ACUTE STROKE AND MANAGEMENT

OUTLINE OF THE TOPIC

Definition
Types
Ischemic stroke
Hemorrhagic stroke
TIA
Lacunar infarct
Large/Small artery stroke
Signs and symptoms of stroke
Features of anterior circulation stroke
Features of posterior circulation stroke
Diagnosis
Differential diagnosis
Complications
Investigations
Treatment of acute stroke
Systemic thrombolysis with tPA
Time factor and Window period
Treatment protocol
Prevention of stroke:
primary/secondary
Surgical treatment for ischemic stroke
Intracerebral hemorrhage
Subarachnoid hemorrhage
Post stroke rehabilitation

SUMMARY STATEMENT
1. Stroke is one of the leading causes of death
2. Stroke is to be recognized in the right time for effective treatment
3. Acute ischemic stroke must be evaluated for IV tPA: patients not fit for it, receive Aspirin
4. Adequate hydration and oxygenation is to be ensured
5. Hyperglycemia, and fever are treated aggressively
6. Treatment of blood pressure is individualized
7. Ischemic stroke is treated with planned thrombolysis as per published guidelines
8. Stroke etiology should be evaluated and results guide secondary stroke prevention
9. Cerebral hemorrhage is more dangerous
10. There is no specific treatment for ICH except control of hypertension and rehabilitation

DEFINITION

Definition: Sudden loss of brain function caused by blockage or rupture of a blood vessel to the brain, -with symptoms lasting for more than 24hrs
or imaging study showing acute clinically relevant brain lesion.
Stroke is one of the three commonest causes of death in most civilized societies.

TYPES OF STROKE
1. Ischemic Stroke incidence 85%
2. Hemorrhagic Stroke incidence 15%
Entails two main mechanisms

a. **Athero thrombotic:**
   - Plaque rupture and thrombus formation which blocks cerebral vessels
   - Can be large vessel thrombus or small vessel thrombus.
   - Large vessel- extra cranial or intracranial large vessels.
   - Small vessel- perforating branches or peripheral branches

b. **Embolic:**
   - Embolism arises from heart, or
   - from plaques in
   - big vessels like aorta, carotid.
   - Embolic stroke is abrupt in onset
Sources of emboli:
Usually cardiac:
Left atrium in atrial fibrillation;
Left ventricle in myocardial infarction
Other sources:-
Bifurcation of carotids, vertebral arteries,
Arch of aorta
Paradoxical emboli in patent foramen ovale

B. HEMORRHAGIC STROKE

Accounts for 15% of strokes
Main Types of hemorrhagic stroke:
- Hypertensive hemorrhage
- Subarachnoid hemorrhage
- Intra cerebral hemorrhage
Other types: Vascular malformation, atherosclerotic aneurysm, mycotic aneurysm

Intra cerebral hemorrhage

Common Sites of deep intracerebral hemorrhage:
Thalamus, putamen, cerebellum, brainstem

Subarachnoid hemorrhage

Bleeding into space between pia and arachnoid mater
Sub arachnoid hemorrhage is considered a stroke only if spontaneous;
not if due to accident or fall.
Often ushered in with severe headache plus warning signs
**Commonest cause:** Rupture of *aneurysm* of cerebral artery in Circle of Willis; Typical site of aneurysm is bifurcation of arteries (weak point); aneurysm of diameter >7mm rupture.

Other causes;

*A-V malformation* in and around the brain

Chronic severe hypertension

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**C. SPECIAL TYPES OF STROKES**

**Transient ischemic attacks:** *(TIA)* synonym- *mini stroke*

- Defined as brief episodic neurological deficit caused by focal brain or retinal ischemia with clinical symptoms typically lasting less than 1hr without evidence of infarction
- Generally lasts for 15 min to 1hr; patient usually recovers within 24 hrs leaving no residual deficit – Ischemia is transient and symptoms disappear completely
- TIA cannot be differentiated from acute stroke at the onset hence prompt evaluation is a must here also. (If the neurological symptoms continue for >24hrs –it is defined as stroke.)
- TIA is a *warning sign* for future acute stroke-greatest stroke risk in first week and 10% risk within 90 days

*Fig.2. Hemorrhagic Stroke*
Symptoms of TIA:

- **Carotid territory TIA;**
  - Sudden mono ocular blindness
  - Hemianesthesia, hemiperesis
  - Transient aphasia (if dominant lobe affected)

- **Vertibrobasilar territory:**
  - Unconsciousness (reticular formation) Drop –attacks
  - ‘Bilateral’ limb motor /sensory dysfunction
  - Diplopia, Dysarthria, vertigo, tinnitus, ataxia-
    (Not as single symptom but in combination)
  - (Dysarthria and ataxia are due to cerebellar lesion)
  - Cortical blindness /homonymous hemianopia

*Amaurosis Fugax;* a special type of TIA-sudden loss of vision; resolves spontaneously: embolus from carotid occludes ophthalmic artery transiently.

**Causes, pathogenesis and types of TIA**

- **Embolic TIA:** arising from plaques in big vessels –aortic arch, carotids or from the heart-usually from bifurcation of common carotid.

- **Low flow TIA:** On account of reduced perfusion pressure
e.g. sudden hypotension, cardiac arrest/cervical spondylosis on suddenly turning the neck

- **Lacunar TIA:** due to lypohyalinosis of penetrating branches.

**Natural history of TIA:**
10% develop infarction in the following year
Another 10% in the next year
Greatest incidence in 3-6mths after initial TIA
A TIA should lead to immediate medical evaluation to determine its cause and a treatment plan to prevent a stroke from occurring soon after.

A simple ABCD score to identify TIA patients who are at high and early risk of going in for stroke is available

**Diagnostic point** about TIA;
All symptoms start together and reach maximal intensity within seconds.
Non specific dizziness on its own is not diagnostic of TIA of posterior circulation.

**Differential diagnosis of TIA:**
In *migraine* and *partial seizures* symptoms build up more gradually.
In migraine typical h/o headache and aura is present
In partial seizures there are positive symptoms like tonic clonic seizures.
Also symptoms spread from one point to the rest of the limb and then to the other side but in TIA all occur at once.
In *hypoglycemia*, impairment or loss of consciousness may occur. But this is very uncommon in TIA.

**Treatment** of TIA: Aspirin. If AF is present -Anticoagulants.

**B. Lacunar infarct: Lacunar strokes**

Another special type of ischemic stroke; Sub type of thrombotic strokes
Very small ischemic infarcts measuring ½ -1cm in diameter.

Cause –local small vessel disease –occlusion of local small penetrating branches of major intra cranial arteries.

Resolution: the infarct which consists of neurons and glial tissue degenerate; eventually are absorbed by activated microglial cells. Finally a cystic cavity or glial scar remains.

Found in poorly controlled hypertensive.
Oclusions are caused by–lypohyalinisation, fibrin deposition, micro atheroma or embolism.

Final outcome: They are multiple and eventually lead to-Dementia and pseudo bulbar palsy.

Note: TIA does not cause permanent damage but lacunar infarct causes permanent damage but only in very small part of the brain.

**Recognized Lacunar syndromes**

- **Pure motor hemiplegia** 60%  ; - Lesion in internal capsule
- **Pure sensory stroke**  10%  ; - lesion in thalamus
- **Dysarthric clumsy hand syndrome**: lesion in base of the pons or genu of-Internal capsule.
  Features  : Dysarthria ,clumsiness of hand, facial weakness (contralateral)
- **Ataxic hemiparesis**: hemiparesis (or leg weakness) with ipsilateral ataxia (pons and internal capsule)

Lacunar TIA -heralds lacunar infarct.

**C. Silent ischemic infarcts**
Cause no symptoms
Occur in elderly especially those with hypertension and smoking risk
Lead to dementia
Indicate increased risk for future stroke

Large artery strokes

• **Large arteries that can be blocked include:**
  - Internal carotid artery, Middle cerebral artery (Left/right)
  - Features: Contralateral hemi paresis, hemi sensory loss.
  - (Dysphasia if lesion on left hemisphere)
  - Signs of cortical dysfunction- aphasia, apraxia, agnosia, visual field defects
  - Vertebral artery (Right or left), Basilar artery
  - Symptoms: weakness/numbness on either side or both sides, nausea, vomiting, vertigo, ataxia, Diplopia & cranial nerve palsies (brain stem and cerebellar dysfunction)
  - Aortic arch atherosclerosis; Thrombus from this can break off and block any of the above large vessels

• **Small artery strokes**: Synonym: Lacunar infarcts
  Small arteries penetrate deep into the brain; block causes any of the symptoms of ischemic stroke. Amount of brain damage is small.

Many lay persons are unable to recognize stroke symptoms though they are aware of its danger

**SIGNS AND SYMPTOMS OF STROKE**

Onset: Almost always acute

**In Severe cases:** Sudden impaired consciousness;
‘Sudden severe headache’ may accompany. (Commoner in hemorrhagic than in ischemic type)

**In less severe** cases:
Focal neurological deficit like
- Hemiparesis
- Hemi sensory loss
- Mono ocular or binocular loss of vision
- Defect in visual field
- Diplopia
- Dysarthria
- Dizziness
- Ataxia
- Vertigo
- Aphasia and Memory loss, confusion, behavioral changes
- Sudden loss of bladder or bowel function

Above symptoms can occur in mild, moderate or severe degree and in any combination.
Lay people’s awareness about these symptoms is essential for reaching hospital early.
Symptoms and signs of Anterior circulation Strokes

<table>
<thead>
<tr>
<th>Distinctive (of cortical dysfunction)</th>
<th>Less specific</th>
</tr>
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<tbody>
<tr>
<td>Aphasia</td>
<td>Unilateral numbness or weakness</td>
</tr>
<tr>
<td>Apraxia</td>
<td>Visual field defect</td>
</tr>
<tr>
<td>Agnosia</td>
<td>Dysarthria</td>
</tr>
<tr>
<td></td>
<td>Headache</td>
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</tbody>
</table>

Symptoms and signs of posterior circulation stroke

**BRAINSTEM**
- Ipsilateral cranial nerve palsy with contralateral motor or sensory deficit
- Bilateral motor /sensory deficit
- Disordered conjugate gaze

**CEREBELLUM**
- Cerebellar dysfunction without ipsilateral long tract deficit

**OCCIPITAL CORTEX**
- Isolated homonymous visual field defect with macular sparing

**ATAXIA**
Can be from lesions of
- Cerebellum,
- Pons, Medulla
- Cervical cord

**VERTIGO**
Hallmark symptom of VBI(Vertibro basilar artery insufficiency)
(Can result from damage to-labyrinth,vestibular nerve,central vestibular structures in brainstem)

**DIAGNOSIS OF STROKE**

Consists of:
1. Medical history,
2. General Examination including vital signs
3. Neurological examination to evaluate Anatomical and etiological diagnosis
(Refer ‘Clinical Examination in Hemiplegia ‘and ‘Diagnosis and management of hemiplegia ‘ by the same author)

**DIFFERENTIAL DIAGNOSIS FOR STROKE**

STROKE MIMICKERS  (Disorders that mimic stroke)
1. Seizures
2. Tumors especially metastatic
3. Systemic infections  
4. Toxic metabolic disturbances  
5. Migranous aura  
6. Hypoglycemia  
7. Multiple sclerosis  
8. Intracranial hematoma (subdural, intradural)  
9. Infective encephalitis  
10. Hyponatremia

*Commonest are Seizure, Migraine and Brain tumor*

<table>
<thead>
<tr>
<th>CLINICAL CONDITION</th>
<th>SIMILARITIES</th>
<th>DIFFERENTIATING FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEIZURES</td>
<td>Todd paralysis in immediate postictal period (without immediate resolve may persists for a day or fits may have been unobserved by attendants or out of patient’s recall)</td>
<td>H/o established seizure, h/o paralysis developing from one point to other parts gradually not all at once.</td>
</tr>
<tr>
<td>CEREBRAL NEOPLASMS</td>
<td>1. hemorrhage within tumor can cause acute stroke like deterioration 2. Tumor associated seizure activity may simulate stroke</td>
<td>Often focal deficit is gradual in onset</td>
</tr>
<tr>
<td>MIGRAINOUS AURA</td>
<td>if aura prolonged, can simulate stroke; rarely ischemic stroke can complicate migraine</td>
<td>Typical h/o prior similar symptoms Associated headache, nausea, vomiting, photophobia</td>
</tr>
<tr>
<td>HYPOGLYCEMIA</td>
<td>Can cause acute focal signs of stroke</td>
<td>But resolve rapidly with treatment (So think of and exclude hypoglycemia in all cases of apparent stroke in diabetics under treatment)</td>
</tr>
<tr>
<td>HYPERTENSIVE ENCEPHALOPATHY</td>
<td>Can mimic stroke</td>
<td>Associated with h/o hypertension</td>
</tr>
<tr>
<td>MULTIPLE SCLEROSIS</td>
<td>May develop signs like acute stroke</td>
<td>Careful history and selective diagnostic tests</td>
</tr>
<tr>
<td>INTRA CRANIAL HEMATOMA</td>
<td>Can manifest like stroke in chronic subdural hematoma</td>
<td>Often h/o headache and h/o fluctuating level of consciousness in subdural hematoma h/o trauma may be missing or patient if elderly and is on warfarin</td>
</tr>
<tr>
<td>INFECTIVE</td>
<td>Can mimic acute stroke</td>
<td>Fever, fits, altered sensorium and abnormal CSF</td>
</tr>
</tbody>
</table>
ENCEPHALITIS findings help in differentiation.

### COMPLICATIONS OF STROKE

1. **Most deadly complication:**
   - *Raised ICP* - can be direct effect of cerebral edema or hematoma
   - Cytotoxic edema after ischemic stroke manifests in 1-4 days
   - Signs of increased ICP are altered sensorium, unequal pupils, VI^th^ nerve palsy, papilledema
   - Tmt: fluid restriction, elevation of head end of bed, infuse osmotic diuretics, hyperventilation

2. Stroke progression in 25%

3. Functional Disability with complete or partial dependence

4. Recurrence

5. Seizures
   - Common in
     - Intracerebral hemorrhage
     - Subarachnoid hemorrhage
     - Large lesion involving cerebral cortex
   - Stroke induced seizures are usually controlled with a single anticonvulsant

6. Vascular cognitive impairment or frank dementia
   - As per recent studies Choline esterase inhibitors may help in this condition

7. Post stroke depression in 60%

8. Medical complications:
   - Cardiac arrhythmias, myocardial infarction, pulmonary embolism, pneumonia, urinary infection, gastrointestinal bleeding.

### INVESTIGATIONS FOR STROKE

**Urgent Imaging studies to distinguish ischemic from hemorrhagic stroke**

**IMAGING OPTIONS AVAILABLE**
- CT scan of the brain
- MR I of the brain

Currently controversy exists as to which is better. Both CT and MRI can accurately distinguish between ischemia and hemorrhage.

**CT** - Advantages: Available in most centers; available 24hrs
- CT is gold standard for detecting *Hemorrhage* fast
- In 60% *infarct* is detected in 3-6 hrs; all in 24 hrs.
- Low cost
- Primary advantage - ability to detect acute hemorrhage
- Can exclude other focal causes

**CT** - Disadvantages: less sensitive than MRI; Detection of early signs of ischemia is not good:
- in 40% stroke may not show up to 3-6hrs; sometimes up to 48hrs.
So a repeat CT scan may be required  
Small strokes may not show at all.

**MRI:**  
**Advantage:** It is more sensitive; can diagnose infarct missed in CT and small vessel infarcts  
**Disadvantage:** More time consuming: scanning time-15 minutes or little more  
- Not available in all hospitals, all 24 hrs  
- Patient’s preparation takes some more time  
- All Patients may not be cooperative-(may not hold still during procedure)  
- MRI is contraindicated in certain cases.  
  (if patient is unstable/If with pacemakers or implanted metal devices)  
- Upto 2-4 hrs MRI also may be negative for infarct signs

**Currently plain CT without contrast is used as ideal first line test in many centers**

**NOTE:** If CT already shows a stroke or cerebral edema it indicates a large stroke has occurred-which has increased risk of hemorrhage; in this situation tPA can precipitate the hemorrhage

*More high quality images* are available for better guidance in diagnosis and Treatment

**CT/MR perfusion technique:**
- Help to image two factors 1.*core area of infarct* 2.*The ischemic penumbra*  
- Core area -area of irreversible damage inside infarct  
- Penumbra is the surrounding area which could be salvaged if blood flow is restored rapidly.

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**Fig 3. ISCHEMIC PENUMBRA**

**DWI / PWI Mismatch**

- Diffusion Abnormality  
- CBF < 10 ml/100g/min  
- Cytotoxic edema  
- Irreversible ischemia

- Perfusion Abnormality  
- CBF = 10-18 ml/100g/min  
- Neuronal paralysis  
- Reversible ischemia

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**CT ANGIOGRAM: or MR angiogram**

Once infarction is diagnosed **next** to know is the vessel involved-through CT-Angiogram  
This test quickly identifies large vessel occlusion and carotid stenosis;  
Thus makes urgent surgery or endovascular intervention possible.  
It is also useful in identifying the vascular territory / exact vessel involved –to facilitate intra arterial infusion of tPA
In addition can diagnose intracerebral hemorrhage.

**Doppler Ultrasound** of the Neck; used to check carotid plaques
- Other names; carotid ultrasound/carotid duplex ultrasound

**Trans cranial Doppler:** Detects atherosclerotic narrowing of intracranial blood vessels

**SPECT and PET** (Single Photon Emission Computed Tomography and Positron Emission Tomography)
Using radioactive material damaged area in the brain is delineated

**General Investigations**
- Blood: sugar, lipids, Urea, creatinine
- Coagulation time
- Test for thrombophilia; proteinC, proteinS, antithrombin
- Anticardiolipin antibodies
- Platelet count
- Test for polycythemia
- Test for vasculitis: ESR, RP, and ANCA
- 12lead ECG, serum Cardiac enzymes
- Test for Cardiac Embolism: ECG, HOLTER MONITORING, ECHO CARDIOGRAM, TEE/TTE

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**Chart 3. TREATMENT OF STROKE**

<table>
<thead>
<tr>
<th>TREATMENT OF ACUTE STAGE</th>
<th>SURGERY</th>
<th>REHABILITATION</th>
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**TREATMENT FOR ACUTE ISCHEMIC STROKE**

**Time factor in stroke therapy:**
1. Time is the most crucial factor, “TIME IS BRAIN”
2. Prompt treatment can reverse the effects of stroke by reestablishing the blood flow.
3. Hence history taking and evaluation must be rapid
4. Determine the exact time of onset of the stroke
Estimate the time period that has elapsed after onset of symptoms
(When was patient completely normal last of all?)
Evaluation of patient must be concluded within 60 minutes of arrival in causality.

5. Stroke is best treated in stroke unit – A unit for organized stroke care with emergency stroke management team-outcome better, mortality is less and hospital stay is shortened.

6. After ruling out cerebral hemorrhage, accepted best treatment is the administration of thrombolytic – TPA – Tissue plasminogen activator

7. Window period – window of opportunity to rescue the penumbra

Window period and tPA

If patient’s criteria for selection is met with
1. Within 0 to 3 hours of onset of symptoms – “intravenous” thrombolytic – through vein of arm is indicated.
   (The most important point in history thus is time of onset of symptoms.)

2. Between 3 to 6 hours of onset of symptoms – “Intra arterial” thrombolytic - administered
   i.e. intra arterial tPA is directly infused right at the site of thrombosed blood vessel via a thin flexible catheter inserted in femoral artery
   But only interventional radiologist/neurosurgeon can perform this

3. (For posterior circulation Stroke window time may be extended up to 18 hrs (American Stroke association)
4. 0-8hrs- is window for Mechanical embolectomy

MODALITIES OF ENDOVASCULAR TREATMENT OF ACUTE ISCHEMIC STROKE

![Chart 4](chart.png)
I. Systemic thrombolysis
II. Local intra arterial thrombolysis
III. Mechanical or non pharmacological methods of revascularization

SYSTEMIC THROMBOLYSIS

1. Drug of choice t-pa
2. Route-Intravenous t-PA
3. Protocol guidelines
   3a. Patient selection and Eligibility criteria
      • Age above 18 or older
      • Clinical diagnosis of ischemic stroke causing measurable neurological deficit
      • Time of onset of symptoms less than 3 hours
   3b. Contra indications for t-pa
      1. Evidence of intracranial hemorrhage on pretreatment CT
      2. Clinical features suggestive of subarachnoid hemorrhage even with normal CT
      3. Active internal bleeding
      4. Known bleeding diathesis including
      5. Platelet count<100000/ml
      6. If patient has received heparin within 48 hours and has an elevated APTT
      7. Current use of oral anticoagulants (e.g.warfarin) or recent use with an elevated Prothrombin time>15 sec
      8. Within previous 3 months any Intracranial surgery, serious head trauma or any serious stroke
      9. On repeated measurement systolic pressure greater than 185mmof Hg or diastolic pressure greater than100mmofHg at the time treatment is to begin. patient requires aggressive treatment to reduce BP within these limits
      10. H/O intracranial hemorrhage and known arteriovenous malformation or aneurysm

   WARNINGS AGAINST THE USE OF t-PA
   Only minor or rapidly improving stroke symptoms
   If patient has had major surgery or trauma excluding head trauma in the previous 14 days
   Recent arterial puncture at a non compressible site.
   Recent lumbar puncture.
   Abnormal blood glucose <50mg or >.400 mg/dl
   Post myocardial infarction pericarditis
   Patient was observed to have seizures at the same time the onset of stroke symptoms were observed

3C. Dose of t-PA
0.9mg/kg (maximum of 90mg) of t-PA, infused over 60 minutes, with 10% of total dose administered as initial Intravenous bolus over 1 minute. **Do not use cardiac dose.**

### 4. TREATMENT PROTOCOL

**4. A. Initial assessment**
1. Determine whether time is available to start treatment with tPA before 3hrs
2. Draw blood for tests while preparations are made to perform non contrast CT scan
3. Start recording BP
4. Neurological examination
5. CT scan without contrast
6. Determine if CT has evidence of hemorrhage
7. If patient had severe head or neck pain or is somnolent or stuporous, be sure there is no evidence of subarachnoid hemorrhage
8. If there s a significant abnormal lucency suggestive of infarction, reconsider the patient-since the stroke might have occurred earlier

**4B. Review of required test results**
- Hematocrit
- Platelets
- Blood glucose
- PT or APTT (in patients with recent h/o oral anticoagulants or heparin)
- Review patient selection criteria

**4C. infuse t-pa**
- Give 0.9mg/kg, 10% as a bolus intravenously
- **Do not use cardiac dose**
- Do not exceed 90mg maximum dose
- Do not give aspirin, heparin or warfarin for 24 hrs
- Monitor the patient carefully, especially the BP; follow the BP algorithm
- Monitor neurological sign
5. Adjunctive therapy
- No concomitant heparin, warfarin or aspirin in first 24 hrs after symptoms onset.
- If heparin or any other anticoagulant is indicated, after 24 hrs, consider performing a noncontract-or other sensitive diagnostic imaging method to rule out any intracranial hemorrhage before starting an anticoagulant.

6. Other general measures in treatment
(In summary give basic life support, maintain electrolytes, treat fever, infection and other comorbid conditions.)

- Intravenous hydration with normal saline
- Supplemental oxygen
- Insulin for hyperglycemia
- Antipyretics for fever
- ECG to be performed and patient is to be put on continuous cardiac monitoring
- No oral intake is permitted until the patient passes a swallow test with sips of water or if arrives late but within 8hrs or along with tPA
- Treatment of Raised intracranial tension
  - Osmotic diuretic mannitol, Loop diuretics, Hyperventilation
- **Key clinical points in treating hypertension**
  - High BP found after ICH or SCH should not be brought down over-enthusiastically. Reasons: 1. it could be transient acute rise consequent to bleed.  
  - Damaged brain tissue needs good perfusion pressure to maintain a good blood flow. Damaged brain tissue has lost its ability to auto regulate. (i.e healthy brain tissue is able to maintain constant blood flow rate despite varying BP levels. This called auto regulation) 
  - Low BP hence leads to low blood flow in the recently damaged area of brain
  - Unless SystolicBP>220 or Diastolic>120 and sustained, with repeated reading do not treat for within first days.
  - Refer table on antihypertensive treatment for details

**Table 2. ANTI HYPERTENSIVE THERAPY FOR ACUTE STROKE**

<table>
<thead>
<tr>
<th>BLOOD PRESSURE</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IN NON THROMBOLYTIC CANDIDATES</strong></td>
<td></td>
</tr>
<tr>
<td>DBP&gt;140mmHg</td>
<td>Sodium nitroprusside 0.5µgm/kg/min Aim for 10-20% reduction in DBP</td>
</tr>
<tr>
<td>SBP&gt;220, DBP&gt;120, or MAPc&gt;130mmHg</td>
<td>10-20 mg labetalold IV push over 1-2 min. May repeat or double labetalol every 20 min to a maximum dose of 150 mg.</td>
</tr>
<tr>
<td>SBP&lt;220, DBP&gt;120, or MAP&gt;130mmHg</td>
<td>Emergency anti hypertensive is deferred in the absence of aortic dissection, acute myocardial infarction, severe congestive heart failure or hypertensive encephalopathy.</td>
</tr>
</tbody>
</table>
IN THROMBOLYTIC CANDIDATES  PRE TREATMENT
SBP>185orDBP>110mmHg

1-2 inches of nitro paste or 1-2 doses of 10-20mg labetalol IV push. *if BP is not reduced* and maintained to <180/110mmHg the patient **should not be treated** with tPA.

DURING AND AFTER TREATMENT
Monitor BP for 24 hrs after starting tmt, Look for hypotension
DBP>140mmHg
SBP>230or DBP121to140mmHg

BP is monitored every 15 min for 2hrs, then every 30 min for 6hrs and then every 1 hr for 16 hrs
Sodium nitroprusside (0.5µgm/kg/min) infusion
1)10mg labetalol IVP over 1-2 minutes. May repeat or double labetalol every 10 min to a maximum dose of 150mg or give the initial labetalol bolus and set a labetalol drip at 2-8mg/mintill desired BP reached
2) If BP not controlled by labetalol consider sodium nitroprusside.
10mg labetalol IV over 1 min. may repeat or double labetalol every 10 to 20 min to a maximum dose of 150mg or give initial labetalol bolus and start a labetalol drip at 2-8 mg/min

SBP 180-230or DBP105-120mmof Hg
On 2 readings 5-10min apart

All initial blood pressures should be verified before treatment by repeating reading in 5 min.
As estimated by 1/3rd the sum of systolic and double diastolic pressure.
Labetalol should be avoided in patients with asthma, cardiac failure or severe abnormalities in cardiac conduction.

Labetalol has Short half life, easily titratable, does not increase ICP
But nitrates-nitroprusside and nitroglycerine can raise ICP, often avoided
ACE inhibitors— slow onset; not first line agent in ICH

Reference; American heart Association
If during treatment ICH is suspected clinically, stop tPA treatment

POINTS TO CONSIDER
• Patient’s BP may decline spontaneously in first 24 hrs after stroke
• BP reduction in acute phase should be avoided if possible.
• BP should be maintained high enough to maintain a cerebral perfusion pressure of >60
• Antihypertensive drugs are withheld unless diastolic BP is >130 and SBP>220
• When treatment indicated BP should be lowered cautiously.

In hemorrhagic stroke BP Should be maintained below 180/100 - American heart Association

After use of tPA BP **maintained at 185/110**

7. MECHANICAL OR NON PHARMACOLOGICAL METHODS OF REVASCULARISATION

1. **CAROTID ENDARTERECTOMY** or **PLACEMENT OF CAROTID STENT**
2. **MERCI retriever**: Mechanical Embolus Removal in Cerebral Ischemia
   A mechanical cork screw shaped device is used at end of the catheter to pull out the clot
   Procedure: approved by FDA; it an Endovascular procedure;
   Limitation: clot must be visible and accessible, small pieces may lodge further down
   But at least area of damage can be smaller
   Only super specialists can perform the procedure
PATIENT AND CARE GIVER’S EDUCATION

Educate patient to recognize stroke symptoms and to seek medical help promptly.
Post stroke depression must be detected and treated
When applicable secondary stroke prevention methods must be emphasized

STROKE CODE ALGORITHM FOR ISCHEMIC STROKE

Activation criteria
1. Patient arrives with or acute worsening of
   Stroke signs <3hrs duration
   or
   ED called prior to arrival

FAST TRACT STROKE PROTOCOL

For Stroke code patients coming in from the field, alert radiologist(for head CT scan) prior to arrival

Procedures: 1. O2 saturation assessment
2. Emergency department MD exam (10 min)
3. Alert radiology(head CT scan)
4. CBC, Platelets, coagulation study, Biochemical parametersto study kidney, liver (Send immediately)
5. Fasting blood sugar
6. ECG
7. IV access X2 (1HL and 1-NS @50cc/hr.)
8. Urine pregnancy test in females

PREPARE for tPA

Door to tmt time, goal: <60min from ED arrival
Dose 0.9mg/kg Not to exceed 90mg
10% of total dose given as a bolus over 1 minute, remainder infused over 1hr (use IVAC)

Administer t-PA with
Neuro exam motor arm, leg
q 15min x 2hrs
q 30min x 6hrs
q 60min x 16 hrs

BP acceptable
Less than 180/100

TRANSPORT TO CT SCAN (<25 min)

CT SCAN INTERPRETATION
(<45 min) from ED arrival

IF CT finds Ischemia and if SUITABLE FOR t-PA TREATMENT AND SYMPTOMS LESS THAN 3 HOURS-admit in ICU

If BP not acceptable, consider tmt while t-PA is being prepared
Labetalol 10mg i.v and further measures
But if target BP not achieved- tPA –not given
**Mechanical Clot busting:** Indications: patient if unsuitable for tPA

**PREVENTION OF STROKE**

- Hypertension is important modifiable risk factor BP is to be maintained, 140/90 to reduce the risk of stroke
- For primary and secondary prevention no difference between drug classes; but Losartan may offer benefit beyond BP lowering.

**RISK FACTORS FOR STROKE**

**Modifiable Risk factors:**
- Hypertension
- Diabetes mellitus
- High cholesterol level
- Obesity
- Sedentary life style
- Smoking
- Heavy drinking
- Low fiber, high fat diet
- Cardiac Disease
- Carotid stenosis
- Atrial fibrillation
- TIA/prior stroke
- Sickle cell disease, polycythemia
- Sleep apnea
Non modifiable risk factors

- Age above 55
- Gender; males are more prone
- Family history
- Race/ethnicity: African –American race

Prevention

Aim: Prevent not only disability but also long term dementia that can occur (after silent strokes); many strokes can be prevented with the use of modern medicines

Types of Prevention

1. Primary prevention
2. Secondary prevention-needs to be aggressive

Stroke prevention is a multifactorial approach

<table>
<thead>
<tr>
<th>Table 3. MEASURES FOR STROKE PREVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRIMARY PREVENTION</td>
</tr>
<tr>
<td>Treat hypertension</td>
</tr>
<tr>
<td>Treat hyperlipedemia</td>
</tr>
<tr>
<td>Quit smoking</td>
</tr>
<tr>
<td>Exercise</td>
</tr>
<tr>
<td>SECONDARY PREVENTION</td>
</tr>
<tr>
<td>All primary prevention treatment</td>
</tr>
<tr>
<td>Carotid endarterectomy/stent</td>
</tr>
<tr>
<td>Anticoagulation for cardiac emboli</td>
</tr>
<tr>
<td>Antiplatelet therapy; ASA, CLOPIDOGREL</td>
</tr>
<tr>
<td>ASA/extended release Dipyridamole</td>
</tr>
</tbody>
</table>

Detect and treat atrial fibrillation
Aspirin for myocardial infarction and stroke

- Treatment of risk factors prevents most strokes
- Diet, exercise, cessation of smoking, antihypertensive, lipid lowering agents are highly important in primary prevention
- in secondary prevention also, same measures are important
- Anticoagulation warfarin is for atrial fibrillation and related cardiac source of embolism.
- For related cardio embolic strokes cardiomyopathy, MVPS, MR, aortic disease- Aspirin.
- Carotid endarterectomy/stenting for secondary stroke prevention if causing TIA or minor stroke
- Anti platelet therapy for all but for warfarin indicated patients;
- increasing evidence for ASA and Extended Release dipyridamole combination; makes a very effective combination
No evidence for ASA+clopidogrel combination but each can be used alone; Combination increases bleeding risk. (But used in acute coronary syndrome, coronary stent patients
• New ASA guidelines for secondary stroke prevention are published

Pharmaco therapeutic strategies for stroke prevention

HYPERTENSION

• Hypertension - An Important stroke risk factor - increases risk by 5-6 fold
• Treatment of hypertension is crucial in secondary prevention also
• Anti hypertensive to be chosen for stroke prevention
  o ACE Inhibitors seem especially effective HOPE STUDY
  o perhaps a diuretic combination is more effective
  o ARB also effective
  o Time to start treatment for hypertension after stroke
    ▪ ARB (Candesartan) initiated on day1 after stroke has shown long term benefit. ACCESS STUDY
• In summary ACEI or ARB + diuretic may be advantageous.
• But control of BP is more important than choice of agent.
• African-Americans require ACEI+DIURETIC or perhaps Calcium channel blockers
• Detection and aggressive treatment of hypertension prevents primary stroke 40-50%: Secondary stroke prevention 28%
• Absolute target level of BP reduction - uncertain; Must be individualized (AHA guideline)
• If diabetes and hyperlipidemia associated, more vigorous control of BP is required

DIABETES
Control to near normoglycemic levels
Vigorous treatment of hypertension and hyperlipidemia indicated
More than 1 agent may be required. First choice are ACEI and ARBs

CHOLESTEROL AND STROKE

• Direct correlation between cholesterol and stroke is small
• But STATINS have shown to have Pleotropic effect: plaque stability, antithrombotic anti platelet, anti inflammatory (CRP) effect.
• Studies show that Statins prevent stroke as well as recurrent MI
• HPS SPARCL studies suggest Statin indication after stroke
• FDA has approved simvastatin 40mg / pravastatin for secondary stroke prevention
• Should be managed according to NECP guidelines

SECONDARY STROKE PREVENTION

I. ANTICOAGULANTS
1. WARFARIN:
Clearly benefits patients with atrial fibrillation in preventing stroke especially those with high risk. (History of CHAD-Congestive heart failure, Hypertension, age >75 Diabetes, Stroke/TIA)
For Non cardio embolic stroke; warfarin not indicated
For recurrent Stroke: Aspirin only indicated not warfarin

2. ANTI PLATELET AGENTS

Aspirin
Combination of aspirin and extended release dipyridamole studied to be better than Aspirin alone
No evidence for aspirin and clopidogrel combination (increased risk of bleeding)

Table 4. SECONDARY STROKE PREVENTIVE THERAPIES

<table>
<thead>
<tr>
<th>CLASS</th>
<th>AGENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anticoagulant</td>
<td>Warfarin only in atrial fibrillation with high risk –target INR2-3.</td>
</tr>
<tr>
<td>Antiplatelet agents</td>
<td>Aspirin 160-300mg /day within 48 hrs</td>
</tr>
<tr>
<td></td>
<td>Aspirin+ Extended release dipyridamole</td>
</tr>
<tr>
<td></td>
<td>(Aspirin25mg+ dipyridamole 200mg)</td>
</tr>
<tr>
<td></td>
<td>Clopidogrel 75mg daily- For patients allergic to aspirin</td>
</tr>
<tr>
<td>Antihypertensives</td>
<td>ACEI</td>
</tr>
<tr>
<td></td>
<td>ARBs</td>
</tr>
<tr>
<td>Antihyperlipidemia</td>
<td>Statins</td>
</tr>
</tbody>
</table>

Table 5. COMPARISON OF ANTIPLATELET AGENTS

<table>
<thead>
<tr>
<th>CLOPIDOGREL</th>
<th>ASPIRIN</th>
<th>Aspirin with dipyridamole SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Tolerability</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Routine blood monitoring</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Dosing frequency</td>
<td>od</td>
<td>od</td>
</tr>
<tr>
<td>Cost</td>
<td>++++</td>
<td>+</td>
</tr>
</tbody>
</table>

SURGICAL TREATMENT OF ISCHEMIC STROKE

(Also serves as secondary stroke prevention)

IA. CAROTID ENDARTERECTOMY OR STENTING
Indication:
In symptomatic carotid stenosis ≥ 70%
In some patient with ≥ 50% symptomatic carotid stenosis
Beneficial in selected patients

IB. Angioplasty and Stenting
Indication: in those with high risk with unstable heart disease,
Unstable neurological status,
Contralateral occlusion
Procedure: A catheter is inserted via femoral artery into
the intra cerebral artery that is narrowed; tiny balloon at the end of
the catheter is inflated to flatten the thrombus; a wire mesh stent is placed
to retain the artery open
  • Stenting/angioplasty is also performed for cervical arteries

II. MERCI RETRIEVER: MECHANICAL EMBOLUS REMOVAL IN CEREBRAL ISCHEMIA
  • Indication: patient if unsuitable for tPA/arrive late but within 8hrs/companion to tPA
  • A mechanical cork screw shaped device is used at end of the catheter to pull out the clot
  • Procedure:
    An endovascular procedure; approved by FDA; speeds up the process of clot removal in ischemic stroke
    A mechanical cork screw shaped device is used at end of the catheter to grab and pull out the clot
  • Limitation: clot must be visible and accessible, small pieces may lodge further down
  • But at least area of damage can be smaller
  • Only super specialists can perform the procedure

INTRA CEREBRAL HEMORRHAGE (ICH)
ICH is bleeding within the brain
Etiology:
  Commonest cause; chronic hypertension
  Less common:
    Amyloid angiopathy of cerebral vessels
Other causes;
Congenital, causes-Cerebral aneurysm, Arterio venous malformation
Traumatic or inflammatory pathology of cerebral vessel
Tumors
Bleeding disorders, high dose anticoagulants
Others;atherosclerotic aneurysm,mycotic aneurysm,

Note: Ischemic stroke can get transformed into hemorrhagic stroke. But they are commonly asymptomatic

Clinical presentation
Characteristic “Severe headache”, nausea, vomiting, seizure
In old people headache may be mild or absent
Progressive neurologic deficit-Unilateral motor/sensory loss
Dimness/loss of vision in one eye

Neck stiffness
Impaired level of consciousness,,coma
Sudden onset, progressive
High, uncontrolled BP- systolic blood pressure greater than 220 mm Hg,
Features of high possibility of ICH: anticoagulation, hyperglycemia in a non diabetic

Sites of ICH
Typical; Basal ganglia, pons, cerebellum
Less commonly: lobar-frontal/parietal/occipital/temporal

Neuro imaging
ICH and infarction cannot be distinguished by clinical exam alone
Neuro imaging is mandatory-CT/MRI brain

Treatment
Best treated in stroke unit
Medical
Surgical
Currently no specific drug or surgery for ICH
Treatment is mostly restricted to Control of hypertension and rehabilitation

Medical treatment
1. Stabilisation of the patient
2. Monitoring of blood pressure simultaneously ensuring adequate intracerebral flow
(Refer details of anti hypertensive therapy given under ischemic stroke)
3. Treatment of raised intracranial pressure
   Intravenous mannitol with or without frusemide
4. for patients on warfarin and elevated INR and ICH-options available are: vitamin K Administration of clotting factors, fresh frozen plasma, Prothrombin complex concentrate (PCC), recombinant factor VIIa

Surgical treatment-in selected cases and if refractory to medical treatment
1. Evacuation of hematoma - moderate hematoma in awake and conscious patient
(In comatose patient and if hematoma is greater than 6cm diameter or more than 80ml with or without surgery outcome is poor; Awake patient with hematoma of less than 3cm and >20ml usually recover without surgery)

2. Evacuation of cerebellar hematoma: prevents brainstem compression and death.

3. For supratentorial ICH neuro surgical opinion is sought

3. Two primary surgical treatment of cerebral aneurysm
   1. Clipping: placing a metal clip across the neck of the aneurysm to prevent blood flow into aneurismal sac.
   2. Coiling; tiny platinum coils are filled into aneurysm thus preventing rupture
      (Aneurysm is accessed via a femoral catheter, advanced into concerned cerebral artery)

4. Arterio venous malformations
   Three main modalities of therapy
   Endovascular therapy, microsurgery, stereotactic radio surgery with gamma knife

SUB ARACHNOID HEMORRHAGE (SAH)

SAH refers to bleeding into space between pia and arachnoid

Age incidence-25-65

CAUSES OF SAH
Most common cause rupture of intracranial aneurysm, trauma
- Head trauma – (not considered as stroke)
- Intra cranial aneurysm cause 80% non traumatic SAH
  o Common Site – berry aneurysm of circle of Willis (MCA bifurcation, ACA, PCA)
  o Also ophthalmic arteries, vertebral/basilar arteries
- Benign peri midbrain hemorrhage
- Less common causes of SAH
  o Arterio venous malformation
  o Extension from ICH
  o AV fistula, meningitis, neoplasm

Risk factors:
Hypertension, Vasculitis, fibro muscular dysplasia/o poly cystic kidney disease

Clinical presentation
Most classical symptom: headache,(worst headache of life), abrupt, reaching maximum intensity in seconds(thunder clap headache)

Neck stiffness/signs of meningism
Nausea, vomiting, altered sensorium,
Signs of raised ICT
Intraocular/subhyaloid hemorrhage
Seizures
Sharp increase in BP (adrenaline release) cardiac arrhythmias, cardiac arrest
Neurogenic pulmonary edema
CSF may be bloody

Imaging Studies
Plain CT brain/MRI
CT Angio, MR Angio
Acute hemorrhage appears as high attenuation material (white) that fills the normally black subarachnoid space. Acute hemorrhage is most evident 2-3 days after acute bleed.

TREATMENT FOR SUBARACHNOID HEMORRHAGE

1. Medical
2. Surgical

1. Medical
Bed rest, normalizing the BP, analgesic to relieve headache plus
Nimodipine for reducing BP and for decrease brain cell loss
Nimodipine also relieves vaso spasm

2. Surgical treatment-May be required
Angiogram performed to identify source of bleeding
Common cause –aneurysm-surgical repair undertaken
Nimodipine is shown to improve outcome in SAH
Prognosis: death or severe disability in nearly half. Survivors get neurological impairment

COMPLICATIONS

ACUTE
Chemical meningitis
Neurogenic pulmonary edema,
Brain stem herniation
Cardiac arrhythmias, myocardial infarction

Sub acute
Vasospasm cerebral ischemia
Syndrome of inappropriate ADH secretion-Hyponatremia

Chronic
Pneumonia,
Pulmonary embolism
Recurrence of SAH
Venous stroke

- Bilateral involvement common
- Convulsions – in 50% of cases
- Common in post partum females
- CSF is hemorrhagic
- CT scan shows delta sign

Recurrent stroke

- Arterial dissection
- Patent foramen ovale
- Hyperhomocysteinemia
- Hypercoagulable state
- Sickle cell disease
- Cerebral venous thrombosis

Post stroke rehabilitation

- Post Stroke Rehabilitation;
  - Help in recovery after stroke.
  - Help patient and family to return home after stroke.
  - Driving recommendations after stroke.
  - Depression after stroke.
  - Help patient and family understand prognosis and recovery after stroke.
  - Memory loss after stroke.
  - Recommendation of Speech Therapy
  - Occupational therapy