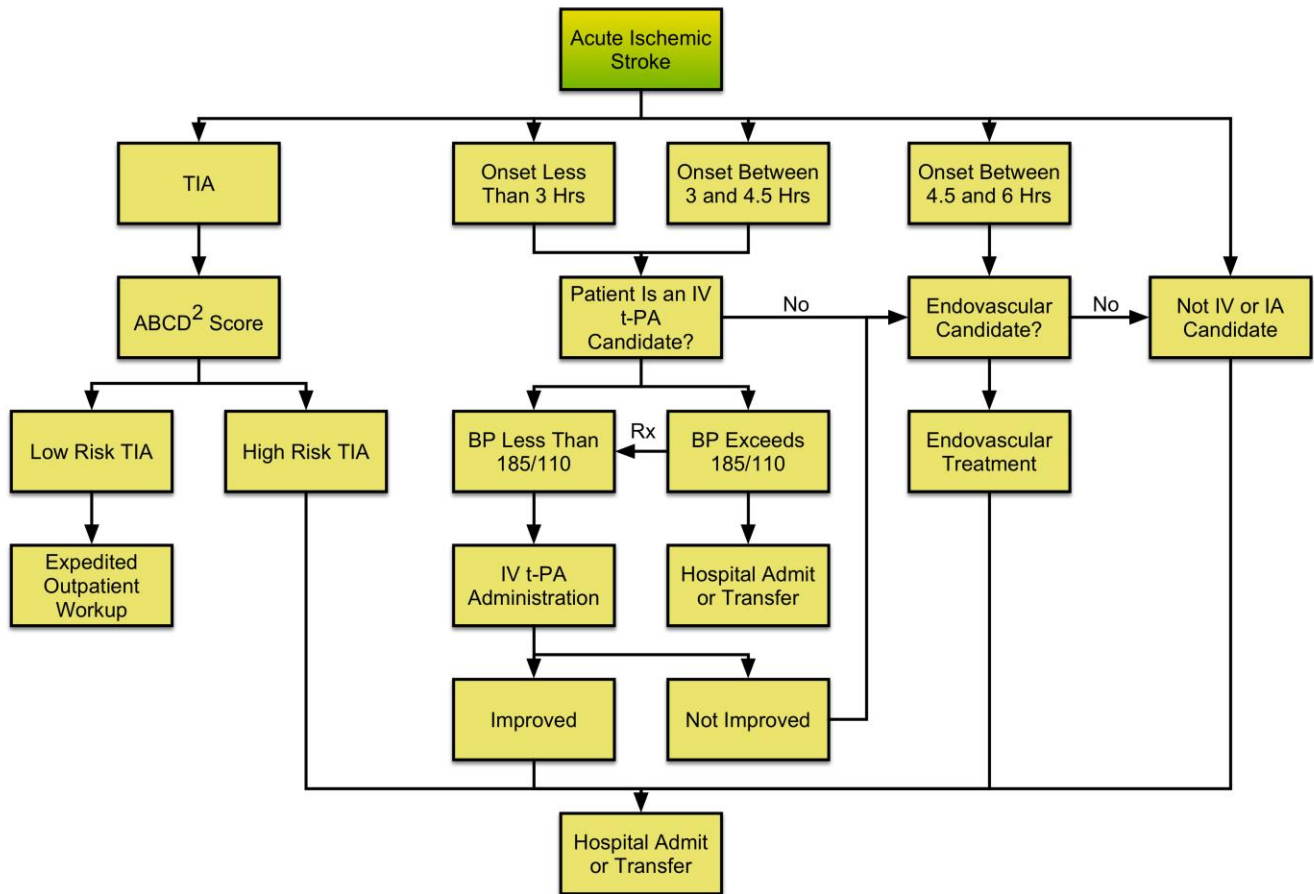


Emergency Neurological Life Support

Ischemic Stroke

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[Checklist & Communication](#)

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Checklist

- Vital signs
- Determine time of stroke onset
- Medication list*
- Labs: capillary glucose, CBC with platelets, PT/PTT, INR, EKG, and beta-HCG for women
- IV access
- Supplemental oxygen to maintain saturation > 94%
- Activate stroke code system (if available)
- Determine NIHSS score
- Obtain brain imaging
- Begin IV t-PA if the patient is eligible

Communication

- Age
- Airway status
- Time of symptom onset
- NIHSS
- CT or MRI results
- t-PA start time or t-PA contraindication(s)
- Plans for endovascular therapy

* When asking about medications, be sure to ask about anticoagulants: e.g. warfarin, heparin (dialysis), low molecular weight heparin (enoxaparin, dalteparin), dabigatran, apixaban, edoxaban, and rivaroxaban, and when medication was last taken/administered.

Acute Ischemic Stroke

Based on imaging and symptoms

The diagnosis of acute ischemic stroke is based on new onset focal neurological findings with an imaging study (CT or MRI of the brain) that shows no hemorrhage, or shows evidence of ischemic infarction.

In some centers, patients may be screened at the door when EMS arrives and then are taken directly to CT (or MRI) based on symptoms of facial droop, dysarthria, gaze preference, motor weakness or other focal findings.

If not completed already:

- STAT vital signs, capillary glucose, CBC with platelets, PT/PTT, INR, EKG, and beta-HCG for women
- IV access
- Supplemental oxygen to maintain saturation >94% (hyperoxia may be detrimental in stroke, so no need for high flow oxygen)
- Activate stroke code system (if available)
- Stroke MD/team to evaluate patient within 5 minutes
- Determine NIHSS score
- Order brain imaging

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Administer IV t-PA

Start IV t-PA infusion

After placing 2 peripheral IV lines:

- Weigh the patient; do not estimate body weight.
- Mix (do not shake) 0.9 mg/kg t-PA, total dose not to exceed 90 mg.
- Give 10% of the total dose of t-PA by bolus over 1-2 minutes, then infuse the remaining dose over 1 hour.

Footnote:

As t-PA is dispensed in 50 and 100 mg bottles, it is suggested to draw off and discard any excess t-PA to avoid accidental infusion of excess t-PA. t-PA remaining in the IV tubing at the end of the infusion should be administered by running an additional small volume of NS at the same rate of the t-PA infusion until the line is cleared.

Endovascular Treatment

Consider IA thrombolysis or thrombectomy

If the patient has a large vessel occlusion (MCA, intracranial ICA, basilar or vertebral artery) and is within a 6-hour time window of starting an endovascular procedure, IA treatment may be helpful. Large vessel occlusion can be suspected by seeing a hyperdense sign (clot within the vessel) on non-contrast CT imaging but this sign is insensitive. The probability of a large vessel occlusion increases with NIHSS score; a value exceeding 9 is often used as a surrogate for large vessel occlusion. CTA or MRA is diagnostic, as is conventional angiography.

- Contact the neurointerventional physician on call; if the treating hospital does not have this capability, consider transfer to a comprehensive stroke center
- Some hospitals use CT perfusion or MR perfusion techniques to select appropriate patients for intervention (ischemic penumbra)

Some factors to consider for endovascular selection and treatment:

- IV t-PA should be given within 4.5 hours for eligible patients while endovascular arrangements are being considered/arranged.
- Adults ≥ 18 years old should have a modified Rankin score of ≤ 1 .
- There should be demonstration or suspicion of occlusion of a proximal vessel
- NIHSS should be ≥ 6 .
- ASPECTS (Alberta Stroke Program Early Computed Tomography Score) ≥ 6 .
- Groin puncture should occur within 6 hours of the onset of the stroke and the procedure should be completed by 8 hours.
- Newer stent retrievers should be used by the interventionalist.
- Intracranial arterial imaging should not delay administration of IV t-PA as endovascular modalities are contemplated.
- Endovascular candidates should be transported to the closest or most appropriate facility capable of performing the necessary procedure; this is usually a comprehensive stroke center.

Hospital Admission & Transfer

While waiting for ICU bed

After IV, IA or no specific treatment consider the following initial admission orders:

- Neuro check every 30 min for 6 hours, then every 1 hour
- Oxygenation to keep O₂ sat > 94%
- Blood Pressure (BP) check every 15 min for 2 hours, then every 30 minutes for 6 hours, then every hour for 16 hours
- BP - after reperfusion treatment keep <180/105 mmHg (Note: this is lower than pretreatment values); if no t-PA given, keep BP < 220/120 mmHg
- Bedside swallow test (30 ml water by mouth) before anything else by mouth
- Keep glucose < 140-180 mg/dl, consider insulin drip
- IVF (normal saline) to keep euvolemia
- Monitor for A-fib
- Treat fever sources with antipyretics
- Avoid indwelling urinary catheter to avoid nosocomial infection

If t-PA was administered:

- avoid indwelling urinary catheter, nasogastric tubes, intra-arterial catheters for 4 hours; do not give anticoagulant/antiplatelet therapy for 24 hours; repeat head CT or MRI at 24 hours before starting anticoagulant/antiplatelet medications

Watch for complications of t-PA, including

- Airway obstruction due to angioedema- consider rapid intubation
- Hemorrhage- stop t-PA
- Sudden deterioration in mental status- see below
- Severe hypertension or hypotension- may be signs of ICH or systemic hemorrhage

A sudden decline in neurological exam during or following t-PA administration may be due to an intracranial hemorrhage. This is often accompanied by a marked rise in blood pressure; however, a marked rise or fall in blood pressure alone may signal an ICH. Do the following immediately:

- STOP t-PA infusion
- Monitor airway closely
- Obtain STAT head CT scan
- Notify your neurosurgeon on call; if not available begin the process to transfer the patient to a facility with neurosurgical capability if the CT scan shows hemorrhage
- Stat labs: PT, PTT, Platelets, fibrinogen, type and cross 2-4 unit PRBCs
- Give the following:
 - 6-8 units of cryoprecipitate

- Consider 40-80 mcg/kg of recombinant Factor VIIa while waiting for platelets and cryoprecipitate

Consider patient transfer

- if the treating hospital cannot provide the level of care for the patient (no ICU for example). Patient outcomes have been shown to improve if the patient is treated in a stroke center.
- if there is suspicion of large vessel occlusion (CTA/MRA, hyperdense vessel sign on imaging; or clinical findings consistent with an MCA stroke) and the patient can arrive and be treated at the receiving hospital within 6 hours of symptom onset.



Low Risk TIA

ABCD² Score 0-3

Patients at low risk of stroke can be treated as outpatients. This can begin in the ED or clinic starting with medications and expediting ECG and imaging of the carotids. Evidence shows this is effective if started the day of the evaluation. Do the following:

- Start on antithrombotic agent (ASA 81 mg/day, clopidogrel 75 mg/day, or ASA/extended release dipyridamole)
- Initiate statin if not taking one already
- Obtain a 12-lead ECG or review the rhythm strip if available. If these show atrial fibrillation consider starting anticoagulation (oral anticoagulant or low molecular weight heparin) or ASA 81 mg if anticoagulation is contraindicated
- Consider initiating longer-term outpatient cardiac monitoring (4 weeks) if the TIA is embolic and atrial fibrillation is not identified already
- Arrange carotid imaging: ultrasound, CTA or MRA
- Consider echocardiography
- Initiate smoking cessation counseling

No

Blood pressure (BP) exceeds 185 over 110 mm Hg

- This is too high for IV t-PA administration and *requires* gentle reduction prior to initiating t-PA.
- Labetalol 10 mg IV every 10 minutes (consider doubling dose (i.e. 20 mg, 40 mg, 80 mg) to maximum total dose of 150 mg. Start maintenance infusion.*
- Nicardipine IV- start 5 mg/hour, titrate up by 2.5 mg/hour at 5- to 15-minute intervals, maximum dose 15 mg/hour; when desired blood pressure attained, reduce to 3 mg/hour.
- Other medications. **

If BP falls below 185/110 mmHg, proceed to IV t-PA administration.

If BP proves refractory to the above, the risk for intracerebral hemorrhage is considered too high and the patient should not be treated with t-PA. Continue to treat BP to keep less than 220/120 mmHg however. ***

Footnotes:

*Be sure to initiate a continuous infusion of the antihypertensive agent as boluses will wear off and BP will likely return to its previous high levels.

**Nitroglycerin paste (for patients with no IV access), labetalol, and nicardipine are recommended by the American Stroke Association. Other new medications are available and have been used successfully to manage high blood pressure in acute stroke, but do not yet have the ASA recommendation. Clevidipine is one such intravenous medication. If used, dosing starts at 1-2 mg/hour, double the rate every 90 seconds until BP goal is neared, then increase by smaller increments every 5-10 minutes until the desired level is reached. Maximum dose is 32 mg/hour. See ENLS reference [Pharmacotherapy](#).

***Permissive hypertension is allowed for TIA, as it is for non-t-PA treated patients, up to 220/120 mmHg.



No Improvement Following t-PA

Within 1 hour no change in exam?

Often this is defined as no change in the NIHSS score. Some define this as < 4-point improvement in NIHSS in a patient who still has debilitating stroke symptoms.

There is little evidence that waiting for a period of time after the start of t-PA to initiate endovascular treatment is helpful, and likely leads to unnecessary delay in patients whom you know have large vessel occlusion on CTA or MRA. Current American Stroke Association guidelines recommend not waiting to refer following the initiation of IV t-PA initiation since it takes time to get patients moved to the endovascular suite.

Not Low Risk

TIA risk moderate or high, or unable to arrange timely outpatient work-up and follow-up

Admit for observation:

- Permissive hypertension (not to exceed 220/120 mm Hg)
- Keep head of bed flat for 24 hours. Pt may get up to eat or toilet with assistance
- Telemetry
- Start on antithrombotic agent (ASA 81 mg/day, clopidogrel 75 mg/day, or ASA/extended release dipyridamole 1 tablet twice daily)
- Initiate statin if not taking one already
- Obtain a 12-lead ECG or review the rhythm strip if available. If these show atrial fibrillation consider starting anticoagulation (oral anticoagulant or low molecular weight heparin) or ASA 81 mg if anticoagulation is contraindicated
- Consider initiating longer-term outpatient cardiac monitoring (4 weeks) if the TIA is embolic and atrial fibrillation is not identified already
- Arrange carotid imaging: ultrasound, CTA or MRA
- Consider echocardiography
- Initiate smoking cessation counseling

Onset Less Than 3 hours

Time from stroke symptom onset is less than 3 hours

Time of onset is when the patient was last seen normal.

- If patient or observer can verify when the first symptoms began, use that time
- If a patient awakens with a stroke, the time of onset is when they last went to bed

The time of onset is critical for using t-PA as the risk of intracerebral bleeding increases with increased time from stroke onset. If you cannot establish the time with certainty, most physicians will not treat with t-PA.

Patients with a shorter time to t-PA administration have a higher likelihood of good outcome. Therefore, expediting care may greatly impact your patient.

Check eligibility for on-label (US and elsewhere) use of IV t-PA:

- Diagnosis of ischemic stroke causing measurable neurological deficit.
- The neurological signs should not be clearing spontaneously.*
- The neurological signs should not be minor and isolated.**
- Caution should be exercised in treating a patient with major deficits.
- The symptoms of stroke should not be suggestive of subarachnoid hemorrhage.
- No head trauma or prior stroke in previous 3 months.
- No myocardial infarction in the previous 3 months.
- No gastrointestinal or urinary tract hemorrhage in previous 21 days.
- No major surgery in the previous 14 days.
- No arterial puncture at a non-compressible site in the previous 7 days.
- No history of previous intracranial hemorrhage.
- Blood pressure not elevated (systolic < 185 mm Hg and diastolic < 110 mm Hg).
- No evidence of active bleeding or acute trauma (fracture) on examination.
- Not taking an oral anticoagulant or, if anticoagulant being taken, INR < 1.7.
- No current use of direct thrombin inhibitors or direct factor Xa inhibitors or elevated sensitive laboratory tests (such as aPTT, INR, platelet count, and ECT (Ecarin clotting time); TT (thrombin time); or appropriate factor Xa assays ***
- If receiving heparin in previous 48 hours, aPTT must be in normal range.
- Platelet count <100 000 mm³.
- Blood glucose concentration < 50 mg/dl (2.7 mmol/l). ****
- No seizure with postictal residual neurological impairments.
- CT does not show a multilobar infarction (hypodensity >1/3 cerebral hemisphere).
- The patient or family members understand the potential risks and benefits from treatment.

* Some stroke patients will have stuttering symptoms or they may have mild improvement, e.g. from a NIHSS of 12 to 8 points, but then hold at 8 with no further improvement. The recommendation is to still treat these patients.

** Many physicians use an NIHSS of 4 or 5 points as a lower end cut off for recommending t-PA. It must be noted that patients may have significant residual stroke symptoms with low NIHSS scores (e.g. isolate hemianopsia, or aphasia, or brain stem injury). t-PA administration should strongly be considered in these patients.

*** Novel new direct thrombin inhibitors or direct factor Xa inhibitors pose a new conundrum in determining t-PA eligibility. Without available blood tests and based on drug half-lives, most practitioners are using a cut off of 2 days (or 5 half-lives) since last use of any of these medications before recommending t-PA.

**** The original t-PA guidelines for acute ischemic stroke included an exclusion for patients with serum or capillary glucose level > 400 gm/dl. While this parameter has been removed for many years, a level this high should prompt the consideration of an alternate diagnosis.



Onset Between 3 and 4.5 Hours

Time from stroke onset is between 3 and 4.5 hours

Time of onset is when the patient was last seen normal.

- If the patient or an observer can when the first symptoms began, use that time
- If a patient awakens with a stroke, the time of onset is when they last went to bed

The time of onset is critical for using t-PA as the risk of intracerebral bleeding increases with increased time from stroke onset. If you cannot establish the time with certainty, most physicians will not treat with t-PA.

In the US, t-PA is not yet FDA approved for 3-4.5 hour time window, although it is approved in Europe and Canada. Nonetheless, the 3-4.5 hour window is endorsed by the American Stroke Association. The inclusion criteria are similar to those of < 3 hours, but are modified as follows:

- Age < 80 years
- No anticoagulant use, regardless of INR
- NIHSS < = 25
- No combined history of prior stroke and diabetes



Patient improves following t-PA

Measurable improvement within 1 hour?

Often this is defined as a lowering of the NIHSS score, and there is no clear consensus as to how much.

 Flowchart

Patient is an IV t-PA Candidate

Is Blood Pressure (BP) less than 185/110 mm Hg?

After reviewing the inclusion/exclusion criteria for IV t-PA use, the patient is eligible to receive the drug. Current blood pressure is the last inclusion criteria. If it is too high, the risk of ICH from t-PA is increased. Steps can be taken to lower blood pressure so as to make the patient eligible for t-PA. See the ENLS reference [Pharmacotherapy](#) for dosing.



Patient is not an IV t-PA or IA Treatment Candidate

Neither IV t-PA or IA intervention is appropriate

Common exclusions for IV t-PA are time (duration > 4.5 hours), contraindications to t-PA (recent surgery, current bleeding at a non-compressible site, etc.), or large area of infarction already present on the brain imaging study (> 1/3 of the MCA territory).

IA exclusions include lack of large vessel occlusion on CTA or MRA, lack of consent from the patient or surrogate, or large area of infarction already present on the brain imaging study. If IA intervention is not available at the treating hospital, but there is clinical or radiographic evidence of a large vessel occlusion, consider rapid transfer to a facility with this capability.



Symptom Onset Between 4.5 and 6 hours

Outside IV t-PA window

Beyond 4.5 hours, IV t-PA is associated with increased risks and unproven efficacy. Endovascular therapies may be helpful in this time window (and earlier as well).

The ABCD² Score

What is the predicted risk for stroke?

The ABCD² score is an ordinal scale that provides risk prediction of stroke following the TIA. It is scored as follows:

ABCD ² Element	Points
Age > 60 years	1
Blood Pressure \geq 140/90 mmHg on initial evaluation	1
Clinical Features	
Speech disturbance without weakness	1
Unilateral weakness	2
Duration of symptoms	
10 - 59 minutes	1
60 minutes or greater	2
Diabetes mellitus in patient's history	1
Total Score	0 - 7

The following is the estimated risk (%) of a stroke occurring within various time ranges:

Total Risk	ABCD ² Score	2 day	7 day	90 day
Low	0-3	1.0	1.2	3.1
Moderate	4-5	4.1	5.9	9.8
High	6-7	8.1	12	18

Ref: Cucchiaro B et al, Ann Emerg Med 2008, 52:S27-39

Based on this risk stratification some physicians choose to admit high-risk patients and discharge low risk, and controversy exists about moderate risk patients.



TIA

Symptoms have completely resolved

Diagnosis of TIA (transient ischemic attack) is based on new onset of focal neurological symptoms that are explainable by a vascular cause (i.e. arterial occlusion of a single or group of arteries adequately explain the patient's signs and symptoms) and these signs and symptoms resolve within 24 hours. If the patient's symptoms clear by 24 hours but an acute infarct is observed on brain imaging, this is defined as a stroke and no longer TIA.



Yes

BP is less than 185/110 mmHg

The patient is eligible for IV t-PA.
Place two peripheral IV lines.