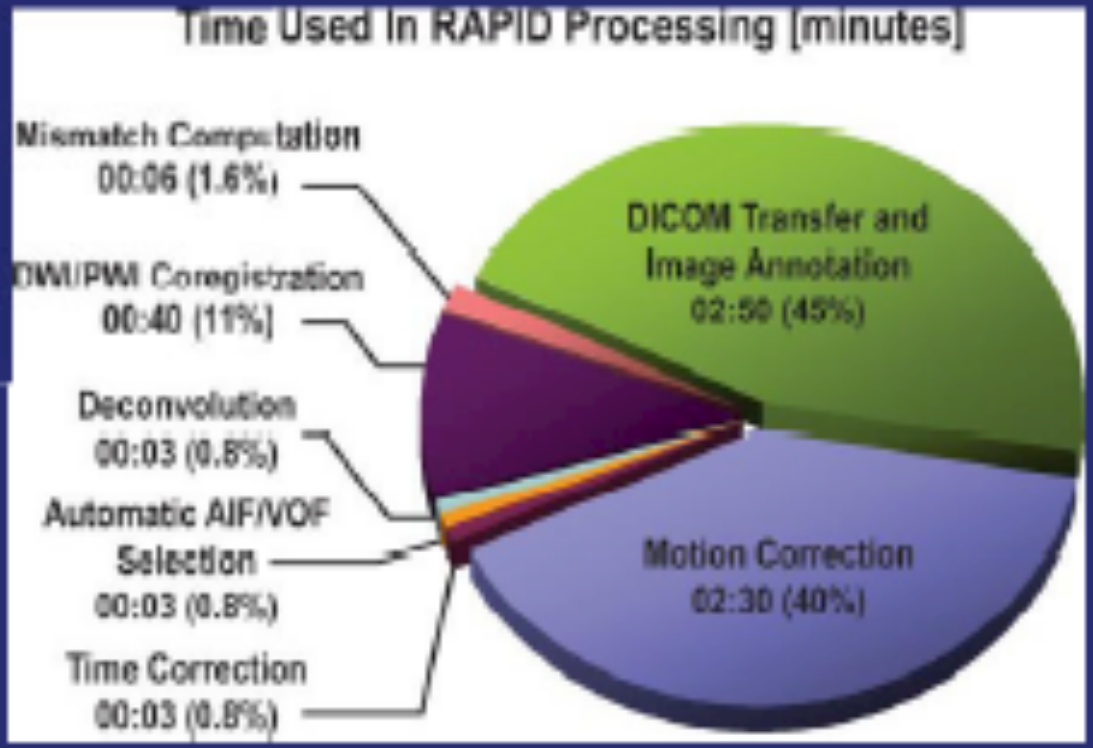
16-24 hours (DAWN trial imaging criteria)

- < 1/3 MCA territory involved, as evidenced by CT or MRI (similar to ASPECTS >=6?)
- Occlusion of the intracranial ICA and/or MCA-M1 (here extracranial ICA occlusion is excluded)
- Clinical Imaging Mismatch (CIM) defined as one of the following on CTP-rCBF maps:
- 0-<21 cc core infarct and NIHSS ≥ 10 (and age ≥ 80 years old)
- 0-<31 cc core infarct and NIHSS ≥ 10 (and age < 80 years old)
- 31 cc to <51 cc core infarct and NIHSS ≥ 20 (and age < 80 years old)

* Provided for your reference only!

What is RAPID?

- RApid processing of PerfusIon and Diffusion
- **NOT a workstation!**



Goals of Imaging

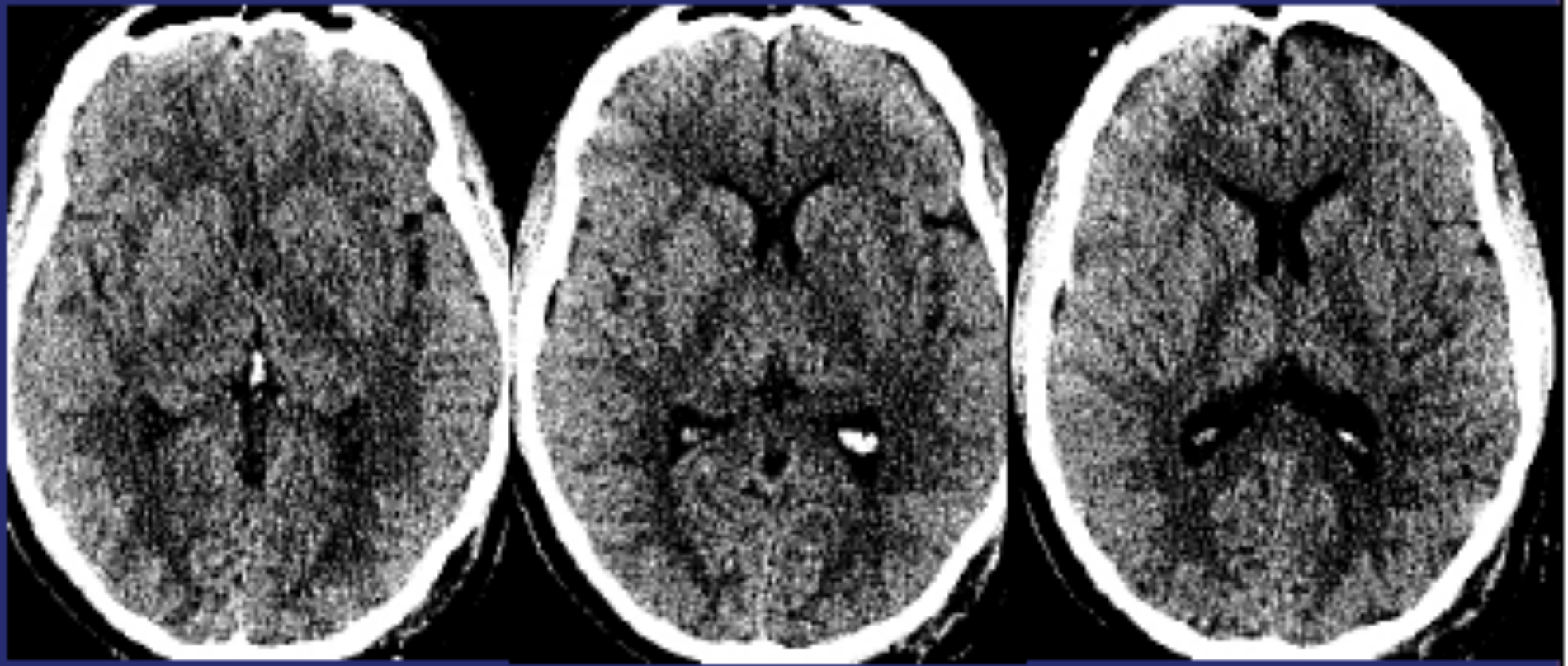
- To detect injuries that may
  - Require immediate surgical or procedural intervention
  - Benefit from early medical therapy
  - **Have prognosis that**
    - **Dictates therapy**
    - **Helps with family counseling**

Medina et al. Evidence-Based Neuroimaging Diagnosis and Treatment. 2013

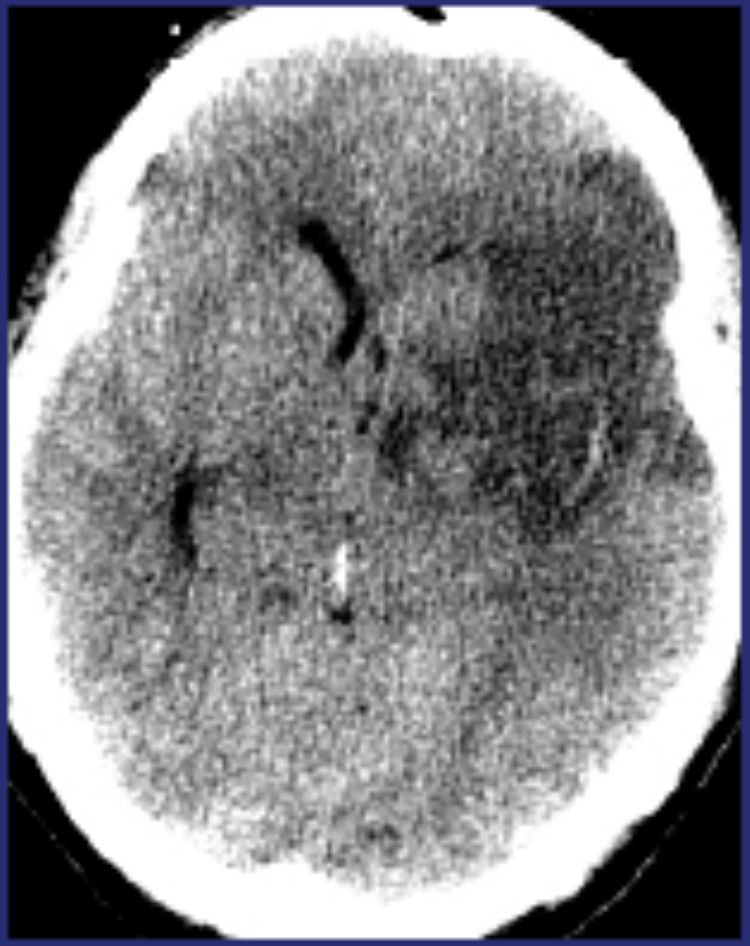
CT Findings

- Signs become prominent over time but initially are subtle (problem!)
- ~ 60% of CT scans are normal first three hours after ischemic insult

Slide courtesy of Norman Beauchamp, MD, MHS



Follow-up



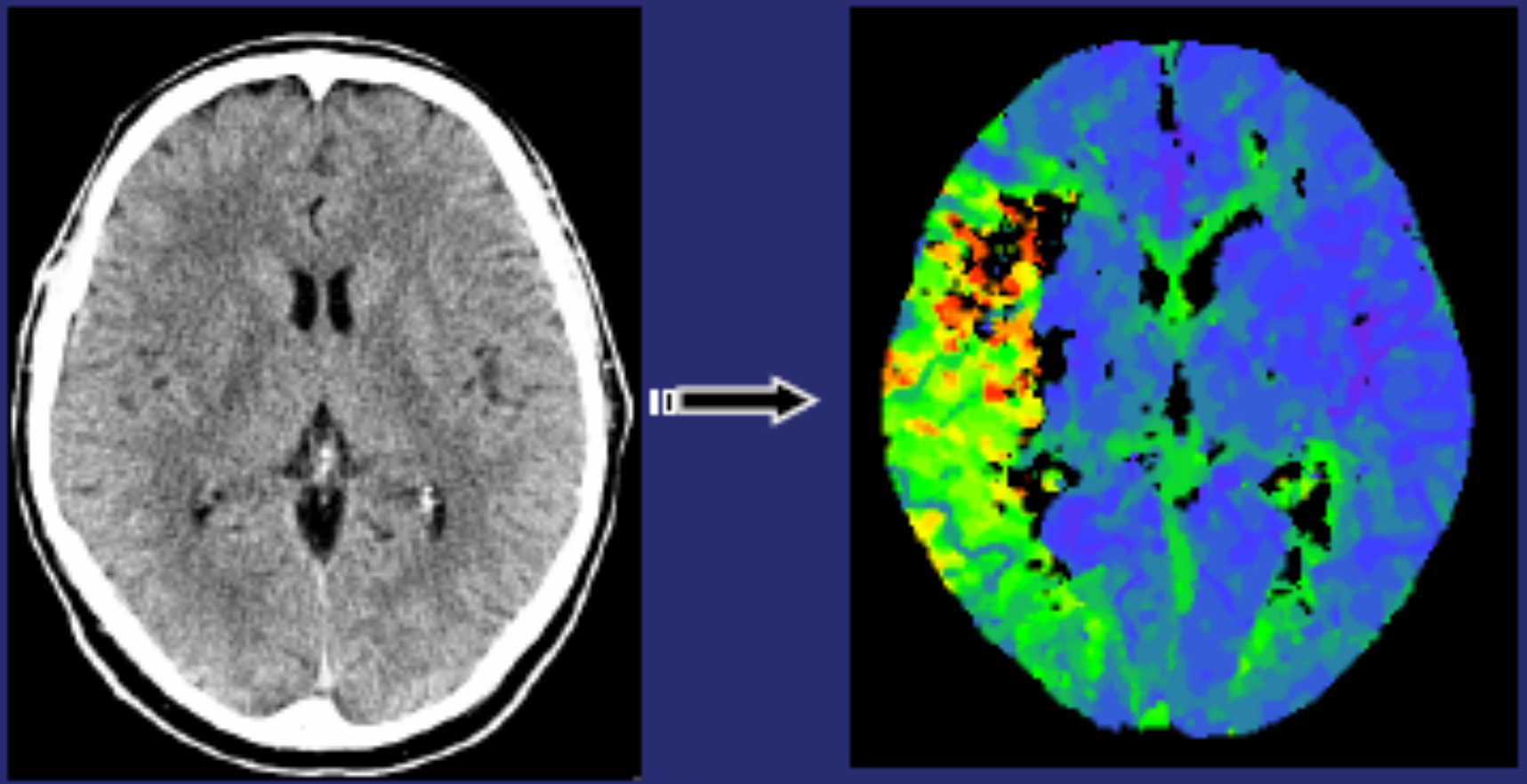
Challenges

- IV tPA time window is very restrictive:
- **Only 1-7% of pts receive IV tPA in 3 h time window, due to late presentation.**[1-3]
- "Time is brain" is an incomplete picture:
  - Effective on a population level
  - Neglects some cerebrovascular physiology
  - Pts. w large infarcts despite early presentation
  - Pts. w negligible infarcts at late presentation
  - Viable penumbral tissue can be substantial at 12 - 24 h.[4-6]

1 Marchal G, *et al. Stroke* 27(4), 599-606 (1996).
2 Baird AE, *et al. Ann. Neurol.* 41(5), 581–589 (1997).
3 Furlan M, *et al. Ann. Neurol.* 40(2), 216–226 (1996).
4 Marchal G, *et al. Stroke* 27(4), 599-606 (1996).
5 Baird AE, *et al. Ann. Neurol.* 41(5), 581–589 (1997).
6 Furlan M, *et al. Ann. Neurol.* 40(2), 216–226 (1996).

CT Perfusion

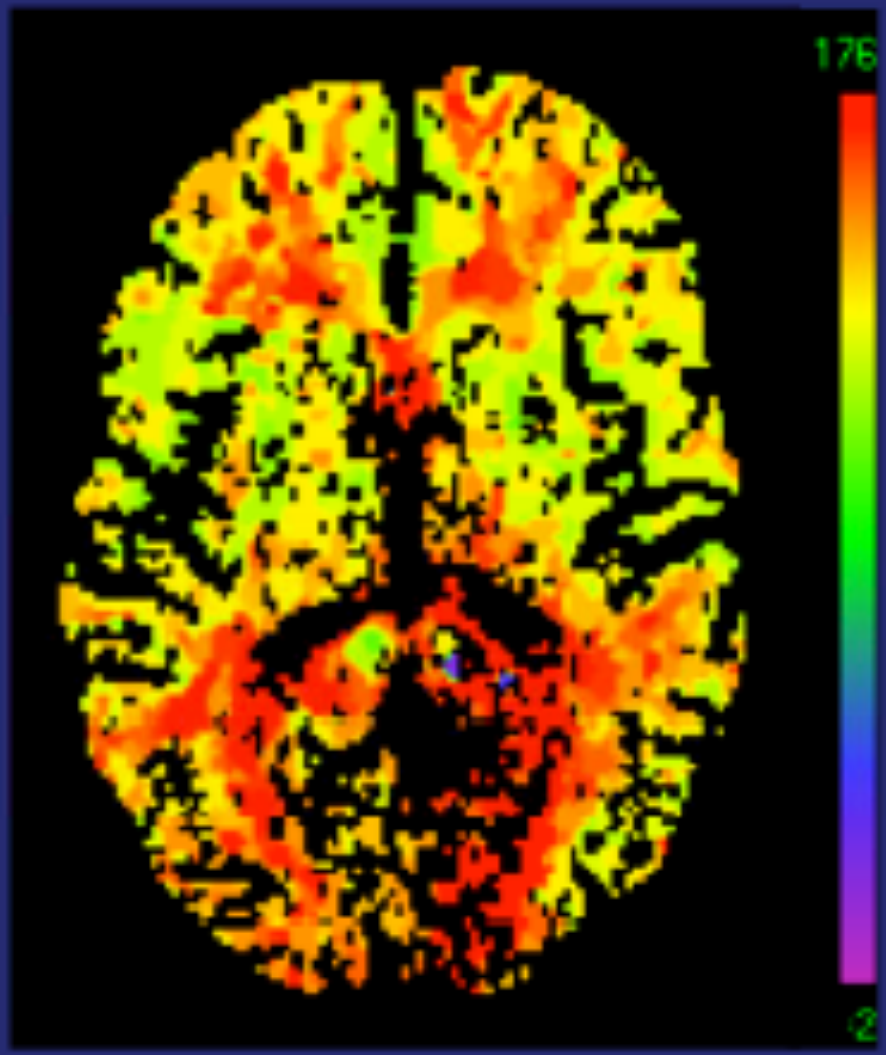
- Demonstrates area of diminished flow
- Helps simulate "panel of experts"



Slide courtesy of Norman Beauchamp, MD, MHS

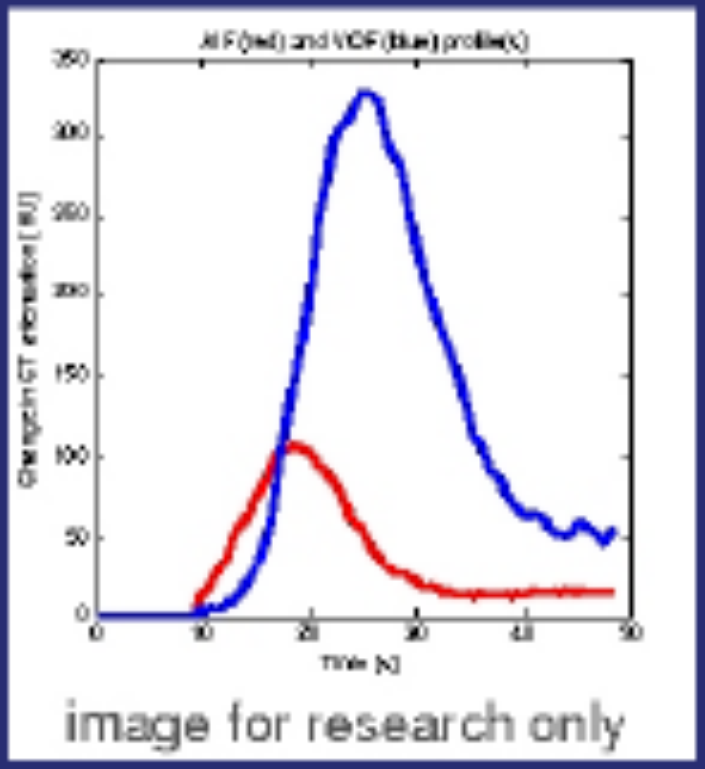
CT Perfusion

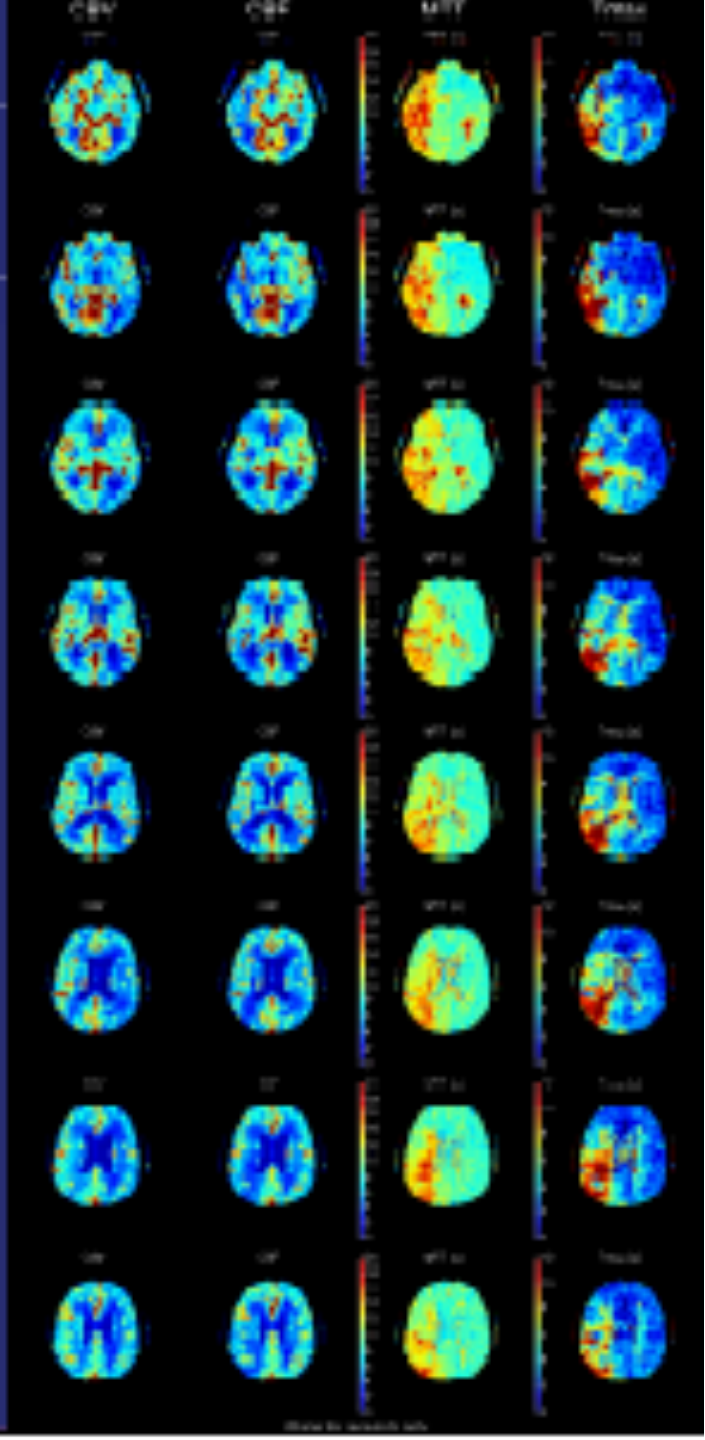
- Time to Peak Map
  - > 6 second
- Intravenous contrast administration
  - 5 cc/sec
  - 40 cc
- Real time MANUAL post processing



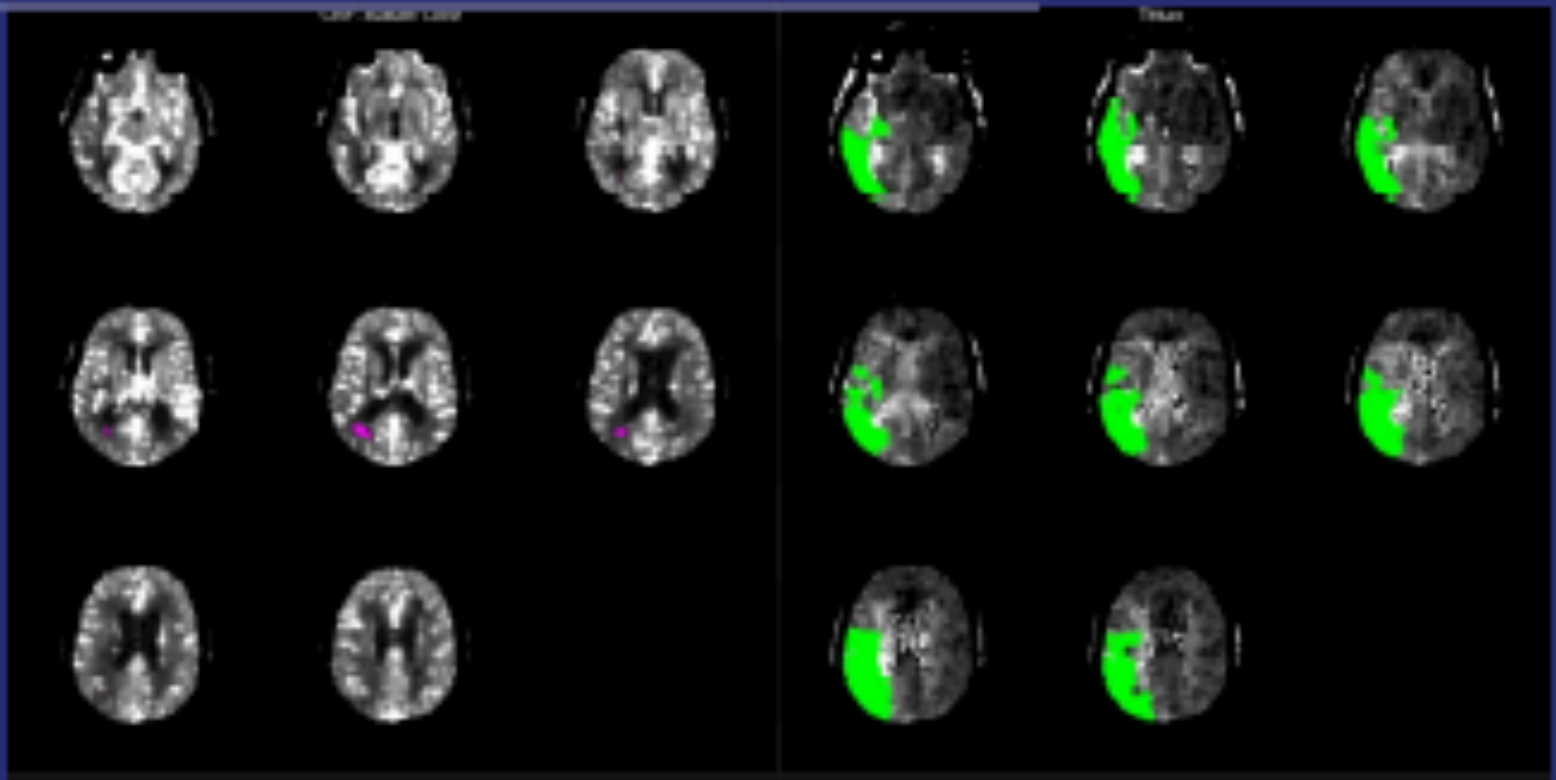
Slide courtesy of Norman Beauchamp, MD, MHS

GE VCT axial mode





GE VCT axial mode



Estimated core 1 ml

Hypoperfusion (Tmax>6s) 87 ml

Mismatch volume: 86 ml

Mismatch ratio: 78.9

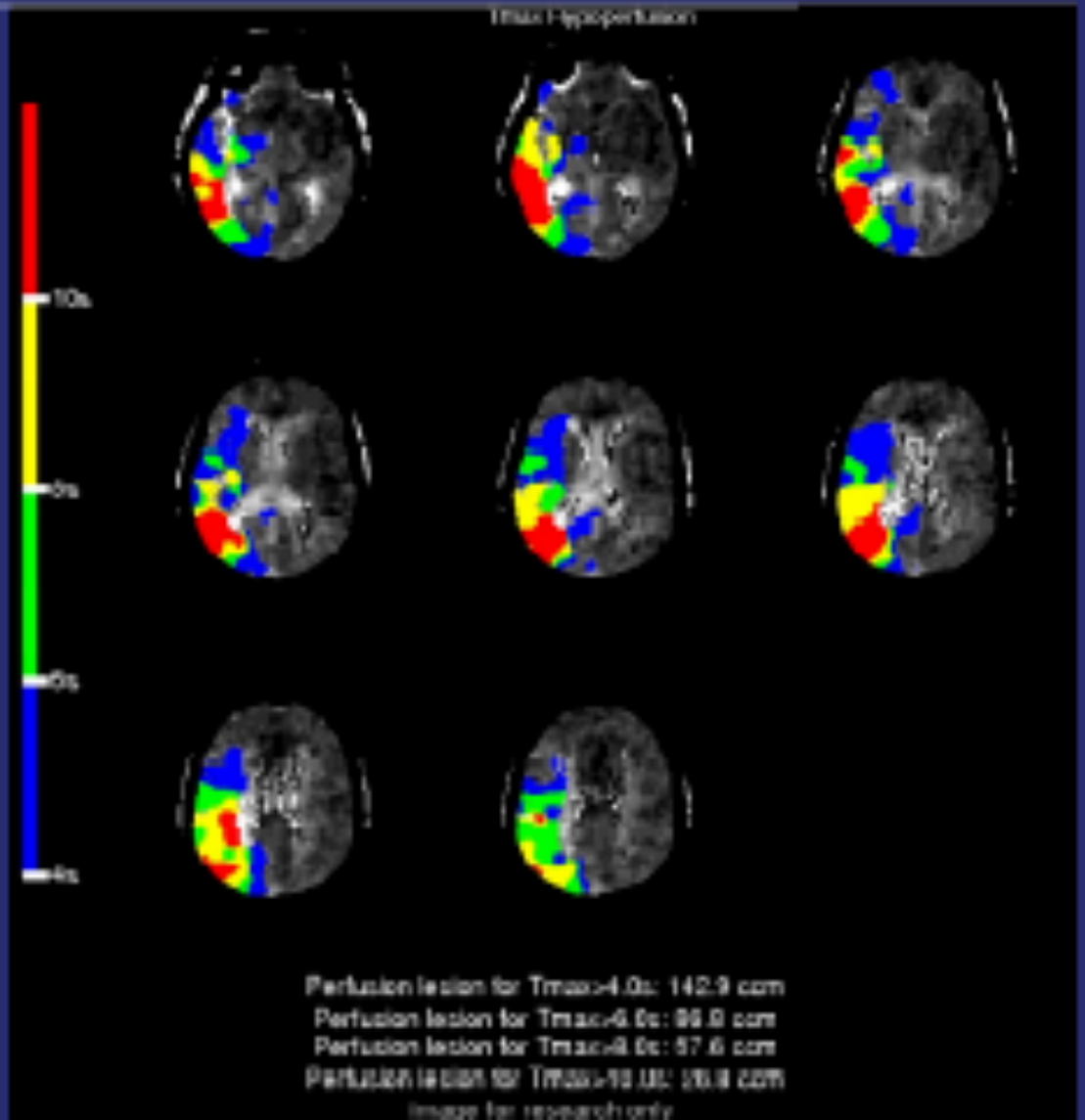
NOTE: Add volumes from BOTH slabs to determine eligibility:

Joint estimated core <= 50ml?

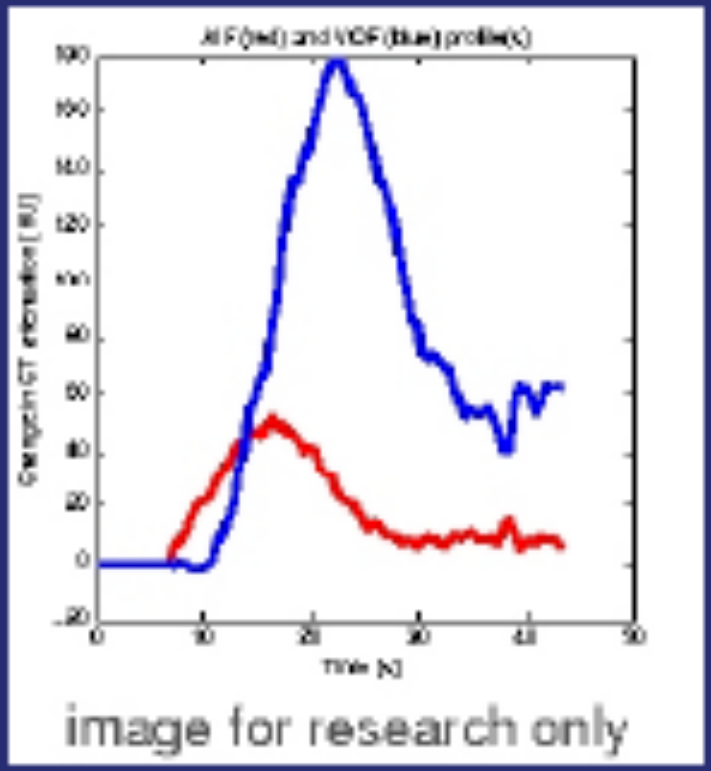
Joint mismatch volume > 15ml and ratio > 1.8?

Joint (Tmax>10s) <=100ml?

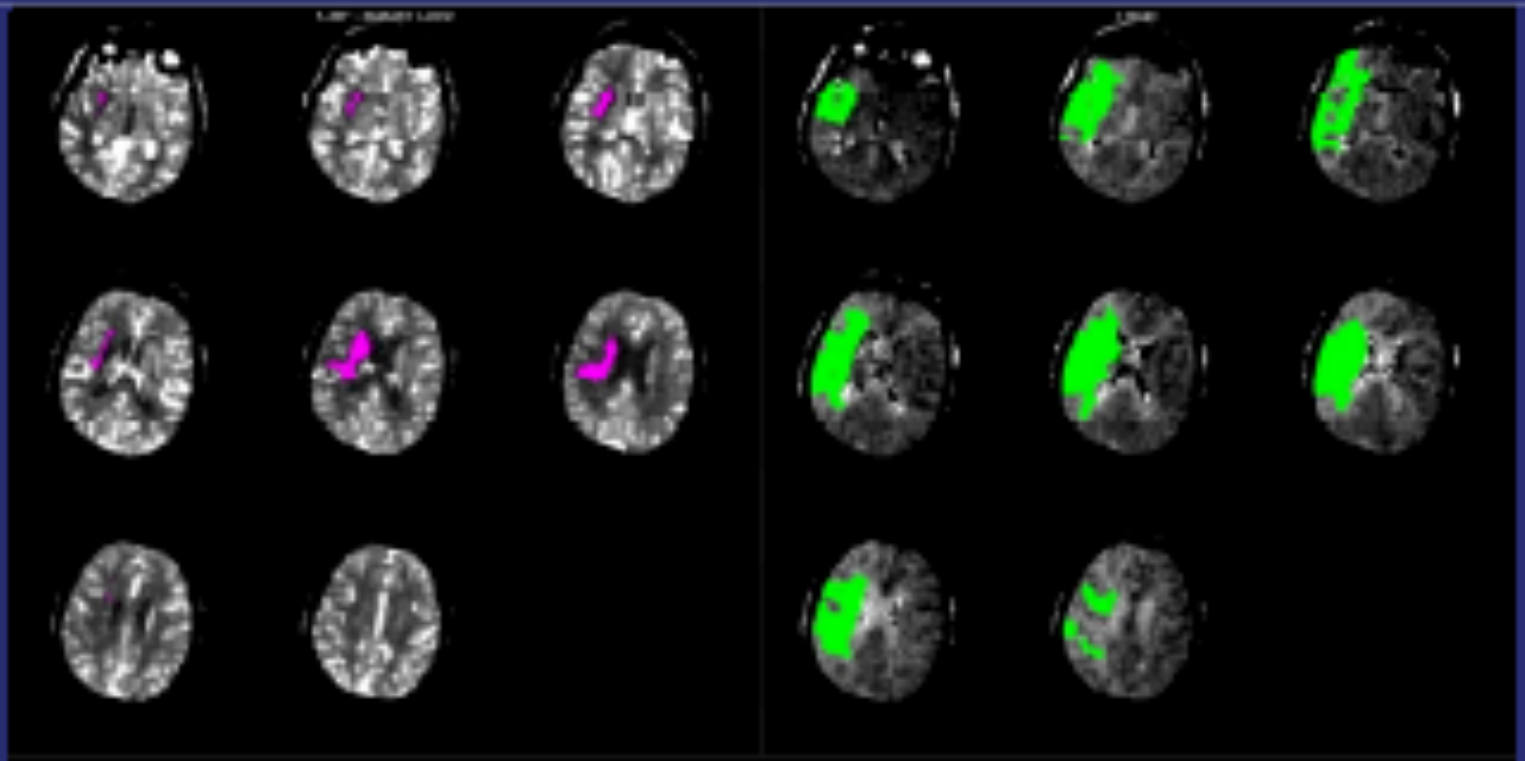
GE VCT axial mode



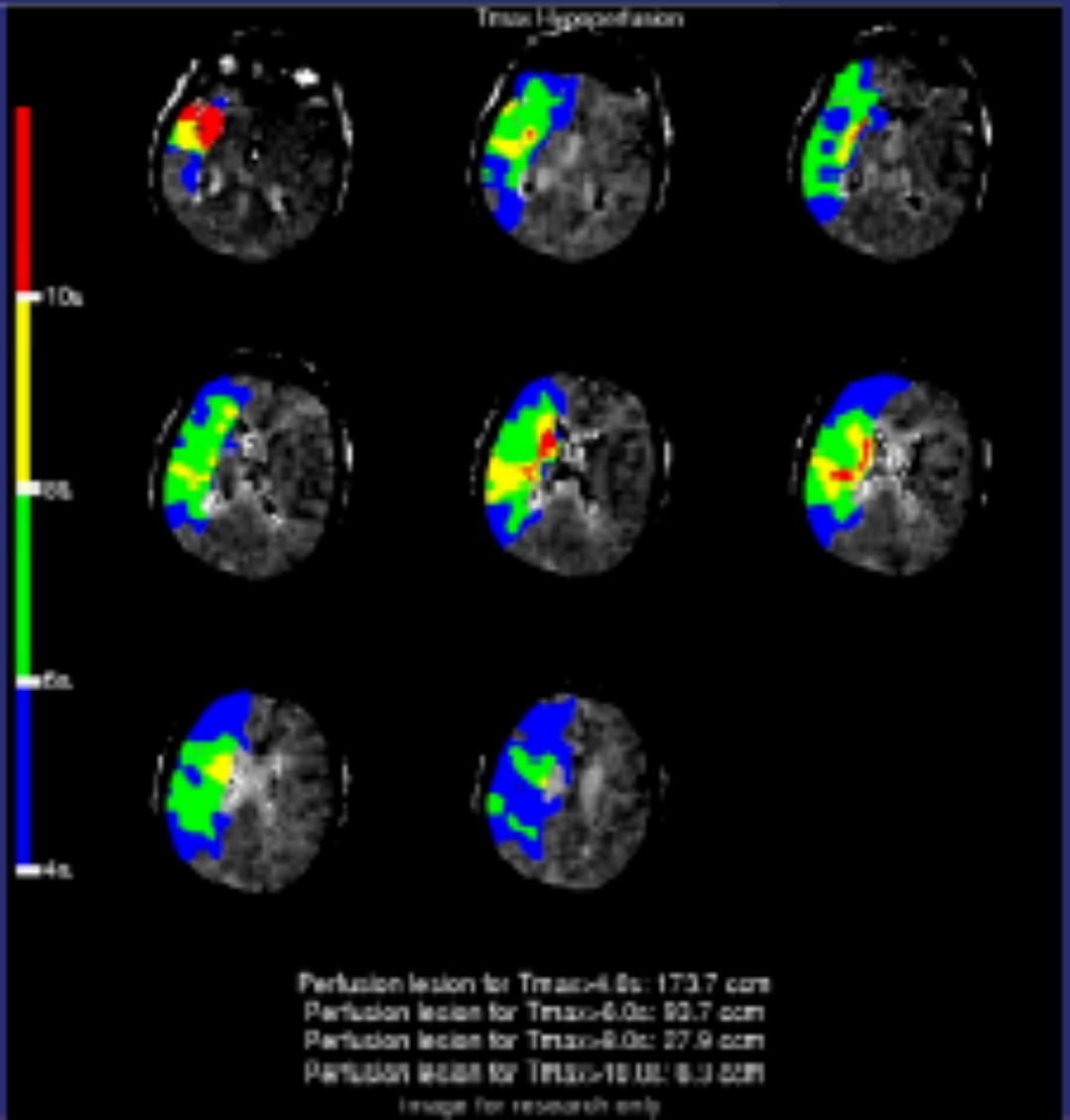
GE VCT CineMode



GE VCT CineMode



GE VCT CineMode



GE MRP

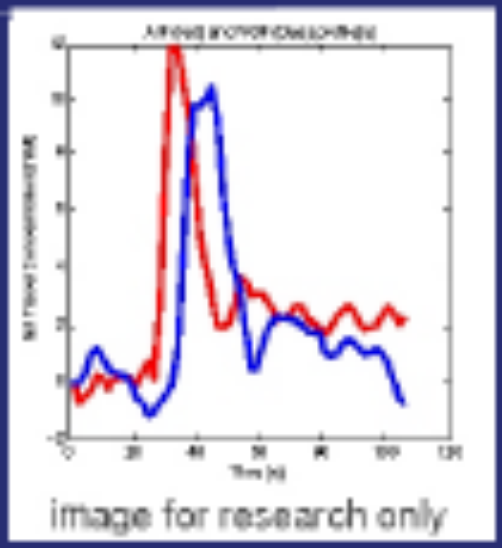
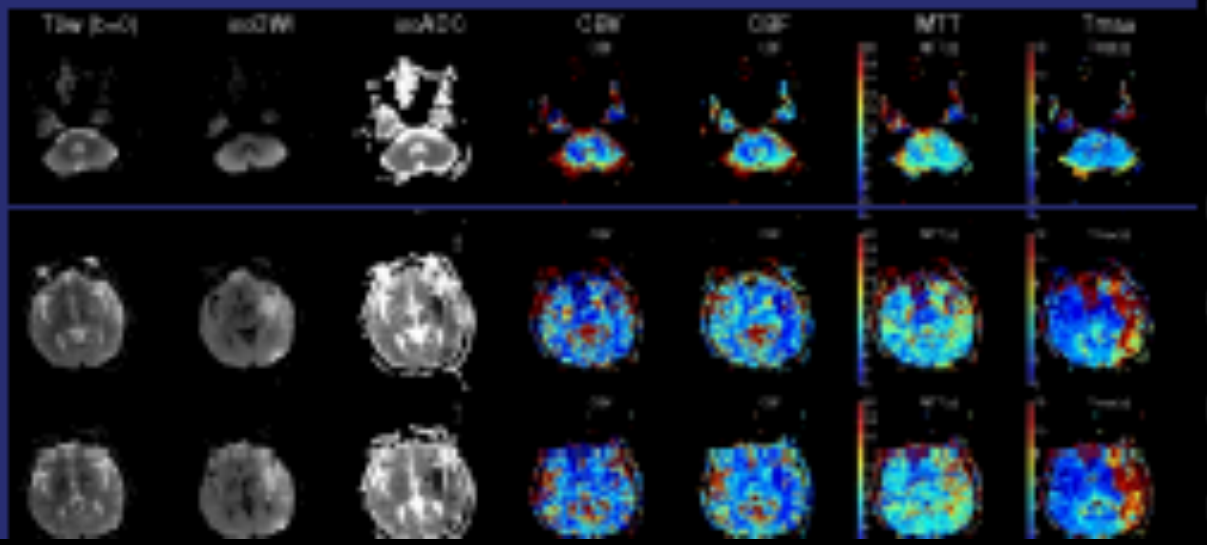
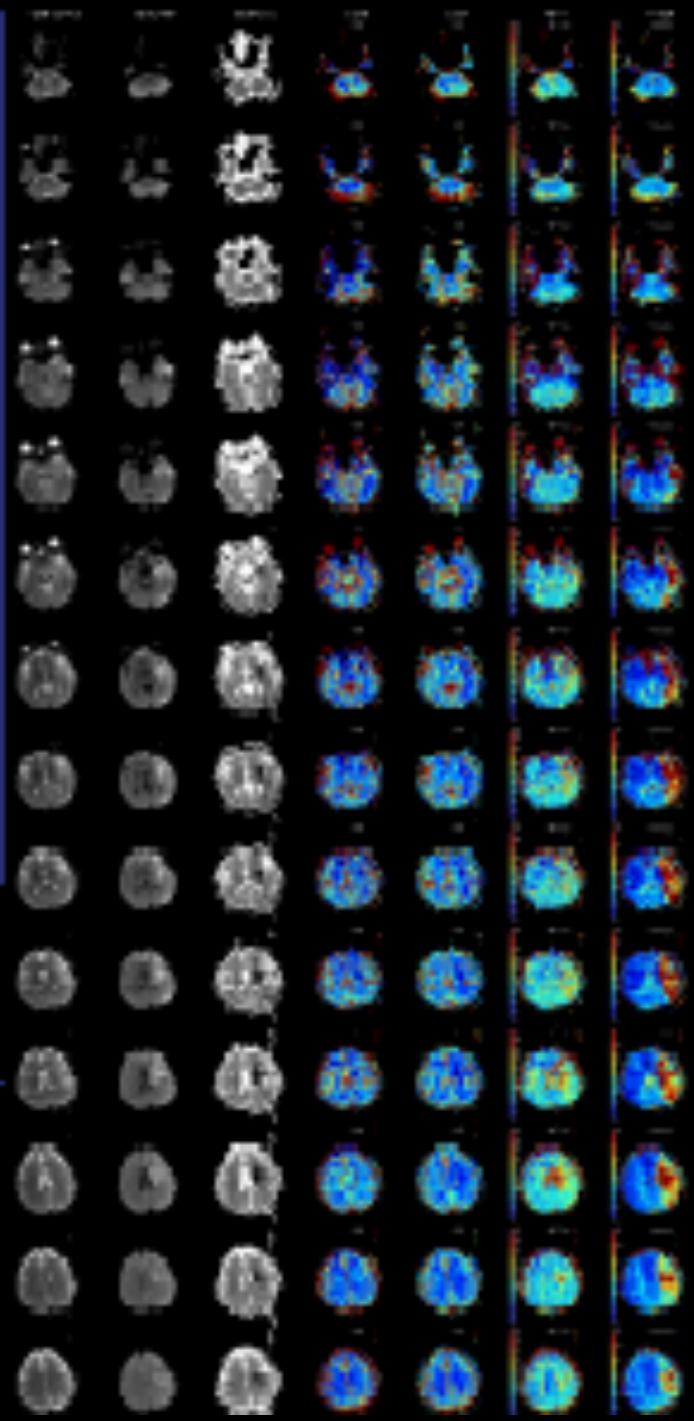
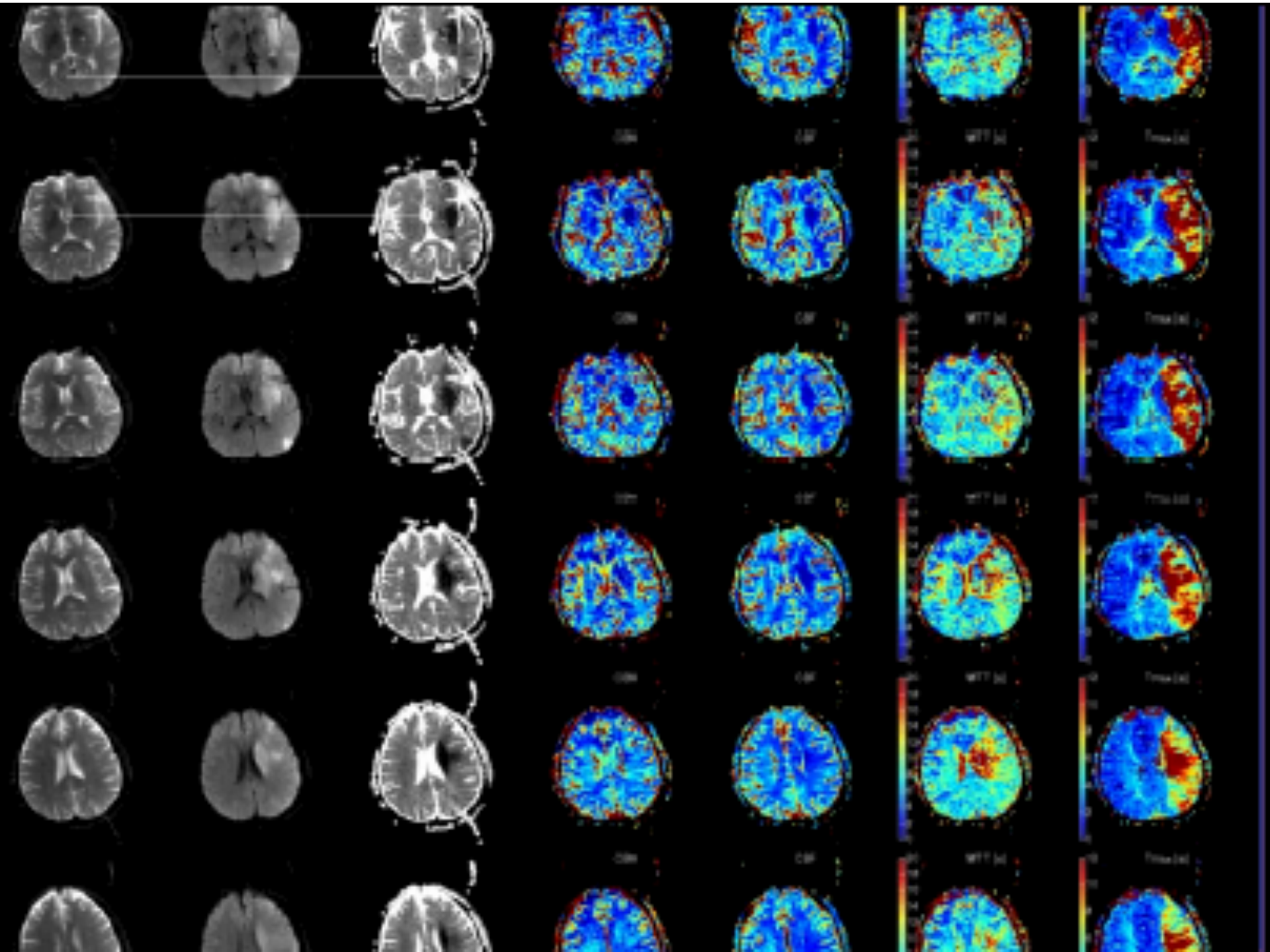


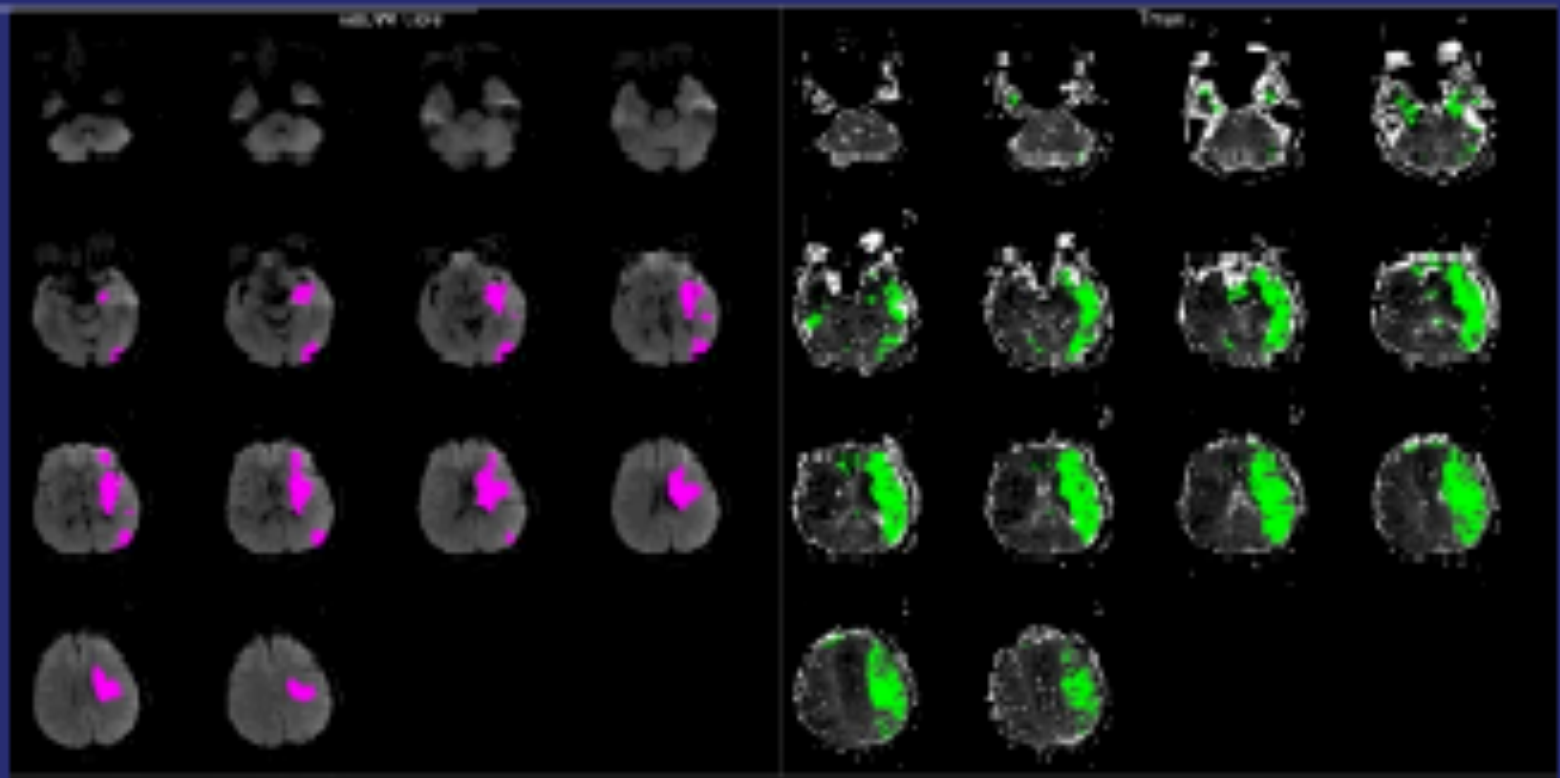
image for research only



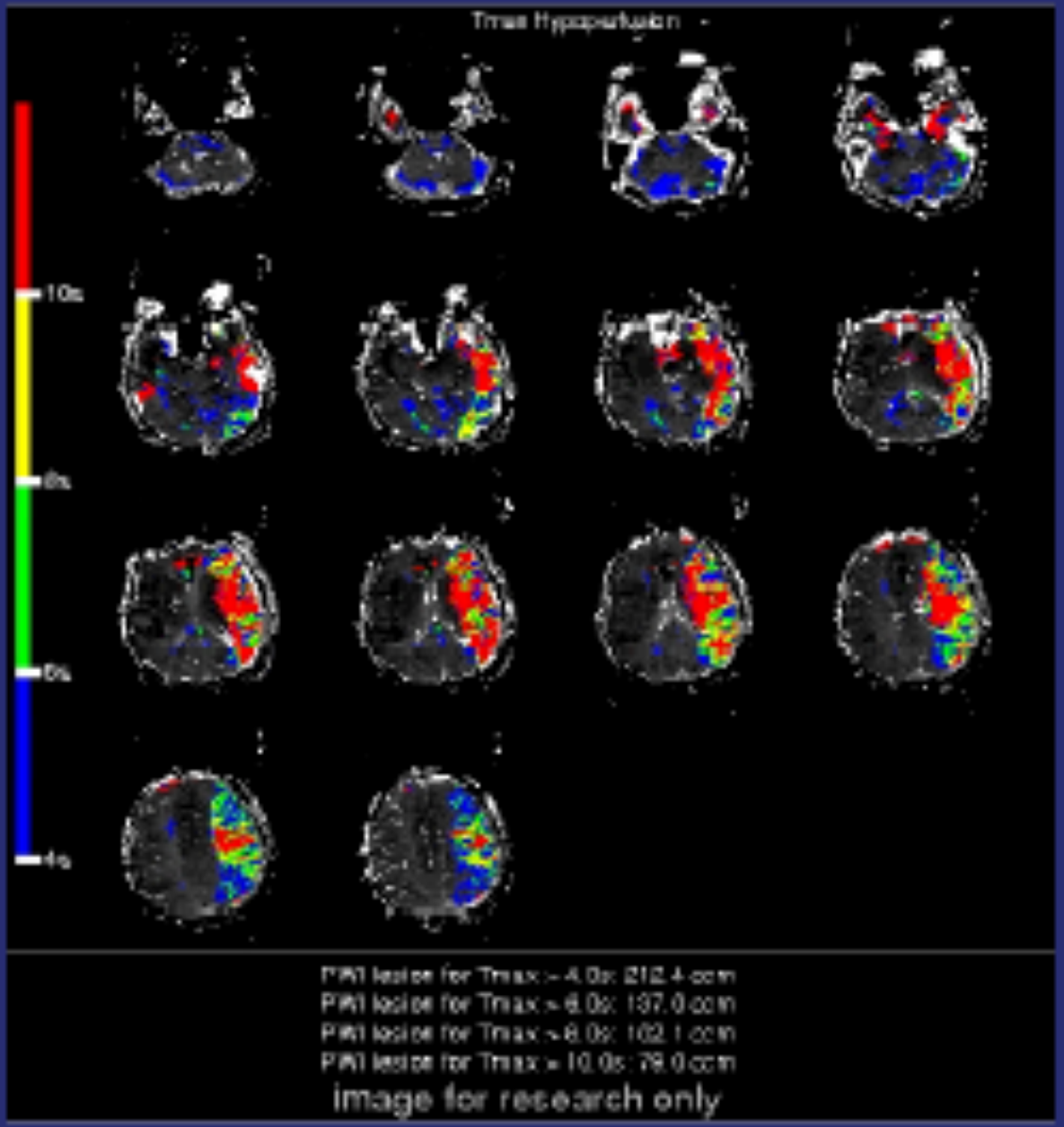


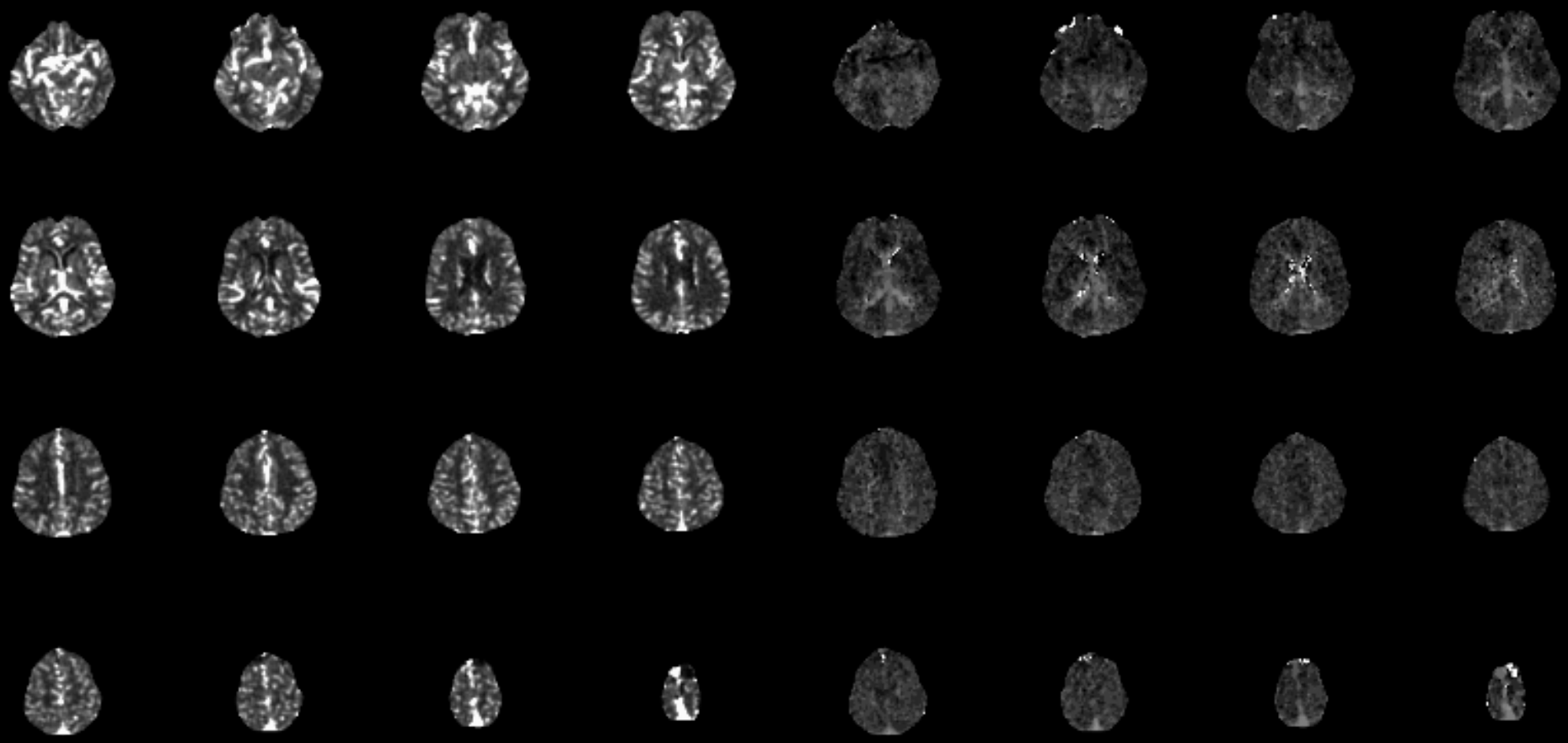


GE MRP


Estimated core 53 ml
Hypoperfusion (Tmax>6s) 137 ml
Mismatch volume: 84 ml
Mismatch ratio: 2.6
Estimated core <= 50ml ?: NO
Mismatch volume >= 15ml and ratio > 1.8?: YES
(Tmax >10s) <= 100ml?: YES
Image for research only

GE MRP


Tmax Hypoperfusion
10s
6s
2s
-2s
PWI lesion for Tmax > 4.0s: 212.4 ccm
PWI lesion for Tmax > 6.0s: 137.0 ccm
PWI lesion for Tmax > 8.0s: 102.1 ccm
PWI lesion for Tmax > 10.0s: 78.0 ccm
image for research only

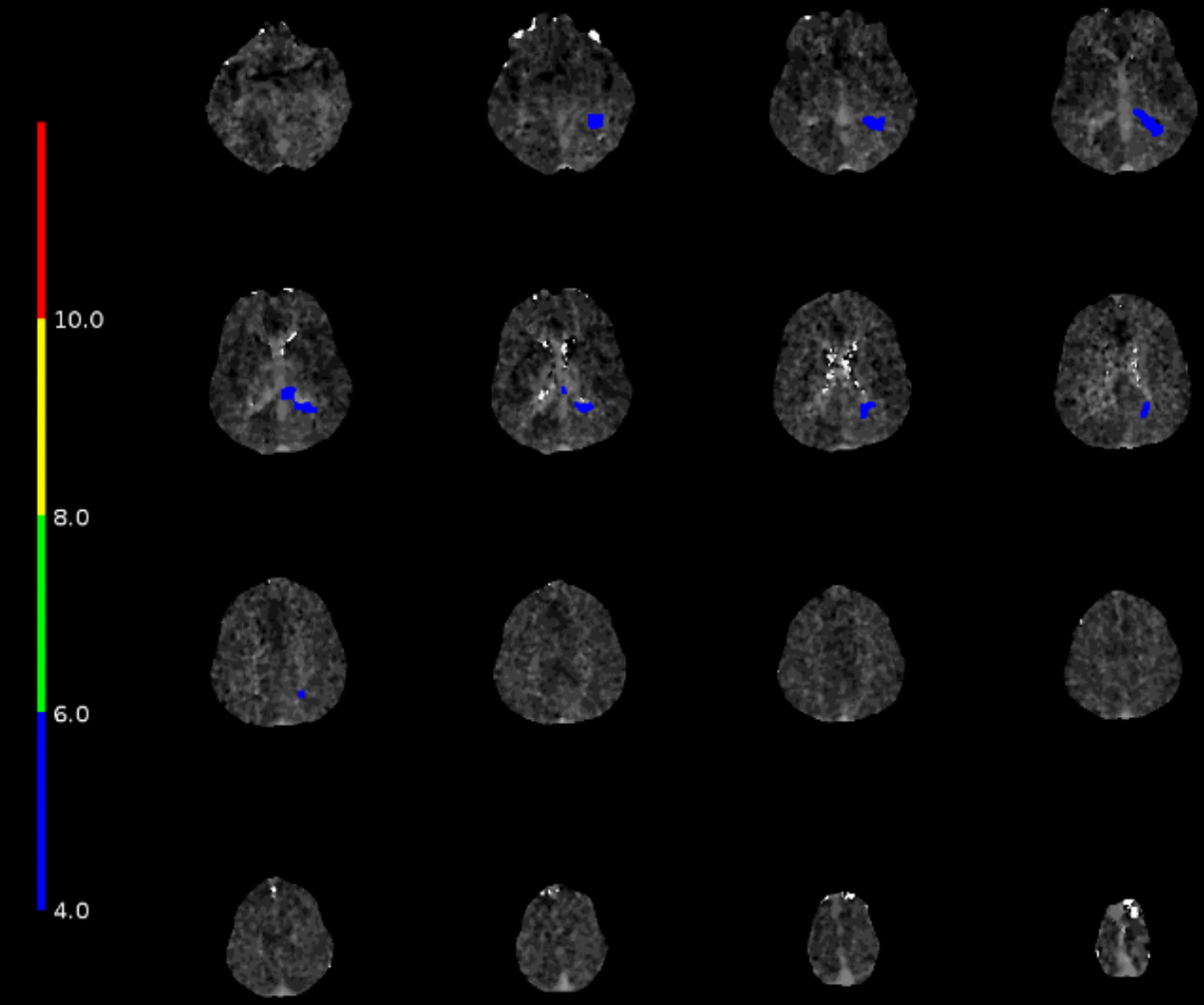


CBF<30% volume: **0 ml**

Tmax>6.0s volume: **0 ml**

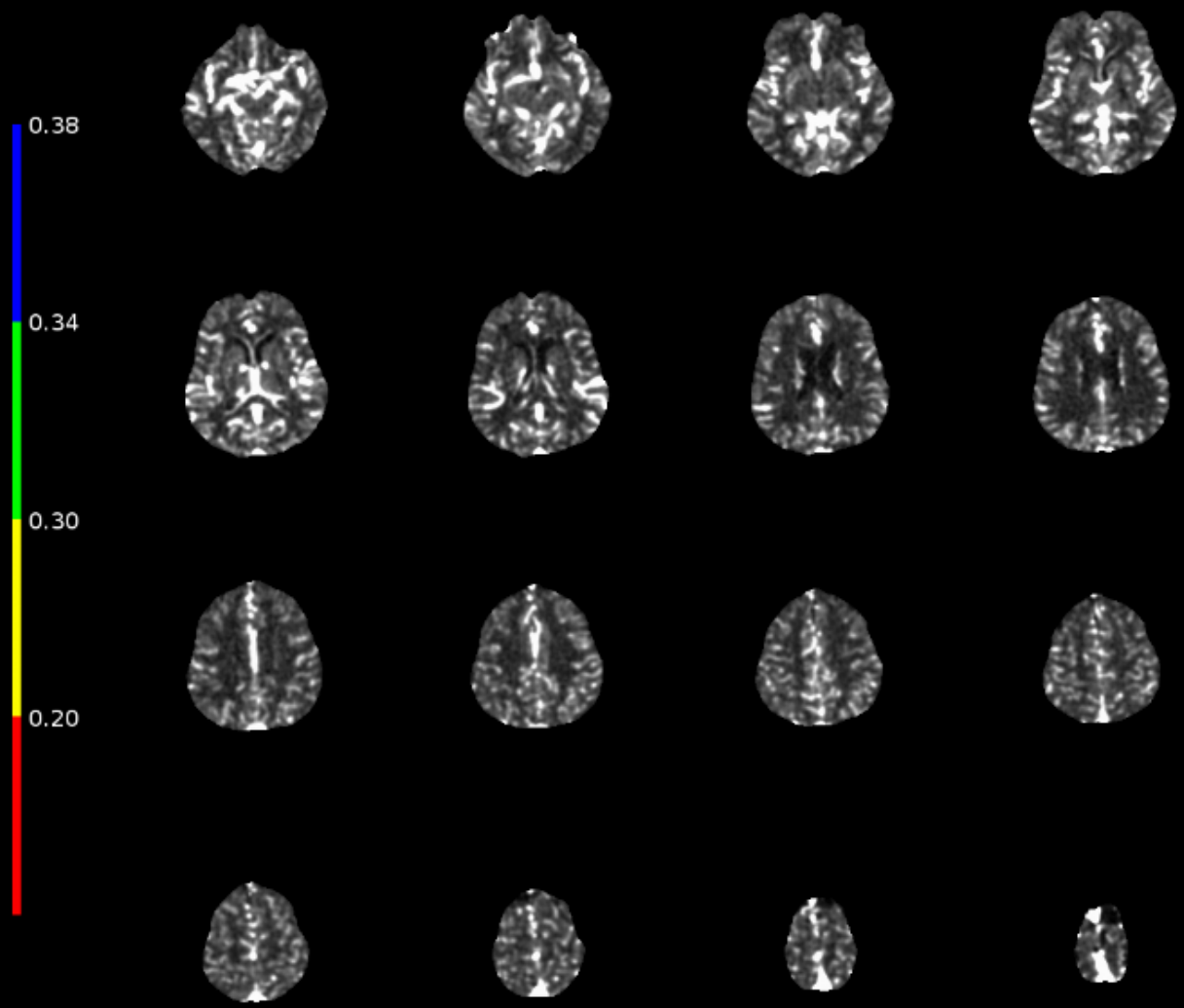
Mismatch volume: **0 ml**
Mismatch ratio: **none**

RAPID



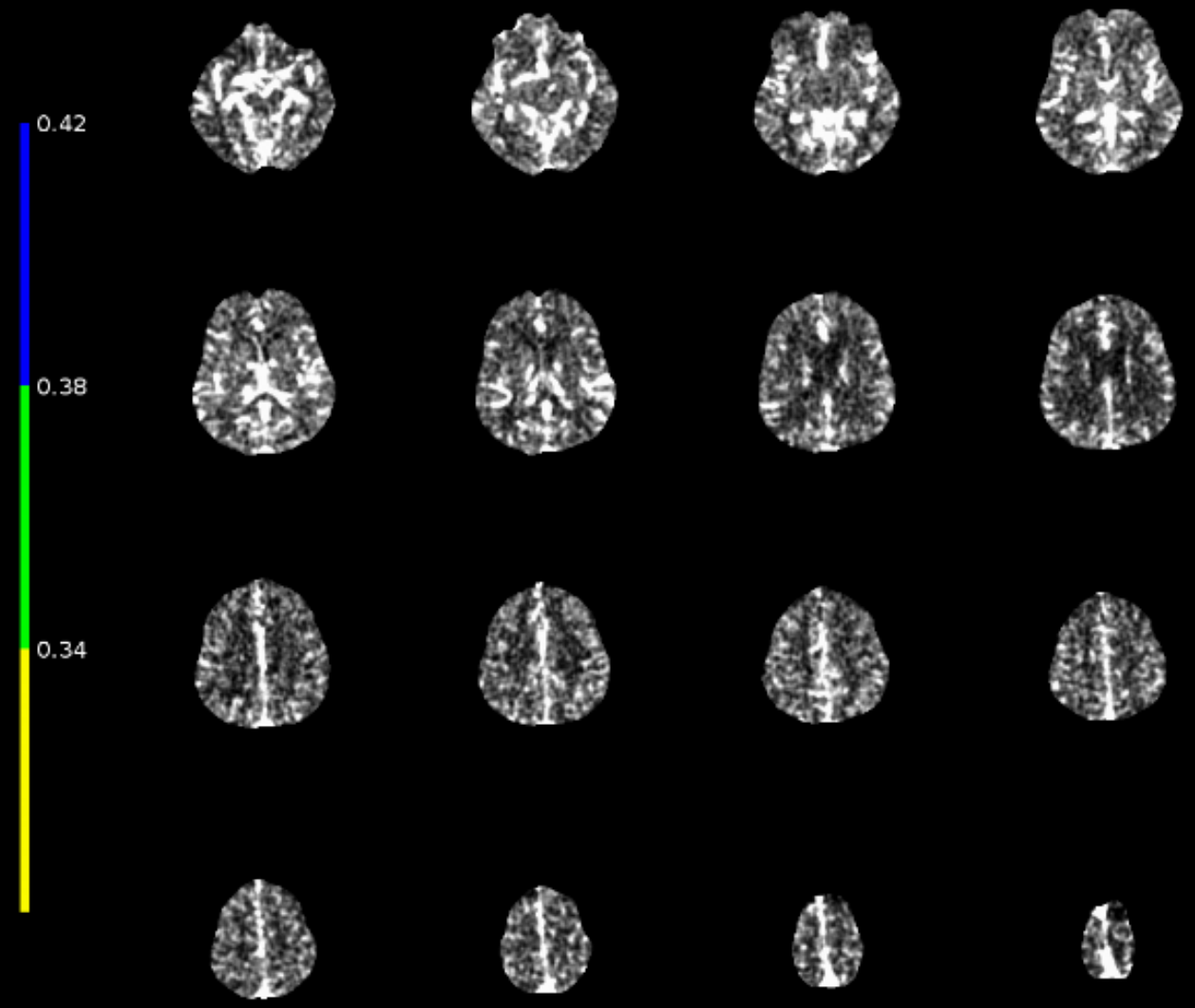
Tmax>10.0s volume: 0 ml
Tmax>8.0s volume: 0 ml
Tmax>6.0s volume: 0 ml
Tmax>4.0s volume: 7 ml
Hypoperfusion Index (Tmax>10s/Tmax>6s): N/A

RAPID



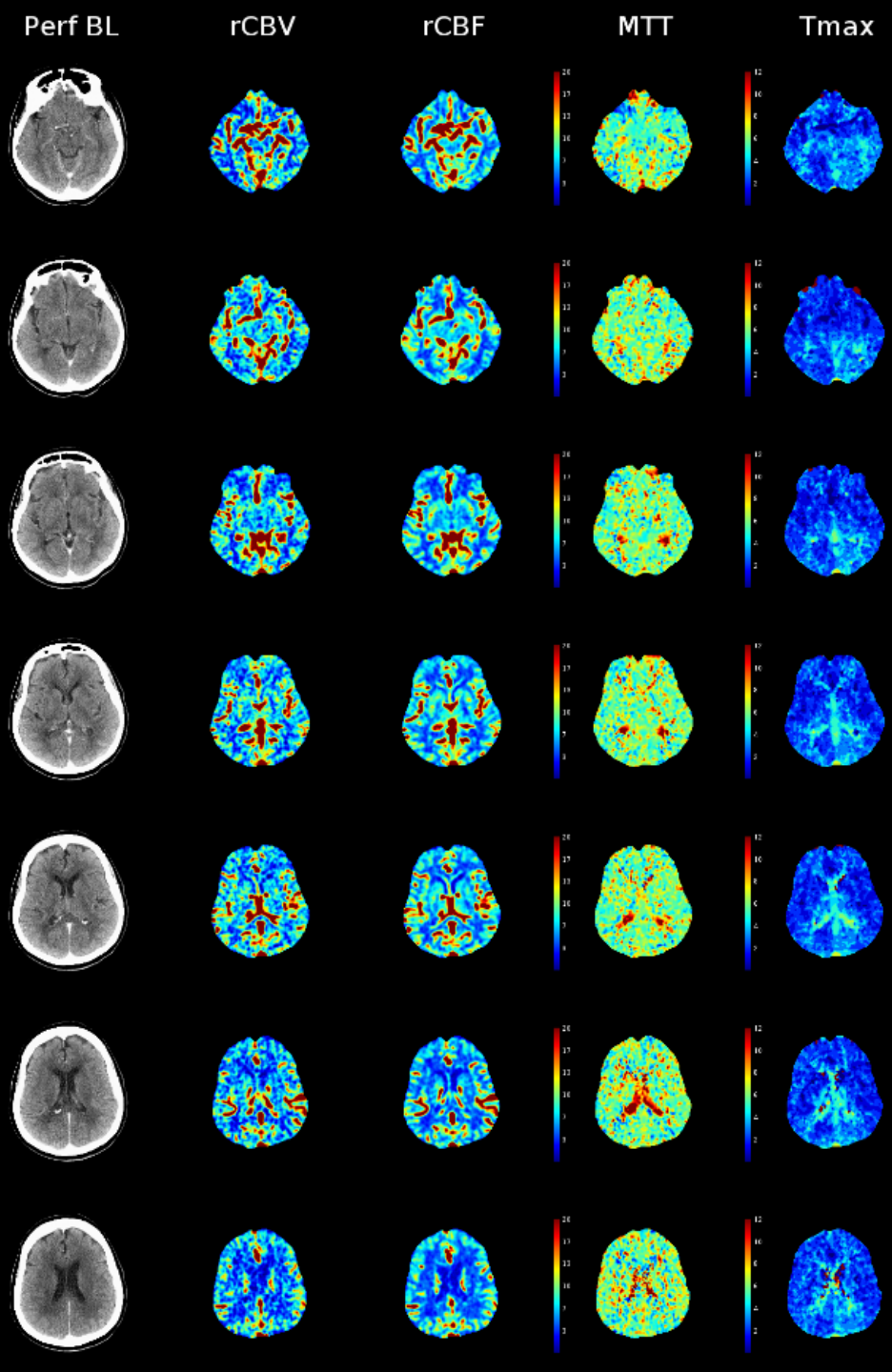
CBF<20% volume: 0 ml
CBF<30% volume: 0 ml
CBF<34% volume: 0 ml
CBF<38% volume: 0 ml

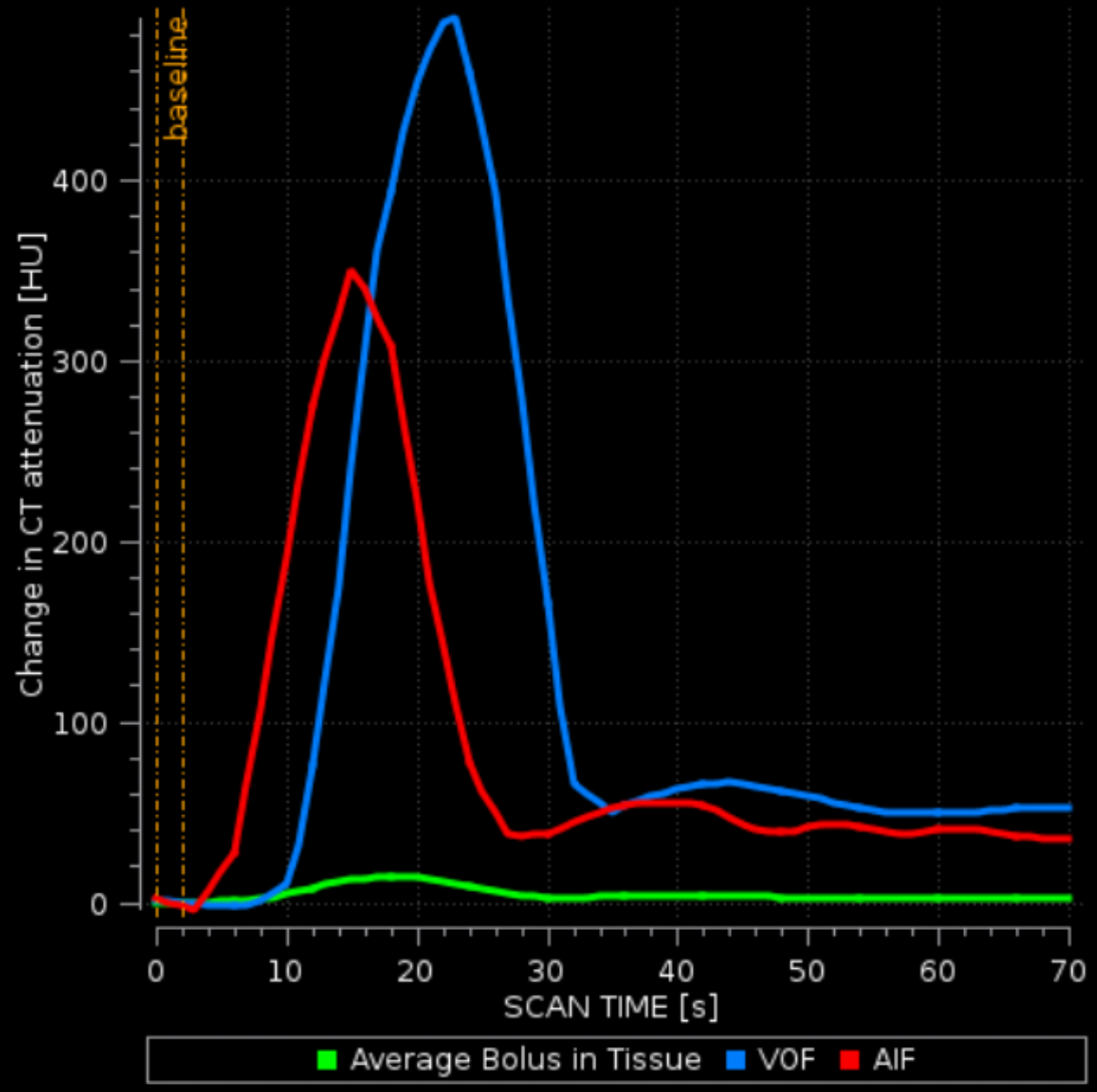
RAPID



CBV<34% volume: 0 ml
CBV<38% volume: 0 ml
CBV<42% volume: 0 ml

RAPID


Perf BL
rCBV
rCBF
MTT
Tmax


baseline
Change in CT attenuation [HU]
400
300
200
100
0
0
10
20
30
40
50
60
70
SCAN TIME [s]
Average Bolus in Tissue
VOF
AIF

RAPID

RADIOLOGIST

What my family thinks I do

What society thinks I do

What the ER intern thinks I do

What the surgeons think I do

What I think I do

What I actually do