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Acute Ischemic Stroke

by Fatih Büyükcam

Introduction

Patients with stroke present with sudden onset of paresis, sensory deficits, visual loss or visual field defects, diplopia, dysarthria, facial droop, ataxia, vertigo, aphasia and altered mental status. These symptoms and signs may be seen alone or in combination.

Acute ischemic stroke is a type of brain ischemia due to thrombosis, embolism or systemic hypoperfusion. Atherosclerosis, dissection, fibromuscular dysplasia, arteritis, vasculitis, non-inflammatory vasculopathy, and vasoconstriction may cause thrombosis . The most common source of emboli is cardiac or aortic diseases.

Management principles include stabilization, diagnosing and reversing the cause and decreasing harm to the patient. All patients with acute ischemic stroke have to be evaluated for suitability to thrombolytic therapy or invasive procedures (see Table 2).

Differential Diagnosis

Syncope, hypoglycemia, drug toxicity, seizure, intracranial hemorrhagic conditions can be misdiagnosed as acute ischemic stroke.

History and Physical Examination Hints

Most important data of the history is the time onset of symptoms because this is the main data that determine the eligibility for thrombolytic therapy. If the symptom onset time is not known, the time the patient was last awake and free of stroke symptoms is accepted as symptom onset time. Also, other important data have to be asked like co-morbidities, medications, head trauma and prior stroke.

Stabilization is a priority in every critically ill patient. Once the patient is stable, a focused neurologic examination should be performed. Level of consciousness (LOC), speech, cranial nerve (CN) function, motor and sensory function, and cerebellar function are the main abilities to assess. The physician may assess LOC and speech in a dialogue with the patient. The physician should also check pupillary size, reactivity, and eye movements to assess CN III through CN VI. Additionally, eyebrow elevation and squinting, smiling, gag reflex, shoulder elevation and tongue protrusion are parts of CN evaluation.

As we are still in differential diagnosis process, we have to do full systemic examination including especially cardiopulmonary and neurological examination. Whole body skin should be controlled for suspicion of trauma. Neurological examination findings give us some clues about the affected or obstructed vascular region.

Next step is to test motor and sensory function. Muscle strength is assessed against resistance. Pronator drift can be tested by having the patient sit with eyes closed and arms outstretched, with palms toward the ceiling, for 10 seconds. Double simultaneous stimulation may be

performed by simultaneously touching the right and left limbs. The patient with sensory neglect may feel the right and left sides individually but may ignore one side when both are touched simultaneously.

The last step is to assess cerebellar function, reflexes, and gait. Finger-to-nose and heel-to-shin evaluations, asymmetry of the deep tendon reflexes or unilateral Babinski's sign and observing routine ambulation are al informative parts of the neurologic examination.

Emergency Tests and Imaging Studies

Hypoglycemia may mimic a stroke. Therefore, fingertip blood glucose measurement is one of the initial essential steps. In case of hypoglycemia (blood glucose level <60 mg/dL), immediate intravenous glucose administration (slow intravenous push of 25 mL of 50% dextrose) is indicated. Whether the patient is hypoglycemic or not, stroke probability should be kept in mind until exclusion.

The basic workup should include an electrocardiogram, complete blood count, plasma urea nitrogen, creatinine, electrolytes, cardiac enzymes, coagulation parameters like prothrombin time, activated partial thromboplastin time and an international normalized ratio (INR). If there is a suspicion for other specific diseases liver function tests, toxicology tests, urinalysis, blood culture, β-HCG, arterial blood gases, lumbar puncture, etc. could be evaluated.

The physician should send the patient to imaging without waiting for the laboratory results.

The evaluation of a suspected stroke patient starts with non-contrast brain computed tomography (CT). A non-contrast brain CT is the fundamental imaging to differentiate hemorrhagic or ischemic stroke. This information determines subsequent treatment.

In the acute ischemic stroke, the sensitivity of standard non-contrast CT increases after 24 hours. However, there may be some early signs of infarction in the first six hours (Table 1) .

Table 1: Early signs of acute ischemic stroke

Hypodensity of the lentiform nucleus obscuration

Hypoattenuation of 1/3 or more of the middle cerebral artery region

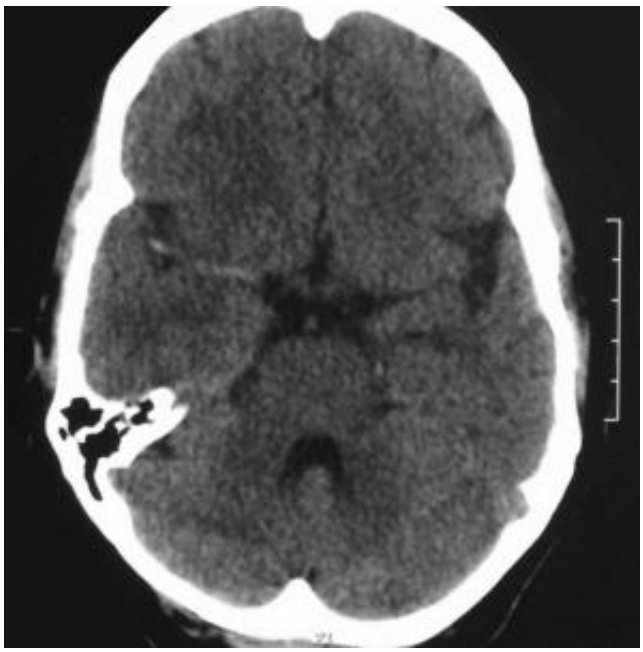
Hyperdensity of large vessels

Sulcal effacement

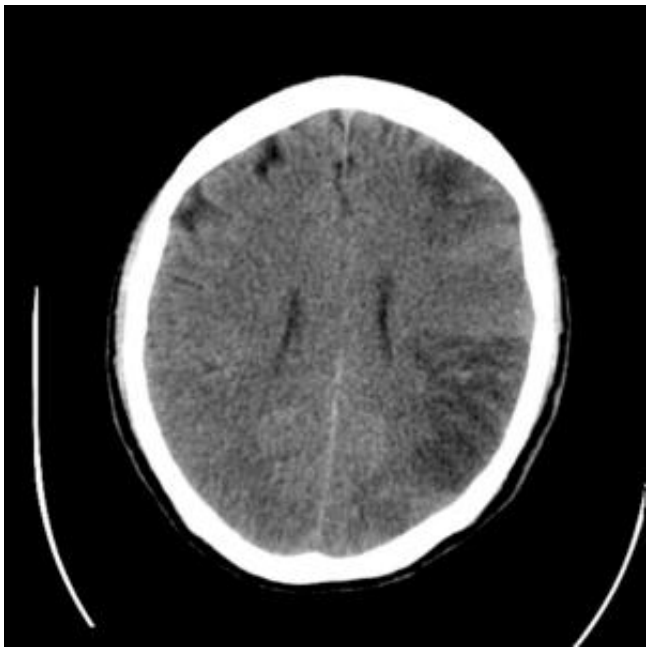
Hypoattenuation of a focal parenchymal region

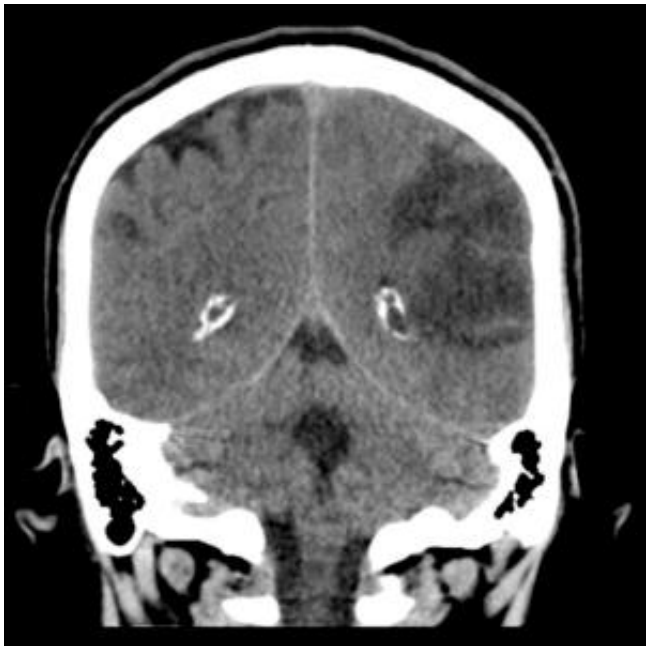
Obscuration of the silvian fissure and insular ribbon

The gray-white matter differentiation defect of basal ganglia



Case courtesy of Dr Mohammad Taghi Niknejad, Radiopaedia.org. From the case rID: 20784



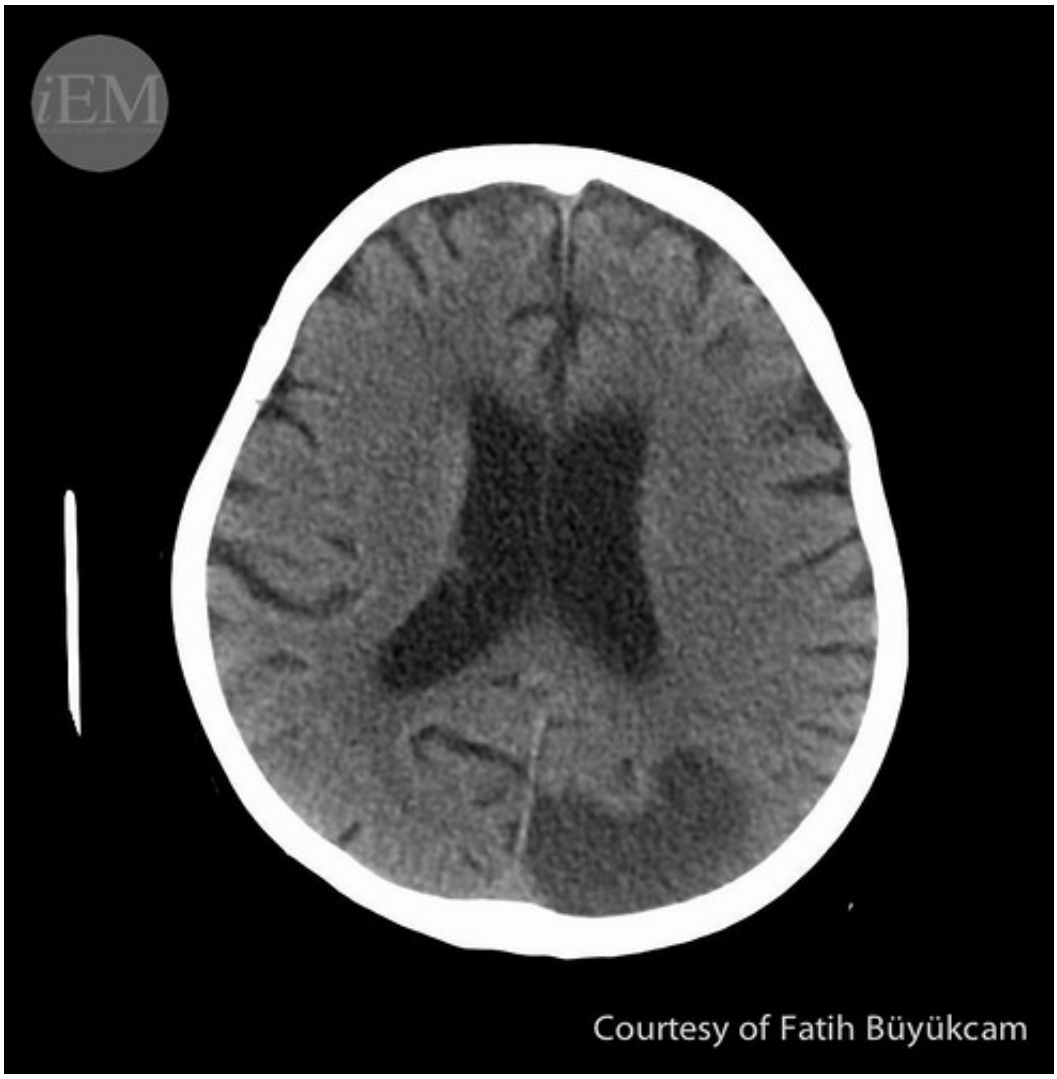


Computed tomographies show two regions of ischemic stroke in the territory of the left middle cerebral artery, involving the regions supplied by both the anterior and posterior branches.
Case courtesy of Dr David Cuete, Radiopaedia.org. From the case rID: 26882

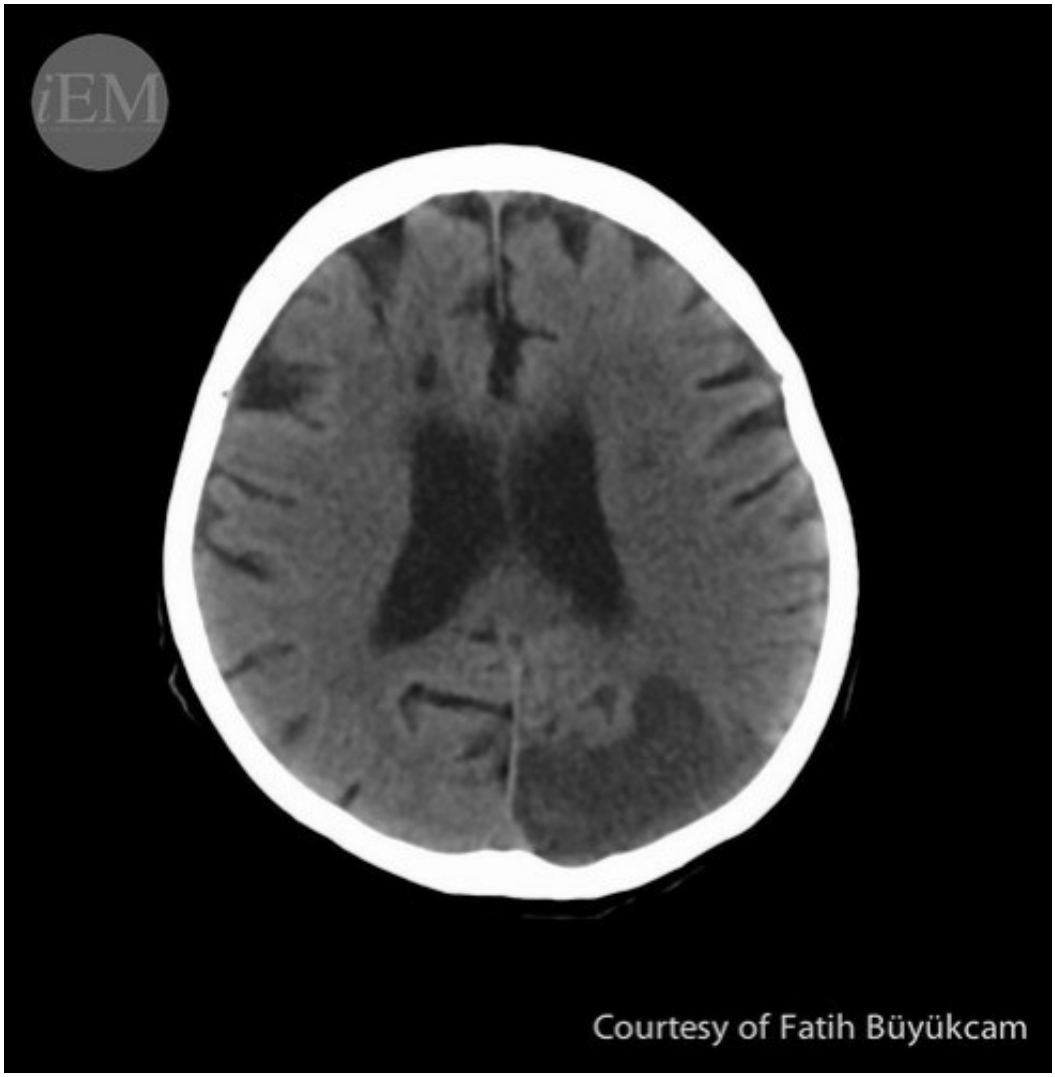
The prevalence of these signs is 61% (±21 standard deviation). The mean sensitivity and

specificity of early CT signs are 66% (range 20-97) and 87% (range 56-100) respectively. If the diagnosis is unclear, a diffusion-weighted magnetic resonance imaging (DW-MRI) may visualize the affected area. DW-MRI can show ischemic changes within 3 to 30 minutes of onset. The apparent diffusion coefficient (ADC) view of DW-MRI gives a quantitative measure of the water diffusion. The decreased water diffusion in cytotoxic edema of acute ischemic stroke causes a hyperintense DW-MRI signal and a hypointense ADC signal. Please see couple examples below.

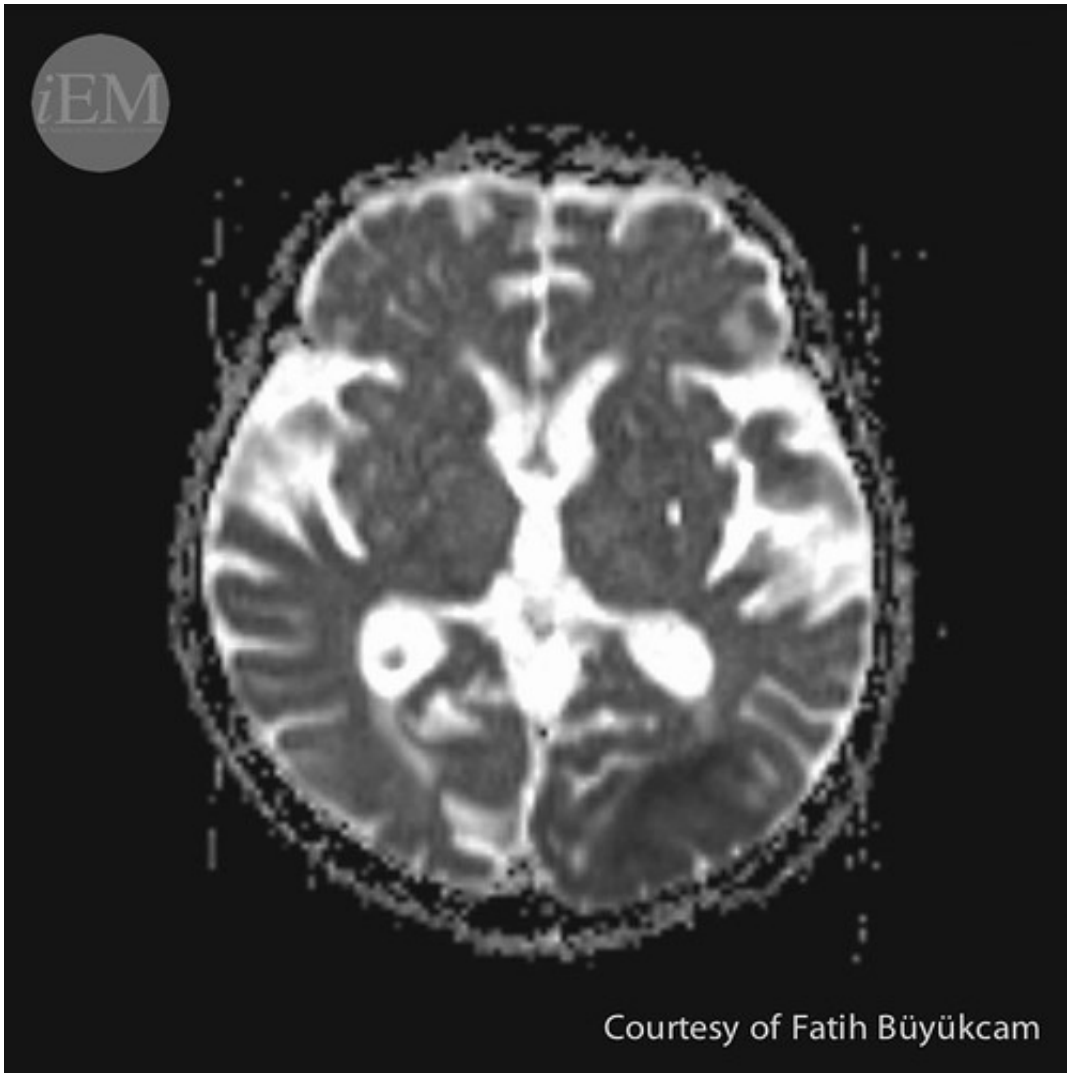
79-year-old female with left parieto-occipital cortex subcortical white matter infarct. CT imagining of at admission.



CT imagining of at 48th hour



DW-MRI imagining of the patient



ADC view of the patient

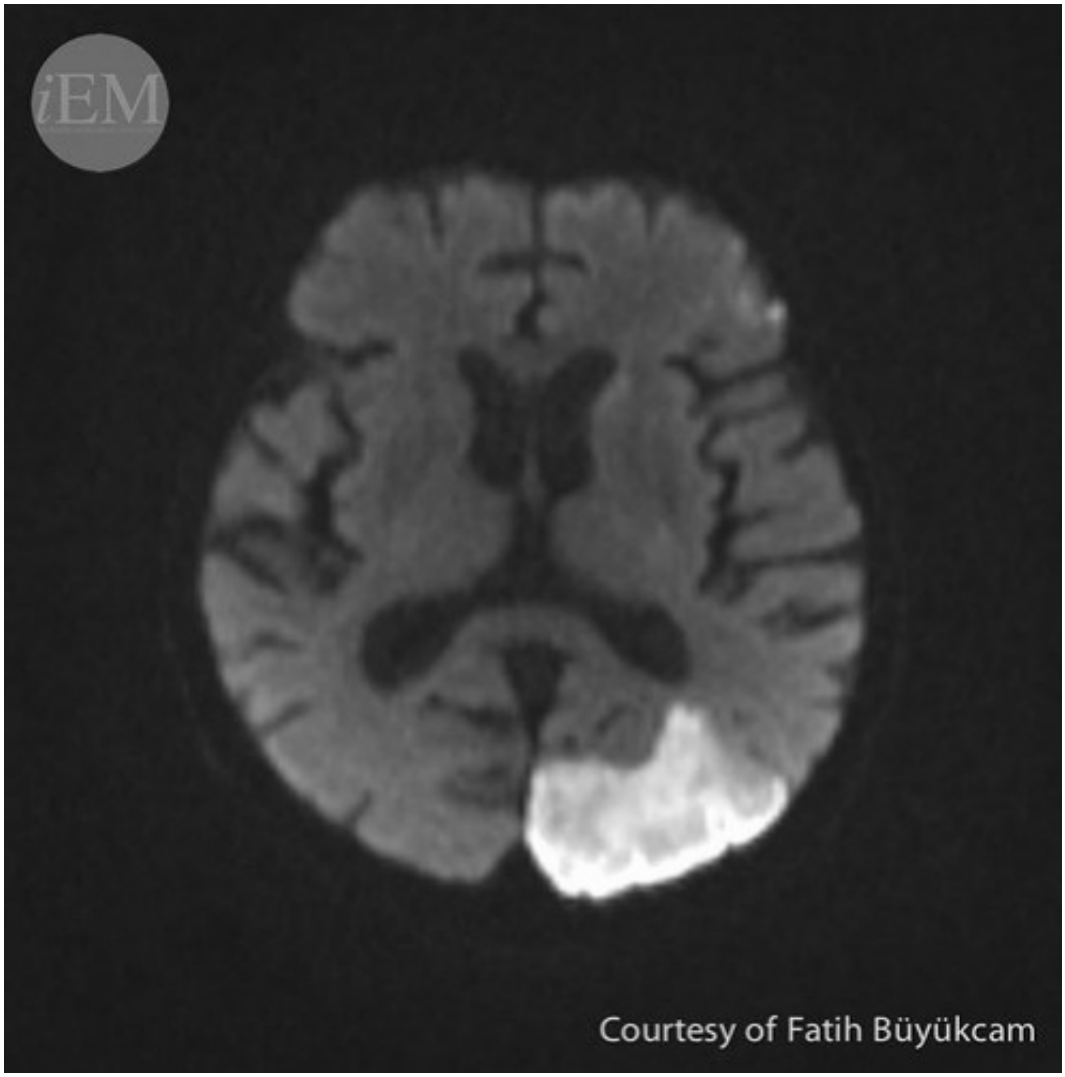


Table 2: Eligibility criteria for treatment of acute ischemic stroke with recombinant tissue plasminogen activator (alteplase)

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
Age ⩾18 years

EXCLUSION CRITERIA
Historical

Significant stroke or head trauma in the previous three months

Previous intracranial hemorrhage

Intracranial neoplasm, arteriovenous malformation, or aneurysm

Recent intracranial or intraspinal surgery

Arterial puncture at a noncompressible site in the previous seven days

Clinical

Symptoms suggestive of subarachnoid hemorrhage

Persistent blood pressure elevation (systolic ⩾185 mmHg or diastolic ⩾110 mmHg)

Serum glucose <50 mg/dL (<2.8 mmol/L)

Active internal bleeding

Acute bleeding diathesis, including but not limited to conditions defined in Hematologic'

Hematologic

Platelet count <100,000/mm3 *

Current anticoagulant use with an INR >1.7 or PT >15 seconds*

Heparin use within 48 hours and an abnormally elevated aPTT*

Current use 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 scan

Evidence of hemorrhage

Evidence of a multilobar infarction with hypodensity involving >33 percent of the cerebral Hemisphere

RELATIVE EXCLUSION CRITERIA

Only minor and isolated neurologic signs

Rapidly improving stroke symptoms

Major surgery or serious trauma in the previous 14 days

Gastrointestinal or urinary tract bleeding in the previous 21 days

Myocardial infarction in the previous three months

Seizure at the onset of stroke with postictal neurologic impairments

Pregnancy

ADDITIONAL RELATIVE EXCLUSION CRITERIA FOR TREATMENT FROM 3 TO 4.5 HOURS FROM SYMPTOM ONSET

Age >80 years

Oral anticoagulant use regardless of INR

Severe stroke (NIHSS score >25)

Combination of both previous ischemic stroke and diabetes mellitus

aPTT: activated partial thromboplastin time; ECT: ecarin clotting time; INR: international normalized ratio; PT: prothrombin time; NIHSS: National Institutes of Health Stroke Scale; TT: thrombin time.

* 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), (3) use of anticoagulants is not known. For patients without recent use of oral anticoagulants or heparin, 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.

¶ The available data suggest that under some circumstances – with careful consideration and weighting of risk-to-benefit – patients may receive fibrinolytic therapy despite one or more relative contraindications. In particular, there is now consensus that patients who have a persistent neurologic deficit that is potentially disabling, despite improvement of any degree, should be treated with tPA in the absence of other contraindications. Any of the following should be considered disabling deficits:

o Complete hemianopsia: ≥2 on NIHSS question 3, or

o Severe aphasia: ≥2 on NIHSS question 9, or

o Visual or sensory extinction: ≥1 on NIHSS question 11, or

o Any weakness limiting sustained effort against gravity: ≥2 on NIHSS question 5 or 6, or

o Any deficits that lead to a total NIHSS >5, or

Emergency Department Management

Oxygen is not recommended for all patients. If the pulse saturation is below 94%, supplemental oxygen should be given.

Fluids should be individualized according to patients' cardiovascular status, plasma glucose, and electrolyte levels. Isotonic fluid is the best choice because hypotonic fluids may aggravate cerebral edema. Both hypoglycemia and hyperglycemia worsen the prognosis; normoglycemia (60–126 mg/dL) is the best target point. American Diabetes Association suggests achieving glucose targets of 140 to 180 mg/dL in acute ischemic stroke.

Thrombolysis is done in patients eligible for thrombolytic therapy by alteplase, (Figure 10) which is a tissue plasminogen activator (explained in Table 2). Within 4.5 hours of symptom onset, thrombolytic therapy may be applied.

Apart from brain injury of acute stroke, central nervous system infection, subdural empyema, brain abscess and any concomitant infection may cause fever. Fever is associated with the increased mortality rate, disability, and extended hospital stays. The physician should find and treat the source of fever. Additionally, antipyretics may be used for febrile patients, but its effect on prognosis is still unclear.

Drug of choice for fever:

- Acetaminophen
  - <50 kg: 12.5 mg/kg IV q4hr OR 15 mg/kg IV q6hr; not to exceed 750 mg/dose or 3.75 g/day
  - ⩾50 kg: 650 mg IV q4hr OR 1000 mg IV q6hr; not to exceed 4 g/day Infuse IV over at least 15 minutes

Reducing the blood pressure does not affect the early and long-term outcome. However, systolic blood pressure should be kept under 185 mmHg and diastolic pressure under 110 mmHg to administer thrombolytic treatment. If thrombolytic therapy is contraindicated, the physician should not interfere unless systolic blood pressure >220 mmHg or diastolic blood pressure >120 mmHg or the patient has active coronary artery disease, aortic dissection, hypertensive encephalopathy, acute renal failure, pre-eclampsia, and eclampsia.

The first-line antihypertensive agents are labetalol and nicardipine, and the second-line choice is nitroprusside.

- Labetalol
  - 20 mg IV over 2 minutes initially, then 40-80 mg IV q10min; total dose not to exceed 300 mg
  - Alternative: 1-2 mg/min by continuous IV infusion; total dose of 300 mg has been used
- Nicardipine
  - Start with 5 mg/hr
  - If necessary, increase infusion rate 2.5 mg/hr every 5 minutes to a maximum dose of 15 mg/hr.
- Nitroprusside sodium
  - Initial: 0.25-0.3 mcg/kg/min IV infusion; may increase by 0.5 mcg/kg/min every few minutes to achieve desired results
  - Usual range: 3-4 mcg/kg/min IV infusion, not to exceed 10 mcg/kg/min

Aspirin reduces the 14-day recurrence of ischemic stroke and total mortality. Clopidogrel and aspirin-extended-release dipyridamole can be used alone or with aspirin. Aspirin is the only medication that is effective for the very early treatment of acute ischemic stroke.

- Aspirin (acetylsalicylic acid)
  - 160 to 325 mg/day PO
  - Aspirin may be given rectally for patients with acute stroke who cannot take by the oral route.
  - To the Asian patients with high-risk TIA (i.e., ABCD2 score of ⩾4) or minor stroke (NIHSS score ⩽3) clopidogrel and aspirin as dual antiplatelet therapy could be given for 21 days 35

Anticoagulation with heparin or low molecular weight heparin is not recommended. It is associated with higher mortality and poor outcomes compared to aspirin alone in 48 hours. However, secondary stroke prevention is recommended for patients with atrial fibrillation and in case of risk for cardiogenic embolism. For this treatment, warfarin may be given in the first 24 hours and continue for two weeks.

Prognosis

Presence of facial paresis, arm weakness or drift and abnormal speech are the main predictors of outcome. The NIHSS (National Institutes of Health Stroke Scale) score on admission gives a clue about stroke outcome. The use of NIHSS score is recommended for all patients with stroke.

References and Further Reading

- Caplan LR. Etiology, classification, and epidemiology of stroke. UpToDate 2015; http://www.uptodate.com/contents/etiology-classification-and-epidemiology-of-stroke?source=search_result&search=Etiology%2C+classification%2C+and+epidemiology+of+stroke&selectedTitle=1~150. Accessed 22.09.2015.
- Jauch EC, Saver JL, Adams HP, Jr., et al. 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; a journal of cerebral circulation. 2013;44(3):870-947.
- von Kummer R, Bourquain H, Bastianello S, et al. Early prediction of irreversible brain damage after ischemic stroke at CT. Radiology. 2001;219(1):95-100.
- Wardlaw JM, Mielke O. Early signs of brain infarction at CT: observer reliability and outcome after thrombolytic treatment–systematic review. Radiology. 2005;235(2):444-453.
- Truwit CL, Barkovich AJ, Gean-Marton A, Hibri N, Norman D. Loss of the insular ribbon: another early CT sign of acute middle cerebral artery infarction. Radiology. 1990;176(3):801-806.
- von Kummer R, Meyding-Lamade U, Forsting M, et al. Sensitivity and prognostic value of early CT in occlusion of the middle cerebral artery trunk. AJNR American journal of neuroradiology. 1994;15(1):9-15; discussion 16-18.
- Marks MP, Holmgren EB, Fox AJ, Patel S, von Kummer R, Froehlich J. Evaluation of early computed tomographic findings in acute ischemic stroke. Stroke; a journal of cerebral circulation. 1999;30(2):389-392.
- Wijdicks EF, Diringer MN. Middle cerebral artery territory infarction and early brain swelling: progression and effect of age on outcome. Mayo Clinic Proceedings. 1998;73(9):829-836.
- Filho JO. Neuroimaging of acute ischemic stroke. 2016; http://www.uptodate.com/contents/neuroimaging-of-acute-ischemic-stroke?

source=search_result&search=neuroimaging+of+acute+ischemic+stroke&selectedTitle=1~150. Accessed 04.07.2016, 2015.

- Warach S, Gaa J, Siewert B, Wielopolski P, Edelman RR. Acute human stroke studied by whole brain echo planar diffusion-weighted magnetic resonance imaging. Annals of neurology. 1995;37(2):231-241.
- Sorensen AG, Buonanno FS, Gonzalez RG, et al. Hyperacute stroke: evaluation with combined multisection diffusion-weighted and hemodynamically weighted echo-planar MR imaging. Radiology. 1996;199(2):391-401.
- Li F, Han S, Tatlisumak T, et al. A new method to improve in-bore middle cerebral artery occlusion in rats: demonstration with diffusion- and perfusion-weighted imaging. Stroke; a journal of cerebral circulation. 1998;29(8):1715-1719; discussion 1719-1720.
- Filho JO. Neuroimaging of acute ischemic stroke. UpToDate 2015; http://www.uptodate.com/contents/neuroimaging-of-acute-ischemic-stroke. Accessed 28.11.2015.
- Burns JD, Green DM, Metivier K, DeFusco C. Intensive care management of acute ischemic stroke. Emergency medicine clinics of North America. 2012;30(3):713-744.
- Bejot Y, Aboa-Eboule C, Hervieu M, et al. The deleterious effect of admission hyperglycemia on survival and functional outcome in patients with intracerebral hemorrhage. Stroke; a journal of cerebral circulation. 2012;43(1):243-245.
- Capes SE, Hunt D, Malmberg K, Pathak P, Gerstein HC. Stress hyperglycemia and prognosis of stroke in nondiabetic and diabetic patients: a systematic overview. Stroke; a journal of cerebral circulation. 2001;32(10):2426-2432.
- Moghissi ES, Korytkowski MT, DiNardo M, et al. American Association of Clinical Endocrinologists and American Diabetes Association consensus statement on inpatient glycemic control. Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists. 2009;15(4):353-369.
- Alteplase (Rx). 2015; http://reference.medscape.com/drug/activase-tpa-alteplase-342287. Accessed 30.11.2015.
- Ginsberg MD, Busto R. Combating hyperthermia in acute stroke: a significant clinical concern. Stroke; a journal of cerebral circulation. 1998;29(2):529-534.
- Filho JO. Initial assessment and management of acute stroke. UpToDate 2015; http://www.uptodate.com/contents/initial-assessment-and-management-of-acute-stroke?

source=search_result&search=Initial+assessment+and+management+of+acute+stroke&selectedTitle=1~150. Accessed 28.11.2015.

- Greer DM, Funk SE, Reaven NL, Ouzounelli M, Uman GC. Impact of fever on outcome in patients with stroke and neurologic injury: a comprehensive meta-analysis. Stroke; a journal of cerebral circulation. 2008;39(11):3029-3035.
- Saini M, Saqqur M, Kamruzzaman A, Lees KR, Shuaib A. Effect of hyperthermia on prognosis after acute ischemic stroke. Stroke; a journal of cerebral circulation. 2009;40(9):3051-3059.
- Prasad K, Krishnan PR. Fever is associated with doubling of odds of short-term mortality in ischemic stroke: an updated meta-analysis. Acta neurologica Scandinavica. 2010;122(6):404-408.
- den Hertog HM, van der Worp HB, van Gemert HM, et al. The Paracetamol (Acetaminophen) In Stroke (PAIS) trial: a multicentre, randomised, placebo-controlled, phase III trial. The Lancet Neurology. 2009;8(5):434-440.
- Acetaminophen (OTC). 2015; http://reference.medscape.com/drug/tylenol-acetaminophen-343346. Accessed 30.11.2015.
- Bath PM, Woodhouse L, Scutt P, et al. Efficacy of nitric oxide, with or without continuing antihypertensive treatment, for management of high blood pressure in acute stroke (ENOS): a partial-factorial randomised controlled trial. Lancet. 2015;385(9968):617-628.
- Wang H, Tang Y, Rong X, et al. Effects of early blood pressure lowering on early and long-term outcomes after acute stroke: an updated meta-analysis. PloS one. 2014;9(5):e97917.
- Labetalol (Rx). 2015; http://reference.medscape.com/drug/trandate-labetalol-342359. Accessed 30.11.2015.
- Nicardipine (Rx). 2015; http://reference.medscape.com/drug/cardene-iv-nicardipine-342377. Accessed 13.07.2016.
- Nitroprusside sodium (Rx). 2015; http://reference.medscape.com/drug/nipride-nitropress-nitroprusside-sodium-342312. Accessed 30.11.2015.
- The International Stroke Trial (IST): a randomised trial of aspirin, subcutaneous heparin, both, or neither among 19435 patients with acute ischaemic stroke. International Stroke Trial Collaborative Group. Lancet. 1997;349(9065):1569-1581.
- CAST: randomised placebo-controlled trial of early aspirin use in 20,000 patients with acute ischaemic stroke. CAST (Chinese Acute Stroke Trial) Collaborative Group. Lancet. 1997;349(9066):1641-1649.
- Oliveira J. Antithrombotic treatment of acute ischemic stroke and transient ischemic attack.

UpToDate 2015; http://www.uptodate.com/contents/antithrombotic-treatment-of-acute-ischemic-stroke-and-transient-ischemic-attack?source=search_result&search=Antithrombotic+treatment+of+acute+ischemic+stroke+and+transient+ischemic+attack&selectedTitle=1~150. Accessed 30.11.2015.

- Lansberg MG, O'Donnell MJ, Khatri P, et al. Antithrombotic and thrombolytic therapy for ischemic stroke: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest. 2012;141(2 Suppl):e601S-636S.
- Wang Y, Zhao X, Liu L, et al. Clopidogrel with aspirin in acute minor stroke or transient ischemic attack. The New England journal of medicine. 2013;369(1):11-19.
- Berge E, Sandercock P. Anticoagulants versus antiplatelet agents for acute ischaemic stroke. The Cochrane database of systematic reviews. 2002(4):CD003242.
- Kothari R, Hall K, Brott T, Broderick J. Early stroke recognition: developing an out-of-hospital NIH Stroke Scale. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine. 1997;4(10):986-990.
- Goldstein LB, Simel DL. Is this patient having a stroke? Jama. 2005;293(19):2391-2402.
- Generalized efficacy of t-PA for acute stroke. Subgroup analysis of the NINDS t-PA Stroke Trial. Stroke; a journal of cerebral circulation. 1997;28(11):2119-2125.
- Adams HP, Jr., Davis PH, Leira EC, et al. Baseline NIH Stroke Scale score strongly predicts outcome after stroke: A report of the Trial of Org 10172 in Acute Stroke Treatment (TOAST). Neurology. 1999;53(1):126-131.
- Adams HP, Jr., del Zoppo G, Alberts MJ, et al. Guidelines for the early management of adults with ischemic stroke: a guideline from the American Heart Association/American Stroke Association Stroke Council, Clinical Cardiology Council, Cardiovascular Radiology and Intervention Council, and the Atherosclerotic Peripheral Vascular Disease and Quality of Care Outcomes in Research Interdisciplinary Working Groups: the American Academy of Neurology affirms the value of this guideline as an educational tool for neurologists. Stroke; a journal of cerebral circulation. 2007;38(5):1655-1711.
- Bier G, Bongers MN, Ditt H, Bender B, Ernemann U, Horger M. Accuracy of Non-Enhanced CT in Detecting Early Ischemic Edema Using Frequency Selective Non-Linear Blending. PloS one. 2016;11(1):e0147378.
- Li Q, Davis S, Mitchell P, Dowling R, Yan B. Proximal hyperdense middle cerebral artery sign predicts poor response to thrombolysis. PloS one. 2014;9(5):e96123.

- Smith WS, Lev MH, English JD, et al. Significance of large vessel intracranial occlusion causing acute ischemic stroke and TIA. Stroke; a journal of cerebral circulation. 2009;40(12):3834-3840.
- Case courtesy of Dr Nafisa Shakir Batta, Radiopaedia.org, rID: 26343. http://radiopaedia.org/cases/loss-of-insular-ribbon-sign-of-early-mca-infarction-1.

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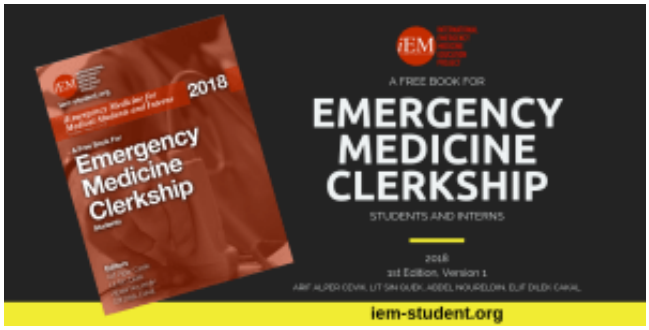

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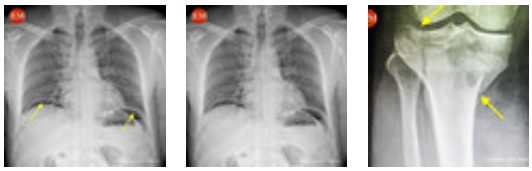

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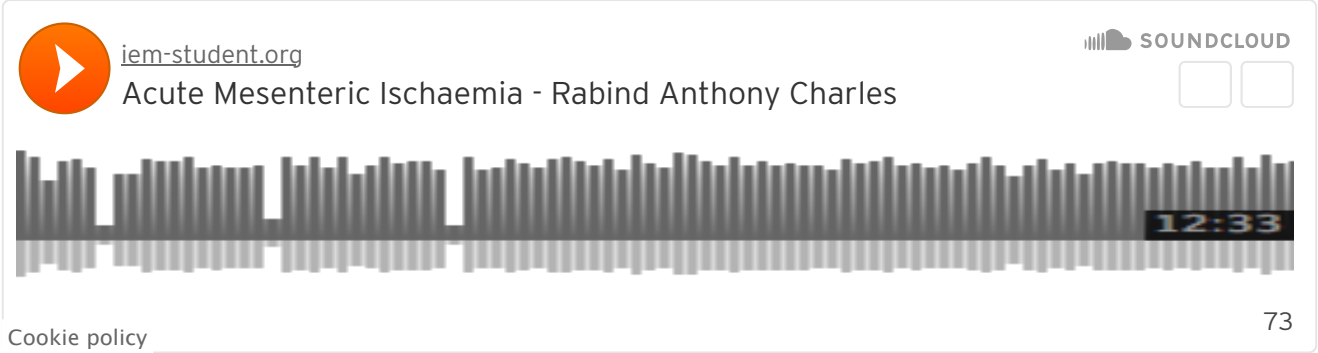

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