Neuro-monitoring in the NICU: aEEG/EEG in Term and Preterm Neonates

Sonia L. Bonifacio MD / Susan Peloquin RN, MS, CN-IV

Disclosures
Sonia Bonifacio
• Content Expert for VON Brainshapers NICQ Next Homeroom

Susan Peloquin
• No conflicts to disclose

Objectives
1. Identify the population of neonates at risk for seizure using the ACNS guidelines, improve identification of electrographic seizures using aEEG, describe process of evaluation of aEEG at the bedside over time
2. Describe potential barriers with using aEEG as a bedside tool that may inhibit practice changes
3. Discuss the critical role of the bedside nurse in application and interpretation of aEEG and role in alerting staff of findings

Use of Brain Monitoring – VVV
• Insert Chapter 2
  – 00:00:15 to 00:00:52
  – 00:01:29 to 00:04:43

Role of Brain Monitoring in the NICU
Monitoring allows us to answer these questions:
• Has this child suffered brain injury?
• How is the brain adapting to illness?
• Is further neurologic evaluation needed?
• Is the baby having seizures?
• When and how long should we treat with AEDs?

Monitoring – Seizure Detection & Treatment
• Clinical detection of seizures in neonates is not reliable
  – Physicians and nurses cannot distinguish clinical seizures from non-seizure events
  – Seizures are often electrographic only and without obvious clinical manifestation
  – Electroclinical dissociation (i.e. EEG seizures without clinical correlate) is especially common after therapy
• Potential Best Practice - Treatment should be guided by results of monitoring and not our best guess

Malone, Epilepsia 2009
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Why is Seizure Detection Important?
- Seizures likely contribute to brain injury and may impact brain development and influence development of epilepsy
- Phenobarbital is first line treatment but also associated with apoptosis in animal models
- Monitoring improves our diagnostic accuracy before treatment – avoid over treatment of paroxysmal movements that are not seizures
- Monitoring improves treatment and reduces seizure burden

Who & How Long to Monitor
Recommendations from the American Clinical Neurophysiology Society
- Monitor those at risk of seizure or those who are suspected of having seizures
- Minimum of 24 hours or until 3-4 spells (seizures) are captured
- If no seizures identified and the EEG background is stable, then can stop after 24 hours of monitoring

Indications for monitoring
1. Differential diagnosis of paroxysmal events
2. To judge the severity of encephalopathy
3. Detect EEG seizures in selected high-risk populations (table)

Clinical Scenarios With High Risk of Seizures
- Term neonates
  - Acute encephalopathy – perinatal asphyxia, post CPR
  - Cardiac & pulmonary illness with risk of acute brain injury
    - PPHN, ECMO, cardiac surgery requiring bypass
  - CNS infection & trauma
  - Inborn errors of metabolism
  - Perinatal stroke
  - Sinovenous thrombosis
- Preterm neonates
  - With acute high grade hemorrhage or encephalopathy

Amplitude Integrated EEG (aEEG)
- Filter, rectify, smooth, compress, amplitude-integrate
- 15 seconds

Conventional Video-EEG
- Gold standard for seizure detection
- More leads (better coverage, artifact Video
- Trained technician
- Experienced reader

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Bedside nurse applies aEEG leads

Nursing staff
- Review and document background pattern
- Screen for seizures and notify physicians

Technician applies full EEG montage

aEEG Seizure Detection
- Seizures may be detected as a sharp rise in upper and lower margins of tracing
- Correlated with raw EEG trace
- Raw EEG should show gradual build-up and then decline (aka ‘evolve’) in frequency and amplitude and last >10 seconds.

Status Epilepticus – Saw-tooth Pattern

Subclinical Status Epilepticus
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Varied Appearance of Seizures
- Term baby readmitted on DOL#8 for lethargy, apneas, progressive encephalopathy (HSV)
- Difficult to see the background pattern

Varied Appearance of Seizures
- Change in background after meds given

Varied Appearance of Seizures
- 35 weeks, vasa previa, hypoglycemia
- Within 6 hours had multiple episodes of apnea without bradycardia
- Neuro exam — 'appropriate for age, no asymmetry'

Limitations
- Seizures are harder to detect if they are:
  - Brief
  - Infrequent
  - Low amplitude
  - Very focal
  - Distal from recording electrodes
- Interpretation is aided by analysis of the “raw” EEG
- Experience counts!

Common Pitfalls
- Artifacts
  - EKG
  - Hand ventilation
  - Patting
  - Sucking
  - HFOV
  - Vent/ECMO tubing
- High amplitude background — caution may be seizures

References:
- Toet MC. Pediatrics 2002
- Rennie JM. Arch Dis Child Fetal Neonatal Ed 2004
- Shah et al. Pediatrics 2009
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High Amplitude Background - Seizures
- Can be misinterpreted as Continuous Normal Voltage or technical problem leading to delay in diagnosis

Vein of Galen Malformation
- Term infant
- Critically ill
- Abnormal mental status

Medical Illness & Neurologic Compromise
Term infant with large hemangioma on chest
- Kaposiform Hemangioendothelioma with Kasabach-Merritt
- On MRI for hemangioma, brain injury identified
- Abnormal mental status – seizures

Preterm – Monitored for Critical Illness
- Rh Isoimmunization
- Developed Status Epileptics
- HUS identified new grade III IVH

Preterm Infant – Placental Abruption
- 25 5/7 weeks, 933 grams, Apgar 8, 8, vigorous
- Initial Hct 37% ->33% -> transfused
- New metabolic acidosis; code event, Hct down to 10%

Monitoring – Review Process
- Neonatal team reviews aEEG at 20 min, 40 min and at 1 hour after recording initiated
  - Review background pattern
  - Look for seizures or EEG correlate of suspicious clinical activity
  - Frequency of review dependent on seizures or risk of seizures
- If video-EEG also initiated – reviewed after 1 hour of recording by neurophysiology service
- If seizures are identified
  - Treat per institutional guidelines
  - Review closely after AED administered – electro-clinical dissociation, change in background
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aEEG Barriers to Implementation

- **Knowledge**
  - Nursing and medical staff need basic training in application and interpretation
  - Seizures are not all the same – there is variation
  - aEEG is a bedside monitor not the gold standard but it likely better than best guess
- **Staff**
  - Can not be one person in unit with knowledge of aEEG
  - Train a group
- **Support**
  - Child Neurology/Neurophysiology
  - Need assistance in responding to seizures
  - Status Epilepticus – emergency

Quality Improvement

- **Seizures in HIE pre-monitoring vs. monitoring era**
  - Lower seizure burden in those treated with hypothermia
  - Length of stay decreased for survivors – 4 fewer days
  - Decreased cumulative phenobarbital in those with seizures related to monitoring - 28mg/kg less (95% CI 12 to 45 mg/kg)*
  - Monitoring and care by NICN service allowed for better identification of which neonates to treat and gave confidence to providers to stop treatment

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*Adjusted for seizure burden; P<0.01
Orbach S, et al. PAS 2013; Accepted to J Child Neurology

Critical Role of the Nurse
Minimize Brain Injury & Optimizing Neurodevelopment

Nursing Objectives
Describe and Discuss:

- Potential nursing barriers with using aEEG
  - Knowledge
  - Staffing
  - Support
  - Teamwork
- Critical Role of the bedside nurse
  - Application of leads
  - Operating aEEG machine
  - Recognizing aEEG patterns
  - Integrating monitoring into care
  - Communicating findings to medical team
  - Collaborating with the team
Potential Nursing Barriers

Knowledge

Teamwork

Staffing

Support

Critical Role of the Bedside Nurse
- Application of leads
- Operating aEEG machine
- Recognizing aEEG patterns
- Integrating monitoring at the bedside
- Communicating and collaborating

Critical Role of the Bedside RN
Lead Application

www.rhythmlink.com
www.natus.com
Imimed.jp
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Critical Role of the Bedside RN
Lead Application

Critical Role of the Bedside RN
Opening the aEEG Machine

Critical Role of the RN
aEEG Interpretation

• Maturation
• Classification
• Effects of Medication

Critical Role of the Bedside RN
Integrating Monitoring into Care

• Knowledge of:
  – Importance of timely monitoring
  – Risk factors for secondary brain injury
  – Effects of medications and treatment on aEEG tracings
  – Risk factors for seizures
  – Assessment of clinical and electrographic seizures
  – Typical AED’s used
• Anticipate medications for seizures
• Skin issues with leads
• Troubleshooting aEEG

Critical Role of the RN
Integrating Monitoring at the Bedside
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Critical Role of the RN
Integrating Monitoring at the Bedside

Communicating and Collaborating
Medical Team

- Confirm suspicious pattern
- Discuss with medical team
- Treatment

aEEG Tracing
Initially Applied

- When aEEG is 1st applied
  - Missed Seizure
- Best practice
  - Review after 20 minutes
  - Seek colleague for review
- Best Practice
  - Anticipate medications
  - Medication preparation
  - Administration of medications
  - Monitoring of seizures and effects of AED(s)

aEEG Tracing
Seizures are Identified

aEEG Tracing
Status Epilepticus
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aEEG Tracing
SE
• Status Epilepticus
• Best Practice
  – Assess for clinical correlate
  – Get help if needed
  – Notify provider immediately
  – Anticipate medications
  – Administer medications
  – Notify neurology
  – Apply (c) EEG
  – Document

Critical Role of the Bedside Nurse

• Initial change in pattern
• If 1st one was missed, high suspicion of 2nd
• Notify medical provider
• Notify neurology
• Anticipate medications
• Observe for effects of medications
  – Seizures extinguished or not
  – Pattern changes as a result of AED
• Document

Summary
• Brain monitoring is the best way to accurately identify seizures
• PBP – seizure treatment should be guided by results of monitoring and not our best guess
• Seizures may have a varied appearance but all have common features
• Seizures may be observed in all types of aEEG background patterns
• Bedside nurses play a critical role in application, interpretation, communication of aEEG
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Links to VON Resources

• Please add links to VVV
• Please add links to NICQpedia