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Saudi Pediatric Neurology Society

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Riyadh, KSA

cEEG Patterns: Interictal vs Ictal – A Practical Guide

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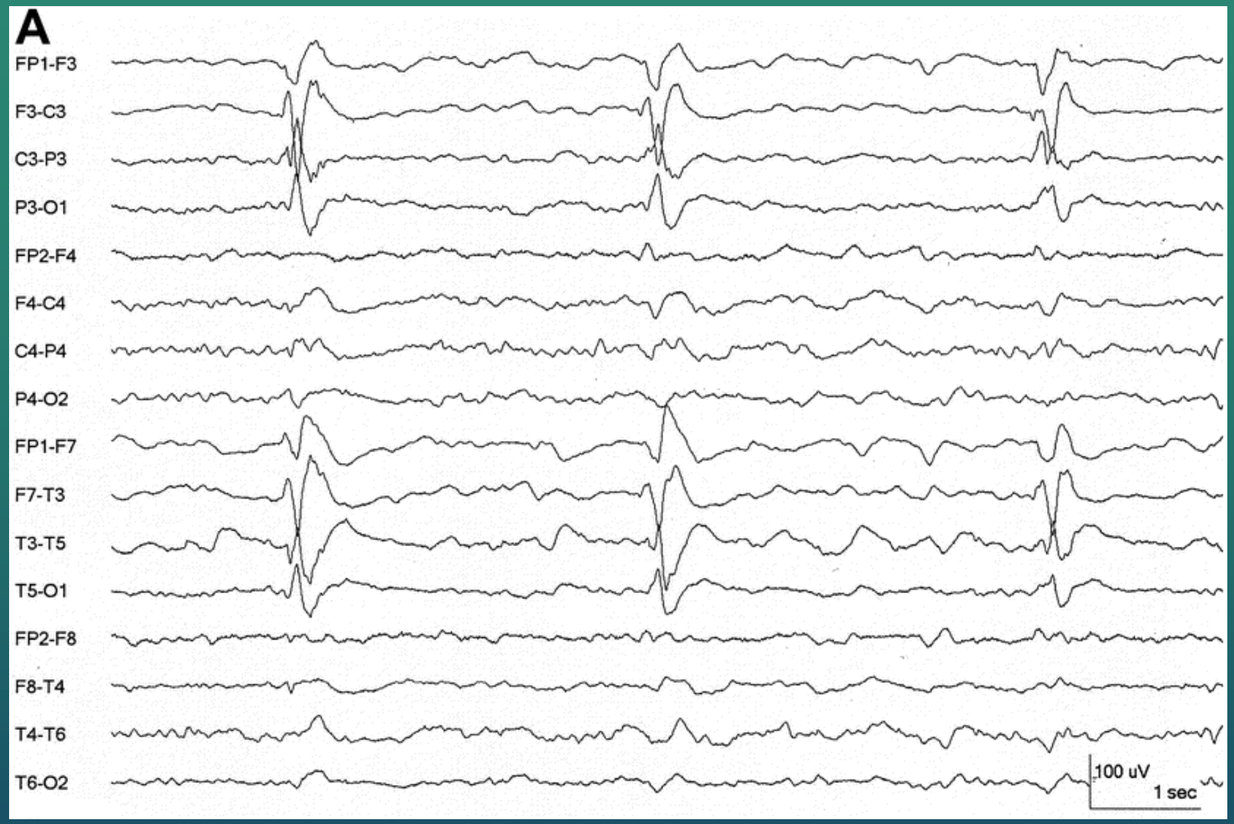
Disclosure:

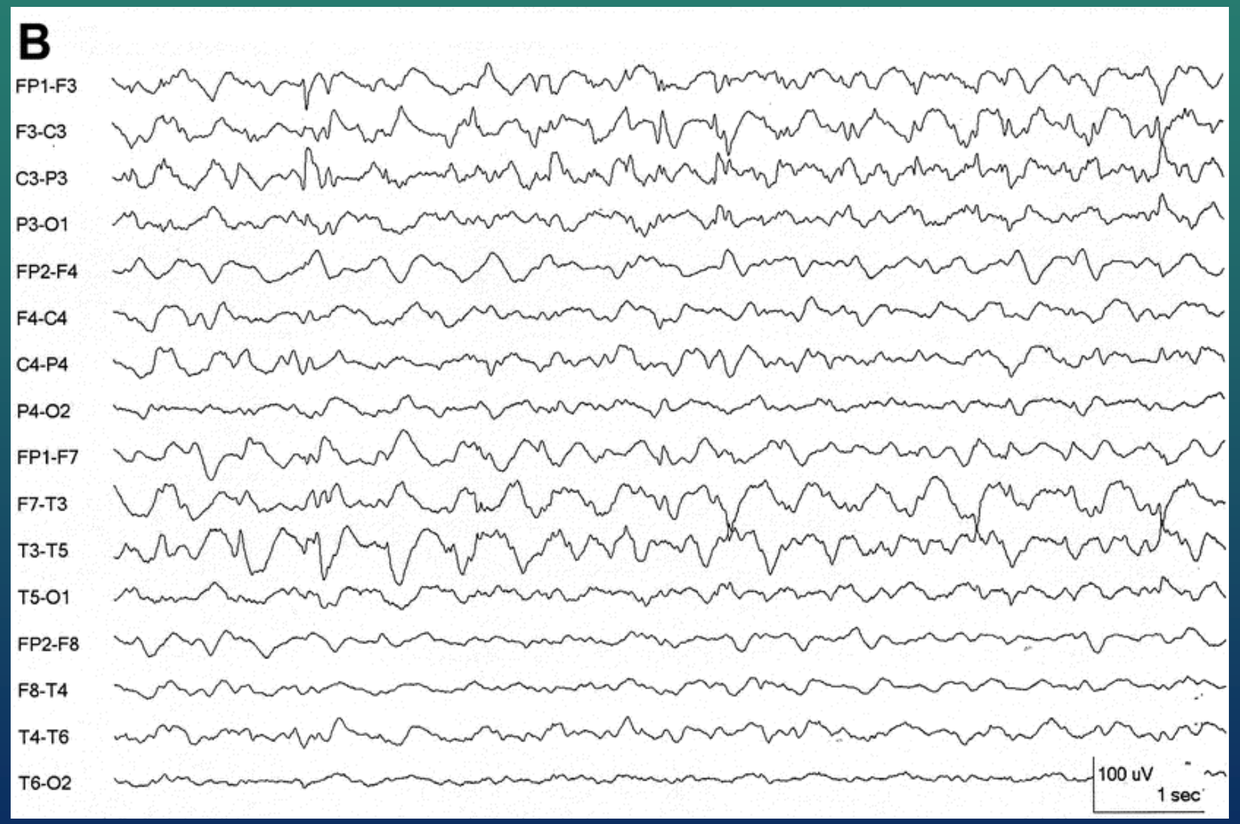
- Nothing to disclose.

Outline:

- Introduction
  - EEG–Related Terminology and definitions
  - cEEG: Definition, indications, recommended duration and limitations
- Classification using the ACNS Standardized Critical Care EEG Terminology: 2021 version
  - Encephalopathy patterns
  - Rhythmic and periodic patterns
  - Seizures, status epilepticus and the ictal–interictal continuum pattern
- A practical approach to EEG interpretation

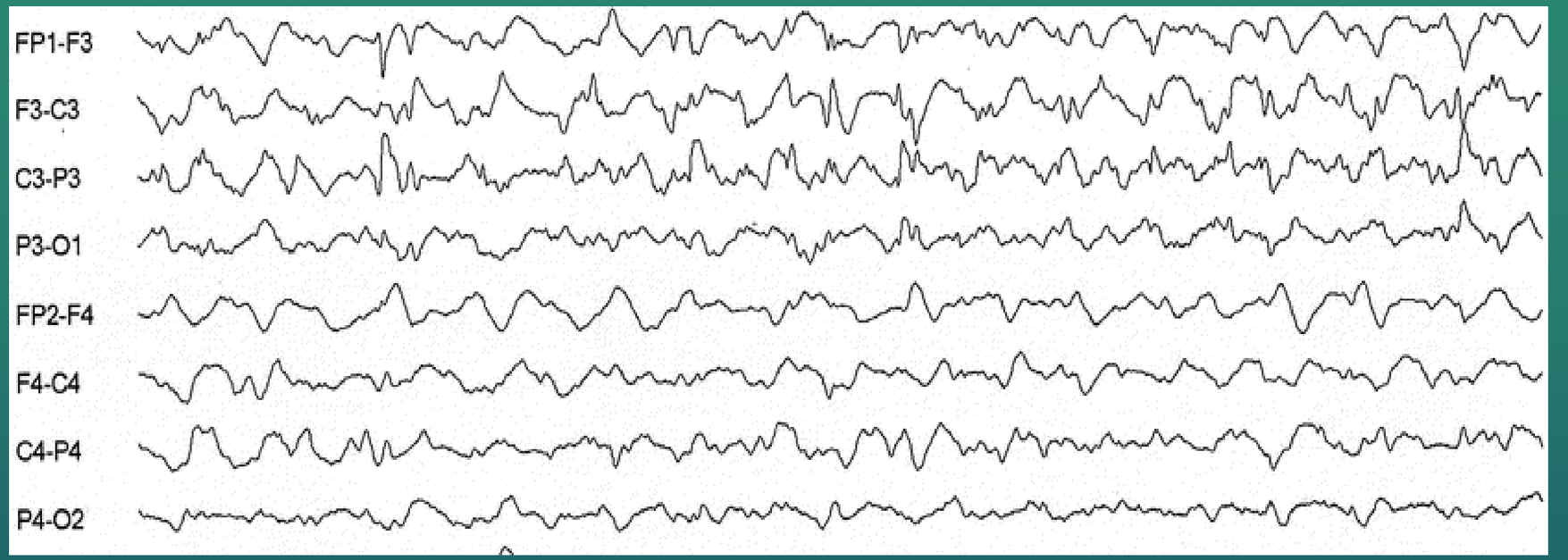


LPDs



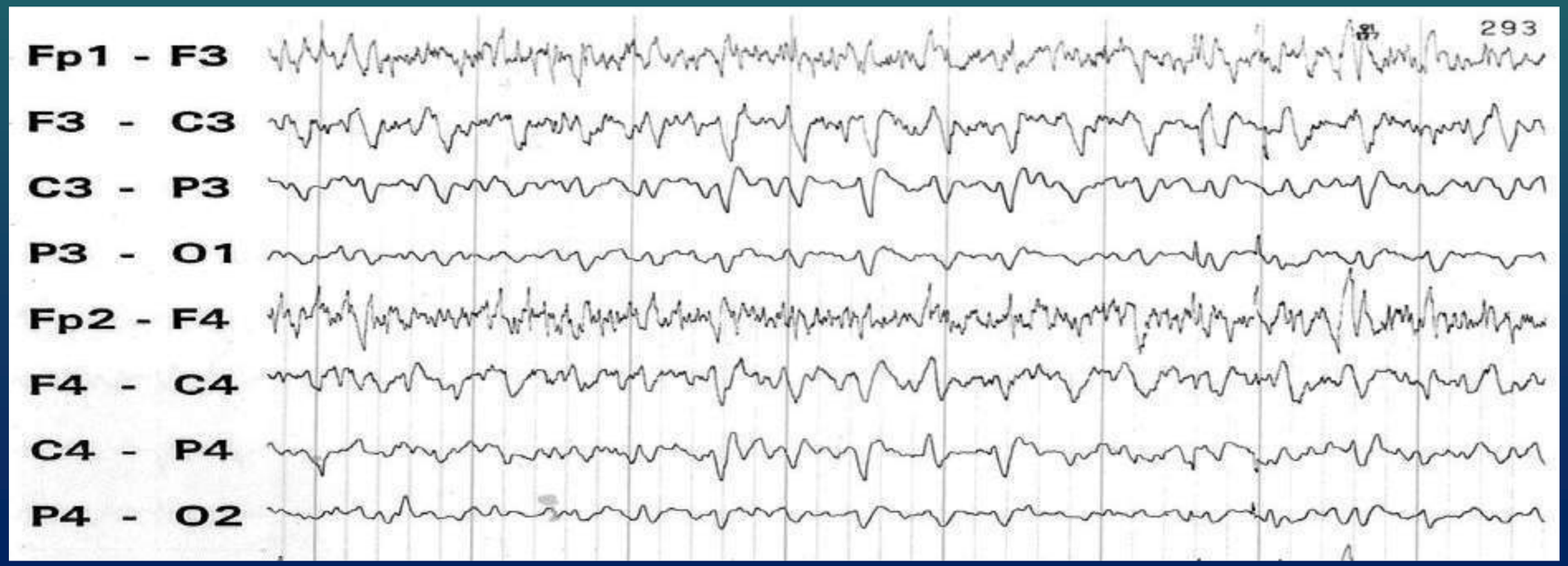
Focal Szs in the Same Patient (Rhythmic with evolution in frequency & amplitude)

Brenner, 2004



Sz in a 74 y/o female w/ left subdural

Brenner, 2004



Triphasic in a pt w/ ammonia level 109

Kaplan, 2004

“Was it a Non-convulsive Status Epilepticus?

Or another interesting electrographic signatures of a (dynamic pathophysiological state in which unstable neurobiological processes create an IIC).”

- Robert T. Wechsler

EEG-Related Terminology

TERMINOLOGY (SYNONYM)	ACRONYM	DEFINITION
Continuous EEG monitoring	cEEG	=> 16 EEG channel recording with simultaneous video recording, typically of > 12h and in ICU settings, with the aim of detecting and monitoring seizures, including ESz.
Routine EEG		=> 16 EEG channels recording, typically 20-60 min duration with simultaneous video recording, with the aim of detecting abnormalities of EEG background, IEDs, seizures, & status epilepticus. In ICU settings, routine EEG is considered a screening tool.
Amplitude-integrated	aEEG	Compressed EEG recording using =>2 channels, typically of >12h duration & in ICU settings.
Sporadic epileptiform discharges (IEDs).	SEDs	Non-rhythmic & non-periodic (intermittent) interictal EEG phenomena that are intermixed with the background & are associated with seizures e.g. spikes, polyspikes, sharp waves.

EEG-Related Terminology

TERMINOLOGY (SYNONYM)	ACRONYM	DEFINITION
Electroclinical seizure	ECSz	A seizure with clinical manifestations & time-locked to an EEG pattern (EEG pattern does not need to full ES criteria) OR an ES & subsequent clinical improvement attributable to suppression of seizures with an ASM.
Electroclinical status epilepticus	ECSE	An uninterrupted electroclinical seizure lasting =>10 min OR recurrent seizures totaling 12 min in any 1h period (hourly seizure burden ~20%) OR 5 min of a convulsive (i.e. with BTC).
Electrographic seizure	ESz	An abnormal paroxysmal electrographic event that differs from the background activity, lasts longer than 10 s (less if with clinical change), has electrographic field, typically has a frequency of >2.5 Hz, & evolves in frequency, morphology, or spatial distribution (*neonatal seizures may not evolve*).
Electrographic status epilepticus	ESE	An uninterrupted electrographic seizure lasting =>10 min OR recurrent ES totaling 12 min in any 1h period (hourly seizure burden ~20%).
Total seizure burden		The proportion of time occupied by seizures during cEEG.

Introduction

Rationale for cEEG monitoring

- EEG is tightly linked to cerebral metabolism EEG is sensitive to ischemia and hypoxia
- EEG detects neuronal dysfunction at a reversible stage
- EEG detects neuronal damage or recovery whereas the clinical exam may not
- EEG is the best available method for detecting epileptiform activity
- EEG provides dynamic information
- EEG provides information about localization

(Jordan and Bleck from Current Practice of Clinical Electroencephalography 2003)

Introduction

How common are seizures in the PICU?

- Electrographic seizures (ESz) occur in 10–40% of critically ill children with acute encephalopathy who undergo cEEG in the PICU.
- Most ESz lack a clinical correlate and cEEG is used for seizure identification.
- High seizure burden is associated with unfavorable neurobehavioral outcomes and can be safely managed with antiseizure medications (ASMs).
- Risk factors for SZs: age <2 years, prior clinical SZs, HIE, stroke, head injury, encephalitis, ECMO, cardiac surgery, and routine EEG showing discontinuous background and epileptiform discharges.

Payne ET, Brain 2014.
Schreiber JM, Neurocrit Care 2012;17:31e8.
Brophy GM, Neurocrit Care 2012;17:3e23.

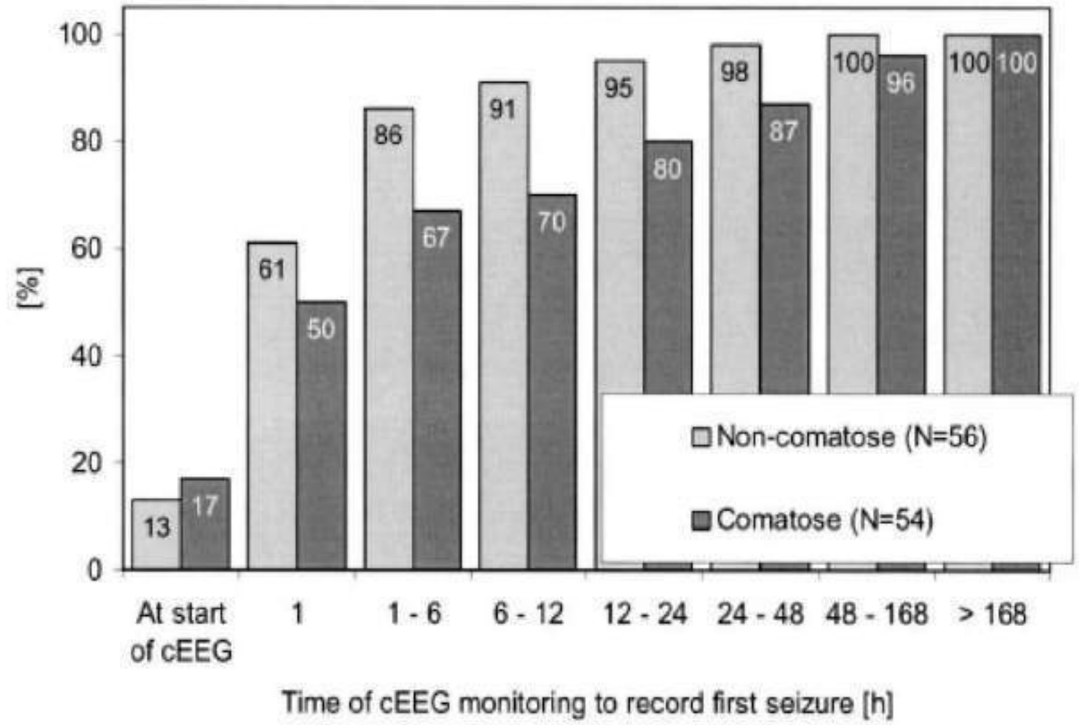
Introduction

How common are seizures in the PICU?

- Most seizures in the acute setting are subclinical.
- J. Claassen and Hirsch (2004): 570 pts
  - cEEG for seizures or unexplained ALC
  - Seizures in 101(19%): 92% nonconvulsive
  - Time to 1st Seizure detection:
    - 88% – Seizure in the 1st 24h
    - 5% – Seizure on day 2
    - Comatose pts – Seizure > 48h+

Detection of electrographic seizures with continuous EEG monitoring in critically ill patients

J. Claassen, MD; S.A. Mayer, MD; R.G. Kowalski, BS; R.G. Emerson, MD; and L.J. Hirsch, MD



Claassen et al. Neurology 2004; 62; 1743-1748

Introduction

How common are seizures in the PICU?

- 19% of critically ill patients evaluated because of
  - Suspicion of nonconvulsive seizures (NCS)
  - Unexplained decrease in LOC
- In Neurologic Intensive Care Unit
  - Up to 34% of patients undergoing EEG monitoring have NCS
    - 76% of these cases are nonconvulsive status epilepticus (NCSE)
- Excluding patients with clinical evidence or history of Sz
  - 8% of comatose patients have been reported to have NCS
- NCS have been described in up to
  - 27% of patients with altered consciousness
  - 48% of patients after termination of generalized convulsive SE
  - 22% with severe traumatic brain injury
  - 6% with ischemic stroke
  - 28% with intracerebral hemorrhage

Detection of electrographic seizures with continuous EEG monitoring in critically ill patients

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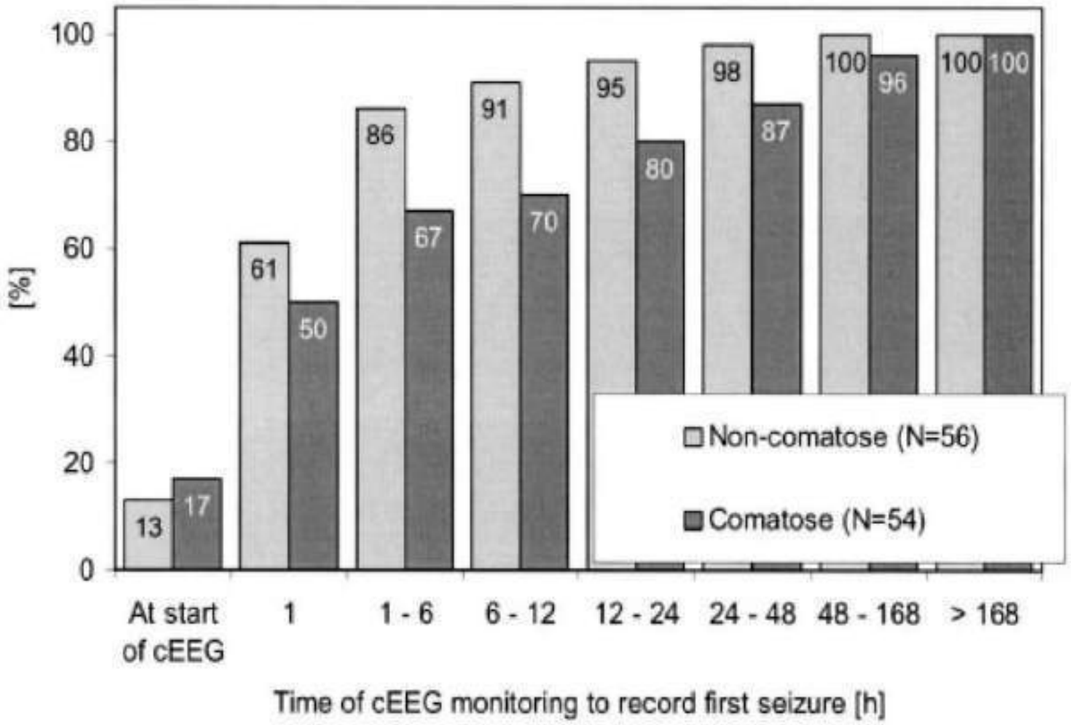


Claassen et al. Neurology 2004; 62; 1743-1748

Introduction

Beyond Seizures – Ictal or Interictal?

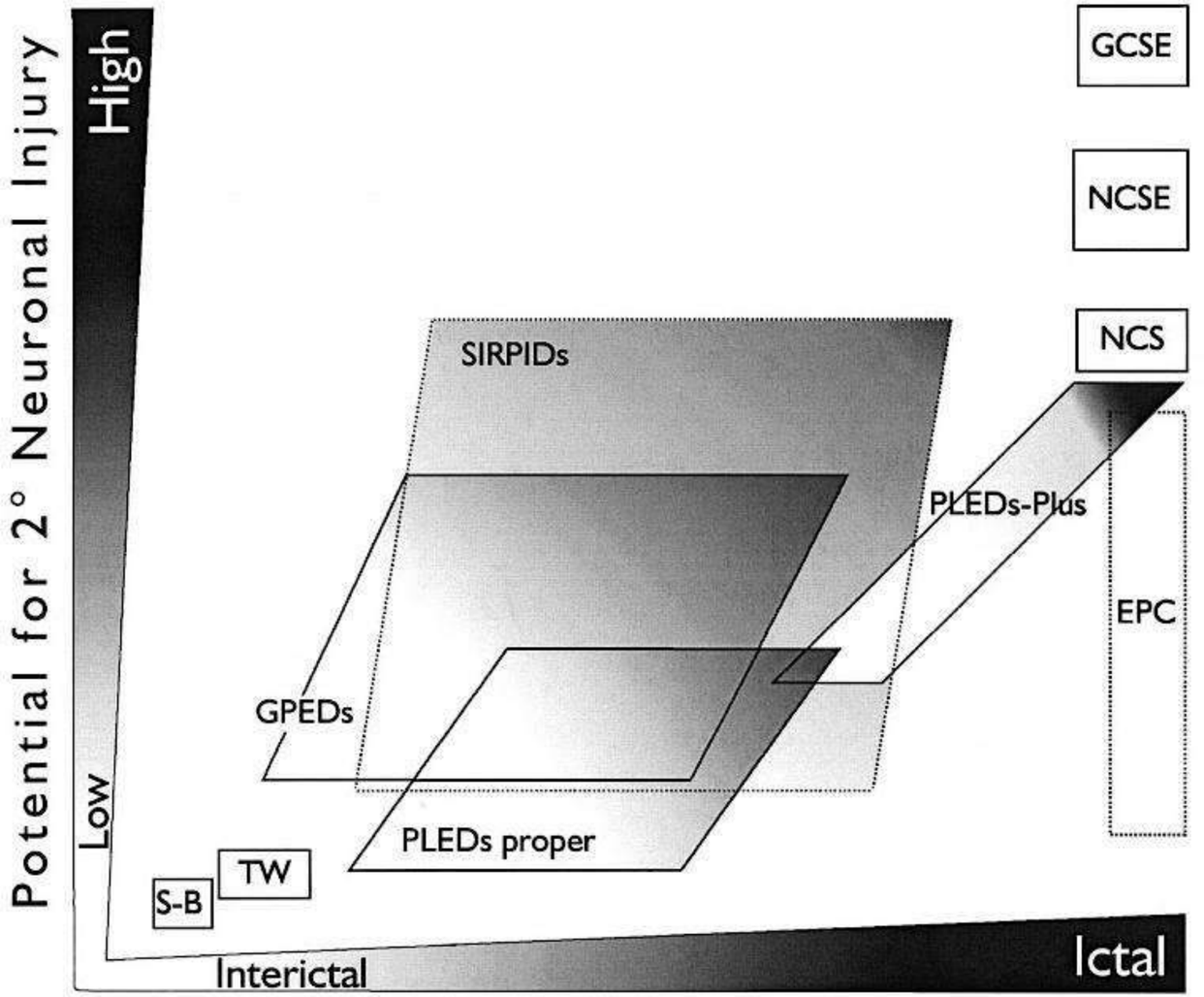
- Diagnostic dilemma: Many findings on cEEG cannot be dichotomized (ictal vs interictal).
- Therapeutic dilemma: What's the pathophysiological relevance of these findings?
- SZs and SZ-like activities known as "ictal-interictal-injury continuum" or "ictal-interictal continuum" (IIC) patterns are seen commonly in patients with epilepsy or critical illness.
- IIC events can damage the brain, especially when prolonged
- IIC patterns are biomarkers of impending delayed cerebral ischemia and risk for post-traumatic epilepsy.
- Tool to predict likelihood of SZs by EEG features e.g. **2HELPS2B** score.

Chong and Hirsch, J Clin Neurophysiol 2005;22: 79 –91

Which EEG Patterns Warrant Treatment in the Critically Ill? Reviewing the Evidence for Treatment of Periodic Epileptiform Discharges and Related Patterns

Derek J. Chong and Lawrence J. Hirsch

The Ictal-Interictal-Injury Continuum



Chong and Hirsch, J Clin Neurophysiol 2005;22: 79 –91

JAMA Neurology | Original Investigation

Assessment of the Validity of the 2HELPS2B Score for Inpatient Seizure Risk Prediction

Table 2. Seizure Risk Based on 1-Hour Screening EEG

Seizure Risk Group	No. (% of Cohort)	Overall Seizure Risk, %	False-Negative Rate,[a] %	Recommend Duration of EEG Monitoring
Low risk:[b] 2HELPS2B score = 0	594 (40)	3.1	3.1	1 h (Length of screening EEG)
Medium risk:[c] 2HELPS2B score = 1	597 (40)	12.0	4.0	12 h
High risk:[d] 2HELPS2B score, ≥2	310 (21)	26.6	3.1	At least 24 h

CONCLUSIONS AND RELEVANCE In this study, 2HELPS2B was validated as a clinical tool to aid in seizure detection, clinical communication, and cEEG use in hospitalized patients. In patients without prior clinical seizures, a screening 1-hour EEG that showed no epileptiform findings was an adequate screen. In patients with any highly epileptiform EEG patterns during the first hour of EEG (ie, a 2HELPS2B score of ≥2), at least 24 hours of recording is recommended.

Table 1. 2HELPS2B

Risk Factor	Score	% 0	1	2	3	4	5+
Frequency >2 Hz[a]	1						
Independent sporadic epileptiform discharges	1						
LPD/BIPD/LRDA	1						
Plus features (superimposed rhythmic, fast, sharp)[b]	1						
Prior seizure[c]	1						
BIRD	2						
Total Score							
Predicted risk of seizure,[d] 2HELPS2B score		<5	12	27	50	73	88
Actual risk of seizure							
FS[e]		3	12	34	52	71	84
VAL[f]		4	15	34	55	75	93

Abbreviations: BIPD, bilateral independent periodic discharges; BIRD, brief potentially ictal rhythmic discharge; FS, foundational study; LPDs, lateralized periodic discharges; LRDA, lateralized rhythmic delta activity; VAL, validation study cohort.

[a] Frequency of any periodic or rhythmic pattern of more than 2 Hz except generalized rhythmic delta activity.

[b] Plus features include superimposed rhythmic, fast, or sharp activity only on LRDA, LPDs, or BIPDs.

[c] Prior seizure includes a remote history of epilepsy or recent events suspicious for clinical seizures.

[d] Predicted seizure risk is based on the 2HELPS2B model.

[e] Foundational study is the actual risk of seizures from the foundational cohort (N = 5427).

[f] VAL is the actual risk of seizures based on the current validation study cohort (N = 2111).

Aaron F. Struck, JAMA Neurol. 2020;77(4):500-507

Indications of cEEG

What are the international consensus statements on cEEG in the ICU?

Society/body	Indications and recommendations
American Clinical Neurophysiology Society (ACNS)	- Diagnosis of ESz, ESE, and paroxysmal events (*recommended*). - Assessment of efficacy of therapy for Szs and SE (*recommended*). - Identification of cerebral ischemia (*suggested*). - Monitoring of sedation and high-dose IV anesthetic therapy (*suggested*). - Assessment of severity of encephalopathy and prognostication (*proposed*)
International Multidisciplinary Consensus Conference on Multimodality Monitoring in Neurocritical Care	- Pts with TBI, unexplained and persistent ALC (*strong recommendation, low evidence*). - ECSE with no return to functional baseline within 60min after ASM and pts with RESE (*strong recommendation, low evidence*). - During TH and within 24hr of rewarming to exclude ESz in comatose pts after cardiac arrest (*strong recommendation, low evidence*). - Comatose ICU pts without acute primary brain condition and with unexplained impairment of mental status or unexplained neurological deficits to exclude ESz, particularly in severe sepsis or renal/hepatic failure (*weak recommendation, low evidence*)

Indications of cEEG

What are the international consensus statements on cEEG in the ICU?

Society/body	Indications and recommendations
European Academy of Neurology	- Not waking 60min post convulsive status epilepticus (*Grade 1C*) - Refractory status epilepticus (*Grade 1C*) - TBI, SAH, CH, encephalitis with unexplained altered consciousness (*Grade 1C*) - Cardiac arrest with persistent coma (*Grade 1C*) - Unexplained altered consciousness without primary brain injury (*Grade 1B*) - Severe TBI with high-risk features, e.g., large contusion (*Grade 2C*) - Acute ischemic stroke with unexplained altered consciousness (*Grade 2D*) - Others: SAH-associated cerebral ischemia, prognostication in ICU pts, cardiac arrest or encephalitis pts with persistent/unexplained coma (*Grade 2C*)

Indications of cEEG

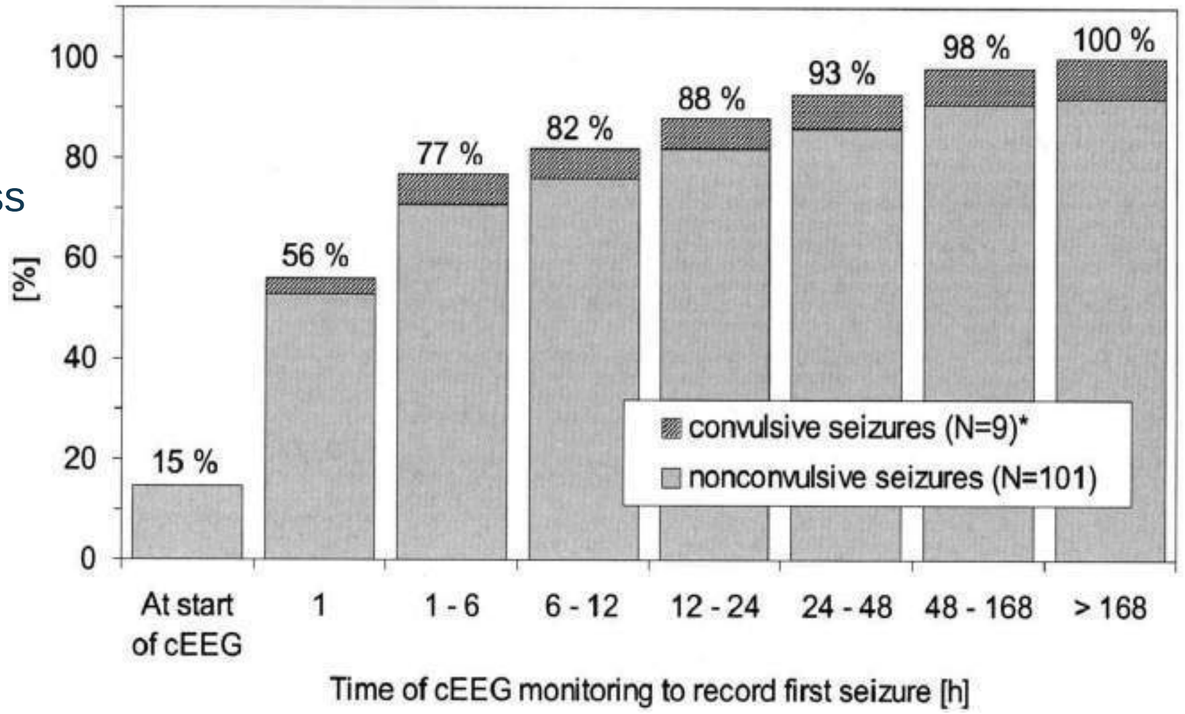
What are the international consensus statements on cEEG in the ICU?

Society/body	Indications and recommendations
Neuro-intensive care section (European Society of Intensive Care Medicine)	- RSE: Urgent (within 60min) recommend cEEG in pts (Grade 1C). - TBI, SAH, ICH: recommend cEEG to rule out ESz in all pts with unexplained/persistent ALC (strong recommendation, Grade 1C). - Stroke: suggest cEEG to rule out ESz in all pts with unexplained and/or persistently altered consciousness (weak recommendation, very low quality of evidenced G 2D). - Coma after cardiac arrest: recommend cEEG during therapeutic hypothermia and within 24h after rewarming to rule out ESz in all patients (strong recommendation, Grade 1C). - Infectious and noninfectious encephalitis: recommend cEEG if comatose or have unexplained neurological deficits to rule out ESz (strong recommendation, Grade 1C). - Comatose ICU patients without primary brain injury: suggest cEEG if unexplained impairment of - mental status or unexplained neurological deficits to rule out ESz, particularly in those with severe sepsis or renal/hepatic failure (weak recommendation, Grade 2C).

Duration for cEEG Monitoring

How Long Do We Need to Record?

- 570 patients underwent continuous EEG monitoring
  - Detection of 'subclinical' seizures
  - Evaluation of unexplained decrease in level of consciousness
- Seizures detected in 19% (89% in ICU setting)
  - Electrographic seizures were associated with
    - Coma
    - Age <18 years
    - History of epilepsy
    - Convulsive seizures prior to monitoring
- Of those in whom seizures were detected
  - 88% detected in first 24 hours of recording
  - 5% detected in second 24 hours of recording
  - 7% detected after 48 hours of recording
  - Comatose patients more likely to have first seizure recorded after >24 hrs



Claassen et al., 2004

The ACNS Standardized Critical Care EEG Terminology Classification

Version 2021

A. EEG background

B. Sporadic epileptiform discharges

C. Rhythmic and periodic patterns (RPPS)

D. Electrographic and electroclinical seizures [new, 2021]

E. Brief potentially ictal rhythmic discharges (BIRDS) [new, 2021]

F. Ictal-interictal continuum (IIC) [new, 2021]

Lawrence J. Hirsch, ACNS Critical Care EEG Terminology Module 2021

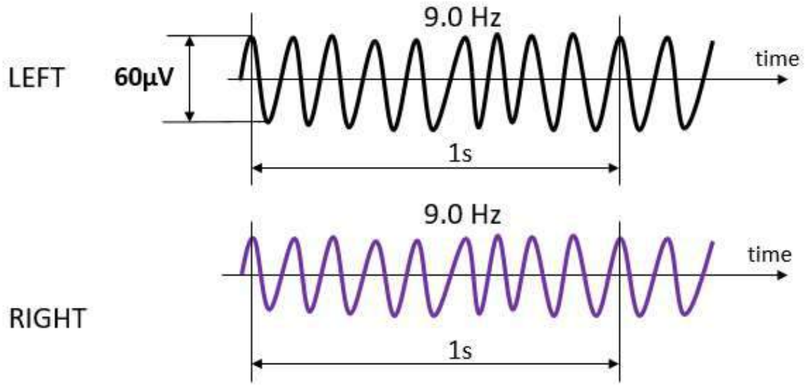
EEG BACKGROUND

1. **Symmetry**
   a. Symmetric.
   b. Mild asymmetry (consistent asymmetry in voltage on an appropriate referential recording of <50% or consistent asymmetry in frequency of 0.5 to 1 Hz).
   c. Marked asymmetry (≥50% voltage or >1 Hz frequency asymmetry).
2. **Predominant Background Frequency When Most Awake or After Stimulation:** Beta (>13 Hz), Alpha, Theta, Delta.
   NOTE: If two or three frequency bands are equally prominent, report each one.
3. **Posterior Dominant ("Alpha") Rhythm** (must be demonstrated to attenuate with eye opening; wait >1 second after eye closure to determine frequency to avoid "alpha squeak"): Present: Specify frequency to the nearest 0.5 Hz, Absent, Unclear.

Symmetry

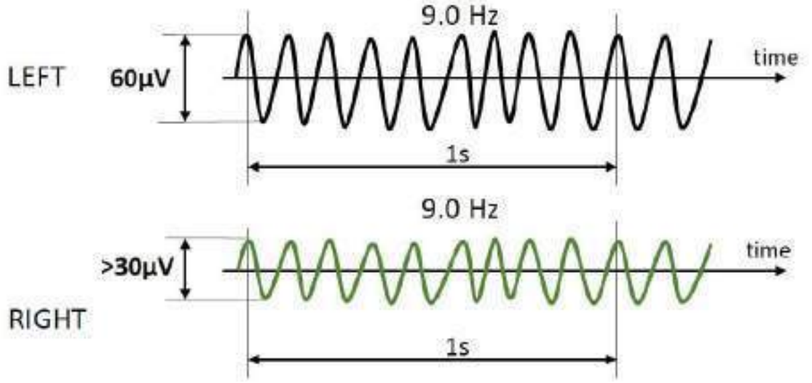
Symmetric

No consistent voltage differences between sides.



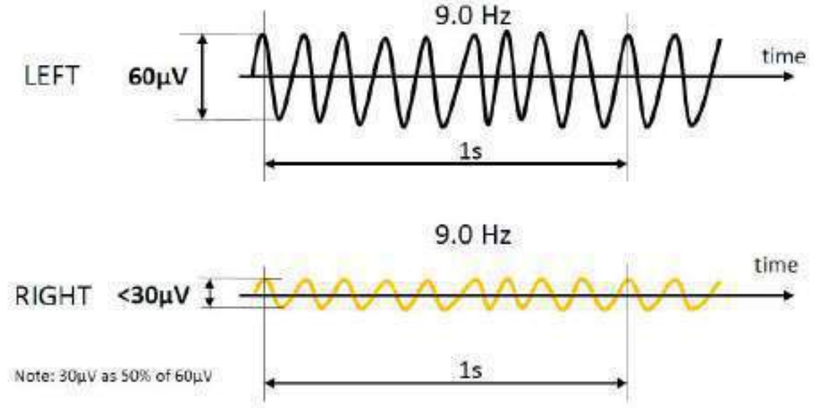
Mild asymmetry

Consistent but <50% voltage difference between sides (on appropriate referential recording).



Marked asymmetry:

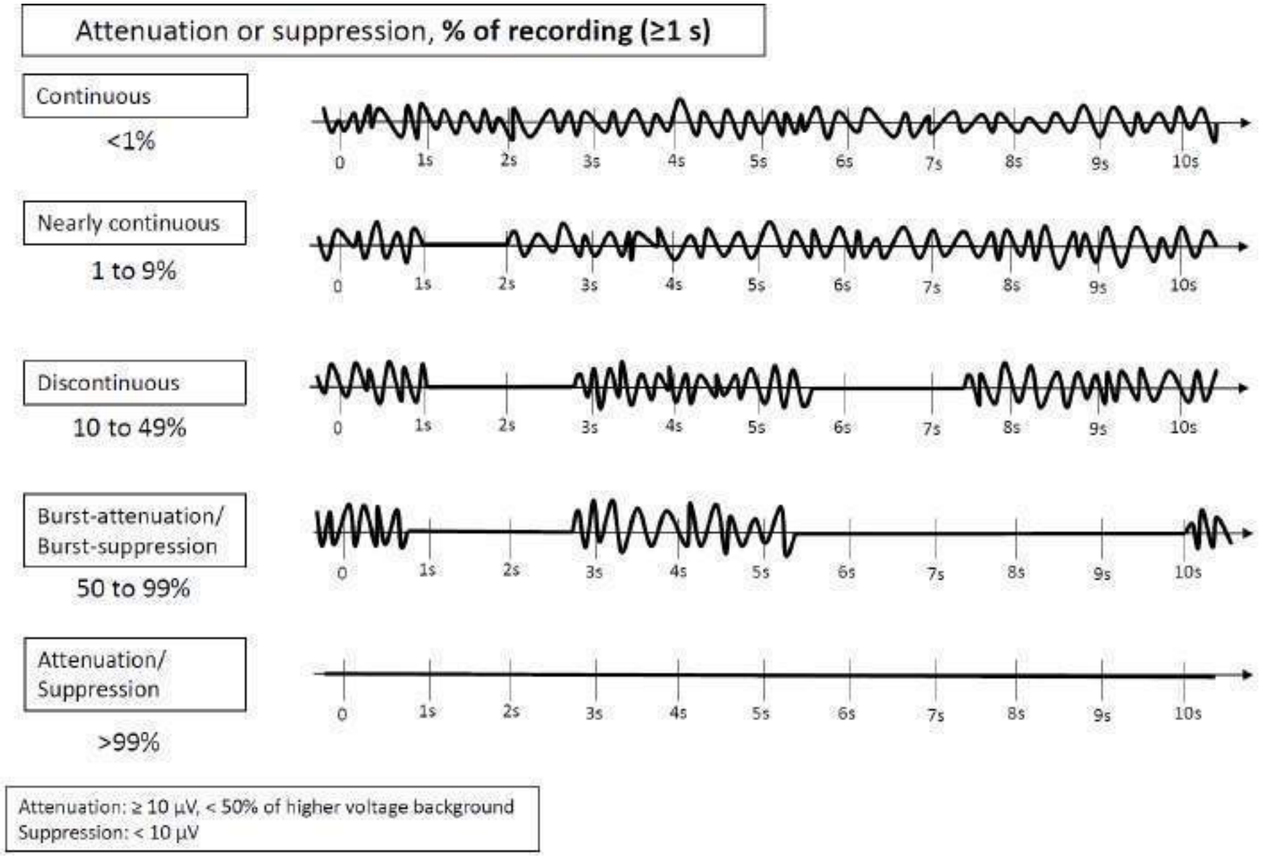
≥50% voltage difference between sides (on appropriate referential recording).



Lawrence J. Hirsch, ACNS Critical Care EEG Terminology Module 2021

EEG BACKGROUND

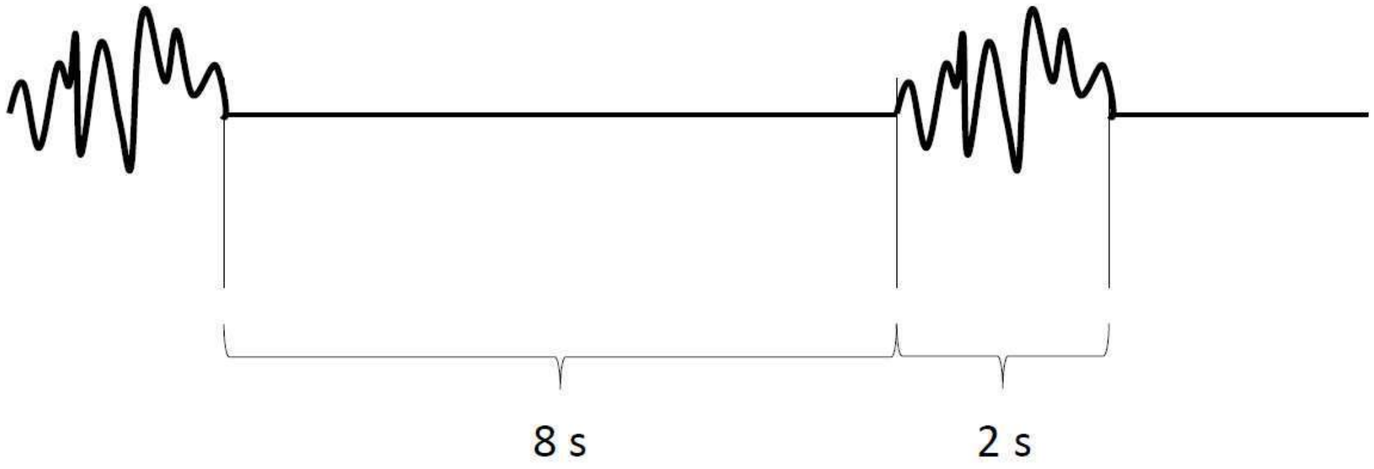
4. **Continuity**
   a. Continuous
   b. Nearly Continuous: continuous, but with occasional (1–9% of the record) periods of attenuation or suppression lasting ≥1 second.
   c. Discontinuous: A pattern of attenuation/suppression alternating with higher voltage activity, with 10% to 49% of the record consisting of attenuation or suppression.
   d. Burst attenuation/Burst suppression: A pattern of attenuation/suppression alternating with higher voltage activity, with 50% to 99% of the record consisting of attenuation
   e. Suppression/attenuation: entirety or near-entirety (>99%) of the record consists of either suppression (all <10 µV, as defined above) or low voltage activity (all <20 µV but not qualifying as suppression). Specify whether attenuated or suppressed.



Lawrence J. Hirsch, ACNS Critical Care EEG Terminology Module 2021

EEG BACKGROUND

<u>Attenuation percent or Suppression percent:</u> the percent of the record/epoch that is attenuated or suppressed. This can range from 1% to 99%. If <1%, it is considered continuous. If >99%, it is considered either suppressed or attenuated, but not discontinuous. **For example, a record with 2 second bursts alternating with 8 seconds of suppression, as shown here, would be Burst-Suppression with a suppression percent of 80%.**



Suppression percent of 80%.

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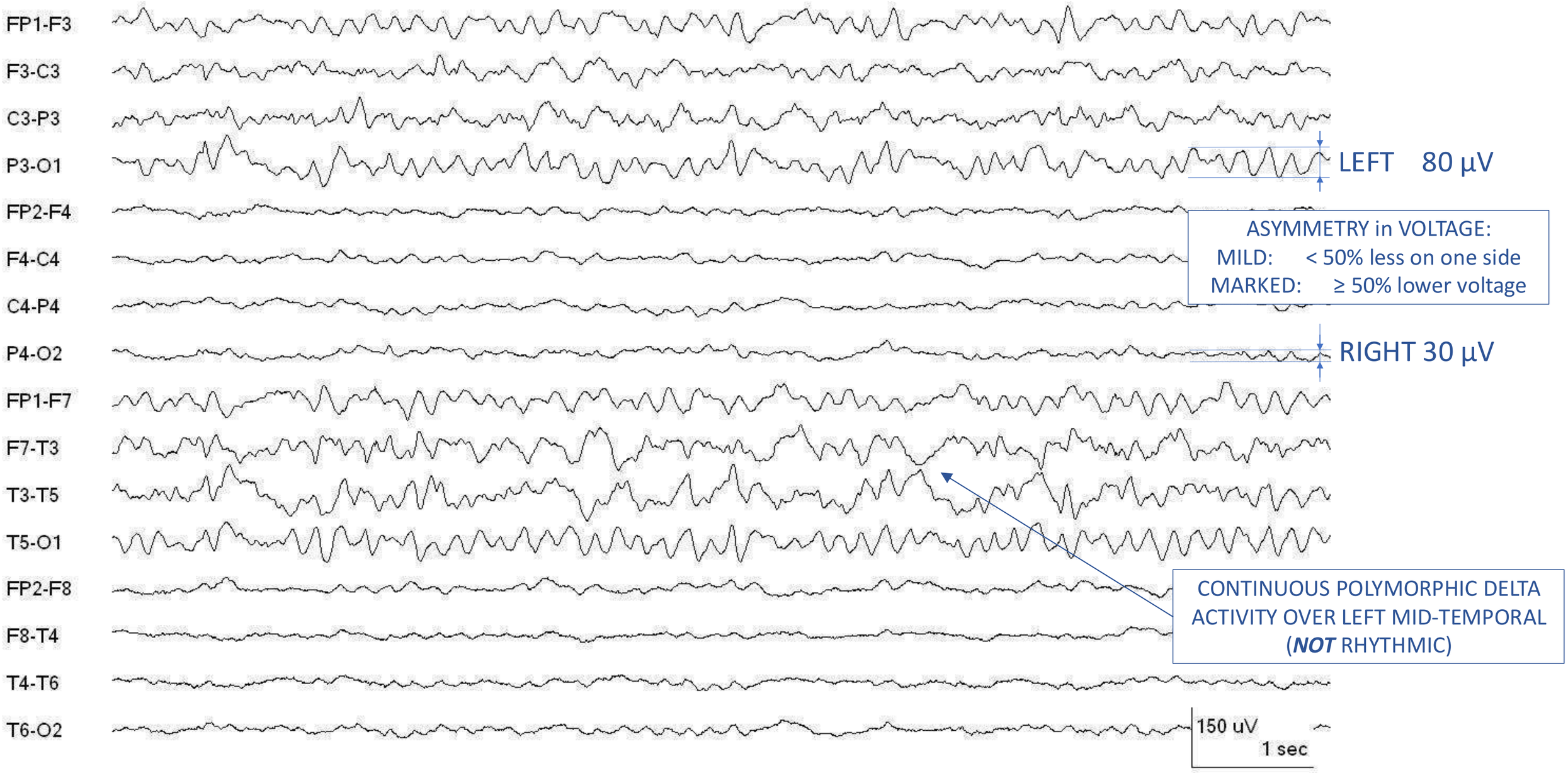
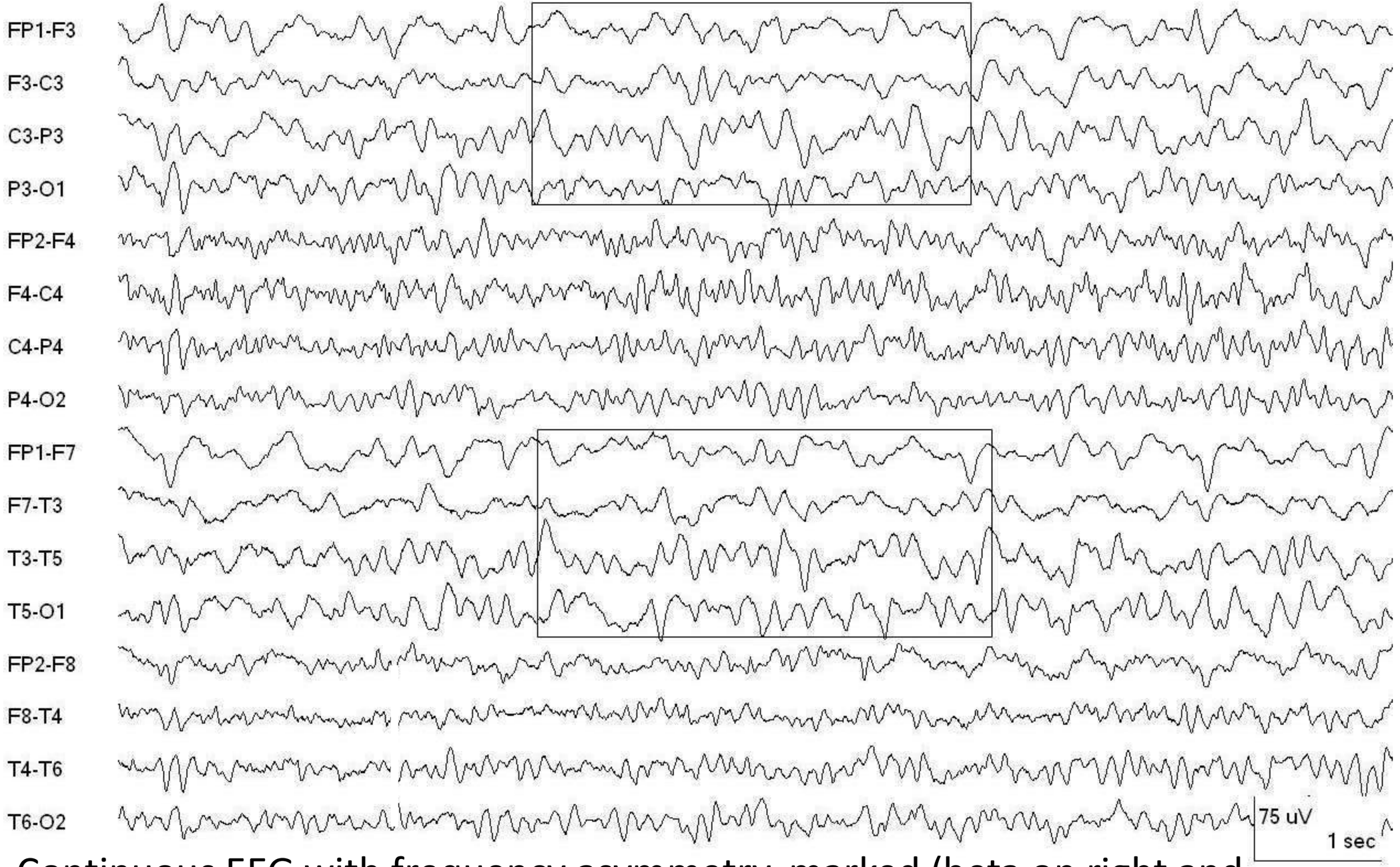


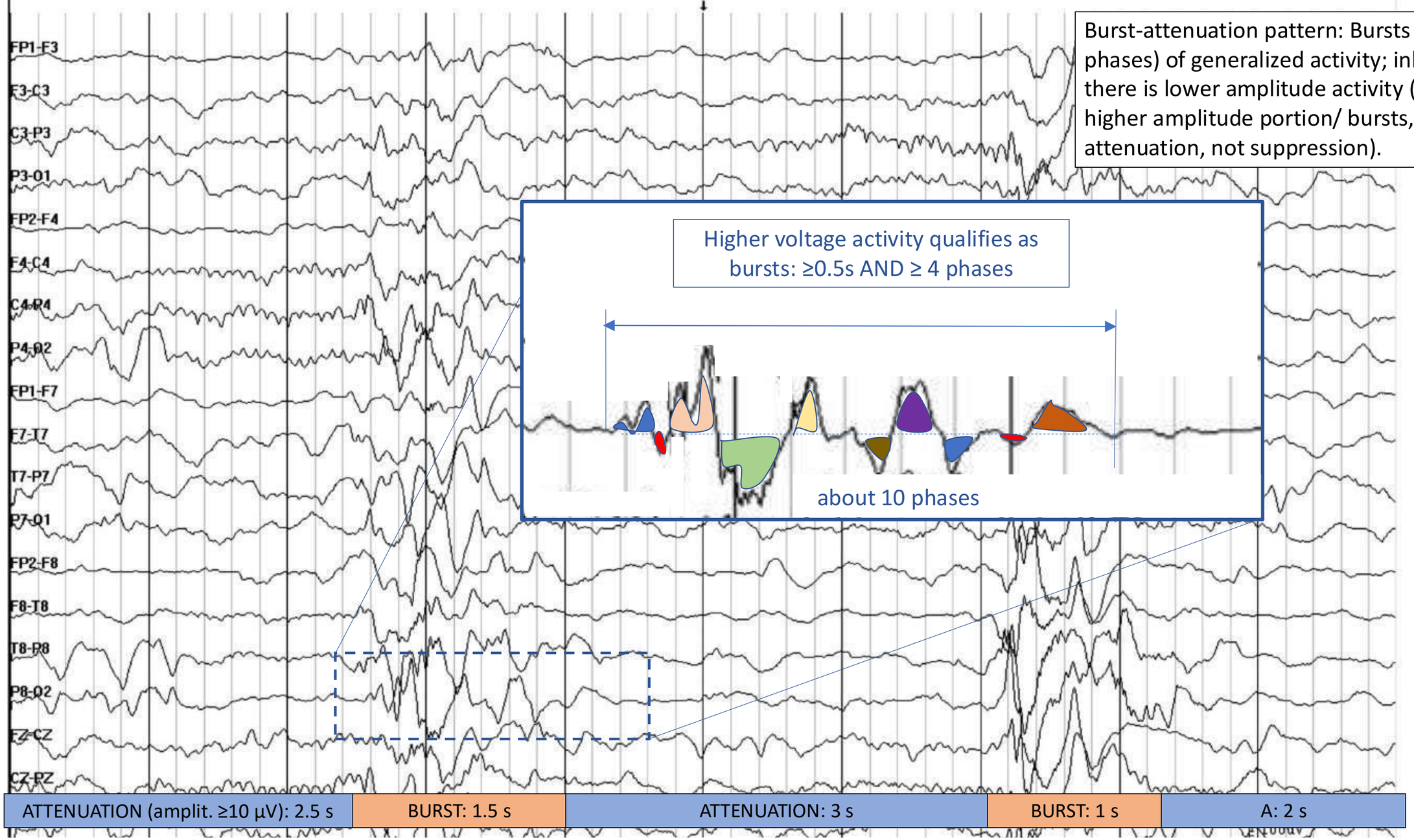
Continuous EEG with voltage asymmetry (marked, lower on right) and slowing on the left, polymorphic delta.

Reproduced with permission from Hirsch LJ, Fong MWK, Brenner RP. Atlas of EEG in Critical Care, second edition, Wiley: 2022



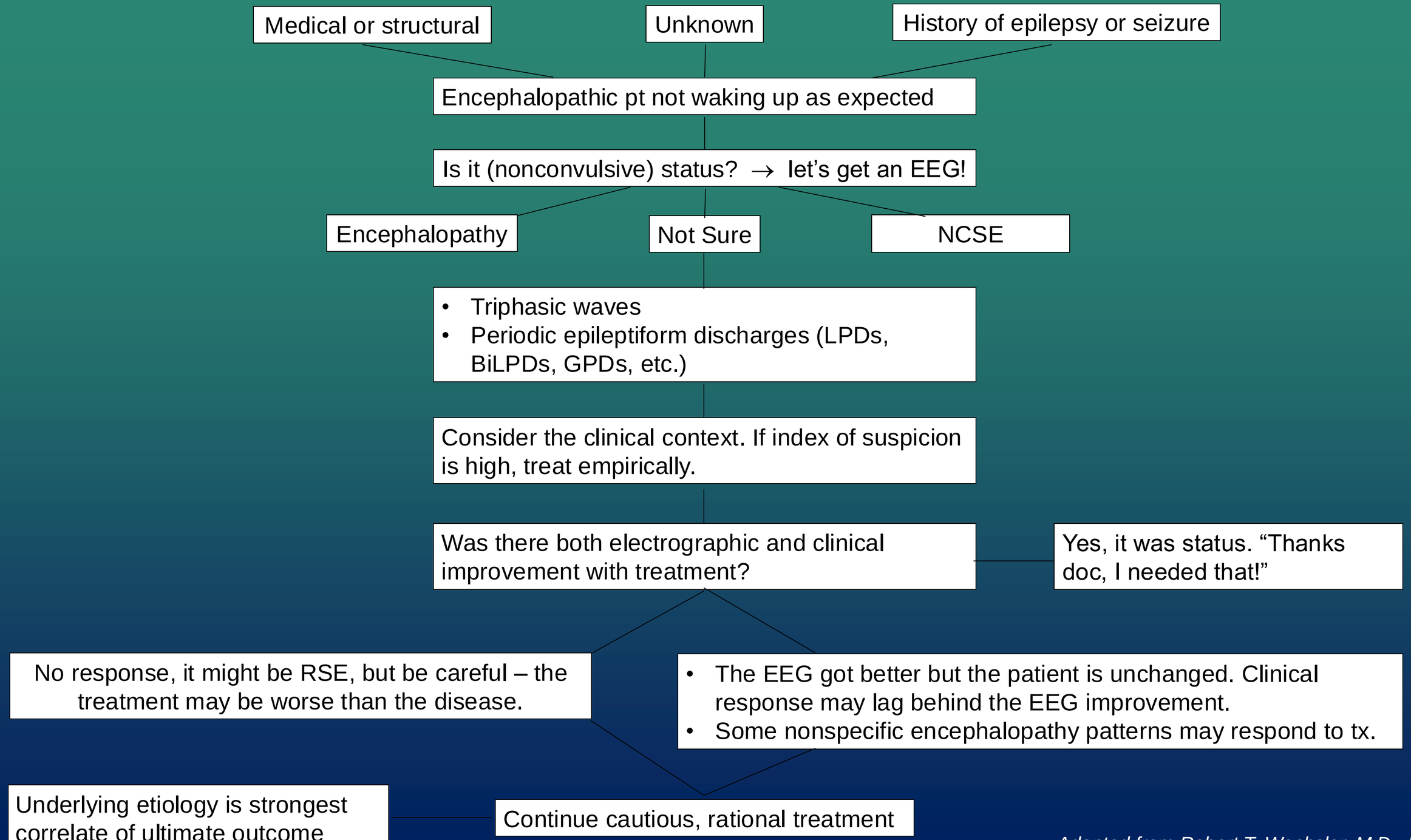
Continuous EEG with frequency asymmetry, marked (beta on right and theta with polymorphic delta slowing [boxes] on left)

Reproduced with permission from Hirsch LJ, Fong MWK, Brenner RP. Atlas of EEG in Critical Care, second edition, Wiley: 2022



Burst-attenuation pattern

Bursts: generalized. Attenuation percent = 7.5s/10s = 75% (i.e., between 50-99%, qualifying as burst suppression/attenuation)



Adopted from Robert T. Wechsler, M.D., Ph.D.

A. EEG Background

Symmetry	Background EEG frequency	PDR	Continuity	Reactivity	State Changes	Cyclic Alternating Pattern of Encephalopathy (CAPE)	Voltage	AP Gradient	Breach effect
Symmetric	**Beta**	**Present** Specify frequency	**Continuous:** <1% **periods of suppression** (<10 µV) or **attenuation** (≥10µV but <50% of background voltage)	**Reactive**	**Present with normal stage N2 sleep transients**	**Present**	**High** ≥150 µV	**Present**	**Present**
Mild asymmetry <50% Voltage OR 0.5-1 Hz Frequency	**Alpha**	**Absent**		**Unreactive**	**Present but with abnormal stage N2 sleep transients**	**Absent**	**Normal** ≥20 to <150 µV	**Absent**	**Absent**
Marked asymmetry ≥50% Voltage OR >1 Hz Frequency	**Theta**	**Unclear**	**Nearly continuous:** 1-9% **periods of suppression attenuation**	**SIRPIDs only**	**Present but without stage N2 sleep transients**	**Unknown/unclear**	**Low** 10 to <20 µV	**Reverse**	**Unclear**
	Delta		**Discontinuous:** 10-49% **periods of suppression** or **attenuation**	**Unclear**	**Absent**		**Suppressed** <10 µV		
Localization of Bursts (G/ L/ BI/ UI/ Mf)	If Burst-suppression or Burst-attenuation then specify if:		**Burst-suppression** or **Burst-attenuation:** 50-99% **periods of suppression** or **attenuation**	**Unknown**					
Highly Epileptiform Bursts (Present or Absent)			**Suppression:** >99% **periods of suppression** or **attenuation**						
Identical Bursts (Present or Absent)									

Summary – Practical Approach to cEEG Interpretation

ACNS Standardized Critical Care EEG Terminology 2021: Reference Chart

Summary

ACNS Standardized Critical Care EEG Terminology 2021: Reference Chart

Prevalence
Abundant ≥1/10s
Frequent ≥1/min but <1/10s
Occasional ≥1/h but <1/min
Rare <1/h

Main term 1
G *Generalized* *- Optional: Specify frontally, occipitally, or midline predominant; or generalized, not otherwise specified.*
L *Lateralized* *- Optional: Specify unilateral, bilateral asymmetric, or bilateral asynchronous* *- Optional: Specify lobe(s) most involved or hemispheric*
BI *Bilateral Independent* *- Optional: Specify symmetric or asymmetric* *- Optional: Specify lobe(s) most involved or hemispheric*
UI *Unilateral Independent* *- Optional: Specify unilateral, bilateral asymmetric, or bilateral asynchronous for each pattern* *- Optional: Specify lobe(s) most involved*
Mf *Multifocal* *- Optional: Specify symmetric or asymmetric* *- Optional: Specify lobe(s) most involved or hemispheric*

Main term 2
PD *Periodic Discharges*
RDA *Rhythmic Delta Activity*
SW *Spike and Wave* *OR* *Polyspike and Wave* *OR* *Sharp and Wave*

Major modifiers

Prevalence	Duration	Frequency	Phases[1]	Sharpness[2]	Voltage (Absolute)	Voltage (Relative)[3]	Stimulus Induced or Stimulus Terminated	Evolution[4]
Continuous ≥90%	Very long ≥1 h	4 Hz	>3	Spiky <70 ms	High ≥150 µV	>2	SI *Stimulus Induced*	Evolving
		3.5 Hz	3			≤2	ST *Stimulus Terminated*	Fluctuating
Abundant 50-89%	Long 10-59 min	3 Hz		Sharp 70-200 ms	Medium 50-149 µV			
		2.5 Hz	2				Spontaneous only	Static
Frequent 10-49%	Intermediate duration 1-9.9 min	2 Hz	1	Sharply contoured >200 ms	Low 20-49 µV			
		1.5 Hz					Unknown	
Occasional 1-9%	Brief 10-59 s	1 Hz			Very low <20 µV			
		0.5 Hz		Blunt >200 ms				
Rare <1%	Very brief <10 s	<0.5 Hz						

Minor modifiers

Onset	Triphasic[5]	Lag	Polarity[2]
Sudden ≤3 s	Yes	A-P *Anterior-Posterior*	Negative
Gradual >3 s	No		Positive
		P-A *Posterior-Anterior*	Dipole
		No	Unclear

E. Brief Potentially Ictal Rhythmic Discharges (BIRDs)

Focal (including L, BI, UI or Mf) or generalized rhythmic activity >4 Hz (at least 6 waves at a regular rate) lasting ≥0.5 to <10 s, not consistent with a known normal pattern or benign variant, not part of burst-suppression or burst-attenuation, without definite clinical correlate, and that has at least one of A, B or C below:

Definite BIRDs feature either:
A. Evolution ("evolving BIRDs") OR
B. Similar morphology and location as interictal epileptiform discharges or seizures in the same patient

Possible BIRDs are
C. Sharply contoured but without (a) or (b) above

Plus (+) Modifiers
No +
+F *Superimposed fast activity – applies to PD or RDA only* **EDB** (*Extreme Delta Brush): A specific subtype of +F*
+R *Superimposed rhythmic activity – applies to PD only*
+S *Superimposed sharp waves or spikes, or sharply contoured – applies to RDA only*
+FR *If both subtypes apply – applies to PD only*
+FS *If both subtypes apply – applies to RDA only*

NOTE 1: Phases: Applies to PD and SW only, including the slow wave of the SW complex
NOTE 2: Sharpness and Polarity: Applies to the predominant phase of PD and the spike or sharp component of SW only
NOTE 3: Relative voltage: Applies to PD only
NOTE 4: Evolution: Refers to frequency, location or morphology
NOTE 5: Triphasic: Applies to PD or SW only

D. Electrographic and Electroclinical Seizures

Electrographic Seizure (ESz)

Either:

A) Epileptiform discharges averaging >2.5 Hz for ≥10 s (>25 discharges in 10 s), OR

B) Any pattern with definite evolution and lasting ≥10 s

Electroclinical Seizure (ECSz)

Any EEG pattern with either:

A) Definite clinical correlate time-locked to the pattern (of any duration), OR

B) EEG *and* clinical improvement with a parenteral (typically IV) anti-seizure medication

Electrographic Status Epilepticus (ESE)

An electrographic seizure for either:

A) ≥10 continuous minutes, OR

B) A total duration of ≥20% of any 60-minute period of recording.

Electroclinical Status Epilepticus (ECSE)

An electroclinical seizure for either

A) ≥10 continuous minutes, OR

B) A total duration of ≥20% of any 60-minute period of recording, OR

C) ≥5 continuous minutes if the seizure is convulsive (i.e., with bilateral tonic-clonic motor activity).

Possible ECSE: An RPP that qualifies for the IIC (below) that is present for ≥10 continuous minutes or for a total duration of ≥20% of any 60-minute period of recording, which shows EEG improvement with a parenteral anti-seizure medication ***BUT*** without clinical improvement.

F. Ictal-Interictal Continuum (IIC)

1. Any PD or SW pattern that averages >1.0 Hz but ≤2.5 Hz over 10 s (>10 but ≤ 25 discharges in 10 s); OR
2. Any PD or SW pattern that averages ≥0.5 Hz and ≤1 Hz over 10 s (≥5 and ≤10 discharges in 10 s), and has a plus modifier or fluctuation; OR
3. Any lateralized RDA averaging >1 Hz for at least 10 s (at least 10 waves in 10 s) with a plus modifier or fluctuation;

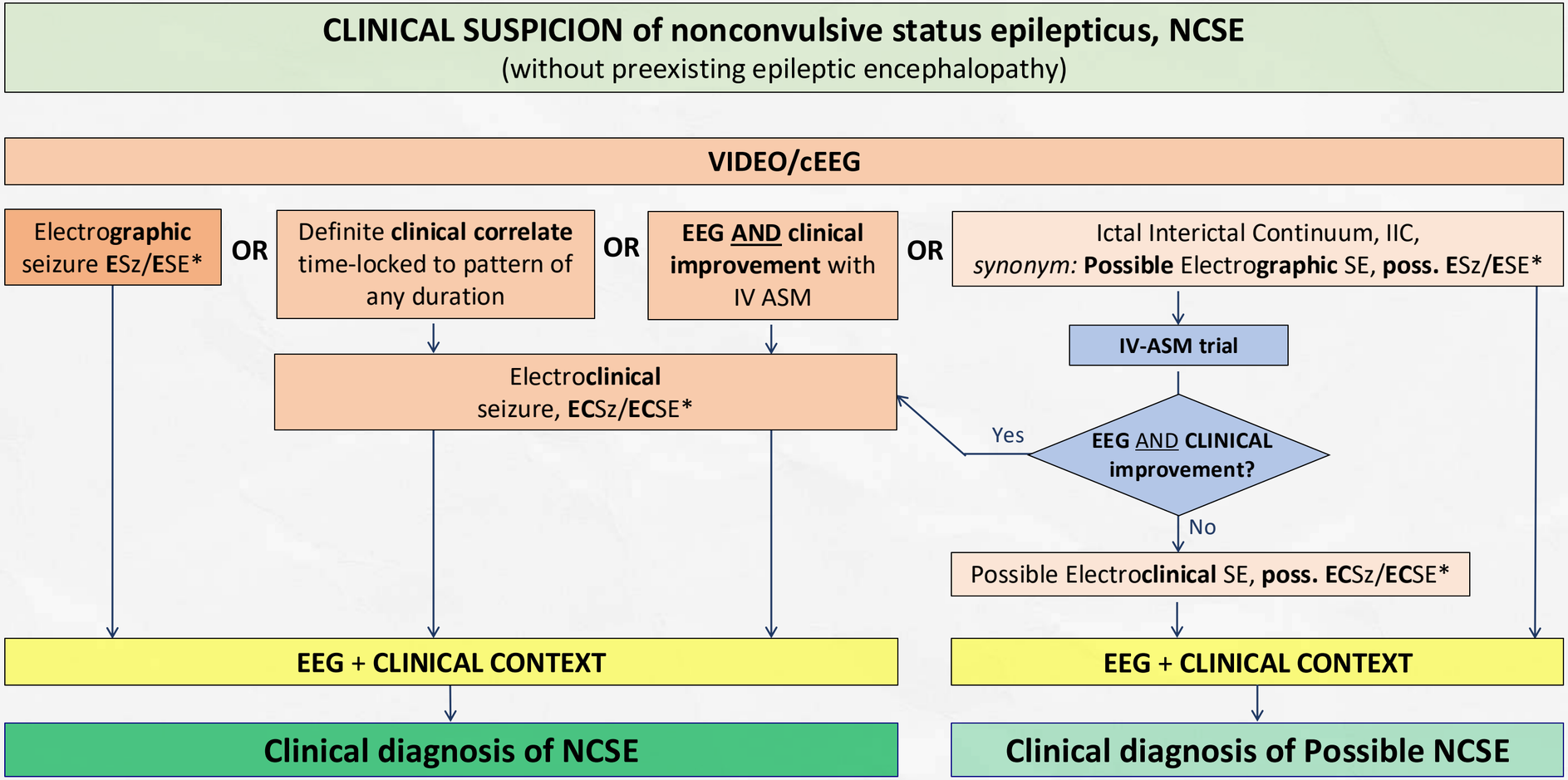
AND

4. Does not qualify as an ESz or ESE.

Summary

ACNS Standardized Critical Care EEG Terminology 2021: Reference Chart

Summary – Practical Approach to cEEG Interpretation



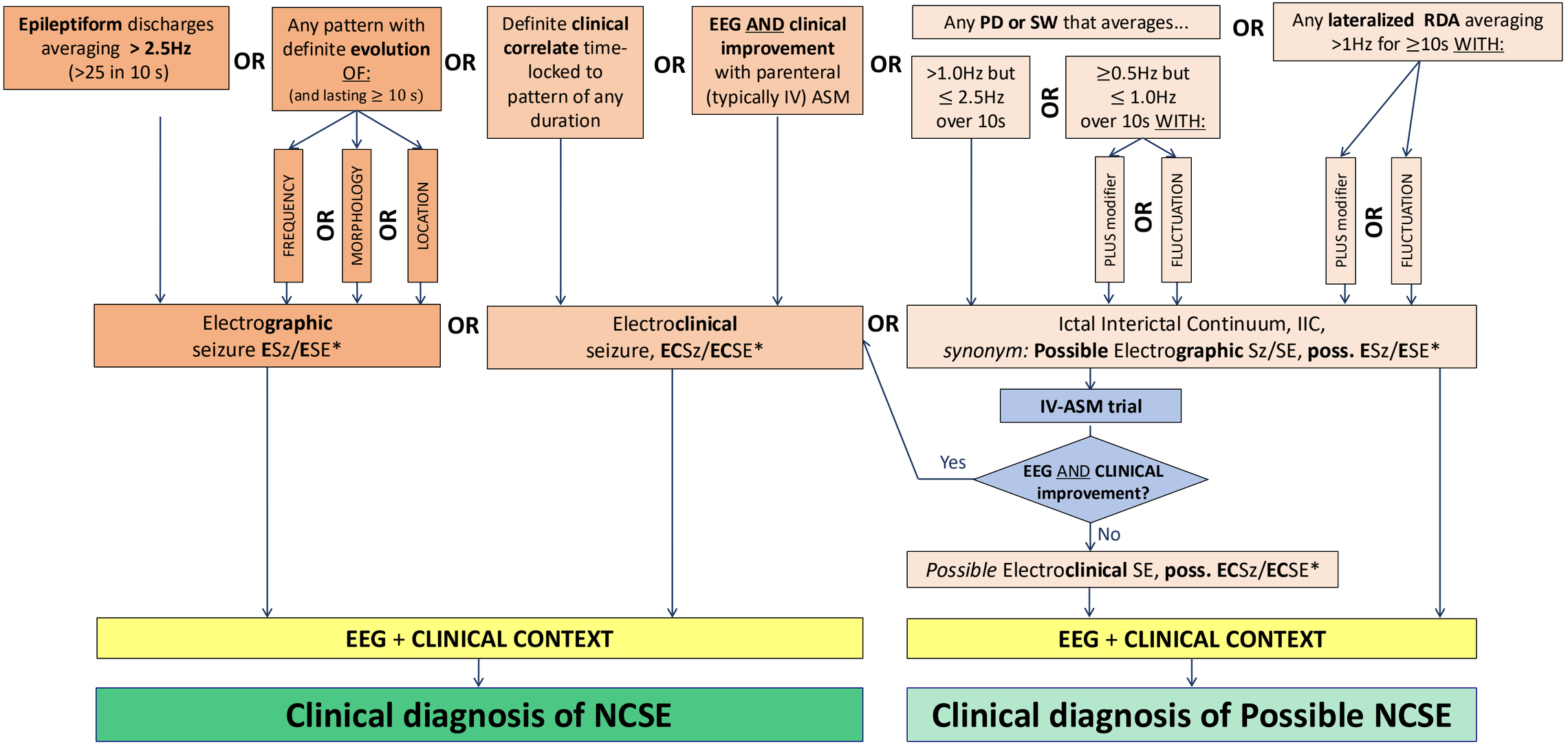
* Status epilepticus if ≥10 continuous minutes OR ≥ 20% of any hour; seizure if neither is true

IV-ASM Intravenous Anti-Seizure Medication; PD Periodic Discharge; RDA Rhythmic Delta Activity; SW Spike-and-wave or sharp-and-wave

Modified from Trinka & Leitinger, 2022,

CLINICAL SUSPICION of nonconvulsive status epilepticus, NCSE (without preexisting epileptic encephalopathy)

VIDEO/cEEG



* Status epilepticus if ≥10 continuous minutes OR ≥ 20% of any hour; seizure if neither is true

IV-ASM Intravenous Anti-Seizure Medication; PD Periodic Discharge; RDA Rhythmic Delta Activity; SW Spike-and-wave or sharp-and-wave

Modified from Trinka & Leitinger, 2022,

Conclusion

- Continuous EEG monitoring is essential:
  - To treat refractory status epilepticus
  - To rule out nonconvulsive seizures in patients with unexplained fluctuating or ALC NYD
- Limited data is available in children on the usefulness of cEEG in this population but:
  - The Columbia experience tells us that
  - Nonconvulsive seizures are common in critically ill children
  - Only 50% of NCS are detected in the first hour of recording and 13% are not recorded until >24 hrs of monitoring
- Outcome in critically ill kids with NCS and NCSE is not well defined

Future Research Areas to be Addressed

- Prospective studies identifying incidence and predictors of NCSE and NCS
- Need RCTs for the treatment of NCSE (needed in adults and children)
  - Need to treat sooner?
  - How aggressive do we have to be?
  - Risks of aggressive treatment in children with NCSE vs CSE
- Prospective studies on the outcome of NCSE in critically ill children
- Identify serum markers that can help us identify degree of neuronal damage/need for more aggressive treatment (e.g. NSE)
- Prospective studies on the outcome and treatment of NCSE in children with ESES, Landau Kleffner