UPDATES IN STROKE
Strengthening the Stroke Chain of Survival
November 12, 2015

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Bruce Lo M.D.

Sentara Save The Brain Campaign
Because every moment counts
Disclosures

Nothing to disclose
Sentara Save The Brain Campaign
Because every moment counts

1. Detection + Dispatch
   - Identify first sign of stroke symptoms
   - Call 9-1-1 immediately for emergency medical services (EMS)

2. Delivery
   - Primary stroke center experts triage stroke patient

3. Door
   - Primary stroke center triage stroke patient

4. Data + Decision
   - Safe and timely administration of "clot busting" drugs for ischemic stroke

5. Drug
   - Rapid EMS stroke assessment and treatment while en route to closest primary stroke center

6. Disposition
   - Stroke experts evaluate treatment options based on type of stroke in the emergency department (ED)

- Fast access to catheter based treatment to remove clot and/or admission to the appropriate hospital units with ongoing stroke care

Recovery
Prehospital to the ED
Arrival: EMS vs. Walk-in

- 1 in 3 – Walk-in

- Arrival within 3 hours: OR 2.00
- Head CT within 25 min of arrival: OR 1.89
- tPA within 2 hours of symptoms: OR 1.47

Double tPA rate from prehospital stroke notification

Can Mass Media Influence Emergency Department Visits for Stroke?

Corinne Hodgson, MA, MSc; Patrice Lindsay, RN, PhD Frank Rubini, BA

From CSH Associates (C.H.), Burlington, Ontario, Canada; Institute for Clinical Evaluative Sciences, Canadian Stroke Network (P.L.), Toronto, Ontario, Canada; Heart and Stroke Foundation of Ontario (F.R.), Toronto, Ontario, Canada.

Mass media campaigns

– Increased awareness

Increased visits for stroke
SUDDEN TROUBLE
SEEING, TALKING, WALKING?
CALL 911   SAVE A LIFE
62% of delays related to calling EMS
EMS

Stroke Screen

Time of onset

Medications

Contact of family members

Nearest appropriate hospital
  – Stroke center/capable
  – Ground vs. Aeromedical
Cincinnati Stroke Scale

3 components:
- **F**acial Droop
- **A**rm Drift
- **S**lurred Speech
- **T**ime (onset)
EMS Accuracy for Stroke

Utilize CPSS or LAPSS
- Sensitivity 80% vs 74%

EMS LKN very close to Neurologist
- Not as accurate for wake-up stroke

Stroke. 2014;45:1275-1279
Time to Onset

When did occur?

Witnessed?

Last seen “normal”?  
– Wake-up Stroke
Their Medications
Other Important Medications

Coumadin

Lovenox/Arixtra

Pradax (Dabigatran)

Xaralton/Eliquis/Savaysa
Family Contact

Phone contact information

Family/friend – last witness patient
Prehospital Interventions
Classic Teaching

Blood glucose

IV, $O_2$, Monitor (ACLS)

Hypoxia is BAD

But is more $O_2$ the better?
Physiological Effects of $O_2$

Vasoconstriction to carotid

20-33% decrease cerebral blood flow
– (100% $O_2$ for 10-15 min)
Evidence for (Against) O₂

HBOT – no benefit in acute ischemic stroke

No improvement in functional outcomes

Mortality OR 0.45 (Against O₂)

AHA/ASA guidelines rec AGAINST routine O₂

Stroke. 2013;44(3):870-947
WHERE TO TRANSPORT?
Emergency Department
ED (Stroke Ready)

TJC/DNV Standards

Set protocols

<table>
<thead>
<tr>
<th>Time</th>
<th>Target</th>
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<tbody>
<tr>
<td>Door to MD</td>
<td>10</td>
</tr>
<tr>
<td>Door to CT</td>
<td>25</td>
</tr>
<tr>
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<td>45</td>
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<tr>
<td>Door to Needle</td>
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ED SUSPECTED STROKE/TIA ORDERSET [594]

3/9/10 added SCH lab
12/15/09 IV Therapy changes
11/3/09 added labs for Port Warwick
8/18/09 added POC labs
2/3/09 all sections opened. Added ASA links, prechecked mult orders in mult sections

ED orders for symptoms of stroke or TIA.
ASA ICH Guidelines Stroke 2007
ASA Ischemic Stroke Guidelines Stroke 2007
ASA SAH Guidelines 2009

URL: Q:\Micromedex\PDF\ASA ICH Guidelines Stroke 2007.pdf
URL: Q:\Micromedex\PDF\ASA Ischemic Stroke Guidelines Stroke 2007.pdf
URL: Q:\Micromedex\PDF\ASA SAH Guidelines 2009.pdf
ED – Stroke Alert Process

Nurse
– Triage – Walk-ins
– Charge – EMS

ED Physician Eval
– Neurologist notified
– Radiology and Interventionalist notified

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ED – Stroke Alert Process

Team Approach
- Blood drawn
  • Lab notified
- IV placed

To CT
- CT tech notified

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IS THIS A STROKE?  WHERE IS THE STROKE?  IS THIS A BLEED?

WHERE IS THE STROKE?

I'm the decider, and I decide what is best.

George W. Bush

ARE THERE CONTRAINDICATIONS TO IV TPA?

WHEN DID THE SYMPTOMS BEGIN?
Types of Stroke

Ischemic
– Arterial (80%)
– Venous (2%)

Hemorrhagic
– Intracerebral (9%)
– Subarachnoid (9%)
## Characteristics of an Ischemic Arterial Stroke

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Differential Diagnosis</th>
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<tbody>
<tr>
<td>Sudden onset</td>
<td>Hypoglycemia</td>
</tr>
<tr>
<td>Focal neurological</td>
<td>SDH/EDH</td>
</tr>
<tr>
<td>Negative symptoms</td>
<td>Post Ictal</td>
</tr>
<tr>
<td>Vascular origin</td>
<td>Complicated migraine</td>
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<td></td>
<td>Brain tumor</td>
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<tr>
<td></td>
<td>Psychiatric/malingering</td>
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</tbody>
</table>
Ischemic Stroke Mechanism
Middle cerebral artery
Dominant (Left) MCA

Right hemiparesis: face, arm > leg
Gaze preference to left
Right hemianesthesia
Aphasia
Right homonomous hemianopsia
Non-dominant (Right) MCA

Left hemiparesis: face, arm > leg
Gaze preference to right
Left hemianesthesia
Left hemineglect
Anosagnosia
Left homonomous hemianopsia
Anterior Cerebral Artery
Anterior Cerebral Artery

Hemiparesis: Leg >> Arm/ Face
Hemianesthesia
Contralateral Grasp
Mutism
Abulia
Disinhibition
Posterior Cerebral Artery
Posterior Cerebral Artery

Homonomous hemianopsia
Anton’s Syndrome
Alexia without agraphia
Visual and/or color anomia
Small Vessel (Lacunar) Syndromes

- Pure Motor Stroke
- Pure Sensory Stroke
- Sensorimotor
- Ataxic-hemiparesis
- Dysarthria Clumsy-hand
- Hemichorea/hemiballism
# Exclusionary Criteria for Alteplase in Acute Ischemic Stroke

## Absolute Contraindications

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from onset would be more than 4.5 hours by the time treatment would begin</td>
<td></td>
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</tr>
<tr>
<td>There is evidence of intracranial hemorrhage on CT scan</td>
<td></td>
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</tr>
<tr>
<td>Symptoms suggest subarachnoid hemorrhage even if the initial CT scan is normal</td>
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<tr>
<td>The patient has had arterial puncture at a non-compressible site or a lumbar puncture in the previous 7 days</td>
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</tr>
<tr>
<td>Presence of intracranial conditions that may increase the risk of bleeding (e.g., some neoplasms, arteriovenous malformation, or ruptured aneurysms)</td>
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<tr>
<td>Significant head trauma or prior stroke in previous 3 months</td>
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<tr>
<td>Recent intracranial or intraspinal surgery within 3 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevated blood pressure (systolic &gt;185 mmHg or diastolic &gt;110 mmHg)</td>
<td></td>
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<tr>
<td>Active internal bleeding</td>
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<tr>
<td>Acute bleeding diastasis, including but not limited to:</td>
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<tr>
<td>Platelet count &lt; 100,000/mm³</td>
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<tr>
<td>Heparin received within 48 hours, resulting in abnormally elevated aPTT greater than the upper limit of normal</td>
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<tr>
<td>Current use of anticoagulant or INR &gt;1.7 or PT &gt; 15 sec</td>
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<tr>
<td>Current use of direct thrombin inhibitors or direct factor Xa inhibitors within the past 48 hours (if GCI &lt; 50 ml/min, then a longer time period may be needed)</td>
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<tr>
<td>The patient has received enoxaparin within the past 24 hours</td>
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</tbody>
</table>

## Relative Contraindications

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient has an abnormal blood glucose (&lt; 50 mg/dl)</td>
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<tr>
<td>CT shows a multi-lobar infarction (hypodensity &gt;1/3 cerebral hemisphere)</td>
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<tr>
<td>Age younger than 18</td>
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<td></td>
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<tr>
<td>Only minor or rapidly improving stroke symptoms (clearing spontaneously)</td>
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<td></td>
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<tr>
<td>Pregnancy</td>
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<tr>
<td>Seizure at onset with postictal residual neurological impairments</td>
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<td></td>
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<tr>
<td>Major surgery or serious trauma within previous 14 days</td>
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<tr>
<td>Gastrointestinal or urinary tract hemorrhage within the previous 21 days</td>
<td></td>
<td></td>
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<tr>
<td>Acute myocardial infarction within previous 3 months</td>
<td></td>
<td></td>
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<tr>
<td>History of previous intracranial hemorrhage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unruptured Aneurysm</td>
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## Additional Relative Contraindications between 3-4.5 hours

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient older than 80 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient is taking oral anticoagulant (no matter what the INR is)</td>
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<tr>
<td>Patients has a baseline National Institutes of Health Stroke Scale score of 25 or more</td>
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<tr>
<td>Patients has a history of prior stroke and diabetes</td>
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</table>

For all the above exclusionary criteria, intra-arterial alteplase or mechanical thrombectomy may be an option if a clot can be identified.
Early Management of Acute Ischemic Stroke
Benefits of TPA
How About Endovascular Thrombectomy?
Evolution of Acute Stroke Management

- **1998-99 PROACT I & II**
  - IA tPA benefit

- **2004 IMS I**
  - IV tPA + IA tPA

- **2005 MERCI Device**
  - Mechanical Embolectomy

- **2008 ECASS III**
  - IV tPA 3 - 4.5 hour window

- **2013 IMS III**

- **Dec. 2014 MR CLEAN World Stroke Conference**

- **2015 many trials D/C**
  - Futile to complete! Strong + IA

- **Exciting Times!**

**Pre-1995**
- Supportive care

**1995 NINDS**
- IV tPA 3 hour window
Meta-Analysis

Across all 6 of the prospective randomized controlled trials (IMS-3, MR RESCUE, SYNTHESIS, MR CLEAN, EXTEND-IA and ESCAPE)

- With LVO confirmation pre-randomization, pts who were randomized to IAT had 1.67 times greater odds of better outcome compared to medical therapy ($p=0.0001$)

- With LVO confirmation regardless of pre-randomization, the superiority of IAT persisted: OR 1.27, $p=0.018$)

*Journal of NeuroInterventional Surgery February 2015 Volume 7 Issue 2*
Acute CVA

- LSN <6 hours
  - NIHSS 6 or >
  - Severe Speech deficit
    - CT brain, CTA Head and Neck
    - IV tPA eval
    - Possible INR

- LSN <6 hours
  - NIHSS <6
    - CT Brain-IV tPA eval

- LSN > 6 hours
  - NIHSS 6 or >
  - Severe Speech deficit
    - CT Brain, CTA Head
    - Possible INR
ICA

M2 Emboli

Distal M1

Proximal M1

Carotid “L”

Carotid “T”

How large is “LARGE” VESSEL OCCLUSION?
Large Vessel Strokes

• Poor natural history of large vessel stroke
• High mortality associated with LVO
  – Carotid-T: 53%  Jansen, 1995
  – MCA: 30-35%  Chambers, 1987
Patient Selection Endovascular Stroke Therapy

NIHSS stroke scale ≥6
Or severe speech deficit

CTA/MRA/Angio defined target
i.e.; a clot to retrieve or stenosis to relieve

Viable brain
<70 cc acutely infarcted brain
Considerations for INR Exclusion

**Acute Endovascular Exclusion**

Criteria:
- Advanced dementia
- Metastatic disease with life expectancy < 1 yr
- Low level baseline functional status (e.g., does not independently meet ADLs pre-stroke)
- Advanced systemic disease with Life expectancy < 1 yr (advanced COPD, Cirrhosis, end-stage cardiac disease)

Please note:
- Past history of ICH is NOT an exclusion
- Recent surgery is NOT an exclusion
- Anticoagulation is NOT an exclusion
- Pediatric patients ARE candidates
IV tPA Contraindications

B. Contraindications

- Age < 18
- CT scan findings (intracranial hemorrhage, or major acute infarct signs)
- Suspicion of subarachnoid hemorrhage (even if head CT is negative for hemorrhage)
- Recent (within 3 months) major surgery or trauma (discuss with Attending)
- History of intracranial hemorrhage or brain aneurysm or vascular malformation or brain tumor
  (May consider IV tPA in patients with CNS lesions that have a very low likelihood of hemorrhage, such as small unruptured aneurysms or benign tumors with low vascularity)
- Known bleeding diathesis OR
  - I. Current use of oral anticoagulants with INR > 1.7 or PT > 15 seconds
  - II. Use of heparin within 48 hours preceding onset of stroke AND prolonged aPTT at time of presentation
  - III. Platelets <100,000
  - IV. Internal hemorrhage (GI hemorrhage, urinary tract hemorrhage) < 3 weeks
  - V. Dabigatran use in the past 48 hours (if last dose >48 hours, confirm normal renal function [creatinine clearance >50 mL/min] and normal coagulation [aPTT, INR, platelet count] before tPA administration).
  - VI. Low molecular weight heparin use (i.e. - Lovenox) in the past 24 hours.
- Persistent systolic BP >185 mm Hg or diastolic BP >110 mm Hg despite treatment.
### IV tPA Warnings

**C. Warnings (risks must be weighted against anticipated benefits)**

**Additional warnings for tPA use from 3 to 4.5 hours**

- Age > 80 years
- Any anticoagulant use (even if INR<1.7)
- NIHSS>25
- History of stroke AND diabetes

- MI within last 2 months (with normal TTE)
- Current use of oral anticoagulants with INR > 1.5 or PT > 15 seconds
- Recent stroke (within one month & depending on type & size)
- Minor neurological deficit or rapidly improving symptoms
- High likelihood of left heart thrombus
- Aortic dissection
- Evidence of infarction of > 1/3 of the MCA territory on CT
- Severe neurological deficit (NIH stroke scale score >22)
- Seizure at stroke-onset
- History of IVDA and/or suspicion for endocarditis
- Tox-screen positive for ETOH, cocaine, opiates, or amphetamines (if available, but should not delay tPA protocol)
- Subacute bacterial endocarditis
- Acute pericarditis
- History of hemorrhagic diabetic retinopathy
- Significant hepatic dysfunction with abnormal INR
- Pregnancy
- Sickle cell disease
- Arterial puncture at non-compressible site < 1 week
- Blood sugar < 50 or > 400 mg/dL
Endovascular Stroke Rescue Tools and Techniques
Sentara INR Stroke Universe

SNGH

SBLH  SLH  SAB  CHKD  PNMC  BSMV
SIAIC  SWMC  SCP  OBX  SNGH  CGH  BSDP
SOH  SPAH  SVBGH  SHMH
Radiographic Triage of Possible Candidates

CT Head
- Blood or dead brain

CTA brain and neck
- Large vessel occlusion

+/- CT/MR Perfusion
- Area at risk versus dead brain

MRI/ MRA
- Most accurate assessment of infarct volume
# Time is Brain Quantified

<table>
<thead>
<tr>
<th></th>
<th>Neurons Lost</th>
<th>Synapses Lost</th>
<th>Demyelinated 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>4470 miles</td>
<td>36 Years</td>
</tr>
<tr>
<td>Per Hour</td>
<td>120 Million</td>
<td>830 Billion</td>
<td>447 Miles</td>
<td>3.6 Years</td>
</tr>
<tr>
<td>Per Minute</td>
<td>1.9 Million</td>
<td>14 Billion</td>
<td>7.5 Miles</td>
<td>3.1 Weeks</td>
</tr>
<tr>
<td>Per Second</td>
<td>32,0000</td>
<td>230 Million</td>
<td>.125 Miles</td>
<td>∞</td>
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What Next?

MAC/ General anesthesia
   – Airway protection
   – Paralytics
   – Blood pressure control

Rapid assembly of INR team to prepare room, equipment and patient
   – Angio techs
   – Angio RN
GOAL:
Table to clot access = 30 minutes!
Tools of the trade....
THROMBOLYTICS = CLOT BUSTERS

IA-tPA
Penumbra Suction Thrombectomy

= Wet Vac
Stent Retriever
= “Chinese finger trap”
Putting the tools to use....
PATIENT OVERVIEW

- 75 y/o with DM and HTN with left hemiparesis, left neglect and left facial droop, awakened with symptoms, last seen normal, previous night 11PM.
- CT head: hyperdense M1 segment, early changes infarct right basal ganglia
- CTA: Pseudoocclusion post bulbar RICA with embolic occlusion M1 segment RMCA
- NIHSS 14
- 135 minutes from presentation to SCP ER to SNG interventional neuroangio suite and intubation
- Not a candidate for IV-tPA

PROCEDURAL DESCRIPTION

- Single deployment and retrieval of TREVO ProVue Stent Retriever during flow arrest and manual suction
- 9 cm of fragmented clot in stent and in the aspirate
- Full revascularization TICI 3 RMCA distribution
- Total Procedural time from arterial puncture to revascularization **33 Minutes!**

CASE CONCLUSION

- Day one: NIHSS 6

- Neurointerventionalists: - Dr. Karah Lanier and Dr. John Agola
  - Neurologist SCP Dr. Maria Guina
  - ED SCP Dr. Jason Garrison
  - ED SNG Dr. Moss Mendelson
  - Air transfer to SNG: Life Evac of VA (Contact Beverly Harris)
Solitaire FR Revascularization

78 y/o with right hemiparesis, right facial droop and aphasia
Stuttering course in ER, recurred 3 hours later after admission to ICU at OSH
NIHSS 14
No change s/p IV tPA
3.5 hours from symptom onset to complete revascularization

30 minutes from arterial access to TICI 3 Solitaire revascularization

NIHSS 5 on D/C with OP rehab (mostly speech deficit)
65 y/o with progressive motor deficit, vision changes and nausea. Required emergent intubation for airway protection

**Time of onset = 20 hours earlier!**
48 Hours Post Intervention
Immediate post embolectomy, on arrival to NICU
Full Revascularization and clot removal of MCA Stroke in Afib Patient
Norfolk General Hospital

PATIENT OVERVIEW
- Patient underwent Afib Ablation at Sentara Heart hospital 48 hours prior
- Alert of stroke occurred at 7:45 am
- Patient was sent to Interventional Lab at 8:30 am
- Groin puncture at 8:41 am
- Full clot retrieval and TICI 3 revascularization at 9:15

PROCEDURAL DESCRIPTION
- Merci Balloon Guide Catheter was used for flow arrest and aspiration
- Trevo ProVue was deployed in MCA
- Full Clot retrieval and full revascularization
- Total procedure time to revasc: 34 minutes...Time to complete revasc from symptom alert: 1 hr 30 min
- TICI 3 revascularization was observed

CASE CONCLUSION
- NIHSS 1
- Neuro Interventionalists: Dr. John Agola and Dr. Karah Lanier
- Special thanks to Sentara Heart Hospital for quick response

600 Gresham Dr.
Norfolk, VA
23507
What can go wrong?

Anything and everything!

- Access complications femoral artery
- Vessel perforation
- Dissection
- Inability to remove clot
- Distal emboli
- ICH due to revascularization of infarcted brain
- Medical issues: Cardiac/respiratory
TIME IS BRAIN!

Average neuron loss during untreated large vessel ischemia is 1.9 million neurons/minute. That equals approx 3.6 years of accelerated brain age for every hour of sustained ischemia. For every 30 minute delay there is a 10% decrease in favorable outcome.
Conclusions

Early revascularization optimizes outcome
  – Door to groin puncture goal 60 minutes
  – Level 1, Class A evidence that rapid embolectomy is superior to IV tPA alone for patients with LVO

Our INR Protocol (Unchanged since 2009!)
  – Immediate frontline INR consult for all stroke alerts
  – NCCT head & CTA for appropriate pt with sufficient deficit
  – Rapid transfer to SNGH ED for endovascular intervention when being considered for intervention
“Team of Teams” required for expedient and successful revascularization!
QUESTIONS?

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Bruce Lo: brucelo1@yahoo.com