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Review Article

Update on the Acute Management of Ischemic Stroke

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Abstract:

Acute ischaemic stroke is a major public health priority and will become increasingly relevant to neurologists of the future. The cornerstone of effective stroke care continues to be timely reperfusion treatment. This requires early recognition of symptoms by the public and first responders, triage to an appropriate stroke centre and efficient assessment and investigation by the attending stroke team. The aim of treatment is to achieve recanalisation and reperfusion of the ischaemic penumbra with intravenous thrombolysis and/or endovascular thrombectomy in appropriately selected patients. All patients should be admitted directly to an acute stroke unit for close monitoring for early neurological deterioration and prevention of secondary complications. Prompt investigation of the mechanism of stroke allows patients to start appropriate secondary preventative treatment. Future objectives include improving accessibility to endovascular thrombectomy, using advanced imaging to extend therapeutic windows and developing neuroprotective agents to prevent secondary neuronal damage.

Key Words: Acute Ischaemic Stroke , I/V Thrombolysis (r-tpa), Mechanical Thrombectomy.

Introduction:

Stroke is defined by the World Health Organization as a clinical syndrome consisting of rapidly developing clinical signs of focal (or global in case of coma) disturbance of cerebral function lasting more than 24 hours or leading to death with no apparent cause other than a vascular origin.[1] Stroke is classified broadly into three categories; ischemic stroke, hemorrhagic stroke and subarachnoid hemorrhage. Ischemic stroke occurs due to blockage of blood vessel which limits the blood supply to the brain whereas hemorrhagic stroke occurs due to rupture of blood vessel leading spillage of blood in the intracranial cavity.[2] Depending on the site of blood spillage the hemorrhagic stroke could be classified as intracerebral hemorrhage or subarachnoid hemorrhage. Approximately 60–80% of all strokes is ischemic.

Therapeutic Goals: Therapeutic goals aimed at ischemic stroke might be characterized as chronic versus acute. Though chronic supervision goal line attention to secondary inhibition of ischemic measures, early acute treatment goal line attention on dropping infarction size and stroke strictness eventually came back a patient to starting point efficient rank. Acute treatment goals for appropriate refurbishment of blood stream to ischemic areas to limit the volume of unsalvageable brain tissue can be recognized as the ischemic essential. Acute treatment also emphasize on preservative—the penumbra—which is an area of salvage. Ischemic neurons nearby the core infarction can be improved by appropriate reperfusion.

Intravenous Thrombolysis: Intravenous (IV) recombinant tissue-type plasminogen activator (alteplase) has been approved by the United States Food and Drug Administration (USFDA) for the treatment of acute ischemic stroke within 3 hours of witnessed symptom onset or last known well since 1996.1 Patients older than 18 years are eligible toreceive this treatment if they have a disabling deficit, which is often quantified using the National Institutes of Stroke Severity Scale (NIHSS), and those deficits are presumed to be due to an ischemic stroke with no evidence of an acute hemorrhage on a noncontrast head computed tomography (CT). This includes patients with rapidly improving symptoms who continue to have deficits, seizure at onset with disabling symptoms not due to a postictal state, large NIHSS scores, and age more than 80 years. Blood pressure must be kept less than 185/110 before and during the infusion and less than 180/105 for 24 hours after the infusion. Blood pressure parameters may be achieved however the treating physician sees fit, though labetalol, nicardipine, and clevidipine are commonly used agents. Patients treated with alteplase have been shown to be 30% more likely to have minimal or no disability at 3 months compared to patients treated with placebo.[3]This favorable outcome helped lead to widespread practice implementation.

***Current Evidence and Guidelines for Intravenous Alteplase Thrombolysis*:** Although the original National Institute of Neurologic Disorders and Stroke (NINDS) trial had an extensive list of exclusion criteria, the AHA/ASA committees have revised this list based on documented scientific evidence of harm or lack of benefit with the use of data repositories and

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clinical expertise. A list of contraindications, based on either a benefit of treatment that equals the risk of treatment or a greater risk of treatment than benefit, are provided in a list below.[4]

Intravenous alteplase contraindications:

1. Mild non-disabling symptoms (NIHSS 0–5)
2. Head CT with extensive regions of hypoattenuation
3. Prior ischemic stroke within 3 months
4. Head CT with acute intracranial hemorrhage
5. Subarachnoid hemorrhage
6. Intra-axial intracranial neoplasm
7. Intraspinal or intracranial surgery or serious head trauma within 3 months
8. History of intracranial hemorrhage
9. Gastrointestinal malignancy or gastrointestinal bleed within 21 days
10. Known coagulopathy, including platelets less than 100,000/mm^3 , INR greater than 1.7, aPTT greater than 40s, or PT greater than 15s
11. Low-molecular-weight heparin full treatment dose received within 24 hours
12. Current use of direct thrombin inhibitors or direct factor Xa inhibitors within 48 hours
13. Infective endocarditis
14. Aortic arch dissection

Expanded inclusion criteria:

Although patients with the following conditions were historically excluded from receiving alteplase, further evidence has shown that IV alteplase is reasonable in patients with[5] :

1. Extra cranial arterial dissection
2. Unruptured intracranial aneurysm $\leq$ 10 mm
3. 1 to 10 cerebral micro bleeds demonstrated on a prior MRI
4. Menstruating women without a history of menorrhagia
5. Extra-axial intracranial neoplasms
6. Acute myocardial infarction
7. Non-ST-segment myocardial infarction (NSTEMI) and STEMI involving the right or inferior myocardium within 3 months
8. Acute ischemic stroke as a complication of cardiac or cerebral angiographic procedures
9. History of diabetic hemorrhagic retinopathy or other hemorrhagic ophthalmic condition while weighing the potential increased risk of visual loss against the benefit of treatment
10. Suspected stroke mimic but obtaining additional confirmatory studies would delay treatment
11. Illicit drug use
12. Sickle cell anemia.

Intravenous alteplase may be considered, with careful weighing of the risks and benefits, in individuals with disabling acute stroke symptoms and the following known conditions[6] :

1. Initial blood glucose values less than 50 or greater than 400 that have normalized, yet clinical deficits remain
2. Dural puncture in the previous 7 days
3. Major non-head trauma within the previous 14 days
4. Major surgery in the previous 14 days
5. History of previous (greater than 21 days prior) gastrointestinal or genitourinary bleeding
6. Active menstruation with a history of menorrhagia without anemia or hypotension
7. Pre-existing dementia
8. Warfarin use and an INR $\leq$ 1.7 or a PT less than 15 seconds
9. Myocardial infarction within 3 months involving the left anterior myocardium
10. Acute pericarditis and stroke symptoms likely to produce severe disability (cardiology consultation is recommended)
11. Left atrial or ventricular thrombus and stroke symptoms likely to produce severe disability
12. Cardiac myxoma or papillary fibroelastoma and stroke symptoms likely to produce severe disability
13. Pregnancy and moderate to severe stroke
14. Pre-existing disability with a modified Rankin score ≥ 2
15. Systemic malignancy and reasonable (>6 months) life expectancy.

Extended Window for Intravenous Alteplase: Intravenous alteplase can also be given within 3 to 4.5 hours of witnessed symptom onset or last known well, although the odds ratio for a favorable outcome compared with placebo during this time frame is 1.28, and its use during this time frame is not approved by the USFDA.7, 8 The European Cooperative Acute Stroke Study (ECASS) III trial showed that alteplase was safe and effective in this time window with strict inclusion criteria that included patients $\leq$ 80 years of age, without a history of both diabetes mellitus and prior stroke, with an NIHSS score $\leq$ 25, not taking any oral anticoagulation, and without imaging evidence of ischemic injury involving more than one-third of the middle cerebral artery (MCA) territory. 3 Further published data indicate that not all these exclusion criteria are justified. The 2019

American Heart Association/American Stroke Association (AHA/ASA) guideline for the early management of acute ischemic stroke states that alteplase treatment in the 3- to 4.5-hour window may be safe and reasonable in patients who are older than 80 years, or have a history of diabetes mellitus and stroke, or are on warfarin with an international normalized ratio (INR) less than 1.7.4 However, the benefit remains uncertain in patients with an NIHSS greater than 25.

Complications of Treatment: Life-threatening complications of intravenous alteplase therapy include orolingual angioedema and symptomatic intracerebral hemorrhage. Box 1 includes treatment algorithms for orolingual angioedema management and alteplase reversal in patients with a symptomatic intracranial hemorrhage.

Box 1 : Management of IV alteplase complications

A. Orolingual Edema
   1. Maintain airway
      a. Intubation may not be necessary if the edema is limited to the anterior tongue and lips
      b. Edema involving larynx, palate, floor of mouth, or oropharynx with rapid progression within 30 minutes may require intubation
      c. Awake fiberoptic intubation is optimal as nasal-tracheal intubation my pose risk of epistaxis post-IV alteplase.
   2. Discontinue IV alteplase infusion and hold any angiotensin-converting enzyme inhibitors
   3. Administer IV methylprednisolone 125 mg x1
   4. Administer IV diphenhydramine 50 mg x1
   5. Administer famotidine 20 mg IV x1
   6. If there is further increase in angioedema:
      a. Administer epinephrine 1 mg/mL 0.3 mL intramuscular injection x1 OR racemic epinephrine 2.25% orally inhaled solution 0.5 mL nebulization x1
      b. Plasma-derived C1 esterase inhibitor (Berinert) 20 international units/kg IV infusion may be considered in refractory cases

B. Symptomatic Intracranial Bleeding within 12 hours of IV Alteplase
   1. Stop alteplase infusion
   2. Obtain CBC, PT (INR), aPTT, fibrinogen level, and type and cross-match
   3. Obtain an emergent nonenhanced head CT
   4. If intracranial hemorrhage is confirmed:
      a. Cryoprecipitate (includes factor VIII): 10 U infused over 10 to 30 minutes (onset in 1 hour, peaks in 12 hours); administer an additional dose for fibrinogen level of less than 200 mg/dL
      b. Consider Tranexamic acid 1000 mg IV infused over 10 minutes OR ε-aminocaproic acid 4 to 5 g over 1 hour, followed by 1 g IV/h if cryoprecipitate is unavailable, or other blood products are contraindicated
   5. Supportive care to include blood pressure, intracranial pressure, cerebral perfusion pressure, and mean arterial pressure management

Current Evidence for Tenecteplase Thrombolysis: Although intravenous alteplase is currently the only agent approved by the USFDA for the treatment of acute ischemic stroke, a second fibrinolytic, tenecteplase, may be as effective. Tenecteplase is a variant of alteplase bioengineered to have higher fibrin specificity and increased resistance to plasminogen activator inhibitor-1, and is administered via a single intravenous bolus. In the largest trial comparing tenecteplase to alteplase in minor stroke patients (median NIHSS 4) without a major intracranial occlusion, tenecteplase at 0.4 mg/kg failed to demonstrate superiority, but had a safety and efficacy profile similar to that of alteplase.[9] Current guidelines recommended that tenecteplase may be considered as an alternative treatment for patients with a minor stroke without a large vessel occlusion at a class IIb level recommendation.[10]Because of the shorter time to prepare and administer tenecteplase and the lack of requirement for an IV infusion pump during interfacility transfer, some institutions have adopted its use.[11]

POST rtPA CARE

Blood Pressure: Blood pressure is found to be elevated in most patients on the day of admission and such early elevation is thought to be a physiological response to ischemia. Patients with preexisting hypertension with moderately elevated pressures may not require antihypertensive therapy as it can impair cerebral blood flow and lead to neurological deterioration[12]. rtPA is given only if blood pressure is less than 185/110; it should be maintained at that level for the first 24 hours after rtPA administration[13,14]. For patients who do not receive rtPA, the American Heart Association/ American Stroke Association (AHA/ASA) guidelines recommend initially withholding antihypertensive treatment unless the blood pressure is greater than 220/120[13,14].

Temperature: Hyperthermia acts through several mechanisms to worsen cerebral ischemia, some of which include enhanced release of neurotransmitters, exaggerated oxygen radical production, and worsening of cytoskeletal proteolysis[15]. A temperature greater than >37.9°C within the first week after the stroke was an independent predictor of a poor outcome[16,17]. Lowering an acutely elevated temperature greatly influences outcome and prognosis[18]. Therefore, guidelines suggest that sources of fever should be treated, and antipyretic medications should be administered to lower the temperature in febrile stroke patients.

Glucose: There is a correlation between an admission glucose

concentration, diabetes, and poor stroke outcomes, which may not be attributed to the stroke type or location. Increased mortality was evident in the hyperglycemicand diabetic groups[19]. Hyperglycemia is associated with lactic acidosis and conversion of penumbral tissue to an infarction, greater final infarct size, and worse functional outcome[19]. These correlations were independent of baseline stroke severity, lesion size, and diabetic status[20]. Insulin therapy benefits transient focal ischemia[21]. Serum glucose concentrations 140-180 mg/dL should probably trigger administration of insulin[22]. Persistent hyperglycemia, as measured by serial blood glucose levels, is indicative of infarct evolution and worse clinical outcome regardless of baseline stroke severity than an isolated measure of glucose on admission to hospital[23].

Antiplatelet/ Anticoagulation: Two large trials studying the effects of aspirin and heparin in an acute stroke, the Chinese Acute Stroke Trial (CAST) and the International Stroke Trial (IST), have shown that starting aspirin as early as possible prevents stroke recurrence[24,25]. AHA/ ASA guidelines recommend a dose of 325 mg orally within 48 hours of an acute stroke[26,27]. The use of anticoagulation is not recommended in the acute setting because of the risk of hemorrhagic transformation[24,25,28,29].

DVT Prophylaxis: Incidence of deep-vein thrombosis (DVT) in stroke patients is comparable with that seen in patients undergoing a hip or knee replacement with multiple risk factors for DVT, like advanced age, low Barthel Index severity score, or hemiplegia[30]. As pulmonary embolism is found to be responsible for approximately 10% of deaths following an acute stroke, the prevention of this complication is of crucial importance[31,32]. Prospective trials have shown that early heparin treatment with low molecular weight heparin (LMWH) is effective in reducing DVT and pulmonary embolism in stroke patients[30,33]. Current guidelines recommend subcutaneous LMWH for DVT prophylaxis[31,32].

Endovascular management of acute ischemic stroke with large vessel occlusion:

Proximal occlusion of a major intracranial vessel accounts for roughly one-third of all anterior circulation acute ischemic strokes. Unfortunately, intravenous alteplase is successful at recanalization of these occluded arteries only one-third of the time.[34]Before 2015, randomized thrombectomy trials in this patient population used inefficacious thrombectomy devices and had long delays from onset to treatment, leading to poor outcomes and lack of support for this treatment modality. In 2015, 5 clinical trials using newer devices were published showing clear benefit of endovascular therapy in the treatment of acute ischemic stroke with a large vessel occlusion from 0 to 6 hours from symptom onset.[35-36] In these studies, patients eligible for IV alteplase before embolectomy were still treated with thrombolysis. The Highly Effective Reperfusion Using Multiple Endovascular Devices (HERMES) meta-analysis published in 2016 included patient-level data from these 5 trials for a total of 1287 patients.[37] For the primary outcome of mRS score reduction by 1 point at 90 days, the authors found a common odds ratio of 2.49 favoring intervention.[37] This equated to a number needed to treat of 2.6. Following the publication of these studies, endovascular treatment became the standard of care for this patient population. Box 2 outlines the inclusion criteria for such treatment when initiated within 6 hours from symptom onset.

Box 2 - Inclusion criteria for endovascular therapy from 0 to 6 hours from symptom onset:

Pre stroke RS of 0 to 1
Causative occlusion of the internal carotid artery or MCA segment 1 (M1)[a]
Age $\geq$ 18 years
NIHSS score of $\geq$ 6 Alberta Stroke Program Early Computed Tomography Score (ASPECTS) of $\geq$ 6
Treatment (groin puncture) can be initiated within 6 hours of symptom onset

[a]M1 is defined as the horizontal or sphenoidal segment of the MCA from the internal carotid terminus until the bifurcation.

Imaging studies required to determine eligibility for endovascular therapy include a noncontrast head CT and CT angiogram of the head and neck. CT perfusion (CTP) is not required. Some institutions may use MRI and magneticresonance angiography (MRA) based on their local accessibility to such imaging. The ASPECTS is a 10-point topographic score used to assess early ischemic stroke changes on noncontrast CT scans in patients with MCA occlusions.

Clinical use: An ASPECTS score less than or equal to 7 predicts a worse functional outcome at 3 months as well as symptomatic haemorrhage.

Posterior circulation: Variations of the ASPECTS scoring system have been described for use in the posterior circulation and referred to as pc-ASPECTS [38].

Thrombectomy Beyond 6 Hours:Eligibility for mechanical thrombectomy was broadened beyond 6 hours in 2018 following the publication of the DWI or CTP Assessment with Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurointervention with Trevo (DAWN) and Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke (DEFUSE 3) trials. Each of these trials used different methods to identify patients with a mismatch between infarcted tissue and ischemic penumbra, selecting patients most likely to benefit from late endovascular therapy.The following criteria are used for selection of patients for DAWN and DEFUSE – 3 trials :

Table 1: Inclusion criteria DEFUSE-3DAWN

Time window	6-16 hours since time last known well	6-24 hours since time last known well
Age	18-90 years	⩾18 years
mRS score before	≤2; life	≤1; life
qualifying stroke	Expectancy >6 months	Expectancy >6 months
NIHSS score	⩾6	⩾10 (see below)
Arterial occlusion	ICA and/or M1*	ICA and/or M1
Mismatch definition	Target mismatch profile on CT or MR perfusion imaging, as determined by an automated image post processing system: Infarct core volume <70 mL AND mismatch volume >15 mL (Tmax>6 s) AND mismatch ratio (penumbra/core) >1.8	Clinical-imaging mismatch Age <80 years and NIHSS score ⩾10 and infarct core 0-30 mL OR age <80years and NIHSS score ⩾20 and infarct core 31-51 mL OR age ⩾80 years and NIHSS score ⩾10 and infarct core 0-20 mL

*Carotid occlusions could be cervical or intracranial, with or without tandem MCA lesions in DEFUSE -3.

Based on CT perfusion or MRI diffussion.

The size of the penumbra was estimated from the volume of tissue for which there was delayed arrival of an injected tracer agent (time to maximum of the residue function (Tmax) exceeding 6s.ICA, internal cerebral artery; MCA, middle cerebral artery; mRS, modified Rankin Scale;

NIHSS, National Institues of Health Stroke Scale.

Neuroimaging for Diagnosis: The exact collection of correctable AIS is as significant as the management itself. The existing supports of assessment comprises of imaging technology, magnetic resonance imaging (MRI)/magnetic resonance angiography (MRA), counting computed tomography (CT)/CT angiography and digital subtraction angiography (DSA).

The following (box 3)neuro-imaging modalities are done for acute ischaemic stroke:

Box 3:Neuro-imaging modalities

Parenchyma		
Noncontrast CT	Fast acquisition time, widely available sensitive to hemorrhage	Limited sensitivity to infarct size, location of early ischemia
Diffusion-weighted MRI	Sensitive to early ischemia, fast acquisition time, high conspicuity of lesion	Lack of availability, patient contraindications (eg, metals, claustrophobia), long acquisition time
Vasculature		
CT angiography	Quantify vascular disease burden (eg, degree with stenosis, length of clot, characteristics of plaques), fast acquisition time	Potential renal toxicity, allergy to contrast agents, radiation exposure; provides no information on directly or velocity of flow
Magnetic resonance angiography	No contrast	Overestimates stenosis, sensitive to motion and other technical artifacts, long acquisition time, patient contraindications (eg, metal, claustrophobia)
Ultrasound (carotid or trans cranial Doppler)	Flow data, portable, low cost	User dependent, time consuming, technical constraints
Tissue Perfusion		
CT perfusion	Fast acquisition time	Potential renal toxicity, allergy to contrast agents, radiation exposure; qualitative
Magnetic resonance perfusion	Good spatial resolution	Qualitative; patient contraindications (eg, metals, claustrophobia), requires gadolinium
Positron emission tomography (PET)	Gold standard for cerebral blood flow measures, provides quantitative measures of physiologic parameters (oxygen extraction fraction and metabolism)	Requires multiple radiotracers with very short half-lives, thus impractical in acute settings; low resolution, limited availability

CT = computed tomography; MRI = magnetic resonance imaging.

Acute stroke unit and early complications: Guidelines recommend that everyone with acute ischaemic stroke is admitted directly to an acute stroke unit.[39] Stroke unit care has an number needed to treat of 17 to avoid death or disability, a benefit that is sustained over time without lengthening hospital stays.[40 41] Key features of the acute stroke unit include stroke-specific multidisciplinary care (physiotherapy, speech and language therapy, occupational therapy) and high nursing ratios.[42 43]Key functions of an acute stroke unit are the prevention of secondary brain insults by maintaining physiological homeostasis (table 2) and monitoring of neurological status.[44] The patient should also undergo bedside cardiac telemetry if atrial fibrillation has not been confirmed.

Table 2: Targets for maintaining homeostasis in acute ischaemic stroke patients

Variable	Target / intervention
Oxygen saturation	**Oxygen supplementation if saturation <95%**
Hydration	Assessed within 4 hours using multiple tools
Swallowing	**Screen for dysphagia with validated tool within 4 hours and before any oral intake (including medication)**
Plasma glucose	5-15 mmol/L
Blood pressure	**Not Target. Indication for treatment:**
► **Systolic BP ≥185 or Diastolic BP ≥110 mmHg**	
► **Hypertensive encephalopathy, nephropathy, cardiac failure or myocardial infarction**	
► **Aortic dissection**	
► **Pre-eclampsia/eclampsia**	

Adapted from National Clinical Guideline for Stroke 2016.[39]

The high incidence of dysphagia after stroke is a risk factor for aspiration pneumonia and is associated with increased mortality and disability.[45] Guidelines recommend that patients receive a bedside swallowing assessment and appropriate adaptation of oral intake to prevent aspiration.[46] Although there are no randomised studies to determine whether screening methods improve outcomes,[47] observational data suggest that delayed assessment is associated with a higher risk of aspiration pneumonia.[48] Prophylactic antibiotics have not proven effective.[49]

Non-ambulatory patients with ischaemic stroke are at high risk of deep vein thrombosis.[50] Prophylaxis with low-molecular-weight heparin is not recommended due to the risk of haemorrhagic transformation,[39] although some studies have shown no significant additional risk.[51] Intermittent pneumatic compression devices are effective (compared to compression stockings) at reducing the risk of deep vein thrombosis and are recommended for all nonambulatory stroke patients.[39 52]

There are many therapies available to reduce disability after acute ischemic stroke. When approaching a patient with symptoms consistent with acute ischemic stroke, the first step is to obtain a last known well time, an onset of symptoms time, and an NIHSS as the patient is taken for imaging. If the patient was last known well less than 6 hours before presentation, obtain a noncontrasted head CT to rule out intracranial hemorrhage, and CTA head and neck to assess for a large vessel occlusion. If the patient has a disabling deficit, normal glucose, and a last known well less than 4.5 hours, assess for alteplase candidacy. If the patient has disabling deficits, symptom onset time is unknown and has no contraindication to alteplase, obtain a rapid MRI brain to determine if there is a DWI-FLAIR mismatch and no hemorrhage to determine alteplase candidacy. If the patient is found to have a proximal large vessel occlusion, has an ASPECTS score ≥ 6 and an NIHSS ≥ 6, proceed to endovascular intervention. If, however, the patient is eligible for both alteplase and endovascular reperfusion, treat with alteplase first if it does not delay endovascular intervention. In patients with a last known well greater than 6 hours and less than 24 hours, obtain a non-contrasted head CT, CTA head and neck, and CT perfusion or rapidMRI brain with MRA head and neck to determine if a patient has a large vessel occlusion and is an endovascular candidate using the DAWN or DEFUSE-3 inclusion criteria.

Secondary Prevention: Secondary prevention focuses on preventing recurrence of cerebrovascular events. Hypertension is a major correctable risk factor for stroke. Treatment of hypertension has been shown to reduce the incidence of primary and secondary strokes[53]. A reduction in diastolic BP of 5 mm Hg is associated with one third lower risk of stroke[54]. There is a high risk of recurrence of transient ischemic attacks and minor ischemic strokes due to atherosclerotic intracranial arterial stenosis and lacunar strokes[55,56]. Dual anti-platelets, like aspirin with clopidogrel, may be necessary in some patients[55,56]. If no contradictions are present, ischemic stroke/ transient ischemic attack patients with atrial fibrillation are anti-coagulated long-term with warfarin or a newer oral anticoagulant[57]. Identification of an aortic atheroma may prompt therapy with aspirin, statins and/ or anticoagulation to prevent recurrent strokes[58,59]. Using statins in such patients decreases the likelihood of a subsequent stroke[60]. Patients with an ejection fraction of < 30% and a predicted 5 year survival tend to do better if anti-coagulated[60]. The timing for starting anticoagulation is individualized to each patient and is dependent on size of the ischemia, etiology of the ischemia, and other risk factors.

Rehabilitation: All stroke patients require a bedside dysphagia screen[61,62]. In case of ongoing aspiration, a percutaneous gastrostomy is recommended. Lastly, an evaluation by physical and occupational therapists is necessary for disposition for rehabilitation.

Early mobilization is thought to be of great importance in order to maximize functional recovery and independence after

AIS. Animal models have shown that neuroplasticity and cortical reorganization, promoting functional improvement, peak 7–14 days after stroke and last for about 1 month[63]. Early rehabilitation is thought to enhance further this dynamic poststroke phase and help patients to gain compensatory mechanisms for remaining disabilities. Data show that even in ICU patients, early rehabilitation and intensity of rehabilitation sessions were associated with a better functional outcome[64].

Outcomes:

Modified Rankin Scale

1. No symptoms
2. No significant disability. Able to carry out all usual activities, despite some symptoms.
3. Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities.
4. Moderate disability. Requires some help, but able to walk unassisted.
5. Moderate severe disability. Unable to attend to own bodily needs without assiatance, and unable to walk unassiasted.
6. Severe disability. Requires constant nursing care and attention, bedridden, incontinent.
7. Dead

The modified Rankin Scale (mRS) is a valid measure of disability and defines 6 grades of disability as demonstrated in Table 3[65]. A scale of 0-2 indicates mild disability; a scale of 3 indicates moderate disability; scores of 4 or 5 indicate severe disability; and a score of 6 denotes death[65,66]. It is employed to assess recovery from stroke after rtPA. A score of 0 or 1 at 3 month follow-up is considered a favorable outcome, whereas a score of 2-6 represents an unfavorable outcome[67]. The scale is found to have satisfactory inter-rater agreement and is widely used as an outcome parameter in clinical trials of stroke treatments[65,68].

Conclusion:

Management of acute ischemic stroke is time dependent. Efficient and effective stroke care depends on a well functioning team from the emergency room to the neurologist and the interventional neurologist. Accurate diagnosis, emergent management to stabilize the patient and correct choice of imaging can make a lot of difference in the outcome of a patient. Every minute lost in wrong imaging or lab test results in decrease in functional outcome and ultimately irreversible paralysis. Success of stroke treatment is dependent on the entire team working smoothly and efficiently. As the times evolve, more and more centres will come up with dedicated stroke teams just like cardiologistsmanage acutemyocardial infarction. Although future of stroke care is bright, two major roadblocks persist like public awareness and hospital competence.

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