Part 7: The Era of Reperfusion
Section 2: Acute Stroke

Major Guidelines Changes

- Intravenous administration of tissue-type plasminogen activator (tPA) for patients with acute ischemic stroke and no contraindications is recommended:
  —Within 3 hours of onset of stroke symptoms (Class I)
  —Between 3 and 6 hours of onset of stroke symptoms (Class Indeterminate)
- Intra-arterial fibrinolysis within 3 to 6 hours after the onset of symptoms may be beneficial in patients with occlusion of the middle cerebral artery (Class IIb).

Introduction

A stroke is a disruption in blood supply to a region of the brain that causes neurological impairment. Stroke is ranked among the top 3 leading causes of death in most countries and is the leading cause of brain injury in adults. Internationally millions of people have a new or recurrent stroke each year, and nearly a quarter of these people die.1 The stroke rate is declining in most western and northern European countries, but there is a large and increasing rate in Russia, possibly attributable to a higher prevalence of hypertension.2 Although stroke mortality and attack rates are falling in many countries, the gain achieved by prevention has been counterbalanced by a growth in the aging population (more people at risk).3,4

Strokes can be classified into 2 major categories, ischemic and hemorrhagic. Approximately 85% of all strokes are ischemic.5 Ischemic strokes occur primarily because a blood vessel supplying the brain is occluded, usually by a thrombus or embolism. Hemorrhagic strokes are the result of rupture of a cerebral artery. Associated spasm of the artery and various degrees of bleeding occur. Until recently, care of the stroke patient was largely supportive, focusing on prevention and treatment of respiratory and cardiovascular complications. No specific therapy was available to alter the course and extent of the evolving stroke. Therefore, little emphasis or need was placed on rapid transport or intervention.

Fibrinolytic therapy now offers healthcare providers an opportunity to possibly limit the extent of neurological damage and to improve outcome in stroke patients. A time-dependent benefit similar to that observed in patients with acute myocardial infarction (AMI) is possible. The time available for treatment, however, is limited.6 Early recognition of stroke and rapid triage, evaluation in the Emergency Department (ED), and definitive management are essential.7–9

Early Recognition

Early treatment of stroke depends strongly on recognition of the event by the patient, family members, or bystanders.10 Common symptoms of transient ischemic attack (TIA) and stroke are described in Table 1.

Role of EMS in Stroke Care

Rapid activation of the EMS system is essential to optimize care of the patient with stroke. Stroke patients who use the EMS system arrive at the hospital faster than those who do not, a major advantage for time-critical treatment.11–18 Furthermore, emergency dispatchers can send the appropriate emergency team with a priority dispatch response and provide instructions for care of the patient until arrival of EMS personnel.19–21 EMS personnel can then quickly transport the patient to a stroke center and notify the facility before arrival to ensure rapid hospital-based evaluation and treatment. Initial contact of the family physician and transport of the patient by car have been shown to delay patient arrival and initial evaluation at the hospital. Such delays may render the patient ineligible for fibrinolytic therapy.11,15,19

Only half of stroke patients currently use the EMS system for transport to the hospital.11,22 Strokes that occur when the patient is alone or sleeping may further delay prompt recognition and action.23 Eighty-five percent of strokes occur at home.22 As a result, public education programs have appropriately focused their efforts on persons at risk for stroke and their friends and family members. Public education has reduced the time to arrival at the ED.8,12

The 7 “D’s” of Stroke Management

Key points in the management of stroke can be remembered using the mnemonic of the 7 D’s: Detection, Dispatch, Delivery, Door, Data, Decision, and Drug (see algorithm for suspected stroke).24 Delay may occur at any point, so the response at each point must be skilled and efficient. The first 3 D’s (detection, dispatch, and delivery) are the responsibility of BLS providers in the community, including the lay public and EMS responders. Detection occurs when a patient, family member, or bystander recognizes the signs and symptoms of a stroke or TIA and activates the EMS system (by phoning 911 or other emergency response number). EMS dispatchers must prioritize the call for a suspected stroke patient as they would for a victim of AMI or serious trauma and dispatch the appropriate EMS team with high transport priority. EMS providers must respond rapidly, confirm the signs and symptoms of stroke, and transport the patient (delivery) to a stroke center (a hospital that can provide fibrinolysis).
lytic therapy within 1 hour after arrival at the ED door). The remaining 3 D’s are performed in the hospital: 
data includes obtaining a computed tomography (CT) scan, decision is made in identifying candidates eligible for fibrinolytic therapy, and 
drug includes treating eligible patients with fibrinolytic therapy.

Airway and Ventilation
Airway obstruction may be a major problem in acute stroke, particularly if the patient loses consciousness. Hypoxia and hypercarbia can occur as the result of inadequate ventilation, contributing to cardiac and respiratory instability. Aspiration
TABLE 1. Common Signs and Symptoms of Transient Ischemic Attack (TIA) and Stroke

Unilateral paralysis—Weakness, clumsiness, or heaviness, usually involving 1 side of the body
Unilateral numbness—Sensory loss, tingling, or abnormal sensation, usually involving 1 side of the body
Language disturbance—Trouble understanding or speaking (aphasia) or slurred speech (dysarthria)
Monocular blindness—Painless visual loss in one eye, often described as a curtain dropping
Vertigo—Sense of spinning or whirling that persists at rest. Isolated vertigo is also a common symptom of many nonvascular diseases; therefore, at least one other symptom of TIA or stroke should also be present.
Ataxia—Poor balance, stumbling gait, staggering, incoordination of one side of the body

of secretions or gastric contents is a serious complication associated with considerable morbidity and mortality. EMS providers must ensure that the patient has an adequate airway. Assisted ventilation or tracheal intubation may be required.

Vital Signs
Check vital signs (pulse, respirations, blood pressure, and temperature) frequently to detect abnormalities and changes. Abnormal respirations are particularly prevalent in comatose stroke patients and usually reflect serious brain dysfunction. Hypertension often occurs after a stroke and may be caused by underlying hypertension, a stress reaction to the neurological event, or a physiological response to decreased brain perfusion. Blood pressure often returns to normal without antihypertensive treatment.

A variety of cardiovascular problems may be present in the patient with stroke. Cardiac arrhythmias may contribute to the cerebral thromboembolism, or they may be the consequence of brain injury. In particular, episodes of paroxysmal atrial fibrillation, severe symptomatic bradycardia, or high-degree atrioventricular block may point to cardiac rhythm disturbances as causative or contributory. In the elderly and in patients with diabetes, AMI with atypical or undetectable symptoms may occur.26,27 Obtain a 12-lead ECG and attempt repeated examinations need not be exhaustive. The Glasgow Coma Scale tests eye opening, verbal response, and motor

General Medical Assessment
Examine the patient for evidence of injury to the head or neck, because trauma is an important consideration in the differential diagnosis of stroke. Blood pressure in both upper extremities should be measured. A difference of >10 mm Hg should raise consideration of aortic dissection and compromise of brain blood supply. Perform diagnostic studies such as CT or angiography if indicated by history or clinical findings. Cardiac murmur, arterial bruit, absent pulse, or other abnormalities should be sought during the cardiovascular examination. The presence of an ocular hemorrhage may allow early identification of intracranial bleeding.

Brief Emergency Neurological Evaluation
The emergency neurological evaluation for stroke should include 6 key elements:
- Stroke screen or scale
- Time of onset of stroke signs
- Level of consciousness
- Type of stroke (hemorrhagic versus nonhemorrhagic)
- Location of stroke (carotid versus vertebrobasilar)
- Severity of stroke

Stroke Screen or Scale
Performing an extensive neurological examination outside the hospital is impractical because it delays transport of the patient to the ED. To conduct an out-of-hospital neurological evaluation, use a validated tool such as the Cincinnati Prehospital Stroke Scale (Table 2) or the Los Angeles Prehospital Stroke Screen (LAPSS)16 (Table 3).31,32 The Cincinnati scale is used to elicit any of the 3 major physical findings suggestive of stroke: facial droop, arm drift, and abnormal speech.31 LAPSS requires the examiner to rule out other causes of altered level of consciousness (eg, history of seizures or severe hyperglycemia or hypoglycemia) and then identify asymmetry (right versus left) in facial smile/grimace, grip, or arm strength. Asymmetry in any category indicates a possible stroke.18,32 These two scales are sensitive and specific in identifying stroke patients.16,31,32 Either evaluation can be performed quickly.

Ambulance personnel can identify stroke patients with reasonable sensitivity and specificity. Once a stroke is suspected, minimize time in the field and immediately transport the patient to a stroke center.

Clinical signs and symptoms of acute stroke often fluctuate. Deterioration or improvement can be detected by frequent and repeated focal neurological examinations. Repeated examinations need not be exhaustive. The Glasgow Coma Scale tests eye opening, verbal response, and motor

### TABLE 2. Cincinnati Prehospital Stroke Scale

<table>
<thead>
<tr>
<th>Severity of stroke</th>
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</thead>
<tbody>
<tr>
<td>Location of stroke (carotid versus vertebrobasilar)</td>
</tr>
<tr>
<td>Level of consciousness</td>
</tr>
<tr>
<td>Time of onset of stroke signs</td>
</tr>
<tr>
<td>Stroke screen or scale</td>
</tr>
</tbody>
</table>

### TABLE 3. LAPSS Prehospital Stroke Screen

| Location of stroke (carotid versus vertebrobasilar) |
| Level of consciousness |
| Time of onset of stroke signs |
| Stroke screen or scale |

Try to elicit one of the following signs (abnormality in any one is strongly suggestive of stroke):

**Facial droop** (have patient show teeth or smile):
- Normal: both sides of face move equally well
- Abnormal: one side of face does not move as well as the other side

**Arm drift** (have patient close eyes and hold both arms straight out for 10 seconds):
- Normal: both arms move the same or both arms do not move at all (other findings, such as pronator grip, may be helpful)
- Abnormal: one arm does not move or one arm drifts down

**Abnormal speech** (have the patient say “you can’t teach an old dog new tricks”):
- Normal: patient uses correct words with no slurring
- Abnormal: patient slurs words, uses the wrong words, or is unable to speak

From Reference 31.
response. It is useful for assessing the initial severity of neurological injury in patients with altered consciousness, especially in cases of injury caused by intracerebral hemorrhage.

Obtain the following information en route to or at the hospital. (Do not delay transport to complete a more detailed evaluation. Rapid transport is essential.)

Time of Onset of Symptoms
If stroke symptoms started within 6 hours of the arrival of EMS personnel, immediately notify the receiving hospital. Prearrival notification of the receiving hospital shortens the time to definitive hospital-based evaluation and intervention. Provide results of the stroke scale or screen, the Glasgow Coma Scale score, and the estimated time of symptom onset in addition to standard information. This allows the ED or Casualty Service time to prepare and coordinate the patient’s time-sensitive therapy. The receiving hospital should have a written plan to begin therapy as quickly as possible.

Level of Consciousness
Determining the stroke patient’s level of consciousness is crucial. Depressed consciousness within hours of the onset of symptoms implies severe brain injury with increased intracranial pressure (ICP), usually due to an intracerebral or subarachnoid hemorrhage. Coma, the lack of any purposeful response to external stimuli, is the result of damage to both cerebral hemispheres or the brain stem. Coma usually implies massive hemorrhage, occlusion of the basilar artery, or cardiac arrest with global brain ischemia. Massive ischemic stroke with cerebral edema may cause coma but is rare. Do not overlook concurrent metabolic problems. Consider drug overdose, sepsis, or severe metabolic abnormalities.

Type of Stroke (Ischemic Versus Hemorrhagic)
The history and physical findings of hemorrhagic and ischemic stroke overlap (see Table 4). Do not depend solely on clinical presentation for diagnosis. In most cases, noncontrast CT is the definitive test for differentiating ischemic and hemorrhagic stroke. (CT is discussed in “Emergency Diagnostic Studies.”)

Location of Stroke
Higher cortical, language, visual, cranial nerve, motor, and sensory functions should be assessed in alert patients with brain infarction. Neurological signs help distinguish infarction of the carotid territory from infarction with a vertebrobasilar distribution. Crossed (cranial nerve palsy with contralateral motor or sensory deficit) or bilateral neurological signs suggest that the infarct is located in the brain stem. Specific patterns of deficit, such as pure sensory stroke or dysarthria with a clumsy hand, may be present. Such deficits suggest a subcortical or lacunar infarct caused by small-vessel disease. The specificity of clinical signs such as pure motor deficit, however, is low. Distinguishing between lacunar and nonlacunar infarcts on the basis of clinical features is often difficult, especially within hours of the onset of stroke.

Severity of Stroke
The National Institutes of Health Stroke Scale (NIHSS) measures neurological function, and scores on this scale are correlated with the severity of stroke and long-term outcome in patients with ischemic stroke. The scale provides a reliable, valid, and

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### TABLE 3. Los Angeles Prehospital Stroke Screen (LAPSS)

For evaluation of acute, noncomatose, nontraumatic neurological complaint: If items 1 through 6 are ALL checked “yes” (or “unknown”), notify the receiving hospital before arrival of the potential stroke patient. If any are checked “no,” follow appropriate treatment protocol.

Interpretation: Ninety-three percent of patients with stroke will have positive findings (all items checked “yes” or “unknown”) on the LAPSS (sensitivity=93%), and 97% of those with positive findings will have a stroke (specificity=97%). The patient may still be having a stroke if LAPSS criteria are not met.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Yes</th>
<th>Unknown</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age &gt;=45 years</td>
<td>[]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>2. History of seizures or epilepsy</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>3. Symptom duration &lt;24 hours</td>
<td>[]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>4. At baseline, patient is not wheelchair bound or bedridden</td>
<td>[]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>5. Blood glucose between 60 and 400</td>
<td>[]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>6. Obvious asymmetry (right vs left) in any of the following 3 categories (must be unilateral)</td>
<td>[]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

| Facial smile/grimace | [ ] | [ ] Droop | [ ] Droop |
| Grip | [ ] | [ ] Weak grip | [ ] Weak grip |
| Arm strength | [ ] | [ ] No grip | [ ] No grip |

From References 18 and 32.

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### TABLE 4. Presenting Clinical Features of Hemorrhagic and Nonhemorrhagic Stroke

<table>
<thead>
<tr>
<th>Infarction</th>
<th>Headache</th>
<th>Decreased Level of Consciousness</th>
<th>Focal Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subarachnoid hemorrhage</td>
<td>++ +</td>
<td>+</td>
<td>+++</td>
</tr>
</tbody>
</table>

+ indicates mild; ++, moderate; and ++++, severe.
The NIHSS is not a comprehensive neurological examination (e.g., it does not record gait or all cranial nerve deficits), and more detailed neurological assessment may be required in certain cases.

The Scandinavian Stroke Scale was used in the European Cooperative Acute Stroke Study and has been shown to identify predictors of early and late progression in stroke patients.38,39

The Hunt and Hess Scale (see Table 5) is often used to grade the severity of stroke in patients with subarachnoid hemorrhage.40 The Hunt and Hess grade is correlated with survival after subarachnoid hemorrhage and the risk of complications such as vasospasm. The scale may be used to guide the timing of aneurysm clipping or coiling.

**Differential Diagnosis**

Very few nonvascular neurological diseases will cause sudden onset of focal brain dysfunction, the hallmark of stroke. The list of potential diagnoses (see Table 6) is longer if the patient is comatose and the medical history is unavailable. If the patient’s condition gradually worsens over several days, a nonvascular neurological disease may be present.

**Prehospital Transport**

EMS systems should develop protocols that provide for priority dispatch, treatment, and transport of patients with signs and symptoms of acute ischemic stroke. These protocols should convey the same urgency as those for patients with signs and symptoms of AMI or major trauma (Class IIb). Give highest priority to patients with a suspected stroke and airway compromise or an altered level of consciousness.

In addition, triage and transport patients with acute onset of stroke symptoms to a facility that can begin fibrinolytic therapy within 1 hour of arrival, unless that facility is >30 minutes away by ground ambulance (Class IIb).

**ED Triage and Treatment**

The ED must be prepared for the arrival of the stroke patient so that triage and therapy can begin immediately. Maximum time intervals for completion of diagnostic studies of candidates for fibrinolytic therapy are listed in Table 7.

**Emergency Diagnostic Studies**

Emergency diagnostic studies are used to establish stroke as the cause of the patient’s symptoms, to differentiate between brain infarction and brain hemorrhage, and to determine the most likely cause of the stroke. Protocols may prioritize and streamline the order of these tests.

CT is the most important diagnostic test for differentiating between infarction and hemorrhage or other intracranial masses.41 To avoid confusing blood and contrast medium, perform CT without contrast enhancement. Withhold anticoagulants and fibrinolytics until brain hemorrhage is ruled out.

The CT scan of almost all patients with a recent intracerebral hemorrhage will show increased density at the site of bleeding.42 Findings in patients with subarachnoid hemorrhage, however, may be subtle (e.g., the scan may show only a thin, white layer adjacent to the brain). Approximately 5% of patients with subarachnoid hemorrhage will have normal findings on the CT scan.43,44 Such patients usually have a small subarachnoid hemorrhage and are alert with no focal neurological deficits (Hunt and Hess grade 1). If clinical suspicion of subarachnoid hemorrhage remains despite negative findings on the CT scan, perform lumbar puncture.

Magnetic resonance imaging (MRI) is not part of the routine evaluation of acute stroke. MRI is very sensitive and will detect some lesions missed by CT. Although MRI can detect early hemorrhage,45,46 it is not superior to CT. MRI is also time consuming and may hamper continuous observation of acutely ill patients. New MRI techniques such as magnetic resonance angiography and diffusion- and perfusion-weighted MRI may help delineate the site of occlusion or the region of the brain at risk for infarction.47,48 These techniques

**Table 5. Hunt and Hess Scale for Subarachnoid Hemorrhage**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Neurological Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>2</td>
<td>Severe headache or nuchal rigidity; no neurological deficit</td>
</tr>
<tr>
<td>3</td>
<td>Drowsy; minimal neurological deficit</td>
</tr>
<tr>
<td>4</td>
<td>Stuporous; moderate to severe hemiparesis</td>
</tr>
<tr>
<td>5</td>
<td>Deep coma; decerebrate posturing</td>
</tr>
</tbody>
</table>

From Reference 40.

**Table 6. Differential Diagnosis of Stroke**

<table>
<thead>
<tr>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhagic stroke</td>
</tr>
<tr>
<td>Ischemic stroke</td>
</tr>
<tr>
<td>Cranioencebral/cervical trauma</td>
</tr>
<tr>
<td>Meningitis/encephalitis</td>
</tr>
<tr>
<td>Hypertensive encephalopathy</td>
</tr>
<tr>
<td>Intracranial mass</td>
</tr>
<tr>
<td>Tumor</td>
</tr>
<tr>
<td>Subdural/epidural hematoma</td>
</tr>
<tr>
<td>Seizure with persistent neurological signs (Todd’s paralysis)</td>
</tr>
<tr>
<td>Migraine with persistent neurological signs</td>
</tr>
<tr>
<td>Metabolic disturbances</td>
</tr>
<tr>
<td>Hyperglycemia (nonketotic hyperosmolar coma)</td>
</tr>
<tr>
<td>Hypoglycemia</td>
</tr>
<tr>
<td>Postcardiac arrest ischemia</td>
</tr>
<tr>
<td>Toxicological cause</td>
</tr>
<tr>
<td>Endocrine disorder (myxedema)</td>
</tr>
<tr>
<td>Uremia</td>
</tr>
<tr>
<td>Psychiatric syndromes</td>
</tr>
<tr>
<td>Shock and CNS hypoperfusion</td>
</tr>
</tbody>
</table>

CNS indicates central nervous system.
**Management of Elevated Blood Pressure**

Management of blood pressure after acute ischemic or hemorrhagic stroke is controversial. Many patients have hypertension after an ischemic or hemorrhagic stroke, but few require emergency treatment. Elevated blood pressure after a stroke is not a hypertensive emergency unless there are other medical problems (eg, AMI or aortic dissection). In most patients, blood pressure will spontaneously decline as pain, agitation, vomiting, and increased ICP are controlled.

**Management of Increased ICP**

Death during the first week after stroke commonly is caused by brain edema and increased ICP. Fortunately only 10% to 20% of
stroke patients develop brain edema sufficient to cause clinical deterioration. When brain edema is clinically suspect, modest fluid restriction, elevation of the head of the bed (20° to 30°), support of oxygenation and ventilation (avoidance of hypoxemia and hypoventilation), and control of agitation and pain will help lower increased ICP. Goals of therapy are (1) reduction of increased ICP, (2) maintenance of cerebral perfusion to prevent worsening of ischemia, and (3) prevention of brain herniation.

Reduction of the partial pressure of CO₂ in arterial gas (Paco₂) through intubation and hyperventilation is the most rapid means of lowering ICP in cases of impending brain herniation. Optimal Paco₂ is 30 to 35 mm Hg.62 Paco₂ values ≤25 mm Hg are occasionally acceptable in rapidly deteriorating patients, but if such values are sustained, ischemia of the brain may occur.62 Aggressive tracheal suctioning increases ICP and should be avoided, with suctioning reduced in frequency and duration to that necessary to maintain tracheal tube patency.

Hyperosmolar therapy with mannitol is used to reduce the mass effect on diencephalic structures or to maximize cerebral perfusion pressure. Mannitol can be given as a bolus (0.25 to 0.5 g/kg per dose given over 20 minutes rapidly) and repeated every 6 hours to a maximum dose of 2 g/kg daily.59 High initial doses are given in emergencies. The effect on ICP usually occurs about 20 minutes after administration. Lower doses (25 to 50 g every 4 hours) given as intermittent boluses are used to manage ICP over longer periods. Furosemide, hypertonic saline, and acetazolamide may also help lower ICP.

High doses of barbiturates (eg, thiopental 1 to 5 mg/kg) rapidly lower ICP and suppress electrical brain activity. Because high doses of barbiturates suppress respiratory activity and may produce vasodilation and myocardial depression, they should be administered in conjunction with mechanical ventilatory support and careful blood pressure monitoring. ICP must be monitored in conjunction with mechanical ventilatory support and careful blood pressure monitoring. The ICP is used to evaluate response to therapy.

Routine measurement of ICP is not indicated, and the value of ICP measurement has not been shown. ICP measurement, however, may be helpful in deteriorating patients, can guide therapy, and can serve as an indicator of prognosis and outcome.59

Neurosurgical decompression can be lifesaving in some patients with high ICP and intracranial hemorrhage, edema after stroke, or other mass effects on brain tissue. Surgery for cerebellar hemorrhage or edema after stroke can produce remarkable improvement. Pharmacological and ventilatory measures for controlling ICP are much less effective than surgery in patients with cerebellar lesions. Corticosteroids are not effective and should not be used.63 Cerebellar edema or hemorrhage frequently causes obstructive hydrocephalus.

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### TABLE 9. Suggested Antihypertensive Therapy for Patients With Acute Stroke

<table>
<thead>
<tr>
<th>Blood Pressure*</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients ineligible for fibrinolytic therapy</td>
<td>Sodium nitroprusside (0.5 µg/kg per minute). Aim for 10% to 20% reduction in DBP.</td>
</tr>
<tr>
<td>1. DBP &gt;140 mm Hg</td>
<td>10 to 20 mg labetalol IV push over 1 to 2 minutes. May repeat or double labetalol every 20 minutes to a maximum dose of 150 mg.</td>
</tr>
<tr>
<td>2. SBP &gt;220, DBP 121 to 140, or MAP† &gt;130 mm Hg</td>
<td>Emergency antihypertensive therapy is deferred in the absence of aortic dissection, AMI, severe CHF, or hypertensive encephalopathy.</td>
</tr>
<tr>
<td>3. SBP &lt;220, DBP ≤120, or MAP† &lt;130 mm Hg</td>
<td></td>
</tr>
</tbody>
</table>

Candidates for fibrinolytic therapy

Pretreatment

1. Monitor BP

During and after treatment

1. Monitor BP

2. DBP >140 mm Hg

3. SBP >230 or DBP 121 to 140 mm Hg

4. SBP 180 to 230 or DBP 105 to 120 mm Hg

(Note: These suggestions are consensus rather than evidence-based and should be individualized, with consideration given to clinical status and baseline blood pressure.)

DBP indicates diastolic blood pressure; SBP, systolic blood pressure; MAP, mean arterial pressure; BP, blood pressure; IV, intravenous; AMI, acute myocardial infarction; and CHF, congestive heart failure.

*Before treatment, all initial blood pressures should be verified by repeating reading in 5 minutes.
†As estimated by one third the sum of SBP and double DBP.
‡Avoid labetalol in patients with asthma, cardiac failure, or severe abnormalities in cardiac conduction. For patients with refractory hypertension, consider alternative therapy with sodium nitroprusside or enalapril.

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necessitating ventricular drainage. Closely monitor patients with cerebellar lesions for neurological deterioration.

**Pharmacological and Interventional Therapies**

**Ischemic Stroke**

**Fibrinolytic Therapy**

Use of intra-arterial and intravenous fibrinolytic agents such as tPA, streptokinase, anecrod, urokinase, and prourokinase in stroke patients has been evaluated in several clinical trials.65–72 The Cochrane Stroke Review group73 evaluated 17 trials with >5000 patients in which >50% of patients received tPA. Fibrinolytic therapy significantly increased the odds ratio of death within the first 10 days and at follow-up, mainly because of fatal intracerebral hemorrhage. Patients treated within 3 hours, however, had reduced death and dependency compared with patients treated within 3 to 6 hours. Overall, the proportion of patients with death or disability was reduced. It is difficult to draw conclusions from this review because there was significant heterogeneity among the comparison trials.73 In the clinical trials reviewed, many different agents were administered, with many different time intervals between onset of stroke symptoms and drug administration.

The National Institute of Neurological Disorders and Stroke rtPA Stroke Trial64 evaluated a single agent administered within 3 hours of symptom onset in a prospective, blinded, randomized, controlled clinical trial. Intravenous tPA was administered in a dose of 0.9 mg given as a 10% bolus over 1 minute, followed by a 1-hour infusion versus a placebo. In this trial, patients treated with tPA within 3 hours of onset of symptoms were at least 30% more likely to have no death or disability at 3 months compared with those treated with placebo. The risk of fatal intracranial hemorrhage, however, was 10 times greater in the tPA-treated group (3% versus 0.3%). A similar increase in the frequency of all symptomatic hemorrhages (6.4% versus 0.6%) was also observed in this group. This increase in symptomatic hemorrhage did not lead to an overall increase in mortality in the treated group.

Based on the results of parts I and II of the National Institute of Neurological Disorders and Stroke study, intravenous administration of tPA is recommended for carefully selected patients with acute ischemic stroke if they have no contraindications to fibrinolytic therapy and if the drug can be administered within 3 hours of the onset of stroke symptoms (Class I). Contraindications to tPA are listed in Table 10.

**TABLE 10. Contraindications to tPA Therapy for Acute Ischemic Stroke**

<table>
<thead>
<tr>
<th>Contraindication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence of intracranial hemorrhage on pretreatment evaluation</td>
</tr>
<tr>
<td>Suspicion of subarachnoid hemorrhage on pretreatment evaluation</td>
</tr>
<tr>
<td>Recent (within 3 months) intracranial or intraspinal surgery, serious head trauma, or previous stroke</td>
</tr>
<tr>
<td>History of intracranial hemorrhage</td>
</tr>
<tr>
<td>Uncontrolled hypertension at time of treatment (see “Management of High Blood Pressure”)</td>
</tr>
<tr>
<td>Seizure at stroke onset</td>
</tr>
<tr>
<td>Active internal bleeding</td>
</tr>
<tr>
<td>Intracranial neoplasm, arteriovenous malformation, or aneurysm</td>
</tr>
<tr>
<td>Known bleeding diathesis, including but not limited to</td>
</tr>
<tr>
<td>— Current use of oral anticoagulants (eg, warfarin sodium), an international normalized ratio &gt;1.7, or a prothrombin time &gt;15 seconds</td>
</tr>
<tr>
<td>— Administration of heparin within 48 hours preceding the onset of stroke and an elevated activated partial thromboplastin time at presentation</td>
</tr>
<tr>
<td>— Platelet count &lt;100 000/mm³</td>
</tr>
</tbody>
</table>

Tablet indicates tissue plasminogen activator. Aspirin, warfarin, and ticlopidine reduce the risk of subsequent stroke in patients with TIA.78–81 These antiplatelet agents should be started within the first few days after a TIA. When started within 48 hours of the onset of ischemic stroke, aspirin produces a small but definite net benefit in patients who are ineligible for fibrinolytic therapy.76,77

Results of a recent, randomized trial of *intra-arterial* prourokinase suggest that use of intra-arterial fibrinolytic agents 3 to 6 hours after the onset of symptoms may be beneficial in patients with occlusion of the middle cerebral artery (Class IIb).71

Three large, randomized trials of streptokinase in patients with stroke have been reported.69,70,75 All 3 studies were suspended because of increased hemorrhage and mortality in the group treated with streptokinase. Do not use streptokinase in patients who have had a stroke except in clinical studies approved by the appropriate institutional review board.

**Anticoagulant Therapy**

The efficacy of anticoagulants in acute stroke has not been established. Heparin is frequently administered to patients with acute ischemic stroke, but its value is unproved.76,77 Heparin may help prevent recurrent embolism or propagation of a thrombus, but it may lead to bleeding complications, including brain hemorrhage. There is no consensus on when heparin therapy should be started or on the dose and duration of therapy. Emergency physicians should consult the attending neurologist about the use of heparin in specific patients (Class IIb). Low-molecular-weight anticoagulants have several advantages not provided by unfractionated heparin.71

Use of low-molecular-weight anticoagulants in the management of stroke is being evaluated.

Aspirin, warfarin, and ticlopidine reduce the risk of subsequent stroke in patients with TIA.78–81 These antiplatelet agents should be started within the first few days after a TIA. When started within 48 hours of the onset of ischemic stroke, aspirin produces a small but definite net benefit in patients who are ineligible for fibrinolytic therapy.76,77

Aspirin, warfarin, and ticlopidine reduce the risk of subsequent stroke in patients with TIA.78–81 These antiplatelet agents should be started within the first few days after a TIA. When started within 48 hours of the onset of ischemic stroke, aspirin produces a small but definite net benefit in patients who are ineligible for fibrinolytic therapy.76,77
therapy.82,83 Antiplatelet therapy with aspirin 160 to 300 mg daily within 48 hours of onset of presumed ischemic stroke reduces the risk of early recurrent ischemic stroke without a major risk of early hemorrhagic complications and improves long-term outcome.84

The Cochrane Stroke Group completed a comprehensive review of anticoagulants in 21 trials involving 23,427 patients. A number of anticoagulants were used in clinical trials: standard unfractionated heparin, low-molecular-weight heparins, heparinoids, oral anticoagulants, and thrombin inhibitors. The conclusion of the Cochrane group was that immediate anticoagulant therapy in patients with acute ischemic stroke is not associated with net gain for either short- or long-term benefit. Routine use of any type of anticoagulant in acute ischemic stroke is not recommended.85

Other Treatments
Calcium channel–blocking drugs, volume expansion, hemodilution, and low-molecular-weight dextran have not been shown to improve clinical outcome after ischemic stroke. A number of cytoprotective agents are being investigated for use in patients with acute ischemic or hemorrhagic stroke. Many of these agents have been shown to provide no benefit in humans, even though benefit was shown in animal models.86

Hemorrhagic Stroke

Subarachnoid Hemorrhage
Patients with subarachnoid hemorrhage often require emergency arteriography. If a saccular aneurysm is detected, early intracranial surgery with clipping (or coiling) of the aneurysm is usually advised.87 The calcium channel–blocking drug nimodipine (60 mg orally every 4 hours, 0.35 mg/kg) improves outcome after subarachnoid hemorrhage.88–92 Correction of hyponatremia and water loss is also important. Avoid strict fluid restriction, however, which may stimulate inappropriate secretion of antidiuretic hormone.

Intracerebral Hemorrhage
Hemorrhage into the brain can be devastating. Death may occur because of compression or distortion of vital deep-brain structures or increased ICP. Mortality is a function of the volume and location of the intracerebral bleeding. Optimal management requires prevention of continued bleeding, appropriate management of ICP, and timely neurosurgical decompression when warranted. Large intracerebral or cerebellar hematomas often require surgical intervention. A CT scan is required for differential diagnosis. Placement of a ventriculostomy tube through a burr hole can be lifesaving if hydrocephalus is the cause of coma.

Appendix A: NIH Stroke Scale
“Quick and Easy” Version

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Score</th>
<th>Baseline Date/Time</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. Level of consciousness (LOC) (Alert, drowsy, etc)</td>
<td>Alert</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drowsy</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stuporous</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coma</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b. LOC questions (Month, age)</td>
<td>Answers both correctly</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Answers 1 correctly</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incorrect</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1c. LOC commands (Open, close eyes, make fist, let go)</td>
<td>Obey's both correctly</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Obey's 1 correctly</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incorrect</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Best gaze (Eyes open—patient follows examiner’s finger or face)</td>
<td>Normal</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Partial gaze palsy</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forced deviation</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Visual (Introduce visual stimulus/threat to patient’s visual field quadrants)</td>
<td>No visual loss</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Partial hemianopia</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete hemianopia</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bilateral hemianopia</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Facial palsy (Show teeth, raise eyebrows, and squeeze eyes shut)</td>
<td>Normal</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minor</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Partial</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix A: Continued

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Score</th>
<th>Baseline Date/Time</th>
<th>Date/Time</th>
</tr>
</thead>
</table>
| 5a. Motor arm—left  
(Elevate extremity to 90° and score drift/movement) | No drift | 0 | | |
| | Drift | 1 | | |
| | Can’t resist gravity | 2 | | |
| | No effort against gravity | 3 | | |
| | No movement | 4 | | |
| | Amputation, joint fusion (explain) | 9 | | |
| 5b. Motor arm—right  
(Elevate extremity to 90° and score drift/movement) | No drift | 0 | | |
| | Drift | 1 | | |
| | Can’t resist gravity | 2 | | |
| | No effort against gravity | 3 | | |
| | No movement | 4 | | |
| | Amputation, joint fusion (explain) | 9 | | |
| 6a. Motor leg—left  
(Elevate extremity to 30° and score drift/movement) | No drift | 0 | | |
| | Drift | 1 | | |
| | Can’t resist gravity | 2 | | |
| | No effort against gravity | 3 | | |
| | No movement | 4 | | |
| | Amputation, joint fusion (explain) | 9 | | |
| 6b. Motor leg—right  
(Elevate extremity to 30° and score drift/movement) | No drift | 0 | | |
| | Drift | 1 | | |
| | Can’t resist gravity | 2 | | |
| | No effort against gravity | 3 | | |
| | No movement | 4 | | |
| | Amputation, joint fusion (explain) | 9 | | |
| 7. Limb ataxia  
(Finger–nose, heel down shin) | Absent | 0 | | |
| | Present in 1 limb | 1 | | |
| | Present in 2 limbs | 2 | | |
| 8. Sensory  
(Pin prick to face, arm, trunk, and leg—compare side to side) | Normal | 0 | | |
| | Partial loss | 1 | | |
| | Severe loss | 2 | | |
| 9. Best language  
(Name items, describe a picture, and read sentences) | No aphasia | 0 | | |
| | Mild to moderate aphasia | 1 | | |
| | Severe aphasia | 2 | | |
| | Mute | 3 | | |
| 10. Dysarthria  
(Evaluate speech clarity by patient repeating listed words) | Normal articulation | 0 | | |
| | Mild to moderate dysarthria | 1 | | |
| | Near to unintelligible or worse | 2 | | |
| | Intubated or other physical barrier | 9 | | |
| 11. Extinction and inattention  
(Use information from prior testing to identify neglect or double simultaneous stimuli testing) | No neglect | 0 | | |
| | Partial neglect | 1 | | |
| | Complete neglect | 2 | | |

Individual Administering Scale:

Appendix B: Scandinavian Stroke Scale
(Scandinavian Stroke Study Group, 1985)

1. Consciousness
   - Fully conscious—6
   - Somnolent, can be awakened to full consciousness—4
   - Reacts to verbal command but is not fully conscious—2
   - Stupor (reacts to pain only)—0
   - Coma—0

2. Orientation
   - Correct for time, place, and person—6
   - Two of these (time, place, person)—4
   - One of these—2
   - Completely disoriented—0

3. Speech
   - No aphasia—10
   - Impairment of comprehension or expression disability—6
   - More than yes/no but not longer sentences—3
   - Only yes/no or less—2

4. Eye movement
   - No gaze palsy—4
   - Gaze palsy present—2
   - Forced lateral gaze—0

5. Facial palsy
   - None/dubious/slight—2
   - Present—0

6. Gait
   - Walks at least 5 m without aids—12
   - Walks with aids—9
   - Walks with help of another person—6
   - Sits without support—3
   - Bedridden/wheelchair—0

7. Arm, motor power (assessed only on affected side)
   - Raises arm with normal strength—6
   - Raises arm with reduced strength—5
   - Raises arm with flexion in elbow—4
   - Can move but not against gravity—2
   - Paralysis—0

8. Hand, motor power (assessed only on affected side)
   - Normal strength—6
   - Reduced strength in full range—4
   - Some movement, fingertips do not reach palm—2
   - Paralysis—0

9. Leg, motor power (assessed only on affected side)
   - Normal strength—6
   - Raises straight leg against resistance with reduced strength—5
   - Raises leg with flexion of knee against gravity—4
   - Can move but not against gravity—2
   - Paralysis—0

10. Foot paresis
    - None—2
    - Present—0

References


Part 7: The Era of Reperfusion: Section 2: Acute Stroke

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