

Periodic and Rhythmic Patterns

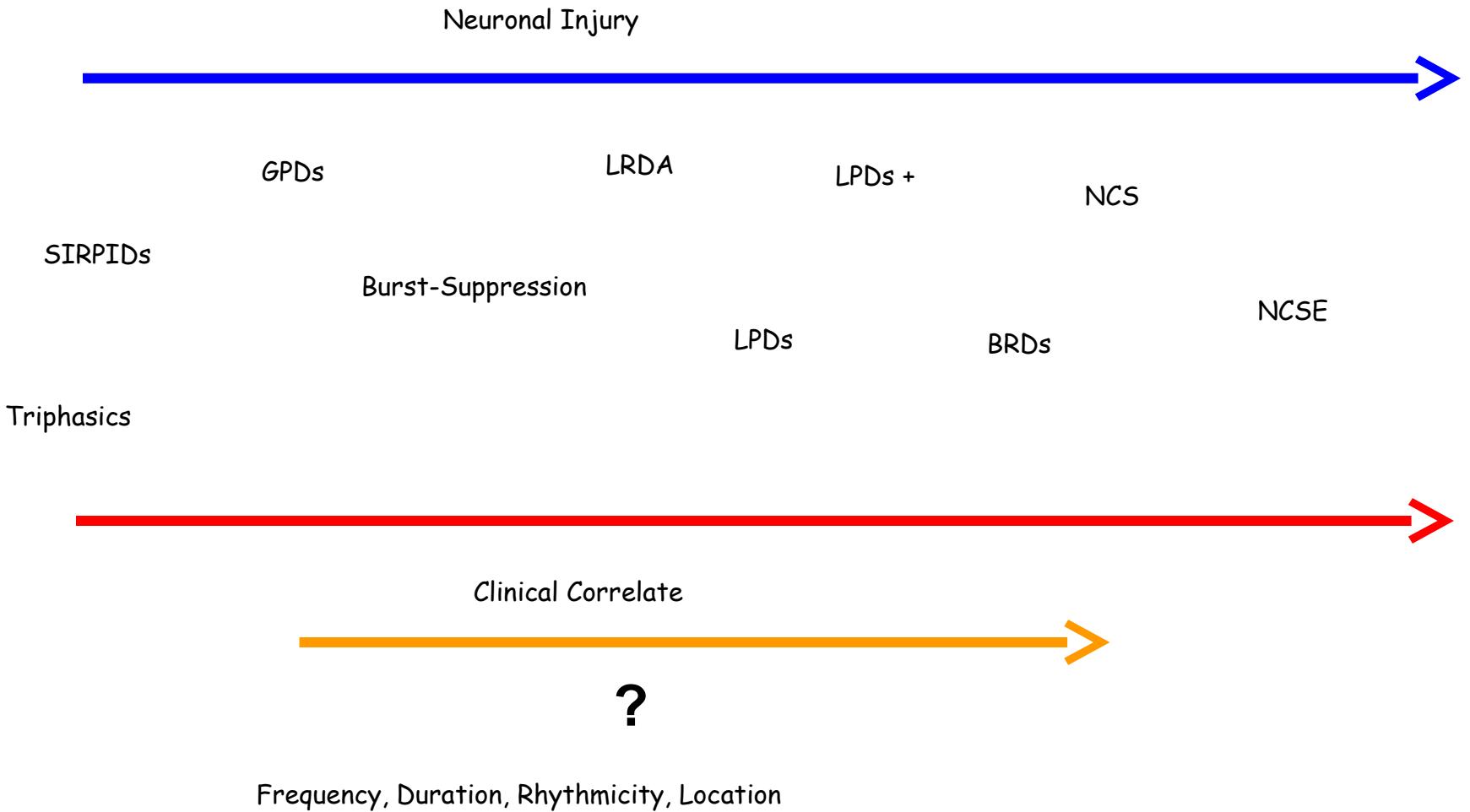
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Continuum of EEG Activity



American Clinical Neurophysiology Society (ACNS): Critical Care EEG Terminology

Main Term #1

Generalized

G

Lateralized

L

Bilateral Independent

BI

Multifocal

Mf

Main Term #2

Periodic Discharges

PD s

Rhythmic Delta Activity

RDA

Spike-wave

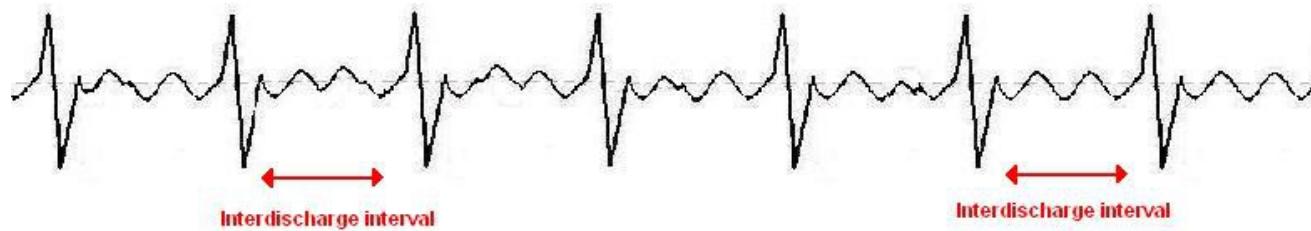
SW

Main Term 1: Location

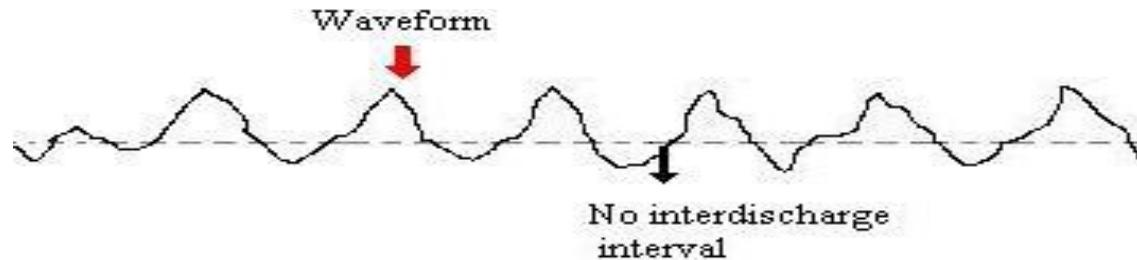
- Generalized
 - Symmetric in both hemispheres
- Lateralized
 - Seen in only one hemisphere: unilateral
 - Seen in both hemispheres but asymmetric: Bilateral asymmetric
- Bilateral Independent
 - Seen in both hemispheres but Asynchronous
- Multifocal

Main term 2: Pattern Type

- Periodic Discharge (PD)
 - Repetition of a waveform with uniform morphology
 - **Quantifiable interval** between waveforms



- Rhythmic Delta Activity (RDA)
 - Repetition of a waveform with uniform morphology
 - **No interval** between consecutive waveforms



Modifiers

- Amplitude
- **Frequency**
- Prevalence (how much of the recording?)
- **Plus (superimposed Fast, Rhythmic, Sharp)**
- Stimulus Induced (SIRPIDs)
- Triphasic Morphology

Lateralized Periodic Discharges: LPDs



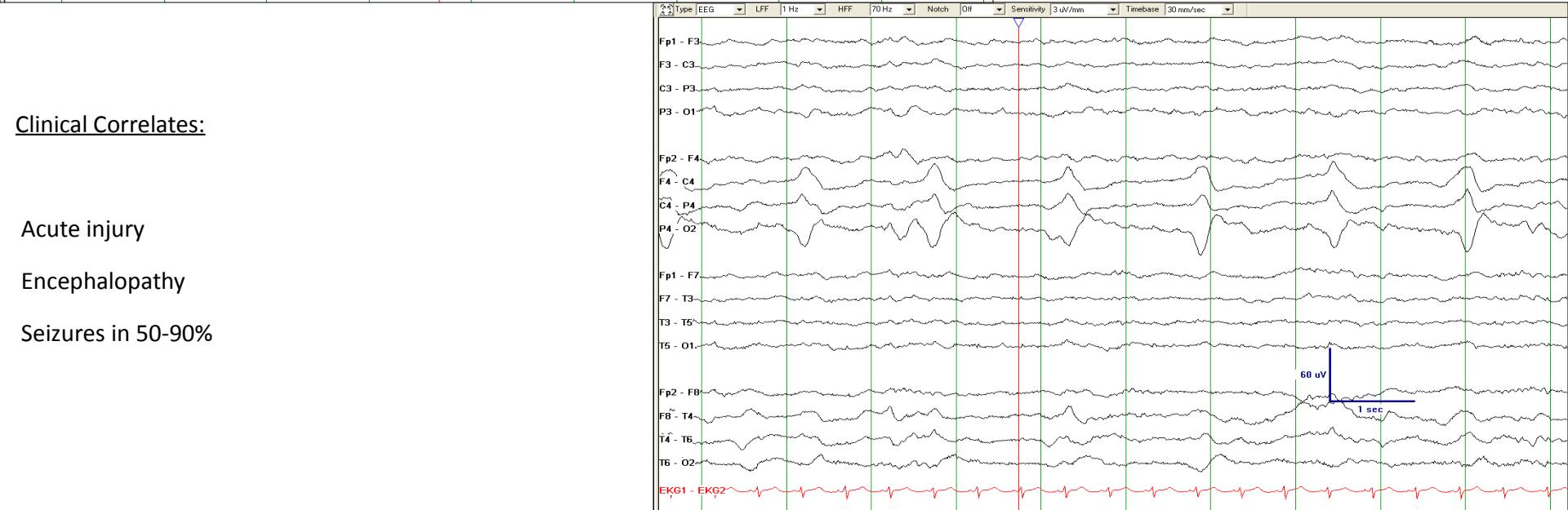
Etiologies:

Stroke

Encephalitis (HSV)

Tumor

Intracranial hemorrhage



Clinical Correlates:

Acute injury

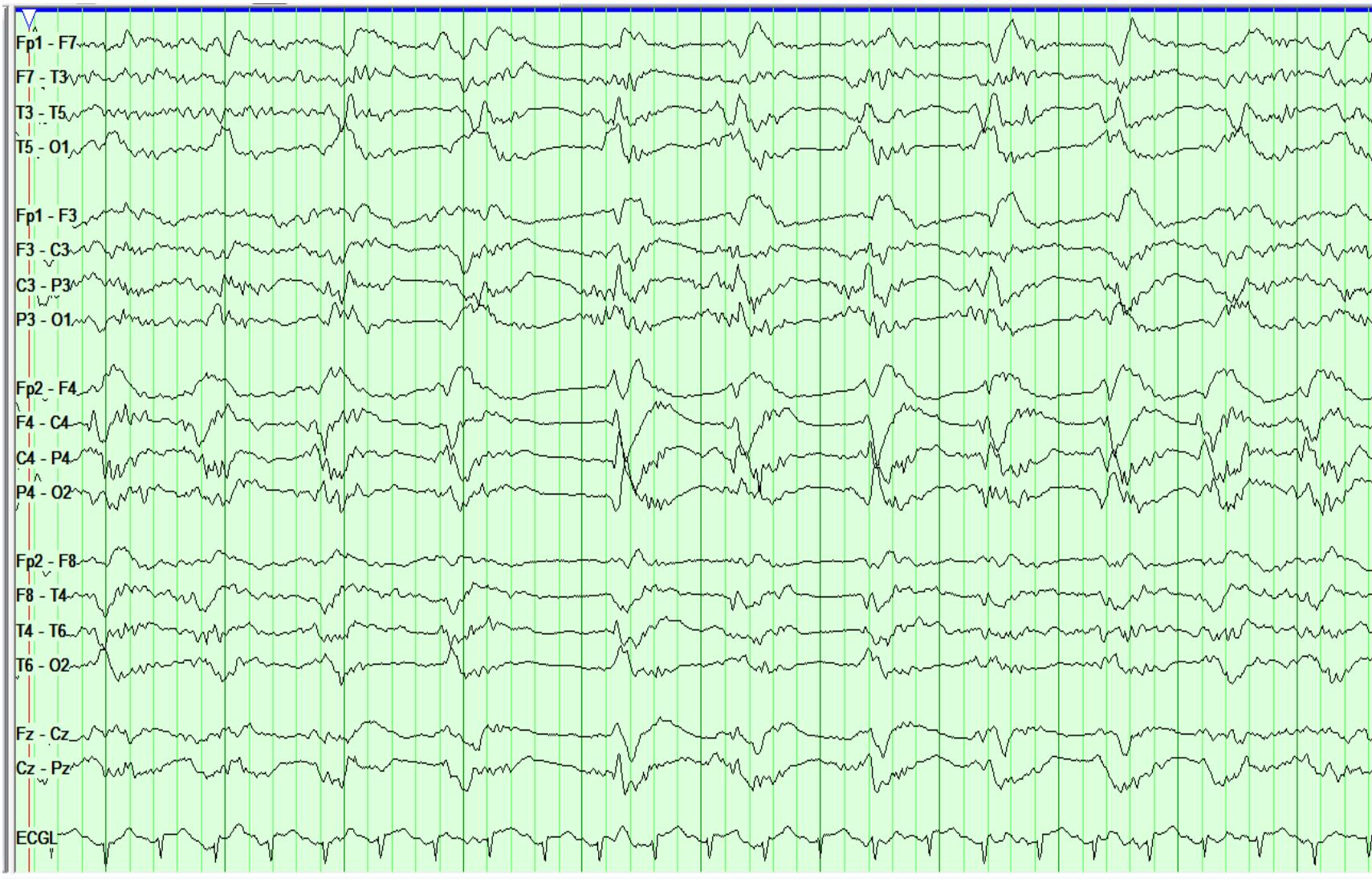
Encephalopathy

Seizures in 50-90%

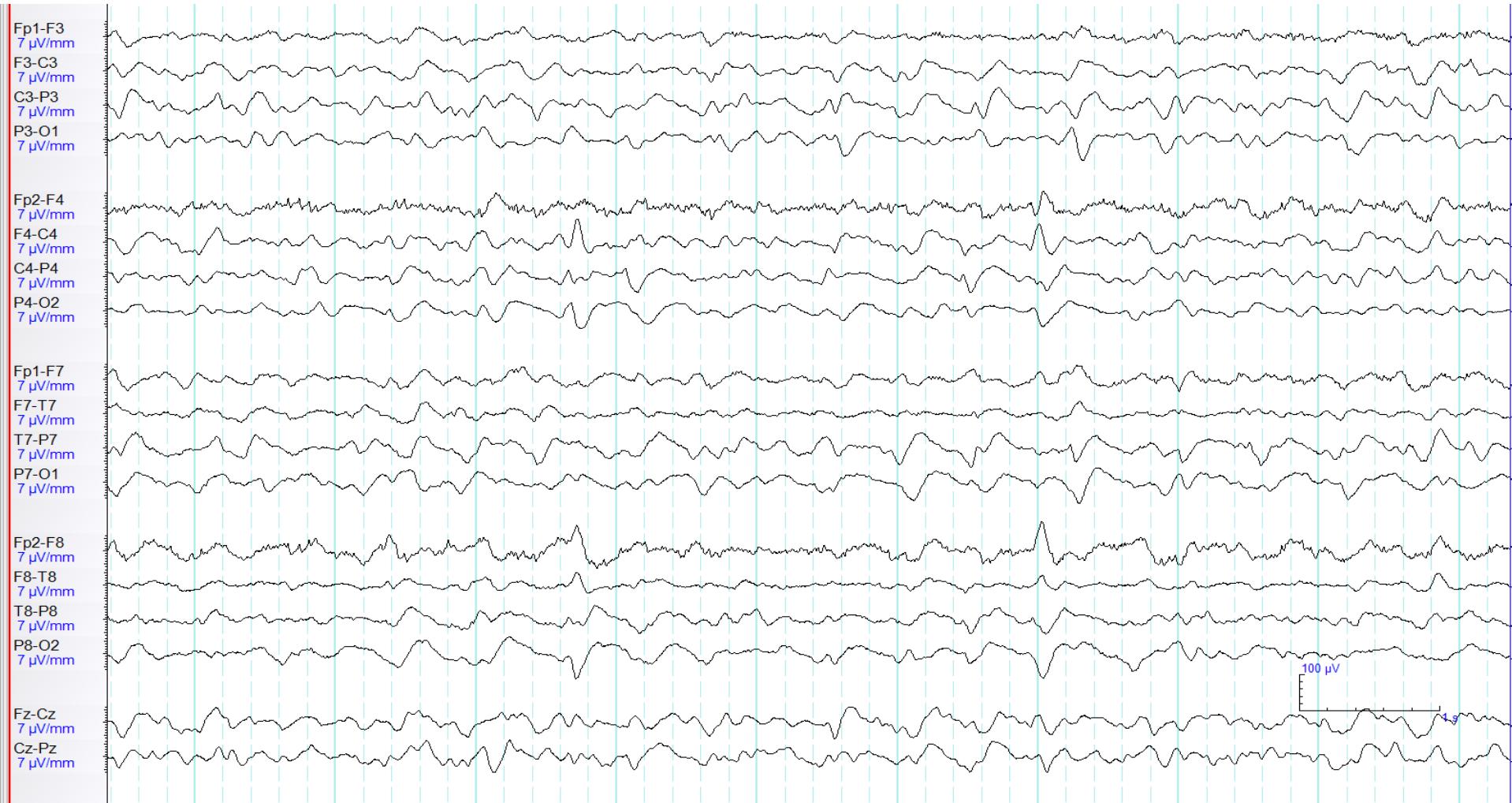
Lateralized Periodic Discharges



Lateralized Periodic Discharges Plus



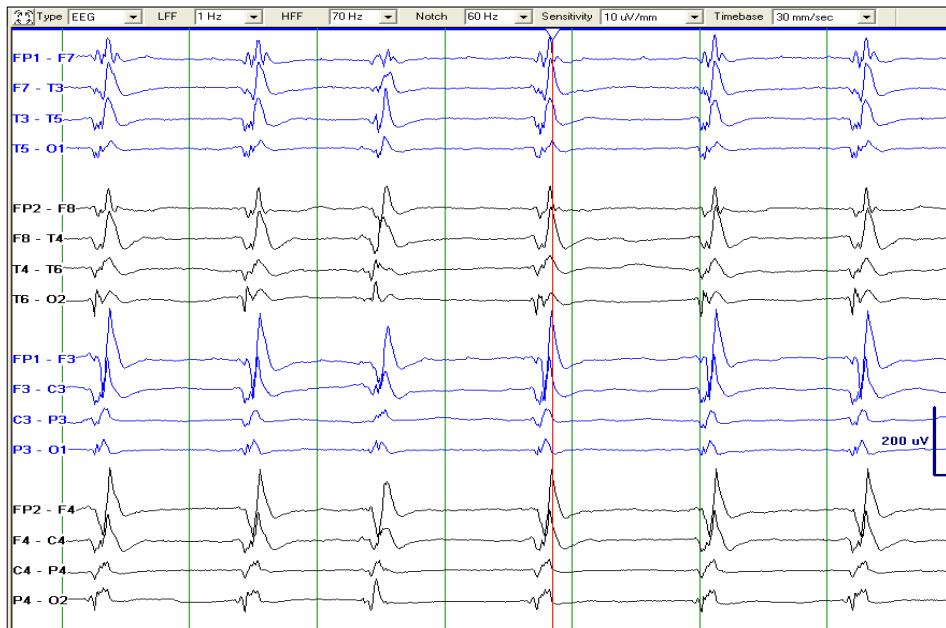
Bilateral Independent Periodic Discharges (BIPDs)



Left Face Twitch: “ictal” LPDs



Generalized Periodic Discharges: GPDs



Etiologies:

Anoxia

Toxic metabolic

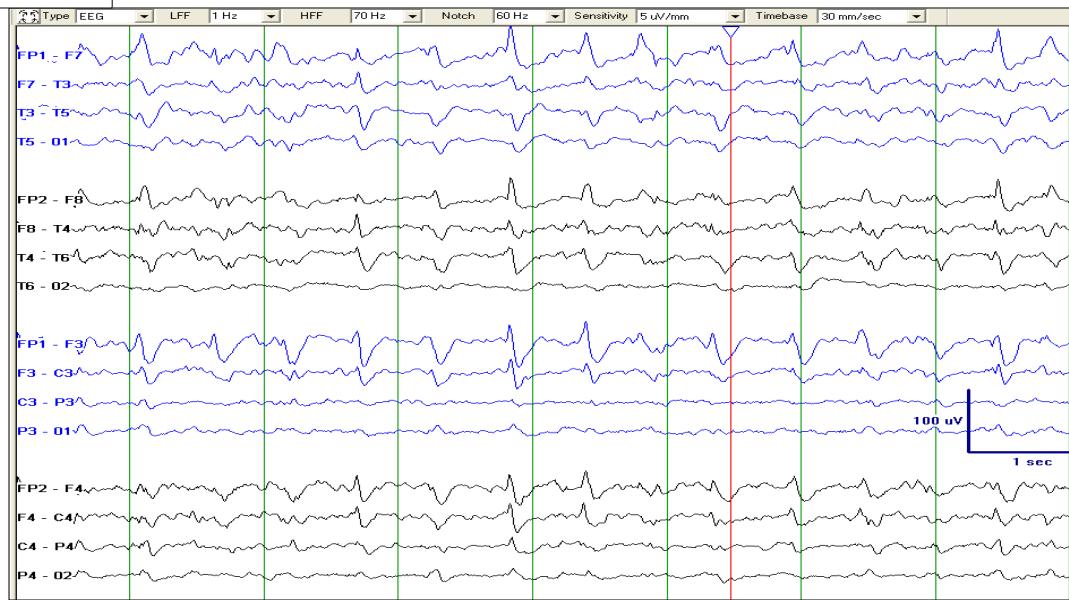
Infections (CJD)

Focal structural lesions

Clinical Correlate:

SEIZURES??

Outcome?



Generalized Periodic Discharges: Relationship to Seizures and Prognosis

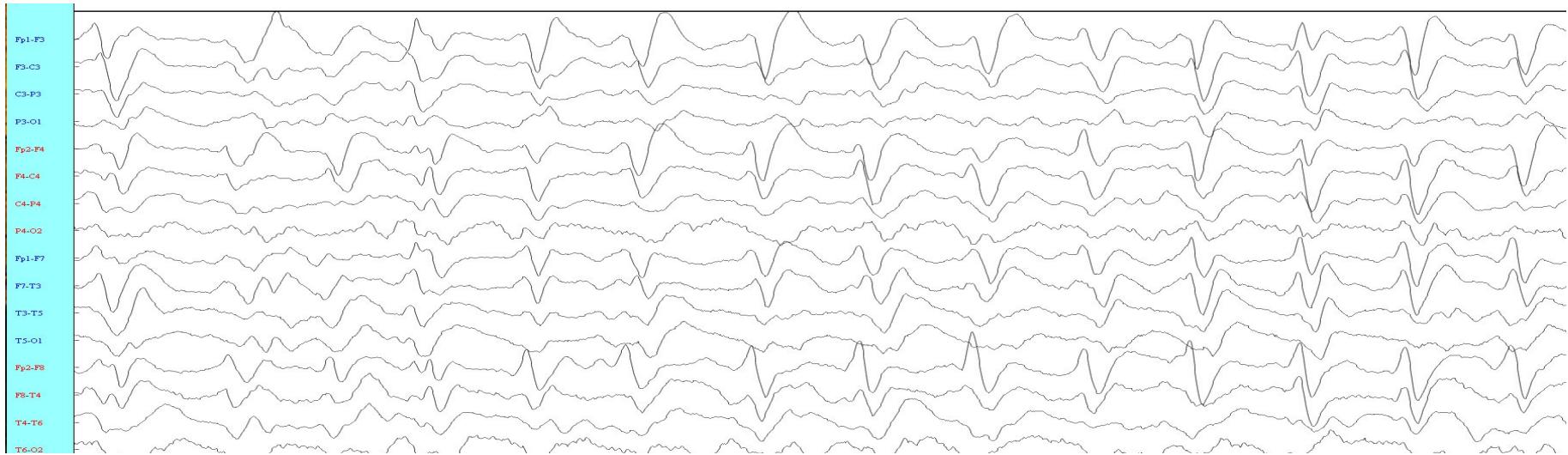
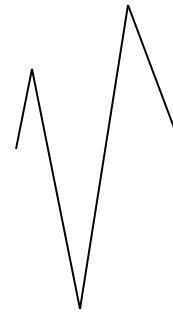
- Patients with GPDs were matched by age, etiology, level of consciousness to patients without GPDs (200 each)

	GPDs	Control	p value
Any seizure during hospitalization	46%	34%	0.014
Non-convulsive seizure	27%	8%	<0.001
NCSE	22%	7%	<0.001
Mortality (univariate)*	36.8%	26.9%	0.049

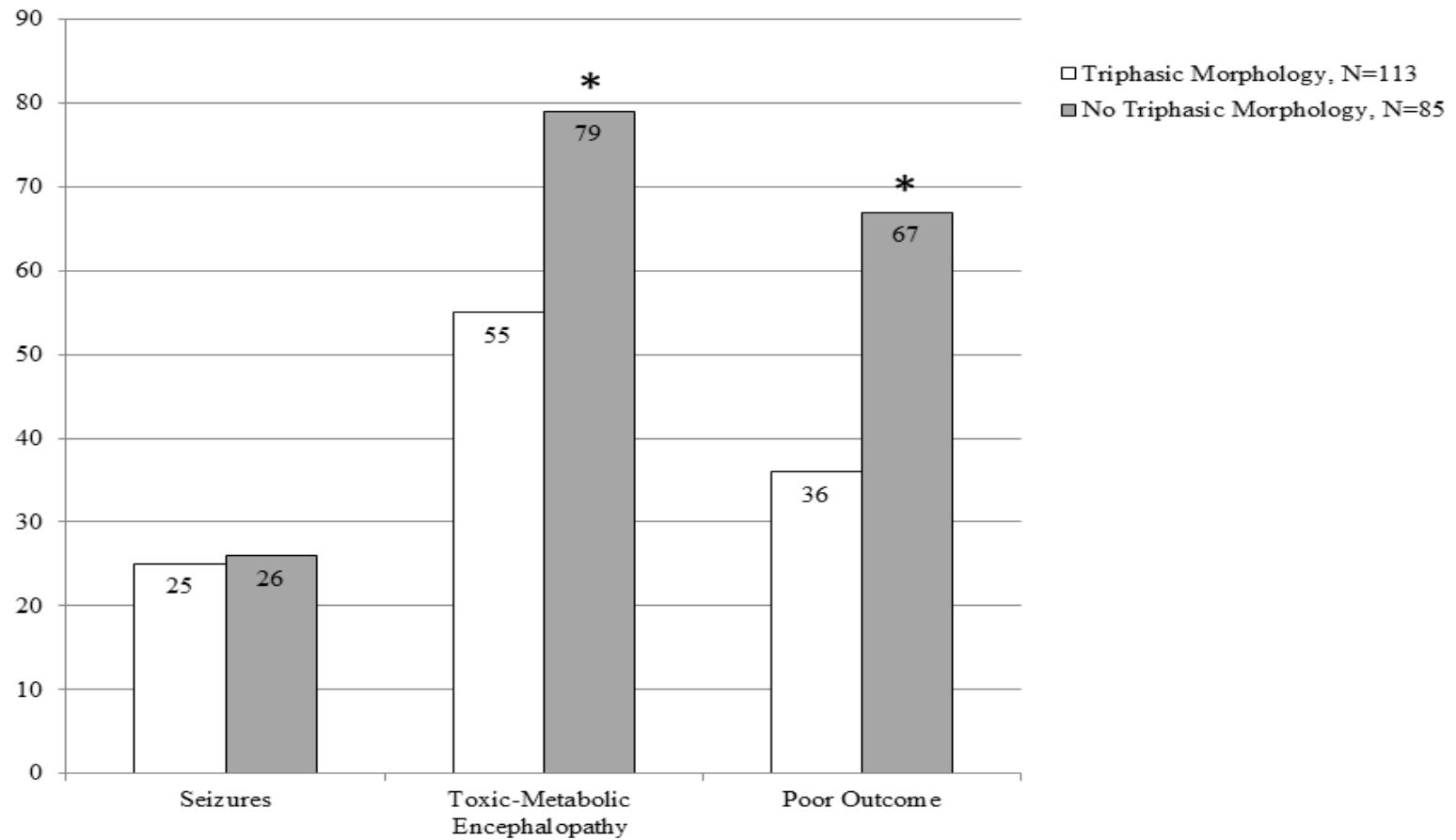
*Multivariate predictors of worse outcome were cardiac arrest, coma, nonconvulsive status epilepticus, and sepsis, but **not generalized periodic discharges**.

GPDs with Triphasic Morphology (old term: Triphasic Waves)

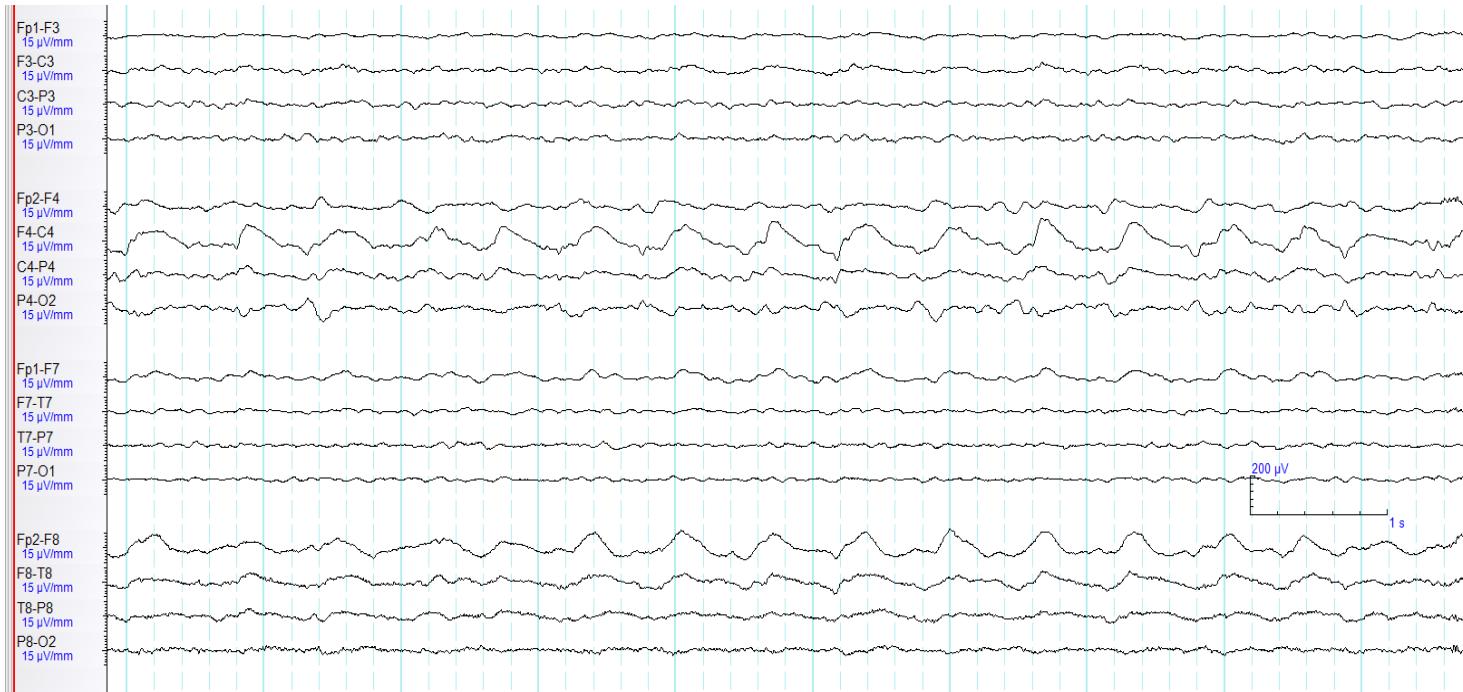
- High amplitude, positive discharge
- Each phase longer than the preceding
- Frontally predominant +/- A-P lag
- Hepatic or renal encephalopathy, anoxia, seizures?



Generalized Periodic Discharges: Clinical Significance of Triphasic Morphology



Lateralized Rhythmic Delta Activity (LRDA)



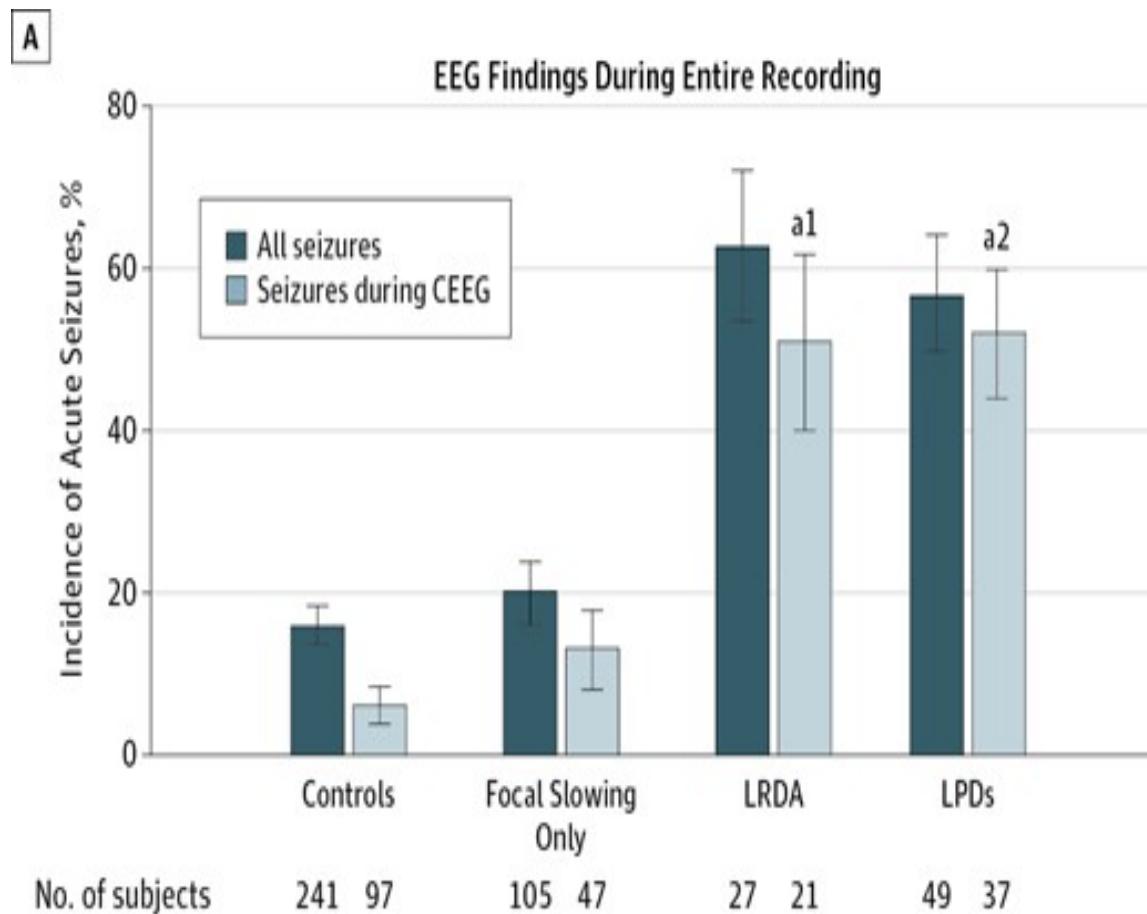
27 patients/570 (4.7%)

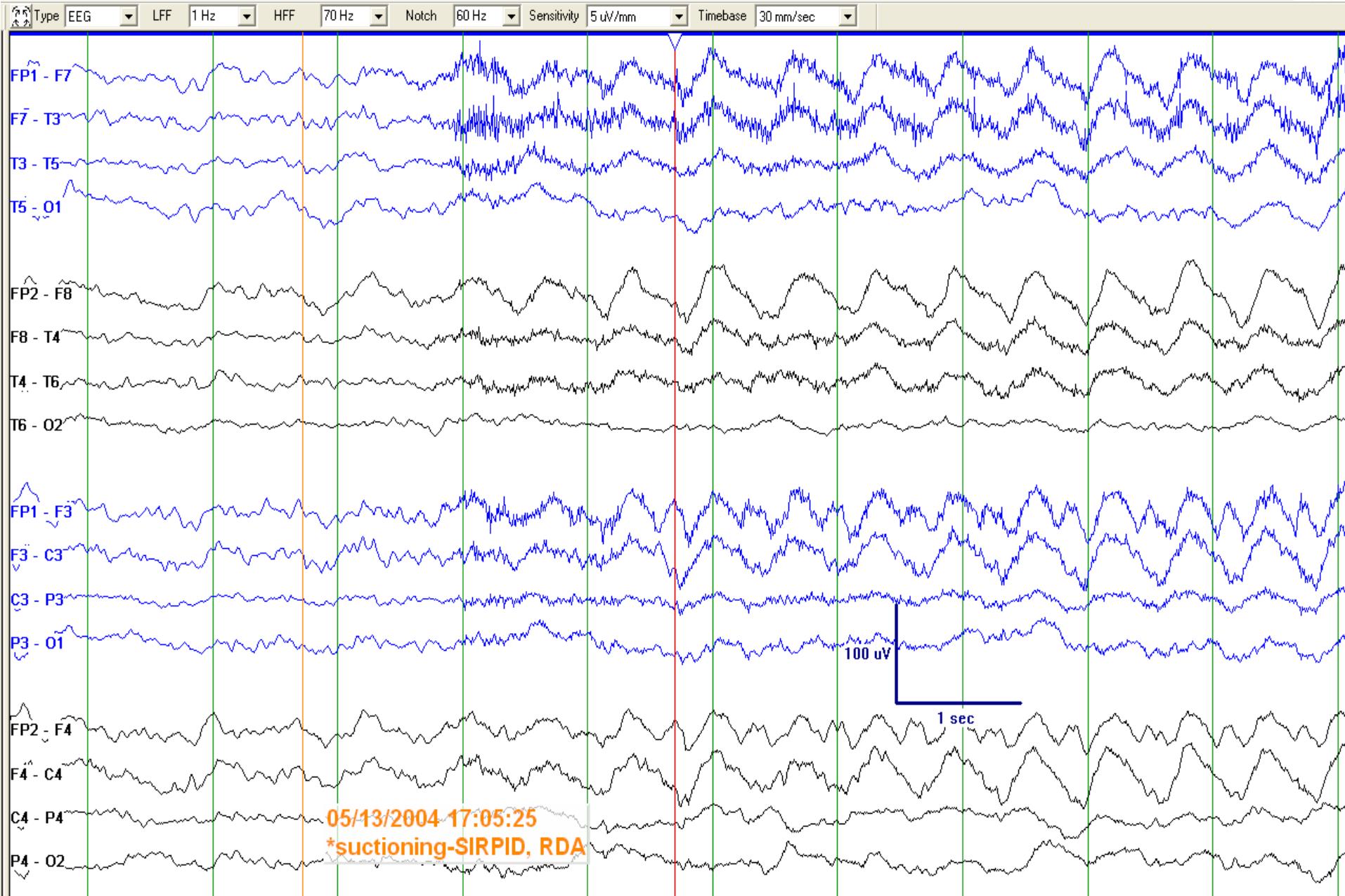
Control populations

- Lateralized Periodic Discharges: N = 49
- Focal slowing: N = 136
- No focal, periodic or rhythmic pattern: N = 241

Gaspard et al. JAMA
Neurology 2013

LRDA: Risk of acute seizures





Generalized Rhythmic Delta Activity (GRDA)

- High amplitude, bisynchronous slow waves
- Typical frequency of 2- 2.5 Hz
- Typically seen in toxic-metabolic disturbances
- May see with large midline structural lesions or increased ICP with herniation

Brief (potentially ictal)Rhythmic Discharges

B(i)RDs, BRDs

“Evolving rhythmic patterns.... less than 10 seconds”



B(i)RDs and Association with Seizures

- 20 adult patients with B(i)RDs and compared to control groups

Table 2. Occurrence of Seizures During CEEG

CEEG Findings ^a	Seizure During CEEG, No. (%)		Univariate Analysis		Multivariate Analysis	
	Yes	No	P Value	P Value	OR (95% CI)	
B(i)RDs	15 (75)	5 (25)	<.001	<.001	17.6 (3.5-89.2)	
LPDs	16 (64)	9 (36)	.001	.004	10.4 (2.1-50.9)	
No B(i)RDs, no LPDs ^b	1 (4)	26 (96)	

Abbreviations: B(i)RDs, brief potentially ictal rhythmic discharges; CEEG, continuous electroencephalography; LPDs, lateralized periodic discharges.

^aEleven patients had both B(i)RDs and LPDs.

^bReference group used for comparison.



SIRPIDS= Stimulus induced rhythmic, periodic or ictal discharges

- 33 of 150 pts. undergoing cEEG (22%)
- 50% experienced clinical or subclinical seizures during hospitalization
- Reactivity? Pathophysiology?

Interrater Reliability of ICU EEG Research Terminology

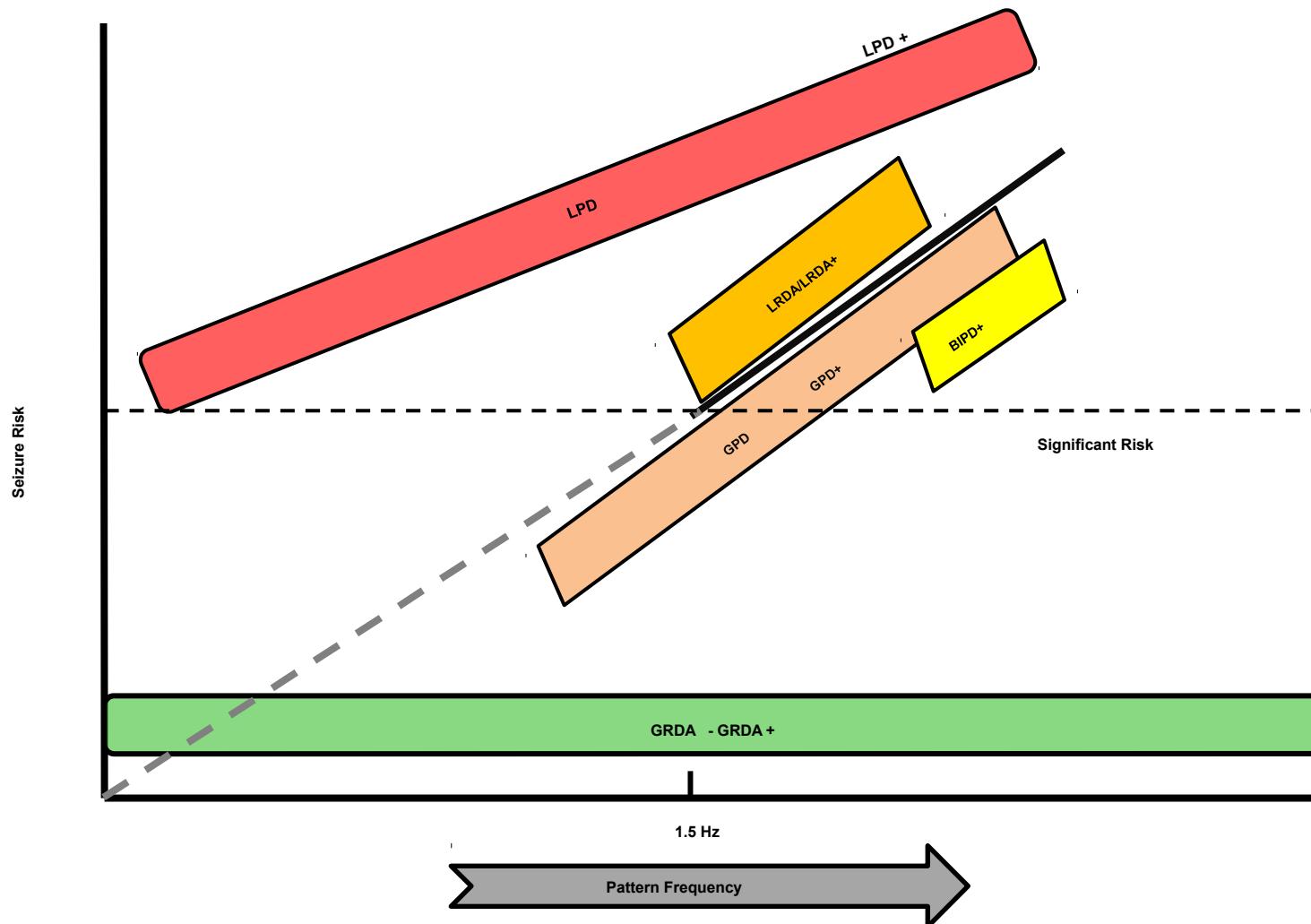
Ram Mani,* Hiba Arif,† Lawrence J. Hirsch,‡ Elizabeth Gerard,§ and Suzette LaRoche||

	Term	% Agreement (SD)	Kappa (95% CI)	Agreement
Main Term 1	Generalized	96% (7%)	.87 (.75-.98)	Almost Perfect
	Lateralized			
	Bilateral Independent			
	Multifocal			
Main Term 2	Periodic Discharges	98% (3%)	.92 (.78-.98)	Almost Perfect
	Rhythmic Delta Activity			
	Spike-Wave			
Modifiers	Amplitude	93% (12%)	n/a	
	Frequency	80% (20%)	n/a	
	+ Fast	83% (18%)	.54 (.16-.87)	Fair
	+ Rhythmic Activity	88% (20%)	.62 (.41-.87)	Moderate
	+ Sharp or Spike	82% (20%)	.16 (.10-.28)	Poor

Periodic and Rhythmic Patterns: Association with Seizures

- Retrospective, 3-center review of 4772 critically ill adults undergoing CEEG
- Seizures were documented in 719 (12.5%) of which 530 (74%) also had a periodic or rhythmic pattern

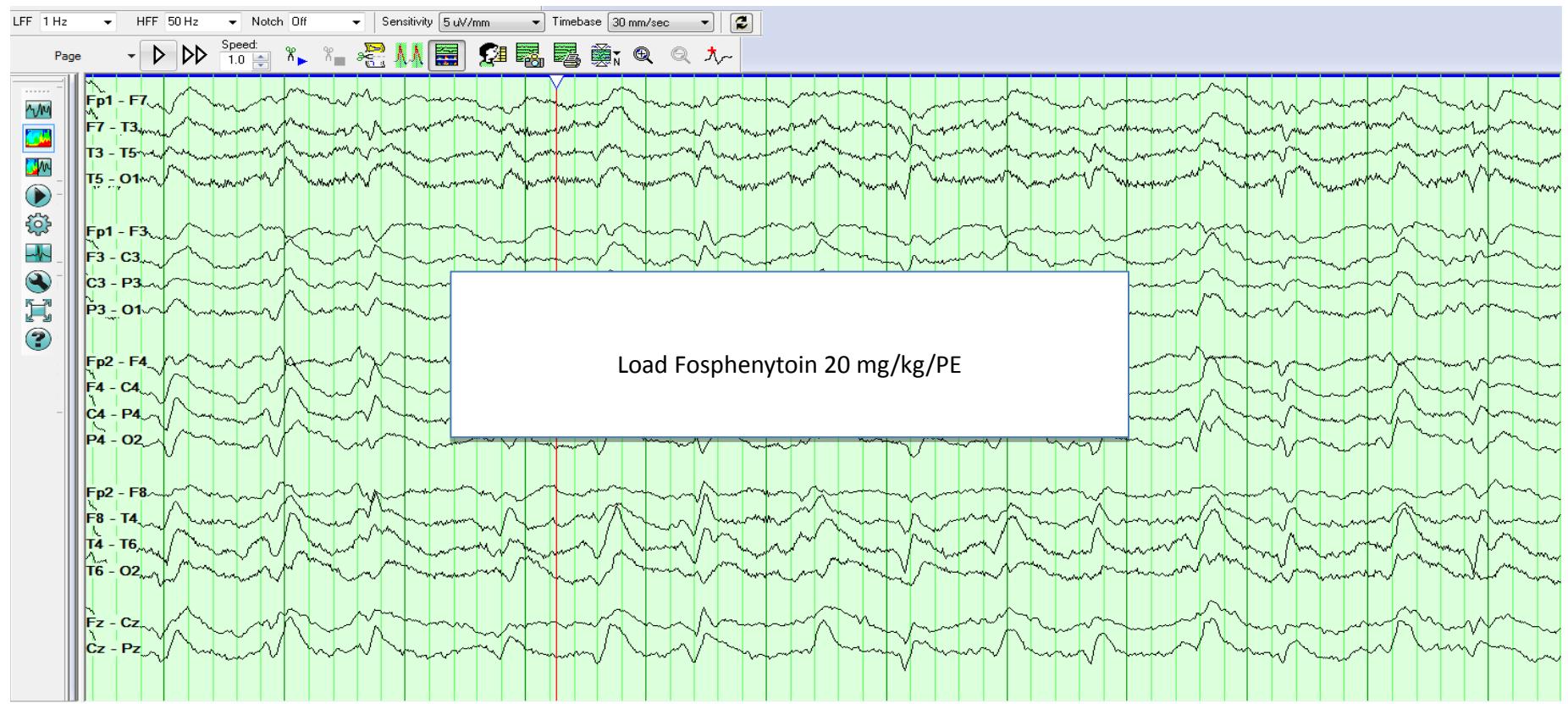
Periodic and Rhythmic Patterns: Association with Seizures



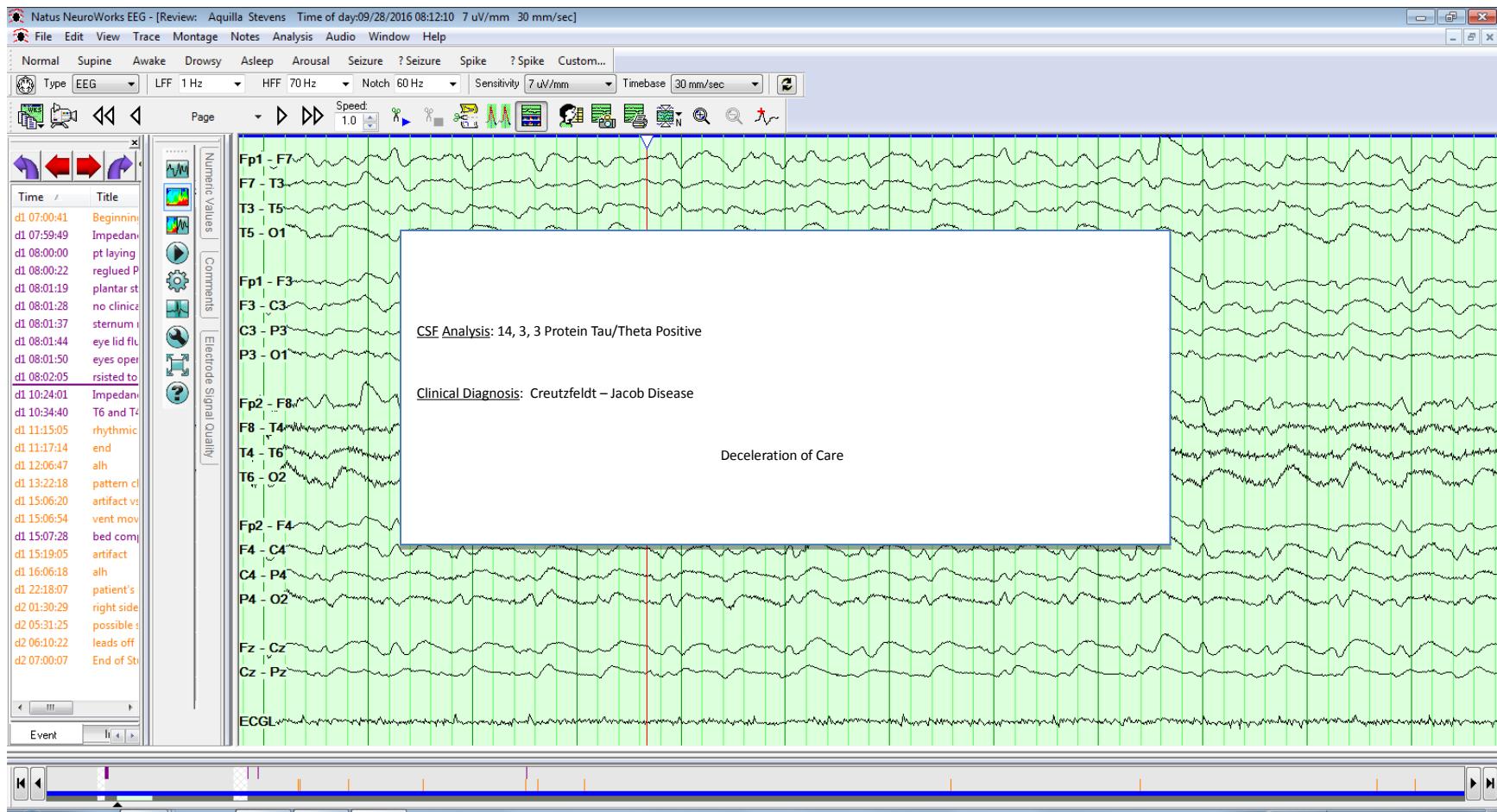
Case

- 66 yo man with 4 months of cognitive decline and gait instability
- Medications: Methadone, Diazepam
- Neurological Exam: Oriented to person only, bilateral visual field deficits, strength intact, reflexes brisk throughout, multifocal myoclonus, unable to stand
- Initial Diagnostic Tests:
 - MRI partially obscured due to movement artifact but essentially unremarkable
 - CSF – Protein 35, Glucose 67, WBC 3/4

Lateralized Periodic Discharges (LPDs)- Not Ictal



2 weeks later....



Case

- 85 yo admitted for fever, productive cough and confusion
- Medications: Albuterol, Lisinopril
- Neurological Exam: Lethargic, oriented to person only, unable to follow commands, otherwise non focal neurological exam
- Chest X ray: Bilateral pulmonary infiltrates
- Brain MRI: Mild generalized volume loss

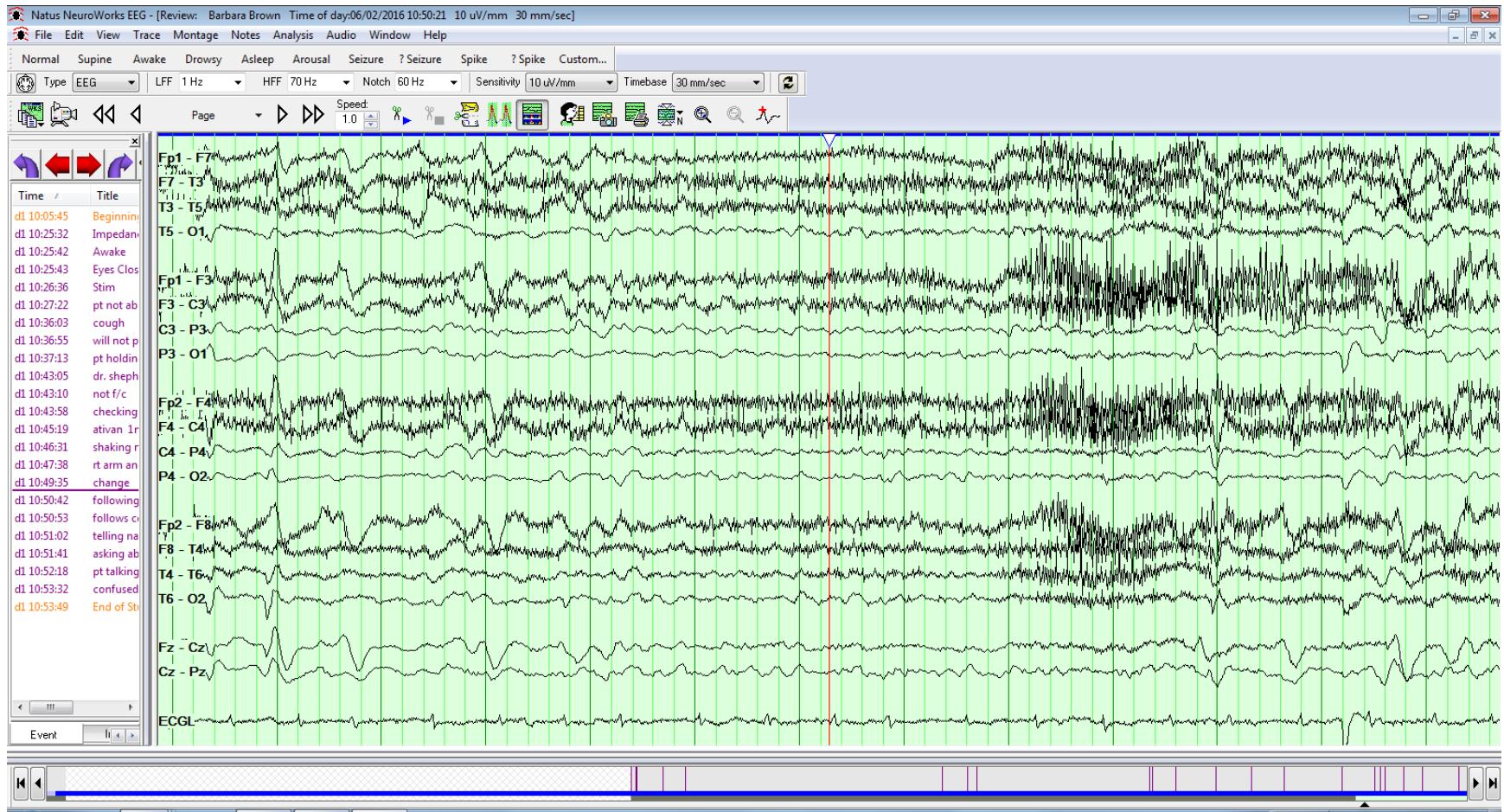
EEG 2 Days later: No improvement in mental status



Generalized Periodic Discharges (GPDs), 1.5-2 Hz, with triphasic morphology



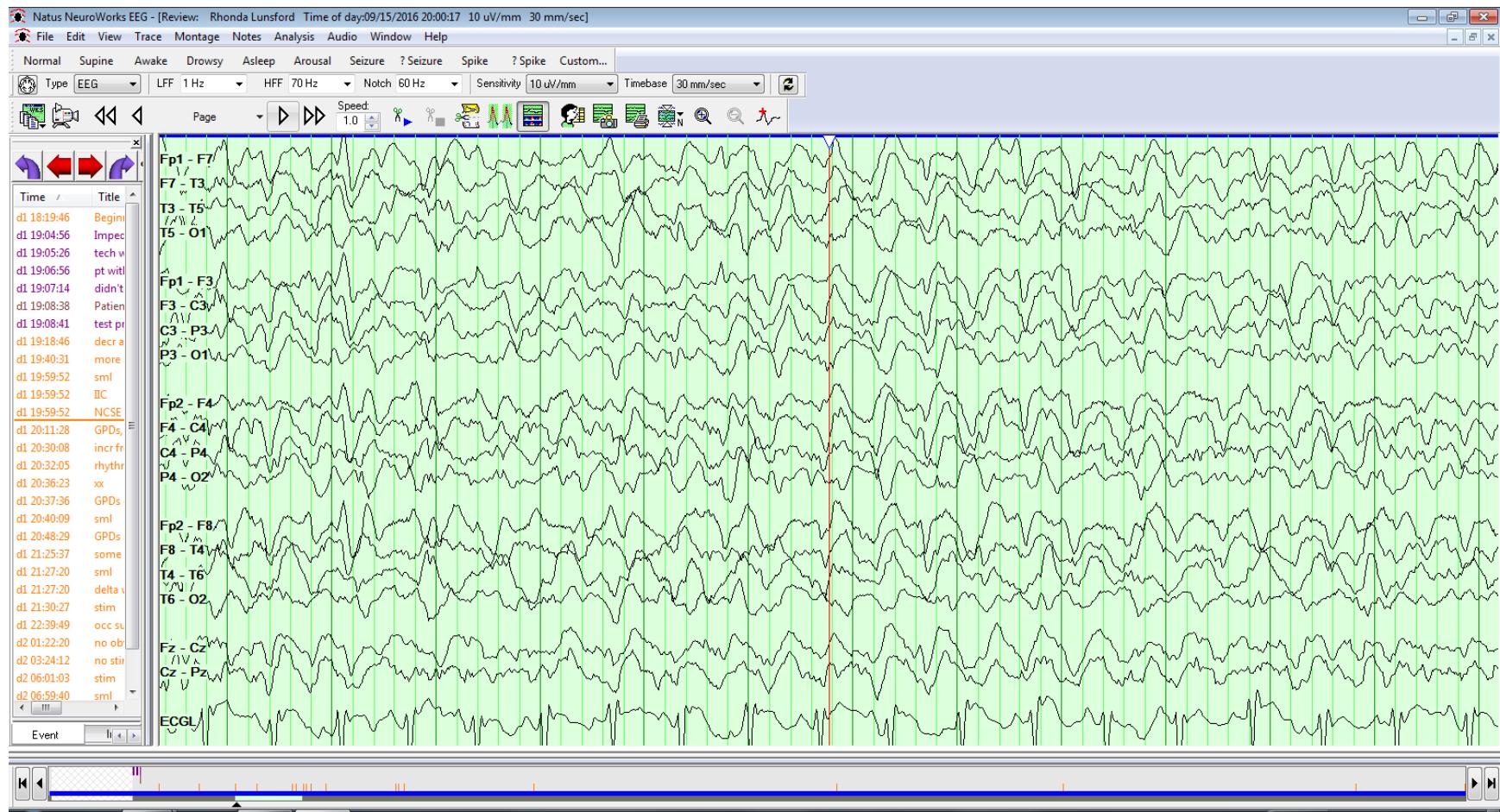
5 min after Lorazepam 2 mg: Awake, Follows Commands



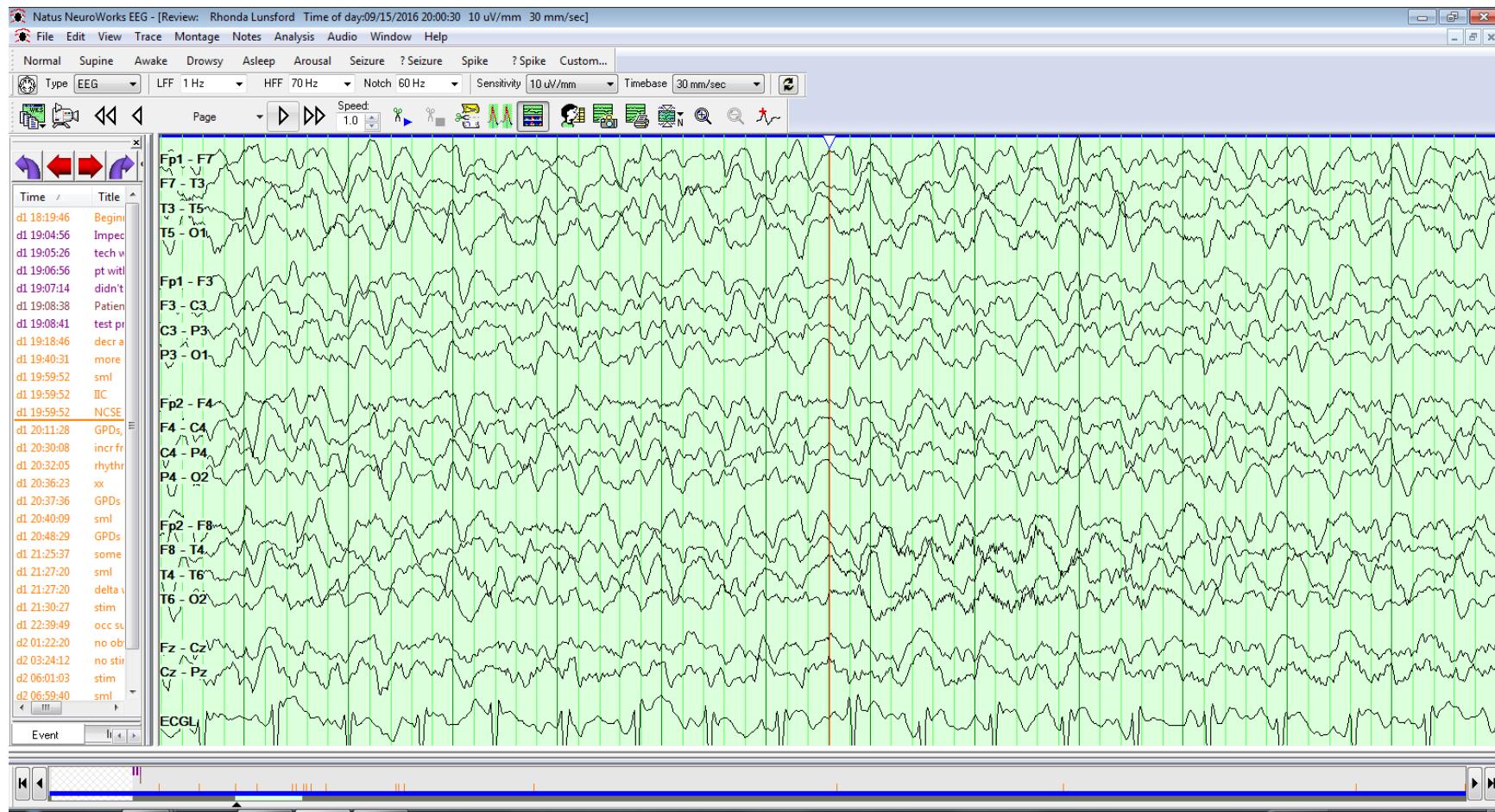
Case

- 44 yo woman with shortness of breath and confusion
- Medications: Oxycodone
- Urine Drug Screen: Positive for opiates, benzodiazepines
- Head CT: Unremarkable
- Intubated and sedated (with propofol) secondary to respiratory distress, possible overdose
- Neurology consult 2 days later for persistent confusion

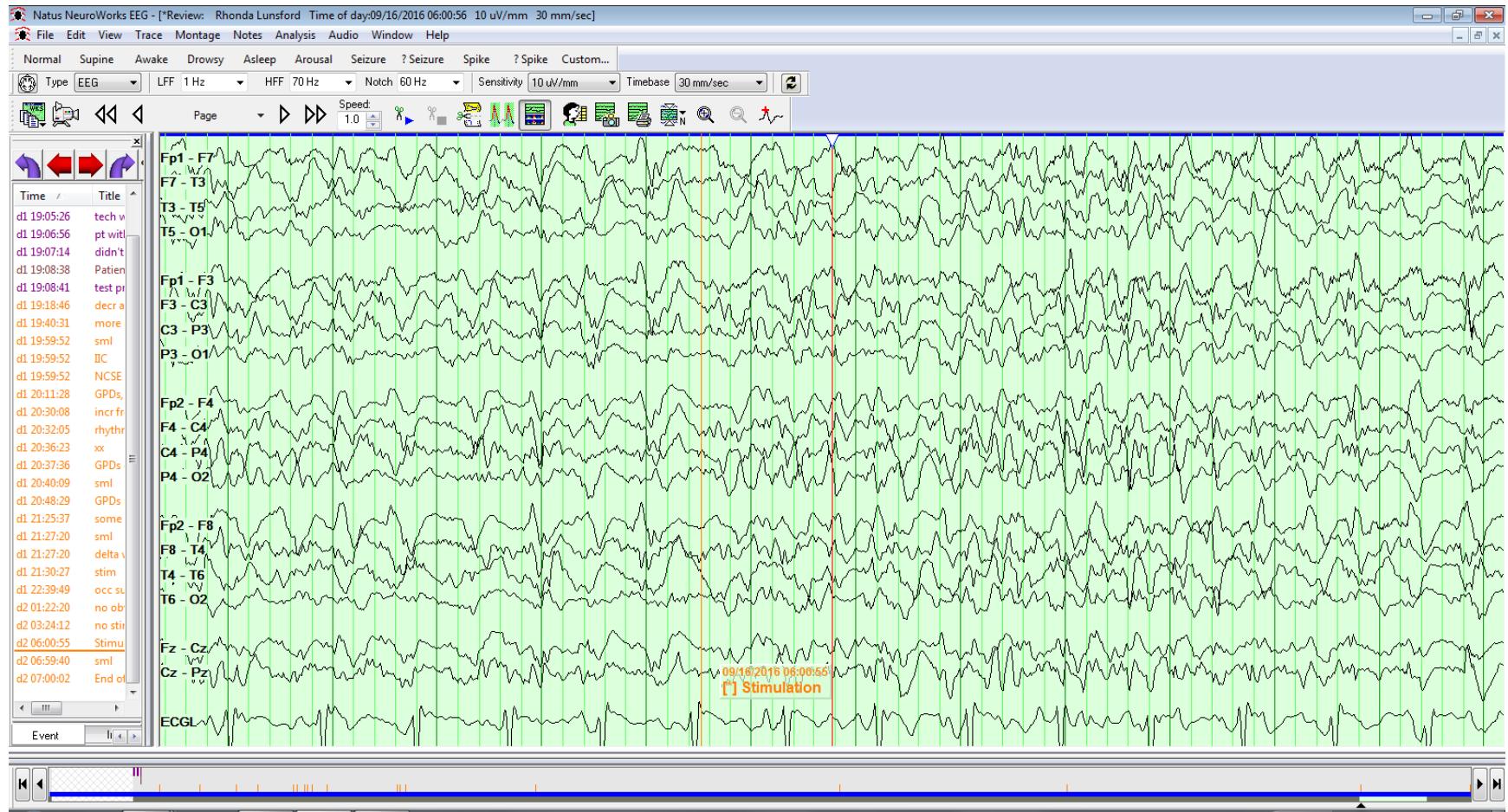
EEG During Propofol Wean: Generalized Rhythmic Delta Activity (GRDA), 2 Hz, Plus Sharp



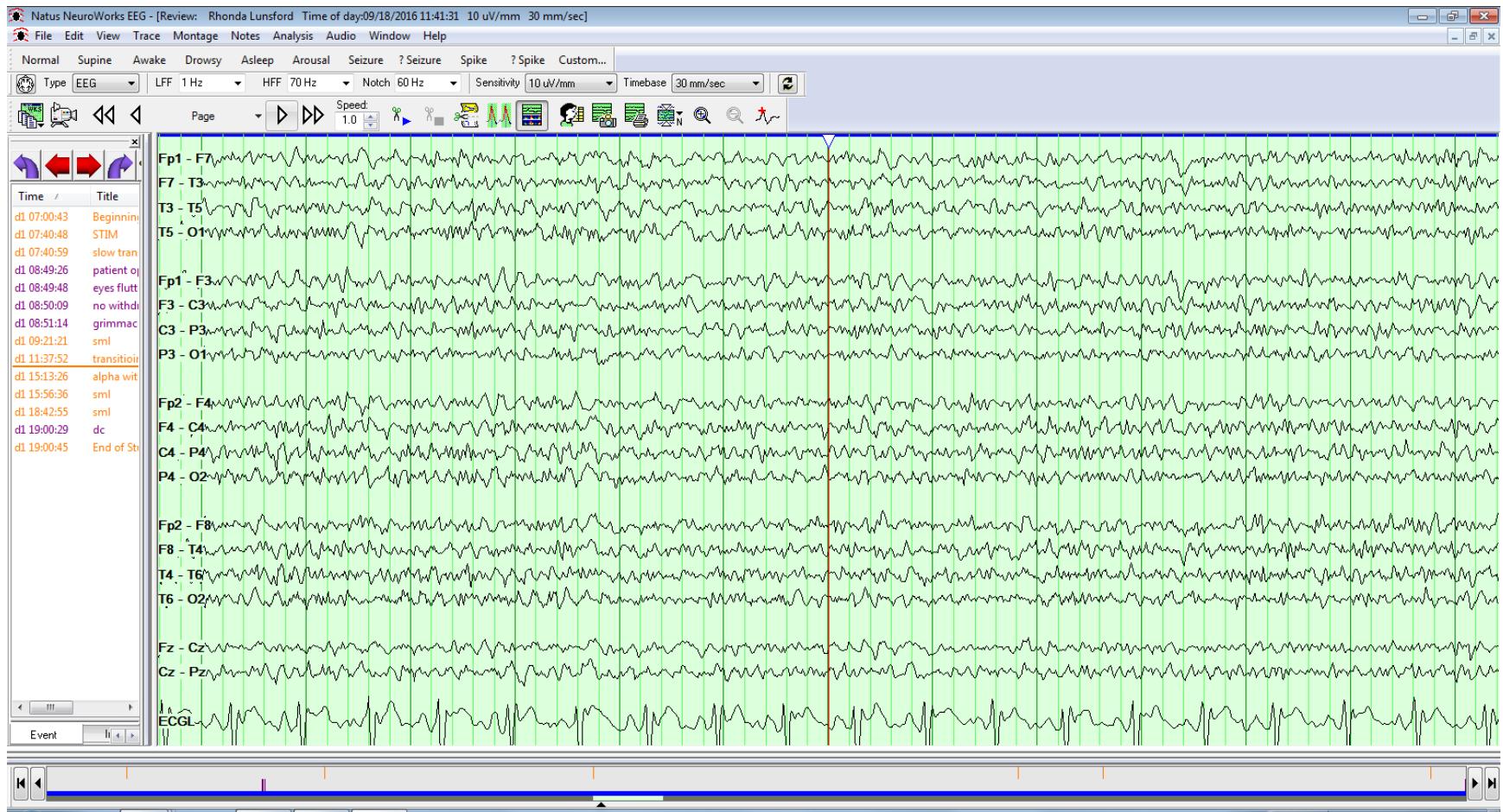
Also.... Fluctuating



Also... Stimulus Induced Rhythmic, Periodic or Ictal Discharges (SIRPIDs)



Next day, propofol off.....transferred out of ICU



Summary

- Periodic and rhythmic patterns are common in the critically ill, many of which have increased association with seizures
- Standardized terminology is critical for consistency in clinical reporting and research
- Medical decisions need to take into account the EEG pattern AND clinical history