International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 14, Issue 6 [June. 2025] PP: 320-325

A Comprehensive Overview of Stroke: Diagnostic Tools and Treatment Strategies

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ABSTRACT

Stroke is the second leading cause of death and a major contributor to disability worldwide. The prevalence of stroke is highest in developing countries, with ischemic stroke being the most common type. Considerable progress has been made in our understanding of the pathophysiology of stroke and the underlying mechanisms leading to ischemic insult. Stroke therapy primarily focuses on restoring blood flow to the brain and treating stroke-induced neurological damage. Stroke is clinically defined as syndrome of acute, focal neurological deficit attributed to vascular injury (infraction, hemorrhage) of the central nervous system. stroke is the second leading cause of death and disability worldwide. Stroke is not a single disease but can be caused by a world-wide range of risk factor, disease processes and mechanism. Most 85% of stroke are ischemic stroke predominantly caused by small vessel arteriolosclerosis, cardio embolism. Approximately 15% of stroke worldwide are the result of intracerebral hemorrhage, which can be deep like basal ganglia, brainstem, cerebella or lobar. These are mainly important in younger patients <50 years. Lack of success in recent clinical trials has led to significant refinement of animal models, focus-driven study design and use of new technologies in stroke research. In this review, we focus on the pathophysiology of stroke, etiology and types of strokes.

Key words: *Stroke, intracerebral hemorrhage, ischemic stroke, stroke pathogenesis, rehabilitation.*

Date of Submission: 14-06-2025 Date of acceptance: 29-06-2025

I. INTRODOUCTION

Stroke is a neurological disorder characterized by blockage of blood vessels. Clots form in the brain and interrupt blood flow, clogging arteries and causing blood vessels to break, leading to bleeding. Rupture of the arteries leading to the brain during stroke results in the sudden death of brain cells owing to a lack of oxygen. Stroke can also lead to depression and dementia. A stroke can occur when blood flow to the brain is blocked or there is sudden bleeding in brain. There are two types strokes. A stroke that occurs because of the brain blocked is called an ischemic stroke. The brain cannot get oxygen and nutrients from the blood, without oxygen and nutrients brain cell begin to die within minute. A stroke that occurs because of sudden bleeding in the brain is called hemorrhagic stroke [1].

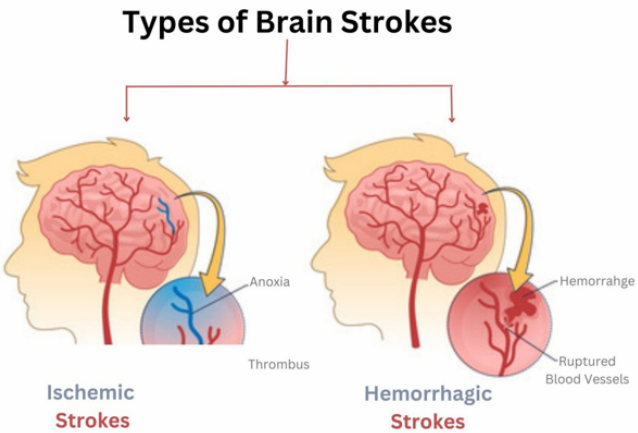

Figure 1: Types of brain stroke

Just under 90% of stroke involve blocked blood vessels (ischemic) and the remaining involved internal bleeding (hemorrhagic). Stroke are further classified based on where in the brain the blockage and bleeding occur a stroke can cause lasting brain damage, long term disability or leads to death. Sign of stroke can lead to mild weakness of paralysis or numbness on one side of face and body. And other sings that includes sudden and severe headache, weakness, trouble of speaking, and understanding of speech [1,2].

Epidemiology

Stroke, a major public health concern globally, has an estimated global prevalence of 89.13 million cases in 2020. The global incidence of stroke was 11.71 million people in 2020 with ischemic stroke accounting for approximately 65% of all cases. Globally stroke is the second leading cause of death and a leading cause of disability [3,4].

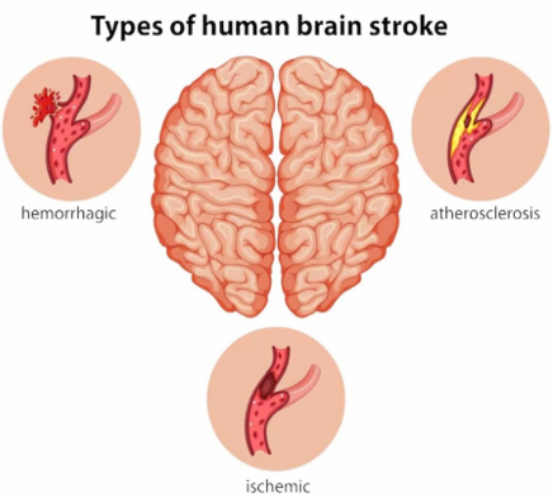

Figure 2: Types of brain stroke

Risk factors

- **Modifiable:** High blood pressure, high cholesterol, smoking, obesity, and diabetes are major modifiable risk factors for stroke.
- **Non-modifiable:** Aging is the most robust non-modifiable risk factor for stroke.
- **Case facility:** Stroke case fatality rate is high in women than in men.
- **Outcomes:** Women who survive stroke may be less favorable outcome compared to men including longer hospital stay and lower likelihood of being discharged home [1,5].

Pathophysiology

- Stroke is a neurological deficit caused by impaired blood flow to the brain can be categorized into ischemic and hemorrhagic types. ischemic stroke, are the most common result for blockages (thrombosis or embolism) in blood vessels, depriving brain tissue of oxygen and nutrients.
- Hemorrhagic stroke on other hand involves bleeding within or around the brain. due to ruptured blood vessel (intracerebral hemorrhage or subarachnoid hemorrhage)**.**
- Impaired blood flow that core of the ischemic stroke involves reduced blood supply to specific brain area.
- Energy failure this led to a cascade of event including a breakdown in the production of adenosine triphosphate (ATP). These causing the ionic imbalance and electrical distribution.
- Excitotoxicity damaged cell release glutamate an, excitatory neurotransmitter, these overstimulates neurons.
- Inflammation microglia are activated and the inflammatory response contributes to secondary brain injury.
- Oxidative stress are free radicals are generated, contributing to tissue damage [6,7].

Hemorrhagic stroke pathology

- Ruptured blood vessel is bleeding within the brain or in the space surrounding the brain.
- Expanding hematoma, the blood clot compresses brain tissue increasing the intracranial pressure.
- Tissue injury pressure from the hematoma that blood injury and potential ischemia cause neuronal damage.
- Cerebral edema is swollen around the hematoma can further worsen the situation.
- Inflammation similar to ischemic stroke play a role in secondary injury [8].

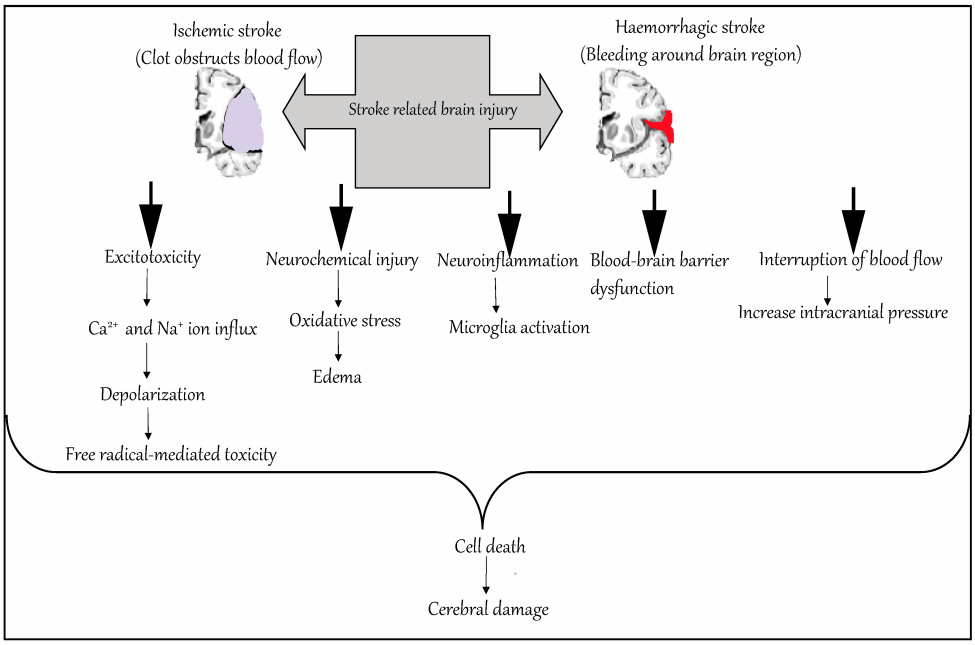

Figure 3: Brain injury

Types of strokes

There are two main types of strokes - ischemic and hemorrhagic stroke.

Ischemic stroke is the stroke occur because of a blocked blood vessel. The cause of blockage can be a blood clot, and buildup of a fatty substance called plaque. Ischemic stroke is the most common type of stroke. According for about 87% of all stroke's cases in the U.S. their present typical stroke symptoms such as;

- Weakness and numbness of the face, arms especially on one side of the body.
- Confusion and difficulty speaking, understanding.
- Problem in vision, loss of vision in one side or both eyes.
- Dizziness and difficulty in walking.
- Loss of consciousness or seizure.

Ischemic stroke is divided into 2 groups. Ther are; Thrombotic stroke - These are caused by a blood clot that develops in the blood vessels inside the brain, Embolic strokes - These are caused by a blood clot or plaque debris that develops elsewhere in the body and then travels to one of the blood vessels in the brain through the bloodstream.

Hemorrhagic stroke occurs when the blood vessel that supplies the brain ruptured and bleeds. When the artery bleeds into the brain, braincells and the tissues do not get oxygen and nutrients. Hemorrhage stroke divided into 2 categories. Intraparenchymal hemorrhages involve bleeding directly in the brain tissue. This type often results from high blood pressure. Subarachnoid hemorrhages occur when bleeding is in the subarachnoid space between the brain and the surrounding membrane. This type often occurs due to aneurysm or arteriovenous malformation.

Other types of strokes

- Transient ischemic stroke: A transient ischemic attack (TIA) is often called a mini stroke. A TIA may not cause permanent damage, but it is often warming sign of a full ischemic stroke in the further.
- Brainstem stroke describes the location of the stroke not the cause. Brainstem stroke can be particularly debilitant because the brainstem control essential functions like breathing, heartbeat, consciousness.
- Recurrent stroke is not a type of stroke but the condition of having multiple strokes.

Sign and symptoms

A stroke can manifest with sudden symptoms like weakness or numbness on one side of the body, difficulty speaking or understanding, vision problems, trouble walking, dizziness, or a severe headache. These symptoms can indicate a stroke and require immediate medical attention. Here's a more detailed look at the signs and symptoms:

Sudden weakness or numbness: This can affect the face, arm, or leg, especially on one side of the body.

Sudden difficulty speaking or understanding: This may involve slurred speech, trouble finding words, or difficulty understanding what others are saying.
Sudden vision problems: This could include blurred or double vision, or blindness in one or both eyes.
Sudden trouble walking: This may involve dizziness, loss of balance, or difficulty coordinating movements.
Sudden severe headache: A sudden, intense headache with no known cause can be a sign of a hemorrhagic stroke [9-12].

Diagnosis
A stroke diagnosis involves a combination of physical exams, medical history review, and various tests to confirm the presence and type of stroke. The first step is often a neurological exam to assess the patient's symptoms and their impact on the nervous system. Following this, imaging tests like CT scans or MRIs are used to visualize the brain and identify any signs of a blood clot or bleeding. Blood tests may also be performed to assess blood clotting and other relevant factors.
Neurological exam: A doctor will assess the patient's alertness, ability to move and coordinate, speech, vision, and other neurological functions.
Medical history: The doctor will ask about the patient's medical history, including any existing conditions, medications, and previous medical encounters.
Physical exam: This includes checking blood pressure, heart rate, and performing other physical assessments.
Diagnostic tests
Imaging tests:
CT scan (Computed Tomography): This is often the first test performed to identify the presence of a stroke and differentiate between ischemic and hemorrhagic strokes.
MRI (Magnetic Resonance Imaging): MRI can be more sensitive in detecting small strokes and changes in brain tissue, especially when used as a follow-up test.
CT Angiography (CTA) or MR Angiography (MRA): These tests use a contrast dye to visualize blood vessels in the brain and help identify blockages or aneurysms.
Blood tests:
Complete Blood Count (CBC): This test checks for abnormalities in blood cells, including platelets.
Clotting Time Tests (PT and PTT): These tests assess how quickly blood clots.
Electrolyte Levels: These tests check kidney function.
Determining Stroke Type:
Ischemic Stroke: Diagnosed when a blood clot blocks blood flow to the brain.
Hemorrhagic Stroke: Diagnosed when a blood vessel bursts and bleeds into the brain.
Transient Ischemic Attack (TIA): A "mini-stroke" where symptoms resolve within 24 hours, but should still be treated urgently.

Treatment
Stroke treatment aims to reduce brain damage and improve recovery by addressing the underlying cause and managing its effects. Treatment may involve medications, surgery, and rehabilitation therapies. For ischemic stroke, the gold standard is an intravenous injection of recombinant tissue plasminogen activator (tPA), which dissolves blood clots. Other treatments include mechanical thrombectomy, surgery to repair damaged blood vessels, and various therapies to improve function and quality of life.

Ischemic stroke
- Ischemic stroke occurs due to blocked or narrowed arteries. Treatment tends to focus on restoring an adequate flow of blood to the brain.
- Treatment starts with taking drugs that break down clots and prevent others from forming. A doctor may administer blood thinners such as aspirin or an injection of tissue plasminogen activator (TPA).
- TPA is very effective at dissolving clots. However, the injection needs to take place within 4.5 h.
- Emergency procedures include administering TPA directly into an artery in the brain or using a catheter to physically remove the clot. Research is ongoing as to the benefits of these procedures.
- There are other procedures that surgeons can perform to reduce the risk of strokes or TIAs. A carotid endarterectomy, for example, involves opening the carotid artery and removing plaque that could break and travel to the brain.
- Another option is angioplasty. This involves a surgeon inflating a small balloon inside a narrowed artery using a catheter. Afterward, they will insert a mesh tube, or a stent, into the opening. This prevents the artery from narrowing again.

Hemorrhagic stroke

- Blood leaking into the brain can cause a hemorrhagic stroke. Treatment focuses on controlling the bleeding and reducing the pressure on the brain.
- Treatment often begins with taking drugs that reduce pressure in the brain and control overall blood pressure, as well as preventing seizures and any sudden constrictions of blood vessels.
- If a person is taking blood-thinning anticoagulants or antiplatelet medication, such as warfarin or clopidogrel, they can receive medications to counter the effects of the blood thinners.
- Surgeons can repair some of the problems with blood vessels that have led or could lead to hemorrhagic strokes.
- When an aneurysm - or a bulge in a blood vessel that may burst - causes a hemorrhagic stroke, a surgeon can place small clamps at the base of the aneurysm or fill it with detachable coils to stop the blood flow and shrink the aneurysm.
- If the hemorrhage occurs due to an AVM, a surgeon can remove it. AVMs are connections between arteries and veins that can be at risk of bleeding.

Rehabilitation

Stroke is a potentially life changing event that can have lasting physical and emotional effects. Successful recovery from a stroke will often involve specific therapies and support systems, including:

- **Speech therapy:** This helps with problems producing or understanding speech. Practice, relaxation, and changing communication style can all make communicating easier.
- **Physical therapy:** This can help a person relearn movement and coordination. It is important to stay active, even though this may be difficult at first.
- **Occupational therapy:** This can help a person improve their ability to carry out daily activities, such as bathing, cooking, dressing, eating, reading, and writing.
- **Support groups:** Joining a support group can help a person cope with common mental health issues that can occur after a stroke, such as depression. Many find it useful to share common experiences and exchange information.
- **Support from friends and family:** Close friends and relatives should try to offer practical support and comfort after a stroke. Letting friends and family know what they can do to help is very important [4,12-14].

II. CONCLUSION

Stroke is the second leading cause of death and contributor to disability worldwide and has significant economic costs. Thus, more effective therapeutic interventions and improved post-stroke management are global health priorities. The last 25 years of stroke research has brought considerable progress with respect to animal experimental models, therapeutic drugs, clinical trials and post-stroke rehabilitation studies, but large gaps of knowledge about stroke treatment remain. Despite our increased understanding of stroke pathophysiology and the large number of studies targeting multiple pathways causing stroke, the inability to translate research into clinical settings has significantly hampered advances in stroke research. Most research has focused on restoring blood flow to the brain and minimizing neuronal deficits after ischemic insult. The major challenges for stroke investigators are to characterize the key mechanisms underlying therapies, generate reproducible data, perform multicenter pre-clinical trials and increase the translational value of their data before proceeding to clinical studies.

Conflicts of interest

The authors declare no conflict of interest.

Ethical approval

Not required.

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