Brain is only ~2% of your body weight but gets 15%-20% of cardiac output. It needs that constant supply of oxygen & energy to maintain neuron functioning.

Blood Supply to the Brain (see 7.2)
- 2 Internal carotid arteries on either side of the neck
- 2 Vertebral arteries on either side of the spinal column, join to form a single basilar artery on anterior surface of brainstem
- All interconnected at the “circle of Willis”

Internal Carotid Arteries

Vertebral Arteries

Circle of Willis

Major Cerebral Arteries (see 7.4)
Dural Sinuses (see 7.8)

Jugular Veins

Stroke or Cerebrovascular Accident (CVA)
- Death or damage of some portion of the CNS due to disruption of normal blood supply to that area
- Area of damaged/dead cells is called the infarct.
- 500,000/year in US

2 Main Varieties
- Ischemic stroke - obstruction of artery deprives the tissue beyond that point of its supply of oxygen & energy ("ischemia" refers to a localized decrease in blood supply)
- Hemorrhagic stroke - vessel ruptures causing both intracerebral bleeding & failure to supply blood to tissues beyond that point
- [Link](http://www.youtube.com/watch?v=6h7Frkj96yM&feature=related)

- Embolus moves until it reaches vessel too small to pass through- then it lodges there and tissue beyond that point suffers ischemia (blue area)
Suffering an Embolism (32% of CVAs)

- Common sources of emboli
  - Heart problems (atrial fibrillation, enlarged heart, heart valve problems, damage due to heart attack)
  - Traveling bit of atheroma (fatty deposits in arteries) or thrombus

- Formation of yellow plaque in artery narrows channel and promotes formation of clot, which then blocks blood flow to tissue beyond that point (blue area)

Fatty Plaques in Vessels

- May form in a small blood vessel causing ischemia in just a small region of the brain ("lacunar stroke")
- May form in major arteries

Cerebral Thrombosis (51%)

Unhealthy blood vessels promote formation of a clot

Thrombosis = process of a clot forming
Thrombus = the clot

Fatty material deposited in vessel wall
Lumen becomes blocked by a blood clot

Fatty Plaques in Vessels

- May form in a small blood vessel causing ischemia in just a small region of the brain ("lacunar stroke")
- May form in major arteries

Carotid Stenosis (narrowing)

- Treated by surgically removing the build-up (carotid endarterectomy)
- An alternative approach is to widen blood vessel channel using balloon angioplasty, but the long-term effectiveness of this approach is not clear.
- If blockage <50% may just use anti-clotting medication

Merci Retriever

Treatments

- “Clot-busters” like tissue plasminogen activator (tPA) or urokinase to break up a new clot
- Clot retrievers
- Medications to control brain swelling
- Anticoagulants to decrease risk of future clots
- Neuroprotective drugs under investigation to control neurotransmitter and metabolic aftereffects of stroke to decrease cell loss
  - Glutamate NMDA receptor blockers

Other Stroke Terms

- Transient ischemic attack (TIA)- short-term disruption of blood supply to region with reversal of symptoms within minutes to 24 hrs
- Reversible neurological deficit (RIND) – neural symptoms disappear within 48 hrs
- Stroke in progress or in evolution - increasing symptoms of stroke over time. If stroke is caught early the progression of brain damage may be halted.
- Multi-infarct or vascular dementia

Tiny dark spots or “pock marks” are multiple little infarcts.
Intracerebral Hemorrhage (ICH) or Hemorrhagic Stroke

- Most often due to the rupturing of a small blood vessel (e.g. the penetrating arteries supplying basal ganglia, thalamus, pons, or cerebellum)
- Major risk factor: hypertension
- Others: smoking, alcohol or stimulant abuse, or use of anticoagulants.
- Accounts for 10-15% of strokes; often lethal

Subarachnoid Hemorrhage

- Although SA bleeding may follow head injury, “primary SAH” is usually due to the rupture of an aneurysm or AVM
  - Symptoms: sudden severe headache, nausea & vomiting, fainting, signs of meningeal irritation like stiff neck & photophobia, possible seizure, LOC
- CT scan or spinal tap to show blood
- Possible aftereffects- rebleeding, hydrocephalus, ischemia from vasospasm

Circle of Willis

Berry Aneurysm
Circle of Willis Aneurysm

Subarachnoid Hemorrhage (7%)

Clipping an Aneurysm

A New Treatment

• Insert platinum coil into aneurysm to obstruct blood from entering

Arteriovenous Malformation

• Congenital malformation where arteries connect directly to veins in a little “nest” of vessels. These malformations may rupture.

http://www.medicalvideos.us/play.php?vid=932
### Warning Signs

- Sudden weakness or paralysis or numbness of lower face, arm, leg on one side
- Sudden difficulty speaking
- Sudden visual problems (blurring, loss, double)
- Sudden severe headache
- Unexplained dizziness, unsteadiness, falls – especially with 1 of above signs

### Common Treatable Risk Factors

- Hypertension (high blood pressure)
- Cigarette smoking; alcohol abuse
- Hyperlipidemia (high fats & cholesterol)
- Heart disease; atrial fibrillation
- Diabetes

### Impairments Caused by Stroke

- Depend on particular blood vessel affected and the site and extent of brain damage
  - Large vessel strokes (e.g. one of the cerebral arteries) affect multiple areas
  - Small vessel or lacunar strokes more limited – may even go un-noticed until you have several. Most often subcortical (basal ganglia, thalamus, internal capsule)

### Patterns of Stroke Deficits

- MCA – Contralateral motor & sensory problems of upper body, aphasia (L), neglect (R)
- ACA – Prefrontal symptoms, incontinence, motor & sensory problems in opposite leg
- PCA- Cortical blindness; visual agnosias
- Basilar – brainstem symptoms: nystagmus, vertigo, eye control probs, dysphagia, dysarthria, ataxia, possible locked-in syndrome
Coma & Related States

- Coma – total unconsciousness (eyes closed, can’t be aroused, no response to pain)
- Persistant vegetative state – eye opening and periodic wakefulness, eye movements, grimaces, grasping/groping, withdrawal from pain, but no real conscious awareness
  
  https://www.youtube.com/watch?v=Pl1IPTpHUHs&feature=related
- Minimally conscious state - inconsistent but clearly discernible behavioral evidence of consciousness (responds to command, reaches for something, nods for Y, verbalizes, approp. emotions, visual pursuit)
- Locked-in syndrome – has consciousness but almost complete paralysis due to brainstem damage
  
  http://www.youtube.com/watch?v=t4Ek4ZBpshs
  http://abclocal.go.com/kabc/video?id=7137306
  http://current.com/1rcucud4

Neurological Rehabilitation or Neurorehabilitation

- Re-training the brain-damaged individual to rebuild strength, coordination, and cognitive-behavioral functioning and teaching compensatory strategies to achieve the greatest recovery and independent functioning as possible.
- Such rehabilitation involves physical and occupational therapists & other rehab professionals & increasingly, neuroscientists.