Practical EEG monitoring in PICU & NICU

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EEG Monitoring in ICU

• Routine EEG
• continuous EEG (cEEG)

Routine EEG in ICU

• better localization
• better Sz detection
• Extra cautions with artifacts (lots more in ICU)
• Duration limit
• Requiring high time & expertise

continuous EEG Monitoring

• Give out a trend
• Able to review raw EEG
• Less time-consuming
• Easily reviewed by ICU team
• sensitivity & specificity depend on number of electrodes

continuous EEG Monitoring

• Neonates
  - Cerebral function monitoring (CFM)
• Pediatric & adult
  - continuous EEG (cEEG)
  - quantitative EEG analysis

Why cEEG in NICU?

• Background
  - low amplitude
  - continuity
  - asymmetry
  - maturity
  - sleep wake cycle
  \[ \rightarrow \text{encephalopathy} \]
• Seizure
  - electroclinical Sz (confirm Sz)
  - electrographic Sz (subclinical Sz)
Uses of cEEG in NICU
- Early indicator - for therapeutic hypothermia
- Confirm the nature of “clinical Sz”
- Detect subclinical Sz / NCSE
- Assess “Cooling” & AED effect
- Predict outcome

Indications in neonates
- Birth asphyxia: mod -severe
- At risk of seizure (esp. subclinical)
- Sz requiring AED IV loading

Neonates: CFM
- portable machine, limited leads
  - 3 leads = whole brain
  - 4 leads = left & right
- easy to do: hydrogel electrodes
- easy to interpret → NICU staff
- amplitude integrated EEG (aEEG)
- immediate bedside assessment

3 leads (1 channel) 4 leads (2 channel)

Standard cEEG

What is aEEG?
- Raw EEG from selected leads
- Filter & rectify EEG amplitude
- Displays data in semi-log scale
- Compressed time interval
- Shows “trend” not “localization”
- Good correlation with EEG
aEEG: Limitation

- Not for localization
- Focal, low amplitude seizure - lower sensitivity
- Never replace standard EEG

### Background Abnormality

<table>
<thead>
<tr>
<th></th>
<th>Lower</th>
<th>Upper</th>
<th>SWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&gt;5</td>
<td>&gt;10</td>
<td>Yes</td>
</tr>
<tr>
<td>Moderate*</td>
<td>&lt;5</td>
<td>&gt;10</td>
<td>No</td>
</tr>
<tr>
<td>Severe</td>
<td>&lt;5</td>
<td>&lt;10</td>
<td>No</td>
</tr>
</tbody>
</table>

* Also seen in AED effect or prematurity

### Background patterns

- **CNV** Continuous normal voltage
- **DNV** Discontinuous normal voltage
  (Min < 5, Max > 10)
- **CLV** Continuous low voltage
  (Min < 5, Max < 10)
- **BS** Burst-suppression
  Min < 5 no variability,
  Max >10 hi-voltage bursts)
- **FT** Flat Tracing (Min and Max < 5)
Seizure in aEEG
- Sudden change
- Raised lower border
- Raised upper border
- Narrow bandwidth
- Sudden drop to normal

Status epilepticus
- Starts like “Sz” but sustains > 30 min
- “Saw tooth pattern”
  = repetitive Sz without gap

Sustained Sz

“Saw tooth pattern”
**cEEG**
- All or selected leads
- Raw data processed by software
- Multiple parameters analysis
- Automatic Seizure detection
- Enable raw EEG analysis
- For neurointensive care

**Why cEEG?**
- ICU: NCS 18-34%, NCSE 10%
- 8-48% in comatose pts
- Post treated GCSE:
  - 20-48% electrographic Sz
  - 14% NCSE, most without clinical signs
- 9% of pt with no acute neuro condition
- Cardiac arrest & sepsis - at risk
- 1st Sz - 95% in 24 hr (non-coma),
  - 87% in 48 h (coma)

**Clinical indications**
1. Detection of nonconvulsive seizures
2. Monitoring of Induced coma or sedation
3. Ischemia detection
   - vasospasm in subarachnoid hemorrhage
   - patients at high risk for stroke
4. Prognosis:
   - cardiac arrest
   - acute brain injury

**Analysis modalities**
- aEEG
- Compressed spectral array (CSA)
- enveloped trend
- asymmetry index & spectogram
- frequency & rhythm analysis
- Sz Detection & Sz probability

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**Sz detection**

**R2D2**

**FFT**

**Sz detection**

**Asymmetry index**

**aEEG**

**Rhythmic Run Detection & Display (R2D2)**

**Sz = Rhythmic activity, decrease in frequency during evolution**
Fast Fourier Transform (FFT)

Frequent polyspikes running over Lt
**Aysmmmetry Index**

Relative asymmetry to Lt could be:
1. Lt side “hot” - e.g. spikes/ sharp/ ictal
2. Rt side dysfunction - e.g. ischemia

Need raw EEG or other parameter

**Case**

- Acute onset of encephalitis
- Stuporus & ventilated in ICU
- Got GTC Szs
AED drip = Discontinuous

Just a “Take home”

- cEEG is a practical monitor in ICU
- Useful for neuro & non-neuro cases
- Basic interpretation requires short training
- Improve detection of NCS/ ischemia
- Can guide Rx & predict outcome

“Monitor aggressively, treat cautiously”