وزارة الصحة
Ministry of Health

رؤية عُمان 2040
Oman Vision

National Acute Stroke Management Protocol

Second Edition/2025

Sultanate of Oman

Ministry of Health

Directorate General of Khoula Hospital

Department of Neurology and Stroke Unit

APPROVED DOCUMENT

وزارة الصحة
Ministry of Health

Document Title	National Acute Stroke Management Protocol
Document Type	Protocol
Directorate/Institution	Directorate General of Khoula Hospital
Targeted Group	Health-Care Providers
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Release Date	October 2025
Review Frequency	3 years

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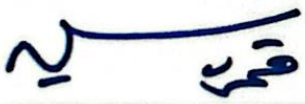
Signature		Signature	
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Disclaimer

This document was developed by the national stroke protocol taskforce committee to outline the main management of acute stroke patients presenting to healthcare institutions of all levels across the Sultanate of Oman.

The information presented is only intended for clinical guidance of health care providers. It should not replace the treating physician's judgment.

Stroke care across all healthcare institutions in Oman is regulated by the Ministry of Health.

Abbreviations

ACA	Anterior cerebral artery
ANA	Antinuclear Antibodies
ANCA	Antineutrophil Cytoplasmic Antibodies
aPTT	Activated Partial Thromboplastin Time
ASA	Acetylsalicylic Acid (Aspirin)
ASU	Acute stroke unit
AV	Arteriovenous
B2M	Beta-2 Microglobulin
BID	Bis In Die (twice daily)
BP	Blood Pressure
CBC	Complete Blood Count
CPP	Cerebral Perfusion Pressure
CBV	Cerebral Blood Volume
CME	Continuing Medical Education
CNS	Central nervous system
CRP	C-reactive protein
CSF	Cerebrospinal fluid
CT	Computed Tomography

CTA	Computed Tomography Angiography
CTV	Computed Tomography venography
CVT	Cerebral Venous Thrombosis
CXR	Chest X-ray
DC	Decompressive Craniectomy
DVT	Deep Vein Thrombosis
ED	Emergency Department
ECG	Electrocardiogram
EMS	Emergency Medical Services
ESR	Erythrocyte Segmentation Rate
FFP	Fresh Frozen Plasma
GCS	Glasgow Coma Scale
Hb	Hemoglobin
HD / HDU	High Dependency Unit
HTN	Hypertension
ICA	Internal Carotid Artery
ICH	Intracranial Hemorrhage
ICU	Intensive Care Unit
ICP	Intracranial pressure

IM	Intramuscular
INR	International Normalized Ratio
IV	Intravenous
IVH	Intraventricular Hemorrhage
LMWH	Low Molecular Weight Heparin
MCA	Middle Cerebral Artery
MRA	Magnetic Resonance Angiography
MRI	Magnetic Resonance Imaging
MRV	Magnetic Resonance Venography
MT	Mechanical Thrombectomy
Na	Sodium
NGT	Nasogastric Tube
NIHSS	National Institute of Health And Stroke Scale
NOACs	Novel Oral Anticoagulants
NPO	Nil Per Oral
OD	Once Daily
PCA	Posterior Cortical Atrophy
PCC	Prothrombin Complex Concentrate
pCO2	Partial Pressure Of Carbon Dioxide

PICA	Posterior Inferior Cerebellar Artery
PT/PTT	Prothrombin/ Partial Thromboplastin Time
QID	*Quater In Die* (4 Times A Day)
ROSIER	Recognition Of Stroke In The Emergency Room
RFT	Renal Function Test
rt-PA	Recombinant Tissue Plasminogen Activator
SC	Subcutaneous
STEMI	ST Elevation Myocardial Infarction
STAT	*Statum* (Immediately)
TEE	Transesophageal Echocardiography
TIA	Transient Ischemic Attack
TID	*Ter In Die* (3 Times A Day)
U	Units

Definitions

Ischemic Stroke

An episode of sudden neurological dysfunction caused by focal cerebral, spinal, or retinal infarction.

Intracerebral Hemorrhage (ICH)

A focal collection of blood within the brain parenchyma or ventricular system that is not caused by trauma.

Stroke caused by Intracerebral Hemorrhage

Rapidly developing clinical signs of neurological dysfunction attributable to a focal collection of blood within the brain parenchyma or ventricular system that is not caused by trauma.

Stroke caused by Cerebral Venous Thrombosis

Infarction or hemorrhage in the brain, spinal cord, or retina because of thrombosis of a cerebral venous structure. Symptoms or signs caused by reversible edema without infarction or hemorrhage do not qualify as stroke.

Transient Ischemic Attack (TIA)

A transient episode of neurological dysfunction caused by focal brain, spinal cord, or retinal ischemia without infarction.

Thrombolytic/Fibrinolytic Therapy

The administration of a drug agent that converts plasminogen to the natural fibrinolytic agent Plasmin. Plasmin lyses clots by breaking down the fibrinogen and fibrin contained in a clot and potentially restoring vascular flow.

Mechanical Thrombectomy

The removal of a thrombus from a blood vessel, performed as an emergency interventional endovascular procedure to restore cerebral circulation using stent retrieval, aspiration technique or both.

Hyperacute Stroke Care

The interventions involved in the assessment, and management in the early hours after ischemic stroke onset. This includes thrombolysis or endovascular interventions and emergency neurosurgical procedures.

Acute Stroke Care

The interventions involved in the assessment and management, and early recovery in the first days after stroke onset. The aims are to identify the nature and mechanism of stroke, prevent further stroke complications, promote early recovery, and provide palliation or end-of-life care.

Stroke Rehabilitation

A progressive, dynamic, goal oriented process aimed at enabling a patient with neurological impairment to reach their optimal physical, cognitive, emotional, communicative and/or social functional level.

Decompressive Craniectomy

A surgical technique used to relieve increased intracranial pressure and brain tissue shifts that occur in the setting of large cerebral hemisphere mass, or space-occupying lesions or massive cerebral or cerebellar infarction (e.g. malignant MCA territory infarction).

Stroke Unit

An organized in-hospital facility that is devoted to care for patients with stroke, staffed by a multidisciplinary team with special expertise in stroke care.

Telestroke

A network of audiovisual communication and computer systems, which provide the foundation for a collaborative, interprofessional care model focusing on acute stroke patients.

Introduction

All acute stroke patients should be managed as a time-critical emergency. Standardization of management is essential in order to ensure universal care and the best possible outcomes for affected patients. The protocols enclosed within this document target healthcare institutions and focus on care that is required from the time of initial hospital presentation. The aims are to provide standardized management and to promote a platform for inter-hospital collaboration. The protocols mainly follow algorithms that start from arrival at the emergency department until the final disposition from hospital.

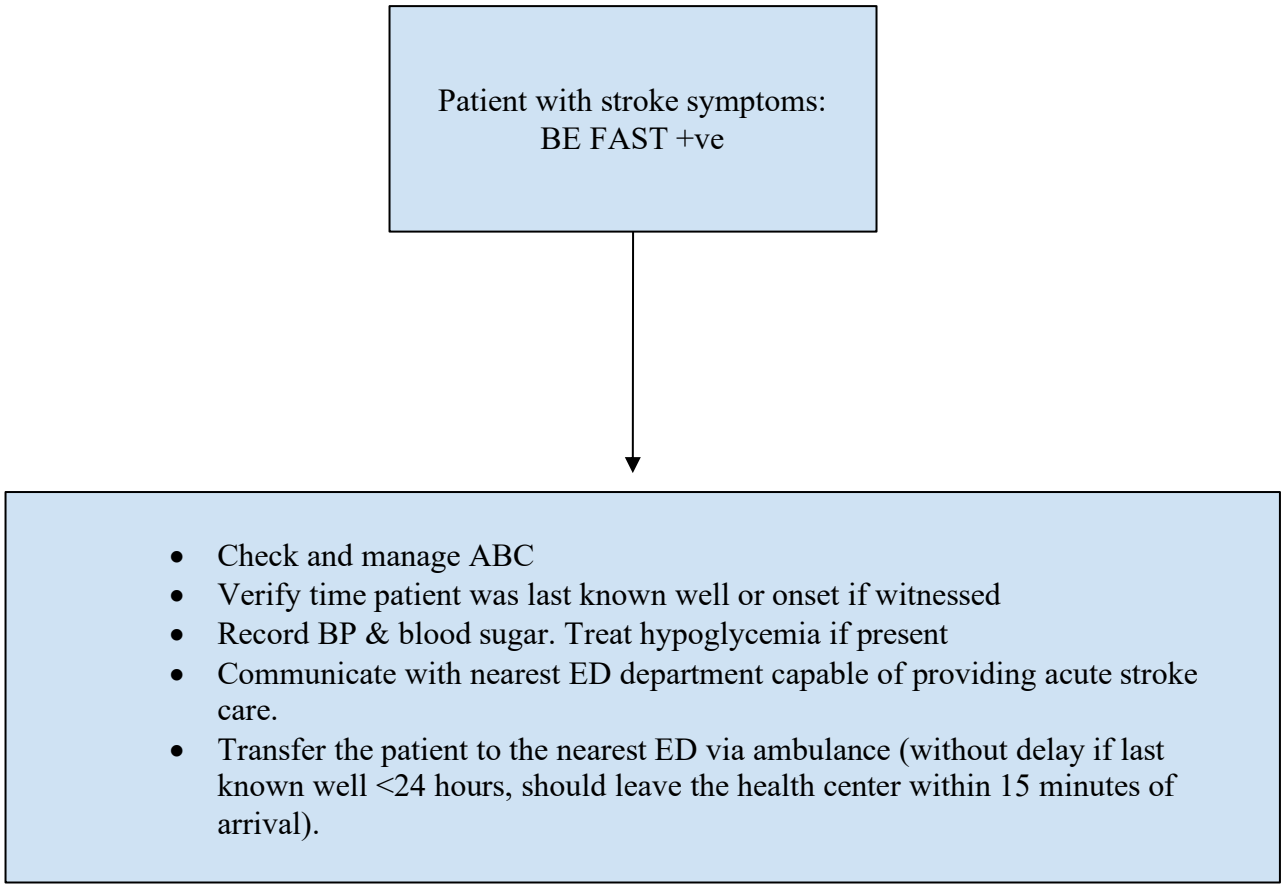
The document includes the following protocols:

- Emergency Department Protocol
- Neuroimaging Protocol
- Intravenous Thrombolysis Protocol
- Mechanical Thrombectomy Protocol
- Intracerebral Hemorrhage Protocol
- Acute Ischemic Stroke Protocol (not candidates for thrombolysis or thrombectomy)
- In-hospital Stroke Protocol
- Inter-Facility Transfer Protocol
- Tele-stroke protocol
- Stroke centers in Oman and referral network protocol
- Stroke Rehabilitation Protocol

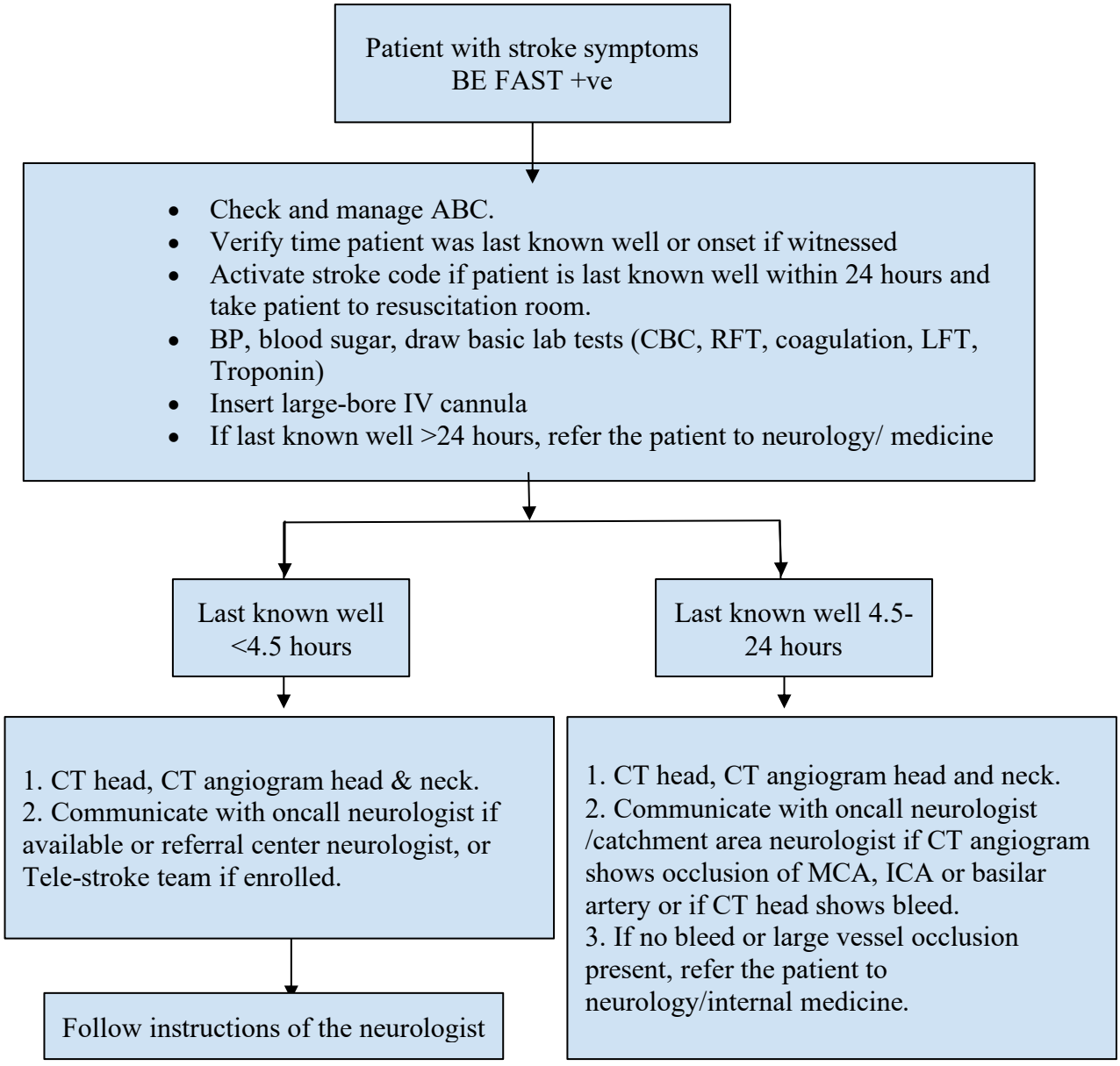
The document does not address pediatric stroke, management of subarachnoid hemorrhage and detailed surgical treatments .

The algorithm on page 17 describes the flow of the protocols.

Stroke Work-flow Algorithm for Primary Healthcare Centers and Hospitals lacking CT scanner
(Acute Stroke Not Ready Centers)

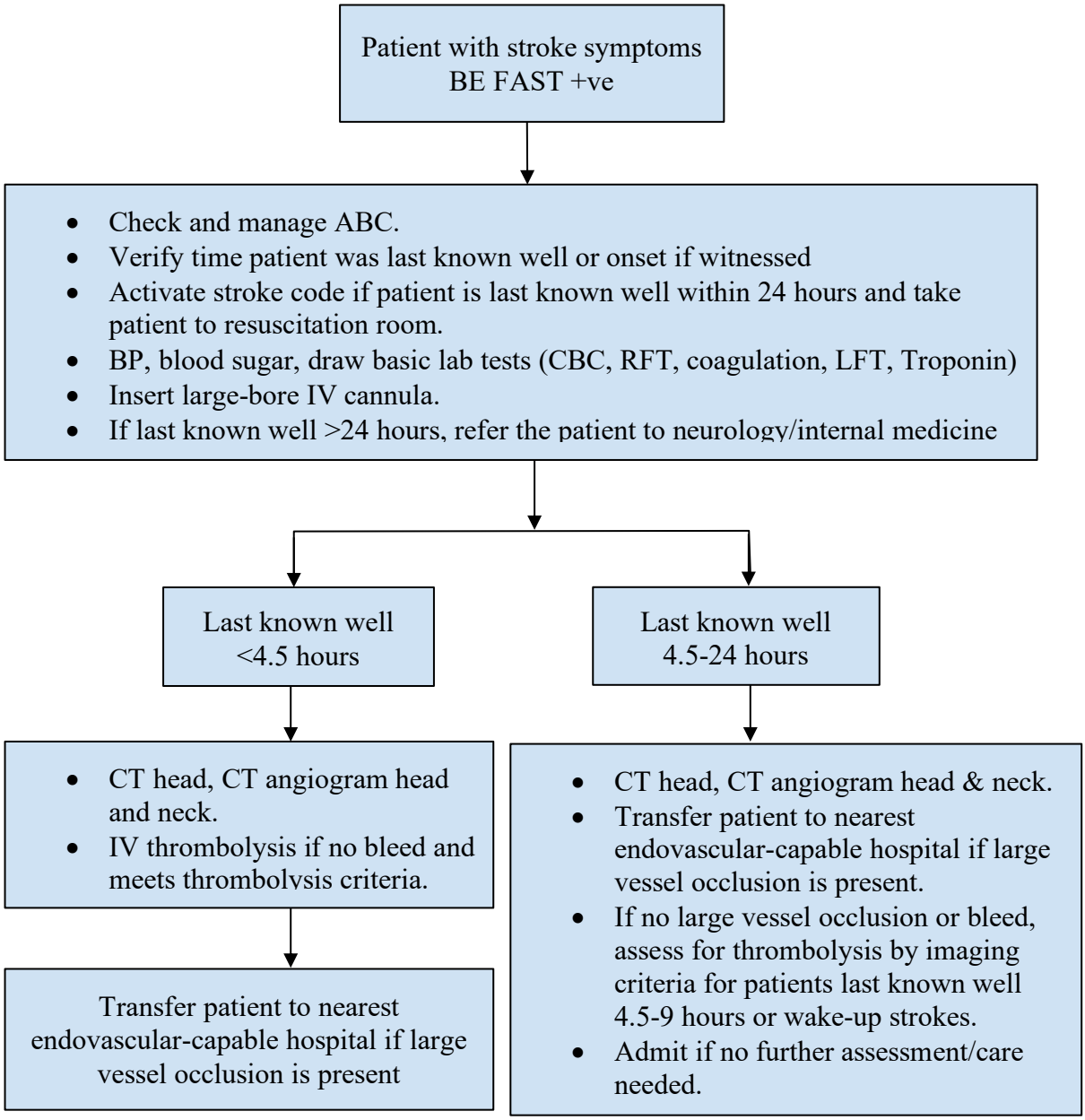


Stroke Work-flow Algorithm for Acute Stroke Ready Hospitals (can administer IV thrombolysis via tele-stroke but lack dedicated neurology service)



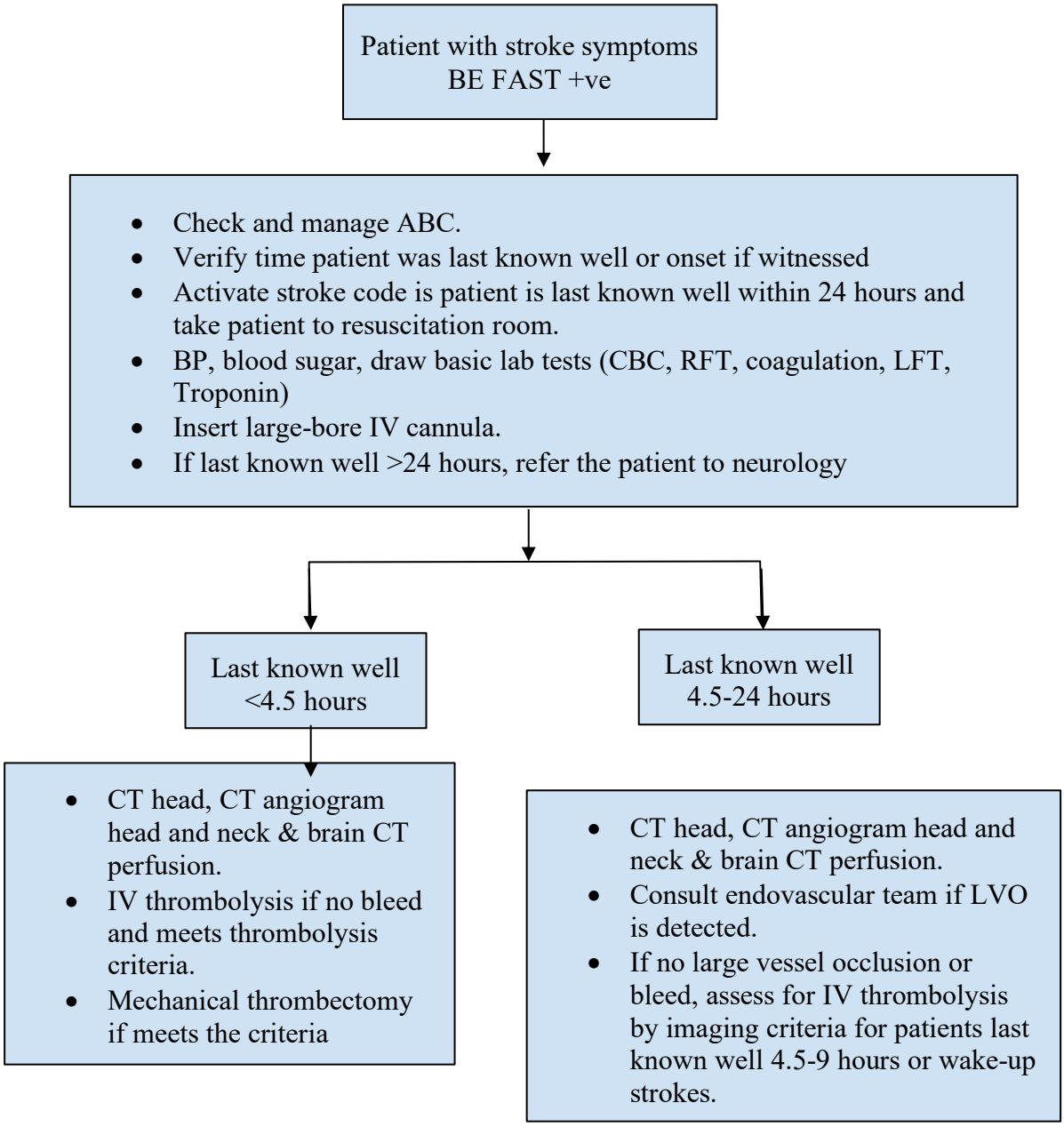
Document the following:
Last known well, Time of arrival to ED
Blood sugar & BP, NIHSS
Time of first slice CT head, Time the call to Neurologist, Time IV thrombolysis bolus
Time of leaving the hospital if transferred to higher level of care

Stroke Work-flow Algorithm for Hospitals with Stroke Units but Not Capable of Endovascular Treatment



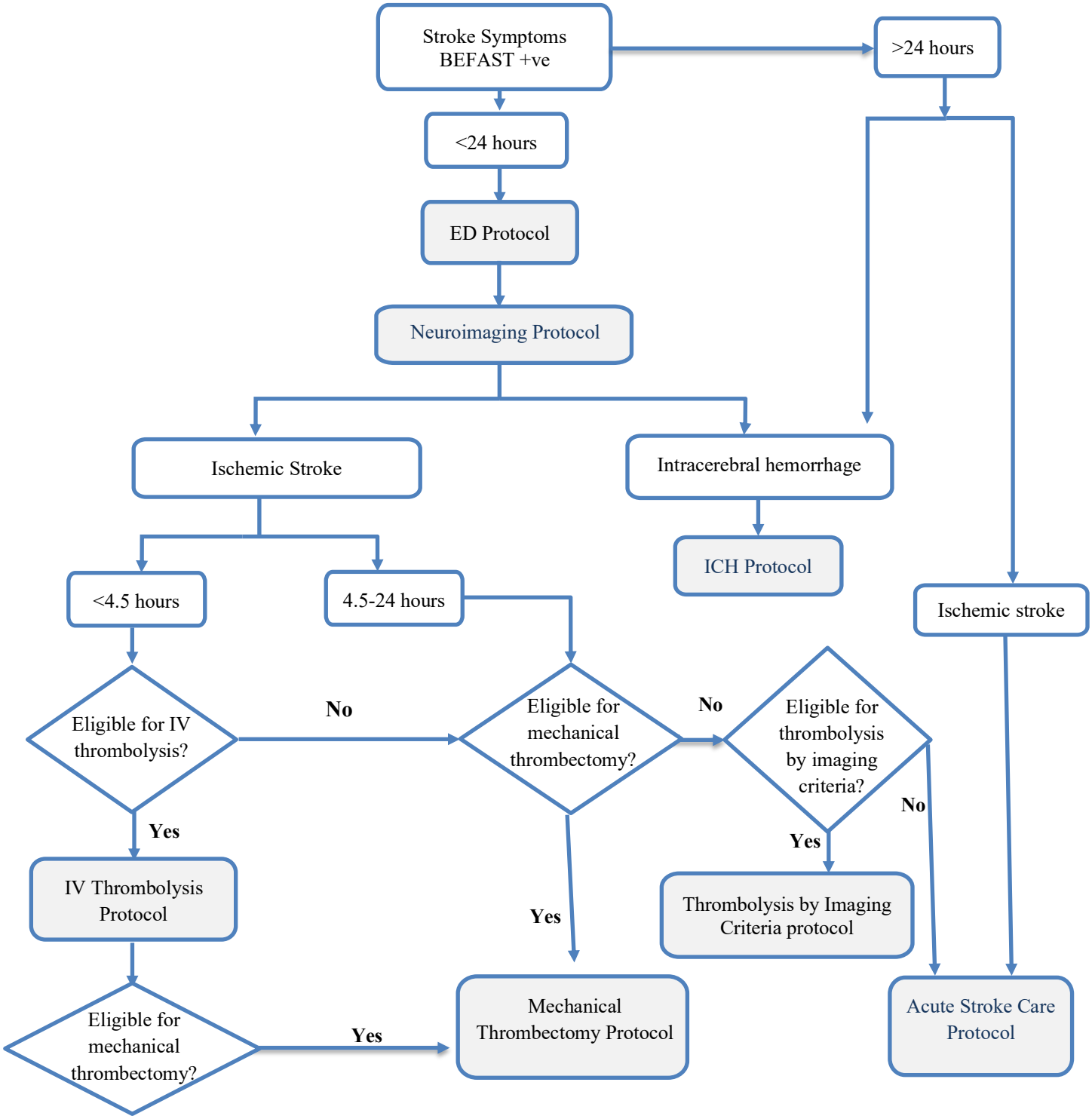
Document the following:
Last known well, Time of arrival to ED
Blood sugar & BP, NIHSS
Time of first slice CT head, Time to call the Neurologist
Time IV thrombolysis bolus, Time of leaving the hospital if transferred to higher level of care

Stroke Work-flow Algorithm for Endovascular-Capable Stroke Hospitals



Document the following:
Last known well, Time of arrival to ED
Blood sugar & BP, NIHSS
Time of first slice CT head, Time to call the Neurologist
Time IV thrombolysis bolus
Time of groin puncture, Final reperfusion score (TICI), number of passes, time at successful reperfusion (TICI 2B or better)

General Acute Stroke Management Protocols Algorithm



Emergency Department Protocol

1. At Triage

- A patient presenting with any of the following symptoms should be considered having a potential stroke:
    - Sudden numbness or weakness of face, arm or leg, especially on one side
    - Sudden confusion, trouble speaking or understanding
    - Sudden trouble seeing in one or both eyes
    - Sudden trouble walking, vertigo, loss of balance or coordination
    - Sudden, severe headache with no known cause

- Patients should initially undergo an immediate finger prick blood glucose level testing. Readings < 3.5 mmol/l should be urgently corrected to normal prior to proceeding with ED Stroke Protocol
- The Triage Nurse / Doctor must immediately determine the timing of symptoms onset (if stroke onset time is unknown, presume <24 hours).
- The Triage Nurse / Doctor should apply the “BE FAST” stroke scale. B: balance problems, E: disturbed vision in one or both eyes, F: facial droop, A: arm or limb weakness. S: speech disturbance and T: time of onset/last known well”
- Patients are deemed potentially eligible for acute reperfusion treatment if:
    - BE FAST scale is positive in 1 or more points (or stroke is suspected on other clinical grounds)
    - Timing of symptoms onset is ≤ 24 hours
- The patient must be triaged as “level 2” red category.
- The senior ED doctor must be immediately notified and the patient transferred to a resuscitation bed

2. At the Resuscitation Area

The senior Emergency Department Doctor and Nurse must perform the following:

- Immediate evaluation and stabilization of airway, breathing, and circulation.
- Rapid assessment to confirm stroke symptoms and exclude stroke mimics.
- Confirmation of eligibility for reperfusion therapy after ruling in stroke.
- If the patient is confirmed to be eligible then **Code Stroke** should be immediately activated (If no response within 5 minutes, contact the Neurology on-call directly or Internal Medicine on-call if no dedicated Neurology on-call service is available in the facility).
- Assessment should include heart rate and rhythm, blood pressure, temperature, oxygen saturation, and presence of seizure activity.
- Oxygen supplementation if spO2<94%. (Target oxygen saturation > 93%).
- Ensure emergent CT brain scans are arranged.
- Insert large bore IV (minimum 18 Gauge) in each cubital vein (two required).
- Venesection and arrange URGENT bloods: Complete blood count (CBC), Renal function test, Glucose, Liver function test, Coagulation profile, Troponin.
- A 12 lead ECG can be obtained after the CT scans if no chest pain is evident clinically (should not delay CT scan).
- Place the weight board card scale under the patient upon arrival to the resuscitation room and document the estimated weight. If the weight board is not available, estimate the weight according to the available measures.
- If the patient is received via EMS or as a transfer from another hospital facility, the ED team should take the handover report of the following information: initial presentation and symptoms, time and place, initial vitals, blood sugar, and blood pressure, any stroke assessment scales applied, medications given, any change of patient condition/vitals while transfer and if any thrombolytic therapy was given.
- Hospitals not licensed to give IV thrombolysis independently should refer to the next available resource: telestroke or interhospital transfer.

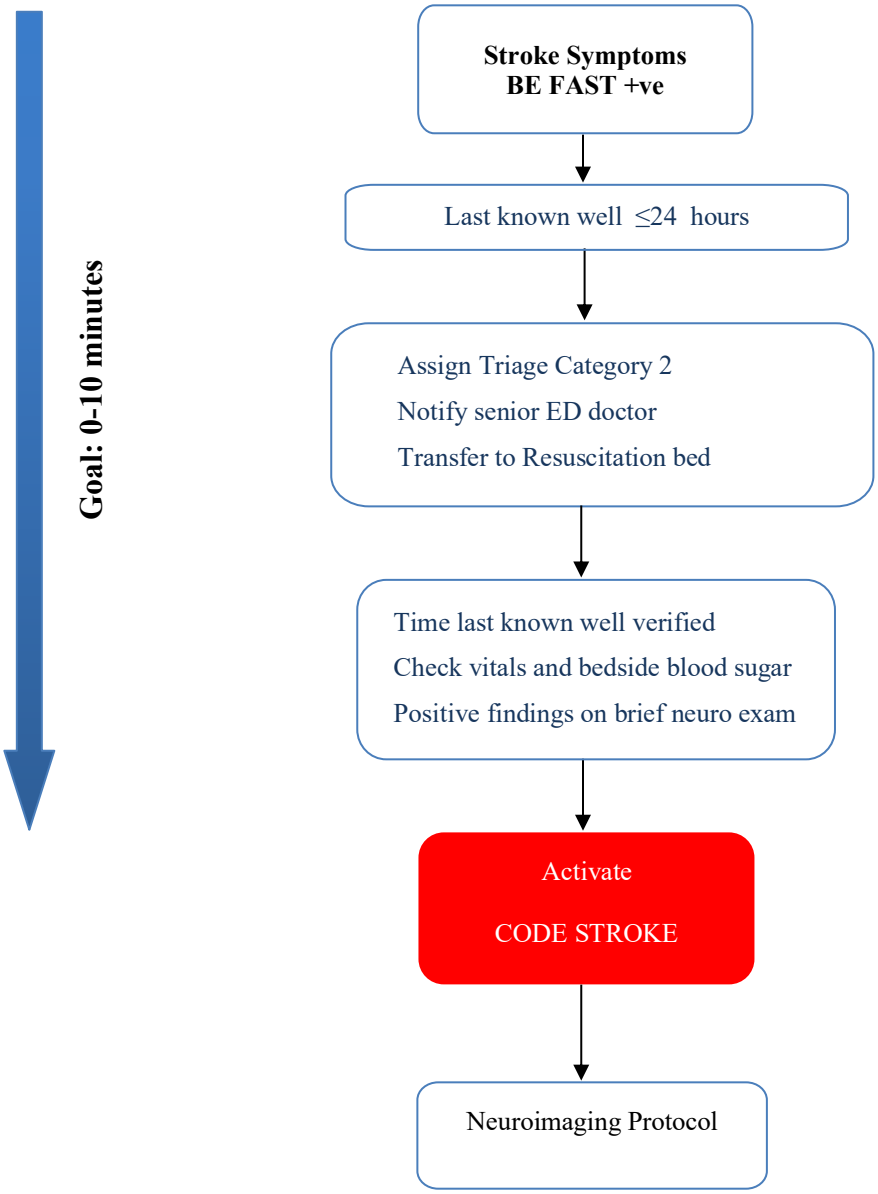
3. Code Stroke

- The protocol recommends that a code stroke team is available 24/7 and that a roster of providers is available to relevant hospital staff. The following are included in the code stroke activation:
    - On-call Neurology/Internal Medicine: should call back the ED and rush to the ED.
    - CT technologist: Should call ED for the patient immediately to the CT room.
    - Radiology on-call: Should rush to CT room immediately.
    - ED nurse in-charge: Should rush to the Resuscitation Area.
    - Stroke nurse: Should call back and rush to the ED.
    - Bed manager: Should call back ED and arrange a bed.

4. Target Times

- Target Initial medical assessment to be completed in the first 10 minutes
- Target Door – Brain CT: < 25 minutes
- Target Door – needle: < 45 min (for IV thrombolysis)
- Target Door – arterial puncture: < 60 min (for Mechanical Thrombectomy – if eligible)
- Target Door-out for inter-hospital transfer: <60 minutes of patient arrival.

Emergency Department Acute Ischemic Stroke Algorithm



Emergency Doctor & Nurse responsibilities:

Assess vital signs and resuscitate
Ensure emergent CT brain arranged
Insert two large bore IVs
Arrange URGENT blood tests

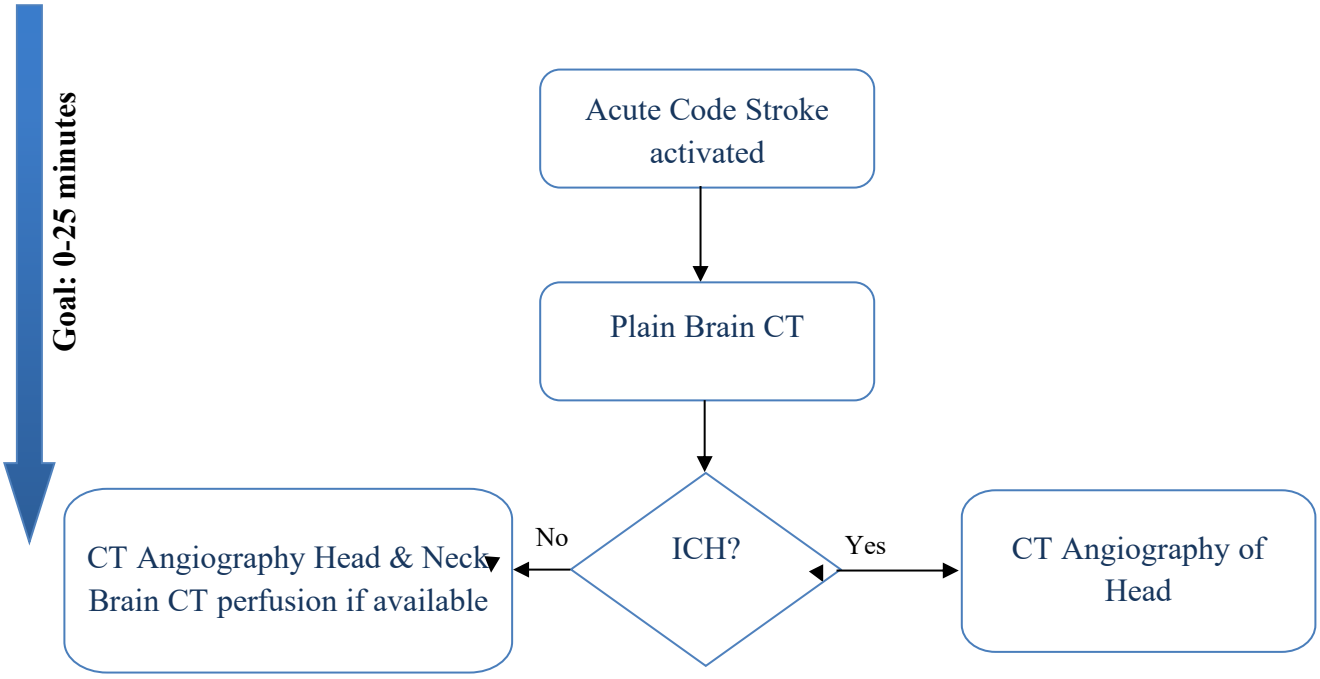
Neuroimaging Protocol

- Brain CT is indicated within 24 hours from onset of stroke symptoms for all patients presenting with symptoms and or signs of acute stroke. Brain CT should still be performed if time is uncertain, e.g. “wake-up” stroke, unwitnessed stroke, etc. Unwitnessed or unknown onset of symptoms is considered a stroke within 24 hours.
- After code stroke activation, the CT technologist and radiologist should head to the CT room immediately.
- The CT requested from the ED should encompass three studies: Plain CT of the brain, CT angiography of the head and neck starting from the aortic arch and CT perfusion of the brain if available.
- Multiphasic CT angiography can be done if CT perfusion is not available.
- CT technologist notifies the ED to shift the patient to the CT suite.
- The patient must arrive at the CT suite accompanied by the ED doctor, ED nurse, medical orderly and neurologist/physician. The ED doctor should be ready to give sedation in uncooperative patients.
- The ED nurse should take the medications-set that include IV antihypertensives, IV sedatives and IV thrombolytic agents.
- Plain CT is performed first then CT angiography of the head and neck from the aortic arch to the vertex and if no bleed is identified then CT perfusion of the brain if available is performed.
- The CT technologist will process the CT angiography of the head and neck and CT perfusion maps.
- The radiologist must call the neurologist/physician /ED physician with the results of the imaging within 10 minutes of study completion. The neurologist/physician/ED physician should follow up with the radiologist actively.
- Neurologist/physician should contact the interventional neuroradiologist once a potentially eligible patient for mechanical thrombectomy is identified even before the results of the imaging (refer to inclusion criteria).
- If subarachnoid hemorrhage or intracerebral hemorrhage is observed, a CT angiography of

the head should be performed to determine the presence of underlying vascular pathology (e.g. aneurysm or vascular malformation) in patients where the apparent etiology is uncertain.

- If cerebral venous thrombosis is suspected, CT venography (CTV) should be done if there is no contraindication for the contrast study. MRV may also be considered.
- All patients who receive IV thrombolysis and /or mechanical thrombectomy should have a repeat plain CT of the brain after 24 hours or earlier if clinical deterioration.
- Pregnant women or women of childbearing age should have abdominal shield cover when undergoing CT scanning. Female patients with known pregnancy status maybe considered for hyperacute MRI protocol which includes the following sequences: DWI, ADC, FLAIR, SWI/GRE and TOF MRA of head and neck. If MRI is not readily available, CT and CT angiography/venography should not be withheld.

Stroke Neuroimaging Algorithm



IV Thrombolysis Protocol

Time Window: 0-4.5 hours

This protocol applies to the use of IV thrombolysis. Currently, two IV thrombolytic agents: IV rt-PA (Alteplase) and IV Tenecteplase (TNK) are approved and are evidence-based for acute ischemic stroke thrombolysis. Either of them can be used, preferably IV Tenecteplase when available. If both are unavailable, it is important to communicate with the stroke neurologist to evaluate the potential use of Reteplase. See appendix and checklist for full list of indications and contraindications.

Eligible healthcare providers who can decide on IV thrombolysis for acute ischemic stroke patients are:

- Consultant neurologists
- Senior specialist neurologists
- Specialist neurologists
- Senior neurology residents (post-graduate year 4 and 5)

Medical officers, junior neurology residents, non-neurology residents, and non-neurologists doctors (ED, internal medicine) can administer IV thrombolysis after consultation with neurologists at level of specialist and above either via tele-stroke or telephonic consultation and a clear documentation in patient's chart is made to reflect the decision was made and/or approved by a neurologist (specialist or higher).

1. **Indications:**

- Diagnosis of acute ischemic stroke causing major neurological deficits.
- NIH stroke scale score of 5 or more, or disabling deficits if less than 5.
- Symptoms onset/last known well within 4.5 hours. Refer to thrombolysis using imaging criteria for thrombolysis 4.5-9 hours and wake-up/unwitnessed onset.
- CT head shows no bleed.
- Age 18 years or older. IV thrombolysis can be considered for patients younger than 18 years of age, in consultation with consultant stroke neurologist.

2. **Contraindications:**

- CT head shows intracranial bleed.

- CT head shows established large infarct (more than ⅓ of middle cerebral artery territory).
- History of intracranial hemorrhage.
- Extremely elevated BP (SBP>185 mmHg or DBP>110 mmHg) that is unresponsive to aggressive treatment.
- History of active or recent bleeding within 3 weeks.
- History of gastrointestinal or genitourinary bleeding in the past 3 weeks.
- Major surgery in the past 2 weeks.
- Significant head injury or history of brain or spine surgery in the past 3 months.
- History of ischemic stroke in the past 3 months.
- Hypoglycemia (blood sugar <2.8 mmol/L), correction of low blood sugar should take place first and blood sugar rechecked after 5 minutes and if symptoms persist despite normalization of blood sugar, then be considered a stroke, not mimic.
- Pregnancy (relative contraindication). Thrombolysis of pregnant women can be considered in consultation with consultant stroke neurologist.
- Rapidly resolving symptoms. If the patient still has disabling symptoms despite improvement from initial severe or moderate symptoms, thrombolysis should be considered.
- Arterial puncture in non-compressive site in the past 7 days.
- Intracranial intra-axial neoplasm.
- Brain aneurysm larger than 1 cm in maximum diameter. Vascular malformation of the brain or spine like arteriovenous malformation, cavernous malformation, or dural arteriovenous fistula.
- Coagulopathy; platelet count <100K, abnormal aPTT or INR>1.7. IV thrombolysis should not be delayed to wait for the results of the lab tests unless the patient is taking warfarin or known to have a history of coagulopathy (e.g. liver disease).
- Intake of non-vitamin K oral anticoagulant (NOAC) in the past 48 hours.
- Intake of therapeutic-dose low molecular weight heparin in the past 24 hours.
- In case of IV heparin use, check aPTT, if normal, can administer thrombolysis.
- Known allergy to thrombolytic agents (tPA or TNK) from previous use.
- Known or suspected infective endocarditis or aortic dissection.

- History of lumbar puncture in the past 6 hours.
- Seizure at the onset of symptoms (Relative contraindication). If stroke symptoms persist, thrombolysis should be considered.

At the ED resuscitation (or CT suite): the Neurologist/Internal Medicine physician and Stroke Nurse must perform the following. It is essential that these steps are carried out in parallel:

- Confirm history with patient and / or EMS, family, witnesses or general practitioner with particular reference to stroke onset time, medical history, advance care directive and medications.
- Perform neurological exam and calculate National Institute of Health Stroke Scale (NIHSS).
- Complete the checklist of inclusion/exclusion criteria for intravenous thrombolysis.
- Identify any potential bleeding sources.
- Assess vital signs every 15 minutes.
- Ensure ED doctor / Nurse responsibilities are completed.
- Obtain and document all results (i.e. ECG, blood tests, vital signs).
- Assist and supervise patient during transfer to CT suite.
- Review CT brain with radiologist to rule out hemorrhage, major hypodensity or other lesion that would contraindicate IV *thrombolytic* therapy.
- Ensure the hospital bed manager has arranged an ICU or stroke unit bed.
- Obtain verbal consent for IV *thrombolysis*. If the patient is not able to consent and no family is around, document clearly in the chart that IV thrombolysis was given in the best interest of the patient due to lack of ability to obtain consent.
- Immediately discuss with stroke/neurology consultant (If certain that benefit to harm ratio favors thrombolysis, administer as per Thrombolysis Protocol).
- Ensure eligibility for endovascular intervention (refer to Mechanical Thrombectomy protocol).
- Lower BP to below 180/105 mm Hg, before administering IV thrombolysis and ensure stabilization of BP level below this range during and after IV *thrombolysis*.
- If large vessel occlusion was detected on CT angiography, keep the head of the bed at 0

degree, if no contraindication, while awaiting the procedure.

- Correct hypotension with IV fluids and vasopressors aggressively.
- Counsel the patient and the family.
- IV *thrombolysis* administration should not be delayed for urinary catheterization, NGT insertion or other bedside procedures.

3. Informed Consent

Whilst written consent is not required for IV *thrombolysis* therapy, every effort possible should be made to contact the patient's legally authorized representative (next of kin or close family members) in order to advise them of the risks and benefits involved and obtain proxy consent but this should not delay IV thrombolysis if they are not available physically and no easy phone contact is possible. A physician's note documenting explicit discussion in a consent conversation is acceptable. In an emergency, when the patient is not competent and there is no available legally authorized representative to provide proxy consent, it is both ethically and legally permissible to proceed with IV thrombolysis. A documentation of the verbal consent must be entered into the patient's chart in the hospital electronic medical record system.

A sample template on how the information is given to the patient or family member about the IV thrombolysis for acute ischemic stroke:

"It appears that you are (your family member is) suffering from a stroke. Stroke is caused by a blockage in one of the blood vessels in the brain. There is a medication we can give that can potentially dissolve this blockage and improve the symptoms. This medication -called TPA/alteplase or TNK/tenecteplase (depending on what is available at the facility)- is a powerful clot-busting medication. Many people who receive this medication see their stroke symptoms improve. However there are some risks. There is a small chance that it could cause bleeding in any part of the body including in the brain. In rare cases, this bleeding can be severe, even fatal. Like any medication, it also carries a very small risk of allergy. Nevertheless, if we do not give the medication, the blockage in the brain will likely remain and the symptoms will persist or even become worse. I recommend that we give you (your family member) the medication, despite the risks we discussed, as the benefits are far more than the risks. This recommendation is in accordance with national and international guidelines. This medication has to be given immediately to prevent further brain damage from the stroke as studies showed that the faster the medication is given, the chances of improvement are higher and risk of bleeding is less. We will go ahead with this recommendation if you do not object. Please confirm that you understood and you agree with this plan.''

4. Blood Pressure

- Very high blood pressure should be treated to a target of below 180/105 mmHg before IV thrombolysis can be initiated. The agents of choice are:
    - Labetalol 10 mg IV over 1 minute, may repeat every 5 to 10 minutes (may repeat once or twice)
    - If the patient requires more than 1 bolus of labetalol, start antihypertensive infusion (either nicardipine or labetalol). Nicardipine is the preferred antihypertensive infusion. Nicardipine infusion is started at 5 mg/hour and up-titrated every 5 minutes by 2.5 mg/hour for a maximum dose of 15 mg/hour.
    - Hydralazine 10 mg to 20 mg IV, may repeat every 15 minutes (may repeat once or twice), used as the first line if heart rate is less than 65 per minute.
- It is important to ensure that the patient should not become hypotensive.

5. Blood Glucose Management

- Hypoglycemia should be corrected emergently with 50 ml of either 25% or 50% IV Dextrose.
- Hyperglycemia > 10 mmol/l (180 mg/dl) should be treated with Insulin.
- Insulin sliding scale as per hospital local protocol (supplements appendix) should be followed routinely for all cases of acute stroke with hyperglycemia.

6. IV Thrombolysis Administration:

IV Tenecteplase (TNK)

- The following steps must be followed to prepare TNK:
    - TNK is supplied as a white powder containing 25 mg in a clear glass vial with diluent solution (sterile water). The vial is reconstituted with diluent using the 5 ml transfer syringe and needle provided. Use the 5 ml syringe to transfer 5 ml of sterile water from the provided sterile water vial to the TNK vial.
    - It should be reconstituted to a concentration of 5 mg/ml using only the diluent (sterile water for injections) provided for reconstitution. Dissolving the powder should be by gentle swirling to prevent excess foaming. It should not be shaken to avoid excessive foaming. Foaming is expected to occur and will reduce if the vial is

kept on the surface. if there is a form, leave it to settle, and make sure all the powder has dissolved. Do not inject undissolved powder.

- The indicated dose is 0.25 mg/kg of the patient's estimated weight to a maximum dose of 25 mg. Draw the calculated dose in a 5 ml syringe noting that 1 ml carries 5 mg of TNK. The entire dose is administered as an intravenous bolus over 5-10 seconds preceded and followed by 10 ml of normal saline flush. Dextrose-containing solutions should not be used.
- For the ease of administration, the dosing of TNK is simplified as:
  - weight<60 kg → 3 ml (15 mg)
  - weight 60-<70 kg → 3.5 ml (17.5 mg)
  - weight 70-<80 kg → 4 ml (20 mg)
  - weight 80-<90 kg →4.5 ml (22.5 mg)
  - weight 90 kg or more → 5 ml (25 mg)

IV Alteplase (rt-PA)

- The following steps must be followed to prepare rt-PA:
  - rt-PA is supplied in 50 mg vials with diluent solution (sterile water). The 50 mg vial is reconstituted with 50 ml of diluent using the transfer cannula provided. The transfer cannula must be introduced vertically into the rubber stopper and through the mark at its centre. Alternatively, a large bore 19-gauge needle can be used.
  - The indicated dose is 0.9 mg/kg of the patient's estimated weight to a maximum dose of 90 mg. 10% (0.09 mg/kg) of the dose is administered as an intravenous bolus followed by 10 ml of normal saline flush and the remaining 90% (0.81 mg/kg) is given as an infusion. It should be reconstituted to a concentration of 1 mg/ml using only the diluent (sterile water for injections) provided for reconstitution. Dissolving the powder should be by gentle agitation to prevent excess foaming.
  - Draw up the bolus dose in a 5-10 ml syringe. The bolus is to be administered over 1 minute.

- Draw up the rest of the infusion dose in a 50 ml syringe (note 2 x 50ml syringes will be required for an amount > 50 ml). The infusion is to be administered over 60 minutes.
- Attach the infusion tubing to the syringe and attach Luer-lock cannula to the other end.
- Insert syringe into syringe pump, prime line as per pump instructions and attach to patient.
- If 2 syringes are used, the syringe driver should still be set to infuse the total dose remaining over 1 hour.
- After the infusion is completed, flush the infusion line with 30 ml 0.9% Sodium Chloride to ensure all drug is infused. IV rt-PA is compatible with sodium chloride 0.9%, not with glucose containing fluids or with fluids containing preservatives.
- Disconnect syringe infusion from patient. Leave IV cannula in situ.
- The total dose of IV rt-PA used for the treatment of acute ischaemic stroke should not exceed 90 mg.
- Avoid application of BP cuff to the arm used for the rt-PA infusion.
- Use alternative IV line for administration of other indicated medications (e.g. Labetalol, Insulin).

7. Post-Thrombolysis Care

- After starting the thrombolysis, the patient should be observed for 1 hour in the emergency department resuscitation room.
- If the patient is not a candidate for thrombectomy, then admit the patient to the ICU for monitoring. Acute Stroke Unit can be used instead of ICU only if the nursing to patient ratio is 1:2 and capable of starting IV infusions.
- The patient should be monitored by a specialized nurse for the first 24 hours.
- Perform neurological assessments and monitor GCS and blood pressure post IV *thrombolysis* at the following intervals:
  - Every 15 minutes for 2 hours
  - Every 30 minutes for 4 hours

- Every hour until 24 hours (unless otherwise directed by the treating physician).

- If the patient develops severe headache, acute hypertension, nausea or vomiting discontinue an on-going rt-PA infusion and obtain an urgent brain CT scan.
- Repeat brain CT at 24 hours to assess for asymptomatic haemorrhage and to allow initiation of antiplatelet therapy.
- Delay placement of intra-arterial line (no punctures of arteries or large veins within 24 hours after starting IV *thrombolysis*), nasogastric tube and Foley's catheter (avoid insertion until 8-24 hours post IV *thrombolysis*).
- Increase the frequency of blood pressure measurements if systolic blood pressure >180 mmHg or diastolic blood pressure of >105 mmHg. Administer antihypertensive medications to maintain blood pressure at or below these levels.
- If systolic BP still exceeds 180 mmHg, or diastolic BP exceeds 105 mmHg consider early transfer to ICU for intra-arterial blood pressure monitoring and management.
- If emergency venepuncture is required, apply direct pressure to the site for 20 minutes after blood collection.
- Watch for allergic reaction and monitor for tongue swelling.
- Watch for bleeding from any site.
- Do not initiate antiplatelet therapy or anticoagulation within 24 hours after starting IV *thrombolysis*.
- Commence blood glucose monitoring for at least 2 readings 6-hours apart post IV *thrombolysis* if not known diabetic and no hyperglycemia on presentation.
- the patient should be on complete bed-rest for the first 24 hours.
- Mobilise only with nursing assistance (including toilet use) 24 hours after IV *thrombolysis* as the patient is at risk of bleeding from falls.
- Additional Nursing Responsibilities include nutrition/dysphagia screen/speech pathology referral.

8. Management of Complications

I. Management of orolingual angioedema:

Isolated angioedema should be distinguished from anaphylaxis. Angioedema threatening the airway warrants the following actions:

- Stop IV rt-PA infusion immediately.
- Administer oxygen and monitor saturation.
- Monitor for stridor and prepare for the possibility of intubation or cricothyrotomy.
- Administer IV Chlorpheniramine 10-20 mg followed by IV Ranitidine 50 mg. IV Famotidine 40 mg can be used if Ranitidine is not available.
- Administer Methylprednisolone (Solu-Medrol) 80-100 mg IV. IV Hydrocotisone 200 mg can be used if Methylprednisolone is not available.
- If the orolingual angioedema has not halted at this point, then urgently: Administer Epinephrine 1:1000 0.3 ml SC or by nebulizer 0.5 ml.
- Consult ENT/anesthesiology or the appropriate in-house service immediately for possible emergency cricothyrotomy / tracheostomy or fiberoptic nasotracheal intubation if oral intubation fails.

II. Management of Anaphylaxis:

Anaphylaxis is more rare than isolated angioedema. The following steps should be done:

- Stop IV rt-PA infusion immediately.
- Administer oxygen and monitor airway.
- Administer Epinephrine 1:1000 0.3 ml IM.
- Administer Chlorpheniramine10 mg IV.
- Administer Hydrocortisone 200 mg IV.
- If hypotensive, start fluid resuscitation.
- Administer nebulized Salbutamol 2 mg for bronchospasm, repeat Epinephrine if no response.
- Consider Epinephrine infusion 1-4 mcg/min IV if inadequate response.

III. Extravasation of IV Thrombolytic Agent

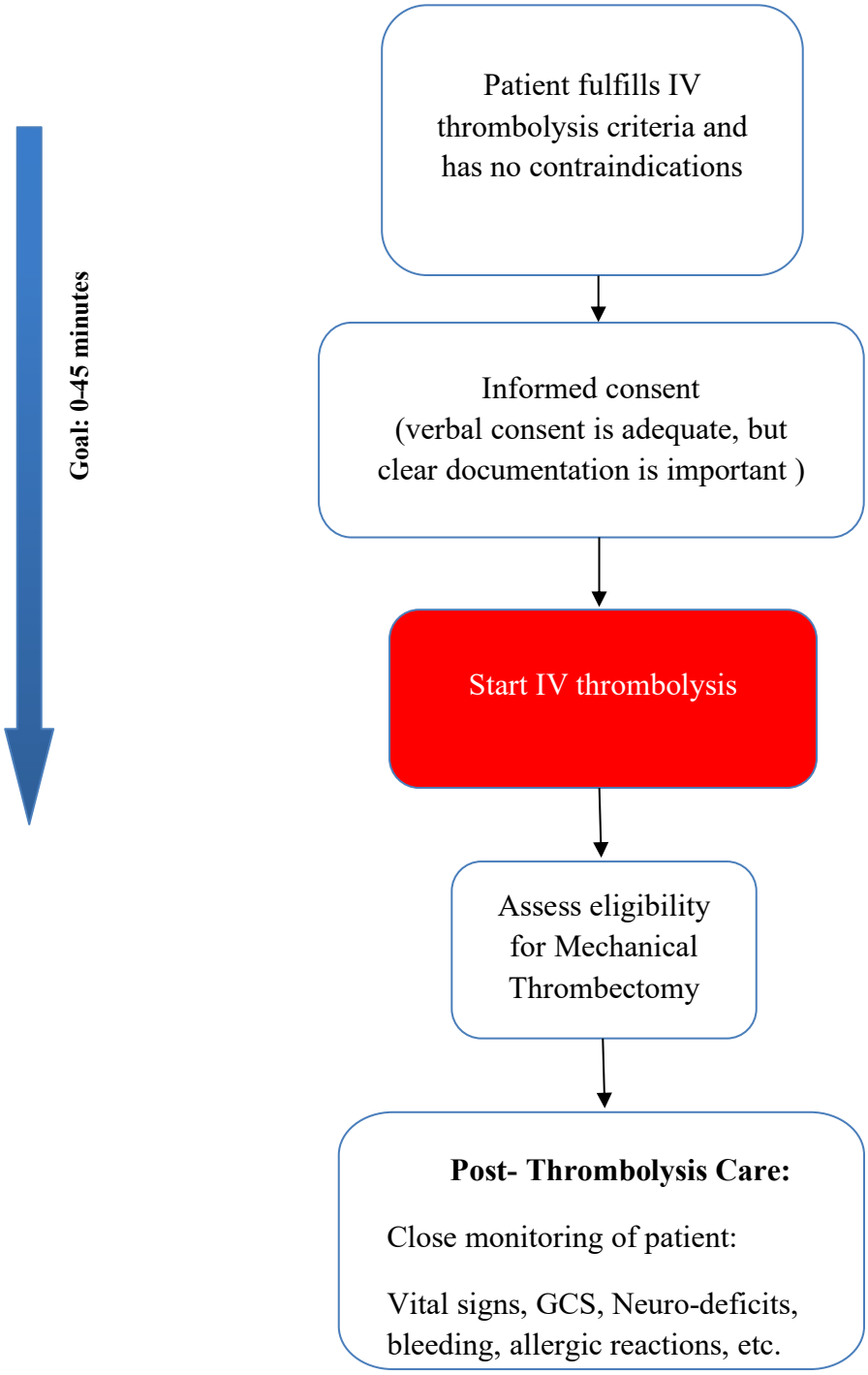
- Change infusion to alternate IV site for continuation of drug.
- It is not necessary to re-dose drug.

- Treat infiltrated site locally with elevation and warm compress.

IV. Management of ICH

- The risk of ICH is increased with old age, diabetes, severe hyperglycemia, uncontrolled hypertension and cerebral small vessel disease on baseline CT scan.
- When sudden neurologic decline occurs during rt-PA infusion, the infusion should be immediately stopped.
- CT scan should be obtained emergently.
- Control of hypertension (target systolic BP is <140 mmHg) -refer to ICH Protocol for further details.
- Consult Neurosurgery and consider consulting Hematologist.
- Immediately send serum Fibrinogen level and empirically transfuse 10 U Cryoprecipitate. Anticipate giving more cryoprecipitate as needed to achieve a Fibrinogen level of ≥150 mg/dL (10 U cryoprecipitate increases fibrinogen by nearly 50 mg/dL). Consider prioritizing cryoprecipitate infusion over other reversal agents.
- Check Fibrinogen levels and recheck every 4 hours.
- Consider transfusing 8-10 units of Platelets if there is evidence of low platelets or platelet dysfunction:
    - Consider administering 25–50 U/kg of Prothrombin Complex Concentrate (PCC) as an adjunctive therapy to cryoprecipitate if patient was on Warfarin before rt-PA administration.
    - Consider administering 12 ml/kg of FFP if patient was on Warfarin before rt-PA administration if PCCs not available.
    - Consider administering 10 mg IV Vitamin K if the patient was on Warfarin before rt-PA administration.
    - Consider administering one of the following anti-fibrinolytic agent as a second line:
        - Aminocaproic acid: 4 g IV during first hour followed by 1 g/h for 8 hours
        - Tranexamic acid: 10 mg/kg 3-4 times/day (adjustment based on kidney function may be necessary)
    - Periodic blood work (CBC, PT/PTT) to re-assess coagulation status & need for blood transfusion
    - Repeat CT head to assess for ICH growth within 6-24 hours

IV Thrombolysis for Acute Ischemic Stroke Algorithm



Thrombolysis by Imaging Criteria

I. Extended Window (4.5-9 hours)

- IV thrombolysis can be considered for patients presenting with onset or last known well 4.5-9 hours if they meet the following criteria:
    - CT perfusion shows small infarct core (estimated less than 70 ml), considerable salvageable tissue (estimated penumbra of more than 10 ml) and mismatch ratio >1.2.
    - For patients who wake up with stroke symptoms, thrombolysis is considered if the midpoint of sleep to needle time is within 9 hours and the patient meets the CT perfusion criteria.

II. Wake-up and unwitnessed Strokes

- IV thrombolysis can be considered for patients presenting within 4.5 hours of waking up from sleep with stroke symptoms or from discovery of symptoms in unwitnessed cases using MRI DWI-FLAIR mismatch.
- The criteria are:
    - The patient is not a candidate for mechanical thrombectomy.
    - MRI DWI-FLAIR mismatch (abnormal signal on DWI but not yet on FLAIR, if not more than ⅓ MCA territory).

Mechanical Thrombectomy Protocol

I. Indication:

- Acute ischemic stroke with emergent large vessel occlusion [intracranial ICA, proximal MCA (M1), MCA bifurcation, proximal M2 and basilar artery] within 24 hours of symptom onset whether or IV thrombolysis was given or not.
- NIH stroke scale score of 6 or more. If NIH stroke scale score is less than 6, symptoms must be disabling.
- ASPECTS score scale of 6 or better.
- CT perfusion study, if available, shows a favorable ischemic penumbra to core ratio (ratio of at least 1.8) for patients presenting beyond 6 hours of last known well/onset or unwitnessed/unknown onset.
- For patients with a large infarct core on CT (ASPECTS 3-5) or CT perfusion core up to 100 ml, mechanical thrombectomy may be considered for very young patients (age<50 years).
- Written informed consent is required for mechanical thrombectomy. If the patient is unable to consent and no family members are available or reachable, two consultants' consent can be obtained and documented in the patient's chart to indicate that the decision was taken in the best interest of the patient. The two consultants are: the on-call neurologist and the operating neurointerventionalist.

II. Contraindication:

- Established large infarct with poor ASPECTS score <6 (see exception above).
- Matched CBV and perfusion defects in the brain perfusion CT study or no collaterals on multiphasic CTA.
- Pre-existing dementia or dependency (modified Rankin score >1).
- Severe comorbidity limiting life expectancy or posing treatment risk (life expectancy less than 6 months).

III. Procedural Care

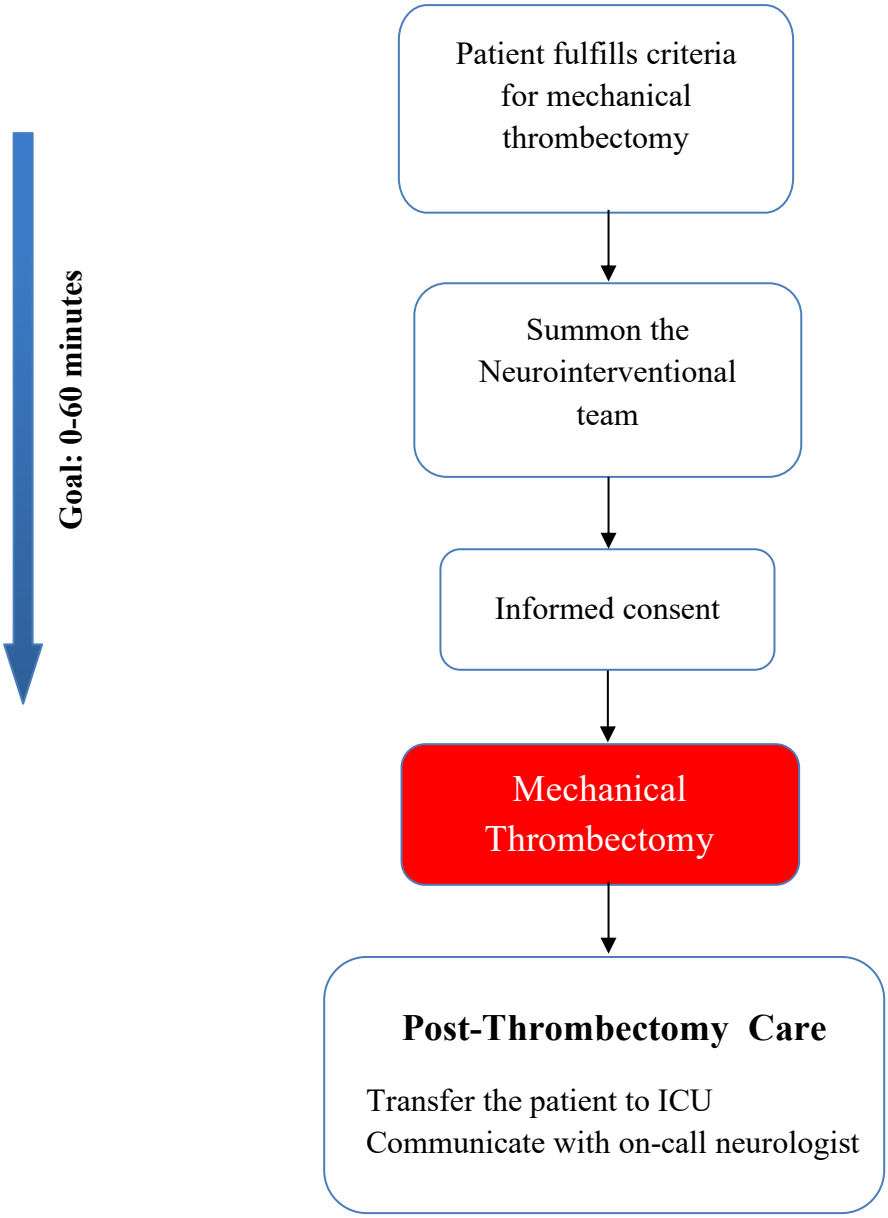
- Eligible patients to be transferred to the angiography suite immediately even if IV rt-PA infusion is still ongoing.
- The head of bed should be kept at 0 degree if there is no contraindication.

- The interventional neuroradiologist to summon the neurointerventional team, which is composed of angiography suite nurse, angiography technologist and anesthesiologist.
- Informed consent should be obtained from the patient or the patient's legally authorized representative by the interventional neuroradiologist or neurologist.
- Type of anesthesia is dependent on the individual patient situation; both options: general anesthesia and conscious sedation are considered equivalent.
- Systolic BP should be kept <180 mmHg during the procedure. Avoid severe drop in BP during the procedure (not less than 120 mmHg).

IV. Post-procedural Care

- The patient should be monitored in ICU (1:2 nursing care) for at least 24 hours.
- If the femoral sheath is placed in the femoral artery and was left in situ, it has to be kept patent by continuous pressure flush and then it should be removed as per written orders. The BP has to be normalized before removing the sheath. After removal of the sheath, the patient has to be placed supine for 6 hours with the accessed leg straight.
- Check for bleeding/hematoma at the groin puncture site, ipsilateral pedal pulse and neurological exam every 15 minutes for the first 2 hours then, every 30 minutes for 2 hours then, every 60 minutes for the remaining 24 hours.
- If radial artery was used for access, then start deflating TR wristband after 1 hour of ICU arrival, deflate by 2 ml every 15 minutes until completely deflated and removed, pulse oximetry monitoring from index finger. If TR wristband not available, 15 minutes pressure can be applied, and pressure bandage to be applied. Monitor pulse oximetry from the index of finger of the right hand, and monitor for hematoma similar to femoral access.
- The interventional neuroradiologist should document the following times: patient arrival to angiosuite, arterial puncture and final reperfusion (if successful, considered at TICI2B or better). Also the number of passes should be documented.
- The optimal BP after the procedure is not established. However the current evidence suggests that a target systolic BP between 120-160 mmHg is reasonable for patients with successful perfusion (TICI 2B or better).

Mechanical Thrombectomy Algorithm



Intracranial Hemorrhage (ICH) Protocol

General Management of Spontaneous ICH

- Admit the patient to the ICU. If no ICU bed is available, admission to an acute stroke unit or high dependency bed can be considered provided that nursing to patients ratio (1:2) can be arranged with capability for IV medications administration.
- Perform neurological assessments and monitor GCS and blood pressure at the following intervals:
  - Every 15 minutes for 2 hours
  - Every 30 minutes for 4 hours
  - Every hour until 24 hours
- Keep on continuous cardiac monitoring for at least 24 -48 hours.
- Urgent control of elevated BP and correction of coagulopathy should be considered to limit hematoma enlargement. For patients presenting with elevated BP (systolic BP 180-220 mm Hg), acute lowering of systolic BP to 140 mmHg within 1 hour of presentation is recommended and systolic BP is maintained between 130 mmHg to 150 mmHg. Options for intravenous agents include:
  - Labetolol 10 mg IV over 1 min initially, then 10-20 mg IV every 10 minutes (total dose not to exceed 300 mg per day). Once target is achieved, start IV infusion preferably nicardipine at 5 mg/hour, dose can be increased every 5 minutes by 2.5 mg/hour for maximum dose of 15 mg/hour. If nicardipine is not available, IV labetalol infusion can be used, start the infusion rate at 30 mg/hour and increase every 5 minutes by 15 mg/hour for a maximum of 120 mg/hour.
  - Hydralazine 10 to 20 mg IV every 30 min.
  - If the patient requires 2 or more boluses of IV antihypertensives in 1 hour, then start nicardipine infusion as explained above (5-15 mg/hour). If nicardipine is not available, labetalol infusion is the alternative.
- Early deterioration is common – usually due to expansion of hematoma. In case of worsening sensorium or anticipated deterioration, consider urgent CT scan and neurosurgical opinion for possible intervention.

- Select patients with ICH should be considered for a non-urgent MRI or diagnostic cerebral angiogram to exclude an underlying lesion e.g. aneurysm, AV malformation, tumor, etc. While an early study may demonstrate some of these, if doubt persists, a delayed imaging after a few weeks, when the hematoma has resolved, should be considered.
- Aggressive management of the blood glucose (to be maintained at 6- 10 mmol/L) with regular subcutaneous insulin sliding scale with close monitoring of blood glucose to avoid hypoglycemia.
- Clinical seizures should be treated with IV antiepileptic drugs. Options include:
  - IV Levetiracetam loading dose of 40-60 mg/kg (max 4000 mg) and then maintenance of 10 mg/kg BID
  - IV Phenytoin 20 mg/kg loading dose followed by 5 mg/kg/day maintenance
  - IV Sodium Valproate 20-40 mg/kg loading dose followed by 10 mg/kg TID or QID maintenance.
- Consider continuous EEG monitoring in ICH patients with depressed mental status to rule out non-convulsive seizures.
- Blood sugar should be monitored and hyperglycemia treated with insulin as per sliding scale.
- ICH score should be documented on presentation.
- Start pneumatic leg compression at admission.
- Start subcutaneous low dose unfractionated heparin or LMWH, e.g. Enoxaparin 0.5mg/kg body weight daily after 24-48 hours if intracranial hematoma is stable and there is no ongoing coagulopathy.
- Formal swallowing assessment to minimize the risk for aspiration should be done to all patients. Patients with no oropharyngeal symptoms/signs, can undergo bedside swallowing evaluation by the admitting doctor or nurse. Patients with oropharyngeal symptoms and those who fail bedside swallow evaluation should be kept NPO until evaluated formally by speech and swallow therapist the next morning. Insertion of NGT depends on acute need for it, most patients can be managed with IV fluids and IV medications in the first 24 hours.
- In some ICH patients, secondary causes like hemorrhagic tumor, hemorrhagic venous infarct or vascular lesions like cavernous malformation, arteriovenous malformation should be

considered and targeted evaluation with MRI, MRV, CTV, DSA or pan CT scan can be considered.

ICH due to Coagulopathy

- Involve Hematologist early.
- Consider delegating personnel for urgent procurement of necessary replacement factors for infusion within minutes.
- Choose rapidly acting methods for initial correction.
- For ICH secondary to Warfarin (INR ≥ 1.3):
    - Stop Warfarin
    - Administer vitamin K 10 mg by slow IV infusion
    - Administer 25–50 U/kg of Prothrombin Complex Concentrate (PCC) (If PCC not available, administer FFP at 10-15ml/kg or cryoprecipitate).

- For ICH secondary to thrombocytopenia:
    - Start Platelets transfusion to maintain the count >100/mm3.
    - Consider IV immunoglobulin total of 2 gram/kg for immune-mediated thrombocytopenia

- For ICH secondary to Heparin/LMWH:
    - Administer Protamine sulphate (1 mg of Protamine sulphate neutralizes the 100 units of heparin).
    - Monitor the PTT 5-15 minutes after the dose and then 2-8 hourly.

- Start FFP at 10-15ml/kg

- For ICH secondary to NOACs:
  - Stop the NOAC
  - Consider administering Activated Charcoal 50 grams if the airway is secured.
  - Use Factor Xa inhibitor (Andexanet alfa) if available, initial IV bolus 400 mg at rate 30 mg/minute followed by IV infusion 4 mg/minute for 120 minutes if time of ingestion>8 hours. If time of ingestion is less than 8 hours or unknown, use initial IV bolus 800 mg at rate 30 mg/minute followed by IV infusion 8 mg/minute for 120 minutes
  - Until the antidote becomes readily available, treat Facor Xa inhibitors associated ICH with 50 units/kg 4-Factors Prothrombin Complex Concentrate. If this is not available, then can utilize FFP at 10-15ml/kg or cryoprecipitate 10 units.
  - Consider hemodialysis in the case of Dabigatran.

ICP monitoring and treatment

- Management principles for elevated ICP recommend placement of an ICP monitor in patients with a GCS score of 3-8 and maintenance of an ICP <20 mm Hg and a CPP of 50-70 mm Hg. Methods of treating elevated ICP include:
  - Elevation of the head of the bed to 30°-45°.
  - The use of mild sedation and avoidance of collar-endotracheal tube ties that might constrict cervical veins.
  - 20% Mannitol 0.5-1.5 g/kg every 6-8 hours for 3 days or Hypertonic Saline aiming not more than 10 mmol/L per day sodium increase or both may be used to treat acute ICP elevations.

- Monitor serum osmolality, sodium, electrolytes, urine output, urea and creatinine (target serum osmolality 310-320 mOsmol/kg and target sodium 145-155 mmol/L).

- In patients with CSF outflow obstruction caused by hydrocephalus or a trapped ventricle or IVH, EVD insertion to achieve CSF drainage and ICP monitoring should be considered.

- In patients who are deteriorating neurologically or have cerebellar hematoma, hematoma evacuation and decompressive craniectomy (DC) are options for treating elevated ICP. See surgical management.

- Salvage therapies might include barbiturate coma or mild hypothermia.

Surgical Management

Supratentorial hemorrhage

- Hematoma evacuation should be considered in patients with large bleed >20 ml with GCS 5-12, preferably utilizing minimally invasive techniques, and are indicated in the following situations:

  - Lobar hematoma located less than 1 cm from the cortical surface

  - Growing hematomas, and large hematomas

  - Supratentorial hematoma evacuation in deteriorating patients might be considered as a life-saving measure

  - Large hematoma with significant midline shift

  - Large hematoma with elevated ICP refractory to medical treatment

Cerebellar hemorrhage

- Urgent surgical evacuation of the hematoma is indicated in the following situations:

- Hemorrhage >3 cm in diameter or those with brainstem compression or hydrocephalus from ventricular obstruction.
- Temporizing EVD until evacuation is done can be considered in patients with hydrocephalus but should not replace evacuation of cerebellar hematoma when surgical treatment is indicated.
- Patients with cerebellar hemorrhage who are neurologically deteriorating more than 2 points in GCS

Intraventricular Hemorrhage

- Patients with spontaneous primary intraventricular hemorrhage or with intracerebral hemorrhage with intraventricular extension, external ventricular drain (EVD) should be placed in the following situations:
  - Large intraventricular hemorrhage with reduced level of consciousness
  - Obstructive hydrocephalus

Acute Ischemic Stroke Protocol (Patients not eligible for both IV thrombolysis and mechanical thrombectomy)

- All such patients should be initially stabilized in the ED and then admitted at the earliest instance to a Stroke Unit or Neurology ward or ICU (as appropriate).

ICU Admission

- Criteria to admit to the ICU:
  - Large hemispheric or cerebellar infarction with expected deterioration and need for decompressive craniotomy.
  - The patient is medically unstable or intubated.

General Stroke Care (These apply to most subcategories of ischemic stroke):

- Vital signs (4 hourly); GCS and cardiac monitoring using telemetry (esp. for Atrial Fibrillation or cardiac ischemia) for at least 24-48 hours (longer in selected patients).
- Dysphagia screen should be done in the ED. Patients with symptoms of dysarthria, facial weakness or aphasia should be kept NPO and NGT is inserted. Formal swallowing assessment by speech and swallow therapist should be obtained at the earliest possible (within 24 hours).
- Administer anti-platelet agents immediately after diagnosing ischemic stroke (including larger artery stroke, lacunar stroke, and stroke of undetermined cause). Regimen includes oral Aspirin 300-325 mg loading dose followed by 81 mg OD. Patients with mild symptoms (NIHSS 5 or less) or TIA should receive additional treatment with oral Clopidogrel 300 mg loading dose followed by 75 mg OD for 3 weeks. If the patient was already on antiplatelet therapy and has been taking them, no need for the loading doses.
- Start high intensity statin therapy (atorvastatin 80 mg or 40 mg nightly or rosuvastatin 20 or 40 mg nightly) to reduce LDL to less than 1.6 mmol/L over the next 3 months.

Control of BP

- Hypotension should be promptly treated with IV fluids and vasopressors as appropriate.
- Allow permissive hypertension up to SBP 220 and DBP 120 mmHg in the first 24 hours. Hold home antihypertensives for 24 hours. Treat hypertension in the first 24 hours only when BP > 220/120 mm Hg or patient has coexisting evidence of acute end-organ damage.
- For persistent SBP > 220 mmHg or DBP >120 mmHg, reduce SBP to 140-180 mmHg and DBP to 90-110 mmHg. Options for intravenous agents include:
    - Labetolol 10-20 mg IV over 2 minutes initially, then 10-20 mg IV every 10 minutes (total dose not to exceed 300 mg per day).
    - If the patient requires more than 1 dose in 1 hour, then start nicardipine infusion 5 mg/hour, uptitrate every 5 minutes by 2.5 mg/hour to maximum dose of 15 mg/hour. If nicardipine is not available, start labetalol infusion, start with 30 mg/hour and increase every 15 minutes by 15 mg/hour to a maximum dose of 120 mg/hour.
    - Hydralazine 10-20 mg IV every 10 min can be used if nicardipine is not available and the patient's heart rate is below 60/minute.
    - Nitroprusside sodium infusion, start at 0.3 mcg/kg/min and titrate to desired effect (max 10 mcg/kg/min x 10 min). Caution should be exercised in cases of large strokes or elevated ICP. Nitrates should be reserved as the last option if labetalol, nicardipine and hydralazine are not available or not effective.
- In patients with evidence of end organ damage, e.g. ongoing cardiac ischemia, aortic dissection, overt cardiac failure and acute renal failure, consider rapid lowering of BP to normal levels, with close monitoring of neurologic status. Consult Cardiology / Cardiac Surgery / Vascular surgery as appropriate.

- In specific circumstances such as major artery stenosis / occlusion causing focal cerebral ischemia, induced hypertension with IV fluids and vasopressors may be considered with close monitoring.
- Monitor GCS and neurologic deficits in all patients requiring reduction in BP. In case of worsening focal deficits / sensorium with the decrease in BP, consider increasing BP partially or to previous levels and observe for neurologic improvement.
- In patients with pre-existing hypertension, restart the patient's regular antihypertensive therapy 24 hours after the onset and when neurologically stable in a graded manner - unless there is specific contraindication to restarting treatment.

Blood Glucose Management

- Hypoglycemia should be promptly treated (50 ml of 25% or 50% dextrose IV bolus).
- Hyperglycemia should be treated in the acute stage with Insulin (e.g. using Insulin sliding scale as per hospital local protocol) targeted to a serum Glucose level of 8-10 mmol.

IV Fluids

- Hypovolemia / hypotension should be promptly treated. Maintenance fluid infusion in acutely ill patients or those NPO is appropriate, preferably with Normal Saline.

General Measures

- Start LMWH prophylaxis e.g. SC Enoxaparin 1 mg/kg body weight (if not contraindicated); also, apply pneumatic compression devices.
- Formal swallowing assessment to minimize the risk for aspiration should be done to all patients. Patients with intact mental status and no oropharyngeal symptoms/signs, can undergo bedside swallowing evaluation by the admitting doctor or nurse. Patients with oropharyngeal symptoms and those who fail bedside swallow evaluation should be kept NPO until evaluated formally by speech and swallow therapist the next morning. Insertion of NGT

depends on acute need for it, most patients can be managed with IV fluids and medications in the first 12-24 hours. NGT insertion at admission for medication administration should be done if the patient falls bedside swallowing evaluation.

- Complete stroke workup, CT angiogram of neck and cerebral vessels i.e.(alternative – MRI brain with MRA); 12-leads ECG, Echocardiography; 24 hours Holter study; serum lipid profile and glycated hemoglobin in addition to basic lab tests CBC, RFT, LFT, coagulation profile and Troponin.
- Arrange for hematological, autoimmune workup, lumbar puncture, tests for neuro-infection, etc. as indicated. Consider these in 'Stroke in Young' or stroke in unusual contexts. Stroke in young and cases suspected to have vasculitis or uncommon causes of stroke should be referred to stroke specialists in the major referral hospitals.

Patients with Altered Mental Status

- Closely monitor GCS, focal deficits, pupils and vital signs, with 1:1 nursing care. Monitor intake/output; administer Oxygen as needed.
- Consider intubation for persistent Coma (GCS $\leq$8).
- Consider NGT placement for medication and feeding.
- Consider IV Mannitol / Hypertonic Saline for patients with raised ICP.
- Consider early Neurosurgical consultation for possible decompressive craniectomy (e.g. Malignant MCA stroke; cerebellar stroke) or external ventricular drainage (for hydrocephalus)
- Consider metabolic causes of coma and systemic or neurologic infection, and treat as indicated.
- Consider non-convulsive status epilepticus and treat accordingly with anticonvulsant agent.

Secondary Stroke Prevention by Etiology

Anticoagulation for cardioembolic TIA/Stroke

- Stroke from a cardioembolic source should be considered in patients with atrial fibrillation (ongoing or paroxysmal), valvular abnormalities, prosthetic cardiac valves, intracardiac clots and multifocal strokes on brain imaging. Most patients with cardioembolic stroke require anticoagulation for optimal prevention of stroke recurrence. Anticoagulation should be initiated after careful assessment for contraindications and also evaluation of serial brain imaging.
- Prevention of recurrent stroke in patients with non-valvular atrial fibrillation
    - Patients with transient ischemic attack or ischemic stroke and non-valvular atrial fibrillation should receive oral anticoagulation.
    - In most patients requiring anticoagulants for atrial fibrillation, direct non-vitamin K oral anticoagulants (NOACs) such as Apixaban, Dabigatran, Edoxaban, or Rivaroxaban should be prescribed in preference over Warfarin. Apixaban should be used as the first line over other NOACs (rivaroxaban, dabigatran or edoxaban) when possible.
    - For patients already receiving Warfarin with good INR control (range 2–3), continuing Warfarin is a reasonable anticoagulation option.
    - When selecting a choice of oral anticoagulant, patient specific criteria should be considered.
    - For patients with acute ischemic stroke and atrial fibrillation, routine use of bridging with Heparin is not recommended. Bridging with antiplatelet therapy is suggested until the patient is anticoagulated.
    - For patients with ischemic stroke or TIA and atrial fibrillation who are unable to take oral anticoagulant therapy (NOAC or warfarin), aspirin alone is recommended.
    - The addition of Clopidogrel to aspirin therapy, compared with aspirin therapy alone, may be reasonable and decisions should be individualized based on patient bleeding risk.

- For patients with a mechanical heart valve, Warfarin is recommended for stroke prevention with careful INR monitoring; NOACs are contraindicated.
- For patients in whom long-term anticoagulant therapy is contraindicated, a left atrial appendage closure procedure may be considered.
- Clinical Considerations for anticoagulation:
    - The optimal timing to start anticoagulant therapy after stroke has not been defined by clinical trial evidence, and should be based on individual benefit / risk assessment taking into account the clinical circumstances, infarct size, imaging appearances, age, comorbidities, and estimated stroke recurrence risk.
    - A general approach to the target timing for initiation of oral anticoagulant therapy post-stroke is as follows: same day post-event after a TIA, 2 days post-stroke after a mild stroke, 7 days post-stroke after a moderate stroke and 14 days post-stroke after a large stroke.

Symptomatic Carotid Stenosis

- Patients with 50-69 % carotid stenosis should have an evaluation by a stroke expert and for selected patients (young age, male sex, no comorbidities) if the perioperative morbidity and mortality risk is estimated to be <6% they should be offered early carotid endarterectomy or carotid stenting (preferably within 14 days).
- Patients with 70-99% carotid stenosis should be considered for carotid endarterectomy/carotid stenting within 14 days if the perioperative morbidity and mortality risk is estimated to be <6%.
- Carotid endarterectomy is generally more appropriate than carotid stenting for patients over age 70 years who are otherwise fit for surgery. Patients with ischemic heart disease, pulmonary disease or retropharyngeal course of the carotid artery should be considered for carotid stenting over carotid endarterectomy.
- Carotid stenting may be considered for younger patients and patients who are not operative candidates for technical, anatomic or medical reasons.

Asymptomatic and Remotely Symptomatic Carotid Stenosis

- Carotid endarterectomy may be considered for selected patients with 60-99 % carotid stenosis who are asymptomatic or were remotely symptomatic (e.g. duration > 6 months, contralateral carotid disease) provided that the expected complication risk ≤ 3%.
- Carotid stenting may be considered as an alternative in patients with 60-99 % carotid stenosis who are not operative candidates for technical, anatomic or medical reasons, or based on patient's preference.

Intracranial Stenosis

- Intracranial stenting is not recommended for the initial treatment of recently symptomatic intracranial 70% to 99% stenosis.
- Medical management includes dual antiplatelet therapy with ASA 325 mg and Clopidogrel 75 mg to be started within 30 days of stroke/TIA and treated for up to 90 days. In addition, aggressive management of all vascular risk factors is recommended.
- If symptoms persist on dual antiplatlets, the patients should be considered for intracranial revascularization by angioplasty with or without stenting

Cervical Artery Dissection

- Antithrombotic therapy for stroke prevention is recommended for extracranial carotid or vertebral artery dissection.
- Choice of treatment and duration should be based on individual risk/benefit analysis. Either antiplatelet therapy or anticoagulation with heparin, warfarin or NOACs is considered reasonable options
- Carotid artery stenting can be considered for patients with recurrent events despite best medical management.

Special Stroke Situations

Cerebellar Infarction with evidence of brain stem compression

- Close monitoring with serial neurological exam (e.g. for 6th nerve or gaze palsy, worsening of GCS) – for evidence of brainstem compression or herniation
- Repeat CT scan for evidence of brainstem compression, herniation or hydrocepahalus.
- IV 20% Mannitol 0.5-1.5 g/kg every 6-8 hours or 3% Hypertonic Saline 100-150 ml QID or as infusion 0.5 ml/kg per hour (as a temporary measure till definitive intervention).
- Decompressive craniectomy should be considered for cerebellar infarcts with mass effect/ obliteration of basal cisterns/brainstem compression and without significant brainstem infarction, altered mental status, hydrocephalus or tonsillar herniation.

Large hemispheric infarction with midline shift (Malignant MCA infarct)

- Close monitoring with serial neurological exam hourly in the ICU
- Repeat CT scan in case of any deterioration
- Measures to control raised ICP (as temporizing measures): head elevation at 30 degrees; IV 20% Mannitol 0.5-1.5 g/kg every 6-8 hours or 3% Hypertonic Saline 100-150 ml QID or as infusion 0.5 ml/kg per hour (as a temporary measure till definitive intervention) with monitoring of serum Na and Osmolality.
- Control pain; correct hypoxemia and hypercapnea; consider hyperventilation to pCO2 25-30 mmHg.
- Early elective Neurosurgery consultation for possible surgical decompression, large infarcts with mass effect, midline shift, brain herniation, altered mental status to be considered for wide decompressive craniectomy.
- Significant hydrocephalus may occasionally require ventricular drainage.
- Indications for decompressive craniectomy include:

- Modified Rankin score 0-2 (pre-stroke).
- Stroke onset up to 120 hours.
- NIHSS score of >14 in non-dominant hemisphere stroke, and > 19 in dominant hemisphere stroke.
- Total infarcted tissue > ⅔ of the MCA territory or a total volume of infarcted tissue > 80ml or Midline shift of > 5mm.

- Contraindications for decompressive craniectomy include:
  - Modified Rankin score > 2 (pre-stroke)
  - GCS < 8
  - Pupils fixed and dilated bilaterally
  - Co-existing brain lesions affecting outcome
  - Coagulation disorders - unless corrected to a level of INR <1.4 and / or platelet function to normal, and platelet count of >100,000. Other coagulopathies are not existent, or if present, complete reversal and cover is available for the first 7 days after surgical intervention.
  - Pregnancy - unless the target is to save the fetus.

Stroke in Young workup (age less than 45 years)

- In young patients with stroke (<45 years age), in addition to aforementioned investigations, the following may be considered based on clinical assessment:
  - Trans-esophageal Echocardiography (TEE), TEE with bubble study.
  - Test for Hemoglobinopathies e.g. Sickle cell disease
  - Tests for systemic autoimmune disorders: ESR, CRP, ANA, ANCA, etc.
  - Tests for Anti-phospholipid antibody syndrome: Phospholipid antibodies, Anti-cardiolipin antibodies, Beta2-glycoprotein antibodies (IgG and IgM). Lupus anticoagulant.

- Tests for pro-coagulant states: Levels of Protein C, Protein S, Anti-thrombin III, Factor VIII assay, Prothrombin (F2) G20210A; Factor V Leiden R506Q mutation, Serum Homocystein level, Lipoprotein A.
- Lumbar puncture for CSF analysis – for possible neuroinfection, meningeal carcinomatosis, CNS angiitis etc.
- Conventional angiography: for evidence of CNS Angiitis.
- Pan-CT scan to look for malignancy.

Management of non-disabling stroke and TIA

- Patients presenting with TIA or minor stroke should have their risk calculated using the ABCD2 screening tool. All patients should be admitted for accelerated workup. Standard stroke workup should be done including:
  - CT angiography ('aortic arch-to-vertex') should be performed at the time of brain CT to assess both the extracranial and intracranial circulation.
  - Head and Neck MRA are alternatives to CTA, and selection should be based on immediate availability, patient characteristics and baseline kidney function.
  - The following laboratory investigations should are part of the initial evaluation: hematology (CBC), electrolytes, coagulation [activated partial thromboplastin time (aPTT), international normalized ratio (INR)], renal function (creatinine, e-glomerular filtration rate), capillary glucose level.
  - All should undergo testing with 12-leads electrocardiogram (ECG), transthroacic echocardiogram, 24-48 Holter monitoring or prolonged ECG monitoring in selected patients.
  - All should be assessed for functional impairment when appropriate (e.g., cognitive evaluation, screening for depression, screening of fitness to drive, and functional assessments for potential rehabilitation treatment).

Cerebral Venous Thrombosis

- Management of CVT includes:
  - Resuscitate and stabilize
  - Detailed history & examination
  - Emergent Brain imaging: Brain CT with CTA/CTV or MRI with MRA/MRV (preferred)
  - Glucose, CBC, ESR, Biochemistry, Coagulation profile, CXR, etc.
  - Consider IV Benzodiazepine / Levetriacetam or Phenytoin or Valproate for seizures
  - Aggressive hydration with normal saline 150-250 ml/hour.
  - Consider IV acetazolemide for raised intracranial pressure.
  - Corticosteroid use for edema is contraindicated in acute venous sinus thrombosis.
  - Consider ICP lowering strategies for patients with fulminant course.
  - Use IV Mannitol or Hypertonic Saline for venous infarction with mass effect and consult neurosurgery for consideration of decompressive craniectomy.
  - Begin anticoagulation if no general contraindication, Initially SC LMWH e.g. Enoxaparin (weight based dose).
  - Anticoagulation recommended even in patients with ICH.
  - Transition later to warfarin or NOACs.
  - Admit to Stroke Unit / ICU / HDU depending on clinical severity.
  - Monitor for signs of hemorrhage: bleeding, hypotension, drop in Hb, etc.
  - Monitor vital signs, GCS, pupils, limb power
  - Serial brain imaging
  - Treat underlying cause
  - Consider intubation for coma/ decerebration/ resistant status

- If stable, bridge LMWH to long-term oral anticoagulation with Warfarin (target INR 2-3) or switch to NOAC.
    - For provoked cases, anticoagulate for 3-6 months.
    - For unprovoked cases, anticoagulant for 6-12 months
    - Lifelong anticoagulation for inherited thrombophilia or recurrent unprovoked event.
- If the patient continues to deteriorate despite anticoagulation and edema management, consult neurosurgery for decompressive craniectomy if there is mass effect.
- If the patient continues to deteriorate despite anticoagulation but without significant mass effect, consult the neurointerventionalist for mechanical venous thrombectomy and local thrombolysis.

In-hospital Stroke Protocol

- The following management steps should be implemented for patients with a suspected stroke while hospitalized:
  - Activate the in-hospital Acute Stroke Team or Internal Medicine physician on-call.
  - Two nurses from the same ward should assist in patient's management in addition to the first oncall doctor taking care of the patient.
  - Check patient's vitals and bedside blood sugar
  - connect the patient to cardiac monitor, pulse oximeter, monitor vital signs
  - Order emergent Head CT and CT angiogram head and neck with CT perfusion as per imaging protocol.
  - The neurologist/IM doctor evaluates the patient and verify last known well, medical history and NIHSS.
  - Prepare order for IV thrombolysis if eligible.
  - Order stat blood tests: Coagulation profile, CBC, RFT, Troponin, Glucose.
  - Establish 2 large bore IV access.
  - Send the patient for urgent CT/CTA/CTP with accompany of one nurse, doctor taking care of the patient and the neurologist/internal medicine doctor
  - Administer IV thrombolysis once approved by neurologist / IM physician.
  - Assess eligibility for mechanical thrombectomy. Refer to interhospital transfer policy if transfer is required to a different facility for thrombectomy.
  - Transfer patient to ICU/ASU

Interfacility Transfer/Transport Protocol

Pre-hospital

- It is recommended that patients with suspected acute stroke be transported directly to the nearest hospital capable of providing stroke care.

Transfer from Basic to Advanced or Comprehensive facility

- If a patient eligible for reperfusion therapy presents to a basic health facility. The physician from the referring healthcare facility should contact the neurologist on-call at the advanced or comprehensive stroke capable hospital.
- Medical team from the referring hospital should arrange an ambulance to transfer the patient.
- The patient's responsibility remains under the referring hospital during the transport process.
- An accompanying medical doctor is required if rt-PA infusion is being administered in transit or if the patient is neurologically sick (severe stroke, basilar occlusion, etc).
- The stroke team at the receiving hospital should continue with stroke protocols and assess the patient eligibility for thrombectomy.

Transfer from a thrombolysis-incapable facility

- ED doctor or IM physician should ensure eligibility for thrombolysis prior to transfer.
- The referring hospital must notify the receiving stroke hospital prior to transport.
- The referring hospital should arrange an ambulance to transfer the patient.
- The patient responsibility remains under the referring hospital during the transport process.
- A medical doctor or nurse should accompany the patient.

Transfer of a potential mechanical thrombectomy patient

- IM physician or neurologist from the referring hospital should contact specialist neurologist on-call in Comprehensive Stroke hospital to confirm eligibility for mechanical thrombectomy and reach a decision on transferring the patient. If the stroke or neurology specialist is available at the referring hospital, they may contact the Interventional Neuroradiologist directly.
- If agreed, IM physician or neurologist from the referring hospital is notified of acceptance of transfer and may then arrange ambulance transfer to Comprehensive Stroke hospital.
- The patient's responsibility remains with the referring hospital during the transport process.
- An accompanying medical doctor is required for these cases.
- The stroke team at the receiving hospital should do a new neurologic examination with NIHSS calculation on arrival and repeat imaging (CT head, CTA head and neck and brain CTP) if the patient arrives more than 2 hours from the initial imagings done at the referring hospital.
- If the stroke patient is critically unwell (e.g. intubated), then the anesthesia and ICU doctors from both hospitals should be involved in the case discussion and patient transfer.
- If a transferred patient is found not to be eligible for mechanical thrombectomy on assessment at the receiving facility, the patient may be sent back to the referring hospital for medical management if the bed situation at the receiving hospital is tight.

Stroke-care hospitals classification

The healthcare institutions caring for stroke patients are divided into three different levels with the following criteria:

I. Basic Stroke Capable Hospital (Acute Stroke Ready Hospital)

- A hospital that does not have the acute care capabilities required of advanced or comprehensive stroke capable hospitals but is able to administer IV thrombolysis in communication with neurologists in the main hospital of the catchment area via Telestroke system or phone consultation. The patient will ultimately be transferred to the higher level of care (drip and ship model).
- The following criteria should be met:
  - Availability of IV thrombolytic therapy
  - Availability of a capable ambulance transfer team.
  - Availability of neuro-imaging and lab services 24/7
  - Support of hospital administration.
  - Availability of a basic Acute Stroke team (IM physician / neurologist)
  - ED staff with training in Acute Stroke care.
  - NIHSS employed in initial Acute Stroke evaluation.
  - Outcomes and quality improvement process.
  - Continuing Medical Education (CME) in stroke management.

II. Advanced Stroke Capable Hospital (Primary Stroke Center)

- All Criteria for Basic Stroke capable hospital in addition to:
  - Availability of Acute Stroke team 24/7.
  - Written stroke care protocols.

- Availability of transfer agreement with a comprehensive stroke capable hospital providing a higher level of care.
- ED staff trained in acute stroke care.
- Expertise in administering and managing IV thrombolysis.
- Availability of dedicated stroke unit and team.
- Availability of Neurosurgery services 24/7.
- Availability of physical, occupational, and speech therapy.
- Availability of public and professional educational programs for the community
- Written protocol for receiving stroke patients transferred from Basic Stroke Capable Hospitals and other facilities.

III. Comprehensive Stroke Capable Hospital

- All criteria for advanced Stroke Center in addition to:
  - Personnel with expertise in Neuro-intervention radiology, Vascular surgery, Neurology, Neurosurgery, Neuroradiology, Critical Care available 24/7.
  - Availability of clinical nurse specialists / nurse practitioners.
  - Availability of advanced diagnostic techniques including MRI, MRA, CT/CTA, cerebral angiography and TEE.
  - Availability of rehabilitation specialists including physical, occupational, and speech therapy.
  - Availability of notification system whereby neurologist on-call notifies their emergency department of transfer and activates the hospital Code Stroke Protocol and provides estimated time of arrival. This process should also pre-notify radiology, stroke nurse and the bed manager of incoming activity.
  - Availability of Stroke Registry.
  - Availability of educational and research programs.

Hospitals with Stroke Care Capability in Oman:

The following are the types and distribution of stroke centers are approved by the Ministry of Health:

1. Comprehensive stroke center level:

    - Khoula Hospital

2. Endovascular-capable primary stroke center level:

    - Sohar Hospital
    - Sultan Qaboos University Hospital
    - Aster Royal Hospital (private)

3. Primary stroke center level:

    - Sultan Qaboos Hospital
    - Nizwa Hospital
    - Sur Hospital.
    - Armed Forces Hospital.
    - Aster Sohar Hospital (private)

4. Acute stroke ready hospital level:

    - Ibri Hospital
    - Ibra Hospital
    - Al Buraimi Hospital
    - Jalan Hospital
    - Rustaq Hospital
    - Khasab Hospital
    - Haima Hospital

Certification of stroke centers in Oman is regulated by the Ministry of Health. Change of status or addition of more centers requires evaluation by the Ministry of Health.

Stroke Rehabilitation Protocol

- As rehabilitation plays a major role in the recovery of stroke victims, evidence states that rehabilitation should be structured to be provided more intensely in the first six months. There are 3 phases of stroke rehabilitation including: acute inpatients rehabilitation, long-term rehabilitation and community rehabilitation. Due to resource constraints and the unavailability of dedicated rehabilitation units and unavailability of community physiotherapy, this protocol shall mainly focus on the acute phase of stroke rehabilitation.
- Active rehabilitation therapy should start within 24 hours for patients who did not receive thrombolysis and medical stability is reached. For post-thrombolysis patients, rehabilitation starts after 24 hours if the patient is stable.
- During hospitalization all patients should receive at least 45 minutes of physiotherapy per day to ensure intensity and continuity.
- The safety of all patients must be ensured during rehabilitation physiotherapy sessions.
- No patient should be excluded from rehabilitation unless he / she is too ill or too cognitively devastated to participate in a treatment program.
- Rehabilitation should be individualized depending on the continuous assessment and the resources available to provide neurorehabilitation including constraint-induced movement therapy and task-specific interventions.
- Once stroke victims have enough strength in the lower limbs, cardiorespiratory fitness should be sought after.
- Post-discharge rehabilitation care plans should be taught to and discussed with caregivers focusing on home-based rehabilitation.
- Rehabilitation referral should be communicated with the nearest health facility to patients' address.

Dysphagia Screening

- All patients with acute stroke should undergo bedside dysphagia screening in the emergency department.
- If the patient has no oropharyngeal symptoms (no dysarthria or dysphasia or facial weakness), then bedside swallow assessment using 100 ml cup of water should be done by the admitting doctor or nurse.
- Patients who fail bedside swallow assessment or those with oropharyngeal symptoms should be kept NPO and if required NGT can be placed for medications administration until evaluated by the speech and swallow therapist and a decision when to start oral intake is made.

Telestroke

- Managing stroke patients who present at acute ready hospitals remotely by stroke specialists via telestroke network is considered integral for providing stroke care to remote peripheral hospitals.
- Caring of stroke patients via telestroke network for the purpose of administering IV thrombolysis and selection for thrombectomy is legal and regulated by the Ministry of Health.

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Appendix I: BEFAST stroke scale

B: BALANCE

Does the patient have loss of balance or is dizzy?
Does the patient have difficulty walking?
Test finger-nose-finger test on both sides, once at a time

E: EYES

Can the patient see out of both eyes OK?
Ask him/her if there is sudden vision loss or blurry or double vision.
test horizontal gaze and look for gaze deviation

F: FACE

Does one side of the face look uneven or like it is drooping? Ask him/her if the face feels numb. Tell him/her to smile and check if the smile is uneven.

A: ARMS
Does one of the arms feel numb or weak?
Ask the patient to raise both arms up with palms facing up and have him/her close eyes and count to 10. See if one arm drifts downward or weak.

S: SPEECH
Ask the patient to repeat a sentence in his language like “today is a sunny day in this city”.
Is the patient's speech hard to understand?
Does he/she seem confused? Is he/she having trouble understanding you?

T: TIME
If someone has any of these warning signs, what time did the first symptom appear? If time is not known or certain, when was the patient last seen normal?

Activate stroke code is any of the above signs/symptoms is present

Appendix II: The National Institutes of Health Stroke Scale (NIHSS)

NIH stroke scale Admission date:		Time:		Before	2 h	24 h	7D/ Disch
1a.Level of consciousness	0	Alert					
	1	Not alert, but arousable with minimal stimulation					
	2	Not alert, requires repeated stimulation to attend					
	3	Coma					
1b. LOC questions *Ask patient the month and their age*	0	Answers both correctly					
	1	Answers one correctly					
	2	Both incorrect					
1c. LOC commands *Ask patient to open/close eyes and form/release fist*	0	Obeys both correctly					
	1	Obeys one correctly					
	2	Both incorrect					
2.Best gaze *Only horisontal eye movement*	0	Normalt					
	1	Partial gaze palsy					
	2	Forced gaze palsy					
***3.* Visual field testing**	0	No visual field loss					
	1	Partial hemianopia					
	2	Complete hemianopia					
	3	Bilateral hemianopia (blind, incl. Cortical blindness)					
4. Facial palsy *Ask patient to show teeth or raise eyebrows and close eyes tightly*	0	Normal symmetrical movemeent					
	1	Minor paralysis (flattened nasolabial fold, asymmetry on smiling)					
	2	Partial paralysis (total or near total paralysis of lower face)					
	3	Complete paralysis of one or both sides (abscence of facial movement in the upper and lower face)					
5. Motor function arm	0	Normal (extends arm 90° or 45° for 10 sec without drift)	**Right**				
	1	Drift					
	2	Some effort against gravity					
	3	No effort against gravity	**Left**				
	4	No movement					
	9	Untestable (joint fused/limb amputated) *(do not add score)*					
6. Motor function leg	0	Normal (holds leg in 30° position for 5 sec without drift)	**Right**				
	1	Drift					
	2	some effort against gravity					
	3	No effort against gravity	**Left**				
	4	No movement					
	9	Untestable (joint fused/limb amputated) *(do not add score)*					
7. Limb ataxia	0	No ataxia					
	1	Present in one limb					
	2	Present in two limbs					
8. Sensory *Use pinprick to test arms, legs, trunk and face, compare side to side*	0	Normal					
	1	Mild to moderate decrease in sensation					
	2	Severe to total sensory loss					
9. Best language *Ask patient to describe picture, name items*	0	No aphasia					
	1	Mild to moderate aphasia					
	2	Severe aphasia					
	3	Mute					
10. Dysarthria *Ask patient to read several words*	0	Normal articulation					
	1	Mild to moderate slurring of words					
	2	Near unintelligible or unable to speak					
	9	Intubated or other physical barrier *(do not add score)*					
11. Extinction and inattention *Use visual double stimulation or sensory double stimulation*	0	Normal					
	1	Inattention or extinction to bilateral simultaneous stimulation in one of the sensory modalities					
	2	Hemi-inattention, severe or to more than one modality					
12. Distal motor function *Ask patient to extend his/her fingers as much as possible*	0	Normal	**Right**				
	1	At least some extension after 5 sec but not fully extended					
	2	No voluntary extention after 5 sec	**Left**				
		Total score:					

Category	Score/Description		Date/Time Initials	Date/Time Initials	Date/Time Initials
1a. Level of Consciousness (Alert, drowsy, etc.)	0 = Alert 1 = Drowsy 2 = Stuporous 3 = Coma				
1b. LOC Questions (Month, age)	0 = Answers both correctly 1 = Answers one correctly 2 = Incorrect				
1c. LOC Commands (Open/close eyes, make fist/let go)	0 = Obeys both correctly 1 = Obeys one correctly 2 = Incorrect				
2. Best Gaze (Eyes open - patient follows examiner's finger or face)	0 = Normal 1 = Partial gaze palsy 2 = Forced deviation				
3. Visual Fields (Introduce visual stimulus/threat to pt's visual field quadrants)	0 = No visual loss 1 = Partial Hemianopia 2 = Complete Hemianopia 3 = Bilateral Hemianopia (Blind)				
4. Facial Paresis (Show teeth, raise eyebrows and squeeze eyes shut)	0 = Normal 1 = Minor 2 = Partial 3 = Complete				
5a. Motor Arm - Left **5b. Motor Arm - Right** (Elevate arm to 90° if patient is sitting, 45° if supine)	0 = No drift 1 = Drift 2 = Can't resist gravity 3 = No effort against gravity 4 = No movement X = Untestable (Joint fusion or limb amp)	Left			
		Right			
6a. Motor Leg - Left **6b. Motor Leg - Right** (Elevate leg 30° with patient supine)	0 = No drift 1 = Drift 2 = Can't resist gravity 3 = No effort against gravity 4 = No movement X = Untestable (Joint fusion or limb amp)	Left			
		Right			
7. Limb Ataxia (Finger-nose, heel down shin)	0 = No ataxia 1 = Present in one limb 2 = Present in two limbs				
8. Sensory (Pin prick to face, arm, trunk, and leg - compare side to side)	0 = Normal 1 = Partial loss 2 = Severe loss				
9. Best Language (Name item, describe a picture and read sentences)	0 = No aphasia 1 = Mild to moderate aphasia 2 = Severe aphasia 3 = Mute				
10. Dysarthria (Evaluate speech clarity by patient repeating listed words)	0 = Normal articulation 1 = Mild to moderate slurring of words 2 = Near to unintelligable or worse X = Intubated or other physical barrier				
11. Extinction and Inattention (Use information from prior testing to identify neglect or double simultaneous stimuli testing)	0 = No neglect 1 = Partial neglect 2 = Complete neglect				
	TOTAL SCORE				

Appendix III: Inclusion and Exclusion Criteria for IV rtPA in Acute Ischemic Stroke

	YES	NO
Inclusion Criteria		
A clinical diagnosis is made of ongoing acute cerebral ischemia which is resulting in a potentially disabling deficit		
● The onset of symptoms was within 4.5 hours from presentation		
● The patient is aged 18 years or older		
Absolute Exclusion Criteria		
Hemorrhage on head CT		
Hypodensity greater than one-third of a cerebral hemisphere demonstrated on head CT		
Active internal bleeding		
History of previous intracranial hemorrhage		
Intracranial neoplasm, arteriovenous malformation, or aneurysm		
Significant head trauma or prior stroke within 3 months		
Recent intracranial or intraspinal surgery		
Infective endocarditis as the cause of cerebral embolism		
Platelet count < 100,000/mm3		
Abnormally elevated aPTT above the upper limit of bormal		

INR > 1.7 or PT > 15 seconds.		
Current use of direct thrombin of factor Xa inhibitors within 48 hours or if a sensitive laboratory test remains elevated (e.g., aPTT, INR, ECT, TT, or factor Xa assay)		
Severely elevated blood pressure (defined as > 185/110 mmHg)+		
Blood glucose concentration < 50 mg/dL +		
Relative Exclusion Criteria*		
Pregnancy		
Major surgery or serious trauma within the previous 14 days		
Recent gastrointestinal or urinary tract hemorrhage within 21 days		
Minor or rapidly improving symptoms (resolving spontaneously)		
Seizure at onset with postictal residual impairments		
Recent acute myocardial infarction within 3 months		
Arterial puncture at a noncompressible site within 7 days		
Symptoms suggestive of subarachnoid hemorrhage		

+ IV thrombolysis may be administered if these vital sign disturbances can be corrected within an appropriate time window. * Depending on the clinical circumstances, with careful consideration of the risks and benefits, patients may receive IV thrombolysis despite 1 or more of these relative contraindications. # These relative contraindications are based on the ECASS III trial exclusionary criteria. Depending on the clinical circumstances, with careful consideration of the risks and benefits, patients may receive IV thrombolysis despite 1 or more of these relative contraindications during an extended time window.
CT = computed tomography; aPTT = activated partial thromboplastin time; INR = international normalized ratio; PT = partial thromboplastin time; ECT = ecarin clotting time; TT = thrombin time; NIHSS = National Institutes of Health Stroke Scale

Appendix IV: IV rt-PA Dosing Table and Example (based on reconstituted concentration of 1 mg/ml)

Weight (kg) **(approximate to nearest 5kg)**	**Total dose (mg) (dose = 0.9mg/kg)** **MAX DOSE: 90mg**	**rt-PA bolus dose volume (mL)** **(bolus = 10% of total)**	**rt-PA infusion dose volume (mL)** **(infusion = 90% of total)**	**Total infusion volume (mL) (approximate)**
100+	90.0	9.0	81.0	131
95	85.5	8.5	77.0	127
90	81.0	8.1	72.9	123
85	76.5	7.6	68.9	119

80	72.0	7.2	64.8	115
75	67.5	6.7	60.8	111
70	63.0	6.3	56.7	107
65	58.5	5.8	52.7	103
60	54.0	5.4	48.6	99
55	49.5	4.9	44.6	95
50	45.0	4.5	40.5	91
45	40.5	4.0	36.5	87
40	36.0	3.6	32.4	82
Patients > 55kg will require 50mg and 10mL vials.		**Bolus dose is given as an IV push over 1 minute.**	**Add to 50mL sodium chloride 0.9% minibag.**	**Infuse over 60 minutes until empty via volume control pump.**

Example:

1. Patient weighs 84 kgs - total dose of rt-PA required = 75.6 ml.

2. Mix one 50 mg vial with 50 ml sterile water.

3. Mix three 10 mg vials each with 10 ml sterile water.

4. Using a 10 ml syringe draw up 7.6 ml of rt-PA (10% of the dose as a bolus). The

remainder is 68 ml.

5. Using a 60 ml syringe number 1 draw up 34 ml of rt-PA (half of remainder solution).

6. Using a 60ml syringe number 2 draw up 34mls of rt-PA (the other half of remainder solution).

7. Set the syringe pump to infuse at 68 ml per hour.

8. Each syringe will take 30 minutes to infuse.

For a 70kg patient

Total dose = 0.9mg/kg bodyweight

= 0.9 x 70 = 63mg rtPA

Bolus dose = 10% of total dose

= 0.1 x 63 = 6.3mg = 6.3mL⇒ give as IV push over 1 minute

Infusion dose = total dose minus bolus dose

= 63 - 6.3 = 56.7mg = 56.7mL, add to 50mL sodium chloride 0.9% minibag ⇒ infuse over 60 minutes.

Appendix V: Nurse observation and task schedule post-IV rt-PA administration

Time	Activity
0 hrs	Apply telemetry monitoring equipment Administer rt-PA bolus and commence infusion as per protocol

0-1 hrs	-Write timetable for observations on chart -15 minutely observation: -modified NIHSS (mNIHSS), BP, Pulse, SpO2, Temperature -Assess size and shape of tongue. Observe for signs of allergy: unilateral or bilateral tongue enlargement, rash or redness, coughing, lip, face swelling. -Nil by mouth – commence 0.9 % sodium chloride intravenous fluids -Hourly Fluid Balance Chart -Strict Bed Rest -Avoid invasive therapies (including thrombo embolic deterrent (TED) stockings) -Internal and external bleeding assessment
1-2 hrs	-15 minutely observation: mNIHSS, BP, Pulse, SpO2, Temperature -Assess size and shape of tongue. Observe for signs of allergy unilateral or bilateral tongue enlargement, rash or redness, coughing, lip, face swelling. -Hourly Fluid Balance Chart -Strict Bed Rest; Safety Precautions: falls prevention, pressure area care -If required blood glucose 2 hourly (ongoing) -Internal/external bleeding assessment
2-6 hrs	-30 minutely observation: mNIHSS, BP, Pulse, SpO2, Temperature -Hourly Fluid Balance Chart -Strict Bed Rest; Safety Precautions: falls prevention, pressure area care -Internal/external bleeding assessment

6-12 hrs	-Hourly observation: mNIHSS, BP, Pulse, SpO2, Temperature -Hourly Fluid Balance Chart -Strict Bed Rest; Safety Precautions: falls prevention, pressure area care -Internal/external bleeding assessment -Commence Sequential Compression Device, plus or minus thigh length TED stockings
12-24 hrs	-Two hourly observation: mNIHSS, BP, Pulse, SpO2, Temperature -Hourly Fluid Balance Chart -Patient can sit out of bed if able / Physiotherapy review if available -Swallow screen assessment -Nasoenteric tube feeding can be inserted if required. -Internal/external bleeding assessment

Appendix VI: Modified Rankin Scale (MRS)

MRS is a commonly used scale for measuring the degree of disability or dependence in the daily activities of people who have suffered a stroke or other causes of neurological disability.

Score	Description
0	No symptoms at all
1	No significant disability despite symptoms; able to carry out all usual duties and activities
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Dead

Appendix VII: ICH score

A routine part of the evaluation should include a standardized severity score, because such scales can help streamline assessment and communication between providers. Although the optimal severity scale is not yet clear, the most widely used and externally validated is the ICH Score.

ICH Score

Clinical or Imaging Factor	Point Score
GCS	
3-4	2 points
5-12	1 point
13-15	0 points
ICH Volume	
≥30 cm^3	1 point
< 30 cm^3	0 points
Intraventricular Hemorrhage	
Yes	1 point
No	0 points
Infratentorial Origin of ICH	
Yes	1 point
No	0 points

Age	
≥80 years	1 point
< 80 years	0 points
Total Score	**0-6 points**

Mortality rate based on ICH Score

ICH Score	Mortality rate
0 points	0%
1 point	13%
2 points	26%
3 points	72%
4 points	97%
5 points	100%
6 points	100%

Appendix VIII: IV Thrombolysis Checklist Forms

Form A. Initial Assessment Form

Date		
Time of Symptoms Onset		
Time Last Seen Normal		
Time of Arrival/Triage		
Patient presents with disabling neurologic deficit (FAST)?	Yes	No
Time stroke code activation	Hour	Minute
Imaging shows no evidence of bleed and meets 6 h window?	Yes	No
	Hour	Minute
Time Patient sent to CT/ CTA/ CT Perfusion		
Departure from CT room		
Neurologist/Physician notified		
Neurologist/Physician arrival		
Neurointervention team notified		
Neurosurgery team notified (if required)		
CT shows no evidence of bleed or established infarct and meets 4.5 hours window for IV thrombolysis	Yes	No
Patient does not meet rt-PA eligibility criteria	Reason (tick applicable)	
	Not ischemic stroke	
	Stroke too severe	

	Family/patient refused	
	Patient palliative status	
	LSN time > 4.5 hours	
	Stroke too mild	
	Contraindication	
	MD decision	
Patient eligible for thrombectomy (6 hours window)?	Yes	No (Reason)

Final stroke management pathway	Tick applicable
Acute ischemic stroke for tPA	
Acute ischemic stroke for tPA/ thrombectomy	
Acute ischemic stroke for thrombectomy	
Acute ischemic stroke neither for tPA nor thrombectomy	

ED Physician Name (print): _____Signature: _____

Staff Number: _____ Time: hr_____min_____

Neurologist Name (print): _____Signature: _____

Staff Number: _____ Time: hr_____min_____

Form B. ED Stroke protocol checklist

Task	YES	NO	Remarks
Stroke symptoms recognized			
Stroke mimic ruled out- check finger glucose			
Time of onset identified (< 24 hours)			
Patient assigned category 2 triage level			
Patient immediately transferred to resuscitation room			
Senior ED doctor immediately notified			
Senior Emergency Department Doctor and Nurse			
Acute stroke confirmed within window			
Assessed vital signs and resuscitated			
Code stroke activated			
Emergent CT ordered			
Oxygen supplementation provided (Target oxygen saturation > 95%)			
Two large bore IV inserted in each cubital vein			
URGENT bloods ordered (Full blood examination, Electrolytes, Glucose, Liver function tests, Coagulation profile, Troponin			
Determined and documented weight			
Senior Neurology Doctor and Stroke Nurse			
Confirmed history with patient and/or EMS, family, witnesses or general practitioner with particular reference to: Stroke onset time, Medical history, Advance care directive , Medication			
Calculated National Institute of Health Stroke Scale (NIHSS)			
Completed the checklist of inclusion/exclusion criteria for intravenous thrombolysis			
Identified any potential bleeding source			

Assessed vital signs every 15 minutes			
Ensured ED Officer/Nurse responsibilities are completed			
Obtained and document all results (i.e. CXR, ECG, blood tests, vital signs)			
Notified Stroke Consultant			
Assisted and supervised patient during transfer to radiology			
Ensured hospital bed manager arranged bed			
Obtained verbal consent for intravenous rt-PA (if applicable)			
Actioned treatment specific protocols as recommended by Stroke Consultant			

Form C. Thrombolysis Protocol checklist

Task	Yes	No	Remarks
Confirmed history with patient and/or EMS, family, witnesses or general practitioner with particular reference to stroke onset time, medical history, advance care directive and medication			
Performed full neurological exam and calculate National Institute of Health Stroke Scale (NIHSS)			Calculated NIHSS
Completed the checklist of inclusion/exclusion criteria for intravenous thrombolysis			
Identified any potential bleeding source			
Assessed vital signs every 15 minutes			
Ensured ED Officer/Nurse responsibilities are completed			

Obtained Chest X-ray			
Obtained and document all results (i.e. ECG, blood tests, vital signs)			
Assisted and supervise patient during transfer to radiology			
Reviewed CT brain with radiologist to rule out hemorrhage, major hypodensity, or other lesion that would contraindicate IV thrombolysis			
Ensured hospital bed manager arranged bed			
Obtained verbal consent for intravenous thrombolysis (if applicable)			
Immediately discussed with stroke/neurology consultant (If certain that benefit to harm ratio of IV thrombolysis favours thrombolysis, administer as per Thrombolysis Protocol)			
Ensured eligibility for endovascular intervention (refer to Mechanical Thrombectomy protocol)			
Lowered BP to below 185/110 mm Hg, before given thrombolysis and insure stabilization of BP level below this range during and after rt-PA infusion, <180/105 mmHg (refer to BP management chart)			
Corrected hypotension with IV fluids and vasopressors aggressively			
Counseled of patient and family			
Did not delay thrombolysis for catheterisation, NGT insertion or other procedures.			

Form D. Post-Thrombolysis Care checklist

Task	Yes	No	Remarks
Admitted the patient to an ICU (1:1) or stroke unit (1:2) for monitoring			
Patient monitored by a specialist nurse for the first 24 hours			
Performed neurological assessments and monitored GCS and blood pressure post rt-PA at the following intervals: ● Every 15 minutes for 2 hours ● Every 30 minutes for 4 hours ● Every hour until 24hours (unless otherwise directed by treating physician).			
Observed for severe headache, acute hypertension, nausea or vomiting			
If yes, discontinued the infusion and obtained an urgent plain brain CT scan			
Repeated brain CT at 24 hours to assess for asymptomatic haemorrhage and to allow initiation of anti-platelet therapy			
Delayed placement of intra-arterial line (no punctures of arteries or large veins within 24 hours after starting rt-PA)			
Avoided insertion Nasogastric tube (avoid insertion until 8 -24 hours post rt-PA infusion)			
Avoided insertion Foley's catheter (no bladder catheterisation within 90 minutes of completing rt-PA).			
Increased the frequency of blood pressure measurements if systolic blood pressure >180 mmHg or diastolic blood pressure of >110 mmHg. Administered antihypertensive medications to maintain blood pressure at or below these levels.			
Considered transfer to ICU for intra-arterial blood pressure monitoring and management if systolic still exceeded 180 mmHg, or diastolic exceeded 110 mmHg after 30 minutes			
Left IV cannula in situ for blood collection. If emergency venepuncture required, applied direct pressure to the site for 20 minutes			

Watched for allergic reaction, tongue swelling and bleeding from any site			
Did not initiate anti-platelet therapy or anticoagulation within 24 hours after starting rt-PA			
Commenced blood glucose monitoring for 8 hours post rt-PA infusion			
Avoided mobilisation (including toilet use) after rt-PA for 24 hours			
Early assessment for dysphagia and Speech			

Form E. Management of Complications (oro-lingual angioedema) checklist

Task	Yes	No	Remarks
Stopped IV rt-PA infusion immediately			
Administered oxygen 2-4 l/min and maintain $SpO_2 > 94\%$			
Monitored the airway, checked for stridor, prepared for possibility of intubation or cricothyrodotomy.			
Administered Chlorpheniramine10-20 mg IV followed by Ranitidine 50 mg IV			
If tongue continued to enlarge after the above steps have been completed then administered Methylprednisolone (Solu-Medrol) 80-100 mg IV			
If the oro-lingual angioedema did not halt at this point, then urgently: o Administered Epinephrine 1:10000.3 ml subcutaneous or by nebulizer 0.5 ml. o Consulted ENT/anesthesiology or the appropriate in-house service immediately for possible emergency cricothrotomy/tracheostomy or fiberoptic-nasotracheal intubation if oral intubation fails.			

Form F. Management of Anaphylaxis checklist

Task	Yes	No	Remarks
Stopped rt-PA immediately			
Administered oxygen 2-4 l/min and maintain SpO_2 > 94% and monitor airway			
Administered Epinephrine 1:10000.3 ml SC or IM			
Administered Chlorpheniramine10 mg IV			
Administered Hydrocortisone 200 mg IV			
If hypotensive (BP < 90 mmHg), started fluid resuscitation 1-2 liter bolus IV Normal Saline			
Administered nebulized Salbutamol 2 mg for bronchospasm, repeated Epinephrine if no response			
Considered Epinephrine infusion 1-4 mcg/min IV if inadequate response			

Form G. Management of post-thrombolysis ICH checklist

Task	Yes	No	Remarks
Stopped rt-PA infusion immediately if sudden neurologic decline occured			
CT scan obtained emergently			
Control of hypertension (systolic target 130-150 mm Hg)			
Consulted Neurosurgery			
Reversal of the fibrinolytic effect with: 1. Cryoprecipitate (10 units) or 2. An antifibrinolytic agent (Tranexamic acid 10 mg/kg to 15 mg/kg IV over 20 minutes or 3. Aminocaproic acid 5 g IV followed by an infusion of 1 g/h if necessary). 4. Additional cryoprecipitate given if required			
Considered consulting Hematologist.			

Form H. Mechanical Thrombectomy checklist

Task	Yes	No	Remarks
Transferred eligible cases to the angiography suite immediately even if IV-rtPA is still ongoing			
Obtained informed consent from the patient or the patient's legally authorized representative by the interventional neuro-radiologist or neurologist			
Monitored the patient in ICU (1:1) /Acute Stroke Unit (1:2 nursing care) for at least 24 hours post-procedure			
Checked femoral sheath, keep it patent by continuous pressure flush and remove it after 24 hours. ● Checked BP before removing the sheath. ● Placed the patient supine for 6 hours after removal the sheath with the accessed leg straight.			
Checked for bleeding/hematoma at the groin puncture site ipsilateral pedal pulse and neurological exam: o Every 15 minutes for 2 hours o Every 30 minutes for 2 hours o Every 60 minutes for the remaining 24 hours.			

Form I. IV thrombolysis order form checklist

rt-PA IV Dose	Nursing	
	Time	Initial
Dose must be calculated for the patient's weight (10% of the total dose given as bolus, followed by 90& of the total dose) TOTAL dose: Patient's weight (kg) _____ X 0.9 = _____ mg IV, (maximum dose 90mg)		
BOLUS dose: 10% TOTAL dose = _____ mg IV over ONE minute. Time: _____Hr _____ Min.		
Continous infusion dose = 90% TOTAL dose = _____ mg over ONE hour Time: _____ Hr _____ Min.		
Discontinue tPA immediately and notify neuro-medical on-call if severe headache, decreased level of consciousness, severe bleeding occur or breathing difficulty.		
Nurse Signature & Staff no.		

Appendix IX: General Acute Stroke Audit Form

Parameter	Y	N	N/ A	Comment/ time
Was stroke code initiated & time documented?				
Did a designated physician/ nurse respond to bedside within 15 minutes & was this documented?				
Were the time parameters included in the stroke assessment protocol or ED stroke protocol documented?				
Were the time parameters included in the stroke assessment protocol or ED stroke protocol met?				
Was the NIHSS done for the initial assessment as defined by organizational policy?				
Was a blood glucose level done?				
Was a neuroimaging of the head completed within 25 minutes of patient presentation with stroke symptoms?				
Was the interpretation by a radiologist completed within 10 minutes & documented?				
Were lab tests (CBC with coagulation, PT/INR, LFT, RFT & troponin) done within 45 minutes of patient presentation, if ordered?				
Was ECG done within 45 minutes of patient presentation, if ordered?				
Was actual patient weight obtained?				
If patient eligible, was the door to needle time <45 minutes?				
If patient was eligible for thrombolysis and did not receive it, was the reason documented?				
Were vital signs done per order post thrombolysis?				
Were neuro assessments completed per organizational policy?				

Were labs drawn, IV started, & Foley inserted, if ordered, prior to IV thrombolysis being started?				
Was the time & amount of bolus dose and IV drip of rt-PA/ bolus of TNK documented?				
Was the patient eligible for mechanical thrombolectomy				
If eligible, was door to femoral <60 minutes?				
Was the patient transferred to another facility and, if so, was the time documented?				
If patient admitted, was he or she admitted to an appropriate stroke ICU/ ASU or floor?				
If patient admitted, was the stroke order set implemented?				
OTHER:				

*adopted from: 2015 Joint Commission Resources

Appendix X: Discharge from Stroke Unit Checklist

	Yes	**No**	**As out-patient**
Discharge Summary given			
Investigations completed /Scheduled			
Serial CT / MRI Head			
Extracranial artery imaging: (Carotid/vertebral CTA or MRA)			
Echocardiography			
Holter monitoring			
Fasting lipids/HbA1c (or other young stroke workup if applicable)			
	Yes	**No**	**Remarks**
Discharge advice			

Patient / Family counseled regarding Stroke prevention and Life-style modification choices			
Stroke education material given			
DVT Prophylaxis (If required)			
Referral to Rehabilitation Team			
Swallowing issues / Diet			
Language and speech assessment			
Referral to Cardiology (if indicated):			
Referral to Vascular Surgery (if indicated)			
Referral to other specialties (specify)			
Referral to local hospital/local health center			
Discharge Medication			
Antiplatelet agent: Aspirin / Clopidogrel/ Other (specify)			
Statin			
Anti-coagulation: Warfarin/NOACs/ LMWH			
Anti-hypertensive treatment (if indicated)			
Anti-Diabetes treatment (if indicated)			
Follow-up Date in Stroke Clinic given			

Discharging physician signature:_____

Discharging nurse signature:_____