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Initial assessment and management of acute stroke

AUTHORS: Jamary Oliveira-Filho, MD, MS, PhD, Michael T Mullen, MD
SECTION EDITORS: Scott E Kasner, MD, Jonathan A Edlow, MD, FACEP
DEPUTY EDITOR: John F Dashe, MD, PhD

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INTRODUCTION

The subacute and long-term assessment and management of patients who have suffered a stroke includes physical therapy and testing to determine the precise etiology of the event so as to prevent recurrence. The acute management differs. Immediate goals include minimizing brain injury, treating medical complications, and moving toward uncovering the pathophysiologic basis of the patient's symptoms.

Patient assessment and management during the acute phase (first few hours) of an ischemic stroke will be reviewed here. Use of thrombolytic therapy, endovascular thrombectomy, treatment of patients not eligible for reperfusion therapy, the clinical diagnosis of various types of stroke, and the subacute and long-term assessment of patients who have had a stroke are discussed separately. (See "Approach to reperfusion therapy for acute ischemic stroke" and "Early antithrombotic treatment of acute ischemic stroke and transient ischemic attack" and "Clinical diagnosis of stroke subtypes" and "Overview of the evaluation of stroke".)

INITIAL ASSESSMENT

Sudden loss of focal brain function is the core feature of the onset of ischemic stroke. However, patients with conditions other than brain ischemia may present in a similar fashion (table 1). (See "Differential diagnosis of transient ischemic attack and acute stroke".)

In addition, patients suffering a stroke may present with other serious medical conditions. Thus, the initial evaluation requires a rapid but broad assessment.

The goals in the initial phase include:

- Ensuring medical stability, with particular attention to airway, breathing, and circulation
- Quickly reversing any conditions that are contributing to the patient's problem
- Determining if patients with acute ischemic stroke are candidates for intravenous thrombolytic therapy (table 2) or endovascular thrombectomy (see "Approach to reperfusion therapy for acute ischemic stroke")
- Moving toward uncovering the pathophysiologic basis of the patient's neurologic symptoms

Time is of the essence in the hyperacute evaluation of stroke patients. The history, physical examination, serum glucose, oxygen saturation, and a noncontrast computed tomography (CT) scan are sufficient in most cases to guide acute therapy (see 'Immediate laboratory studies' below). Other tests are considered based upon individual patient characteristics, but the absence or unavailability of any additional tests need not be a reason to delay therapy if otherwise indicated.

Airway, breathing, and circulation — Assessing vital signs and ensuring stabilization of airway, breathing, and circulation is part of the initial evaluation of all patients with critical illness, including those with stroke [1]. Patients with decreased consciousness or bulbar dysfunction may be unable to protect their airway, and those with increased intracranial pressure due to hemorrhage, vertebrobasilar ischemia, or bihemispheric ischemia can present with vomiting, decreased respiratory drive, or muscular airway obstruction. Hypoventilation, with a resulting increase in carbon dioxide, may lead to cerebral vasodilation and elevate intracranial pressure.

In these cases, intubation may be necessary to restore adequate ventilation and to protect the airway from aspiration. Patients with adequate ventilation should have the oxygen saturation monitored. Patients who are hypoxic should receive supplemental oxygen to maintain oxygen saturation >94 percent [1]. Supplemental oxygen should not routinely be given to nonhypoxic patients with acute ischemic stroke.

History and physical — Establishing the time of ischemic stroke symptom onset is critical because it is the main determinant of eligibility for treatment with intravenous thrombolysis (table 2) and endovascular thrombectomy [2]. For patients who are unable to provide a reliable onset time, symptom onset is defined as the time the patient was last known to be normal or at baseline neurologic status [1]. At times, information from family members, co-

workers, or paramedics (who interviewed witnesses to the onset) may establish the time the patient was last known to be normal. For patients presenting within the therapeutic window for intravenous thrombolysis (less than 4.5 hours from symptom onset) or mechanical thrombectomy (less than 24 hours from symptom onset), the history needs to be accurate but rapid; contraindications to thrombolytic treatment should also be assessed (table 2). (See "Approach to reperfusion therapy for acute ischemic stroke", section on 'Rapid evaluation'.)

The history and physical examination should be used to distinguish between other disorders in the differential diagnosis of brain ischemia (table 1). As examples, seizures, syncope, migraine, hypoglycemia (see 'Hypoglycemia' below), hyperglycemia, movement disorders, or drug toxicity can mimic acute ischemia [1,3]. The most difficult cases involve patients with the combination of focal signs and altered level of consciousness. It is important to ask the patient, relative, or any reliable informant whether the patient takes insulin or oral hypoglycemic agents, has a history of epilepsy, drug overdose or abuse, or recent trauma. (See "Differential diagnosis of transient ischemic attack and acute stroke".)

Diagnosing an intracerebral hemorrhage (ICH) or subarachnoid hemorrhage (SAH) as soon as possible can be lifesaving [4,5]. The history may be helpful in this regard. The presence of acute onset headache and vomiting favor the diagnosis of ICH or SAH compared with a thromboembolic stroke (figure 1), while the abrupt onset of impaired cerebral function without focal symptoms favors the diagnosis of SAH. Another important element of the history is whether the patient takes anticoagulant drugs. Even with these clues, diagnosing intracranial hemorrhage on clinical grounds is very imprecise, so early neuroimaging with a CT or magnetic resonance imaging (MRI) scan is critical. CT is preferred at most centers, as it can be obtained very rapidly and is effective at distinguishing between ischemic and hemorrhagic stroke (see "Neuroimaging of acute stroke"). It is important to assess and stabilize vital physiologic functions **before** sending the patient for an imaging study.

The physical examination should include careful evaluation of the neck and retroorbital regions for vascular bruits, and palpation of pulses in the neck, arms, and legs to assess for their absence, asymmetry, or irregular rate. The heart should be auscultated for murmurs (see "Auscultation of cardiac murmurs in adults"). The lungs should be assessed for abnormal breath sounds, bronchospasm, fluid overload, or stridor.

The skin should be examined for signs of endocarditis, cholesterol emboli, purpura, ecchymoses, or evidence of recent surgery or other invasive procedures, particularly if reliable history is not forthcoming. The funduscopic examination may be helpful if there are cholesterol emboli or papilledema. The head should be examined for signs of trauma. A tongue laceration may suggest a seizure.

In cases where there is a report or suspicion of a fall, the neck should be immobilized until evaluated radiographically for evidence of serious trauma. Examination of the extremities is important to look for evidence of systemic arterial emboli, distal ischemic, cellulitis, and deep vein thrombosis; the latter should raise the possibility that the patient is receiving anticoagulant treatment.

Neurologic evaluation — Ischemia in different vascular territories presents with specific syndromes (table 3). The history should focus upon the time of symptom onset, the course of symptoms over time, possible embolic sources, possible recent trauma (which could either represent a contraindication to intravenous thrombolysis or suggest an arterial dissection as a cause), conditions in the differential diagnosis, and concomitant diseases. (See "Clinical diagnosis of stroke subtypes".)

The neurologic examination should attempt to confirm the findings from the history and provide a quantifiable examination for further assessment over time. Many scales are available that provide a structured, quantifiable neurologic examination. One of the most widely used and validated scales is the National Institutes of Health Stroke Scale (NIHSS), composed of 11 items (table 4) adding up to a total score of 0 to 42 (calculator 1); defined cutpoints for mild, moderate, and severe stroke are not well established, but cut-points of NIHSS score <5 for mild, 5 to 9 for moderate, and ≥10 for severe stroke may be reasonable.

The three most predictive examination findings for the diagnosis of acute stroke are facial paresis, arm drift/weakness, and abnormal speech (a combination of dysarthria and language items derived from the NIHSS) [6,7]. The NIHSS score on admission has been correlated to stroke outcome (table 5) [8,9], and its use is recommended for all patients with suspected stroke [10]. The NIHSS does not capture all stroke-related impairments, particularly with posterior circulation strokes. (See "Use and utility of stroke scales and grading systems", section on 'NIHSS'.)

Immediate laboratory studies — Urgent brain imaging with CT or MRI is mandatory in all patients with sudden neurologic deterioration or acute stroke. (See 'Neuroimaging' below.)

All patients with suspected stroke should have the following studies urgently as part of the acute stroke evaluation [1,4]:

- Noncontrast brain CT or brain MRI
- Finger stick blood glucose
- Oxygen saturation

Other immediate tests for the evaluation of ischemic and hemorrhagic stroke include the following [1,4]:

- CT angiography of the head and neck with CT perfusion, or MR angiography with diffusion-weighted imaging (DWI), with or without MR perfusion-weighted imaging (PWI), for patients who may be eligible for mechanical thrombectomy
- MRI with DWI, to identify patients with wake-up stroke or unknown stroke onset time who have lesions that are positive on DWI but negative on fluid-attenuated inversion recovery (FLAIR), suggesting onset within 4.5 hours and eligibility for intravenous thrombolysis
- Electrocardiogram (this should not delay the noncontrast brain CT)
- Complete blood count including platelets
- Troponin
- Prothrombin time and international normalized ratio (INR)
- Activated partial thromboplastin time
- Ecarin clotting time, thrombin time, or appropriate direct factor Xa activity assay if known or suspected that the patient is taking direct thrombin inhibitor or direct factor Xa inhibitor and is otherwise a candidate for intravenous thrombolytic therapy

However, thrombolytic therapy for acute ischemic stroke (see 'Acute therapy' below) should not be delayed while awaiting the results of hematologic studies unless the patient has received anticoagulants or there is suspicion of a bleeding abnormality or thrombocytopenia. The only test that is mandatory before initiation of intravenous thrombolysis is blood glucose [1].

The following laboratory studies may be appropriate in selected patients [1,4,5]:

- Serum electrolytes, urea nitrogen, creatinine
- Liver function tests
- Toxicology screen
- Blood alcohol level
- Pregnancy test in women of childbearing potential
- Arterial blood gas if hypoxia is suspected
- Chest radiograph if lung disease is suspected
- Lumbar puncture if subarachnoid hemorrhage is suspected and head CT scan is negative for blood; note that lumbar puncture will preclude administration of intravenous thrombolysis, though thrombolysis should not be given if there is suspicion for subarachnoid hemorrhage as the cause of the symptoms
- Electroencephalogram if seizures are suspected

Chest radiography, urinalysis and blood cultures are indicated if fever is present. We also suggest blood for type and cross match in case fresh frozen plasma is needed to reverse a coagulopathy if ICH is present. (See "Spontaneous intracerebral hemorrhage: Pathogenesis, clinical features, and diagnosis".)

In order to limit medication dosage errors, particularly with the use of intravenous thrombolysis with alteplase or tenecteplase, an accurate body weight should be obtained early during the urgent evaluation [11].

Neuroimaging — In the evaluation of the acute stroke patient, imaging studies are necessary to exclude hemorrhage as a cause of the deficit, and they are useful to assess the degree of brain injury and to identify the vascular lesion responsible for the ischemic deficit. Advanced CT and MRI technologies may be able to distinguish between brain tissue that is irreversibly infarcted and that which is potentially salvageable, thereby allowing better selection of patients who are likely to benefit from therapy. This topic is discussed separately. (See "Neuroimaging of acute stroke".)

Cardiac studies — Electrocardiography (ECG) is important for detecting signs of concomitant acute cardiac ischemia. This test is particularly important in the setting of stroke, as patients with ischemic stroke frequently harbor coronary artery disease but may not be able to report chest pain.

Stroke alone can be associated with ECG changes. The sympathetic response to stroke can lead to demand-induced myocardial ischemia. In large strokes, especially subarachnoid hemorrhage, there are centrally mediated changes in the ECG.

The ECG and cardiac monitoring are important for the detection of chronic or intermittent arrhythmias that predispose to embolic events (eg, atrial fibrillation) and for detecting indirect evidence of atrial/ventricular enlargement that may predispose to thrombus formation. Current guidelines recommend cardiac monitoring for at least the first 24 hours after the onset of ischemic stroke to look for atrial fibrillation (AF) or atrial flutter [1]. However, paroxysmal AF may be undetected on standard cardiac monitoring such as continuous telemetry and 24- or 48-hour Holter monitors. Extended cardiac event monitoring for patients with ischemic stroke or transient ischemic attack (TIA) who present with sinus rhythm can significantly increase the detection of occult AF. Such monitoring may reduce the risk of recurrent ischemic stroke by prompting the appropriate use of long-term anticoagulation. The optimal monitoring method – continuous telemetry, ambulatory electrocardiography, serial electrocardiography, transtelephonic ECG monitoring, or insertable cardiac monitors (ICMs; also sometimes referred to as implantable cardiac monitor or implantable loop recorder) – is uncertain, though longer

durations of monitoring are likely to obtain the highest diagnostic yield. (See "Overview of the evaluation of stroke", section on 'Monitoring for subclinical atrial fibrillation' and "Stroke in patients with atrial fibrillation", section on 'Long-term anticoagulation'.)

Transthoracic and transesophageal echocardiography adequately detect cardiogenic and aortic sources for cerebral embolism other than atrial fibrillation (see "Echocardiography in detection of cardiac and aortic sources of systemic embolism"). However, their use can be postponed to later in the hospitalization, when the patient is in a more stable clinical condition. Exceptions include patients with a moderate or high suspicion of endocarditis, where echocardiography may provide confirmation of the diagnosis. (See "Overview of the evaluation of stroke", section on 'Cardiac evaluation' and "Clinical manifestations and evaluation of adults with suspected left-sided native valve endocarditis".)

STROKE MANAGEMENT ISSUES

In addition to stabilization of airway, breathing, and circulation, and rapid neurologic evaluation discussed above, early key management issues that often arise in acute stroke include blood pressure control (see 'Blood pressure management' below), fluid management (see 'Fluids' below), treatment of abnormal blood glucose levels (see 'Hypoglycemia' below and 'Hyperglycemia' below), swallowing assessment (see 'Swallowing assessment' below), and treatment of fever and infection (see 'Fever' below). Care in a dedicated stroke unit (see 'Stroke unit care' below) is associated with better outcomes.

Fluids — Intravascular volume depletion is frequent in the setting of acute stroke, particularly in older adult patients [12], and may worsen cerebral blood flow. For most patients with acute stroke and volume depletion, isotonic saline without dextrose is the agent of choice for intravascular fluid repletion and maintenance fluid therapy [13]. In general, it is best to avoid excess free water (eg, as in ½ isotonic saline) because hypotonic fluids may exacerbate cerebral edema in acute stroke and are less useful than isotonic solutions for replacing intravascular volume. In addition, it is best to avoid fluids containing glucose, which may exacerbate hyperglycemia. However, fluid management must be individualized based on cardiovascular status, electrolyte disturbances, and other conditions that may perturb fluid balance. (See "Maintenance and replacement fluid therapy in adults".)

In particular, hyponatremia following subarachnoid hemorrhage may be due to inappropriate secretion of antidiuretic hormone (SIADH) or rarely, to cerebral salt wasting; these are physiologically distinct and are treated differently, as discussed separately. (See "Aneurysmal subarachnoid hemorrhage: Treatment and prognosis", section on 'Hyponatremia'.)

Hypoglycemia — Hypoglycemia can cause focal neurologic deficits mimicking stroke, and severe hypoglycemia alone can cause neuronal injury. It is important to check the blood sugar and rapidly correct low serum glucose (<60 mg/dL [3.3 mmol/L]) at the first opportunity [1].

Hyperglycemia — Hyperglycemia, generally defined as a blood glucose level >126 mg/dL (>7.0 mmol/L), is common in patients with acute stroke and is associated with poor functional outcome [14-19]. In a series of 59 patients with acute ischemic stroke, admission hyperglycemia was present in 32 percent of patients without diabetes and 81 percent of patients with diabetes [20]. Stress hyperglycemia may be the most common cause [16], although newly diagnosed diabetes is also important [17]. Hyperglycemia may augment brain injury by several mechanisms, including increased tissue acidosis from anaerobic metabolism, free radical generation, and increased blood brain barrier permeability [21-23]. Hyperglycemia may also rarely present as a stroke mimic [24].

In light of these observations, it is reasonable to treat severe hyperglycemia in the setting of acute stroke. The American Heart Association/American Stroke Association guidelines for acute ischemic stroke recommend treatment for hyperglycemia to achieve serum glucose concentrations in the range of 140 to 180 mg/dL (7.8 to 10 mmol/L) [1]. The European Stroke Initiative guidelines recommend treatment for glucose >180 mg/dL (>10 mmol/L) [25].

Tighter control of glucose with intravenous insulin does **not** improve functional outcome in patients with acute ischemic stroke. The multicenter SHINE trial randomly assigned over 1100 adults with hyperglycemia and acute ischemic stroke to either intensive treatment of hyperglycemia (continuous insulin infusion with a target blood glucose concentration of 80 to 130 mg/dL) or standard treatment (subcutaneous insulin on a sliding scale with a target glucose of 80 to 179 mg/dL) [26]. At 90 days, there was no difference in the proportion of patients achieving a favorable functional outcome between the intensive and standard treatment groups (20.5 versus 21.6 percent). In addition, treatment withdrawal for hypoglycemia or other adverse events was more common in the intensive treatment group (11.2 versus 3.2 percent). Similarly, a 2014 systematic review identified 11 controlled trials involving nearly over 1500 adults with acute ischemic stroke who were randomly assigned to either intensively monitored insulin infusion therapy or to usual care; there was no difference between the treatment and control groups for the combined outcome of death or dependency, and no difference between groups for the outcome of final neurologic deficit [27]. In addition, the intervention group had a higher rate of symptomatic hypoglycemia.

Swallowing assessment — Dysphagia is common after stroke and is a major risk factor for developing aspiration pneumonia. It is important to assess swallowing function prior to administering oral medications or food. Thus, prevention of aspiration in patients with acute

stroke includes initial nil per os (NPO) status until swallowing function is evaluated. (See "Complications of stroke: An overview", section on 'Dysphagia'.)

Note that aspirin, if and when indicated, can be given rectally.

Head and body position — During the acute phase of stroke, the position of the patient and the head of bed should be individualized with respect to the risk of elevated intracranial pressure and aspiration, and the presence of comorbid cardiopulmonary disease [28]. We recommend keeping the head in neutral alignment with the body and elevating the head of the bed to 30 degrees for patients in the acute phase of stroke who are at risk for any of the following problems:

- Elevated intracranial pressure (ie, intracerebral hemorrhage, cerebral edema >24 hours from stroke onset in patients with large ischemic infarction)
- Aspiration (eg, those with dysphagia and/or diminished consciousness)
- Cardiopulmonary decompensation or oxygen desaturation (eg, those with chronic cardiac and pulmonary disease)

In the absence of these problems, we suggest keeping the head of bed in the position that is most comfortable for the patient. In addition, a cervical collar or a central intravenous line dressings, if present, should be loose enough so that they do not occlude venous outflow from the head.

A number of reports suggest that cerebral perfusion is maximal when patients are in the horizontal position [29-31]. As an example, in a study involving 20 patients with moderately severe ischemic stroke in the middle cerebral artery (MCA) territory, mean flow velocity in the MCA measured by transcranial Doppler increased by an average of 20 percent when the head-of-bed elevation decreased from 30 to 0 degrees, and by an average of 12 percent when head-of-bed elevation decreased from 30 to 15 degrees [30]. Furthermore, some patients with acute ischemic stroke may develop increased ischemic symptoms upon standing, sitting, or elevating the head of the bed, due to reduction in flow through stenotic vessels or collateral pathways [32,33]. Thus, some stroke experts have favored a supine position is preferred for nonhypoxic patients with acute ischemic stroke who are able to tolerate lying flat. When done, keeping the patient flat is a temporary measure that should be discontinued in most patients after 24 to 48 hours.

Nevertheless, the benefit of maintaining the head flat in this setting remains unproven [34]. In the HeadPoST controlled trial of over 11,000 subjects with acute stroke (85 percent ischemic)

who were randomly assigned to either a lying-flat position or a sitting-up position with the head elevated to at least 30 degrees, there was no difference between treatment groups in disability outcomes, mortality, or serious adverse events [35].

Mobilization of stable patients after 24 hours may lessen the likelihood of major complications such as pneumonia, deep vein thrombosis, pulmonary embolism, and pressure sores after stroke. Exceptions may include those who exhibit neurologic deterioration upon assuming more upright postures. In addition, there is a potential increased risk of aspiration if a flat position is maintained for a prolonged period [36].

However, very early mobilization, within 24 hours of symptom onset, may be harmful [37]. The multicenter randomized AVERT trial, with over 2000 patients, evaluated a protocol of very early mobilization, which was started within 24 hours of stroke onset and consisted of frequent out-of-bed activity including sitting, standing, and walking. Compared with usual care, very early mobilization and early rehabilitative therapies reduced the odds of a favorable outcome at three months [38].

Fever — The source of fever should be investigated and treated, and antipyretics should be used to lower temperature in febrile patients with acute stroke. Common etiologies of fever, including aspiration pneumonia and urinary tract infection, should also be excluded. (See "Complications of stroke: An overview", section on 'Fever and infection'.)

We suggest maintaining normothermia for at least the first several days after an acute stroke [39]. However, the clinical utility of this approach has not been established.

- The Paracetamol (Acetaminophen) In Stroke (PAIS) trial evaluated 1400 adults no later than 12 hours after symptom onset of acute ischemic stroke or intracerebral hemorrhage [40]. Included patients had a body temperature of 36 to 39°C. Compared with placebo, paracetamol (acetaminophen) 1 g six times daily for three days did not improve outcome [40]. However, a post-hoc subgroup analysis of 661 patients with a baseline body temperature of 37 to 39°C suggested benefit for paracetamol.

- In a systematic review and meta-analysis of five small randomized controlled trials with a total of 293 patients, there was no benefit for pharmacologic temperature reduction for acute stroke [41]. All the trials enrolled patients within 24 hours of stroke onset, and the duration of treatment ranged from 24 hours to five days. With addition of results from the PAIS trial, the updated meta-analysis found no difference between active treatment and control for a favorable outcome (odds ratio [OR] 1.1, 95% CI 0.9-1.3) [40].

Larger trials are needed to determine if pharmacologic temperature reduction improves outcome from acute stroke, particularly for patients with temperature of ≥37°C, though it seems unlikely that acetaminophen will be effective by itself. In patients who are nil per os (NPO), acetaminophen is now available in the United States as an intravenous preparation.

Induced hypothermia is not currently recommended for patients with ischemic stroke, outside of clinical trials [1].

Stroke unit care — Evidence suggests that patients with acute stroke have better outcomes when admitted to a hospital unit that is specialized for the care of patients with all types of acute stroke, including ischemic, intracerebral hemorrhage, and subarachnoid hemorrhage [42-46]. The precise components of an acute stroke unit vary between centers and countries, but generally include a hospital ward with dedicated telemetry beds that is continuously staffed by a team of physicians, nurses and other personnel who specialize in stroke care, emphasizing expertise in vascular neurology and neurosurgery [47,48]. Additional components include prompt availability of neuroimaging (eg, CT, MRI, various types of angiography, ultrasound, transcranial Doppler) and cardiac imaging. Implementation of stroke protocols and disease-performance measures may contribute to improved outcomes and decreased risk of stroke-related complications, as shown in some reports [49,50].

Current national guidelines support stroke unit care, when available, for patients with suspected acute stroke [1,51].

BLOOD PRESSURE MANAGEMENT

The approach to blood pressure management in acute ischemic stroke is inherently different from the approach in acute hemorrhagic stroke. For this reason, a neuroimaging study with CT or MRI is critical to help guide blood pressure therapy in patients with acute stroke. Likewise, there are important differences between the blood pressure management in the acute and chronic phases of stroke.

The management of blood pressure in acute phase of stroke is reviewed in the sections that follow. The management of blood pressure after the acute phase of stroke is discussed separately. (See "Antihypertensive therapy for secondary stroke prevention".)

Blood pressure in acute ischemic stroke — The long-term benefit from antihypertensive therapy does not mean that a reduction in blood pressure will be beneficial during initial management of an acute ischemic stroke [52]. In patients with ischemic stroke, the perfusion pressure distal to the obstructed vessel is low, and the distal vessels are dilated. Because of

impaired cerebral autoregulation (figure 2), blood flow in these dilated vessels is thought to be dependent upon the systemic blood pressure.

The arterial blood pressure is usually elevated in patients with an acute stroke. This may be due to chronic hypertension, an acute sympathetic response, or other stroke-mediated mechanisms [53]. In many cases, however, the acutely elevated blood pressure is necessary to maintain brain perfusion in borderline ischemic areas [54].

The observation that the blood pressure frequently rises spontaneously following cerebral ischemia is consistent with this protective hypothesis, although a stress response to the acute event and to hospitalization may also contribute [55]. The hypertensive effect is transient, as blood pressure falls by as much as 20/10 mmHg within 10 days.

An analysis from the International Stroke Trial of 17,398 patients with an ischemic stroke noted a U-shaped relationship between baseline systolic blood pressure and outcomes [56]. Elevated systolic blood pressure was associated with an increased risk of recurrent ischemic stroke (50 percent greater risk of recurrence with a systolic blood pressure of >200 mmHg versus 130 mmHg), while low blood pressure (particularly <120 mmHg) was associated with an excess number of deaths from coronary heart disease.

A subsequent analysis of 1004 patients with acute ischemic stroke from Okinawa also found a U-shaped relationship between admission blood pressure and death within 30 days after stroke onset [57]. The U-shaped relationship was shifted toward higher pressure in patients who had previous hypertension compared with those who did not have previous hypertension. This finding mirrors the shift seen in cerebral autoregulation that occurs in longstanding hypertension (figure 2) [58].

Effect of lowering blood pressure — There are few data from randomized controlled trials specifically designed to guide blood pressure management in the acute phase of ischemic stroke (ie, the first 24 hours) when the ischemic penumbra may be at risk of irreversible damage if cerebral blood flow is reduced by lowering the blood pressure [59]. The MAPAS trial found no clear benefit for blood pressure lowering within 12 hours of acute ischemic stroke onset, but an adjusted analysis suggested that a goal systolic blood pressure of 161 to 180 mmHg increased the odds of a good outcome compared with higher or lower goal blood pressures [60]. The RIGHT-2 trial found that lowering blood pressure within four hours of onset of suspected stroke did not improve functional outcomes; the results are confounded by inclusion of patients with transient ischemic attack (TIA), intracerebral hemorrhage, and stroke mimics [61]. Lowering the systemic blood pressure in patients within 24 hours of acute ischemic stroke onset has been associated with clinical deterioration in several observational studies [62-64].

Other large trials (eg, CATIS [65], SCAST [66], COSSACS [67], and ENOS [68]) enrolled patients as long as 30 to 48 hours after stroke onset, and are therefore less informative regarding the impact of blood pressure treatment in the first hours of ischemic stroke. In addition, many of these trials, including the meta-analyses discussed below, enrolled patients with intracerebral hemorrhage, a group that might be expected to benefit from early blood pressure lowering. Keeping these limitations in mind, some of the randomized trial data suggest that initiating blood pressure reduction in acute stroke or merely continuing prestroke blood pressure medications can be harmful:

- In a 2014 meta-analysis of 16 trials (including ENOS) of antihypertensive medications that included over 19,000 patients with acute stroke, early blood pressure reduction had no effect on functional outcome (OR 1.0, 95% CI 0.93-1.07) [68]. Similarly, a 2015 meta-analysis of 13 randomized trials (also including ENOS) and over 12,000 subjects found that blood pressure lowering started within three days of ischemic stroke onset did not alter the risk of death or dependency at three months or trial end point (relative risk, 1.04, 95% CI 0.96-1.13) [69].

- A meta-analysis of individual patient data from COSSACS and ENOS trials found that continuing versus stopping antihypertensive treatment had no effect on the risk of death or dependency at final follow-up [70]. However, in a subgroup analysis, patients who stopped antihypertensives within 12 hours of stroke onset showed a nonsignificant trend towards less death or dependency. In the ENOS trial itself, the group assigned to continuing blood pressure treatment had an increased likelihood of hospital death or discharge to an institution, an increased risk of death or disability (Barthel index <60) at 90 days, and significantly lower cognition scores at 90 days compared with the group that stopped treatment, even though there was no difference in functional outcome between the two groups [68].

These results are not definitive for the reasons noted above.

Blood pressure goals in ischemic stroke — Special considerations apply to blood pressure control in patients with acute ischemic stroke who are eligible for intravenous thrombolytic therapy. Before thrombolytic therapy is started, treatment is recommended so that systolic blood pressure is ≤185 mmHg and diastolic blood pressure is ≤110 mmHg (table 6) [1]. The blood pressure should be stabilized and maintained at or below 180/105 mmHg for at least 24 hours after thrombolytic treatment. This issue is discussed in detail separately. (See "Intravenous thrombolytic therapy for acute ischemic stroke: Therapeutic use", section on 'Management of blood pressure'.)

For patients with ischemic stroke who are not treated with thrombolytic therapy, blood pressure should **not** be treated acutely unless the hypertension is extreme (systolic blood pressure >220 mmHg or diastolic blood pressure >120 mmHg), or the patient has active ischemic coronary disease, heart failure, aortic dissection, hypertensive encephalopathy, or pre-eclampsia/eclampsia [1,71]. When treatment is indicated, cautious lowering of blood pressure by approximately 15 percent during the first 24 hours after stroke onset is suggested.

It is reasonable to start or restart antihypertensive medications during hospitalization for patients with blood pressure >140/90 mmHg who are neurologically stable, unless contraindicated [1]. This can be done as early as 24 to 48 hours after stroke onset for most hospitalized patients, with the goal of gradually controlling hypertension within a few days to a week [72]. Importantly, patients with extracranial or intracranial large artery stenoses may require a slower reduction in blood pressure (eg, over 7 to 14 days after ischemic stroke), as some degree of blood pressure elevation may be necessary to maintain cerebral blood flow to ischemic brain regions. For this reason, we suggest not restarting antihypertensive agents until after vascular imaging is completed and a symptomatic large artery stenosis is excluded.

If acute antihypertensive therapy is needed, intravenous agents are generally used. (See 'Choice of antihypertensive agent' below.)

Systemic hypotension and hypovolemia should be corrected to improve cerebral blood flow and systemic organ function [1]. However, drug-induced hypertension is unproven for the treatment of ischemic stroke.

Choice of antihypertensive agent — In the acute phase of stroke, there is no good evidence to support the use of any specific antihypertensive agent to achieve recommended blood pressure goals. Nevertheless, reversible and titratable intravenous agents are best suited for precise blood pressure lowering. Consensus guidelines suggest intravenous labetalol, nicardipine, and clevidipine as first-line antihypertensive agents if pharmacologic therapy is necessary in the acute phase, since they allow rapid and safe titration to the goal blood pressure (table 6) [1].

Intravenous nitroprusside should be considered second-line therapy since it carries added theoretical risks of increasing intracranial pressure or affecting platelet function. Medications likely to cause a prolonged or precipitous decline in blood pressure (eg, rapid-acting formulations of nifedipine) should be avoided. In addition, their use is associated with an increased risk of stroke, particularly in older adult patients [73].

Blood pressure in acute hemorrhagic stroke — In both intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH), the approach to blood pressure management must take into

account the potential benefits (eg, reducing further bleeding) and risks (eg, reducing cerebral perfusion) of blood pressure lowering. Recommendations for blood pressure management in acute ICH and SAH are discussed in detail separately. (See "Spontaneous intracerebral hemorrhage: Acute treatment and prognosis", section on 'Blood pressure management' and "Aneurysmal subarachnoid hemorrhage: Treatment and prognosis", section on 'Blood pressure control'.)

ACUTE THERAPY

Ischemic stroke management — For eligible patients (table 2) with acute ischemic stroke, intravenous thrombolysis is first-line therapy, provided that treatment is initiated within the appropriate time window (algorithm 1). Because the benefit of intravenous thrombolysis is time dependent, it is critical to treat patients as quickly as possible.

Mechanical thrombectomy (algorithm 2) is indicated for patients with acute ischemic stroke due to a large artery occlusion in the anterior circulation who can be treated within 24 hours of symptom onset or the time last known to be well at stroke centers with appropriate expertise, regardless of whether they receive intravenous thrombolytic therapy for the same ischemic stroke event. The eligibility criteria and utility of thrombolytic therapy, endovascular thrombectomy, and the treatment of patients not eligible for thrombolysis are discussed separately. (See "Approach to reperfusion therapy for acute ischemic stroke" and "Mechanical thrombectomy for acute ischemic stroke" and "Early antithrombotic treatment of acute ischemic stroke and transient ischemic attack".)

In addition to intravenous thrombolysis and endovascular thrombectomy, a number of interventions for ischemic stroke are associated with either reduced disability, complications, or stroke recurrence, including:

- Antithrombotic therapy with aspirin initiated as soon as possible after stroke onset (see "Early antithrombotic treatment of acute ischemic stroke and transient ischemic attack", section on 'Efficacy of aspirin')
- Prophylaxis for deep venous thrombosis and pulmonary embolism (see "Prevention and treatment of venous thromboembolism in patients with acute stroke", section on 'Approach to VTE prevention')
- Antithrombotic therapy at discharge (see "Long-term antithrombotic therapy for the secondary prevention of ischemic stroke" and "Atrial fibrillation in adults: Use of oral anticoagulants")

- Lipid lowering with high intensity statin therapy (see "Overview of secondary prevention of ischemic stroke", section on 'LDL-C lowering therapy')

- Blood pressure reduction after the acute phase of ischemic stroke has passed (see "Antihypertensive therapy for secondary stroke prevention" and "Overview of secondary prevention of ischemic stroke"); management of blood pressure in the acute phase of ischemic stroke is discussed above (see 'Blood pressure management' above)

- Behavioral and lifestyle changes including smoking cessation, exercise, weight reduction for patients with obesity, and a Mediterranean style diet (see "Overview of secondary prevention of ischemic stroke" and "Overview of smoking cessation management in adults")

Appropriate and timely use of these therapies should be considered as soon as ischemic stroke is recognized. Utilization of these interventions may be improved by the use of standardized stroke care orders or critical pathways beginning with hospital admission through discharge [1,74].

Full-dose anticoagulation is rarely indicated in the hyperacute phase of ischemic stroke, although low-dose heparin anticoagulation is often used for prevention of venous thromboembolism in patients with restricted mobility. (See "Prevention and treatment of venous thromboembolism in patients with acute stroke".)

The main indication for oral anticoagulation after ischemic stroke is atrial fibrillation. When indicated, oral anticoagulation can be started immediately for patients with a transient ischemic attack, and soon after ischemic stroke onset for medically stable patients with a small- or moderate-sized infarct and no bleeding complications or uncontrolled hypertension. For patients with atrial fibrillation who have a large infarct, symptomatic hemorrhagic transformation, or poorly controlled hypertension, withholding oral anticoagulation for one to two weeks is generally recommended. (See "Early antithrombotic treatment of acute ischemic stroke and transient ischemic attack", section on 'Cardioembolic source'.)

- **Statin therapy** – For patients with acute ischemic stroke, we suggest starting or continuing statin treatment as soon as oral medications can be used safely. There is clear evidence that long-term intensive statin therapy is associated with a reduced risk of recurrent ischemic stroke and cardiovascular events, as discussed separately (see "Overview of secondary prevention of ischemic stroke", section on 'LDL-C lowering therapy'). The utility of statin therapy during the acute phase of ischemic stroke is less well studied, but is supported by the following observations:

- A single-center randomized controlled trial of 89 patients who were already treated with a statin and were assigned to continuation or cessation of statin therapy in the acute phase of ischemic stroke [75]. The rate of death or dependency at three months was significantly lower with continuation of statin treatment (39 versus 60 percent).

- An observational study, which evaluated over 12,000 subjects hospitalized with ischemic stroke, found that statin use before and during hospitalization was associated with improved outcome at hospital discharge and with improved survival at one year [76,77]. Furthermore, initiation of statin treatment early in hospitalization was associated with improved survival, while statin discontinuation early in hospitalization, even for a short period, was associated with decreased survival.

- An uncontrolled study of 448 patients reported that new or continued statin treatment in the first 72 hours after acute ischemic stroke was associated with improved early and late (one-year) survival [78].

- An observational study of 2072 patients who received intravenous thrombolysis for acute ischemic stroke found that statin treatment started within 72 hours of thrombolysis was associated with a favorable functional outcome and a reduced risk of death at three months [79]. Of the 839 patients treated with statins, 65 percent were statin naïve.

- **SSRIs** – For patients with hemiparesis but without depression after ischemic stroke, evidence from a few small randomized controlled trials (including the FLAME trial) suggested that early initiation of selective serotonin-reuptake inhibitors (SSRIs) enhanced motor recovery and reduced dependency [80-82]. However, subsequent randomized controlled trials, including the FOCUS, AFFINITY, and EFFECTS trials, which together enrolled over 5900 adult patients with acute ischemic stroke or intracerebral hemorrhage, found no benefit in functional outcome at six months for treatment with fluoxetine compared with placebo [83-85]. Treatment with fluoxetine reduced the risk of developing depression in FOCUS and EFFECTS but increased the risk of bone fractures in all three trials, increased the risks of falls and epileptic seizures in AFFINITY, and increased the risk of hyponatremia in EFFECTS.

Intracranial hemorrhage management — The treatment of patients with intracerebral hemorrhage or subarachnoid hemorrhage is reviewed in detail elsewhere. (See "Spontaneous intracerebral hemorrhage: Acute treatment and prognosis" and "Aneurysmal subarachnoid hemorrhage: Treatment and prognosis" and "Intravenous thrombolytic therapy for acute

ischemic stroke: Therapeutic use", section on 'Management of symptomatic intracerebral hemorrhage'.)

Neuroprotective treatment — Numerous neuroprotective agents have shown promising results in animal experiments. However, clinical trials have thus far failed to confirm consistent benefit [86]. This failure may be due, at least in part, to limitations of animal models of acute stroke and to shortcomings of clinical trials.

The search for effective neuroprotective treatment continues [86-91]. As examples, nerinetide and remote ischemic conditioning have shown signals suggesting benefit in some clinical trials [91-95]. More study is needed to determine if these treatments are safe and effective for acute ischemic stroke.

PREVENTION OF COMPLICATIONS

The prevention of medical complications of stroke is an important goal of stroke management, and this aspect of care begins with initial evaluation of the patient. Common acute and subacute medical problems associated with stroke include:

- Myocardial infarction
- Heart failure
- Dysphagia
- Aspiration pneumonia
- Urinary tract infection
- Deep vein thrombosis
- Pulmonary embolism
- Dehydration
- Malnutrition
- Pressure sores
- Orthopedic complications and contractures

The prevention, impact, and management of these complications are discussed separately. (See "Complications of stroke: An overview" and "Prevention and treatment of venous thromboembolism in patients with acute stroke".)

Delirium, characterized by a disturbance of consciousness with decreased attention and disorganized thinking, is another potential complication of stroke [96]. Findings from systematic reviews and meta-analyses suggest that the rate of post-stroke delirium is approximately 25 percent [97,98]. Patients with delirium have longer hospital stays and higher inpatient and 12-

month mortality rates [97]. Risk factors for developing post-stroke delirium include preexisting cognitive decline, infection, and greater stroke severity [99]. (See "Diagnosis of delirium and confusional states" and "Delirium and acute confusional states: Prevention, treatment, and prognosis".)

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Stroke in adults".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Stroke (The Basics)" and "Patient education: Intracerebral hemorrhage (The Basics)")
- Beyond the Basics topics (see "Patient education: Stroke symptoms and diagnosis (Beyond the Basics)" and "Patient education: Ischemic stroke treatment (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- **Main goals of initial evaluation** – The main goals in the initial phase of acute stroke management are to ensure medical stability, to quickly reverse conditions that are contributing to the patient's problem, to determine if patients with acute ischemic stroke

are candidates for reperfusion therapy, and to begin to uncover the pathophysiologic basis of the neurologic symptoms. (See 'Initial assessment' above.)

- **Important aspects of immediate assessment** – Important aspects of acute stroke evaluation and management include the following:

  - **Vital signs** – Assess vital signs and stabilize airway, breathing, and circulation. (See 'Airway, breathing, and circulation' above.)

  - **Rapid history and examination** – Obtain a rapid but accurate history and examination to help distinguish stroke mimics and other disorders in the differential diagnosis (table 1) of acute stroke. (See 'History and physical' above and 'Neurologic evaluation' above.)

  - **Urgent brain imaging** – Obtain urgent brain imaging (with CT or MRI), neurovascular imaging (with CT angiography or magnetic resonance angiography [MRA]) and other important laboratory studies, including cardiac monitoring during the first 24 hours after the onset of ischemic stroke. (See 'Immediate laboratory studies' above and 'Neuroimaging' above and 'Cardiac studies' above.)

  - **Fluid management** – Manage volume depletion and electrolyte disturbances. (See 'Fluids' above.)

  - **Check serum glucose** – Low serum glucose (<60 mg/dL [3.3 mmol/L]) should be corrected rapidly. It is reasonable to treat hyperglycemia if the glucose level is >180 mg/dL (>10 mmol/L) with a goal of keeping serum glucose levels within a range of 140 to 180 mg/dL (7.8 to 10 mmol/L).

  - **Check swallowing** – All patients with acute stroke should be assessed for ability to swallow in order to prevent aspiration. (See 'Swallowing assessment' above and "Complications of stroke: An overview", section on 'Dysphagia'.)

  - **Optimize head of bed position** – For patients with intracerebral hemorrhage, subarachnoid hemorrhage, or ischemic stroke who are at risk for elevated intracranial pressure, aspiration, cardiopulmonary decompensation, or oxygen desaturation, we recommend keeping the head in neutral alignment with the body and elevating the head of the bed to 30 degrees (**Grade 1C**). For patients with stroke who are not at high risk for these complications, we suggest keeping the head of the bed in the position that is most comfortable. (See 'Head and body position' above.)

- **Check for fever** – Evaluate and treat the source of fever, if present; for patients with acute stroke, we suggest maintaining normothermia for at least the first several days after an acute stroke (**Grade 2C**). (See 'Fever' above.)

- **Blood pressure management** – The management of blood pressure in acute stroke depends on the type of stroke and anticipated treatment. (See 'Blood pressure management' above.)

  - **Thrombolytic therapy** – For patients with acute ischemic stroke who will receive intravenous thrombolytic therapy, antihypertensive treatment is recommended so that systolic blood pressure is ≤185 mmHg and diastolic blood pressure is ≤110 mmHg prior to treatment and <180/105 mmHg for the first 24 hours after treatment (table 6). This issue is discussed in detail separately. (See "Intravenous thrombolytic therapy for acute ischemic stroke: Therapeutic use", section on 'Management of blood pressure'.)

  - **No thrombolytic therapy** – For patients with acute ischemic stroke who are **not** treated with thrombolytic therapy, we suggest treating high blood pressure only if the hypertension is extreme (systolic blood pressure >220 mmHg or diastolic blood pressure >120 mmHg), or if the patient has another clear indication (active ischemic coronary disease, heart failure, aortic dissection, hypertensive encephalopathy, or pre-eclampsia/eclampsia) (**Grade 2C**). When treatment is indicated, we suggest cautious lowering of blood pressure by approximately 15 percent during the first 24 hours after stroke onset (**Grade 2C**). (See 'Blood pressure goals in ischemic stroke' above.)

  - **Hemorrhagic stroke** – In both intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH), the approach to blood pressure lowering must account for the potential benefits (eg, reducing further bleeding) and risks (eg, reducing cerebral perfusion). Recommendations for blood pressure management in acute ICH and SAH are discussed in detail separately. (See 'Blood pressure in acute hemorrhagic stroke' above and "Spontaneous intracerebral hemorrhage: Acute treatment and prognosis", section on 'Blood pressure management' and "Aneurysmal subarachnoid hemorrhage: Treatment and prognosis", section on 'Blood pressure control'.)

- **Eligibility for reperfusion therapy** – For eligible patients (table 2) with acute ischemic stroke, intravenous thrombolytic therapy is first-line therapy, provided that treatment is initiated within the appropriate time window (algorithm 1). Patients with acute ischemic stroke due to a proximal large artery occlusion who can be treated within 24 hours of time last known to be at neurologic baseline should be evaluated for treatment with mechanical thrombectomy (algorithm 2). The eligibility criteria and utility of

thrombolytic therapy, mechanical thrombectomy, and the treatment of patients not eligible for thrombolysis are discussed separately. (See "Approach to reperfusion therapy for acute ischemic stroke" and "Mechanical thrombectomy for acute ischemic stroke" and "Early antithrombotic treatment of acute ischemic stroke and transient ischemic attack".)

- **Other early interventions that improve outcome** – In addition to reperfusion therapy, a number of interventions for ischemic stroke are associated with either reduced disability, complications, or stroke recurrence, including (see 'Acute therapy' above):

  - **Antiplatelet therapy** – Antiplatelet agents should be started as soon as possible after the diagnosis of ischemic stroke is confirmed, even before the evaluation for ischemic mechanism is complete. (See "Early antithrombotic treatment of acute ischemic stroke and transient ischemic attack", section on 'Treatment on presentation'.)

  - **Prophylaxis for venous thromboembolism** – Prophylaxis for deep venous thrombosis and pulmonary embolism is indicated for all patients with acute stroke and restricted mobility. (See "Prevention and treatment of venous thromboembolism in patients with acute stroke", section on 'Approach to VTE prevention'.)

  - **Statin therapy** – For patients with acute ischemic stroke, we suggest starting or continuing statin treatment as soon as oral medications can be used safely (**Grade 2C**). (See 'Ischemic stroke management' above.)

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GRAPHICS

Acute stroke differential diagnosis

Migraine aura
Seizure with postictal paresis (Todd paralysis), aphasia, or neglect
Central nervous system tumor or abscess
Cerebral venous thrombosis
Functional deficit (conversion reaction)
Hypertensive encephalopathy
Head trauma
Mitochondrial disorder (eg, mitochondrial encephalopathy with lactic acidosis and stroke-like episodes or MELAS)
Multiple sclerosis
Posterior reversible encephalopathy syndrome (PRES)
Reversible cerebral vasoconstriction syndromes (RCVS)
Spinal cord disorder (eg, compressive myelopathy, spinal dural arteriovenous fistula)
Subdural hematoma
Syncope
Systemic infection
Toxic-metabolic disturbance (eg, hypoglycemia, exogenous drug intoxication)
Transient global amnesia
Viral encephalitis (eg, herpes simplex encephalitis)
Wernicke encephalopathy

Graphic 69869 Version 7.0

Eligibility criteria for the treatment of acute ischemic stroke with intravenous thrombolysis (recombinant tissue plasminogen activator or tPA)

Inclusion criteria

- Clinical diagnosis of ischemic stroke causing measurable neurologic deficit
- Onset of symptoms <4.5 hours before beginning treatment; if the exact time of stroke onset is not known, it is defined as the last time the patient was known to be normal or at neurologic baseline
- Age ≥18 years

Exclusion criteria

Patient history

- Ischemic stroke or severe head trauma in the previous three months
- Previous intracranial hemorrhage
- Intra-axial intracranial neoplasm
- Gastrointestinal malignancy
- Gastrointestinal hemorrhage in the previous 21 days
- Intracranial or intraspinal surgery within the prior three months

Clinical

- Symptoms suggestive of subarachnoid hemorrhage
- Persistent blood pressure elevation (systolic ≥185 mmHg or diastolic ≥110 mmHg)
- Active internal bleeding
- Presentation consistent with infective endocarditis
- Stroke known or suspected to be associated with aortic arch dissection
- Acute bleeding diathesis, including but not limited to conditions defined under 'Hematologic'

Hematologic

- Platelet count <100,000/mm^3*
- Current anticoagulant use with an INR >1.7 or PT >15 seconds or aPTT >40 seconds*
- Therapeutic doses of low molecular weight heparin received within 24 hours (eg, to treat VTE and ACS); this exclusion does not apply to prophylactic doses (eg, to prevent VTE)
- Current use (ie, last dose within 48 hours in a patient with normal renal function) of a direct thrombin inhibitor or direct factor Xa inhibitor with evidence of anticoagulant effect by laboratory tests such as aPTT, INR, ECT, TT, or appropriate factor Xa activity assays

Head CT

- Evidence of hemorrhage
- Extensive regions of obvious hypodensity consistent with irreversible injury

Warnings¶

- Only minor and isolated neurologic signs or rapidly improving symptoms$^{\Delta}$
- Serum glucose <50 mg/dL (<2.8 mmol/L)$^{\diamond}$

- Serious trauma in the previous 14 days[§]
- Major surgery in the previous 14 days[¥]
- History of gastrointestinal bleeding (remote) or genitourinary bleeding[‡]
- Seizure at the onset of stroke with postictal neurologic impairments[†]
- Pregnancy**
- Arterial puncture at a noncompressible site in the previous seven days[¶¶]
- Large (≥10 mm), untreated, unruptured intracranial aneurysm[¶¶]
- Untreated intracranial vascular malformation[¶¶]

Additional warnings for treatment from 3 to 4.5 hours from symptom onset[ΔΔ]

- Age >80 years
- Oral anticoagulant use regardless of INR
- Severe stroke (NIHSS score >25)
- Combination of both previous ischemic stroke and diabetes mellitus

ACS: acute coronary syndrome; aPTT: activated partial thromboplastin time; ECT: ecarin clotting time; INR: international normalized ratio; PT: prothrombin time; NIHSS: National Institutes of Health Stroke Scale; tPA: tissue plasminogen activator (alteplase or tenecteplase); TT: thrombin time; VTE: venous thromboembolism.

* Although it is desirable to know the results of these tests, thrombolytic therapy should not be delayed while results are pending unless (1) there is clinical suspicion of a bleeding abnormality or thrombocytopenia, (2) the patient is currently on or has recently received anticoagulants (eg, heparin, warfarin, a direct thrombin inhibitor, or a direct factor Xa inhibitor), or (3) use of anticoagulants is not known. Otherwise, treatment with intravenous tPA can be started before availability of coagulation test results but should be discontinued if the INR, PT, or aPTT exceed the limits stated in the table, or if platelet count is <100,000 mm^3.

¶ With careful consideration and weighting of risk-to-benefit, patients may receive intravenous thrombolysis despite one or more warnings.

Δ Patients who have a persistent neurologic deficit that is potentially disabling, despite improvement of any degree, should be treated with intravenous thrombolysis in the absence of other contraindications. Any of the following should be considered disabling deficits:

- Complete hemianopia: ≥2 on NIHSS question 3, or
- Severe aphasia: ≥2 on NIHSS question 9, or
- Visual or sensory extinction: ≥1 on NIHSS question 11, or
- Any weakness limiting sustained effort against gravity: ≥2 on NIHSS question 5 or 6, or
- Any deficits that lead to a total NIHSS >5, or
- Any remaining deficit considered potentially disabling in the view of the patient and the treating practitioner using clinical judgment

◇ Patients may be treated with intravenous thrombolysis if glucose level is subsequently normalized.

§ The potential risks of bleeding with tPA from injuries related to the trauma should be weighed against the anticipated benefits of reduced stroke-related neurologic deficits.

¥ The increased risk of surgical site bleeding with tPA should be weighed against the anticipated benefits of reduced stroke-related neurologic deficits.

‡ There is a low increased risk of new bleeding with tPA in the setting of past gastrointestinal or genitourinary bleeding. However, tPA administration within 21 days of gastrointestinal bleeding is not recommended.

† Intravenous thrombolysis is reasonable in patients with a seizure at stroke onset if evidence suggests that residual impairments are secondary to acute ischemic stroke and not to a postictal phenomenon.

** tPA can be given in pregnancy when the anticipated benefits of treating moderate or severe stroke outweigh the anticipated increased risks of uterine bleeding.

¶¶ The safety and efficacy of administering tPA is uncertain for these relative exclusions.

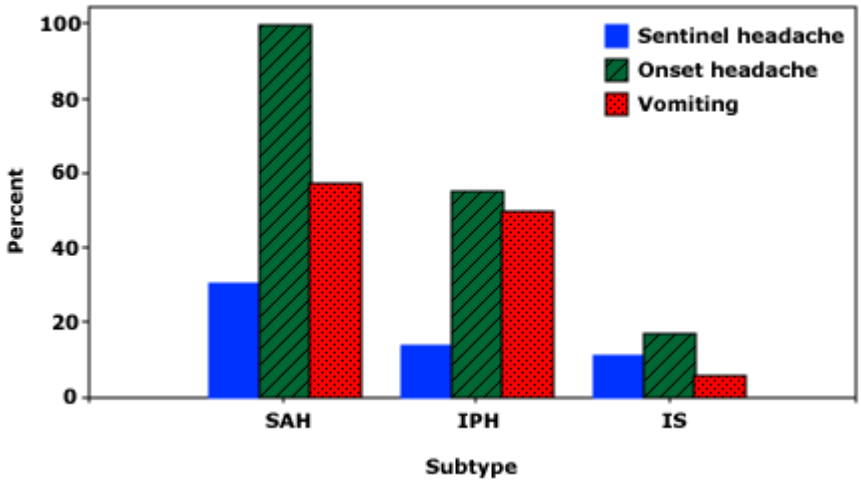
ΔΔ Although these were exclusions in the trial showing benefit in the 3 to 4.5 hour window, intravenous tPA appears to be safe and may be beneficial for patients with these criteria, including patients taking oral anticoagulants with an INR <1.7.

Adapted from:

1. *Hacke W, Kaste M, Bluhmki E, et al. Thrombolysis with alteplase 3 to 4.5 hours after acute ischemic stroke. N Engl J Med 2008; 359:1317.*
2. *Del Zoppo GJ, Saver JL, Jauch EC, et al. Expansion of the time window for treatment of acute ischemic stroke with intravenous tissue plasminogen activator. A science advisory from the American Heart Association/American Stroke Association. Stroke 2009; 40:2945.*
3. *Re-examining Acute Eligibility for Thrombolysis (TREAT) Task Force:, Levine SR, Khatri P, et al. Review, historical context, and clarifications of the NINDS rt-PA stroke trials exclusion criteria: Part 1: rapidly improving stroke symptoms. Stroke 2013; 44:2500.*
4. *Demaerschalk BM, Kleindorfer DO, Adeoye OM, et al. Scientific rationale for the inclusion and exclusion criteria for intravenous alteplase in acute ischemic stroke: A statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2016; 47:581.*
5. *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:e344.*

Graphic 71462 Version 27.0

Headache and vomiting in stroke subtypes



The frequency of sentinel headache, onset headache, and vomiting in three subtypes of stroke: subarachnoid hemorrhage, intraparenchymal (intracerebral) hemorrhage, and ischemic stroke. Onset headache was present in virtually all patients with SAH and about one-half of those with IPH; all of these symptoms were infrequent in patients with IS.

SAH: subarachnoid hemorrhage; IPH: intraparenchymal (intracerebral) hemorrhage; IS: ischemic stroke.

Data from: Gorelick PB, Hier DB, Caplan LR, Langenberg P. Headache in acute cerebrovascular disease. Neurology 1986; 36:1445.

Graphic 60831 Version 4.0

Acute ischemic stroke syndromes according to vascular territory

Artery involved	Syndrome
Anterior cerebral artery	Motor and/or sensory deficit (leg > face, arm) Grasp, sucking reflexes Abulia, paratonic rigidity, gait apraxia
Middle cerebral artery	Dominant hemisphere: aphasia, motor and sensory deficit (face, arm > le > foot), may be complete hemiplegia if internal capsule involved, homonymous hemianopia Non-dominant hemisphere: neglect, anosognosia, motor and sensory deficit (face, arm > leg > foot), homonymous hemianopia
Posterior cerebral artery	Homonymous hemianopia; alexia without agraphia (dominant hemisphere); visual hallucinations, visual perseverations (calcarine cortex); sensory loss, choreoathetosis, spontaneous pain (thalamus); III nerve palsy, paresis of vertical eye movement, motor deficit (cerebral peduncle, midbrain)
Penetrating vessels	Pure motor hemiparesis (classic lacunar syndromes) Pure sensory deficit Pure sensory-motor deficit Hemiparesis, homolateral ataxia Dysarthria/clumsy hand
Vertebrobasilar	Cranial nerve palsies Crossed sensory deficits Diplopia, dizziness, nausea, vomiting, dysarthria, dysphagia, hiccup Limb and gait ataxia Motor deficit Coma Bilateral signs suggest basilar artery disease
Internal carotid artery	Progressive or stuttering onset of MCA syndrome, occasionally ACA syndrome as well if insufficient collateral flow

Graphic 75487 Version 7.0

National Institutes of Health Stroke Scale (NIHSS)

Administer stroke scale items in the order listed. Record performance in each category after each subscale exam. Do not go back and change scores. Follow directions provided for each exam technique. Scores should reflect what the patient does, not what the clinician thinks the patient can do. The clinician should record answers while administering the exam and work quickly. Except where indicated, the patient should not be coached (ie, repeated requests to patient to make a special effort).

Instructions	Scale definition	Score
1a. Level of consciousness: The investigator must choose a response if a full evaluation is prevented by such obstacles as an endotracheal tube, language barrier, orotracheal trauma/bandages. A 3 is scored only if the patient makes no movement (other than reflexive posturing) in response to noxious stimulation.	0 = **Alert;** keenly responsive. 1 = **Not alert;** but arousable by minor stimulation to obey, answer, or respond. 2 = **Not alert;** requires repeated stimulation to attend, or is obtunded and requires strong or painful stimulation to make movements (not stereotyped). 3 = Responds only with reflex motor or autonomic effects or totally unresponsive, flaccid, and areflexic.	____
1b. Level of consciousness questions: The patient is asked the month and his/her age. The answer must be correct - there is no partial credit for being close. Aphasic and stuporous patients who do not comprehend the questions will score 2. Patients unable to speak because of endotracheal intubation, orotracheal trauma, severe dysarthria from any cause, language barrier, or any other problem not secondary to aphasia are given a 1. It is important that only the initial answer be graded and that the examiner not "help" the patient with verbal or non-verbal cues.	0 = **Answers** both questions correctly. 1 = **Answers** one question correctly. 2 = **Answers** neither question correctly.	____
1c. Level of consciousness commands: The patient is asked to open and close the eyes and then to grip and release the non-paretic hand. Substitute another one step command if the hands cannot be used. Credit is given if an unequivocal attempt is made but not completed due to weakness. If the patient does not respond to command, the task should be demonstrated to him or her (pantomime), and the result scored (ie, follows none, one or two commands). Patients with	0 = **Performs** both tasks correctly. 1 = **Performs** one task correctly. 2 = **Performs** neither task correctly.	____

trauma, amputation, or other physical impediments should be given suitable one-step commands. Only the first attempt is scored.		
2. Best gaze: Only horizontal eye movements will be tested. Voluntary or reflexive (oculocephalic) eye movements will be scored, but caloric testing is not done. If the patient has a conjugate deviation of the eyes that can be overcome by voluntary or reflexive activity, the score will be 1. If a patient has an isolated peripheral nerve paresis (cranial nerves III, IV or VI), score a 1. Gaze is testable in all aphasic patients. Patients with ocular trauma, bandages, pre-existing blindness, or other disorder of visual acuity or fields should be tested with reflexive movements, and a choice made by the investigator. Establishing eye contact and then moving about the patient from side to side will occasionally clarify the presence of a partial gaze palsy.	0 = **Normal.** 1 = **Partial gaze palsy;** gaze is abnormal in one or both eyes, but forced deviation or total gaze paresis is not present. 2 = **Forced deviation,** or total gaze paresis not overcome by the oculocephalic maneuver.	____
3. Visual: Visual fields (upper and lower quadrants) are tested by confrontation, using finger counting or visual threat, as appropriate. Patients may be encouraged, but if they look at the side of the moving fingers appropriately, this can be scored as normal. If there is unilateral blindness or enucleation, visual fields in the remaining eye are scored. Score 1 only if a clear-cut asymmetry, including quadrantanopia, is found. If patient is blind from any cause, score 3. Double simultaneous stimulation is performed at this point. If there is extinction, patient receives a 1, and the results are used to respond to item 11.	0 = **No visual loss.** 1 = **Partial hemianopia.** 2 = **Complete hemianopia.** 3 = **Bilateral hemianopia** (blind including cortical blindness).	____
4. Facial palsy: Ask - or use pantomime to encourage - the patient to show teeth or raise eyebrows and close eyes. Score symmetry of grimace in response to noxious stimuli in the poorly responsive or non-comprehending patient. If facial trauma/bandages, orotracheal tube, tape or other physical barriers obscure the face, these should be removed to the extent possible.	0 = **Normal** symmetrical movements. 1 = **Minor paralysis** (flattened nasolabial fold, asymmetry on smiling). 2 = **Partial paralysis** (total or near-total paralysis of lower face). 3 = **Complete paralysis** of one or both sides (absence of facial movement in the upper and lower face).	____

5. Motor arm: The limb is placed in the appropriate position: extend the arms (palms down) 90 degrees (if sitting) or 45 degrees (if supine). Drift is scored if the arm falls before 10 seconds. The aphasic patient is encouraged using urgency in the voice and pantomime, but not noxious stimulation. Each limb is tested in turn, beginning with the non-paretic arm. Only in the case of amputation or joint fusion at the shoulder, the examiner should record the score as untestable (UN), and clearly write the explanation for this choice.	0 = **No drift;** limb holds 90 (or 45) degrees for full 10 seconds. 1 = **Drift;** limb holds 90 (or 45) degrees, but drifts down before full 10 seconds; does not hit bed or other support. 2 = **Some effort against gravity;** limb cannot get to or maintain (if cued) 90 (or 45) degrees, drifts down to bed, but has some effort against gravity. 3 = **No effort against gravity;** limb falls. 4 = **No movement.** UN = **Amputation** or joint fusion, explain:_____ **5a. Left arm** **5b. Right arm**	____
6. Motor leg: The limb is placed in the appropriate position: hold the leg at 30 degrees (always tested supine). Drift is scored if the leg falls before 5 seconds. The aphasic patient is encouraged using urgency in the voice and pantomime, but not noxious stimulation. Each limb is tested in turn, beginning with the non-paretic leg. Only in the case of amputation or joint fusion at the hip, the examiner should record the score as untestable (UN), and clearly write the explanation for this choice.	0 = **No drift;** leg holds 30-degree position for full 5 seconds. 1 = **Drift;** leg falls by the end of the 5-second period but does not hit bed. 2 = **Some effort against gravity;** leg falls to bed by 5 seconds, but has some effort against gravity. 3 = **No effort against gravity;** leg falls to bed immediately. 4 = **No movement.** UN = **Amputation** or joint fusion, explain:_____ **6a. Left leg** **6b. Right leg**	____
7. Limb ataxia: This item is aimed at finding evidence of a unilateral cerebellar lesion. Test with eyes open. In case of visual defect, ensure testing is done in intact visual field. The finger-nose-finger and heel-shin tests are performed on both sides, and ataxia is scored only if present out of proportion to weakness. Ataxia is absent in the patient who cannot understand or is paralyzed. Only in the case of amputation or joint fusion, the examiner should record the score as untestable (UN),	0 = **Absent.** 1 = **Present in one limb.** 2 = **Present in two limbs.** UN = **Amputation** or joint fusion, explain:_____	____

and clearly write the explanation for this choice. In case of blindness, test by having the patient touch nose from extended arm position.		
8. Sensory: Sensation or grimace to pinprick when tested, or withdrawal from noxious stimulus in the obtunded or aphasic patient. Only sensory loss attributed to stroke is scored as abnormal and the examiner should test as many body areas (arms [not hands], legs, trunk, face) as needed to accurately check for hemisensory loss. A score of 2, "severe or total sensory loss," should only be given when a severe or total loss of sensation can be clearly demonstrated. Stuporous and aphasic patients will, therefore, probably score 1 or 0. The patient with brainstem stroke who has bilateral loss of sensation is scored 2. If the patient does not respond and is quadriplegic, score 2. Patients in a coma (item 1a=3) are automatically given a 2 on this item.	0 = **Normal;** no sensory loss. 1 = **Mild-to-moderate sensory loss;** patient feels pinprick is less sharp or is dull on the affected side; or there is a loss of superficial pain with pinprick, but patient is aware of being touched. 2 = **Severe to total sensory loss;** patient is not aware of being touched in the face, arm, and leg.	____
9. Best language: A great deal of information about comprehension will be obtained during the preceding sections of the examination. For this scale item, the patient is asked to describe what is happening in the attached picture, to name the items on the attached naming sheet and to read from the attached list of sentences. Comprehension is judged from responses here, as well as to all of the commands in the preceding general neurological exam. If visual loss interferes with the tests, ask the patient to identify objects placed in the hand, repeat, and produce speech. The intubated patient should be asked to write. The patient in a coma (item 1a=3) will automatically score 3 on this item. The examiner must choose a score for the patient with stupor or limited cooperation, but a score of 3 should be used only if the patient is mute and follows no one-step commands.	0 = **No aphasia;** normal. 1 = **Mild-to-moderate aphasia;** some obvious loss of fluency or facility of comprehension, without significant limitation on ideas expressed or form of expression. Reduction of speech and/or comprehension, however, makes conversation about provided materials difficult or impossible. For example, in conversation about provided materials, examiner can identify picture or naming card content from patient's response. 2 = **Severe aphasia;** all communication is through fragmentary expression; great need for inference, questioning, and guessing by the listener. Range of information that can be exchanged is limited; listener carries burden of communication. Examiner cannot identify materials provided from patient response. 3 = **Mute, global aphasia;** no usable speech or auditory comprehension.	____
10. Dysarthria: If patient is thought to be normal, an adequate sample of speech must be obtained by asking patient to read or	0 = **Normal.**	____

repeat words from the attached list. If the patient has severe aphasia, the clarity of articulation of spontaneous speech can be rated. Only if the patient is intubated or has other physical barriers to producing speech, the examiner should record the score as untestable (UN), and clearly write an explanation for this choice. Do not tell the patient why he or she is being tested.	1 = **Mild-to-moderate dysarthria;** patient slurs at least some words and, at worst, can be understood with some difficulty. 2 = **Severe dysarthria;** patient's speech is so slurred as to be unintelligible in the absence of or out of proportion to any dysphasia, or is mute/anarthric. UN = **Intubated** or other physical barrier, explain:_____	
11. Extinction and inattention (formerly neglect): Sufficient information to identify neglect may be obtained during the prior testing. If the patient has a severe visual loss preventing visual double simultaneous stimulation, and the cutaneous stimuli are normal, the score is normal. If the patient has aphasia but does appear to attend to both sides, the score is normal. The presence of visual spatial neglect or anosognosia may also be taken as evidence of abnormality. Since the abnormality is scored only if present, the item is never untestable.	0 = **No abnormality.** 1 = **Visual, tactile, auditory, spatial, or personal inattention** or extinction to bilateral simultaneous stimulation in one of the sensory modalities. 2 = **Profound hemi-inattention or extinction to more than one modality;** does not recognize own hand or orients to only one side of space.	____
		____

Adapted from: Goldstein LB, Samsa GP. Reliability of the National Institutes of Health Stroke Scale. Extension to non-neurologists in the context of a clinical trial. Stroke 1997; 28:307.

Graphic 61698 Version 8.0

Stroke outcome at three months in the placebo group of the NINDS trial

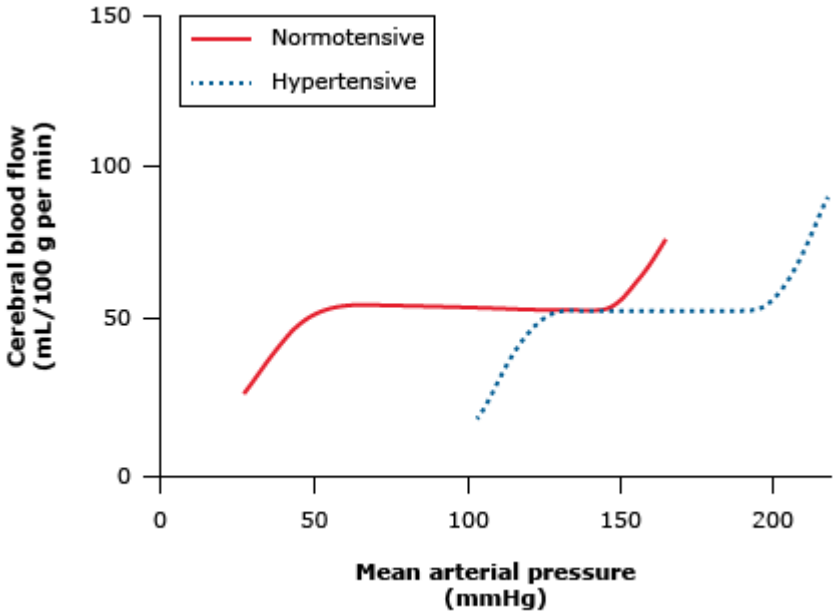
Baseline NIHSS score	Percent with favorable outcome (three-month NIHSS score = 0 or 1)
Age <60 y	
0-9	42
10-14	18
15-20	27
>20	12
Age 61-68 y	
0-9	37
10-14	25
15-20	25
>20	0
Age 69-75 y	
0-9	54
10-14	27
15-20	0
>20	0
Age >75 y	
0-9	36
10-14	15
15-20	6
>20	0

NIHSS: National Institutes of Health Stroke Scale.

Adapted from: NINDS t-PA Stroke Study Group, Stroke 1997; 28:2119.

Graphic 81859 Version 4.0

Cerebral autoregulation in hypertension



Schematic representation of autoregulation of cerebral blood flow in normotensive and hypertensive subjects. In both groups, initial increases or decreases in mean arterial pressure are associated with maintenance of cerebral blood flow due to appropriate changes in arteriolar resistance. More marked changes in pressure are eventually associated with loss of autoregulation, leading to a reduction (with hypotension) or an elevation (with marked hypertension) in cerebral blood flow. These changes occur at higher pressures in patients with hypertension, presumably due to arteriolar thickening. Thus, aggressive antihypertensive therapy will produce cerebral ischemia at a higher mean arterial pressure in patients with underlying hypertension.

Redrawn from: Kaplan NM. Management of hypertensive emergencies. Lancet 1994; 344:1335. Based on data from: Strandgaard S, Paulson OB. Cerebral blood flow and its pathophysiology in hypertension. Am J Hypertens 1989; 2:486.

Graphic 57676 Version 5.0

Options to treat hypertension before and during reperfusion therapy for acute ischemic stroke

Patient otherwise eligible for acute reperfusion therapy except that blood pressure is >185/110 mmHg*
Labetalol 10 to 20 mg intravenously over 1 to 2 minutes, may repeat one time; **or**
Nicardipine 5 mg/hour intravenously, titrate up by 2.5 mg/hour every 5 to 15 minutes, maximum 15 mg/hour; when desired blood pressure reached, adjust to maintain proper blood pressure limits; **or**
Clevidipine 1 to 2 mg/hour intravenously, titrate by doubling the dose every 2 to 5 minutes, maximum 21 mg/hour, until desired blood pressure reached¶; **or**
Other agents (hydralazine, enalaprilat, etc) may also be considered
If blood pressure is not maintained at or below 185/110 mmHg, do **not** administer alteplase
Management to maintain blood pressure at or below 180/105 mmHg during and after acute reperfusion therapy*
Monitor blood pressure every 15 minutes for 2 hours from the start of rtPA therapy, then every 30 minutes for 6 hours, and then every hour for 16 hours
If systolic blood pressure is >180 to 230 mmHg or diastolic is >105 to 120 mmHg:
Labetalol 10 mg intravenously followed by continuous infusion 2 to 8 mg/min; **or**
Nicardipine 5 mg/hour intravenously, titrate up to desired effect by 2.5 mg/hour every 5 to 15 minutes, maximum 15 mg/hour; **or**
Clevidipine 1 to 2 mg/hour intravenously, titrate by doubling the dose every 2 to 5 minutes, maximum 21 mg/hour, until desired blood pressure reached¶
If blood pressure is not controlled or diastolic blood pressure >140 mmHg, consider intravenous sodiun nitroprusside

* Different treatment options may be appropriate in patients who have comorbid conditions that may benefit from acute reductions in blood pressure, such as acute coronary event, acute heart failure, aortic dissection, or preeclampsia/eclampsia.

¶ Clevidipine has been included as part of the 2018 guidelines for the early management of patients with acute ischemic stroke[1].

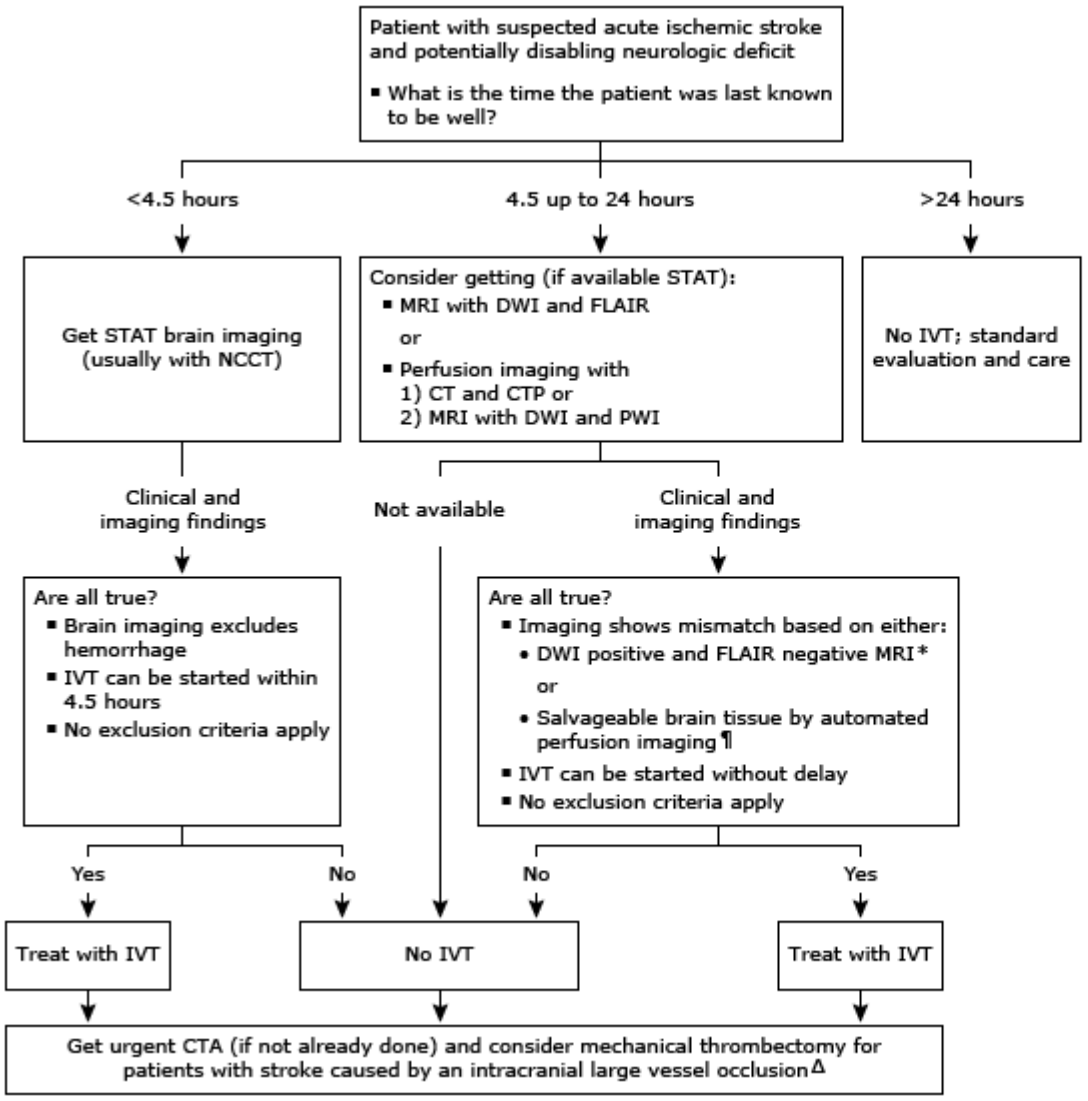
Reference:

1. *Powers WJ, Rabinstein AA, Ackerson T, et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2018; 49:e46.*

Adapted with permission. Stroke. 2013: 44:870-947. Copyright © 2013 American Heart Association, Inc.

Graphic 50725 Version 15.0

Patient selection for intravenous thrombolytic therapy in acute ischemic strok



IVT with alteplase or tenecteplase is the mainstay of treatment for acute ischemic stroke. Because the benefit of treatment is time dependent, it is critical to treat patients as quickly as possible. The SBP/DBP must be <185/110 mmHg before starting IVT and must be <180/105 mmHg for 24 hours following IVT. Refer to relevant UpToDate topics for full details of IVT including dosing and administration, potential adverse effects, and post-treatment management.

IVT: intravenous thrombolysis; NCCT: noncontrast computed tomography; MRI: magnetic resonance imaging; DWI: diffusion-weighted MRI; FLAIR: fluid-attenuated inversion recovery; CT: computed tomography; CTP: CT perfusion; PWI: perfusion-weighted MRI; CTA: CT angiogram; SBP: systolic blood pressure; DBP: diastolic blood pressure; INR: international normalized ratio; aPTT: activated partial thromboplastin time; DOAC: direct oral anticoagulant; LMWH: low molecular weight heparin; VTE: venous thromboembolism.

* An MRI mismatch, defined by an acute ischemic brain lesion detected on DWI but no corresponding hyperintensity on FLAIR (diffusion positive and FLAIR negative), correlates with a stroke onset time of 4.5 hours or less, and therefore with IVT eligibility.

¶ Automated perfusion imaging reveals an ischemic core with a larger penumbra of hypoperfused but viable brain tissue.

Δ Refer to UpToDate content on mechanical thrombectomy for acute ischemic stroke.

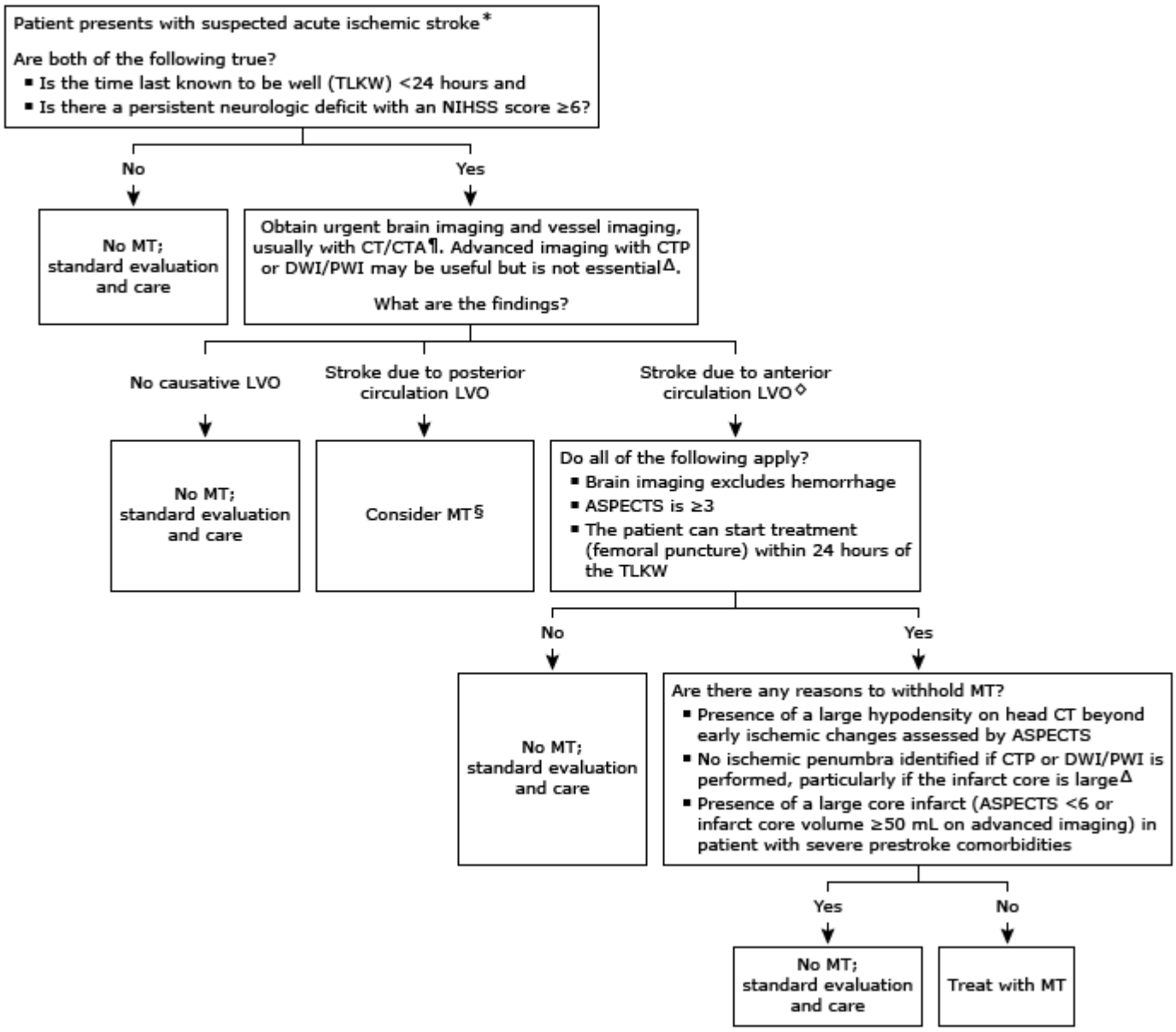
◇ IVT should NOT be delayed while coagulation tests are pending unless (1) there is clinical suspicion of a bleeding abnormality or thrombocytopenia, (2) the patient is currently on or has recently received anticoagulants (eg, heparin, warfarin, DOAC), or (3) use of anticoagulants is not known. Otherwise, treatment with IVT can be started before availability of coagulation test results.

§ Platelet count should be checked only if there is clinical suspicion for thrombocytopenia.

¥ Patients may be treated with IVT if glucose level is subsequently normalized without reversal of neurologic deficit.

Graphic 141876 Version 1.0

Patient selection for mechanical thrombectomy to treat acute ischemic stroke



MT should be performed at a stroke center with appropriate neurointerventional expertise. The TLKW is judged to be the time of stroke symptom onset (if known), or the time the patient was last seen at their baseline for patients with wake-up stroke or those found down. The ASPECTS method is used to assess the extent of ischemic changes on head CT or DWI. Refer to UpToDate topics for a full discussion of MT, including calculation of ASPECTS, NIHSS, and mRS, and other clinical issues pertaining to MT.

ACA: anterior carotid artery; ASPECTS: Alberta Stroke Program Early CT Score; CT: computed tomography; CTA: computed tomography angiography; CTP: computed tomography perfusion; DSA: digital subtraction angiography; DWI: diffusion-weighted magnetic resonance imaging; ICA: internal carotid artery; LVO: large vessel (artery) occlusion; MCA: middle cerebral artery; MRA: magnetic resonance angiography; MRI: magnetic resonance imaging; mRS: modified Rankin Scale; MT: mechanical thrombectomy; NIHSS: National Institutes of Health Stroke Scale; PWI: perfusion-weighted magnetic resonance imaging.

* All patients with acute ischemic stroke should be simultaneously evaluated for treatment with intravenous thrombolysis; refer to UpToDate topics for details.

¶ Urgent imaging is usually done with CT and CTA, less often with MRI and MRA.

Δ Advanced imaging is not essential but can be used at centers with CTP or DWI/PWI and automated software imaging analysis to determine infarct volume; patients can be selected for MT if they have salvageable brain tissue with a mismatch between a relatively larger area of hypoperfusion (ischemic penumbra) and a smaller area of irreversibly injured brain tissue (infarct core). Refer to UpToDate text for details.

◇ There is intracranial arterial occlusion of the distal ICA, or the M1 or proximal M2 segment of the MCA, as shown by CTA, MRA, or DSA.

§ MT may be a treatment option at expert stroke centers for patients with basilar artery LVO, but benefit is uncertain.

Graphic 141874 Version 2.0