Management of Cerebral/Cerebellar Infarcts with Swelling

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Objectives

Define what patients are at risk for neurological deterioration from cerebral swelling and clinical signs used to identify these patients

Explain recommendations for how these patients should be managed to support optimal outcomes

Define treatment options for patients when neurological deterioration occurs and implications for nursing care

Describe how RN can be supportive to family
Introduction

Emergence of brain swelling is the most troublesome even life-threatening consequence of large territory ischemic stroke.

Brain swelling occurs as a result of loss of function of membrane transporters:

- Causes Na+ and H2O influx into necrotic or ischemic cell leading to cytotoxic edema.
- The BBB is disrupted by unrelenting swelling.
Cellular injury related to Ischemia

Mild to Moderate Ischemia

- Insufficient 02 and glucose
- Inadequate E Supply
- Failure of neuronal activity
  Regional Brain Dysfunction

Severe Ischemia

- Influx of H2O, Na+, CL-
- Cytotoxic edema
- Influx of Ca++
- Irreversible cellular injury
- Anaerobic metabolism
- Accumulation of lactic acid
  And H+ compromise
  Of neuronal integrity

Advanced Ischemia

- Influx of H2O, Na+,
  Ca++
- Destruction Of Cellular components
- Formation of Free radicals,
  Ecosanoids,
  leukotrienes

DSUS/INS/0315/0829
Epidemiology

Hard to estimate incidence of severe brain edema

The prevalence of hemispheric MCA infarction by these variable definitions has been reported to be:

• 2-8% of hospitalized stroke
• 10-15% of all MCA territory ischemic stroke
• 18-31% of all ischemic stroke caused by MCA occlusion

The risk of subsequent neurological deterioration or death is high at 40-80%
Epidemiology

Actual frequency of decompressive craniectomy for malignant MCA infarction is estimated to have increased from 0.04% in 1999-2000 to 0.14% of all stroke admissions in 2007-2008.

Incidence of severe brain edema in cerebellar infarction and frequency of decompressive craniectomy for cerebellar edema are sparse.

- Studies suggest around 20% of patients will develop radiographic signs of mass effect accompanied by neurological deterioration.
Epidemiology: Recommendations

Standardized terms and definitions for severe hemispheric and cerebellar edema resulting from infarction should be established to facilitate multicenter and population based studies of incidence, prevalence, risk factors and outcomes (Class I; Level of Evidence C)

Additional data should be collected to determine the use of decompressive craniectomy in current clinical practice, including whether there is variation by physician, hospital, health system, or patient characteristics and preferences (Class I, Level of Evidence C)
Patients with significant swelling typically have occlusions of internal carotid artery, MCA or both

- Most common clinical presentation are hemiplegia, global or expressive aphasia, severe dysarthria, neglect, gaze preference, and a visual field defect

Initial NIHSS is often >20 with dominant hemispheric infarction and >15 with nondominant hemispheric infarction

- The initial score is a reflection of stroke severity and infarct volume and not a marker of tissue swelling, although it is sensitive it isn’t specific
Definition and Clinical Presentation: Hemispheric Stroke

Most specific sign of significant cerebral swelling after stroke is decline in level of consciousness.

No clinical feature has been validated to reliably measure LOC, nor has there been a good way of documenting early changes in LOC.

- 1a of NIHSS has been used in some studies.

One study suggested that diffuse slowing and increased delta activity on cEEG in first 24h may document early global dysfunction in patients likely to swell.
Neurological deterioration usually occurs in most patients within 72-96h.

Age has been an inconsistent measure associated with outcome after severe stroke.

- Generally younger patients have increased risk for shift related to edema due to decreased compliance.

Other clinical factors associated with edema:

- Early N/V, female, CHF and leukocytosis.
Definition and Clinical Presentation: Cerebellar Stroke

Few reliable clinical S&S can serve to stratify severity of cerebellar stroke
Swelling may result in pontine compression, acute hydrocephalus secondary to obstruction of 4th ventricle
Most reliable clinical symptom of swelling is decreased LOC
Deterioration is directly related to initial infarct volume

• Initial CT is normal in 25% of patients
Hemorrhagic Transformation of Strokes

Common complication of severe stroke and is manifestation of damage to BBB, loss of microvascular integrity and disruption of neurovascular unit

- It may be a consequence of recanalization and reperfusion of infarcted area

Seen more commonly in patients with severe stroke at high risk for swelling

Increased risk may be attributable to primary injury or a higher incidence of thrombolytic therapy

Advanced age and hyperglycemia have also been associated which results in increased mortality especially in patients with cerebellar infarction
Definition and Clinical Presentation: Recommendations

Patients with or at higher risk for infarction and swelling should be identified through the use of clinical data, including vessel occlusion status (Class I, Level of Evidence B)
Case Scenario: AC 7:18

EMS calls into ED with possible stroke patient, ETA 10 mins
Pt is 39 yo white female found down with left sided weakness
Department secretary announces overhead medical alert stroke symptoms 10 minutes by ground
Case Scenario: AC 7:28

- Patient arrives to ED via EMS and triaged as Stroke I
- EMS crew provides history that husband found her down this morning a little after 7:00 am with left sided weakness. She was last known normal at 3:00 am
- Past medical history of smoking and 2 months post-partum; currently on no medications
- BP enroute had been 140s-150s/70s-80s, HR 70 SR and blood sugar 110
- What is time of onset? How far along are we into this stroke? What are the next steps of the RN?
Case Scenario: AC 7:30

VS: 155/88, HR 70 SR, 95% on RA

Assessment reveals that patient is not alert, but arousable by minor stimulation, following commands, forced gaze deviation, partial hemianopia, has minor paralysis of left face, no movement in left arm, severe left hemiparesis of left leg, severe sensory deficit mild dysarthria and severe neglect

• What is his NIHSS?
  ➢ A) 6
  ➢ B) 17
  ➢ C) 22
CT Imaging
A non-contrast head CT is first line diagnostic test to exclude other diagnoses, ascertain cause and prognosis and guide intervention

- CT is also modality of choice to follow up on infarcts with swelling

CT findings that predict malignant edema and poor prognosis

- Frank hypodensity within 1st 6 hours and involvement of 1/3 or more of MCA territory
- Presence of dense MCA sign or midline shift >5 mm within first 2 days associated with neurological deterioration and early mortality
Neuroimaging

Angiographic findings
- Occlusion of distal internal carotid is frequently associated with malignant edema
- Incomplete circle of Willis is predictive of worse outcome

MRI can be substituted by is less widely available and utility for predicting swelling, shift has not been sufficiently examined

TCDs is a means to monitor elevated ICPs and detect cerebral herniation and deciding on medical or surgical therapy
Neuroimaging: Recommendations

Frank hypodensity on head CT within the first 6 hours, involvement of $\frac{1}{3}$rd or more of MCA territory and early midline shift are CT findings that are useful in predicting cerebral edema (Class I; Level of Evidence B).

The measurement of MRI DWI volume within 6 hours is useful, and volumes (>80ml) predict rapid fulminant course (Class I; Level of Evidence B).

A noncontrast CT scan of brain is a useful first line diagnostic test and modality of choice to monitor patients with hemispheric cerebral or cerebellar infarcts with swelling. Serial CT findings in first 2 days are useful to identify patients at high risk for developing symptomatic swelling (Class I, Level of Evidence C).
Case Scenario: AC 7:40

- Stroke CT Protocol completed
- Neurologist arrives in scanner and is updated
- CT Interpretation: CTA head/neck and CTP reveal hyperdense MCA, Right T-shaped clot from ICA to right M1 and right ACA A1
- Unfortunately, the infarct was completed and there was no acute intervention that could be offered
Basics of Support: Triage

Before any interventions are taken, patients should be admitted to intensive care or stroke units with neuromonitoring capabilities and multidisciplinary approach to care coordinated by neurointensivists, vascular neurologists, and neurosurgeons.

- Neurosurgical consultation should be sought early to facilitate planning of decompressive surgery or ventriculostomy with decompressive surgery if necessary.
Triage: Recommendations

Transfer to an intensive care or stroke unit is recommended for patients with a large territorial stroke to plan close monitoring and comprehensive treatment (Class I; Level of Evidence C). Triage to a higher level center is reasonable if comprehensive care and timely neurosurgical intervention are not available locally (Class Iia; Level of Evidence C).
Case Scenario: AC 08:00

- Husband arrives in the ED
- Neurologist meets with him and explains that wife has had a stroke and unfortunately we cannot offer any recanalizing therapies
- Concerned about how large stroke is and will be admitting her to ICU for close observation
- Also will be focusing on identifying the cause of her stroke
Acute Care

Nursing Care Objectives:
• Focus on continued stabilization of patient
• Prevent progression of stroke
This is accomplished by:
• Frequent neurological, respiratory, and hemodynamic monitoring
• Prevention of complications

Medical Management Objectives:
• Prevent progression of the stroke and prevent recurrent events
• Identify cause of event
Accomplished by:
• Ordering appropriate diagnostic tests to identify source of event
• Secondary Prevention
• Rehabilitation

Frequent monitoring of neurological, respiratory, and hemodynamic statuses

• Need to establish good baseline neurological exam to pick up on subtle changes (Class I, Level of Evidence B)
• Oxygenation needs to be maintained (Class I, Level of Evidence C)
• Hemodynamic monitoring important because of blood pressure control and cardiac arrhythmias (Class I, Level of Evidence B)

Most common reason for intubation is decline in consciousness and inability to maintain a patent airway

Recommendations:

• Maintaining normocarbia is reasonable (Class Iia, Level of Evidence C)
• Intubation may be considered for patients with decreased LOC resulting in poor oxygenation or impaired control of secretions (Class IIb, Level of Evidence C)
• Prophylactic hyperventilation is not recommended (Class III, Level of Evidence C)
Monitoring of oxygen saturation will reduce the risk of neurological injury

Factors that can compromise oxygenation

- Decreased LOC
- Aspiration
- Atelectasis

Vigilant nursing assessment is important to pick up on threats to adequate oxygenation (Class I, Level of Evidence C)

Summers, et al. Comprehensive Overview of Nursing and Interdisciplinary Care of the
Maintenance fluid management in patients is important to ensure adequate cerebral perfusion and normovolemia

- Isotonic saline is recommended and avoidance of hypo-osmolar fluids and fluids without dextrose

Cardiac arrhythmias or worsening of pre-existing cardiac arrhythmias is common after a large ischemic stroke, particularly with cerebellar infarcts compressing the brainstem or infarcts involving the insular region

- Most are self-limiting and don’t require intervention

Insufficient data to support exact BP parameters
Fluids: It is important to keep the acute stroke patient hydrated to promote blood flow by decreasing blood viscosity, prevent fluctuations in blood pressure, and reoccurrence of stroke.

- Generally managed with IVFs and monitoring of labs and vital signs
- Avoid IVFs with dextrose
- Avoid hemodilution (Class III, Level of Evidence A)

Hemodynamic Support and BP Management: Recommendations

Aggressive treatment of cardiac arrhythmias with appropriate medications and continued cardiac monitoring is recommended (Class 1; Level of Evidence C)

There are insufficient data to recommend specific SBP or MAP targets. BP meds may be recommended for extreme HTN (Class IIb; Level of Evidence C)

Use of adequate fluid administration with isotonic fluids might be considered (Class IIb; Level of Evidence C)

Use of prophylactic osmotic diuretics before apparent swelling is not recommended (Class III; Level of Evidence C)
Acute Nursing Care: Blood Pressure

Should be managed with caution and recommend that for first 24-48 hours manage according to guidelines outlined in hyperacute phase *(Class I, Level of Evidence C)*

If blood pressure rises, assess for causative reasons

- Physiological response to hypoxia
- Increasing ICP
- Hemorrhagic transformation
- Full bladder
- Pain, Nausea
- Loud environment
Nutrition: Assessment of patient’s baseline nutritional status upon admission is important as is maintaining and promoting this status.

- This can be achieved by promoting early feeding via PO or NG if PO is unsafe (Class I, Level of Evidence B)
- It is very important that patient’s swallow be evaluated before anything is given by mouth; RN needs to be familiar with bedside swallow assessment (Class I, Level of Evidence B)

Acute Nursing Care: Glucose Management

Hyperglycemia is associated with increased edema in patients with cerebral ischemia and increased risk of hemorrhagic transformation

• Ideal glucose is unknown, but the European Stroke Initiative suggested avoiding hyperglycemia exceeding 180 mg/dL

• A recent randomized study in ischemic stroke found an increase in infarct size with aggressive control- target 126 mg/dL
Hyperglycemia should be avoided and glucose levels between 140-180 mg/dL is recommended (Class I; Level of Evidence C)

Tight glycemic control (glucose <110 mg/dL) is not indicated, but an insulin infusion may be used to avoid significant hyperglycemia (Class IIb; Level of Evidence C)

Hypoglycemia should be avoided at all times (Class III; Level of Evidence C)
Acute Nursing Care: Hyperglycemia

Associated with poor outcomes, infarct expansion, and hemorrhagic transformation

Patients should be monitored frequently and treated according to institutions policy

- ICU with blood glucose >140 mg/dL monitor every 1-2h
- Non-ICU setting, monitor every 24 to 48 h and treat accordingly

Blood glucose levels should therefore be maintained in a range below 140 mg/dL with insulin as necessary to avoid the increased risk of cerebral edema or hemorrhage

Summers, et al. Comprehensive Overview of Nursing and Interdisciplinary Care of the Acute Ischemic Stroke
Fever is uncommon after ischemic stroke and may more often indicate early infection rather than a stress response. Normothermia is preferred, but therapeutic hypothermia has not been sufficiently studied. European Stroke Initiative recommends treating temperatures > 37.5 °C.
Temperature Management: Recommendations

Temperature management is part of basic support and a normal temperature is reasonable (Class IIa; Level of Evidence C)
The effectiveness of the use of therapeutic hypothermia before brain swelling is not known (Class IIb; Level of Evidence C)
Acute Nursing Care: Fever

Even an increase of 1 degree F is a predictor of poorer patient outcome and independent factor in short and long-term mortality rates

- **Rationale:** An environment is created that promotes further damage to the brain related to neurotransmitter release, free radical formation, and impaired recovery of brain metabolism.

Care needs to be centered around treating cause of fever and maintaining normothermia (Class I, Level of Evidence C).
Case Scenario: AC 09:00 am

Patient admitted to TNICU for close monitoring
VS stable BP 138/78; HR 80s NSR; O2 96% RA; Temp 98.3 F
Patient kept NPO as too sleepy to complete dysphagia screen
IV fluids started NS at 125 cc/hour
Neurosurgery consulted to follow patient
RN provides support to family by explaining what the plan of care is currently and what testing will be ordered in the next 24 hours
Diagnostic Testing During Acute Phase

- Continuous cardiac monitoring for at least 1st 24 hours
- Further Cerebral imaging: MRI/MRA; angiography
- Carotid dopplers; TTE and TEE
- Laboratory tests: fasting lipids, Hgb A1C, coagulopathy tests, homocysteine
- RNs should be familiar with basic neuroimaging testing so able to educate patient/family (Class I, Level of Evidence C)
Deep venous thrombosis prophylaxis with subcutaneous or low-molecular-weight heparin should be used (Class I; Level of Evidence C)

Intravenous heparin or combination antiplatelet agents are not recommended in patients with swollen strokes (Class III; Level of Evidence C)

Seizure prophylaxis in patients without seizures at presentation is not indicated (Class III; Level of Evidence C)
VS 148/80; HR 80s, NSR, O2 96% on RA; Temp 98.1 F
Patient NIHSS 17
Neurosurgery has seen patient and reviewed initial CT
• Spoken with family about ordering serial CTs and that will be watching patient very closely for the next several days for development of cerebral edema
Corpak has been placed for medications and nutrition
RN at bedside and further explaining recommendations from neurosurgery and preparing family for testing that will be completed over the next couple of days
Case Scenario: AC 19:00

VS 150/88, HR 85 NSR; O2 94% on 2 L per NC
MRI completed and reveals large stroke in R hemisphere
Case Scenario: AC 24h after Stroke

Patient is a little less arousable this morning

- NIHSS 18
- VS 135/76, HR 76 NSR, O2 96% 2L NC, Temp 98.8 F
- Labs drawn and sent for hypercoaguable work-up, fasting lipid panel, HgbA1C, CBC, Chem 7
- Head CT without shows evolution of R MCA infarct and development of mass effect
- TTE will be completed today
Cerebral Edema (CE)

CE begins to develop immediately but does not peak until 3-5 days after event

Monitoring for increased ICP should be part of ongoing assessment

Treatment plan goals:
• Reduce ICP
• Maintain cerebral perfusion pressure
• Prevent secondary brain injury

Care should focus on
• Evaluation for hypoxia, hypercarbia and hyperthermia
• HOB 20-30 degrees
• Head position may be one of single most important nursing modalities for controlling increased ICPs
• Good head and body alignment
• Pain management

Case Study: AC 36h after stroke

- Patient has become less responsive, requiring more O2 support, now has low grade fever, BP and heart rate elevated
- Stat Head CT ordered and showed slight increase in swelling
- IV mannitol started
- Maintaining HOB at 30 degrees and head/body alignment
- Tylenol given and CXR showed pneumonia and antibiotic started
- Neurosurgery updates family and talks to them about surgical treatment options
ICP Management

Clinical deterioration is more often the result of displacement of midline structures such as the thalamus and the brainstem than a mechanism of globally increased ICP. There doesn’t appear to be any value of ICP monitoring or placement of ventriculostomy in a patient presenting early with large supratentorial swollen hemispheric brain.
ICP Management: Recommendation

Routine ICP monitoring is not indicated in hemispheric ischemic stroke (Class III; Level of Evidence C)
Ventriculostomy is recommended in obstructive hydrocephalus after a cerebellar infarct but should be followed or accompanied by decompressive craniectomy (Class I; Level of Evidence C)
Recognition of Deterioration

Deterioration in supratentorial hemispheric infarct may present in 2 ways

• A gradual progressive rostrocaudal deterioration (development of midline pupil, worsening or motor responses, and progression to irregular breathing and death)

• More suddenly present with unilaterally dilated pupil progressing to bilateral pupils followed by decreasing motor response from localization to flexion rigidity respiratory patterns, signaling lower brainstem dysfunction, typically occur late in the course

• Central neurogenic hyperventilation or ataxic respiratory patterns and periodic breathing
Recognition of Deterioration

In cerebellar infarcts, clinical signs are related to brainstem compression and obstructive hydrocephalus

- Depression of LOC, GCS <12 on admission
- Acute hydrocephalus
- Rapid deterioration to coma

Deterioration from swelling or extension of infarct into the brainstem cannot be clinical distinguished but many patients develop pupillary anisocoria, pinpoint pupils, and loss of oculocephalic responses
Recognition of Deterioration: Recommendations

Clinicians should frequently monitor level of arousal and ipsilateral pupillary dilation in patients with supratentorial ischemic stroke at high risk for deterioration. Gradual development of midposition pupils and worsening of motor response may also indicate deterioration (Class I; Level of Evidence C)

Clinicians should frequently monitor for level of arousal or new brainstem signs in patients with cerebellar stroke at high risk for deterioration (Class I; Level of Evidence C)
Medical Options in Deteriorated Patient

Initial management should focus on reducing space-occupying effects of brain swelling

• Elevate HOB 30 degrees
• Osmotic therapy either mannitol or other hypertonic solution
  • Creates osmotic gradient and draws H2O out of neurons into arteries leading to vasoconstriction and reduced cerebrovascular volume

Hypothermia has been used to various degrees and prospective studies are currently underway
Medical Options: Recommendations

Osmotic therapy for patients with clinical deterioration from cerebral swelling associated with cerebral infarction is reasonable (Class IIa; Level of Evidence C)

There are insufficient data on the effect of hypothermia, barbiturates, and corticosteroids in the setting of ischemic cerebral swelling and they are not recommended (Class III, Level of Evidence C)
Neurosurgical Options in Deteriorated Patient

In cerebellar infarction, it has been shown repeatedly that patients benefit from suboccipital craniectomy with dural expansion

- One series of 84 patients with massive cerebellar infarcts, 40% required craniectomies and 17% managed with ventricular drainage alone
  - 74% of patients had very good outcomes with mRS score of 0 or 1
In cerebral infarction, there have been 3 prospective, randomized trials which have shown reduced mortality with hemicraniecotomy when compared to medical management alone:

- 22% vs 71% mortality in patients <60 years of age
- No individual study has shown improvement in the percentage of survivors with good outcomes (mRS 0-3)
- No survivors with mRS 0 or 1
- Only 14% of surgical survivors could look after their own affairs (mRS 2)
Distribution of modified Rankin Scale (mRS) grades at 1 and 3 years.

Neurosurgical Options: Recommendations

In patients < 60 years of age with unilateral MCA infarctions that deteriorate neurologically within 48h despite medical therapy, decompressive craniectomy with dural expansion is effective. The effect of later decompression is not known, but it should be strongly considered (Class I; Level of Evidence B)

Although the optimal trigger is unknown, it is reasonable to use LOC and its attribution to brain swelling as selection criteria (Class IIa; Level of Evidence A)

The efficacy of decompressive craniectomy in patients >60 years of age and the optimal timing for surgery is unknown (Class IIb; Level of Evidence C)

Suboccipital craniectomy with dural expansion should be performed in patients with cerebellar infarctions who deteriorate neurologically despite maximal medical therapy (Class I; Level of Evidence B)
Outcome and Family Discussion

Mortality after large ischemic stroke has remained between 20% and 30%
The vast majority of patients are left markedly disabled
Outcome assessed years after stroke is not available, but continuously improving quality of life has been described
There is a discrepancy between physical disability and QOL despite severe functional handicap
The decision is shared between the physician and family and discussion needs to focus on what would the patient want

- Families need to understand that if surgery is performed within 2 days of stroke, nearly 3 of 4 patients survive, but nearly half will be severely disabled and nearly half will also be suffering from depression
  - If their loved one is >60, good information is lacking and our expectations may not be as high as in younger patients
Clinicians may discuss with family members that half of surviving patients with massive hemispheric infarctions, even after decompressive craniectomy, are severely disabled and a third are fully dependent on care (Class IIb; Level of Evidence C).

Clinicians may discuss with family members that the outcome of cerebellar infarct can be good after suboccipital craniectomy (Class IIb; Level of Evidence C).
Patient became more somulent overnight and NIHSS in 22 and is intubated

- VS 130/80; HR 72 NSR; O2 95%; temp 99.5 F
- Midline shift has increased and Neurosurgery recommends surgery
Case Scenario: AC 72 h post-op

- Patient’s NIHSS 17
- VS are stable; temperature WNL
- Immediate goals: extubation and therapies evaluating patient
Prevention of complications

Infections
Detection of Dysphagia and Prevention of Aspiration
Pulmonary Embolism and VTE
Falls
Skin Breakdown
Aspiration pneumonia is one of the most serious complications that can occur after a patient has a stroke.

How can we prevent aspiration pneumonia?

- Ensuring that the patient is safe to take PO with evaluation of swallow *(Class I, Level of Evidence B)*
- Dysphagia is common following stroke and is found in almost 50% of acute stroke patients. Up to 17% of these patients require tube feedings
- Monitoring patients condition and swallow; if feel that pt’s swallow is no longer safe make pt NPO an obtain speech therapy consult for swallow

UTIs are common in approximately 15-60% of stroke patients and independently predict poor outcomes
Indwelling catheters should be avoided unless medically and neurologically necessary
Patient should be assessed for UTI if change in LOC and no known cause for deterioration
PE and VTE

PE occurs more commonly than is suspected and accounts for substantial number of death after acute ischemic stroke. Both ischemic and hemorrhagic patients are at risk for developing VTE.

- Recommend early mobilization, application of SCDs and anticoagulants when not contraindicated.

If taking anticoagulants, patients should be assessed daily for bleeding.

Falls

Falls are a common cause of injury in stroke patients. Minimization of fall risk is a global responsibility and needs to be tailored for each patient. Nurses must implement fall prevention programs and educate fellow health team members, patient and family about risk and fall precautions (Class I, Level of Evidence B).

Skin

At risk for breakdown r/t:
• hemiparesis
• decreased mobility, decreased LOC
• Incontinence
• loss of sensation
• compromised nutrition

Braden scale predicts risk of skin breakdown and can assist in developing plan of care  (Class I, Level of Evidence A)

Case Scenario: AC Outcome

- Patient required tracheostomy and PEG placement
- Antiphospholipid syndrome was identified as cause of stroke and patient started on warfarin with INR range >3.0; also started on a blood pressure medication and a statin
- Patient transferred to LTAC and then acute rehabilitation hospital
- Bone flap was replaced
- After extensive time in rehab, patient was able to return home with family
Summary

- Strokes that swell require immediate close attention
- Therefore any measure that relieves compression is warranted
- Medical options have not been validated but surgical management of supratentorial strokes has been tested
  - Decompressive craniectomies reduces mortality by reducing progression to brain death and reducing probability of permanent coma the eventually may lead to withdrawal of care and death
  - In surviving patients, morbidity can be substantial in 1/3 of patients but the remaining patients have good potential for recovery after rehabilitation
References


Thank You!!!

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