Management of Ischemic Stroke

Initial Assessment / Triage

- Use National Institutes of Health (NIH) Stroke Scale to assess patient for signs/symptoms of stroke.
- Rapidly assess from initial time of last known well (LKW) per patient and/or family.
  - Last known well (LKW) < 8 hours.
- Presence of active stroke signs and symptoms may include but are not limited to:
  - Face numbness or weakness especially on one side of the body.
  - Arm/leg numbness or weakness especially on one side of the body.
  - Slurred speech or difficulty speaking or understanding.
  - Decreased level of consciousness.
- No known head trauma.
- Finger-stick glucose > 50 mg/dl or < 400 mg/dl.
- No known significant hypoxic episode.
- Any other clinical indications at the discretion of the ED physician.
- Patients who received thrombolytics and/or are candidates for mechanical stroke intervention transported to OSUWMC through Telestroke.

Making the Diagnosis

Emergency Department

- Call Stroke Level 1 for symptom onset < 8 hours from LKW.
- Call Stroke Level 2 for symptom onset between 8-12 hours from LKW.
- Refer to NIH Stroke Scale (document in all patients).

Inpatient

- Consult Stroke Team- Internal Stroke Code.
- Call ERT for evaluation of patient with stroke symptom onset < 8 hours from LKW.
  - UH Main: 6-3133
  - UH East: 6-3133
- ERT will activate Stroke Code after initial evaluation.

Acute Stroke Evaluation – For All Patients

Labs for Admission

- PT, INR, aPTT, CBC with platelet count, electrolytes, BUN, creatinine, troponin.

Labs for Administration of Thrombolytics

- Although it is desirable to know the results of the labs prior to giving intravenous recombinant tissue-type plasminogen activator, fibrinolytic therapy should not be delayed while awaiting the results unless there is clinical suspicion of a bleeding abnormality or thrombocytopenia or the patient has received heparin, warfarin, or other anticoagulants.
- For additional information, refer to:
  - Intra-Arterial and Intravenous Alteplase for Stroke.
  - ED Pharmacist Stroke Alert Response Algorithm.
- Complete Thrombolytic Therapy Checklist.

Stroke Level 1 and Internal Stroke Code

- Required for administration of thrombolytic medication:
  - Patient taken directly to Radiology for STAT head CTA/CTP.
  - Glucose.
  - Blood pressure.
  - Oxygen saturation.

Other Diagnostic Tests

- EKG, HbA1c, lipid profile, LFT.
- If the patient is a candidate for TPA, IV access should be obtained in at least two sites:
  - One site for administration of TPA.
  - One site for IV fluids or other medications.

Additional Evaluation – For Selected Patients

The etiology of stroke in young patients (≤ 50 years of age) is more varied than in the elderly (> 50 years of age), and intensive evaluation of the young patient MUST be undertaken to give an accurate determination of the etiology.

Patients ≤ 50 Years of Age

- Magnetic resonance (MR) brain scan.
- Magnetic resonance angiography (MRA) or computed tomography angiography (CTA) of the head and neck.
- Conventional cerebral angiography (CCA).
- Transthoracic echocardiography (TTE) or Transesophageal echocardiography (TEE).
- Transcranial Doppler.
- Carotid ultrasound.
- CT perfusion or magnetic resonance perfusion.
- Obtain EKG.
- Hypercoaguable work-up for cryptogenic stroke or unexplained arterial or valvular thrombosis:
  - Anticardiolipin antibody.
  - Lupus anticoagulant.

Patients > 50 Years of Age

- CTA.
- CT perfusion or MR perfusion.
- Obtain repeat head CT scan or MR brain scan for patients with:
  - An unclear stroke etiology.
  - Severe stroke.
  - Neurologic deterioration.
- Obtain carotid ultrasound, MRA neck, or CTA neck for carotid distribution stroke.
• Obtain MRA neck/head for cerebellar distribution stroke.
• Consider cerebral angiography to confirm noninvasive testing, particularly in patients with:
  o 30-40% stenosis by ultrasound or > 50% stenosis by MRA in the symptomatic carotid artery.
  o Occlusion by carotid ultrasound in the symptomatic carotid artery.
• Obtain EKG.
• Hypercoaguable work-up for cryptogenic stroke or unexplained arterial or valvular thrombosis:
  o Anticardiolipin antibody.
  o Lupus anticoagulant.
• The choice of TEE should be guided by the particular suspected cardiac source.
• Consider Endovascular Surgery consultation.

**Patient Care**

**Immediate Care**

- Use airway support (if needed).
- Treat hypoxia.
  - Give supplemental oxygen to patients with $O_2$ sat < 94% and a decreased LOC.
- Treat hypothermia.
- Treat fever when temp > 38.0°C (> 99.6°F).
- Treat hypoglycemia (< 60 mg/dL).
  - See OSUWMC Diabetes: Hypoglycemia Treatment in Non-Pregnant Adults guideline.
- Treat hyperglycemia (> 150 mg/dL).
- Maintain strict NPO until Neurological Swallow Screen is performed by nursing prior to oral intake.
  - Please see RN Neurological Swallow Screen available in doc flow sheets.
  - OSUWMC Swallow Screen Video.
- HOB flat as tolerated.
- Correct any major nutritional or hydration problems.
- Provide continuous cardiac monitoring until stroke etiology has been identified.
- Position all patients with dysphagia HOB at 90° for all oral intake.

**Patient Education in Hospital**

- Document that patients or their caregivers receive educational materials during the hospital stay addressing all of the following:
  - Activation of emergency medical system (EMS) – 911.
  - Need for follow-up after discharge.
  - Medications prescribed at discharge.
  - Individualized risk factors for stroke:
    - Overweight.
    - Smoking: provide tobacco cessation information.
    - Sedentary lifestyle.
    - Warning signs and symptoms for stroke.

**Nursing Care after Thrombolytic Administration**

- For patients who have received tPA, assess vital signs and modified NIH scale (including pupils) at the following frequencies:
  - Every 15 minutes during infusion then,
  - Every 15 minutes for 2 hours then,
  - Every 30 minutes for 6 hours then,
  - Every hour for 16 hours (total of 24 hour after initiation of thrombolytic therapy).
- Complete vital signs and modified NIH scale (including pupils) at least every 4 hours for up to 24 hours after tPA administration.
  - Frequency of checks should be based on the patient’s stability and other comorbid conditions.
- Blood pressure goal of SBP < 180 mmHg and DBP < 105 mmHg for 24 hours after thrombolytic administration.
- Perform frequent monitoring and assessment for worsening of neurological deficits or bleeding for up to 24 hours after tPA administration.
- Monitor for bleeding and implement bleeding precautions after thrombolytic therapy.

**Nursing Care without Thrombolytic Administration**

- For patients who do not receive thrombolytics, assess vital signs and modified NIH scale (including pupils) at the following frequencies:
  - Every 30 minutes for 1 hour.
  - Every 1 hour for 4 hours.
  - Then every 4 hours.
- Blood pressure goal of SBP < 220 mmHg and DBP < 110 mmHg during acute phase.
- Perform frequent monitoring and assessment for worsening of neurological deficits.

**General Interdisciplinary Care**

- Institute early bowel and bladder care to prevent complications.
- Avoid use of indwelling catheters, if possible, to reduce risk of UTI.
- Initiate fall precautions- the patient should be told not to ambulate without assistance.
- Start ROM exercises in the early phase of the acute stroke care once risk has been assessed.
- Maintain strict NPO until Neurological Swallow Screen is performed by nursing prior to oral intake.
  - Nursing should perform Neurological Swallow Screen prior to any oral intake and within the first 24 hours after stroke.
  - If patient fails the screen, then Speech Therapy will complete dysphasia screening.
  - OSUWMC Swallow Screen Video.
  - Please see RN Neurological Swallow Screen available in doc flow sheets.
- Place a nasogastric tube in patients who cannot swallow or, if severity warrants, place a percutaneous endoscopic gastronomy tube to provide proper nutrition.
Complete NIH Stroke Scale every 4 hours or if patient exhibits a change in status and/or level of care.

Perform nutritional status assessment.

Initiate VTE prophylaxis by end of hospital day 2, or document contraindications.

Initiate early rehabilitation.

Consult PT, OT, and Speech Language Pathology as indicated.

Endovascular procedures as indicated.

### Pharmacological Treatment

#### Antihypertensive Therapy

Manage hypertension appropriately:

- Withhold antihypertensive agents unless the SBP > 220 mmHg or DBP > 120 mmHg.
- Prior to administering tPA, blood pressure SBP > 185 mmHg or DBP > 110 mmHg.
- After tPA administration, blood pressure SBP > 180 mmHg or DBP > 105 mmHg.
- When treatment is indicated, lower BP cautiously.
  - Aim for a 10-15% reduction in BP.

#### Antithrombotics, Antiplatelets, or Anticoagulants

- Administer by end of hospital day 2.
- For patients receiving thrombolytic therapy, give aspirin or antithrombotic agent 24 hours after thrombolytic completion and HCT without hemorrhage.
- If atrial fibrillation documented, discharge patient on anticoagulation unless contraindicated.
- If therapeutic heparin is indicated, local practice usually involves infusion initiation at 12 units/kg/hr with no bolus and a lower aPTT goal initially of 20 below the standard target range.

#### Thrombolytic Reversal

- Abruptly discontinue alteplase in any patient with an intracranial hemorrhage or if one is suspected.
- For symptomatic hemorrhagic conversion a reversal agent may be considered if alteplase was received within the previous 24 hours.
  - Cryoprecipitate to target a fibrinogen level of ≥150 mg/dL with an initial dose of 10 units.
  - Single dose of tranexamic acid 10-15mg/kg IV or amniocapric acid 4-5g IV. If cryoprecipitate is contraindicated or not available in timely manner.
  - Platelet transfusion.
  - Prothrombin complex concentrates and recombinant factor VIIa are not supported by clinical evidence or expert consensus.
    - The risk of thrombosis, especially in patients who just experienced an ischemic stroke, should be heavily weighed.
- In small, asymptomatic hemorrhagic conversion, conservative medical management may be considered after weighing the risks and benefits of reversal agents.

### Endovascular Care

#### Immediate Endovascular Care

- If patient received tPA prior to endovascular consideration, treat BP accordingly.
- Withhold antihypertensive initially unless SBP > 220 mmHg or DBP > 120 mmHg or unless contraindicated.
- After recanalization, bring BP down to the limits prescribed for patient after thrombolytic therapy.
  - SBP > 180 mmHg.
  - DBP > 105 mmHg.
- Maintain limits for at least 24 hours after completion of procedure.
- Use mechanical devices or intra-arterial thrombolytic to achieve recanalization.
- Transfer patient to Neuroscience ICU after procedure.

#### Indication Criteria

- Modified Rankin Scale ≤ 2.
- NIH Stroke Scale ≥ 8.
- MRA or CTA showing large vessel occlusion.
- Expected survival > 90 days or no significant confounding past medical history. For example systemic cancer or LVAD.
- Thrombolytic administration not a factor in decision making.

#### Exclusion Criteria

- NIH Stroke Scale < 8.
- Age ≥ 85.
- Platelets ≤ 40k.
- INR ≥ 3.
- Intracranial hemorrhage.
- Absence of large treatable vessel occlusion evidence (vertebral artery, basilar artery, carotid artery, ICA terminal bifurcation, or the middle cerebral artery (M1)).
- MRI or CT revealing significant mass effect with midline shift or greater than one-third of the MCA region with hypodensity.

### Surgical Care

#### Immediate Surgical Care

- Pharmacological VTE prophylaxis - to be done at discretion of neurosurgeon.
- Decompressive craniectomy significantly reduces morbidity and mortality in patients with large, space-occupying hemispheric infarction and also leads to improved functional outcome when performed within 48-hours of stroke onset.
- Patient assessment by neurosurgeon before and after surgery and endovascular procedures.

#### Cerebellar Infarction: Decompressive Suboccipital Craniectomy

#### Indication Criteria

- Neurological signs of brainstem compression:
  - Hypertension.
  - Bradycardia.
Cranial nerve dysfunction.
Reduction of consciousness due to infarct (other causes exclude).
Mass effect on CT or MR.

**Exclusion Criteria**
- Clinical or radiological signs of severe irreversible brainstem ischemia.
- Lack of informed consent.

**MCA Infarction:**
*Decompressive Hemicraniectomy*

**Indication Criteria**
- Clinically large MCA infarct.
  - NIH Stroke Scale > 15.
- Decreased level of consciousness due to infarct (other causes excluded).
- Radiographic signs of large MCA infarct:
  - Mass effect on CT or MR or
  - At least 50% of the MCA territory.
- Surgery within 48 hours after onset of symptoms (minimum of 6 hours after any thrombolytic therapy).

**Exclusion Criteria**
- Pre-stroke Modified Rankin Scale ≥ 2.
- Two fixed dilated pupils.
- Other serious illness that could affect outcome.
- Known coagulopathy or systemic bleeding disorder.
- Lack of informed consent.

**Discharge Planning**
- Involve patient’s family/caregiver in assessment of post discharge needs, decision making and treatment planning.
- Perform at discharge:
  - Full NIH Scale.
  - Modified Rankin Scale.
- Follow-up outpatient appointment with the Neurovascular Stoke Team scheduled prior to discharge.

**Multidisciplinary Focus**
- Provide education for patient’s family/caregivers on:
  - Stroke (pathology, prevention, signs/symptoms, and actions to take).
  - Follow-up appointments/therapy.
  - Treatment plan.
  - Community resources and how to access those resources.

**Rehabilitation Services**
- Encourage patient’s family/caregiver to participate in the rehabilitation sessions and to be trained to assist the patient with functional activities.
- If the patient is aphasic, Speech Pathology should assist the patient and family in establishing a communication pattern before discharge.

**Case Manager/Social Work**
- Arrange family and team meeting to discuss:
  - Patient progress.
  - Rehabilitation goals.
  - Discharge needs or issues.
  - Explanation of next level of care.
  - Providing care and support associated with these deficits.
  - Ways to cope with stress associated with these impairments.
  - Respite care.
  - Post-stroke depression.
- Consider availability of support services and desires of the patient’s family/caregiver.
- Provide information about discharge plans and post-discharge management to primary care physicians and community services.

**Order Sets**
- ED: Stroke Alert [2265]
- ED: Ischemic Stroke – Confirmed (TPA) [2931]
- ED: Ischemic Stroke – Confirmed no TPA [2993]
- ED: Suspected Stoke Triage Protocol [2332]
- NV1: Stroke Bundle with and without TPA [4389]
- NV1: Admission Stroke – no TPA [2240]
- NV1: Admission Stroke – with TPA [2148]
- NV1: Internal Stroke – Confirmed Ischemic with TPA
- NV1: Internal Stroke alert – diagnostic ONLY [2238]
- NV1: Post Cerebral Angiogram (with or without intervention)
- NEU Stroke Consult/Evaluation [780]
- PMR: Admission Stroke Rehab [2030]
- PVS: Pre-Procedure Vascular Surgery Diagnostic Interventional (aka angiogram) [2976]

**References**


**Quality Measures**

- Venous thromboembolism (VTE) prophylaxis.
- Discharged on antithrombotic therapy.
- Anticoagulation therapy for atrial fibrillation/flutter.
- Thrombolytic therapy.
- Antithrombotic therapy by end of hospital day 2.
- Dysphagia screening.
- Stroke education.
- Tobacco cessation information.
- Assessed for rehabilitation.
- Discharged on statin medication.
- LDL documented when statin therapy initiated.
- Percent of patients on high-intensity or moderate-intensity statin therapy with LDL ≥ 190 mg/dL.
- NIHSS on Admission.
- Interpretation of the initial head CT study within 45 minutes.
- Door-to-needle treatment goal if treated with tPA is 60 minutes.
  - Decision time must be within 6 hours of last known well.

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**Guideline Approved**


**Disclaimer:** Clinical practice guidelines and algorithms at The Ohio State University Wexner Medical Center (OSUWMC) are standards that are intended to provide general guidance to clinicians. Patient choice and clinician judgment must remain central to the selection of diagnostic tests and therapy. OSUWMC’s guidelines and algorithms are reviewed periodically for consistency with new evidence; however, new developments may not be represented.

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### Table 1: Management of Risk Factors Associated with Stroke or TIA

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Management</th>
</tr>
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<tbody>
<tr>
<td><strong>Hypertension</strong></td>
<td>• Individualize BP targets and drug therapy.</td>
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<tr>
<td></td>
<td>• If appropriate, consider:</td>
</tr>
<tr>
<td></td>
<td>o Benefit has been associated with average reduction of 10/5 mmHg.</td>
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<tr>
<td></td>
<td>o Normal BP levels have been defined as:</td>
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<tr>
<td></td>
<td>▪ ≤ 60 years of age: 140/90 mmHg.</td>
</tr>
<tr>
<td></td>
<td>▪ &gt; 60 years of age: &lt;150/90 mmHg.</td>
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<tr>
<td></td>
<td>o Drug regimen of diuretics or the combination of diuretics and an ACEI.</td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td>• Hemoglobin A1c goal no higher than 7%.</td>
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<tr>
<td></td>
<td>• Glucose control near-normoglycemic levels.</td>
</tr>
<tr>
<td><strong>Hypercholesterolemia</strong></td>
<td>High- or moderate-intensity statin therapy should be initiated on all patients regardless of LDL (in the absence of contraindications).</td>
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<tr>
<td></td>
<td><strong>Note:</strong> See ACC/AHA guideline for recommendations on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk.</td>
</tr>
<tr>
<td><strong>Tobacco</strong></td>
<td>• Advise patients who have smoked in the last year to discontinue cigarette smoking.</td>
</tr>
<tr>
<td></td>
<td>• Consider tobacco cessation information.</td>
</tr>
<tr>
<td><strong>Alcohol Consumption</strong></td>
<td>• Advise heavy drinkers to eliminate or reduce consumption of alcohol.</td>
</tr>
<tr>
<td></td>
<td>• Light to moderate levels of no ≤ 2 drinks for men and ≤ 1 drink per day for non-pregnant women acceptable.</td>
</tr>
<tr>
<td><strong>Obesity</strong></td>
<td>• BMI goal of 18.5 to 24.9 kg/m².</td>
</tr>
<tr>
<td></td>
<td>• Waist circumference of &lt; 35 in. for women and &lt; 40 in. for men.</td>
</tr>
<tr>
<td><strong>Physical Activity</strong></td>
<td>• Advise at least 30 min. of moderate-intensity physical activity most days.</td>
</tr>
<tr>
<td></td>
<td>• Advise supervised therapeutic exercise regimen for those with disability after stroke.</td>
</tr>
</tbody>
</table>

### Table 2: Noncardioembolic Stroke or TIA

<table>
<thead>
<tr>
<th>Noncardioembolic Stroke or TIA</th>
<th>Acceptable options for initial therapy:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>o Aspirin and extended-release dipyridamole (Aggrenox®).</td>
</tr>
<tr>
<td></td>
<td>▪ May be more effective than aspirin alone.</td>
</tr>
<tr>
<td></td>
<td>o Aspirin 81-325 mg daily</td>
</tr>
<tr>
<td></td>
<td>o Clopidogrel (Plavix®) 75 mg daily.</td>
</tr>
<tr>
<td></td>
<td>▪ Consider in patients with aspirin allergy.</td>
</tr>
</tbody>
</table>
### Table 3: Treatment Recommendations for Patients with Stoke Caused by Large Artery Atherosclerosis

#### Extracranial Carotid Disease
- **Carotid Endarterectomy (CEA)**
  - Recommended for patients with recent TIA or ischemic stroke within the last 6 months and severe stenosis (70% to 99%) and perioperative morbidity and mortality of < 6%.
  - Consider for moderate stenosis (50% to 69%), depending on risk factors and symptoms; not recommended for < 50% stenosis.
  - When CEA is indicated, surgery within 2 weeks of TIA or stroke is suggested rather than delaying surgery.
  - Measure carotid stenosis using North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria.
- **Carotid Artery Balloon Angioplasty and Stenting (CAS)**
  - Consider in patients with severe stenosis, and CEA contraindicated and peri-procedural morbidity and mortality 4-6%.
- **Extracranial-Intracranial (EC/IC) Bypass Surgery**
  - Not routinely recommended.

#### Intracranial Arterial Disease
- **Endovascular Treatment**
  - Recommendation limited to lesion refractory to medical therapy.

#### Extracranial Vertebrobasilar Disease
- **Endovascular Treatment**
  - Consider endovascular treatment when symptoms persist despite medical therapies.

### Table 4: Treatment Recommendations for Patients with Cardioembolic Stroke

**Note:** TIA or ischemic stroke patients with cardiac disease are generally treated with anticoagulant drugs.

#### Atrial Fibrillation
- Alternatives to warfarin in patients with nonvalvular AFib include:
  - Dabigatran (Pradaxa®)*150mg Q12H
  - Rivaroxaban (Xarelto®)* 20mg Q24H
  - Apixiban (Eliquis®)* 5mg Q12H
  - Edoxaban (Lixiana®)* 60mg Q24H
    - Not part of OSUWMC formulary.
- Warfarin.
  - Target INR: 2.5 (range 2-3)
- Aspirin 325 mg/day if unable to take oral anticoagulants.

*Note:* Dosing may require adjustment for renal dysfunction.

#### Acute MI and Left Ventricular Thrombus
- Oral anticoagulation (target INR 2-3) for 3-12 months and enteric-coated aspirin up to 162 mg/day.

#### Dilated Cardiomyopathy
- Warfarin (target INR: 2-3) or antiplatelet therapy.

#### Valvular Heart Disease
- **Rheumatic Mitral Valve Disease**
  - Warfarin.
    - Target INR: 2.5 (range 2-3).
    - Add aspirin 81 mg per day if recurrent embolism on warfarin.
- **Mitral Valve Prolapse (MVP)**
  - Long-term antiplatelet therapy.
- **Mitral Annular Calcification (MAC)**
  - Antiplatelet or warfarin therapy may be considered for mitral regurgitation resulting with MAC without atrial fibrillation.
- **Aortic Valve Disease**
  - Antiplatelet therapy without atrial fibrillation.
- **Prosthetic Heart Valves**
  - See Anticoagulation Recommendations Post-Valve Replacement.