1. Stroke Syndromes

2. Brain Attack!

BRAIN ATTACK!

- Stroke is a brain attack
- Organ affected is the brain and NOT the heart
- Stroke is an emergency
- "Time is brain"
3. Impact of acute ischemic stroke

**Impact of acute ischemic stroke**

- Leading cause of serious, long-term disability
- >50% of neurological hospitalizations
- 3rd leading cause of death
- In the USA, a stroke occurs every 53 seconds
- ~600,000 strokes/year
- ~1/3 of survivors are partially dependent
- ~29% die within 1 year (higher if >65y)
- In 1995, $3.7 billion paid by Medicare

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4. Estimated prevalence of stroke by age and sex

**Estimated prevalence of stroke by age and sex**

![Graph showing prevalence by age and sex](image)

Source: AHA 1999 Heart and Stroke Statistical Update

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5. Modifiable and non-modifiable risk factors

6. Symptoms of stroke

Symptoms of stroke

- Sudden blurred or decreased vision in one or both eyes
- Numbness, weakness, or paralysis of the face or in an arm or leg occurring on one or both sides of the body
- Difficulty speaking or understanding
- Sudden dizziness or loss of balance
- Headache (usually severe and abrupt onset) or unexplained change in the pattern of headache
7. Stroke Syndrome: Slide 7

Arteries at the Base of the Brain

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8. Branches of the middle cerebral artery

Branches of the middle cerebral artery

Image removed due to copyright.
9. Vascular territories - Coronal section

Image removed due to copyright.

10. Vascular territories - Medulla

Image removed due to copyright.
11. Stroke Subtypes

12. Four types of intracranial hemorrhage

Image removed due to copyright.
13. Intracerebral hemorrhage: Causes

Intracerebral hemorrhage:
Causes
- Hypertension
- Hypertension
- Hypertension
- Congophilic ("amyloid") angiopathy
- Hemorrhagic masses (tumor, AVM, etc)
- Hemorrhagic transformation of infarct

14. Hypertensive ICH: Locations

Hypertensive ICH: Locations

Graph showing the distribution of locations for hypertensive ICH:
- Putamen: 55%
- Cerebellum: 10%
- Pons: 10%
- Thalamus: 10%
- Lobar: 15%

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15. Intracerebral hemorrhage: Symptoms/Signs

Intracerebral hemorrhage:
Symptoms/Signs
- May have sudden onset with smooth progression of deficit
- Focal deficits
- Headache
- Nausea/vomiting
- Decreased level of consciousness

16. Lobar hemorrhage

Lobar hemorrhage

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17. Putamenal hemorrhage

18. Intracerebral hemorrhage: Treatment

- No specific therapy has been shown to be useful with the exception of posterior fossa decompression for cerebellar hemorrhage
- BP management
- Supportive
Aneurysms

- 2mm - 2-3cm
- 90% on the circle of Willis
- Peak incidence 35-65y

Cerebral aneurysms: Symptoms

- Asymptomatic
- Mass effect
  - eg IIIrd nerve palsy
- Rupture
21. Stroke Syndrome: Slide 21

3rd nerve proximity to the PCoMA

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22. Subarachnoid hemorrhage: Symptoms

Subarachnoid hemorrhage: Symptoms

- Sudden onset headache
- Stiff neck
- Photophobia
- Nausea/vomiting
- Transient loss of consciousness

Does NOT need to be “the worst headache of my life”
23. Subarachnoid hemorrhage: Signs

**Subarachnoid hemorrhage: Signs**

- **Meningismus**
  - Stiff neck
  - Pain with eye movement
  - Photophobia
- **Subhyloid hemorrhages in fundus**
- **Focal signs are rare**

24. Subarachnoid hemorrhage: Diagnosis

**Subarachnoid hemorrhage: Diagnosis**

- **History**
  - ~50% have “sentinal bleed”
- **CT scan (~90% sensitive)**
- **Lumbar puncture shows red blood cells and xanthochromia**
- **Angiography (MRA, CTA, conventional)**
25. Subarachnoid hemorrhage

Image removed due to copyright.

26. Subarachnoid hemorrhage

Image removed due to copyright.
Hunt and Hess Classification of subarachnoid hemorrhage

Grade 1: Asymptomatic, mild headache, slight nuchal rigidity
Grade 2: Moderate to severe headache, nuchal rigidity, no neurologic deficit other than cranial nerve palsy
Grade 3: Drowsiness/confusion, mild focal neurologic deficit
Grade 4: Stupor, moderate-severe hemiparesis
Grade 5: Coma, decerebrate posturing

Subarachnoid hemorrhage: Major concerns

- Rebleeding (~20% in 2 wks)
- Vasospasm (peaks day 3-14)
- Seizure (rare but preventable)
- Increased intracranial pressure
29. Subarachnoid hemorrhage: Management

**Subarachnoid hemorrhage:**
**Management**

- Bedrest with sedation
- BP tightrope
- Surgical clipping as soon as possible
- Prophylactic anticonvulsant
- Nimodipine
- “Triple H” - hypertension (pressors), hypervolemia (colloids), and hemodilution (Hct ~33)

30. Arteriovenous malformation (AVM)

**Arteriovenous malformation (AVM)**

A tangle of abnormal vessels which form an aberrant communication between arterial and venous systems

Abnormally thinned walled vessels
31. Arteriovenous malformation (AVM): Symptoms

**Arteriovenous malformation (AVM): Symptoms**

- Subarachnoid hemorrhage
- Intraparenchymal hemorrhage
- Seizures
- Headaches

**Signs**

- Any focal deficit
- Cranial bruits

32. Arteriovenous malformation (AVM)

**Arteriovenous malformation (AVM)**

Images removed due to copyright.
33. Arteriovenous malformation (AVM): Treatment

**Arteriovenous malformation (AVM): Treatment**

Obliteration of malformation by:
- Surgical excision
- Endovascular thrombosis
- Radiation - including Gamma knife

34. Stroke Subtypes

**Stroke Subtypes**

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35. Stroke: Definition

**Stroke: Definition**

“Sudden onset neurological deficit in a vascular territory”

36. Stroke defined by pace

**Stroke defined by pace**

- TIA - <24 hours
- RIND
- Completed stroke
- Stroke in progression

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37. What is the underlying mechanism?

"Stroke is an observation not a diagnosis"

38. Common mechanisms of cerebral ischemia

- "Small vessel disease" - lipohyalinosis
- Embolism
  - Artery-to-artery (carotid, aorta, other)
  - Cardiac source
  - Paradoxical
- Decreased perfusion through a fixed stenosis
39. **Etiology of ischemic stroke**

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**Etiology of ischemic stroke**

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40. **Small vessel disease**

---

**“Small vessel disease”**

- Associated with hypertension, diabetes, cholesterol
- “Lacune” ≠ small volume or small deficit

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41. Stroke Syndrome: Slide 42

**Intimal thickening**

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42. Major lacunar syndromes (C. Miller Fisher)

**Major lacunar syndromes**

*(C. Miller Fisher)*

- Pure motor stroke
- Pure sensory stroke
- Sensorimotor stroke
- Ataxic hemiparesis
- Clumsy hand - dysarthria
43. Lacunar stroke (0.2-15mm³)

Lacunar stroke
(0.2-15mm³)

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44. Other causes of cerebral ischemia

Other causes of cerebral ischemia
- Vasculitis
- Collagen vascular diseases: isolated angitis of the CNS, temporal (giant cell) arteritis, polyarteritis nodosa, Wegener's granulomatosis, Takayasu's arteritis, syphilis
- Meningitis: tuberculosis, fungi, syphilis, bacteria, herpes zoster
- Arterial dissection: carotid, vertebral, basilar intracranial arteries
- Hematologic disorders: polycythemia, thrombocytosis, thrombotic thrombocytopenic purpura, disseminated intravascular coagulation, dysproteinemias, hemoglobinopathies (sickle cell disease)
- Miscellaneous: cocaine, amphetamines, moyamoya disease, fibromuscular dysplasia, CADASIL
- Hypercoaguable states: secondary to systemic disease, carcinoma (especially pancreatic), eclampsia, oral contraceptives, lupus, Factor C or S deficiency, Factor V mutation, etc.
- Vasospasm: following subarachnoid hemorrhage
- Reversible cerebral vasoconstriction: idiopathic, migraine, eclampsia, trauma
- Various: Dehydration, pericranial infection, postpartum and postoperative states, systemic cancer

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45. Ms I.C.

Ms I.C.

- 46 y/o LH F with recent tooth abscess, on antibiotics, presented with L-face and arm weakness, dysarthria
- Still had tooth pain in R-upper teeth
- No vascular risk factors or family history of stroke

46. Carotid dissection

Carotid dissection

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47. Mimics of cerebral ischemia

**Mimics of cerebral ischemia**

- Migraine
- Seizure
- Subdural hematoma
- Tumor
- Syncope
- Cardiac arrhythmia
- Panic attack
- Hypoglycemia
- Demyelinating disease
- Amyloid angiopathy
- Brain abscess
- Encephalitis

48. Risk for stroke after transient ischemic attack (TIA)

**Risk for stroke after transient ischemic attack (TIA)**

- 4% to 8% in first month
- 12% to 13% in first year
- 24% to 29% in five years
49. Unstable angina of the brain

“Unstable angina of the brain”

TIA = “Treat Ischemia Aggressively”

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50. Transcranial ultrasound
51. Baseline: Conventional T2 vs. Diffusion

```
Baseline: Conventional T2 vs. Diffusion

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52. 24 Hours: Conventional T2 vs. Diffusion

```
24 Hours: Conventional T2 vs. Diffusion

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53. Diffusion/Perfusion mismatch

Diffusion/Perfusion mismatch

73-year-old 3 with L-HP.
A. 6 hours after the onset of symptoms.
B. 6 hours: larger area of hypoperfusion on the rCBF map
C. Infarct growth at 27 hours
D. 1 week

54. Diffusion/Perfusion match

Diffusion/Perfusion match

71-year-old 9 with L-HP
A. 15 hours after the onset of symptoms.
B. 15 hours a matching area of hypoperfusion.
C. No significant growth is seen in the infarct at 39 hours
D. 1 week. Note the hemorrhagic transformation at 1 week (dark regions representing the breakdown products of hemoglobin).
55. Conventional angiography

Conventional angiography

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56. Carotid angiogram
Internal carotid artery stenosis

Carotid angiogram
Internal carotid artery stenosis

Image removed due to copyright.
57. Carotid artery disease

Carotid artery disease

Image removed due to copyright.

58. Carotid artery stenosis: Treatment

Carotid artery stenosis: Treatment

Asymptomatic
Asymptomatic and progressing
Asymptomatic and severe
Symptomatic and

Medical management
Consider surgery
Consider surgery
Surgery
Consider surgery
Medical management

Medical management = risk factor control, antiplatelet agent, and HMG-CoA reductase inhibitor (?)
59. Proximal aortic atherosclerosis

Proximal aortic atherosclerosis

- Amereneco (1992) - Autopsy series
  Ulcerated aortic plaque seen in:
  - Non-stroke neurological disease 5%
  - Stroke of known cause 20%
  - Cryptogenic stroke 58%

- French study (1996) - Transesophageal echo
  Stroke recurrence at 48 months
  - Plaque thickness ≥4mm 40%
  - Plaque thickness 1-3.9mm 9%
  - Plaque thickness <1mm 8%

60. Cardiac conditions associated with cerebral embolism

Cardiac conditions associated with cerebral embolism

- High risk (>1%/year)
  - Atrial myxoma
  - Infective endocarditis
  - Dilated cardiomyopathy
  - Atrial fibrillation
  - Anterior MI with thrombus
  - Ventricular aneurysm
  - Prosthetic cardiac valves
  - Nonbacterial thrombotic endocarditis
61. Cardiac conditions associated with cerebral embolism

Cardiac conditions associated with cerebral embolism

- Low risk (<1%/year)
  - Mitral valve prolapse
  - Lone AF
  - Inferior MI
  - Bioprosthetic aortic valve
- Unclear risk
  - Patent foramen ovale
  - Atrial septal aneurysm
  - Left atrial spontaneous echo contrast ("smoke")

62. Investigations for hypercoagulable states

Investigations for hypercoagulable states

- Protein S
- Protein C
- Antithrombin III
- Factor V Leiden (= activated protein C resistance)
- Antiphospholipid antibodies
  - Lupus anticoagulant
  - Anticardiolipin antibody
  - Antiphosphatidylserine antibody
- Prothrombin gene mutation (A → G)
- Antiphosphatidylserine antibodies
63. Progression of ischemic stroke

Progression of ischemic stroke
The “ischemic penumbra”

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64. Strategies for acute stroke treatment

Strategies for acute stroke treatment

- Revascularization
  - “Plumbing approach”
- Preventing damage from ischemic cascade
  - “Neuroprotection”

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The Plumbing Approach

National Institute of Neurological Diseases and Stroke (NINDS) t-PA trial

- First major trial to demonstrate the efficacy of ANY treatment for acute stroke
- Patients with stroke treated within 3 hours of symptom onset had a ~30% better chance of recovery without symptoms.
67. NINDS t-PA Trial

NINDS t-PA Trial:
1 year follow-up NEJM 1999 (340): 1781

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68. Symptomatic hemorrhages

Symptomatic hemorrhages
• Cases 1 and 2 are placebo
• 4 ICHs outside of distribution of stroke: 4, 9, 16, 17
  = 1.3% of all t-PA patients

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69. NINDS t-PA Trial

NINDS t-PA Trial:
1 year follow-up *NEJM* 1999 (340): 1781
- Benefit of t-PA therapy was across all ischemic stroke subtypes
- For every 100 patients treated 11 will have a better outcome

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70. Neuroprotection

Neuroprotection

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71. Cerebral response to declining blood flow

72. Stroke Syndrome: Slide 73

Pathogenesis of ischemic stroke
73. Neuroprotectant mechanisms and some tested compounds

### Neuroprotectant mechanisms and some tested compounds

<table>
<thead>
<tr>
<th>NMDA antagonists</th>
<th>GABA agonists</th>
<th>Membrane stabilizers</th>
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<tr>
<td>Dextrophin</td>
<td>Clomethiazole</td>
<td>Citicolino</td>
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<td>Seltoxel (CGS 19755)</td>
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<td>Cerestat (aptiganel)</td>
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<td>Magnesium</td>
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<th>Ischemic injury cascade inhibitors</th>
<th>Inhibitors of leukocyte adhesion</th>
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74. Timing, timing, timing

### Timing, timing, timing

How often do patients with stroke arrive at the hospital early enough for treatment and what factors contribute to early arrival?

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75. Immediate management of patients with suspected stroke

Immediate management of patients with suspected stroke

- Neuroimaging
- Keep head of bed flat
- Do not treat hypertension
- Hydrate with isotonic fluids
- Cardiac monitor

76. Immediate management of patient with suspected stroke

Immediate management of patient with suspected stroke

- ABCs
- CBC
- ESR
- BUN/creatinine
- Electrolytes
- INR
- Lipid profile
- ECG
- CXR

CONSIDER
R/O MI
Lumbar puncture
Hypercoagulable studies
RPR
Sickling tests
ANA
ANCA

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77. **Short-term complications**

**Short-term complications**

- Non-neurological
  - MI
  - Arrhythmia
  - Pneumonia
  - DVT/PE

- Neurological
  - Edema/herniation
  - Recurrence
  - Hemorrhagic transformation
  - Seizure

---

78. **Prevention of DVT**

**Prevention of DVT**

- Heparin 5000u s/c bid
- TED stockings
- Intermittent compression boots ("pneumoboots")
- Mobilization
79. The Magic Hour

The Magic Hour: “Door to …”

60 minutes

- 10 Emergency MD
- 15 Stroke Neurologist
- 25 CT started
- 15 CT interpreted
- 10 tPA started

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80. Time: Traditional vs. Emerging Views

Time:
Traditional vs. Emerging Views

Traditional | Y2K View
---|---
**View** | **View**
Patient | Wait and see if symptoms disappear | Stroke is a “Brain Attack” – Call 911
Pre-hospital | Low-priority transport | High priority transport
Acute | Wait and watch | Stroke Codes, protocols, and clinical pathways

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81. Brain Attack!

**BRAIN ATTACK!**

- Stroke is a brain attack
- Organ affected is the brain and NOT the heart
- Stroke is an emergency
- “Time is brain”

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