Emergency Neurologic Life Support (ENLS): What to Do in the First Critical Hour of A Neurologic Emergency

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Agenda

• Thromboembolic Events
• Bleeding Complications
• Encephalopathy
• Brain Death
• Where does ENLS fit in?
Patient Population

- Pre-/Post-CABG
- Pre-/Post-LVAD
- Pre-/Post-Heart Transplant
CABG Complications

• Neurologic Dysfunction
  – stroke, encephalopathy, delirium and post-operative cognitive dysfunction

• Atherosclerotic disease of the ascending aorta strongest independent risk factor
  – cannulation of the aorta for establishing cardiopulmonary bypass
  – when the aortic clamp is applied or released
  – when proximal graft anastomoses are performed using side-biting clamp.

• Cerebral Hypoperfusion
  – carotid stenosis
  – Intra-operative hypoperfusion ➔ cerebral emboli and may be responsible of bilateral watershed infarcts after CABG

• Atrial Fibrillation—15-30% undergoing CABG

• No clear support for Off Pump CABG > On Pump to decrease stroke risk
• 46% of LVAD placements are DT
• Median time of support while awaiting transplantation is 300 days (IQR 147-537)
• Number of implanted LVADs approaching number of transplants in the US
• Survival 1yr-81%, 2yr 70%, 3yr 60%, 4yr 48%
  – Kirklin JK. Seventh INTERMACS annual report. JHLT Dec 2015.
LVAD Complications

• CNS Bleeding
  – 11% risk in the HeartMate II DT trial in the first 2 years after LVAD placement

• Thromboembolic Stroke
  – Advanced Heart Failure no LVAD 0.013-0.035 EPPY
    • Slaughter MS. et al. NEJM Dec 2009.
  – HeartMate II, BTT or DT 0.064-0.082 EPPY
  – HeartWare 0.11 EPPY
    • Slaughter MS. et al. JHLT Jul 2013.
2-YEAR RESULTS FROM THE MOMENTUM 3 TRIAL
FULL COHORT ANALYSIS — AS PUBLISHED IN THE NEW ENGLAND JOURNAL OF MEDICINE

LARGEST LVAD RANDOMIZED CONTROLLED TRIAL EVER
1,028 PATIENTS
69 U.S. CENTERS
MET PRIMARY ENDPOINT AND SHOWED SUPERIORITY VS. PRIOR GOLD STANDARD

UNPRECEDENTED* SURVIVAL
79% AT 2 YEARS
COMPARABLE TO HEART TRANSPLANT**

IMPROVED PATIENT LIVES
METERS WALKED IN 6 MINUTES
2.4x INCREASE IN DISTANCE
KCCQ*** SCORE (+5 POINT IS MEANINGFUL)

LOWEST PUBLISHED STROKE, THROMBOSIS AND BLEEDING RATES FOR CONTINUOUS-FLOW LVADS
STROKE 10%
PUMP THROMBOSIS 1%
GI BLEEDING 25%
MOMENTUM 3

- **Largest LVAD trial**—1,028 all-comer patients included in the full cohort follow-up and an additional 1,500+ patients included in the Continued Access Protocol (CAP) study.

- **Primary endpoint** of survival at 2 years with freedom from disabling stroke or reoperation to replace or remove a malfunctioning device was met, with **HeartMate 3 showing superiority to HeartMate II** (event-free survival of 75% vs 61%, respectively).

- **HeartMate 3**—lowest published hemocompatibility-related adverse events for an LVAD in an RCT at 2 years for thrombosis (1.4%), stroke (9.9%), and GI bleeding (24.5%).
• Independent Predictors of Stroke
  – Diabetes – 6.36x
  – Aortic Clamping (complete with cardioplegia > side-biting clamp)
  – Duration of Support
  – INR (subtherapeutic)

• Preoperative Atrial Fibrillation may not increase risk
Post-OHT

Figure 1.

Pathogenesis of ischemic stroke in general population (A) and in patients submitted to orthotopic heart transplantation (B).

53 yo M s/p CABG x 4 now with cardiogenic shock. Impella flow only 0.2 L/min
57 yo M—3 ECMO runs, TAH, and OHT.
62 yo M after ECMO for 15 days
67 yo M with LVAD for 3 years
62 yo M 3 weeks post-OHT
57 yo M 1 week post CABG
52 yo M 2 weeks post CABG
CVA

• CHF is 2\textsuperscript{nd} to Atrial Fibrillation as a cause of CVA
• 12.1\%-28.7\% incidence after CF-LVAD
• Stroke risk factors
  – Hypertension, Infection, Pump thrombosis, GI Bleeding, Insufficient or Excessive antithrombotic treatment

Willey et al. JHLT. Aug 2016
Ischemic Stroke Treatment

• No IV thrombolysis
• Intra-arterial embolectomy
  – If presenting within 8 hours of symptoms with a large vessel occlusion and no obvious infarct on non contrast Head CT (Stroke 2013 Guidelines)
  – Up to 24 hours
• Anti-platelet and anti-coagulation are continued
  – If no evidence of hemorrhagic conversion and infarct < 33% of hemispheric volume (to prevent hemorrhagic conversion

Willey JZ. et al. JHLT 2014.
Hemorrhagic Stroke Treatment

• Reversal of anti-coagulant
  – Vitamin K and PCC
  – Platelet transfusion +/- desmopressin
  – Goal INR < 1.3 or 1.5

• Anti-platelet agents resumed in 2 weeks if imaging remains stable

• Check Blood cultures

• Look for pump thrombosis

• Check LDH
Blood Pressure Management

• For ICH patients presenting with SBP between 150 and 220 mm Hg and without contraindication to acute BP treatment, acute lowering of SBP to 140 mm Hg is safe (Class I; Level of Evidence A) and can be effective for improving functional outcome (Class IIa; Level of Evidence B). (Revised from the previous guideline) – Stroke 2015 Guidelines
• Ischemic Stroke and Hemorrhagic Stroke do not preclude transplantation
• Ischemic Stroke more likely to progress to transplantation
Cerebral Hyperperfusion

• Neurologic dysfunction
  – Confusion, focal neurologic deficit, visual changes, seizures, coma
• 24h-30d post LVAD implantation
• Previous CABG best predictor
• Reduction in LVAD flow led to improvement in symptoms in 87% of patients
• ? Normal flow may overwhelm cerebral autoregulation in patients with heart failure

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Brain Death

I. The clinical evaluation (prerequisites).
   - A. Establish irreversible and proximate cause of coma.
   - B. Achieve normal systolic blood pressure.
   - C. Perform 2 neurologic examinations

The clinical evaluation (neurologic assessment).
   - A. Coma.
   - B. Absence of brainstem reflexes.
   - C. Apnea Test

Common confirmatory tests in Brain Death
   - Cerebral angiography
   - Electroencephalography
   - Transcranial Doppler ultrasonography
   - Cerebral scintigraphy (technetium Tc 99m hexametazime)

ECMO and Brain Death

• Apnea Testing
  – Decrease Sweep to 0.5 L/min
Brain Death

- Guidelines are state specific
- NCS Brain Death Toolkit
- Brain Death. org
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ENLS - Overview

• Designed to help healthcare professionals improve patient care and outcomes during the critical first hours of a patient’s neurological emergency.

• Demonstrates a collaborative, multi-disciplinary approach, with a consistent set of protocols, practical checklists, decision points, and suggested communication to use during patient management.
ENLS – Course Layout

The course is comprised of 14 modules, covering the following reference topics:

- Acute Ischemic Stroke
- Acute Non-Traumatic Weakness
- Airway, Ventilation, and Sedation
- Approach to the Comatose Patient
- Intracerebral Hemorrhage
- Intracranial Hypertension and Herniation
- Meningitis and Encephalitis
- Pharmacotherapy
- Resuscitation Following Cardiac Arrest
- Spinal Cord Compression
- Status Epilepticus
- Subarachnoid Hemorrhage
- Traumatic Brain Injury
- Traumatic Spine Injury
ENLS – Course Layout, continued

Each of the 14 modules includes:

- Algorithm
- Checklists – procedural and communication
- Manuscript – evidence-based and up-to-date
- Lecture slides
- Exam – multiple choice (score of 70% or above is required for certification; may be taken as many times as necessary)
ENLS - Accreditation

- Upon completion of the online course, this activity is designated for a maximum of 15 AMA PRA CME, ANCC, ACPE and CECBEMS credits.
- This activity does not qualify for live credit hours.
ENLS – Sample Algorithm: Intracerebral Hemorrhage
Emergency Neurological Life Support: Intracerebral Hemorrhage

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Abstract Intracerebral hemorrhage (ICH) is a subset of stroke due to bleeding within the parenchyma of the brain. It is potentially lethal, and survival depends on ensuring an adequate airway, reversal of coagulopathy, and proper diagnosis. ICH was chosen as an Emergency Neurological Life Support protocol because intervention within the first critical hour may improve outcome, and it is critical to have site-specific protocols to drive care quickly and efficiently.

Keywords Intracerebral hemorrhage · Coagulopathy · ICH Score

Introduction

The availability of treatments proven to benefit ICH patients has lagged behind that of ischemic stroke and aneurysmal subarachnoid, and this has resulted in variability in care that ranges from aggressive treatment to a nihilistic approach. Guidelines exist for the management of ICH, and the purpose of this ENLS protocol is to emphasize initial management, with the goal of optimizing recovery. Acknowledging that there is variability in the strength of evidence for treatment recommendations for certain interventions, aggressive initial care of the ICH patient is recommended, in accordance with existing guidelines [1, 2].

Management of the ICH patient during the initial “golden hour” emphasizes the following aspects:

1. Stabilization and reassessment of the patient’s airway, breathing, and circulation (ABCs)
ENLS – Online Protocols: http://ENLSprotocols.org

Works on all browsers and smartphones
About the Neurocritical Care Society

• NCS Vision is to provide and advocate for the highest quality of care for patients with critical neurological illness throughout the world.

• NCS Mission is to provide:
  o Quality patient care
  o Professional collaboration
  o Research
  o Training and Education
  o Advocacy
NCS Membership

• NCS has a worldwide membership of over 2,400 multidisciplinary professional health care providers from over 50 countries.
NCS Membership, continued

• Benefits to becoming an NCS member, including:
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  o Discounted Annual Meeting rates
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  o Access to NCS member discussion forums on the NCS website
  o Global Partners/Dual Membership Discounts
  o Eligibility for various awards including Best Abstract, Young Investigator, Travel Grants, and Research Grants
NCS Resources

• Educational resources:
  o Pharmacotherapy of Neurocritical Care Series (PONS)
  o NCS Podcast Series
  o Nursing-related resources, or N-Case
  o Brain Death Toolkit
  o Pocket Guide to Neurocritical Care
  o NCS Annual Meeting presentations

• Additional resources:
  o Annual Scientific Meetings
  o Neurocritical Care Research Network
  o Guidelines
  o Research
  o Publications
NCS Annual Meeting
Save the Date!
FOR MORE INFORMATION:
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