Evidence-Based Guidelines for the Management of Large Hemispheric Infarction (LHI)
Purpose and Process

• Purpose is to provide recommendations based on the best available evidence for critical care management of patients with LHI
• Experts from Europe and North America from neurosurgery, neurocritical care, interventional neuroradiology and neuroanesthesiology
• Divided groups into subtopic panels based on area of expertise
• Critical literature review performed and quality of evidence assessed (GRADE system)
• Data presented to Neurocritical Care Society and German Society for Neuro-Intensive Care and Emergency Medicine
Methods: GRADE System

- Classifies recommendations as strong or weak based on:
  - Balance of risk vs benefit
  - Patient Preferences
  - Cost
  - Quality of Evidence

- Quality of Evidence:
  - **High**: further research very unlikely to change the estimate of effect
  - **Moderate**: Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate
  - **Low**: Further research very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.
  - **Very Low**: any estimate of effect is uncertain
Evaluating the Evidence

• Throughout the slideset, quality of data is color coded for easier discrimination and reference:
  – Strong Recommendation, High/Moderate Quality of Evidence
  – Strong Recommendation, Low Quality of Evidence
  – Weak Recommendation, Low or Very Low Quality of Evidence
Topics Covered

• General Patient Management
  – Airway Management, Hyperventilation, Gastrointestinal Tract, Glucose and Hemoglobin Control, Blood Pressure Management, Temperature Control, Head Position

• Pharmacotherapeutics
  – Analgesia and Sedation, Osmotic Therapy, DVT Prophylaxis, Anticoagulation, Steroid and Barbiturate Therapy,

• Imaging and Additional Testing
  – CT and MRI, Ultrasound, EEG, Evoked Potentials, Invasive Multi-Modality Monitoring

• Surgical Interventions
  – Decompressive Hemicraniectomy

• Ethical Considerations
  – Quality of Life
GENERAL PATIENT MANAGEMENT
Airway Management

• **Strong Recommendation, Very Low Quality Evidence**
  
  – LHI with signs of respiratory insufficiency of neurologic decline should be intubated immediately
  
  – Extubation should be attempted in the following, even if communication/cooperation can’t be established:
    • Successful spontaneous breathing trial
    • absence of oropharyngeal secretions
    • absence of need for frequent suctioning
    • + cough and tube intolerance
    • Free of analgesia and sedation

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Airway Management

- **Weak Recommendation, Low Quality of Evidence**
  - Tracheostomy should be considered in LHI patients failing extubation or in whom extubation is not feasible by 7-14 days from intubation
Hyperventilation

- **Strong Recommendation, Very Low Quality of Evidence**
  - We recommend against prophylactic hyperventilation in LHI patients

- **Weak Recommendation, Very Low Quality of Evidence**
  - Hyperventilation can be used for short period of time as a rescue maneuver in LHI patients showing clinical signs of brain herniation
Blood Pressure Management

- **Strong Recommendation, Low Quality of Evidence**
  - Clinicians should follow current blood pressure management guidelines for ischemic stroke in general when caring for patients with LHI. Maintain a MAP of >85mmHg in ischemic stroke without hemorrhagic transformation. Lower SBP to <220

- **Weak Recommendation, Low Quality of Evidence**
  - Avoid blood pressure variability, especially in the early phase of LHI treatment
Temperature Control and Head Position

• Weak Recommendation, Low/Very Low Quality of Evidence
  – Consider hypothermia as a treatment option in patients not eligible for surgical intervention
  – If hypothermia considered, suggest target of 33-36 °C for 24-72 hours
  – Maintain normal core body temperature
  – Horizontal body position in most patients with LHI. However, in patients with increased ICP, suggest a 30° backrest elevation
Glucose Control

- **Strong Recommendation, Very Low Quality of Evidence**
  - Hypoglycemia and hyperglycemia should be avoided in LHI. Intermediate glycemic control (serum glucose 140-180 mg/dl) should be the target of insulin therapy in LHI patients.
  - IV sugar solutions should be avoided in LHI.
Hemoglobin Control

- **Strong Recommendation, Very Low Quality of Evidence**
  - Maintain a hemoglobin of 7g/dl or higher in patients with LHI

- **Weak Recommendation, Very Low Quality of Evidence**
  - Consider specific situations such as planned surgery, hemodynamic status, cardiac ischemia, active significant bleeding, and arteriovenous oxygen extraction compromise when determining the ideal hemoglobin level in patients
  - Consider reducing blood sampling wherever possible in order to decrease the risk of anemia in LHI
Gastrointestinal Tract

- **Weak Recommendation, Very Low Quality of Evidence**
  
  - Recommend dysphagia screening in the early phase of LHI. Dysphagia can be assessed once the patient is weaned from sedation and analgesia.
  
  - LHI patients with dysphagia should receive a nasogastric tube as soon as possible.
  
  - High NIHSS scores and persisting dysphagia on endoscopic swallowing should prompt discussion with family on placement of e PEG tube between weeks 1 and 3 of ICU stay.
PHARMACOTHERAPEUTICS
Analgesia and Sedation

• **Strong Recommendation, Very Low Quality of Evidence**
  
  – We recommend analgesia and sedation if signs of pain, anxiety of agitation arise in LHI patients
  
  – We recommend the lowest possible sedation intensity and earliest possible sedation cessation, while avoiding physiologic instability and discomfort in LHI patients
  
  – We recommend against the use of routine of daily wake-up trials in LHI patients. Caution is particularly warranted in patients prone to ICP crises. Neuromonitoring of at least ICP and CPP is recommended to guide sedation, and daily wake-up trials should be abandoned or postponed at signs of physiologic compromise or discomfort.
Osmotic Therapy

- **Strong Recommendation, High Quality of Evidence**
  - Hypertonic saline should be used cautiously in patients with volume overload states (i.e., heart failure, cirrhosis) since this agent expands intravascular volume

- **Strong Recommendation, Moderate Quality of Evidence**
  - Recommend use of mannitol and hypertonic saline for reducing brain edema and tissues shifts in LHI only when there is clinical evidence of cerebral edema
  - Hypertonic saline dosing should be guided by serum osmolality and serum sodium
  - Recommend using mannitol cautiously in patients with acute renal impairment

- **Weak Recommendation, Low Quality of Evidence**
  - Use osmolar gap instead of serum osmolality to guide mannitol dosing and treatment duration
DVT Prophylaxis

- **Strong Recommendation, Moderate Quality of Evidence**
  - Use of intermittent pneumatic compression (IPC) for DVT prophylaxis
  - Against the use of compression stockings for DVT prophylaxis

- **Strong Recommendation, Very Low/Low Quality of Evidence**
  - Early mobilization to prevent DVT in hemodynamically stable LHI patients with no evidence of increased ICP
  - DVT prophylaxis for all LHI patients upon admission to the ICU and for the duration of immobilization
Anticoagulation

• **Weak Recommendation, Very Low Quality of Evidence**
  
  – Suggest oral anticoagulation be reinitiated 2-4 weeks after LHI in patients with high thromboembolic risk
  
  – Earlier re-initiation of oral anticoagulation should be based on clinical risk assessment and additional diagnostic tests (prosthetic valve, acute DVT, acute PE, TEE with intracardiac thrombus)
  
  – Suggest use of aspirin during the period of no anticoagulation in LHI with AF or increased thromboembolic risk, provided surgery is not imminent
Steroid and Barbiturate Therapy

• **Strong Recommendation, Low Quality of Evidence**
  – Recommend against use of steroids for brain edema in patients with LHI
  – Barbiturates not recommended in patients with LHI because the risks outweigh the benefits
NEUROIMAGING AND ADDITIONAL TESTING
Neuroimaging by CT and MRI

• **Strong Recommendation, Low Quality of Evidence**
  – Recommend using early changes on CT and MRI to predict malignant edema after LHI
Additional Testing: Ultrasound and Evoked Potentials

• **Weak Recommendation, Low/Very Low Quality of Evidence**
  – Suggest using transcranial color-coded duplex (TCCS) as a complimentary test to predict a malignant course and possibly as a primary test if the patient is too unstable to be transferred outside the ICU for neuroimaging
  – Consider brainstem auditory evoked potentials (BAEP) as a complimentary method to predict malignant course within the first 24 hours after MCA infarction, particularly in patients too unstable to be transported to neuroimaging
Additional Testing: EEG

• Weak Recommendation, Very Low Quality of Evidence
  – Consider EEG in the first 24 h after stroke to assist with predicting clinical course in LHI
  – Continuous and quantitative EEG represent a promising non-invasive monitoring technique and a tool for estimation of prognosis after LHI that might be useful in the future pending further study
Invasive Multi-Modality Monitoring

• **Weak Recommendation, Low Quality of Evidence**
  – Invasive multi-modality monitoring has not been sufficiently studied, and therefore cannot be recommended in the routine management of patients with LHI.
SURGICAL MANAGEMENT
Decompressive Hemicraniectomy (DHC)

- **Strong Recommendation, High Quality of Evidence**
  - DHC recommended as a potential therapy to improve survival after LHI regardless of patient age

- **Strong Recommendation, Moderate Quality of Evidence**
  - In patients older than 60 years, recommend taking into consideration patients and family wishes, since in this age group, DHC can reduce mortality but with a higher likelihood of being severely disabled
  - To achieve the best neurological outcome, recommend performing DHC within 24-48 hours of symptom onset and prior to any herniation symptoms
  - Recommend a size of 12cm as an absolute minimum for DHC. Larger Sizes of 14-16cm seem to be associated with better outcomes
Decompressive Hemicraniectomy (DHC)

- **Strong Recommendation, Low Quality of Evidence**
  - Data currently insufficient to recommend against DHC in LHI patients based on hemispheric dominance

- **Weak Recommendation, Low Quality of Evidence**
  - Lobectomy or duraplasty only be considered as in individualized treatment option
  - Resection of the temporal muscle only be considered as an individualized treatment option

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ETHICAL CONSIDERATIONS
Ethical Considerations

• Weak Recommendation, Low Quality of Evidence
  – The decision to perform DHC should depend on values and preferences of patients and relatives regarding survival and dependency
  – Future research should use quality of life (QoL) as an outcome measure in LHI patients