EVMT: New Horizons in Acute stroke care

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Ischemic Stroke

• 80% of strokes, ~800k/yr in US
  • Inadequate blood flow to the brain
    • Stenosis or complete occlusion
    • Intracranial or extracranial
  • Common Causes
    • Atrial fibrillation
    • Atherosclerosis
    • Dissection
    • DVT with PFO
  • Embolus to cerebral artery
  • Hypoperfused vascular territory
Time is Brain

- How much time?
- How much brain?
- It’s a complicated question...
  - Within 1 person’s brain, there are differences in sensitivity to ischemia
  - Between different people, the same occlusion can result in different degree of ischemia
Time is Brain

- Cardiac arrest
  - Neurons start to die after 5 MIN
  - But not all at the same time…

- Deep gray is more sensitive than Cortex
- An inherent physiological difference
Time is Brain

- Acute stroke *usually* due to occlusion of 1 vessel
- Anatomical location of embolus affects time window to treat
- Anterior circulation more sensitive than posterior
Time is Brain

• Whether talking about the whole brain or just 1 territory, how do we ever have more than a few minutes to treat?

• Collateral circulation
  • Circle of Willis
  • Pial Collaterals
Circle of Willis

- Anterior communicating
- Ophthalmic
- Middle cerebral
- Posterior cerebral
- Basilar
- Labyrinthine (internal acoustic)
- Posterior inferior cerebellar
- Vertebral
- Anterior spinal
Time is Brain

• Circle of Willis
  • Protects us from occlusion in the neck
  • Variable

• What protects us from occlusion of a cerebral artery? → Pial collaterals
  • Interconnections between vessels of adjacent vascular territories that allow one territory to supply another in a retrograde fashion
  • Highly variable
Vascular Territories

- ACA
- MCA superior division
- MCA inferior division
- MCA deep branches
- PCA deep branches
- Anterior choroidal artery
- Temporal lobe
- Hippocampal formation
- Globus pallidus
- Putamen
- Thalamus
- Caudate
- Lateral ventricle
Time is Brain

• There are multiple layers of complexity.
• Same occlusion can progress at very different rates in different patients
• Can we say anything about a “typical stroke” in an “average patient”?
## Estimated Pace of Neural Circuitry Loss in Typical Large Vessel, Supratentorial Acute Ischemic Stroke

<table>
<thead>
<tr>
<th></th>
<th>Neurons Lost</th>
<th>Synapses Lost</th>
<th>Myelinated Fibers Lost</th>
<th>Accelerated Aging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Stroke</td>
<td>1.2 billion</td>
<td>8.3 trillion</td>
<td>7140 km/4470 miles</td>
<td>36 y</td>
</tr>
<tr>
<td>Per Hour</td>
<td>120 million</td>
<td>830 billion</td>
<td>714 km/447 miles</td>
<td>3.6 y</td>
</tr>
<tr>
<td><strong>Per Minute</strong></td>
<td>1.9 million</td>
<td>14 billion</td>
<td>12 km/7.5 miles</td>
<td><strong>3.1 wk</strong></td>
</tr>
<tr>
<td>Per Second</td>
<td>32,000</td>
<td>230 million</td>
<td>200 meters/218 yards</td>
<td>8.7 h</td>
</tr>
</tbody>
</table>

IV tPA

- Proven benefit at 90 days if IV tPA < 3-4.5 hr
  - NINDS Stroke trial 1995
  - ECASS 3 trial 2008
- Likelihood of good outcome decreases rapidly over time

NNT: 3.6……4.3……..5.9………19.2

Lansberg et al, Stroke 2009; 40:2079-2084
IV tPA

- If IV tPA works, why do we need anything else?

Riedel et al, Stroke 2011; 42:1775-1777
IA Therapy

• PROACT II (1999): IA Prourokinase + IV heparin < 6 hrs
• 1\textsuperscript{st} generation mechanical thrombectomy

Merci

Penumbra
IA therapy

1\textsuperscript{st} Mechanical thrombectomy RCTs
- MR Rescue (2013): Merci, Penumbra
- IMS III (2013): Merci, Penumbra, EKOS, (Solitaire)
- ** No benefit **

TIME IS STILL BRAIN
Every 30 min delay results in 15% decrease in likelihood of a good clinical outcome

Endovascular Therapy

• Everything changed in 2015….

2015 AHA/ASA Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment
IA therapy with Stentrievvers

- Proven benefit *if patients selected appropriately:
  - Large Vessel Occlusion (“LVO”)
  - No large completed infarct
  - Use imaging to select the patients that can benefit from reperfusion
  - EVMT < 6 hr
  - *Risk of SICH 2-3% < IV tPA*
How to Select Candidates?

- Is there an LVO? → CTA
- Is there an ischemic penumbra?
  - ASPECTS score
  - CTP

CBF  CBV  MTT
Current Standard of Care

- Patients eligible for IV r-tPA IV should receive it even if endovascular treatments are being considered
  - These are parallel, simultaneous pathways

Acute Stroke Patient

- IV tPA Time
- Non contrast CT

Treatment

Patient selection

Improved Clinical Outcome

EVMT Angiographic Imaging Time
2015: New Standard of Care

- Patients who *should* undergo thrombectomy:
  - Pre-stroke modified Rankin scale score of 0-1
  - Causative occlusion of the internal carotid artery or proximal middle cerebral artery (M1)
  - National Institutes of Health Stroke Scale NIHSS $\geq 6$
  - Alberta Stroke Program Early CT Score ASPECTS $\geq 6$
  - Groin puncture within 6 hours of symptom onset.
Gray Areas…

• Does NOT mean patients should not undergo thrombectomy if:
  • Pre-stroke modified Rankin scale score > 1
  • Occlusion is of Basilar, M2, ACA, PCA
  • NIHSS < 6
  • ASPECTS < 6
  • > 6 hours of symptom onset (or wake up stroke)
  • *DAWN, DEFUSE3*
DAWN/DEFUSE 3 Trials

• Designed specifically to address late (> 6 hr) presentation or wake up strokes

  • DAWN
    • 6-24 hours from LKW
    • ICA or M1 occlusion
    • Mismatch between clinical deficit and infarct volume (DWI or CTP)

  • DEFUSE 3
    • 6-16 hours from LKW
    • ICA or M1 occlusion
    • Penumbra:Infarct volume > 1.8
    • Infarct volume < 70 cc (approx. 5.5 cm dia)

• BOTH trials showed ~30% higher rate of functional independence with EVMT and NNT < 3
AHA/ASA Guideline

2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke

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

Reviewed for evidence-based integrity and endorsed by the American Association of Neurological Surgeons and Congress of Neurological Surgeons

Endorsed by the Society for Academic Emergency Medicine

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What’s your role? SAVE TIME

• Stroke patients are like Trauma patients
  • Have protocols in place and work as a team
  • Pre-notification → prepare in advance
  • CSC Metric Door to CT result: 45 min
  • IV Access – 18G AC for Labs, IV tPA, CTA/CTP
  • If suspected LVO: CTA/CTP on first trip to CT
    • DO NOT wait for Cr, pregnancy test

• Door in → Door out time
73 M

- Afib
- Acute onset aphasia, R hemiplegia
- NIHSS 11
- IV tPA given at 3.5 hrs
L MCA Occlusion
Direct Aspiration, 1 pass
Outcome

- NIHSS 6 next day
- Small cortical infarct
- D/c home day 3
  - Mild aphasia
  - Outpatient Speech therapy
67 F

- Prior CVA x 2, CAD, HTN, Hyperlipidemia, Smoker, Drinker
- Acute onset expressive aphasia, R facial droop
- NIHSS 4
- Transfer from OSH, no IV TPA, now 5+ hours from onset
L MCA, M2 Occlusion
Stent-retriever, 1 pass
Outcome

- No extension of L MCA infarct
- Also small R side infarcts, but TEE negative
- Symptoms resolved day 2
- D/c home day 4
81 F

- Afib and Aortic valve replacement, off Coumadin
- Acute onset global aphasia and R hemiplegia
- Lives alone and independent at baseline
- NIHSS 15
- IV tPA given at 2 hrs
L MCA occlusion
Good pial collaterals
Local aspiration with stentreiver
Outcome

• Moving R side well day 2
• Speaking well and ambulating day 3
• Rehab day 7
82F

• Afib, DM, HTN
• Acute onset L hemiplegia, confusion
• NIHSS 20
• IV TPA given at 1-1.5 hrs
Carotid occlusion
Direct aspiration, 2 passes
Outcome

- Thrombectomy complete at 3-3.5 hrs post onset
- Patient did not improve overnight
- Acute decompensation the next morning
- Expired on day 3
66M

- H/o prior R MCA infarct
- New onset global aphasia, waxing and waning
- Initial NIHSS 7, partially due to old stroke
- Currently no new symptoms
CTA

L MCA is patent

RICA occluded

LICA stenotic
So what’s going on?

- RICA chronic occlusion
  - Old RMCA infarct
  - Only collateral inflow is across Ophthalmic artery
  - Autoregulatory vasodilation throughout RMCA territory
- LICA stenosis with LMCA infarcts
  - Infarcts likely combination of embolic and watershed
  - Symptoms due to hypoperfusion around LMCA infarcts?
Stent LICA

• Next 24 hrs - additional events
• Angioplasty and stent with minimal residual stenosis
• D/c home on day 6, back to baseline
41 F

• HA
• Dysarthria
• Dysmetria
• Cranial nerve palsy
• R side weakness/paresthesias
• Waxing and waning symptoms
  • NIHSS 0-9
  • To IR > 8 hrs from arrival
Basilar thrombosis
Stent-retriever

- 6 x 20 mm
- 2 passes
- Complete reperfusion
Post thrombectomy
Outcome

• NIHSS 0 next day
• ICU 2 days
• Home 5 days
• Full recovery
Final thoughts

• Neurointervention is now an integral part of Comprehensive Stroke Care
  • Traditionally Neuroradiology Subspecialty
  • Now also Neurology or Neurosurgery
• Traits of a good program
  • Responsiveness – Stroke is an emergency!
  • Teamwork – EVERYONE must know and be committed to perform their role to get a good outcome