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

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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

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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

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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

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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 commmunication/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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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NEUROIMAGING AND ADDITIONAL TESTING

Neuroimaging by CT and MRI

- Strong Recommendation, Low Quality of Evidence
  - Recommend using early early changes on CT and MRI to predict malignant edema after LHI

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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

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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

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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 patient with LHI

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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 disable
  - 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

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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

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