New trends in EEG: Continuous EEG monitoring

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1

continuous EEG Monitoring

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

2

Neonates: CFM

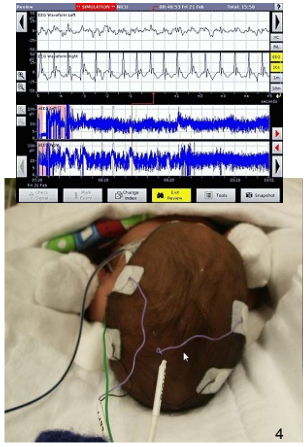
- portable machine, limited leads
  - 3 leads = whole brain
  - 4 leads = left & right
- easy to do: hydrogel electrodes

- easy to interpret → NICU staff
- amplitude integrated EEG (aEEG)
- immediate bedside assessment

3

3 leads (1 channel)

2 channels



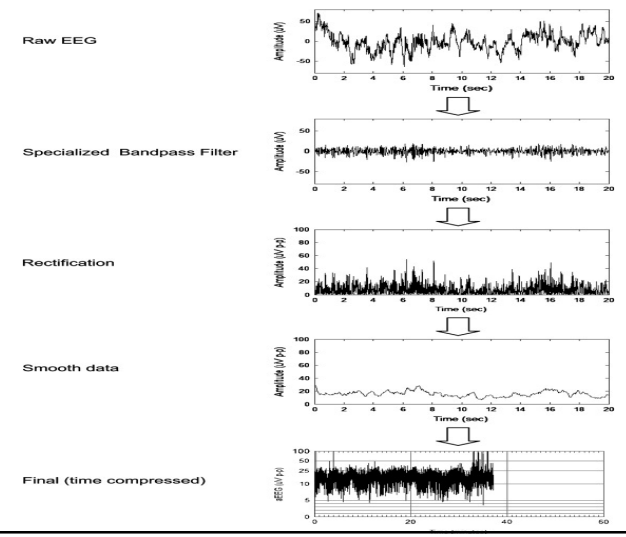
4

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”

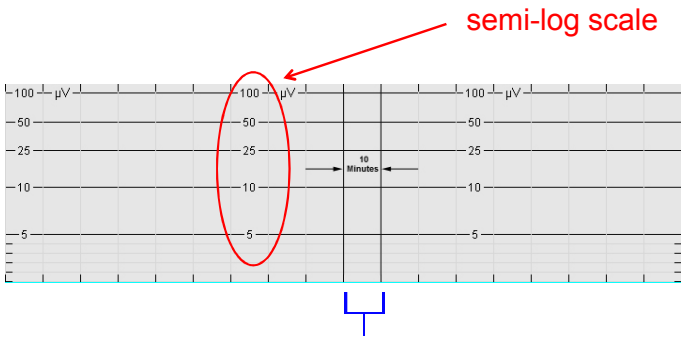
- Good correlation with EEG

5



6

aEEG display



7

To detect …

- Background
  - low amplitude
  - continuity
  - asymmetry
  - maturity
  - sleep wake cycle

→ encephalopathy

- Seizure
  - electroclinical Sz (confirm Sz)
  - electrographic Sz (subclinical Sz)

8

aEEG: Limitation

- Not for localization
- Focal, low amplitude seizure - lower sensitivity

- **<u>Never replace standard EEG</u>**

9

Indications

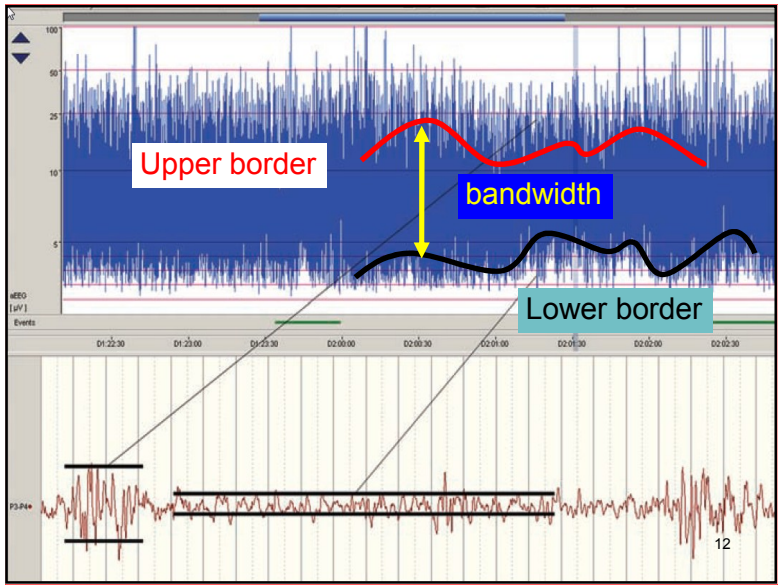
- Birth asphyxia: mod -severe
- At risk of seizure (esp. subclinical)
- Sz requiring AED IV loading

10

Purposes

- Early indicator - for therapeutic hypothermia
- Confirm the nature of “clinical Sz”
- Detect subclinical Sz / NCSE
- Assess “Cooling” & AED effect
- Predict outcome

11



12

Background Abnormality

	Lower	Upper	SWC
Normal	>5	>10	Yes
Moderate*	<5	>10	No
Severe	<5	<10	No

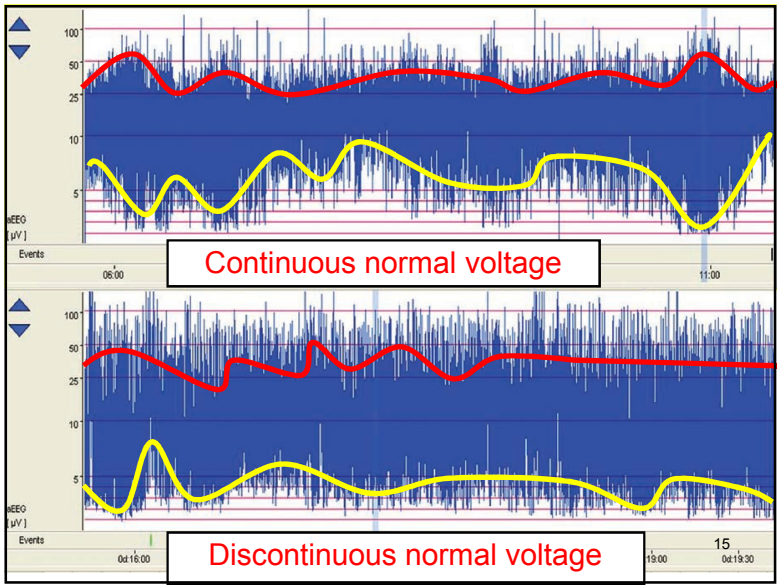
* Also seen in AED effect or prematurity

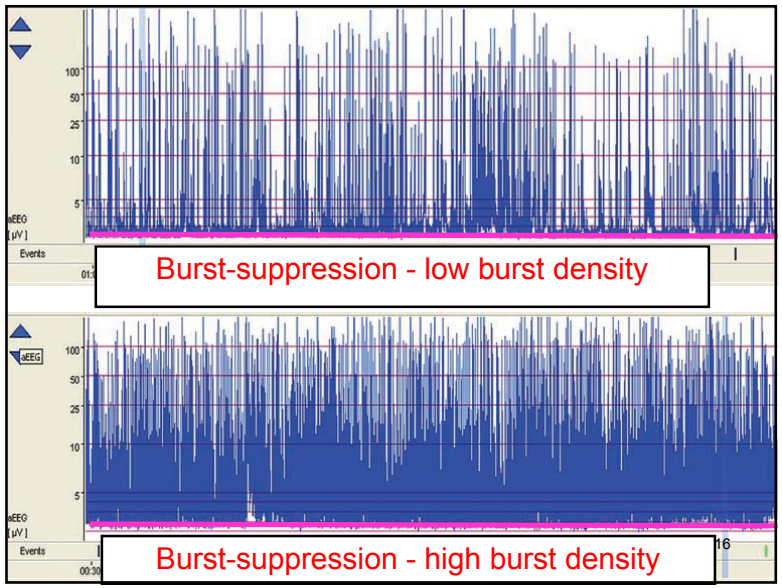
13

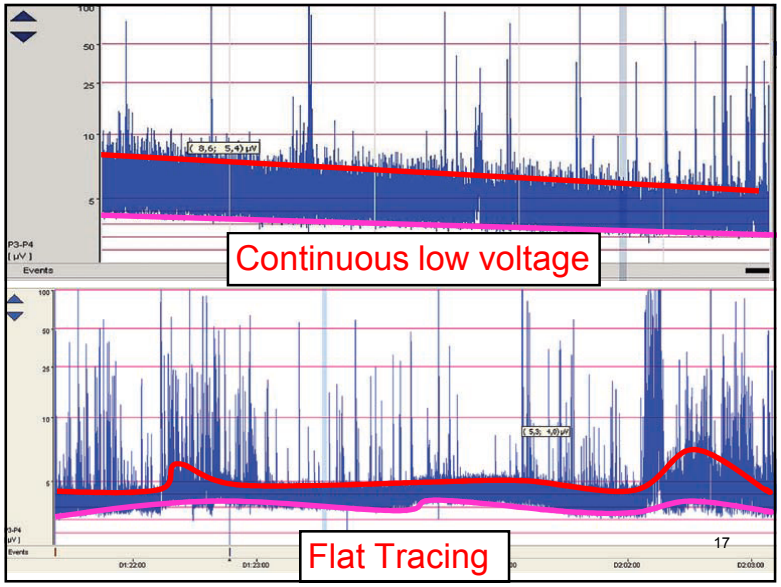
Background patterns

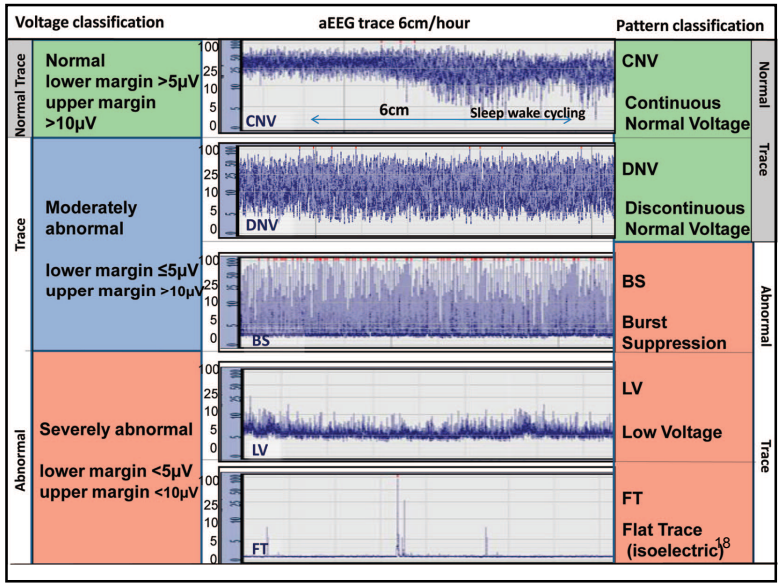
- CNV Continuous normal voltage
- DNV Discontinuous normal voltage (Min < 5, Max > 10)
- CLV Continuous low voltage (Min < 5, Max < 10)
- BS Burst-suppression Min < 5 no variability, Max >10 hi-voltage bursts)
- FT Flat Tracing (Min and Max < 5)

14





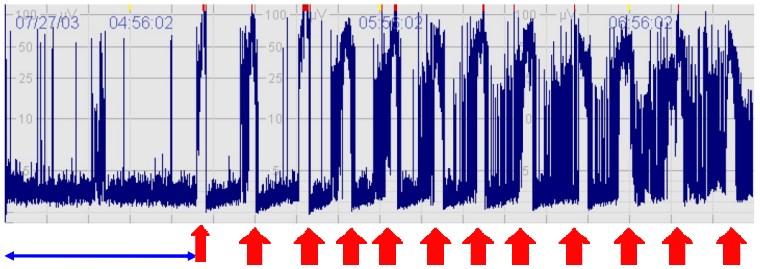




Seizure in aEEG

- Sudden change
- Raised lower border
- Raised upper border
- Narrow bandwidth
- Sudden drop to normal

19

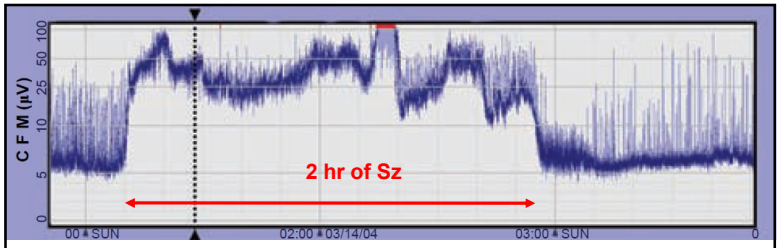


20

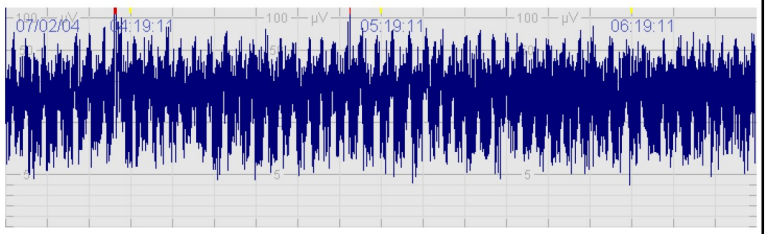
Status epilepticus

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

21

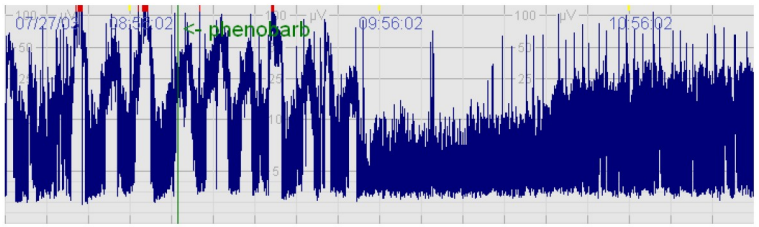


Sustained Sz



“Saw tooth pattern”

22



Repetitive Sz

Discontinuous pattern = AED effect

Modified from: Hellstrom-Westas_An Atlas of Amplitude-Integrated EEGs in the Newborn 2nd ed

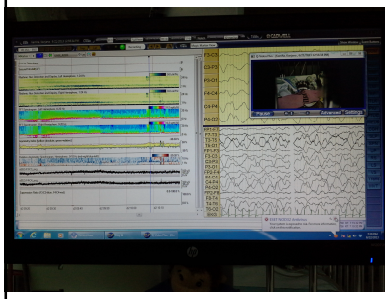
23

cEEG

- All or selected leads
- Raw data processed by software
- Multiple alysis parameters
- Automatic Seizure detection
- Enable raw EEG analysis
- Remote review recommended

24

cEEG



25

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)

26

Friedman, Claassen, Hirsch. cEEG in ICU. Anesthesia & Analgesia 2009

Clinical applications

I. Detection of subclinical seizures

a. Fluctuating mental status

b. Unexplained alteration of mental status

c. Acute supratentorial brain injury with altered mental status

d. After convulsive status epilepticus

27

Clinical applications

II. Characterization of spells

a. Episodic posturing, paroxysmal or repetitive movements

b. Subtle twitching, nystagmus, eye deviation, chewing

c. Paroxysmal autonomic spells e.g. tachycardia

28

Clinical applications

III. Detection of ischemia

a. After subarachnoid hemorrhage

b. During and after vascular procedures

c. patients with hemodynamic lesions and borderline flow

d. patients at risk for acute ischemia

29

Clinical applications

IV. Assessment of level of sedation

V. Management of burst-suppression in anesthetic coma

VI. Prognosis: - cardiac arrest

- acute brain injury

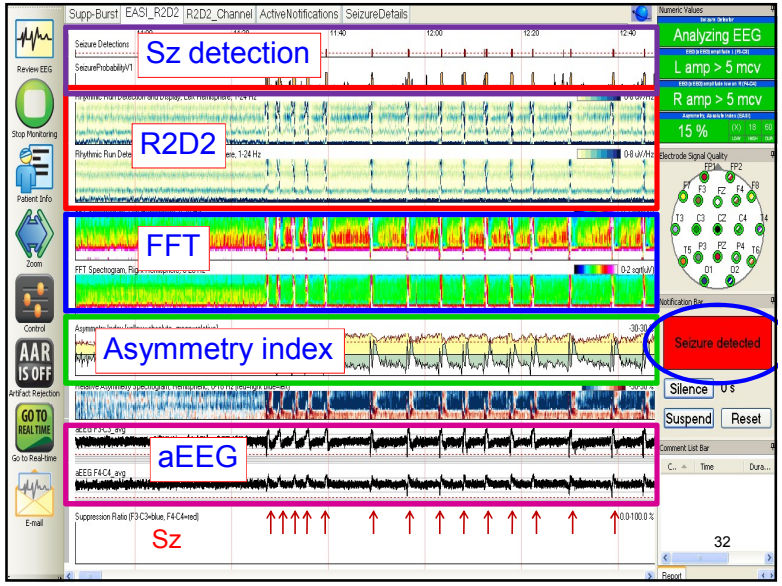
30

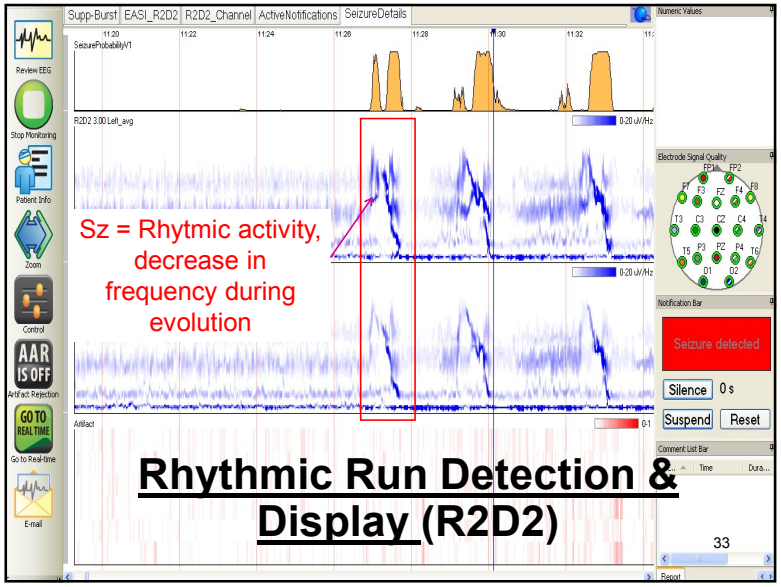
Analysis modalities

- aEEG
- Compressed spectral array (CSA)
- asymmetry index & spectogram
- frequency & rhythm analysis
- etc

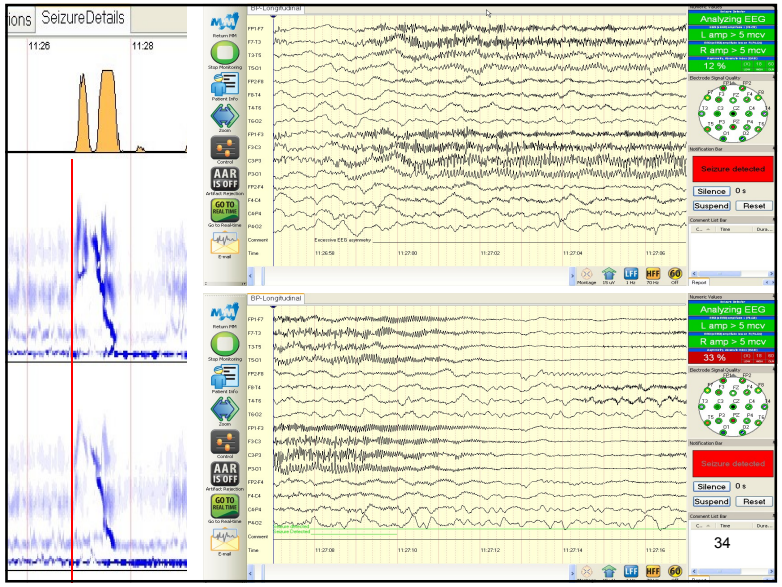
- Sz Detection & Sz probability

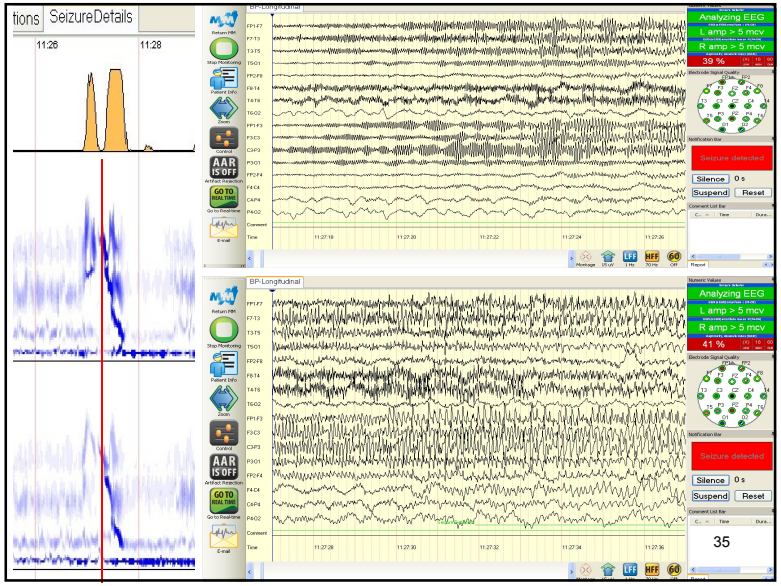
31

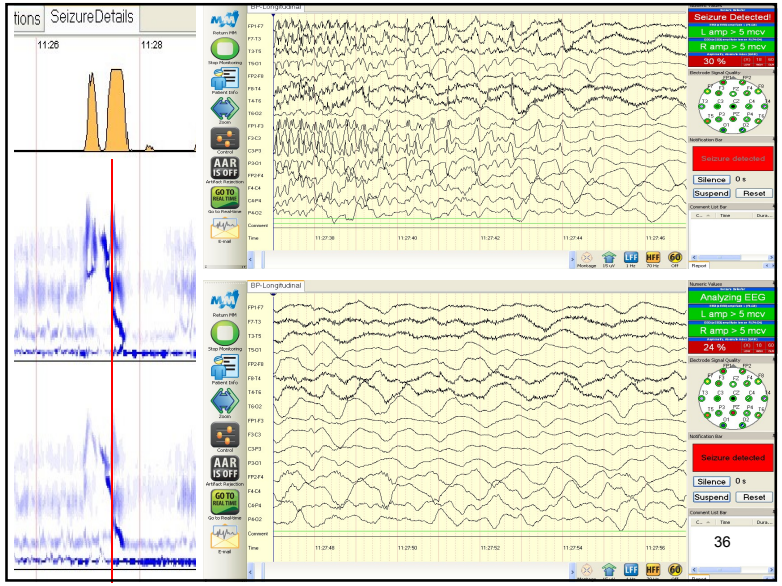




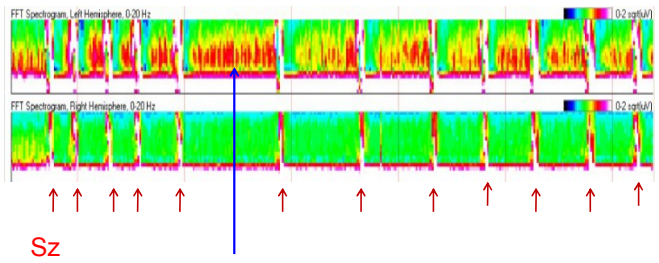
Rhythmic Run Detection & Display (R2D2)





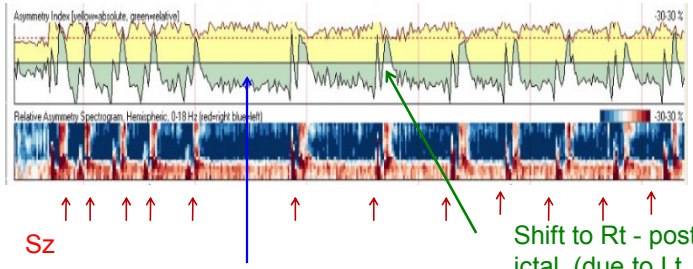


Fast Furior Transform(FFT)



37

Aysmmetry 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

38

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"

39

Thank you for your attention

40