STROKE

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STROKE

• Stroke is the 5th leading cause of death in the U.S., and a leading cause of physical disability

• The brain is very metabolically active - neurons communicate electro-chemically – which takes a huge amount of “energy”

• The brain has no way to store either glucose or oxygen – so neurons must have a constant supply of blood; within minutes of being deprived of oxygen, neurons will start to undergo potentially irreversible changes, ultimately leading to their death – lose neurons – lose function!
BLOOD SUPPLY TO THE CNS

• The entire blood supply to the brain and spinal cord is via
  – Two carotid arteries
  – Two vertebral arteries

• The carotid and vertebral systems join on the underside of the brain to form a “circle” called the Circle of Willis (in the subarachnoid space); branches of the carotid and vertebral arteries will provide the blood supply to different areas of the brain
Different areas of the brain are supplied by specific arteries and branches of arteries
TYPES OF STROKES

• A stroke is a “brain attack” brought about by an acute impairment of CNS blood supply (similar to a “heart attack”)

• Strokes can be
  – Hemorrhagic: a vessel bleeds; about 10-15% of strokes
  
  – Ischemic: a vessel is occluded (either from something that has traveled in the blood from somewhere else in the body or brain [embolic ischemic stroke], or local occlusion [thrombotic ischemic stroke]); 85% of strokes
HEMORRHAGIC AND ISCHEMIC (EMBOLIC & THROMBOTIC) STROKE

<table>
<thead>
<tr>
<th>Thrombotic Stroke</th>
<th>Embolic Stroke</th>
<th>Cerebral Hemorrhage</th>
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<tbody>
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<td>Blood clot (thrombus) blocks flow of blood in brain.</td>
<td>Fatty plaque or blood clot (embolism) breaks away and flows to brain where it blocks an artery.</td>
<td>Break in blood vessel (aneurysm) in brain.</td>
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<tr>
<td>Area deprived of blood</td>
<td>Area deprived of blood</td>
<td>Area of bleeding</td>
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SIGN/SYMPTOMS SEEN IN STROKE

• *In general*, strokes have a rapid onset; except in rare instances, strokes occur unilaterally (on one side)

• The *specific* signs/symptoms seen in the patient will depend on what arteries are involved — because different arteries and their branches supply different areas of the brain

• A single major artery can supply many different *functional areas of the brain* — *individual* signs/symptoms for a specific function may be *ipsilateral* or *contralateral*
HEMORRHAGIC STROKE

Risk Factors

• **Weakened blood vessels** – *for whatever reason*
  
  – Hypertension (high blood pressure), atherosclerosis, obesity, diabetes, and other systemic and chronic disorders, through a variety of mechanisms, weaken the blood vessel wall making it susceptible to rupture (hemorrhagic stroke); *note that these conditions, in addition to coronary artery disease, are also risk factors for ischemic stroke*

  – Hemorrhagic stroke can also occur from the rupture of an aneurysm, which represents a weakened blood vessel wall which balloons out; aneurysms may bleed or rupture (spontaneously or following trauma) to produce *subarachnoid hemorrhage* (hemorrhage between the arachnoid and pia meninges)
An **aneurysm** is a weakened area of a blood vessel.

The **most common** site for an aneurysm is at arterial junctions in the Circle of Willis.
SUBARACHNOID HEMORRHAGE

EPIDURAL SPACE
  • DURA

SUBDURAL SPACE
  • ARACHNOID

SUBARACHNOID SPACE
  • PIA

THE CIRCLE OF WILLIS LIES IN THE SUBARACHNOID SPACE, which also contains CEREBROSPINAL FLUID (CSF)

A RUPTURE OF AN ANEURYSM CAUSES THE CSF, WHICH IS NORMALLY CLEAR AND COLORLESS, TO TURN PINK OR RED
ANEURYSM/SUBARACHNOID HEMORRHAGE

Clinical Triad: sudden onset of a severe headache (often with exertion), stiffness of the neck (nuchal rigidity), and decreased level of consciousness

On CT or MRI, the distribution of blood will show a distinctive pattern (“crab of death”)

An aneurysm may leak for some time before rupture (producing a very bad headache); if identified in time, there are a number of interventional ways that the aneurysm can be prevented from rupturing or repaired
ISCHEMIC STROKE

• Occlusion of a vessel can result in anoxia (without oxygen) and infarction (tissue death resulting from loss or insufficiency of blood supply) of the brain tissue supplied by that artery

• Sudden onset; loss/change of function depending on the artery involved – and the areas supplied by that artery or branches

• Stroke may “progress” over the first 24 hrs. (the area surrounding the actual stroke site is at continued risk – this area is called the penumbra); if identified early, there are a number of interventions that can save this surrounding tissue from infarction

• TRANSIENT ISCHEMIC ATTACK (TIA; sometimes called a “mini” stroke) is an acute, transient neurological episode which is caused by ischemia (function can return almost immediately [~30 mins], or at least by 24 hrs. TIAs significantly increase risk for a major stroke!}


CLINICAL EXAMPLES WILL BE OF THROMBOTIC ISCHEMIC STROKE WHERE BLOOD FLOW THROUGH AN ARTERY IS OCCLUDED

The vast majority of ischemic strokes are thrombotic strokes – which there is local occlusion of a vessel that interferes with blood flow.
HOW PHYSICIANS DIAGNOSE A STROKE

• They know what arteries and their branches supply specific areas of the brain

• They know the functional anatomy of the brain

• The constellation of signs/symptoms will inform them about what specific arteries/branches have been involved; the sudden onset of signs/symptoms makes stroke likely
A 42 yo African-American male (Mr. J. L.) was brought to the hospital after collapsing in the street. After regaining consciousness, a neurological exam revealed the following:

- Spastic paralysis of the right upper limb and trunk
- Loss of fine touch, vibration and conscious proprioception of the right upper limb and trunk
- Pain & temperature were only crudely perceived in the right upper limb and trunk
- The patient could wrinkle his forehead, but the lower right side of his face was paralyzed
- Both eyes deviated to the left
- He could understand what was said to him, but he had difficulty speaking language fluently
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- Pain & temperature were only crudely perceived in the right upper limb and trunk (indicates lesion is above the diencephalon)
- The patient could wrinkle his forehead, but the lower right side of his face was paralyzed
- Both eyes deviated to the left (a “cortical” sign)
- He could understand what was said to him, but he had difficulty speaking language fluently (a “cortical” sign)
CONCEPTS RELEVANT TO UNDERSTANDING THE CLINICAL CASE

CORTEX: Outer 1-4 mm layer of neurons on the outside of the hemisphere; involved in “Higher-order” functions
**CLINICAL CASE I**

**Area 4:** Motor cortex; contralateral spastic paralysis or weakness; contralateral lower facial paralysis

**Areas 3, 1 & 2:** Somatosensory cortex; contralateral loss of fine touch, vibration and conscious proprioception; also contralateral loss of ability to precisely localize pain

**Area 8:** Unilateral lesion will cause both eyes to deviate to the side of the lesion

**Areas 44 & 45:** Broca’s aphasia – ability to understand, but not be able to speak language fluently
CLINICAL CORRELATION: ISCHEMIC STROKE OF THE MIDDLE CEREBRAL ARTERY

The Middle Cerebral Artery (MCA) is a branch of the Internal Carotid Artery; it supplies most of the lateral surface of hemisphere, and a small portion of the medial hemisphere.

ALL OF THE S/S IN MR. L ARE CONSISTENT WITH A STROKE INVOLVING UPPER BRANCHES OF THE MIDDLE CEREBRAL ARTERY ON THE LEFT
Wallenberg’s, PICA (posterior inferior cerebellar artery – a branch of the vertebral artery), or lateral medullary syndrome

- Vertigo, nausea, vomiting
- Ipsilateral ataxia (incoordination)
- Difficulty speaking, breathing, and swallowing; ipsilateral loss of gag reflex
- Ipsilateral loss of pain and temperature in the face, and contralateral loss of pain and temperature in the body
- Other
Wallenberg’s, PICA (posterior inferior cerebellar artery – a branch of the vertebral artery), or lateral medullary syndrome

- Vertigo, nausea, vomiting (vestibular nuclei)
- Ipsilateral ataxia (inferior cerebellar peduncle)
- Difficulty speaking, breathing, and swallowing; ipsilateral loss of gag reflex (nucleus ambiguus)
- Ipsilateral loss of pain and temperature in the face, and contralateral loss of pain and temperature in the body (pain pathway for the body which has already crossed; pain pathway for the face which has not yet crossed)
- Other
STROKE

• Stroke is the 5\textsuperscript{TH} leading cause of death in the U.S., and a leading cause of physical disability

• Within minutes of being deprived of oxygen, neurons will start to undergo potentially irreversible changes, ultimately leading to their death – lose neurons – lose function

• Interventions after stroke include dissolving blockage, surgical repair, determination of underlying risk factors to prevent future stroke, physical therapy, etc.

• Remember, brain has limited capacity to repair itself – so better to prevent strokes from ever occurring!
PROTECT YOUR BRAIN FROM STROKE: eat a healthy diet, keep blood pressure and blood sugar regulated, maintain a healthy weight, etc. and EXERCISE!

NOTIFY YOUR PHYSICIAN IMMEDIATELY if you experience a sudden loss of any function, like vision, or if you experience numbness, tingling, etc. EVEN IF IT SEEMS TO GO AWAY!

The American Academy of Neurology: “TIME LOST IS BRAIN LOST”