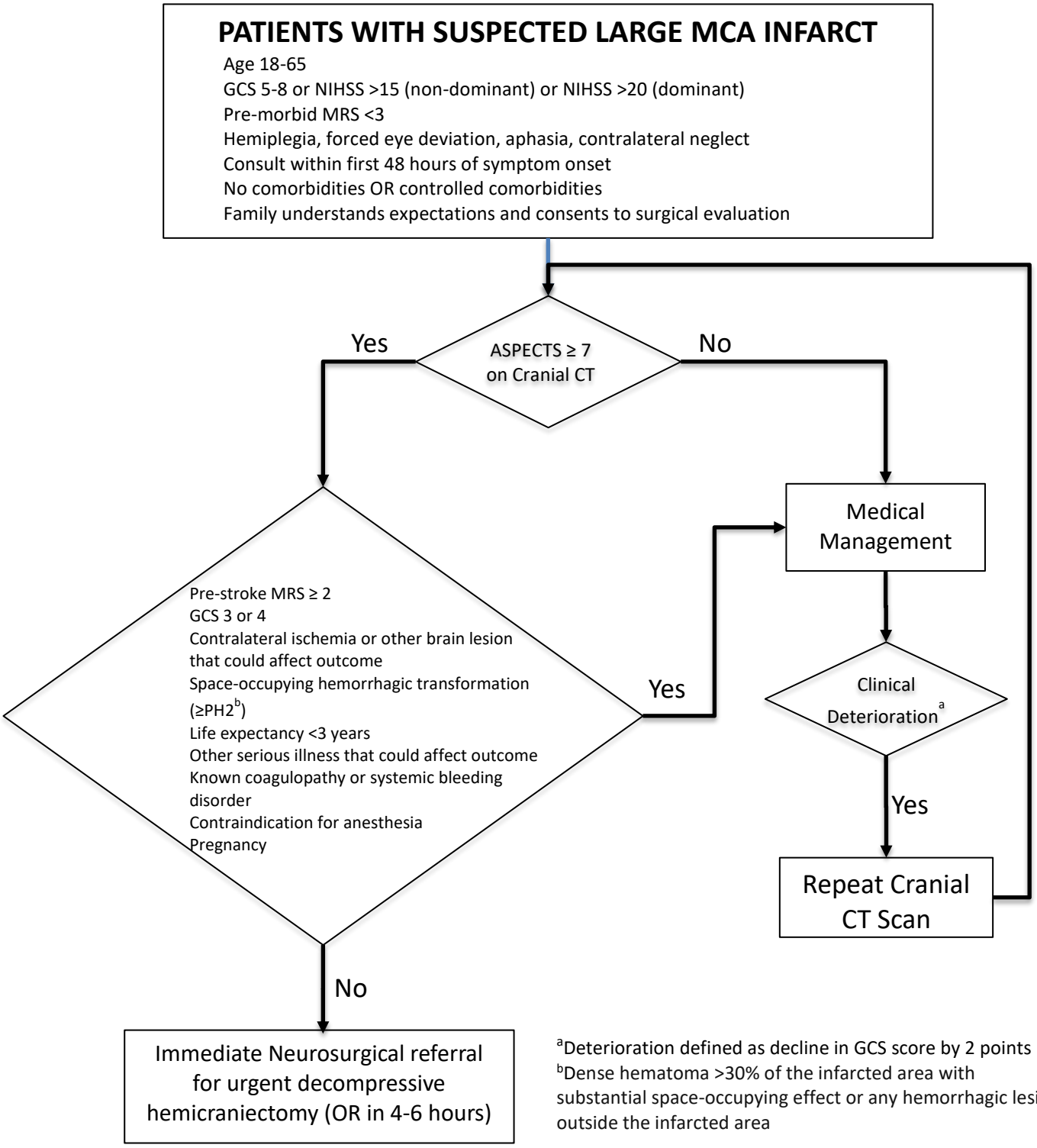
CLINICAL PATHWAY FOR MALIGNANT MCA INFARCTS

(Adapted from the STATE Criteria of the Massachusetts General Hospital Stroke Service[1])



[a]Deterioration defined as decline in GCS score by 2 points

[b]Dense hematoma >30% of the infarcted area with substantial space-occupying effect or any hemorrhagic lesion outside the infarcted area

TREATMENT ALGORITHM[1]

Assign the patient into one of 3 categories:

A. **MOST LIKELY to benefit from early hemicraniectomy** (meets all STATE criteria)
1. Consult neurosurgery emergently
2. Proceed for hemicraniectomy within the defined timeframes
3. Admit to the Neuro ICU before and after the procedure for close neurological monitoring and medical treatment
4. For patients who meet all STATE criteria except for drowsiness, these patients should be admitted the Neuro ICU and closely monitored. If they develop drowsiness, they should be sent for hemicraniectomy.

B. **UNCERTAIN to benefit from early hemicraniectomy** (age <75 yrs and meets many but not all STATE criteria)
1. Hemicraniectomy is offered as a compassionate therapy if there is consensus among the treating teams and family that the patient would want to proceed recognizing that there is uncertainty as to the benefit.
2. Regardless of the decision to proceed with hemicraniectomy, if full aggressive treatment is requested by family and felt appropriate by treating team, then admit the patient to an intensive care unit, preferably the Neuro ICU, for close neurological monitoring and medical treatment.

C. **UNLIKELY to benefit from early hemicraniectomy** (age >75 yrs or terminal illness or signs of active herniation)
1. Hemicraniectomy will not be offered
2. If full aggressive treatment is requested by family and felt appropriate by treating team, then admit the patient to an intensive care unit, preferably the neuroICU, for close neurological monitoring and medical treatment. If there are previously expressed wishes about limitations on aggressive care or the treating team feels that the patient's prognosis is so poor that aggressive treatment is not warranted, then an informed discussion with the family should precede a decision about intensive care admission and management.

Pre-surgical and Surgical Management

A. If hemicraniectomy is offered, withhold anti-coagulation and anti-platelets until deemed safe post-procedure with input from neurosurgery
B. For adequate external decompression, the size of the bone flap removed should ideally be **12 cm (anterior-posterior) by 9 cm (superior-inferior), combined with duraplasty**.
C. Temporal lobectomy may be considered during the procedure, at the neurosurgeon's discretion. If performed, tissue should be submitted for neuropathological examination.
D. The bone flap should be placed in a subcutaneous abdominal pouch or stored in the bone bank.

Post-surgical Management

A. Admit the patient to an intensive care unit, preferably the Neuro ICU. The Neurocritical Care attending will be the attending of record.
B. Once appropriate, a protective helmet should be worn until the bone flap is replaced.
C. The bone flap should be replaced as soon as the patient can tolerate the surgery, preferably within 12 weeks, unless the patient develops intercurrent infections or other complications requiring delay.

Medical (Adjunctive) Therapy

Although not proven efficacious, medical strategies may reduce the risk of developing fulminant brain edema. These strategies should be used in all patients with large MCA stroke and as an adjunct to hemicraniectomy (if the patient is deemed eligible). They should not used be to defer or delay hemicraniectomy if STATE criteria are met.

A. **General management:** patients with raised intracranial pressure require special attention to pain relief, avoidance of noxious stimuli, proper head positioning, adequate oxygenation, maintenance of normothermia, and prevention of DVT. Avoid oral or gastric feedings if the patient is likely to go to surgery imminently.
B. **Hyperventilation:** a temporary measure to reduce ICP if signs of brain herniation develop. Should be avoided unless other measures are exhausted and there is a plan to proceed immediately to surgery.
C. **Osmotic therapy:** Mannitol 0.5-1.5g/kg IV q4-6 hours or Hypertonic Saline Solution (3%) given as IV bolus q4-6 hours (Target Na 145-155 mmol/L)
D. **Invasive ICP monitoring** (subarachnoid screw or bolt) is not required to determine suitability for decompressive surgery. An external ventricular drain should be considered if brain imaging shows evidence of acute hydrocephalus. It may be useful to monitor the ICP post-operatively if there is concern that the decompression was insufficient

References

1. Marquevich V., Kimberly T., Ogilvy C., Schwamm L., Singhal A. www2.massgeneral.org/stopstroke/protocolHemicraniectomyGuidelines.aspx

2. Vahedi, K., Hofmeijer, J., Juetler, E., Vicaut, E., George, B., Algra, A., et al. Early decompressive surgery in malignant infarction of the middle cerebral artery: a pooled analysis of three randomised controlled trials. *Lancet Neurol* 2007; 6:215-22.

3. Hofmeijer, J., Kappelle, L.J., Algra, A., Amelink, G., van Gijn, J., van der Worp, H., Surgical decompression for space-occupying cerebral infarction (the Hemicraniectomy After Middle Cerebral Artery infarction with Life-threatening Edema Trial [HAMLET]): a multicentre, open, randomised trial. *Lancet Neurol* 2009; 8:326-33.

4. Philippines, S. S. (2010). *Guidelines for the Prevention, Treatment and Rehabiliation of Stroke* (5th ed.). (A. R. Jr., Ed.) The Stroke Society of the Philippines.

Appendix: Criteria and Scales

Table 1. STATE Criteria

STATE Criteria for *IMMEDIATE NEUROSURGICAL CONSULTATION* for hemicraniectomy for malignant MCA infarction

Factor	Criteria
Score*,**	NIHSS item 1a >=1 or GCS <= 8, and NIHSS > 15 (non-dominant) or > 20 (dominant)
Time	<=48 hr since last seen without neurological deficits
Age	<=60 years
Territory	Infarct lesion volume >150 cm^3 (use ABC/2 criteria for estimating lesion volume), or >50% MCA territory infarction
Expectations	Life expectancy 'reasonable' in the opinion of the Neurology Attending or NeuroICU Fellow. In addition, the health care proxy or family members understand that while the procedure is proven to reduce disability and mortality, the patient may still survive with severe disability.

If all the above "STATE" criteria are met, *proceed to hemicraniectomy urgently (to OR within 4-6 hrs).*

*for intubated/sedated patients, monitoring of the level of alertness can be challenging and the clinical judgment of the Neurology Attending is important in determining whether a patient meets this criterion. ** for patients who meet all STATE criteria except the level of drowsiness, patients should be triaged to the Neuro ICU for close neuromonitoring.

Indications for *EMERGENT HEMICRANIECTOMY:* STATE criteria met above, AND	
Early Signs of Herniation	Asymmetry in pupil size
Midline Shift	>10mm at septum pellucidum, or >5mm at pineal gland

Table 2. NIHSS

NATIONAL INSTITUTES OF HEALTH STROKE SCALE (NIHSS)

ITEM	SCORE
Level of consciousness	
Alert	0 points
Drowsy	1 point
Stupor	2 points
Coma	3 points
Response to 2 questions (orientation)	
Know age and current month	0 points
Answers 1 question correctly	1 point
Cannot answer either question correctly	2 points
Response to 2 commands	
Follows 2 commands correctly	0 points
Follows 1 command	1 point
Cannot follow either command	2 points
Best gaze (movement of eyes to left or right)	
Normal eye movements	0 points
Partial gaze paresis to one side	1 point
Forced gaze palsy to one side	2 points
Visual fields	
No visual loss	0 points
Partial homonymous hemianopia	1 point
Complete homonymous hemianopia	2 points
Bilateral visual loss	3 points
Facial motor function	
No facial weakness	0 points
Minor unilateral facial weakness	1 point
Partial unilateral facial weakness	2 points
Complete paralysis of 1 or both sides	3 points
Upper-extremity motor function (right and left scored independently 0 – 8 points)	
Normal movement	0 points
Drift of upper extremity	1 point
Some effort against gravity	2 points
No effort against gravity but moves	3 points
No movement	4 points
Lower-extremity motor function (right and left scored independently 0 – 8 points)	
Normal movement	0 points
Drift of lower extremity	1 point
Some effort against gravity	2 points
No effort against gravity but moves	3 points
No movement	4 points
Limb ataxia (cannot be tested in presence of paresis)	
No limb ataxia	0 points
Ataxia present in 1 limb	1 point
Ataxia present in 2 limbs	2 points
Sensory function	
No sensory loss	0 points
Mild-to-moderate sensory loss	1 point
Severe-to-total sensory loss	2 points
Language	
Normal language	0 points
Mild-to-moderate aphasia	1 point
Severe aphasia	2 points
Mute	3 points
Articulation	
Normal articulation	0 points
Mild-to-moderate dysarthria	1 point
Severe dysarthria	2 points
Extinction or inattention (neglect)	
No neglect or extinction	0 points
Visual or sensory inattention or extinction	1 point
Profound inattention to visual and sensation	2 points

Table 3. Glasgow Coma Scale

Component	Score
Eye Opening Response 1- No eye opening 2- Eye opening to pain 3- Eye opening to verbal stimuli 4- Spontaneous	
Verbal Response 1- No verbal response 2- Incomprehensible sounds 3- Inappropriate words 4- Confused 5- Oriented	
Motor Response 1- No motor response 2- Extension to pain (*decerebrate response*) 3- Abnormal flexion to pain (*decorticate response*) 4- Flexion/Withdrawal to pain 5- Localizes to pain 6- Obeys commands	

Table 4. Modified Rankin Score

0	No symptoms at all
1	No significant disability despite symptoms; able to carry out all usual duties and activities
	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
2	Moderate disability; requiring some help, but able to walk 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