This care process model (CPM) is maintained by the Neurosciences and Cardiovascular Clinical Programs, and Emergency Department/Trauma Operations at Intermountain Healthcare. The CPM development team includes multidisciplinary representation from neurovascular medicine, interventional radiology, cardiology, anesthesia, hospitalists, and others. This CPM provides expert advice for the emergency management of acute ischemic stroke and summarizes current medical literature and national practice guidelines (see page 10). Intermountain’s care management system for stroke also includes:

- Education materials and programs for providers and patients
- Data systems that help providers and facilities track stroke management success
- Multidisciplinary coordination of stroke care

**Why Focus on ISCHEMIC STROKE?**

- **Incidence and mortality.** In the U.S., about 795,000 strokes occur each year, 610,000 of which are first attacks, and nearly 134,000 of which are fatal. About 87% of all strokes are ischemic strokes. When considered separately from other cardiovascular diseases, stroke is the fifth leading cause of death.

- **Impairment.** Stroke is a leading cause of disability. Six months after a stroke, 26% of patients still need institutional care; 15% to 30% are permanently disabled.

- **Cost.** U.S. stroke-related, direct and indirect costs in 2011 were $33.6 billion. Between 2012 and 2030, total direct medical stroke-related costs are projected to triple.

- **Improved outcomes when key processes are followed.** Patients suffering from a stroke are more likely to have improved outcomes and fewer complications when hospitals use standardized care processes. Key processes for emergency management of ischemic stroke include:
  - Initial assessment, rapid transport, and early notification by EMS personnel.
  - A system for prompt evaluation, diagnosis, and treatment decisions by ED personnel, incorporating limited laboratory testing, stat brain imaging, and a stroke rating scale such as National Institutes of Health Stroke Scale (NIHSS). Smaller or rural facilities should treat to capacity using the Telestroke process and transport to a stroke center as quickly as possible.
  - Administration of the thrombolytic drug alteplase, recombinant tissue-type plasminogen activator (tPA), within 4.5 hours of the onset of stroke symptoms in eligible patients.
  - Endovascular treatment (EVT) of selected patients with large vessel occlusion (LVO).

**What’s new IN THIS UPDATE?**

- Updated treatment algorithms for classification, diagnosis, and emergency management of acute ischemic stroke, and EVT (see pages 2 – 8)
- Added selection criteria and process for patients that can receive mechanical EVT up to 24 hours after stroke (see page 8)
ALGORITHM 1: CLASSIFICATION

Patient presents with signs and symptoms of stroke (a)

Have symptoms entirely resolved?

yes

no

DERmine time last known well (b)

0–6 hours

6–24 hours

>24 hours

On-site Neurology available?

yes

no

On-site Neurology available?

yes

no

ACTIVATE ED Code Stroke 1; ORDER ED Code Stroke 1 PP *

ACTIVATE ED Code Stroke 2; ORDER ED Code Stroke 2 PP *

ACTIVATE ED Code Stroke Telestroke 1; CALL Transfer Center; ORDER ED Code Stroke Telestroke 1 PP *

ACTIVATE ED Code Stroke Telestroke 2; CALL Transfer Center; ORDER ED Code Stroke Telestroke 2 PP *

PROCEED to Algorithm 2: Emergency Management of Acute Ischemic Stroke (0 – 6 h) (see page 4)

PROCEED to Algorithm 3: Emergency Management of Acute Ischemic Stroke (6 – 24 h) (see page 6)

ALGORITHM NOTES

(a) Signs and symptoms

ASSESS using BE FAST:

• Balance: Sudden loss of balance or coordination
• Eyes: Sudden loss of vision or double vision
• Face: Sudden weakness of the face
• Arms: Sudden weakness of an arm or leg
• Speech: Sudden difficulty speaking
• Time: Time the symptoms started

(b) Determine time last known well

IDENTIFY:

• Time of last normal interaction with another person
• Bedtime and when patient awoke with deficits
• Patient-reported onset time, when this is dependable despite current deficits

* Note: PP = Power Plan
National Institutes of Health Stroke Scale\textsuperscript{NIH} — Plain English Version (NIHSS-PE)*

<table>
<thead>
<tr>
<th>Item</th>
<th>Title</th>
<th>Responses and Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>Level of Consciousness</td>
<td>0 — Alert &lt;br&gt;1 — Sleepy but arouses &lt;br&gt;2 — Can’t stay awake &lt;br&gt;3 — No purposeful response</td>
</tr>
<tr>
<td>1B</td>
<td>Orientation Questions (2)</td>
<td>0 — Both correct &lt;br&gt;1 — One correct / intubated &lt;br&gt;2 — Neither correct</td>
</tr>
<tr>
<td>1C</td>
<td>Commands (2)</td>
<td>0 — Obeys both &lt;br&gt;1 — Obeys one &lt;br&gt;2 — Obeys neither</td>
</tr>
<tr>
<td>2</td>
<td>Lateral Gaze</td>
<td>0 — Normal side-to-side movements &lt;br&gt;1 — Partial side-to-side movements &lt;br&gt;2 — No side-to-side movement</td>
</tr>
<tr>
<td>3</td>
<td>Visual Fields</td>
<td>0 — Normal visual fields &lt;br&gt;1 — Blind upper OR lower field, one side &lt;br&gt;2 — Blind upper AND lower field, one side &lt;br&gt;3 — Blind in both eyes / four fields</td>
</tr>
<tr>
<td>4</td>
<td>Facial Weakness</td>
<td>0 — Normal &lt;br&gt;1 — Mild one-sided droop with smile &lt;br&gt;2 — Obvious droop at rest &lt;br&gt;3 — Upper and lower face is weak</td>
</tr>
<tr>
<td>5</td>
<td>Arm weakness (left and right)</td>
<td>0 — No drift (X — Joint fused / amputee) &lt;br&gt;1 — Drifts down, does not hit bed &lt;br&gt;2 — Drifts down to hit bed &lt;br&gt;3 — Can move, but cannot lift &lt;br&gt;4 — No movement</td>
</tr>
<tr>
<td>6</td>
<td>Leg weakness (left and right)</td>
<td>0 — No drift (X — Joint fused / amputee) &lt;br&gt;1 — Drifts down, does not hit bed &lt;br&gt;2 — Drifts down to hit bed &lt;br&gt;3 — Can move, but cannot lift &lt;br&gt;4 — No movement</td>
</tr>
<tr>
<td>7</td>
<td>Coordination</td>
<td>0 — Normal or no movement &lt;br&gt;1 — Clumsy in one limb &lt;br&gt;2 — Clumsy in two limbs</td>
</tr>
<tr>
<td>8</td>
<td>Sensation (feeling)</td>
<td>0 — Normal &lt;br&gt;1 — Decreased sensation &lt;br&gt;2 — Can’t feel, no pain withdrawal</td>
</tr>
<tr>
<td>9</td>
<td>Speech (content)</td>
<td>0 — Correct full sentences &lt;br&gt;1 — Wrong or incomplete sentences &lt;br&gt;2 — Words don’t make sense &lt;br&gt;3 — Can’t speak at all</td>
</tr>
<tr>
<td>10</td>
<td>Speech (slurring)</td>
<td>0 — No slurring (X — Intubated / barrier) &lt;br&gt;1 — Slurs, but you can understand &lt;br&gt;2 — Slurs (you can’t understand) or mute</td>
</tr>
<tr>
<td>11</td>
<td>Neglect</td>
<td>0 — Sees &amp; feels as both sides tested at once &lt;br&gt;1 — Doesn’t see OR feel one side &lt;br&gt;2 — Doesn’t see AND feel one side</td>
</tr>
</tbody>
</table>

* Note: The NIHSS-PE is used with permission of the Providence Brain Institute. The original NIH form and instructions are available on the NIH website (https://www.ninds.nih.gov/sites/default/files/NIH_Stroke_Scale.pdf).
ALGORITHM 2: EMERGENCY MANAGEMENT OF ACUTE ISCHEMIC STROKE (0–6 HOURS)

Acute ischemic stroke

**Note:** STAT Stroke Imaging Power Plans:
- ED Code Stroke 1
- ED Code Stroke Telestroke 1
- PR Stroke Symptoms (nurses)
- PR Stroke Symptoms Telestroke (nurses)

**Note:** See table 1 (page 7) for EVT-related data points and metrics.
**ALGORITHM NOTES**

**a) Intravenous (IV) alteplase (tPA) relative exclusion criteria for < 3 hours since symptom onset**

**Contraindications (risk of bleeding is greater than the potential benefit)**
- Thrombolytic therapy initiated by another hospital prior to arrival
- CT findings (intracranial hemorrhage, subarachnoid hemorrhage, or major infarct signs)
- SBP > 185 or DBP > 110 mm Hg despite maximal treatment
- PLTs < 100,000, PTT > 40 seconds after heparin use, PT > 15, or known bleeding diathesis
- INR > 1.7 (for known or suspected warfarin use, wait for lab INR result to determine if contraindicated when point of care [POC] INR 1.6 – 2.3)
- Confirmed use, in the last 48 hours, of direct oral anticoagulants (DOACs), such as dabigatran (Pradaxa), rivaroxaban (Xarelto), apixaban (Eliquis), or edoxaban (Savaysa)

**Warnings and Precautions (use clinical judgment)**
- Blood glucose concentration ≤ 50 mg/dL or ≥ 400 mg/dL
- Seizure at onset
- Recent surgery/major trauma (< 15 days)
- Active internal bleeding (< 22 days)
- Significant stroke or head trauma (< 3 months)
- Intracranial or spinal surgery (< 3 months)
- Myocardial infarction (MI) (< 3 months)
- Non-disabling stroke symptoms
- Severe comorbid illness
- History of vascular malformation
- History of intracranial hemorrhage
- History of brain aneurysm or brain tumor
- Pregnant or lactating

**b) Additional relative exclusion criteria for IV alteplase (tPA) at 3 – 4.5 hours**
- Age > 80
- Imaging finding of infarction with hypodensity involving > 33% of the cerebral hemisphere
- History of both stroke and diabetes
- NIHSS > 25
- Oral anticoagulant regardless of INR

**c) Monitoring frequency (for any amount or route administered)**

Monitor vital signs and conduct neuro assessment from start of alteplase (tPA): Every 15 minutes for 2 hours; then, every 30 minutes for 6 hours; then, every hour for 16 hours.

**d) Endovascular therapy (0 – 6 hour criteria)**
- ICA or M1 occlusion (select M2, M3)
- NIHSS ≥ 6
- Age ≥ 18
- Prehospital mRS 0 – 1
- ASPECT ≥ 6

**Note:** Consider other patients with large vessel occlusion that may not meet these criteria. See table 1 (page 7) for EVT-related performance metrics.
ALGORITHM 3: EMERGENCY MANAGEMENT OF ACUTE ISCHEMIC STROKE
(6 – 24 HOURS)

Acute ischemic stroke

ED Code Stroke 2

CONDUCT stat imaging (CT / CTA / CTP) *

REVIEW criteria for endovascular therapy (EVT)
with Neurology consult (a)

no

yes

Appropriate candidate per 6–24 h criteria?

ED Code Stroke Telestroke 2

CONDUCT stat imaging (CT / CTA) *

ACTIVATE Interventional Radiology (IR) Team**

TRANSFER to nearest Endovascular Center ED for CTP

Receiving ED will PROCEED to Algorithm 4:
Emergency Management of EVT Transfer Patients
(6–24 h) (see page 8)

TRANSFER to IR for EVT

ADMIT to ICU-level care for post-IR care;
CONSIDER Tele-Neurocritical Care consultation

RISK CENTER
Non-Endovascular Center

DISCUSS with Neurology for possible admission.

** Note: See table 1 (page 7) for EVT-related data points and metrics.

* Notes: STAT Stroke Imaging Power Plans (PP):
- ED Code Stroke 2
- ED Code Stroke Telestroke 2

CTP = CT perfusion
# ALGORITHM NOTES

## (a) Endovascular therapy (6–24 hour criteria)

<table>
<thead>
<tr>
<th>Clinical criteria:</th>
<th>Perfusion criteria:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• ICA or M1 occlusion</td>
<td>• Core &lt; 70 mL</td>
</tr>
<tr>
<td>• NIHSS ≥ 6</td>
<td>•Mismatch &gt; 1.8 and &gt; 15 mL</td>
</tr>
<tr>
<td>• Age ≥ 18</td>
<td></td>
</tr>
<tr>
<td>• Prehospital mRS 0–1</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Consider other patients with large vessel occlusion that may not meet these criteria. See table 1 below for EVT-related performance metrics.

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Table 1 lists the endovascular therapy performance metrics that will be monitored and reported.

## TABLE 1. Endovascular therapy performance metrics that will be monitored and reported

<table>
<thead>
<tr>
<th>The following metrics will be monitored and reported (goal in parentheses):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Door-to-IR page time</td>
</tr>
<tr>
<td>• IR page-to-puncture time</td>
</tr>
<tr>
<td>• Door-to-puncture time (goal: 90 minutes)</td>
</tr>
<tr>
<td>• Door-to-TICI 2b/3 time (goal: &lt; 150 minutes)</td>
</tr>
<tr>
<td>• Percentage of patients with final TICI score 2b/3</td>
</tr>
<tr>
<td>• Symptomatic intracerebral hemorrhage (ICH) rate (based on Safe Implementation of Thrombolysis in Stroke-Monitoring Study (SITS-MOST criteria)(^{NH}))</td>
</tr>
</tbody>
</table>

\(^{NH}\)
ALGORITHM 4: EMERGENCY MANAGEMENT OF EVT TRANSFER PATIENTS (6 – 24 HOURS)

Arrival of stroke patient

- On-site Neurology available?
  - yes
    - ACTIVATE ED Code Stroke 2; ORDER ED Code Stroke Transfer Power Plan
  - no
    - ACTIVATE ED Code Stroke Telestroke 2; CALL Transfer Center; ORDER ED Code Stroke Transfer Power Plan

- Favorable CTP profile?*
  - yes
    - TRANSFER to IR for EVT
      - ADMIT to ICU-level care for post-IR care; CONSIDER Tele-Neurocritical Care consultation
  - no
    - CANCEL IR Team; MANAGE based on clinical judgment

* Note: Favorable CTP criteria include:
  - Core < 70 mL
  - Mismatch > 1.8 and > 15 mL
RESOURCES

Patient Education

Patients and their families can find these materials and links to other reliable stroke resources in the Health Library at Intermountain’s public website (intermountainhealthcare.org/stroke).

Clinicians can view or order Intermountain patient education materials for distribution to their patients.

- **View** by opening the appropriate topic page via the Clinical Programs pages on intermountain.net or intermountainphysician.org.
- **Order** from Intermountain’s iprintstore.org.

Intermountain stroke-related patient materials include the following:

- The booklet, *Life After Stroke and TIA*, to help educate patients and families about stroke symptoms and treatments.

- Fact sheets on:
  - Conditions that may be associated with emergency management of stroke, such as *Ischemic Stroke Treatment: tPA Decision Guide*
  - Anticoagulation medication, including *Dabigatran, Rivaroxaban, Apixaban, Edoxaban*, and *Warfarin*

- **BE FAST** refrigerator magnet which includes signs of stroke and reminder to call 9-1-1.

Provider Resources

This CPM and other stroke-related resources are accessible through the Clinical Programs Care Process Models page on intermountainphysician.org or the Neurosciences Clinical Program home page on intermountain.net.
**KEY GUIDELINES**


**ADDITIONAL REFERENCES**


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**Note:** This document presents an evidence-based model of care that is appropriate for most patients. It should be adapted to meet the needs of individual patients and situations and should not replace clinical judgment. Send feedback to Kevin Call, MD, Director, Stroke Development Team, Intermountain Healthcare (Kevin.Call@imail.org).