38 yo M L Hemiparesis
38 yo M L Hemiparesis
38 yo M L Hemiparesis
38 yo M L Hemiparesis
38 yo M s/p IA Thrombolysis
Acute Ischemic Stroke

- Stroke basics
- Stroke imaging: evidence based
- Stroke imaging algorithm for therapy
- Time versus Physiology
Ischemic Infarction Types

Major
- Severe Sxs
- Large Art. Occl
- Large Infarct
- Poor outcome

Minor
- Mild Sxs
- No L. Art. Occl
- Small Infarct
- Good outcome

Lacunar
- ~35%
- ~45%
- ~20%
Stroke

• ~700,000 cases/year in US
• 3rd Leading cause of death
• Leading cause of severe disability
• Yearly costs > $55 billion
Goal of Treatment

Major
- Severe Sxs
- Large Art. Occl
- Large Infarct
- Poor outcome

Minor
- Mild Sxs
- No L. Art. Occl
- Small Infarct
- Good outcome

Lacunar

150,000-200,000 Patients/yr
Collateral Flow

Penumbra

Core
Occlusion
CTA/MRA

Core
NCCT
Diffusion MRI
Perfusion MR/CT

Penumbra
Perfusion MR/CT

Core+Penumbra
Neurological Exam

Penumbra
Core
Acute Ischemic Stroke

- Stroke basics
- Stroke imaging: evidence based
- Stroke imaging algorithm for therapy
- Time versus Physiology
## Consensus Conference

### Presentation of Evidence

<table>
<thead>
<tr>
<th>NCCT</th>
<th>Pomerantz</th>
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<tbody>
<tr>
<td>CTA</td>
<td>Gonzalez</td>
</tr>
<tr>
<td>DWI</td>
<td>Schaefer</td>
</tr>
<tr>
<td>CTP</td>
<td>Lev</td>
</tr>
<tr>
<td>PWI</td>
<td>Copen</td>
</tr>
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<td>Perfusion Issues</td>
<td>Hunter</td>
</tr>
<tr>
<td>Stroke Therapy</td>
<td>Yoo</td>
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### Review Panel

Gupta, Rapalino, Romero, Larvie, Chen, Ackerman, Fellows
<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
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<tbody>
<tr>
<td>Class I</td>
<td>Conditions for which there is evidence for and/or general agreement that a procedure or treatment is beneficial, useful, and effective</td>
</tr>
<tr>
<td>Class II</td>
<td>Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment</td>
</tr>
<tr>
<td>Class IIa</td>
<td>Weight of evidence/opinion is in favor of usefulness/efficacy</td>
</tr>
<tr>
<td>Class IIb</td>
<td>Usefulness/efficacy is less well established by evidence/opinion</td>
</tr>
<tr>
<td>Class III</td>
<td>Conditions for which there is evidence and/or general agreement that a procedure/treatment is not useful/effective and in some cases may be harmful</td>
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</table>
Core+Penumbra
Neurological Exam
Class I
Penumbra
Core

Occlusion CTA
Core
Penumbra
BASIS
Boston Acute Stroke Imaging Scale

Screening Technology and Outcome Project in Stroke (STOPStroke) Study

N = 645 stroke patients
MGH and UCSF
All underwent CTA/CTP
Admission NIHSS
6 month mRS
101 received IV tPA
Screening Technology and Outcome Project in Stroke (STOPStroke) Study

N = 645 stroke patients

CTA did not hinder management:
>15% received IV tPA

Admission NIHSS & BASIS:
Independent Predictors of Outcomes
Patient Outcomes by Classification

Figure 2

- NIHSS≤10 & BASIS-
- NIHSS>10 or BASIS +
- NIHSS>10 & BASIS +
Core+Penumbra
Neurological Exam
Class I
Penumbra

Occlusion
CTA
Class I
Core
NCCT
DWI
CTP
Penumbra
Evidence-based guideline: The role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke

Report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology
Evidence Based Guideline

Diffusion MRI:
Class I Level of Evidence A

Schellinger et al. Neurology 2010;
75(2):177-185
Prediction of clinical outcome

- DWI best predictor of final infarct volume

- DWI > 70 cc’s is specific for poor outcome
  - Sanak et al, Neuroradiology 2006
  - Yoo et al. Stroke 2010; 41:1728-35
Acute Infarct Volume Threshold

DWI volume vs Dichotomized outcome

72 cm$^3$

Good Outcome (mRS 0-2) Poor Outcome (mRS 3-6)
Core+Penumbra

Neurological Exam

Class I

Penumbra

Core

Occlusion

CTA Class I

Core NCCT Class I

DWI Class I

CTP

Penumbra
<table>
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<tr>
<th></th>
<th>CBV</th>
<th>CBF</th>
<th>MTT</th>
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</thead>
<tbody>
<tr>
<td>Underperfused, Alive</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Underperfused, Dead</td>
<td>↑↓</td>
<td>↓</td>
<td>↑↓</td>
</tr>
</tbody>
</table>
Examples of ROI Placements

**DWI**
- 6x6 pixel placed in center of DWI lesion

**PWI**
- 6x6 pixel placed in contralateral location
CBV in Center of Diffusion Abnormality

Time (Hours)

rCBV

0 1 2 3 4

0 1 2 3 4

0 1 2 3 4 5 6 7 8 9 10
Core+Penumbra
Neurological Exam
Class I
Penumbra

Core
Penumbra

Occlusion
CTA
Class I

Core
NCCT
Class I

Core
DWI
Class I

Core
CTP
Class IIb
Acute Ischemic Stroke

- Stroke basics
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Acute Ischemic Stroke
Recommended Imaging Algorithm

NCCT

CTA

MR Capable?

Yes

No

ICA/MCA/Basilar Occlusion + Small DWI?

Yes

IA Rx

No IA Rx

CTP

MR Capable?

Yes

No

DWI

MRP
MRI-Based Selection for Intra-Arterial Stroke Therapy

Value of Pretreatment Diffusion-Weighted Imaging Lesion Volume in Selecting Patients With Acute Stroke Who Will Benefit From Early Recanalization

Albert J. Yoo, MD; Luis A. Verduzco, BS; Pamela W. Schaefer, MD; Joshua A. Hirsch, MD; James D. Rabinov, MD; R. Gilberto González, MD, PhD

Stroke 2009; 40:2046-54
Clinical Outcome by DWI & Time to Recanalization by IAT

Clinical Outcome

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Good</th>
<th>Number of Poor</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early RC</td>
<td>64%</td>
<td></td>
<td>&lt;0.008</td>
</tr>
<tr>
<td>Late RC</td>
<td>17%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Futile DWI</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

"Futile DWI": initial DWI volume > 70 cm³

Acute Ischemic Stroke

- Stroke basics
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Physiology based management

Time based management
CONCLUSIONS:
The typical patient loses 1.9 million neurons each minute in which stroke is not treated.

Key Words: brain ischemia ■ imaging techniques ■ neurons ■ physiopathology

A. Average Neuronal Loss

![Graph showing average neuronal loss over hours](image-url)
Time after Ictus & DWI

1.4 hr
Acute Ischemic Stroke

• Stroke basics
• Stroke imaging: evidence based
• Stroke imaging algorithm for therapy
• Time versus Physiology
Acknowledgements

James Thrall, MD

• Neuroradiology
  – Schaefer, Lev, many others

• Interventional Neuroradiology
  – Yoo, Hirsch, many others

• Martinos/MGH NMR Center
  – Rosen, Brady, Sorenson, many others

• Neurology
  – Koroshetz, Schwamm, Singhal, many others