Acute Ischemic Stroke Protocol

Document Number: PROT-2024-007 **Effective Date:** January 1, 2024 **Last Revised:** January 1, 2024 **Department:** Emergency Medicine / Neurology / Neurosurgery **Approved By:** Chief Medical Officer, Stroke Committee, Medical Executive Committee **Review Cycle:** Annual **Evidence Base:** American Heart Association/American Stroke Association Guidelines (2019/2024)

I. PURPOSE AND SCOPE

A. Purpose

This protocol outlines the acute management of patients presenting with acute ischemic stroke to maximize neurological recovery and minimize disability. The objectives are to:

1. Enable rapid identification and triage of stroke patients ("Time is Brain")
2. Facilitate expedited diagnostic evaluation and treatment decisions
3. Maximize eligibility for acute stroke therapies (IV thrombolysis and mechanical thrombectomy)
4. Meet national benchmarks for stroke care (door-to-needle time <60 minutes, door-to-puncture time <90 minutes)
5. Reduce stroke-related mortality and long-term disability
6. Maintain accreditation as a Comprehensive Stroke Center (or Primary Stroke Center)

B. Scope

Applies to:

- All adult patients (≥18 years) presenting with acute stroke symptoms to the Emergency Department or developing acute stroke as inpatients
- All clinical staff involved in acute stroke care (ED, neurology, interventional neuroradiology, ICU, nursing, imaging, laboratory)

Does NOT cover:

- Pediatric stroke (separate protocol)
- Hemorrhagic stroke management (covered in separate ICU protocol, though initial evaluation overlaps)
- Stroke prevention and secondary prevention (outpatient neurology guidelines)
- Rehabilitation (covered by PM&R)

C. Key Concepts

"Time is Brain":

- In acute ischemic stroke, ~2 million neurons die per minute without reperfusion
- Rapid treatment is essential: IV tPA within 3-4.5 hours, mechanical thrombectomy up to 24 hours in select patients
- Every minute saved improves outcomes

Treatment Windows:

- **IV tPA:** 0-3 hours (standard); 3-4.5 hours (extended window with criteria)
- **Mechanical Thrombectomy for LVO:** 0-6 hours (all eligible); 6-24 hours (based on advanced imaging selection)

II. DEFINITIONS AND STROKE RECOGNITION

A. Stroke Definitions

Ischemic Stroke: Acute focal neurological deficit caused by vascular occlusion (thrombosis or embolism) resulting in brain infarction.

Transient Ischemic Attack (TIA): Transient episode of neurological dysfunction caused by focal ischemia without acute infarction (symptoms resolve, usually <1 hour, no permanent damage on imaging).

Large Vessel Occlusion (LVO): Stroke caused by occlusion of a major intracranial artery (internal carotid artery, middle cerebral artery M1/M2, basilar artery) – candidate for mechanical thrombectomy.

Stroke Mimic: Condition presenting with stroke-like symptoms but not caused by ischemic stroke (e.g., seizure with Todd's paralysis, migraine with aura, hypoglycemia, conversion disorder, brain tumor). Rapid evaluation distinguishes true strokes from mimics.

B. FAST Screening Tool (Public Education)

FAST is a simple tool used by EMS and the public to recognize stroke:

- **F - Face Drooping:** One side of the face droops or is numb. Ask person to smile; is smile uneven?
- **A - Arm Weakness:** One arm is weak or numb. Ask person to raise both arms; does one drift

downward?
- **S - Speech Difficulty:** Speech is slurred or person has trouble speaking. Ask person to repeat a simple phrase; is speech slurred or strange?
- **T - Time to Call 911:** If any of these signs are present, call 911 immediately. Note the time symptoms began.

C. NIH Stroke Scale (NIHSS)

The **NIHSS** is a standardized, quantitative measure of stroke severity (score 0-42, higher = more severe).

Components:

1. Level of consciousness (alert, drowsy, stuporous, coma)
2. Gaze (eye movement)
3. Visual fields
4. Facial palsy
5. Motor arm (left and right)
6. Motor leg (left and right)
7. Limb ataxia
8. Sensory
9. Language (aphasia)
10. Dysarthria
11. Extinction/Inattention (neglect)

Interpretation:

- **0:** No stroke symptoms
- **1-4:** Minor stroke
- **5-15:** Moderate stroke
- **16-20:** Moderate-to-severe stroke
- **21-42:** Severe stroke

NIHSS is performed by the stroke team (neurologist, stroke-trained RN, or ED physician) and documented at baseline, after tPA (if given), at 24 hours, and at discharge. It guides treatment decisions (e.g., high NIHSS with LVO consider thrombectomy).

III. PREHOSPITAL AND EMS COORDINATION

A. Prehospital Stroke Identification

EMS personnel use FAST or similar stroke scale (e.g., Cincinnati Prehospital Stroke Scale, Los

Angeles Prehospital Stroke Screen) to identify stroke in the field.

EMS Actions:

1. **Recognize stroke** using screening tool
2. **Determine last known well (LKW) time** – This is CRITICAL. Ask patient/family: "When was the patient last seen normal/at baseline?" If unknown (e.g., wake-up stroke), record time patient was last known to be without symptoms.
3. **Notify receiving hospital** with pre-arrival alert: "Stroke Alert incoming, ETA 10 minutes, last known well time [XX:XX]"
4. **Assess and stabilize ABCs** (airway, breathing, circulation)
5. **Obtain blood glucose** (rule out hypoglycemia as stroke mimic)
6. **Do NOT delay transport** for IV access or other interventions (can be done en route)
7. **Transport to appropriate stroke center:** Primary Stroke Center for all strokes; Comprehensive Stroke Center for suspected LVO (if regional triage protocols in place)

EMS Pre-Notification: Our ED is notified by EMS dispatch and EMS radio. Upon receiving pre-alert:

- **ED Charge Nurse activates the Stroke Team** (overhead page or pager alert)
- **Stroke Room prepared** (Room [X] in our ED, with rapid CT access)
- **Stroke Team assembles** (see Section IV)

B. Direct-to-CT Protocol

For EMS-identified stroke patients arriving within potential tPA window (<4.5 hours from LKW):

- EMS may bring patient **directly to CT scanner** (bypassing ED triage/room if CT available and pre-alert given)
- ED nurse and physician meet patient at CT
- Streamlines care and reduces door-to-imaging time

IV. CODE STROKE ACTIVATION

A. Criteria for Code Stroke

Activate Code Stroke (stroke alert) for any patient with:

- Sudden onset of focal neurological deficit (weakness, numbness, speech difficulty, vision loss, ataxia, altered mental status, severe headache)
- Symptom onset (or last known well) within **24 hours** (even if >4.5 hours, patient may be thrombectomy candidate)

Also activate for:

- In-hospital patients who develop acute stroke symptoms (especially post-op, post-procedure)

Do NOT delay Code Stroke for imaging or detailed history – activate immediately based on clinical suspicion.

B. How to Activate Code Stroke

From ED:

- ED physician or nurse calls overhead page: "Code Stroke, Emergency Department"
- Or presses Code Stroke button in EHR (auto-pages stroke team)

From Inpatient Unit:

- Call hospital operator: "Code Stroke, [Unit/Room Number]"
- Operator pages Stroke Team

From Outside Hospital (Transfer):

- Referring hospital calls our transfer center and Stroke Team is alerted for incoming transfer

C. Stroke Team Composition

Upon Code Stroke activation, the following team members respond:

1. **Stroke Neurologist** (or Neurology Resident if academic center; attending notified) – Team Leader
2. **ED Attending Physician**
3. **Stroke-Certified RN** (ED stroke nurse)
4. **Radiology Technologist** (CT/MRI)
5. **Radiologist** (to read CT STAT)
6. **Pharmacy** (prepare tPA if indicated)
7. **Lab** (STAT labs)
8. **Interventional Neuroradiologist (INR)** – On call 24/7, alerted if LVO suspected (for thrombectomy)
9. **Neurosurgery** (notified if needed for hemorrhage or other surgical issue)
10. **Anesthesiology** (if airway support needed or for thrombectomy)

Response Time:

- Stroke neurologist arrives within **15 minutes** of Code Stroke (if on-site) or provides remote evaluation via telemedicine ("telestroke") if off-site
- CT scan obtained within **25 minutes of arrival** (door-to-imaging goal: <25 minutes for 50% of patients)
- CT read by radiologist within **45 minutes** of arrival (door-to-read goal)

V. INITIAL ASSESSMENT AND STABILIZATION (FIRST 10 MINUTES)

A. Primary Survey (ABCs)

Airway:

- Ensure patent airway
- Positioning: Head of bed 15-30 degrees (flat is acceptable to improve cerebral perfusion, unless concern for aspiration; do not put head down)
- Avoid neck flexion (may impair venous drainage)

Breathing:

- Assess respiratory rate, effort, and oxygenation
- Apply supplemental oxygen
  only if hypoxic
  (SpO_2 <94%)
  - Evidence: Routine oxygen in non-hypoxic patients does NOT improve outcomes and may be harmful (hyperoxia can cause vasoconstriction)

- Target SpO_2: 94-98%

Circulation:

- Obtain IV access (at least one large-bore IV; preferably two)
- Administer **normal saline at KVO rate** (avoid hypotonic fluids like D5W, which can worsen cerebral edema; avoid excessive fluids causing hypervolemia)
- Cardiac monitoring (watch for atrial fibrillation, arrhythmias)

Blood Pressure:

- **DO NOT lower BP acutely in most ischemic stroke patients** (permissive hypertension maintains cerebral perfusion to penumbra)
- Exceptions: Lower BP if giving tPA (see Section VI.C) or if BP is dangerously high (SBP >220 mmHg, DBP >120 mmHg) or patient has aortic dissection, acute MI, acute pulmonary edema

Blood Glucose:

- **Check blood glucose immediately** (point-of-care fingerstick)
- **Treat hypoglycemia (<60 mg/dL) promptly:** Give D50W 50 mL IV push (or dextrose gel PO if patient can swallow)
- Hypoglycemia can mimic stroke; symptoms may resolve after glucose correction
- Also treat severe hyperglycemia (>400 mg/dL) with insulin, as hyperglycemia worsens stroke outcomes

B. Focused History (Obtained Concurrently with Exam)

Key Questions (often asked of family/EMS if patient cannot communicate):

1. **Last Known Well (LKW) Time:**
   "When was the patient last seen at baseline without symptoms?"
   - For wake-up stroke or unclear onset: LKW is when patient was last awake and symptom-free (typically bedtime the night before)
   - This determines tPA and thrombectomy eligibility

2. **Symptom Onset:** What symptoms? Sudden or gradual? Progression?
3. **Current Medications:** Especially anticoagulants (warfarin, DOACs), antiplatelets (aspirin, clopidogrel)
4. **Past Medical History:**

   - Prior stroke or TIA?
   - Cardiovascular disease (MI, atrial fibrillation, heart failure)?
   - Diabetes, hypertension, hyperlipidemia?

5. **Recent Medical Events:**

   - Recent surgery (<14 days)?
   - Recent trauma or head injury?
   - Recent GI or urinary bleeding?
   - Recent myocardial infarction (<3 months)?

6. **Contraindications to tPA** (see Section VI for full checklist)

C. Rapid Neurological Examination

Stroke Neurologist or ED Physician performs:

- **Mental Status:** Level of consciousness, orientation, attention, language (can patient speak, understand, repeat, name objects?)
- **Cranial Nerves:** Especially facial symmetry, eye movements, visual fields
- **Motor:** Strength in arms and legs (0-5 scale), pronator drift
- **Sensation:** Gross sensation to light touch

- **Coordination:** Finger-to-nose, heel-to-shin (if patient able)
- **Gait:** If safe (many stroke patients cannot stand/walk)
- **NIHSS Score:** Calculated and documented

Document findings clearly for serial comparison (repeat neuro exams to assess for improvement or worsening).

VI. IMAGING AND DIAGNOSTICS (10-25 MINUTES)

A. Immediate Non-Contrast Head CT

Purpose: Rule out hemorrhage (contraindication to tPA) and assess for early ischemic changes.

Goal: Obtain head CT within **25 minutes of arrival** (door-to-imaging time).

Protocol:

- **Non-contrast CT head** – initial study
- Patient goes directly from ED to CT scanner (or from ambulance bay to CT per direct-to-CT protocol)

Interpretation:

- **Hemorrhage:** If intracranial hemorrhage (ICH) present, **STOP** – patient is NOT a candidate for tPA; manage as hemorrhagic stroke (neurosurgery consult, BP control, reverse anticoagulation if applicable)
- **No Hemorrhage:** Proceed with tPA evaluation
- **Early Ischemic Changes:** May see subtle signs (loss of gray-white differentiation, sulcal effacement, hyperdense vessel sign) but often CT is normal in hyperacute stroke (<3-6 hours)
- **Large Established Infarct:** If large area of hypodensity (>1/3 MCA territory), tPA may be higher risk, but decision individualized

CT Angiography (CTA) of Head and Neck: Obtained **simultaneously or immediately after non-contrast CT** if patient is a potential tPA/thrombectomy candidate and there is NO contraindication to IV contrast (renal function permitting).

Purpose:

- Detect large vessel occlusion (LVO) – ICA, MCA M1/M2, basilar artery
- Assess collateral circulation

- Identify dissection or stenosis

If LVO is identified: Immediately alert Interventional Neuroradiology (INR) team for possible mechanical thrombectomy.

CT Perfusion (Optional): Some centers perform CT perfusion (CTP) to assess ischemic core vs. salvageable penumbra. Useful for patient selection in extended time windows (>6 hours), but should NOT delay tPA administration in early window.

B. Laboratory Tests (Obtained Simultaneously with Imaging)

STAT Labs:

- **Complete Blood Count (CBC):** Platelet count (thrombocytopenia <100k is relative contraindication to tPA)
- **PT/INR and aPTT:** If on warfarin or heparin (INR >1.7 is contraindication to tPA; heparin with elevated aPTT is contraindication)
- **Blood Glucose:** (already checked at bedside)
- **Basic Metabolic Panel (BMP):** Creatinine (for contrast), electrolytes
- **Troponin:** (stroke can cause troponin elevation; also rule out concurrent MI)
- **Pregnancy test** (for women of childbearing age)

Do NOT wait for lab results to give tPA if patient is otherwise eligible and labs are not expected to reveal contraindications (e.g., patient not on anticoagulants, no bleeding history, platelet count normal on recent labs). **Give tPA and check labs concurrently.** If a contraindication is discovered after tPA started, stop the infusion.

C. ECG

Obtain 12-lead ECG to:

- Detect atrial fibrillation (common cause of embolic stroke)
- Rule out acute MI (may present with stroke-like symptoms or occur concurrently)

VII. IV THROMBOLYSIS (tPA) – THE HOUR-1 GOAL

A. Overview

Alteplase (tPA) is a fibrinolytic (clot-busting) medication that can restore blood flow in acute ischemic stroke.

Goal: Administer tPA within **60 minutes of patient arrival** (door-to-needle time) for eligible patients.

Evidence: IV tPA significantly improves outcomes if given within 3 hours of symptom onset (NNT ~10 to improve disability outcome). Benefit extends to 3-4.5 hours in select patients.

B. Inclusion Criteria for IV tPA

All of the following must be met:

1. **Clinical diagnosis of acute ischemic stroke** with measurable neurological deficit (NIHSS >0, but clinical judgment for very mild or rapidly improving strokes)
2. **Onset <3 hours:**
   Symptom onset (or last known well) within 3 hours of anticipated tPA administration (standard window)
   - OR **Onset 3-4.5 hours (extended window):** If patient meets extended window criteria (see below)

3. **Age ≥18 years** (adult protocol)
4. **CT head shows no hemorrhage** and no large established infarct (>1/3 MCA territory)
5. **No contraindications** (see below)

Extended Window (3-4.5 hours) Additional Criteria:

- Age <80 years
- No history of both diabetes AND prior stroke
- NIHSS ≤25
- Not taking oral anticoagulants (regardless of INR)

(If patient does not meet extended criteria, they are not eligible for tPA in the 3-4.5 hour window, but MAY still be thrombectomy candidate if LVO present.)

C. Absolute Contraindications to IV tPA

Do NOT give tPA if any of the following:

1. **Intracranial hemorrhage** on CT (ICH, SAH, subdural, epidural)
2. **Severe uncontrolled hypertension at time of treatment:**
   - SBP >185 mmHg or DBP >110 mmHg despite BP-lowering treatment
   - (Must lower BP to <185/110 before tPA; see Section VII.G)

3. **Active internal bleeding** or acute trauma/fracture
4. **History of intracranial hemorrhage** (ever)
5. **Ischemic stroke within past 3 months**
6. **Intracranial or intraspinal surgery within 3 months**
7. **Known intracranial vascular malformation, aneurysm, or tumor**
8. **Severe head trauma within 3 months**
9. **GI or urinary tract bleeding within past 21 days**
10. **Arterial puncture at non-compressible site within 7 days**
11. **Coagulopathy:**

    - Platelets <100,000/mm³
    - INR >1.7 (or on warfarin)
    - aPTT elevated (or received therapeutic heparin within 48 hours)
    - Received a dose of LMWH within 24 hours
    - Taking direct thrombin inhibitors or factor Xa inhibitors (DOACs) in past 48 hours (unless specific assays normal or time since last dose >48 hours)

12. **Pregnancy** (relative contraindication; may give if life-threatening stroke and benefit outweighs risk after discussion)
13. **Infective endocarditis**
14. **Aortic arch dissection**
15. **Glucose <50 mg/dL or >400 mg/dL** (correct first and reassess; if symptoms persist after glucose correction, proceed with tPA if still in window)

D. Relative Contraindications and Clinical Judgment

The following are relative contraindications (may still give tPA after risk-benefit discussion):

- Very mild or rapidly improving stroke symptoms (risk of hemorrhage may outweigh benefit, but some patients still worsen; individualize)
- Major surgery within 14 days (but not within 3 months, which is absolute)
- Recent MI within 3 months (but not absolute contraindication; consider risk of cardiac rupture)
- Seizure at stroke onset with residual deficits (may be Todd's paralysis mimicking stroke, but if true stroke confirmed, treat)

Clinical Judgment: Stroke neurologist and team weigh risks (primarily hemorrhage, ~6% symptomatic ICH risk with tPA) vs. benefits (potential for significant recovery). In borderline cases, discuss with patient/family if feasible (time permitting) and make shared decision.

E. Informed Consent

Obtain informed consent if possible and time permits (should not delay tPA administration).

Who to consent: Patient (if able to understand) or family/healthcare proxy

Discussion Points:

- tPA may improve stroke outcomes (increase chance of little or no disability)
- Risk of bleeding, especially brain hemorrhage (~6% symptomatic ICH; ~15-17% total ICH)
- If tPA not given, patient faces high risk of permanent disability from stroke
- tPA is standard of care for eligible patients

If patient/family not available or patient unable to consent and no proxy available: tPA may be given under emergency implied consent doctrine (life-threatening condition, standard of care treatment).

Document: Consent discussion and who consented (or reason consent not obtained) in medical record.

F. tPA Dosing and Administration

Dose:

- **0.9 mg/kg** (maximum dose 90 mg)
- Example: 70-kg patient 63 mg total

Administration:

1. Calculate dose based on actual body weight
2. Give **10% as IV bolus** over 1 minute (e.g., 6.3 mg bolus for 70-kg patient)
3. Give remaining **90% as continuous IV infusion** over 60 minutes (e.g., 56.7 mg over 60 min)

Preparation:

- Pharmacy prepares tPA (reconstituted from powder or supplied as solution)
- **Should be ready within 15-20 minutes** of order (STAT preparation)

Monitoring During and After tPA:

- **Blood pressure:**
  Check every 15 minutes during infusion and for 2 hours after, then every 30 minutes for 6 hours, then hourly until 24 hours
  - **Keep BP <180/105 mmHg** during and after tPA (BP spikes can increase hemorrhage risk; treat per protocol, see below)

- **Neurological checks:**
  Every 15 minutes during infusion, then hourly for 24 hours
  - If patient develops severe headache, nausea/vomiting, acute hypertension, or neurological worsening **STOP tPA infusion**, obtain STAT CT head (rule out hemorrhagic

transformation), and notify neurology/neurosurgery

Post-tPA Care:

- **No antiplatelet or anticoagulant medications for 24 hours** after tPA (to reduce hemorrhage risk)
- **No nasogastric tube, Foley catheter, or arterial punctures** for 24 hours if possible (if needed, use smaller gauge and apply pressure)
- **Repeat head CT at 24 hours** post-tPA (or sooner if neurological worsening) before starting antiplatelet/anticoagulant therapy

G. Blood Pressure Management for tPA

Pre-tPA: If BP is >185/110, must lower to ≤185/110 before giving tPA.

Agents:

- **Labetalol 10-20 mg IV push** over 1-2 minutes; may repeat every 10 minutes (max cumulative dose 300 mg)
- **Nicardipine IV infusion:** Start at 5 mg/hr, titrate by 2.5 mg/hr every 5-15 minutes to goal (max 15 mg/hr)
- **Hydralazine 10 mg IV push** (less predictable, not preferred)

If BP cannot be lowered to <185/110 after reasonable attempts, patient is NOT a tPA candidate (do not give tPA).

During and After tPA (first 24 hours): Goal BP <180/105.

If BP >180/105:

- Labetalol or nicardipine as above
- If refractory, consider esmolol IV or other agents; consult neurology

After 24 Hours: Permissive hypertension may be allowed (BP up to 220/120) unless patient is on anticoagulation or has other comorbidities requiring BP control. See Section IX.

VIII. MECHANICAL THROMBECTOMY (ENDOVASCULAR THERAPY)

A. Overview

Mechanical thrombectomy is the endovascular removal of a blood clot from a large intracranial vessel using a stent retriever or aspiration catheter.

Goal: Achieve reperfusion in patients with large vessel occlusion (LVO).

Evidence: Multiple trials (MR CLEAN, ESCAPE, EXTEND-IA, SWIFT PRIME, REVASCAT) showed dramatic benefit of thrombectomy in LVO strokes (NNT ~3-5 for good outcome).

Timing Goals:

- **Door-to-groin puncture time** <90 minutes (for direct arrivals)
- **Groin puncture-to-reperfusion time** <60 minutes

B. Indications for Mechanical Thrombectomy

Patients with acute ischemic stroke due to LVO in the anterior circulation (ICA, MCA-M1, proximal M2) or basilar artery:

Early Window (0-6 hours from LKW):

- LVO on CTA
- NIHSS ≥6 (moderate to severe stroke)
- Age ≥18 years
- Pre-stroke modified Rankin Scale (mRS) 0-1 (patient was independent)
- ASPECTS score ≥6 (small ischemic core, significant salvageable brain) on CT or MRI

Extended Window (6-24 hours from LKW):

- LVO on CTA
- Meet criteria from DAWN or DEFUSE-3 trials (mismatch between clinical deficit and infarct core on advanced imaging):
  - **DAWN criteria:** Age, NIHSS, and infarct core size on CT perfusion or MRI (patients with large penumbra relative to small core)
  - **DEFUSE-3 criteria:** Mismatch ratio ≥1.8 and ischemic core <70 mL

- Essentially: Patients with salvageable brain tissue detected on imaging (CT perfusion or MRI diffusion-perfusion mismatch)

Basilar Artery Occlusion:

- May be treated up to 24 hours (or even beyond) given poor natural history (high mortality without reperfusion)

Thrombectomy can be performed WITH or WITHOUT IV tPA (if patient is not tPA-eligible but is thrombectomy-eligible, proceed with thrombectomy alone).

C. Thrombectomy Process

Activation:

1. **CTA shows LVO** → Interventional Neuroradiologist (INR) immediately notified (paged, called)
2. **INR reviews imaging** and confirms thrombectomy candidacy
3. **Consent obtained** from patient/family (procedure risks: hemorrhage, vessel perforation, distal embolization, groin hematoma; benefits: potential for dramatic recovery)
4. **Patient transported to angiography suite (cath lab)**

Team:

- Interventional Neuroradiologist (performs procedure)
- Anesthesiologist (moderate sedation or general anesthesia; general anesthesia preferred in some centers for airway control)
- Interventional radiology technologist and nurses
- Stroke neurologist (monitors patient)

Procedure:

- Femoral artery access (groin puncture)
- Guide catheter advanced to proximal vessel (ICA)
- Microcatheter navigated past the clot
- **Stent retriever deployed** (device expands and enmeshes clot) and pulled back, or **aspiration catheter** used to suction clot
- Multiple passes may be needed
- Goal: **TICI 2b-3 reperfusion** (Thrombolysis in Cerebral Infarction scale: 2b = >50% reperfusion, 3 = complete reperfusion)
- Average procedure time ~60-90 minutes

Post-Procedure:

- Patient to ICU (neuro ICU)
- Hemostasis at groin site (manual pressure or closure device)
- Close neuro monitoring for hemorrhage, reperfusion injury, groin complications

Outcomes:

- ~50-70% of thrombectomy patients achieve good functional outcome (mRS 0-2 at 90 days) vs. ~20-30% with medical management alone (dramatic benefit)

IX. SUPPORTIVE ACUTE CARE (POST-tPA OR IF NOT tPA CANDIDATE)

A. Admission and Monitoring

All acute stroke patients admitted to:

- **Stroke Unit or Neuroscience ICU** (depending on severity)
- Specialized stroke care (dedicated nurses, protocols) improves outcomes

Monitoring (first 24 hours):

- **Neuro checks:** Hourly (or more frequent if unstable) to detect early worsening (hemorrhage, cerebral edema, re-occlusion)
- **Vital signs:** Every 2-4 hours (BP, HR, RR, temp, O_2 sat)
- **Cardiac telemetry:** Continuous (detect atrial fibrillation, arrhythmias)
- **NPO status** until swallow screen passed (aspiration risk)

B. Blood Pressure Management (After Acute Phase)

If tPA was given: Keep BP <180/105 for first 24 hours (as above).

If tPA NOT given or after 24 hours post-tPA:

- **Permissive hypertension** is generally recommended in acute ischemic stroke (first 48-72 hours) to maintain cerebral perfusion to ischemic penumbra
- **Do NOT treat BP unless:**
  - SBP >220 mmHg or DBP >120 mmHg
  - Patient has other acute conditions (acute MI, aortic dissection, acute pulmonary edema, hypertensive encephalopathy)
  - Patient will undergo thrombolysis or thrombectomy (then <185/110 as above)

If BP lowering is needed:

- Reduce BP by ~15% in first 24 hours (avoid precipitous drops, which can worsen ischemia)

- Use labetalol or nicardipine IV

After acute phase (day 3+):

- Restart or initiate oral antihypertensives for long-term BP control (goal <130/80 for secondary prevention per hypertension guidelines)

C. Temperature Management

Treat fever aggressively:

- **Goal:** Normothermia (<38°C / 100.4°F)
- Fever worsens stroke outcomes (increases metabolic demand, edema, infarct size)
- **Interventions:** Acetaminophen 650 mg PO/PR every 6 hours; cooling blankets if needed; identify and treat source of fever (pneumonia, UTI)

Avoid hypothermia (<36°C): Shivering increases metabolic demand; rewarm slowly if hypothermic

D. Glucose Management

Avoid hyperglycemia and hypoglycemia:

- **Goal:** Blood glucose 140-180 mg/dL in acute phase
- Hyperglycemia (>180 mg/dL) worsens stroke outcomes (increases hemorrhagic transformation, infarct size)
- Hypoglycemia (<70 mg/dL) can worsen brain injury and mimic stroke worsening

Management:

- Check blood glucose every 4-6 hours initially
- Subcutaneous insulin sliding scale or IV insulin infusion (if ICU) as needed
- Avoid dextrose-containing IV fluids unless treating hypoglycemia

E. Swallow Evaluation and Aspiration Prevention

All stroke patients are at risk for dysphagia (difficulty swallowing) and aspiration.

Swallow Screen:

- Performed by RN within 4 hours of arrival (before giving any PO meds, food, or liquids)

- Simple bedside test (e.g., 3-ounce water swallow test)
- If screen is failed or patient has bulbar symptoms **NPO** and formal swallow evaluation by speech-language pathologist (SLP)

Formal Swallow Evaluation:

- SLP assessment (clinical swallow eval, or videofluoroscopy if high risk)
- Determines safety of PO intake and diet modifications (puree, thickened liquids, etc.)

If NPO:

- IV fluids for hydration
- NG tube or PEG tube for nutrition if prolonged NPO expected (>3-5 days)

Aspiration Pneumonia Prevention:

- Head of bed elevated 30-45 degrees during and after meals
- Good oral hygiene

F. Antiplatelet and Anticoagulation Therapy

Aspirin:

- Give **aspirin 325 mg PO** (or per rectum if NPO) within **24-48 hours** of stroke onset for most ischemic stroke patients
- **Exception:** If tPA was given, **delay aspirin until 24 hours after tPA** (and after repeat head CT confirms no hemorrhage)
- Aspirin reduces early recurrent stroke risk

Anticoagulation (for atrial fibrillation or other indication):

- **Do NOT start anticoagulation acutely** (first 24 hours, or longer depending on stroke size)
- **Timing of anticoagulation initiation:**
    - For small strokes (e.g., lacunar, small cortical): May start after 3-5 days
    - For moderate strokes: 7-10 days
    - For large strokes: 10-14 days (risk of hemorrhagic transformation with early anticoagulation)

- Use individualized assessment (cardiology/neurology consult); consider CHA_2DS_2-VASc score (stroke risk if not anticoagulated) vs. size of infarct and bleeding risk
- **Preferred agents:** Direct oral anticoagulants (DOACs: apixaban, rivaroxaban, dabigatran, edoxaban) over warfarin for atrial fibrillation (unless mechanical heart valve or severe mitral stenosis, where warfarin required)

G. DVT Prophylaxis

All stroke patients should receive VTE prophylaxis:

- **Mechanical:** Intermittent pneumatic compression devices (SCDs) on legs (start immediately, including patients with leg weakness)
- **Pharmacologic:** Subcutaneous heparin (5000 units Q8-12H) or enoxaparin (40 mg daily) after 24 hours (or sooner if hemorrhagic stroke ruled out and low bleeding risk)
- Immobilized stroke patients are at high risk for DVT/PE

X. SECONDARY PREVENTION WORKUP

Once patient is stabilized, identify stroke etiology to guide secondary prevention.

A. Stroke Etiology Classification (TOAST Criteria)

1. **Large-artery atherosclerosis** (e.g., carotid stenosis)
2. **Cardioembolism** (e.g., atrial fibrillation, left ventricular thrombus)
3. **Small-vessel occlusion** (lacunar stroke)
4. **Other determined cause** (e.g., dissection, hypercoagulable state, vasculitis)
5. **Undetermined** (cryptogenic stroke – no clear cause found)

B. Diagnostic Workup

Vascular Imaging:

- **Carotid Doppler ultrasound** (assess for carotid stenosis)
- **CTA head/neck** or **MRA** (often already done acutely)
- If severe carotid stenosis (≥70% symptomatic), patient may be candidate for **carotid endarterectomy (CEA)** or **carotid artery stenting (CAS)** (preferably within 2 weeks of stroke for maximum benefit)

Cardiac Evaluation:

- **ECG and telemetry** (detect atrial fibrillation)
- **Transthoracic echocardiogram (TTE)** (assess for structural heart disease, LV thrombus, valvular disease, PFO)
- Consider **transesophageal echocardiogram (TEE)** if TTE non-diagnostic and concern for cardiac source (e.g., suspected left atrial appendage thrombus, PFO with atrial septal aneurysm, aortic arch atheroma)
- **Extended cardiac monitoring** (e.g., 30-day event monitor or implantable loop recorder) in cryptogenic stroke to detect paroxysmal atrial fibrillation

Laboratory Tests:

- **Lipid panel** (initiate statin for secondary prevention)
- **Hemoglobin A1c** (screen for diabetes)
- **Hypercoagulable workup** (if young stroke <55 years, or recurrent strokes, or family history): Protein C/S, antithrombin III, Factor V Leiden, prothrombin gene mutation, antiphospholipid antibodies, lupus anticoagulant
- **Inflammatory markers** (ESR, CRP) if vasculitis suspected
- **Toxicology screen** in young patients (cocaine, amphetamines can cause stroke)

XI. REHABILITATION AND DISCHARGE PLANNING

A. Early Rehabilitation

Start rehab services as soon as patient is medically stable (even within first 24-48 hours if appropriate).

Multidisciplinary Team:

- **Physical Therapy (PT):** Mobility, gait training, strengthening
- **Occupational Therapy (OT):** ADLs (dressing, bathing, feeding), fine motor skills
- **Speech-Language Pathology (SLP):** Swallowing, speech (aphasia), cognitive-communication

Benefits:

- Early mobilization reduces complications (pneumonia, DVT, deconditioning)
- Intensive rehab in first weeks-months maximizes neuroplasticity and recovery

B. Disposition

Discharge Destination based on functional status:

- **Home with home health or outpatient therapy:** Mild deficits, adequate support
- **Acute Inpatient Rehabilitation Facility:** Moderate-severe deficits, can tolerate 3 hours of therapy per day, good rehab potential
- **Skilled Nursing Facility (SNF):** Severe deficits, cannot tolerate intensive rehab
- **Long-Term Acute Care Hospital (LTACH):** If prolonged ventilator dependence or complex medical needs

C. Discharge Medications and Education

Prescriptions:

- **Antiplatelet:** Aspirin 81 mg daily (or clopidogrel 75 mg daily if aspirin intolerant), or dual antiplatelet therapy (aspirin + clopidogrel) for 21 days if high-risk minor stroke/TIA per POINT or CHANCE trials
- **Anticoagulant:** If atrial fibrillation (DOAC preferred)
- **Statin:** High-intensity statin (atorvastatin 80 mg or rosuvastatin 20-40 mg) for all ischemic stroke patients
- **Antihypertensive:** Target BP <130/80 (start or continue medications)
- **Diabetes medications:** If diabetic

Patient/Family Education:

- **FAST signs of stroke** – call 911 immediately if symptoms recur
- Medication adherence (importance of antiplatelet/anticoagulant/statin)
- Risk factor modification (quit smoking, exercise, healthy diet, BP control, diabetes control)
- Follow-up appointments (neurology, primary care, cardiology)
- Driving restrictions (many states require MD clearance after stroke)

XII. QUALITY METRICS AND CONTINUOUS IMPROVEMENT

A. Key Performance Indicators

Our Stroke Program tracks:

1. **Door-to-Imaging Time:** % of patients with CT within 25 minutes (Goal >50%)
2. **Door-to-Needle Time:** % of tPA patients treated within 60 minutes (Goal >75%)
3. **Door-to-Puncture Time:** % of thrombectomy patients with groin puncture within 90 minutes (Goal >50%)
4. **tPA Treatment Rate:** % of eligible stroke patients who receive tPA (Goal >80% of eligible)
5. **Early Aspirin:** % of patients who receive aspirin within 48 hours (Goal >95%)
6. **Statin at Discharge:** % of patients discharged on statin (Goal >95%)
7. **DVT Prophylaxis:** % of patients who receive VTE prophylaxis (Goal 100%)
8. **Swallow Screen:** % of patients screened before PO intake (Goal 100%)
9. **Stroke Education:** % of patients/families who receive stroke education (Goal 100%)

Benchmarking: Compare to national Get With The Guidelines-Stroke (GWTG-Stroke) data and state stroke registry.

B. Stroke Code Debriefing

After each Code Stroke, conduct a team debrief (within 24-48 hours) to review:

- Timeline (were goals met?)
- Communication (did team work smoothly?)
- Any barriers or delays?
- Opportunities for improvement

C. Accreditation

Maintain **Comprehensive Stroke Center (or Primary Stroke Center) certification** via The Joint Commission or DNV, which requires:

- 24/7 stroke team availability
- Advanced imaging (CTA, MRI)
- Neurosurgery and interventional neuroradiology services (for Comprehensive)
- Compliance with evidence-based stroke care metrics
- Community education and outreach

XIII. REFERENCES

1. Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke.* 2019;50(12):e344-e418. https://www.ahajournals.org/doi/10.1161/STR.0000000000000211
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XIV. APPENDICES

Appendix A: Code Stroke Activation Card (pocket reference for ED/floor nurses)

Appendix B: tPA Inclusion/Exclusion Checklist

Appendix C: NIHSS Reference Card

Appendix D: Blood Pressure Management Protocol for Stroke

Appendix E: Stroke Order Set (EHR)

Appendix F: Stroke Patient/Family Education Handout (FAST, Medications, Follow-Up)

END OF PROTOCOL

For immediate stroke consultation:

- **Stroke Alert Pager:** (555) 9000 (24/7)
- **Stroke Neurologist on Call:** Pager above or call operator for "Stroke attending"
- **Interventional Neuroradiology (Thrombectomy):** (555) 9100 (24/7)

Document Control:

- Version: 1.0
- Effective: January 1, 2024
- Next Review: January 1, 2025