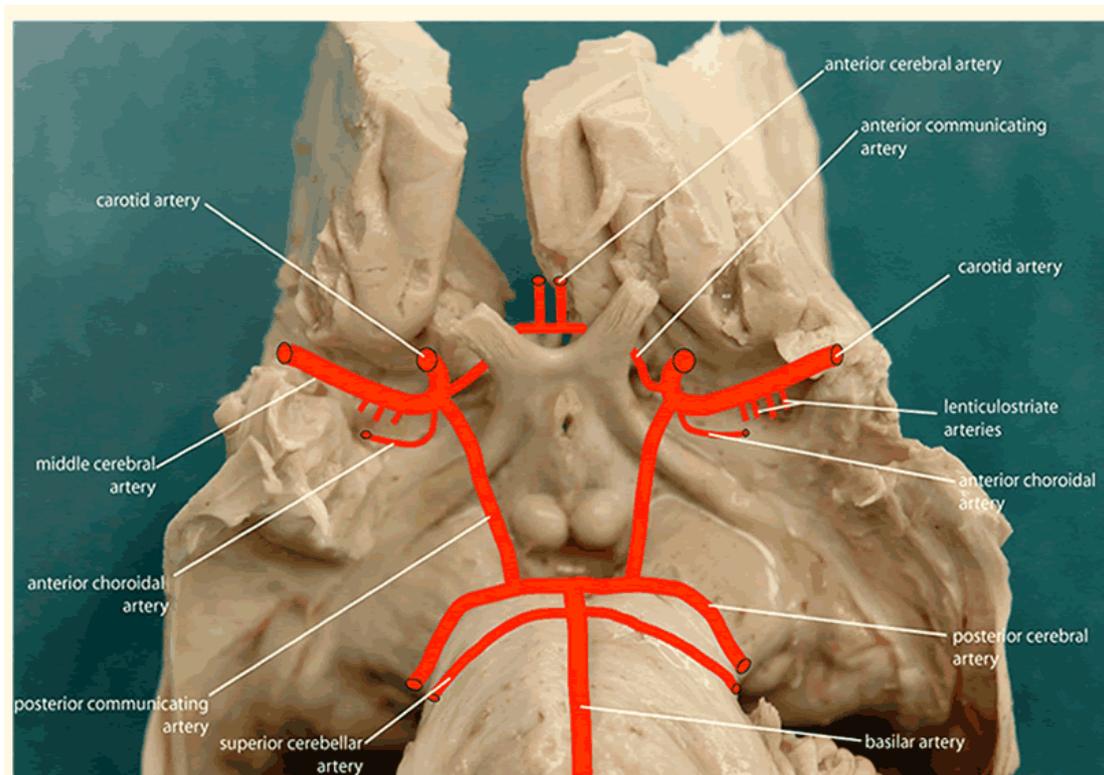


Clinically Relevant Anatomy

At the base of the brain, the carotid and vertebrobasilar arteries form a circle of communicating arteries known as the Circle of Willis. From this circle, other arteries—the anterior cerebral artery (ACA), the middle cerebral artery (MCA) and posterior cerebral artery (PCA)—arise and travel to all parts of the brain.



Mechanism of Injury /Pathological Process

What is a stroke - <https://www.youtube.com/watch?v=uLJewzJcCZ0>

A stroke occurs when there is interruption of the blood supply to a particular area of the brain, ultimately leading to cell injury and cell death.

Strokes can be classified as either:

- Ischaemic
- Haemorrhagic

Ischaemic strokes are the most common, accounting for up to 80% of strokes, and occur when there is an occlusion of a blood vessel impairing the flow of blood to the brain.

Ischaemic strokes are divided into:

1. thrombotic - where a blood clot forms in a main brain artery or within the small blood vessels deep inside the brain. The clot usually forms around atherosclerotic plaques.
2. embolic - a blood clot, air bubble or fat globule forms within a blood vessel

elsewhere in the body and is carried to the brain.

3. systemic hypoperfusion - a general decrease in blood supply, eg. in shock.
4. venous thrombosis

Haemorrhagic strokes occur when a blood vessel in the brain ruptures and bleeds.

1. Intracerebral haemorrhagic stroke — there is bleeding from a blood vessel within the brain. High blood pressure is the main cause of intracerebral haemorrhagic stroke.
2. Subarachnoid haemorrhagic stroke — there is bleeding from a blood vessel between the surface of the brain and the arachnoid tissues that cover the brain.

Nb. Some experts do not classify subarachnoid haemorrhage as stroke because subarachnoid haemorrhages present differently from ischaemic strokes and intracerebral haemorrhagic strokes.

Epidemiology/Etiology

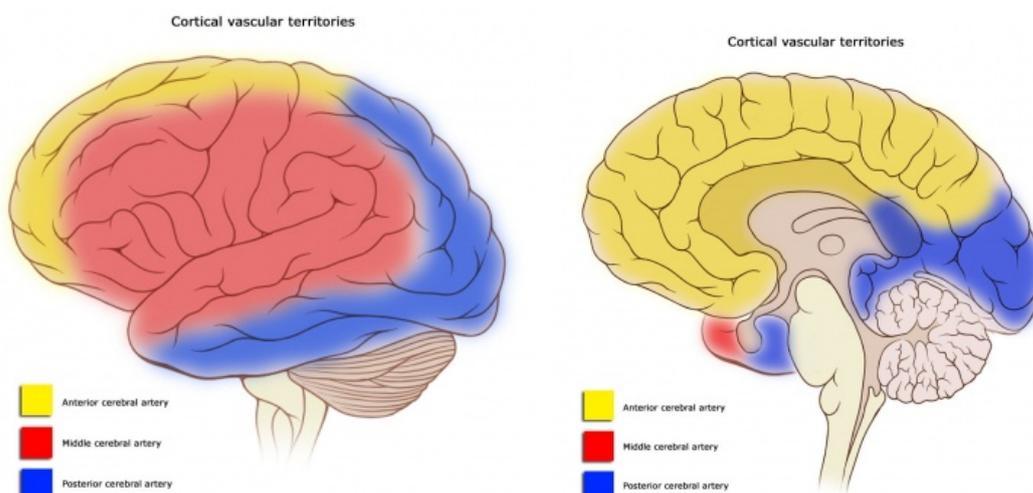
According to the World Health Organization (WHO), 15 million people suffer stroke worldwide each year. Of these, 5 million die and another 5 million are left permanently disabled.[2]

Stroke subtypes vary greatly in different parts of the world and between different races. For example, the proportion of haemorrhagic strokes may be higher in certain populations, such as the Chinese population, in which it has been reported to be up to 39.4%, and the Japanese, in which it is reportedly up to 38.7%.[3]

Stroke kills more than 49,000 people each year in the UK, nearly 1 in 10. In 2010 stroke was the fourth largest cause of death in the UK after cancer, heart disease and respiratory disease.[4]

Clinical Presentation

Cortical Areas and their vascular supply:



Location of Infarct and deficits

Left MCA Superficial Division

Right face and arm upper-motor weakness due to damage to motor cortex, nonfluent (Broca's) aphasia due to damage to Broca's area. There may also be right face and arm cortical type sensory loss if the infarct involves the sensory cortex. Other deficits include a fluent (Wernicke's) aphasia due to damage to Wernicke's area. [Aphasia: a disturbance of the comprehension and expression of language]

Right MCA Superficial Division

Left face and arm upper-motor weakness due to damage to motor cortex. Left hemineglect (variable) due to damage to non-dominant association areas. There may also be left face and arm cortical type sensory loss if the infarct involves the sensory cortex.

Left MCA Lenticulostriate Branches

Right pure upper-motor hemiparesis due to damage to the basal ganglia (globus pallidus and striatum) and the genu of the internal capsule on the left side. Larger infarcts extending to the cortex may produce cortical deficits such as aphasia.

Right MCA Lenticulostriate Branches

Left pure upper-motor hemiparesis due to damage to the basal ganglia (globus pallidus and striatum) and the genu of the internal capsule on the right side. Larger infarcts extending to the cortex may produce cortical deficits such as aphasia.

Left PCA

Right homonymous hemianopia due to damage to left visual cortex in the occipital lobe. Extension to the the corpus collusom interferes with communication between the two visual association areas so can cause alexia without agraphia. Larger infarcts involving the internal capsule and thalamus may cause right hemisensory loss and right hemiparesis due to disruption of the ascending and descending information passing through these structures. [Hemianopia: visual loss in half of the visual field]

Right PCA

Left homonymous hemianopia due to damage to right visual cortex in the occipital lobe. Larger infarcts involving the internal capsule and thalamus may cause left hemisensory loss and left hemiparesis due to disruption of the ascending and descending information passing through these structures.

Left ACA

Right leg upper-motor neuron weakness due to damage to motor cortex and right leg cortical sensory loss due to damage to sensory cortex. Grasp reflex, frontal

lobe behavioral abnormalities, and transcortical aphasia can also be seen if the prefrontal cortex and supplemental motor areas are involved.

Right ACA

Left leg upper-motor neuron weakness due to damage to motor cortex and left leg cortical type sensory loss due to damage to sensory cortex. Grasp reflex, frontal lobe behavioural abnormalities and left hemineglect can also be seen if the prefrontal cortex and non-dominant association cortex are involved.

Effects of stroke (MCA) - <https://www.youtube.com/watch?v=6sk7AXNw9Ns>

Effects of stroke (PCA) - <https://www.youtube.com/watch?v=OFIL9Dm8qCM>

Effects of stroke (ACA) - <https://www.youtube.com/watch?v=NSWnNnfDt70>

Outcome Measures

[NIH Stroke Scale](#)

[Dynamic Gait Index](#), the [4-item Dynamic Gait Index](#), and the [Functional Gait Assessment](#) show sufficient validity, responsiveness, and reliability for assessment of walking function in patients with stroke undergoing rehabilitation, but the Functional Gait Assessment is recommended for its psychometric properties^[8].

[Chedoke-McMaster Stroke Assessment](#)

[Chedoke Arm and Hand Activity Inventory](#)

Take a look at our [Stroke Outcome Measures Overview](#) for more information

Management / Interventions

Early management of acute stroke: The goal for the acute management of patients with stroke is to stabilize the patient and to complete initial evaluation and assessment, including imaging and laboratory studies, within a short time frame. Critical decisions focus on the need for intubation, blood pressure control, and determination of risk/benefit for thrombolytic intervention.[9]

Patients presenting with Glasgow Coma Scale scores of 8 or less or rapidly decreasing Glasgow Coma Scale scores, require emergent airway control via intubation.

Physiotherapy

Physiotherapists should be involved early, and should make their own assessment of how much they can work with a patient. Early mobilisation is associated with better outcomes - even after taking account of the potential confounding influence of disease severity. If rehabilitation is to take place on a different ward

from acute care, the care received should be made as seamless as possible. Type and intensity of therapy should be determined by the patient's needs not location.[10]

Primary goals of rehabilitation:

1. Prevent complications
2. Minimise impairments
3. Maximise function

Optimising post stroke rehabilitation:

1. early assessment with standardised evaluations and validated assessment tools
2. early employment of evidence based interventions relevant to individual patient needs
3. patient access to an experienced multidisciplinary rehabilitation team
4. ongoing medical management of risk factors and co-morbidities

Upper Limb

Upper limb impairments:

- subluxation
- changes in sensation
- contracture
- swelling
- co-ordination problems
- weakness
- altered muscle power
- changes in muscle tone
- hand dysfunction

Aims of treatment:

- Prevent shoulder pain and if unable to do so, manage shoulder pain effectively.
- Be selective when choosing compensatory versus remedial intervention methods to treat clients who are predicted to have a low return of motor function and poor functional use of their arm and hand.
- Provide remedially focused rehabilitation to clients who are predicted to change in arm and hand function.
- Use measures of known reliability and evidence of validity for treatment planning and outcome prediction.

In the upper extremity with severe impairment and/or poor prognosis for recovery (Chedoke McMaster Stroke Assessment (CMSA) of Arm and Hand <stage 4) treatment should focus on maintaining a comfortable, pain-free, mobile arm and hand[11][12].

- Focus on proper positioning to provide support at rest and careful handling during functional activities
- Participate in classes supervised by professional rehabilitation clinicians in institutional or community setting that teach the client and caregiver to perform self range of motion exercises.
- Avoid use of overhead pulleys (risk of shoulder tissue injury)
- Use some means of external support for stage 1 or 2 upper limb during transfers and mobility
- Place arm and hand in a variety of positions that include placement within the client's visual field
- Use some means of external support to protect the upper limb during wheelchair use

In the upper extremity with moderate impairments who show high motivation and potential for functional motor gains (CMSA => stage 4)[11][12]

- Engage in repetitive and intense use of novel tasks that challenge the stroke survivor to acquire necessary motor skills to use the involved upper limb during functional tasks and activities
- Engage in motor-learning training including the use of imagery.

Treatment techniques:

- **Strength Training** - There is evidence that strength training can improve upper-limb strength and function without increasing tone or pain in individuals with stroke[13][14].
- **Orthotics** - therapy incorporating a dynamic wrist-hand orthosis may be no better than manual therapy[15]. Long term use of static orthoses requires complimentary appropriate treatment opportunities to prevent clenched fist, problems with ADL and hygiene maintenance[16]
- **Gaming** - goal orientated computer gaming has proven to significantly reduce upper limb impairment in stroke survivors[17][18]
- **Virtual Reality** - virtual reality training has been shown to be effective in restoring upper limb motor impairments and motor related functional abilities[19][20]
- **Mirror Therapy** - Mirror therapy has been shown to have a beneficial effect on motor control and function compared with conventional therapy[21][22][23]
- **Robot-Assisted Therapy** - has been shown to have a beneficial effect on motor recovery and function[24][25][26]

Clinical Guidelines

Overall Management:

- [National clinical guideline for stroke](#), Royal College of Physicians Intercollegiate Stroke Working Party, 2012.
- [Canadian Best Practice Recommendations for Stroke Care](#). Heart and Stroke Foundation and the Canadian Stroke Network, Ottawa, Ontario Canada, 2013 (see also 2010 Canadian Best Practice Recommendations for Stroke Care).

- [Stroke Management. National Stroke Foundation, Australia, 2010.](#)
- [Guidelines from the American Heart Association/American Stroke Association](#)

Acute Care

- [Stroke: Diagnosis and initial management of acute stroke and transient ischaemic attack.](#) NICE Guidelines, 2008.

Rehabilitation

- [Stroke rehabilitation: Long-term rehabilitation after stroke.](#) NICE Guidelines, 2014.
- [Clinical Guidelines for Stroke Management A quick guide for physiotherapy.](#) National Stroke Foundation, Australia, 2010.
- [Clinical Practice Guideline for Physical Therapy in patients with stroke.](#) Royal Dutch Society for Physical Therapy (KNGF), 2014.
- [Canadian Best Practice Recommendations for Stroke Care: Stroke Rehabilitation.](#) Heart and Stroke Foundation and the Canadian Stroke Network, Ottawa, Ontario Canada, 2013.

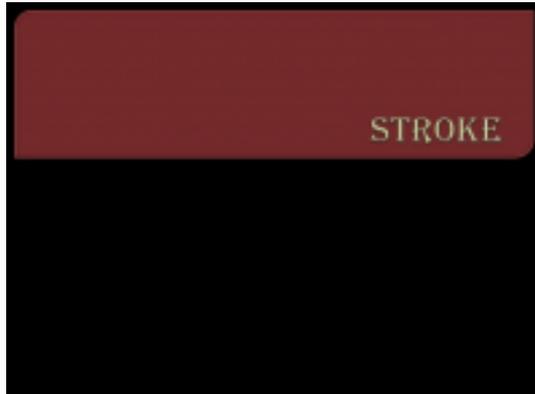
Differential Diagnosis

- Hypoglycemia and hyperglycemia need to be identified and treated early in the evaluation. Not only can both produce symptoms that mimic ischemic stroke, but they can also aggravate ongoing neuronal ischaemia.
- Hemiplegic Migraine

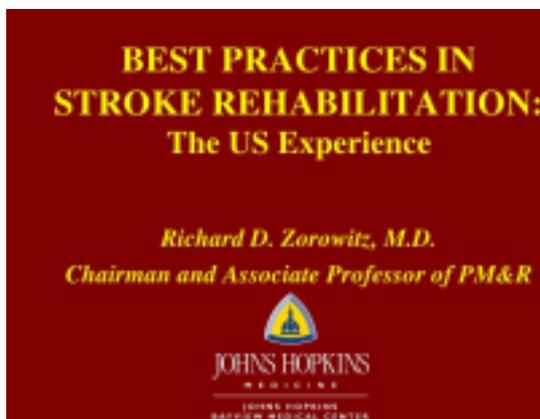
Resources

- [Stroke Scales & Clinical Assessment Tools](#)
- The [Evidence-Based Review of Stroke Rehabilitation](#) (EBRSR) is a comprehensive and up-to-date review available examining therapy-based (and also pharmacological) interventions associated with stroke rehabilitation.

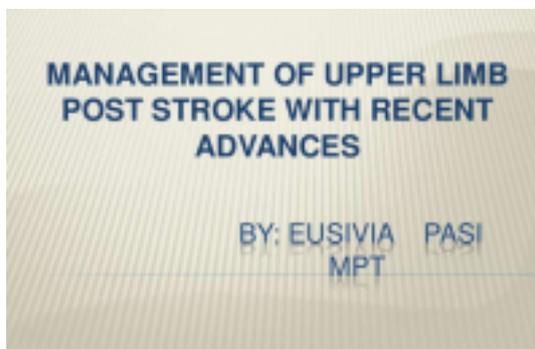
Presentations



[Stroke: PT Assessment and Management](#)



[Best Practices in Stroke Rehabilitation: The US Experience](#)



[Management of Upper Limb Post Stroke with Recent Advances](#)

References

1. Cal Shipley, M.D. What Is A Stroke? - Narration and Animation by Cal Shipley, M.D. Available from: <http://www.youtube.com/watch?v=uLJewzJcCZ0> [last accessed 10/10/14]
2. Global Burden of Stroke. The Atlas of Heart Disease and Stroke. MacKay J, Mensah GA. World Health Organization.
3. Feigin VL, Lawes CM, Bennett DA, Anderson CS. Stroke epidemiology: a review of population-based studies of incidence, prevalence, and case-fatality in the late 20th century. *Lancet Neurol*. Jan 2003;2(1):43-53.
4. Townsend N, Wickramasinghe K, Bhatnagar P, fckLRSmolina K, Nichols M, Leal J, Luengo-Fernandez R, fckLRRayner M (2012). Coronary heart disease statistics fckLR2012 edition. British Heart Foundation: London. P21
5. USMLEFastTrack. Effects of Strokes - Middle Cerebral Artery. Available from: <http://www.youtube.com/watch?v=6sk7AXNw9Ns>[last accessed 10/10/14]
6. USMLEFastTrack. Effects of Strokes - Posterior Cerebral Artery. Available from: <http://www.youtube.com/watch?v=OFIL9Dm8qCM>[last accessed 10/10/14]
7. USMLEFastTrack. Effects of Strokes - Anterior Cerebral & Lateral Striate Artery. Available from:<http://www.youtube.com/watch?v=NSWnNnfDt70> [last accessed 10/10/14]
8. Lin JH, Hsu MJ, Hsu HW, Wu HC, Hsieh CL. [Psychometric Comparisons of 3 Functional Ambulation Measures for Patients With Stroke](#). *Stroke*. 2010 Jul 29; online article ahead of print
9. Adams H, Adams R, Del Zoppo G, Goldstein LB. Guidelines for the early management of patients with ischemic stroke: 2005 guidelines update a scientific statement from the Stroke Council of the American Heart Association/American Stroke Association. *Stroke*. Apr 2005;36(4):916-23.
10. Harwood R, Huwez F, Good D. *Stroke Care: A practical manual*. New York: Oxford, 2011.
11. Norine Foley, Swati Mehta, Jeffrey Jutai, Elizabeth Staines, Robert Teasell. *Upper Extremity Interventions*. EBRSR, 2013
12. Susan Barreca et al. [Management of the Post Stroke Hemiplegic Arm and Hand: Treatment: Recommendations of the 2001 Consensus Panel](#). Heart and Stroke Foundation of Ontario, 2001.
13. Carolyn Patten, Elizabeth G Condliffe, Christine A Dairaghi5 and Peter S Lum. [Concurrent neuromechanical and functional gains following upper-extremity power training post-stroke](#). *Journal of NeuroEngineering and Rehabilitation* 2013, 10:1
14. Harris JE, Eng JJ. [Strength training improves upper-limb function in individuals with stroke: a meta-analysis](#). *Stroke*. 2010 Jan;41(1):136-40.
15. Barry JG1, Ross SA, Woehrle J. [Therapy incorporating a dynamic wrist-hand orthosis versus manual assistance in chronic stroke: a pilot study](#). *J Neurol Phys Ther*. 2012 Mar;36(1):17-24.
16. Aukje Andringa, Ingrid van de Port, and Jan-Willem Meijer. [Long-Term Use of a Static Hand-Wrist Orthosis in Chronic Stroke Patients: A Pilot Study](#). *Stroke Research and Treatment*, 2013.
17. Ann Reinthal, Kathy Szirony, Cindy Clark, Jeffrey Swiers, Michelle Kellicker and Susan Linder. [ENGAGE: Guided Activity-Based Gaming in](#)

- [Neurorehabilitation after Stroke: A Pilot Study](#). *Stroke Research and Treatment*, Volume 2012 (2012), Article ID 784232, 10 pages
18. ↑ Jordan, Kimberlee; Sampson, Michael; King, Marcus. [Table-Top Exergaming Improves Arm Function in Chronic Stroke](#). Rehabilitation Engineering & Assistive Technology Society of North America, 2013
 19. Andrea Turolla¹, Mauro Dam¹, Laura Ventura, Paolo Tonin, Michela Agostini, Carla Zucconi, Pawe Kiper, Annachiara Cagnin and Lamberto Piron. Virtual reality for the rehabilitation of the upper limb motor function after stroke: a prospective controlled trial. *Journal of NeuroEngineering and Rehabilitation* 2013, 10:85
 20. S Bermúdez i Badia, E Lewis, S Bleakley. [Combining virtual reality and a myo-electric limb orthosis to restore active movement after stroke: a pilot study](#). Proc. 9th Intl Conf. Disability, Virtual Reality & Associated Technologies Laval, France, 10–12 Sept. 2012
 21. Thieme H, Mehrholz J, Pohl M, Behrens J, Dohle C. Mirror therapy for improving motor function after stroke. *Cochrane Review*, 2012
 22. Ching-Yi Wu, Pai-Chuan Huang, Yu-Ting Chen, Keh-Chung Lin, Hsiu-Wen Yang. Effects of Mirror Therapy on Motor and Sensory Recovery in Chronic Stroke: A Randomized Controlled Trial. *Archives of Physical Medicine and Rehabilitation*, American Congress of Rehabilitation Medicine, 2013
 23. Lee, Myung Mo; Cho, Hwi-young; Song, Chang Ho. [The Mirror Therapy Program Enhances Upper-Limb Motor Recovery and Motor Function in Acute Stroke Patients](#). *American Journal of Physical Medicine & Rehabilitation*: August 2012 - Volume 91 - Issue 8 - p 689–700
 24. Nahid Norouzi-Gheidari, Philippe S. Archambault, Joyce Fung. Effects of robot-assisted therapy on stroke rehabilitation in upper limbs: Systematic review and meta-analysis of the literature. *JRRD*, 2012, 49 (4), 479–496
 25. Patrizio Sale¹, Marco Franceschini¹, Stefano Mazzoleni, Enzo Palma¹, Maurizio Agosti and Federico Posteraro. [Effects of upper limb robot-assisted therapy on motor recovery in subacute stroke patients](#). *Journal of NeuroEngineering and Rehabilitation* 2014, 11:104
 26. Kwakkel G, Kollen BJ, Krebs HI. [Effects of robot-assisted therapy on upper limb recovery after stroke: a systematic review](#). *Neurorehabil Neural Repair*. 2008 Mar-Apr;22(2):111-21. Epub 2007 Sep 17.

Quiz Questions

According to WHO approximately how many people suffer from strokes each year?

- 15 million [correct]
- 1.5 billion
- 1.5 million
- 150 million

According to WHO approximately what proportion of these individuals who experience a stroke will be left with permanent disability?

- One third [correct]
- Half
- One quarter
- Two thirds

A stroke occurs where there is an interruption in the blood supply to specific areas of the brain causing damage. There are two MAIN classifications of stroke, what are they? (Select both)

- Traumatic
- Ischaemic [correct]
- Bleeding
- Haemorrhagic [correct]
- Thrombolytic
- Hemiparetic

One type of classification accounts for 80% of all strokes, which type is that?

- Bleeding
- Traumatic
- Hemiparetic
- Ischaemic [correct]
- Haemorrhagic
- Thrombolytic

Which of the following is NOT a subdivision of Ischaemic stroke?

- Thrombotic
- Embolic
- Venous Thrombosis
- Subarachnoid [correct]
- Systemic Hypoperfusion
-

An ischaemic stroke occurs when?

- Blood vessels rupture and there is bleeding within the brain
- Blood flow to the brain is impaired [correct]

A haemorrhagic stroke occurs when?

- Blood vessels rupture and there is bleeding within the brain [correct]
- Blood flow to the brain is impaired

Of the two subdivisions of haemorrhagic strokes which has an unusual presentation.

- Subarachnoid haemorrhagic stroke [correct]
- Intracerebral haemorrhagic stroke

What are the communicating arteries at the base of the brain known as?

- Carotid Ring
- Circle of Willis [correct]
- Anterior - Posterior Cerebral communicating arteries
- Thomas Willis arteries

It is important to know the arteries of the brain and where they go so that you know which areas of the brain are likely to be affected after a stroke. Which area of the brain may be affected with a left middle cerebral artery lesion? (select all that apply)

- Brain stem
- Sensory cortex [correct]
- Parietal lobe
- Broca's area [correct]
- Cerebellum
- Motor cortex [correct]
- Wernicke's area [correct]
- Basal ganglia [correct]
- Occipital lobe
- Internal capsule [correct]

How many symptoms may a stroke caused by a left middle cerebral artery lesion present? (select all that apply)

- Motor dysfunction on the right side [correct]
- Difficulties understanding and expressing language [correct]
- Right face and arm sensory deficits [correct]
- Motor dysfunction on the left side
- Motor dysfunction on both sides
- Left face and arm sensory deficits

How will damage to Broca's and/or Wernicke's areas present?

- Dysarthria
- Dysphagia
- Aphasia [correct]
- Hemianopia

What is aphasia?

- Difficulty with forming words
- Difficulty swallowing
- Difficulty with comprehension and expression of language [correct]
- Weakness on one side of the body
- Loss of reflexes

Hemianopia is a term used to describe a loss of what?

- Sensation in the upper limb
- Movement control on one side of the body
- Reactions
- One half of the visual field [correct]
- Reflexes

What are the areas of the brain may be affected by a lesion of the posterior cerebral artery?

- Internal capsule [correct]
- Visual cortex [correct]
- Occipital lobe [correct]
- Thalamus
- Temporal lobe
- Corpus collusom
- Frontal lobe
- Basal ganglia

How may a stroke caused by a right anterior cerebral artery lesion present?

- Hemineglect [correct]
- Sensory deficits in the contralateral lower limb [correct]
- Contralateral hemiparesis of lower limb [correct]
- Sensory and motor deficits in the upper limb
- Ipsilateral motor deficits

What is a useful outcome measure to assess physical impairment and activity of an individual following a stroke?

- Chedoke Arm and Hand Activity Inventory
- Chedoke-McMaster Stroke Assessment [correct]
- Dynamic Gait Index
- Functional Gait Assessment
- Timed Get Up and Go Test

Early mobilisation of stroke patients is associated with better outcomes. True or False?

- False
- True [correct]