Acute Stroke: Types, Pathophysiology, Diagnosis and Acute Management

STROKE FACTS AND PREVALENCE

Allison Burke RN
HRMC Stroke Program Coordinator

STROKE FACTS
- 795,000 people in the U.S. suffer strokes each year
- 133,000 deaths in the U.S. each year
- 4 million stroke survivors
- Stroke incidence is likely increasing due to aging of the US population
- From 1998 to 2008, the stroke death rate fell approximately 35 percent and number of deaths fell by 19 percent

STROKE PREVALENCE
- Stroke is the fourth leading cause of death in the United States
- On average, someone suffers a stroke every 40 seconds in the United States

STROKE PREVALENCE cont.
- A leading cause of adult disability
- Up to 80 percent of all strokes are preventable through risk factor management
- The estimated direct and indirect cost of stroke in the United States in 2010 is $73.7 billion.

THE STROKE BELT

WHO'S AT RISK.
- Approximately 55,000 more women than men have a stroke each year.
- African Americans have almost twice the risk of first-ever stroke compared with whites.
- Stroke kills twice as many women as breast cancer every year.
- Children and infants have strokes, too

All Stroke Mortality 2007-2009

Cumulative Mortality Over 5 Years After Ischemic Stroke

Source: CDC/NCHS

Age-specific rate per 100,000 population

> 187.8 – 208.6
> 174.5 – 187.8
> 164.6 – 174.5
> 153.0 – 164.6
> 126.3 – 153.0

The Stroke Belt


Cumulative Mortality Over 5 Years

30 Days 1 Year 3 Years 5 Years

0% 10% 20% 40%

Approximately 55,000 more women than men have a stroke each year.
African Americans have almost twice the risk of first-ever stroke compared with whites.
Stroke kills twice as many women as breast cancer every year.
Children and infants have strokes, too
Annual Rate of First Cerebral Infarction by Age, Sex, and Race

How Many Strokes in the US Can Be Prevented by Risk-Factor Control?

Stroke Symptoms

Two million brain cells die every minute during stroke, increasing risk of permanent brain damage, disability or death. Recognizing symptoms and acting FAST to get medical attention can save a life and limit disabilities.

Pathophysiology

Acute ‘Ischemic’ stroke can be caused by a sudden blockage (occlusion), due to clotting blood, in an artery that supplies a part of the brain.

What Are the Types of Stroke?

- **Ischemic Stroke (Blockage)**
  - Caused when there is a blockage in the blood vessels to the brain

- **Hemorrhagic Stroke (Bleeding)**
  - Caused by burst or leaking blood vessels in the brain

Pathophysiology

The formation of a permanent ischemic stroke can be averted, if the occlusion is opened up within the first few hours of stroke onset.

Gorelick PB. *Stroke*. 2002;33:862-75.


*Rates for black men and women 45-54 years and for black men ≥ 75 years are considered unreliable.*

Based on estimated 700,000 annual strokes: *Neuroanatomy and Pathophysiology*
A “Hemorrhagic” STROKE (different from an ischemic stroke) forms from a spontaneous bleed in the substance of the brain.

**Pathophysiology**

**Neuroanatomy**

The Motor and Sensory Cortex

Neuroanatomy

The Motor and Sensory Cortex

Cortical brain functions are mapped out to specific locations on the surface of the brain.

**IN GENERAL**, each side of the brain is responsible for the other side of the face and body.

**Neuroanatomy**

The Motor and Sensory Cortex

Cortical brain functions such as sensation and motion tend to cross to the other side of the body as they track down the spinal cord.

**IN GENERAL**, a disturbance on the right side of the brain = signs and symptoms on the left side of the body or face, and vice versa.

It is therefore unusual to get brain stroke symptoms in, for example, both arms, both legs, or both sides of the face.

**Carotid and Basilar Systems**

**Circle of Willis**

Cerebral Blood Supply
Cerebral Blood Supply

- Anterior cerebral artery
- Middle cerebral artery
- Posterior cerebral artery

A specific artery is responsible for a specific region of the brain. A stroke in one of those arteries will result in symptoms typical for the area supplied by that artery.

Acute Stroke Symptoms

Disturbance of Regional Blood Supply

- “ACA” Stroke
  - Leg > arm weakness
  - Leg > arm numbness
  - Confusion

- “MCA” Stroke
  - Arm > leg weakness
  - Facial weakness
  - Aphasia (problems with understanding speech), if on dominant side

- “Posterior Circulation” Stroke
  - Blindness in one half of the visual field
  - Dizziness, vertigo, problems with balance
  - Unsteady gait
  - Slurred speech
  - Double vision
  - Nystagmus

What Are the Effects of Stroke?

- Right Brain

What Are the Causes of Ischemic Stroke?

- Begins with the development of fatty deposits lining the blood vessel wall
- Thrombus: Development of blood clot at the fatty deposit
- Embolus: Traveling particle too large to pass through a small vessel

Mimics Things That Look Like Stroke, But Aren’t

- Complex Migraine
- Seizure
- Occult Trauma

Occlusions

- Hypoglycemia: Neurons without energy supply (glucose)

What Are the Causes of Ischemic Stroke?
Transient Ischemic Attack (TIA)

- Transient ischemic attack (TIA) is a brief episode of neurologic dysfunction resulting from focal temporary cerebral ischemia not associated with cerebral infarction.
- TIA was originally defined clinically by the temporary nature (<24 hours) of the associated neurologic symptoms. However, the arbitrary nature of the 24-hour time limit and lack of specific pathophysiologic meaning hampered the clinical and research utility of the term "TIA." Recognition of these problems led to a change to a tissue-based definition of TIA. The change was driven by advances in neuroimaging that enabled very early identification of ischemic brain injury.

Risk of Stroke After TIA

Risk Factors for Stroke After TIA: ABCD² Score

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥ 60 years</td>
<td>1 point</td>
</tr>
<tr>
<td>Systolic pressure ≥ 140/90 mm Hg</td>
<td>1 point</td>
</tr>
<tr>
<td>Clinical features of TIA</td>
<td>2 points for unilateral weakness; 1 point for speech impairment without weakness</td>
</tr>
<tr>
<td>Duration of TIA</td>
<td>2 points for ≥ 60 minutes; 1 point for 10-59 minutes</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1 point</td>
</tr>
</tbody>
</table>

Maximum score is 7. Score 6 or 7 = high risk.

TIA: Misperception and Missed Opportunity

- Hospitalized TIA patients receive less diagnostic testing, secondary prevention therapy, and stroke education than hospitalized stroke patients.
  - TIA patients were much less likely to get an echocardiogram, carotid duplex, or stroke education as compared to stroke patients.
  - This is particularly important because of available management options for carotid disease and cardioembolism.
- We may thus be missing a substantial opportunity for preventing a future stroke.
- There is a clear need for greater recognition and education about TIA as an opportunity to intervene and not ignore.

Ischemic stroke: Low blood flow to focal part of brain

- Most common cause: thromboembolism
- Rare: embolic unusual cause
- Acute therapy: thrombolysis (intravenous); & endovascular therapy
- 2nd prevention depends on source of risk:
  - Heart
  - Large artery to brain
  - Small artery (in brain)
  - Blood itself

Ischemic stroke

Time is brain: Save the penumbra

Penumbra is zone of reversible ischemia around core of irreversible infarction—salvageable in first few hours after ischemic stroke onset.
Stroke Care in the Emergency Department

Bhuvaneshwari K. Dandapani, M.D.
Medical Director
Neuroscience Service Line
Health First

Principles of Acute Management
- Reperfusion (IV-tPA) + IA modalities
- Neuroprotection
- Increase Collateral Flow
- Prevent further harm

Brevard County Stroke Alert Form

CT with ICH

Stroke: Progression of CT findings
Day 1
Day 2
Day 5

MRI in acute stroke
(Kidwell, Saver, and Alger, 2000)

Multimodal MRI Imaging
- DWI, diffusion-weighted imaging
- PWI, perfusion-weighted imaging
- MRA, magnetic resonance angiography

Images courtesy of UCLA Stroke Center.

Multimodal CT Imaging
- CT, computed tomography
- PCT, positron computed tomography
- CTA, computed tomography angiography

Images courtesy of UCLA Stroke Center.
IV t-PA Indications

- hs (last time pt known to be nl) & CT c/w AIS < 3 h
- sx not minor or rapidly improving
- no shaking or staring at onset of sx
- no antithrombotic agent with elevated PT/PTT
- normal PT, PTT, plts, glucose
- sustained SBP < 185 and DBP < 110
- Seizure is relative (not absolute) t-PA contraindication

Are there more exclusions?

- Gastrointestinal or urinary tract hemorrhage within the last 21 days
- Arterial puncture, lumber puncture or internal biopsy within the last 7 days
- Glucose less than 50 or greater than 500mg/dl
- Seizure preceding or during the stroke (Todd’s Paralysis)
- Current or recent MI, percarditis, endocarditis or septic emboli
- Recent pregnancy
- Inflammatory bowel disease
- Active alcohol or drug abuse

IV t-PA Dose

- Total dose 0.9 mg/kg (maximum 90 mg)
- 10% as IV bolus over 1 min
- 90% as constant infusion over 60 min
- Give IV t-PA as early as possible
- better outcomes w/in 1.5 h than between 1.5 & 3 h
- IV t-PA is always given in ED, by ED personnel

IV tPA for Acute Ischemic Stroke: NINDS Trial

- Primary end point: Favorable outcome at 3 months
  - Defined as normal or near normal neurological function using a global scale that incorporated 4 commonly used scales
  - Odds ratio: 1.7 (95% CI, 1.2-2.6) favoring tPA over placebo
  - Includes an increased incidence of symptomatic ICH (4.5% vs 0.5%)

ECASS III: Results

- Median time to treatment: 3 hours 59 minutes
- 7.2% absolute improvement with tPA over placebo

How do I prepare to give t-PA?

- Weigh patient or get an accurate weight from family.
- Two IV sites that are functional.
- Insert Foley catheter.
- Review lab results, CT results with MD.
- Ensure discussion with MD and family and provide support and education.
- Check dosage with pharmacy, physician and or second RN
- Document the above!!!

How do you manage blood pressure for t-PA

- Remember SLOW AND STEADY
- Use the ischemic stroke blood pressure orders
- Drugs of choice
- Nicardipine/cardene
- labetalol

Using TPA in Routine Clinical Practice

- Overall only about 2-3% of stroke patients receive TPA, mostly 2nd time delays
- Efficacy = 12% absolute benefit (mRs 0,1 = nearly normal at 3 months)
- Rate of intracranial hemorrhage (ICH): 4-6%
- Risk of ICH increases with protocol violations – Time > 3 hrs, BP, dose, etc.
Where do I get the drug?
- In the ICUs the pharmacy will bring you (Hand carried) the drug.
- Check the dosage with the pharmacist.
- In the ER the drug is pulled from the Pyxis machine.
- Nursing is responsible for mixing, dosing, documentation of times and administration.

What is the dosage for IV t-pa?
- Total dose 0.9 mg/kg (maximum 90 mg).
- 10% of the drug is given over 1 min.bolus dose.
- 90% of the drug is given as a constant infusion over 60 minutes.
- Remember the sooner the drug given the better the outcomes.
- IV t-PA is always given in ED or in the ICU by RNs.
- The stroke team can administer the drug.
- Retavase or TNKase are not used in acute stroke.
- Stroke dosages are less than in myocardial infarctions.

Post t-PA management?
- Monitor and document vitals for q 15 minutes time 2 hours, q 30 minutes time 6 hours, then q 1 hour time 16 hours.
- Neuro exam q 4 hours 24 hours.
- Monitors for any bleeding, urine, abdomen, wound etc.
- Treat all consistent blood pressure systolic > 160 diastolic greater 105 as directed if no guidelines/orders call physician.
- No anticoagulant or antiplatelet agent should be given for 24 hrs.
- No IM injections, arterial punctures, subcutaneous injections or invasive procedures for 24 hours.
- NPO except meds unless otherwise ordered.
- Monitor I’s and O’s and document.

Post t PA care
- Change in neurological deterioration. Sudden increase in BP, headache, nausea vomiting.
- Stop the infusion. Check vital signs.
- Notify the physician.
- Obtain a Stat CT scan of the head to rule out an intracranial hemorrhage.
- Use stroke alert system.
- Perform an NIH Stroke Scale.

Blood Pressure Management
BP Management Immediately After an Acute Ischemic Stroke
What Antihypertensive Agents Are Appropriate for Use in the Acute Setting?

What if the patient is beyond the 3 hour window?
- All depends on the timing and size of the penumbra.
- Ischemic tissue which is functionally impaired.
- Is at risk of infarction.
- Potential to be salvaged by reperfusion and/or other strategies.
- Tissue salvage is associated with better clinical outcome.

Time to progression of stroke

Treatment Options
- Pharmaceutical:
  - Urokinase, tPA.
- Mechanical:
  - MERCI.
  - Penumbra.
  - X-Sizer device.
  - Snare.
  - Suction thrombectomy.

Endovascular Recanalization Strategies
- Intra-arterial fibrinolytics.
Recent clinical trials on Interventional therapy

- **SYNTHESIS:** Compared IA tpa vs IV tpa: No benefit of IA Rx (30.4% vs 34.8%)  
- **IMS III:** 40.8% (IV-IA) versus 38.7% (IV only) achieved MRS 0-2 at 90d (95% CI - 6.1 to 9.1). No benefit  

Good clinical outcome following angiographic reperfusion with IA therapy is strongly time-dependent. A 30-minute delay leads to a 10% relative reduction in the probability of a good outcome.

**MR RESCUE**

- MR within 8 hours from onset and whether thrombectomy improves outcome compares to standard medical therapy  
- Randomized multicenter trial to evaluate whether brain imaging (perfusion study) can identify patients most likely to benefit from acute stroke therapy  

**CONCLUSIONS:** Favorable penumbral pattern does not preferentially identify patients who differentially benefit from therapy, nor was embolectomy superior to standard care.

Interventional Stroke Management will be discussed in Pyramid III

Research in Stroke

**Advanced Ischemic Stroke Education**

**Hospital Management of Stroke**

- Five main reasons for admission:  
- Stabilization and prevention of progression of deficits  
- Identify etiology to prevent recurrence  
- Treat complications  
- Initiate Rehabilitation  
- Education

Acute Hospital Management
Acute stroke treatment in the ICU will be discussed in Pyramid III.
Management of ICH and Subarachnoid hemorrhage will be covered in Pyramid III.

**Most Common Complications of Acute Ischemic Stroke**

**Neurologic:**
- Cerebral Edema
- Hydrocephalus
- Increased intracranial pressure
- Intracranial hemorrhage

**Medical:**
- Hypertension
- Pneumonia
- Myocardial ischemia
- Anhydremia
- Deep Vein Thrombosis
- Pulmonary Embolism
- UTI
- Decubitis
- Stress Ulcers
- Meningitis
- Contusions and skull fractures

**Pneumonia in the stroke patient**
- Aspiration
- Atelectasis
- Ineffective airway clearance
- Bacterial infection
- Impaired level of consciousness

**Nursing Management for Prevention of Pneumonia**
- Assess patient’s respiratory status
- Turn patient every 2 hours
- Get patient out of bed at least twice a day
- Incentive spirometry every four hours
- Elevate the head of the bed 30%
- Aggressive pulmonary toilet
- Mouth care q 4 hours and prn

**Cardiac Dysrhythmia in the stroke patient**
- Don’t let the patient die of “Complications”
  - Monitor your patient’s Rhythm status
  - Check status of antithrombotic agents and anticoagulants frequently to avoid systemic and cerebral hemorrhage
  - Report all rhythm changes particularly new onset atrial fibrillation to the physician and document the strip
  - Obtain an EKG with all rhythm changes
  - Remember a stroke is a vascular disease and it does not just affect the brain.

**Deep Vein Thrombosis**
- Definition: DVT is the development of thrombi in the deep veins primarily the popliteal, femoral and iliac veins.
- Pathophysiology of a venous thrombosis includes blood stasis from immobility, changes in blood coagulability and damage to the vessel wall.
- Every stroke patient should be considered a risk for DVT and preventive measures should be considered the standard of care.

**Prevention is the standard of care**
- Once it has been established that the patient is stable get the patient moving.
- Initiate at least one of the following: subcutaneous heparin, or lovenox.
- Teds and compression stockings or Teds and Plexi boots
- Call the physician and get an order if one of these have not been initiated

**Prevention of Iatrogenic Complications**
- **Stress Ulcers**
  - Patient should be on an H2-Blocker if no history of Peptic Ulcer Disease
  - Patient should be on a Proton Pump Inhibitor if there is a history of GI bleeding, Peptic Ulcer Disease, or if a patient was on an H2-Blocker or Proton Pump Inhibitor prior to admission

**Pulmonary Embolism**
- Pathophysiology: caused by a clot from another site which detaches and lodges in the pulmonary artery.
- Prevention of DVT is primary for the stroke patient.
- Pulmonary embolisms cause severe hypoxia which increases the damage to the brain.
Nutritional Support
- Should be started as soon as possible (within 24 hours)
- Do not leave the patient without hydration.
- Aspiration is one of the most common sources of morbidity and mortality after a stroke. No feeding unless a formal evaluation is done (3oz swallowing test).
- Feeding tubes may be used if absolutely necessary. Check placement with two RNS then perform a Chest X-ray.
- They may be used for medications and bolus feeding if they are in the stomach.

Skin integrity in the stroke patient
- Immobility
- Incontinence
- Decreases sensation
- Inability to communicate discomfort
- All of these factors increase our patients risk for skin breakdown.

Skin integrity in the stroke patient
- Consult the ostomy nurse for any breakdown
- Evaluate the bed for the patients weight, activity level and nutritional status (albumin)
- Consult dietician for nutritional evaluation
- Turn the patient
- Protect the heels with waffle boots
- Use Proshield for incontinence

Infections including Urinary Tract Infections
- Prevention is the key
- Monitor intake and output
- Assess urine every shift for color, amount and strong odor
- Foley Catheter Care every shift
- Medicate with Acetaminophen for fevers greater than 100.5

Care of hemiparetic upper limb
- Contractures: Prevention, early mobilization, early rehabilitation and proper positioning.
- Subluxation: Shoulder support, positioning on a pillow, arm sling?
- Avoid edema but preventing dependency
- Consult Occupational therapy

Evaluation of etiology of stroke

Diagnostic Procedures
- Computed tomography (CT) scan
- Magnetic resonance imaging (MRI)
- Magnetic resonance angiography (MRA)
- Carotid ultrasound
- Echocardiography (2D and TEE)
- Transcranial Doppler ultrasonography
- CT Angiography
- Cerebral angiography (or arteriography)
- Laboratory tests including Lipid profile, Homocysteine levels (and hypercoagulable profile in select cases)

Acute infarct on MRI

MRA of Brain
Cerebellar Stroke

CTA: Carotid vessels

CTA: Cerebral Aneurysm

Cerebrovascular Disease: Pathogenesis

- Hemorrhagic Stroke (17%)
  - Intracerebral Hemorrhage (20%)
  - Spinal Subarachnoid Hemorrhage (15%)
- Ischemic Stroke (83%)
  - Embolic Stroke (20%)
  - Arterial Thrombotic Cerebrovascular Disease (20%)
- Lacunar (25%)
- Small Vessel Disease (30%)
- Cryptogenic (30%)

Intracerebral Hemorrhage (59%)

Subarachnoid Hemorrhage (41%)


Stroke Subtypes

- Ischemic:
  - Cerebral Infarction
- Hemorrhagic:
  - Intracerebral Hemorrhage
  - Subarachnoid Hemorrhage

Cryptogenic 30-40%

Lacunar 25-30%

Cardioembolic 20%

Extracranial ASO 10-15%

Intracranial ASO 10-15%

Options for Stroke Prevention

- Risk factor modification
  - Hypertension, diabetes, cigarette smoking, homocysteine, exercise, avoid HRT
  - Carotid surgery, carotid stenting
- Anticoagulation for emboli
- Antiplatelet therapy
- ACE Inhibitors
- Statin therapy