Continuous EEG as a tool for prognosis in neonates and children

Andrea Lowden Joaquín, M.D.
Assistant Professor of Pediatric Neurology and Epilepsy
Children's Medical Center Dallas
University of Texas Southwestern

children's MEDICAL CENTER

UT SOUTHWESTERN MEDICAL CENTER

Disclosures

- None

Objective

- Recognize abnormal EEG patterns and their clinical implication as well as prognostic significance.

Important points when assessing prognosis

- Correlation with history, medications and other laboratory findings is vital.
- Predicting outcome on a single EEG feature is discouraged as certain abnormal EEG findings may be transient.
- Maturational changes that occur from 25-44 weeks and beyond into early childhood.
- Patterns that are normal at one developmental age may be abnormal in others.

Holmes & Lombroso 1993

EEG background features with prognostic significance

Associated with unfavorable prognosis.

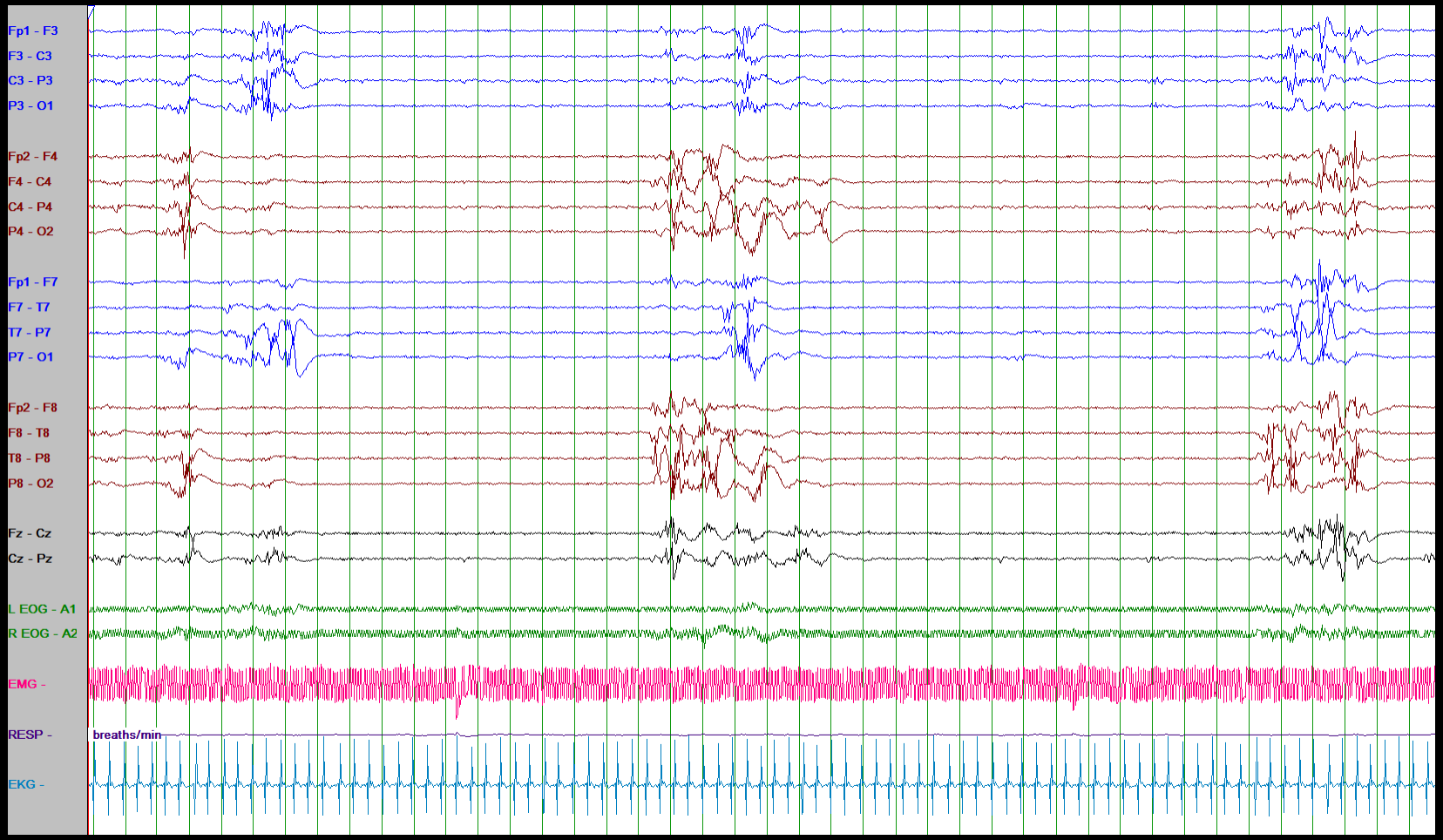
- Burst-suppression pattern
- Excessive discontinuity
- Severe attenuation
- Lack of reactivity
- Abnormal background

Associated with favorable prognosis

- Rapid EEG improvement over hours
- Reactivity
- Normal sleep patterns

EEG patterns that can be a valuable prognostic tool.

Dysmaturity

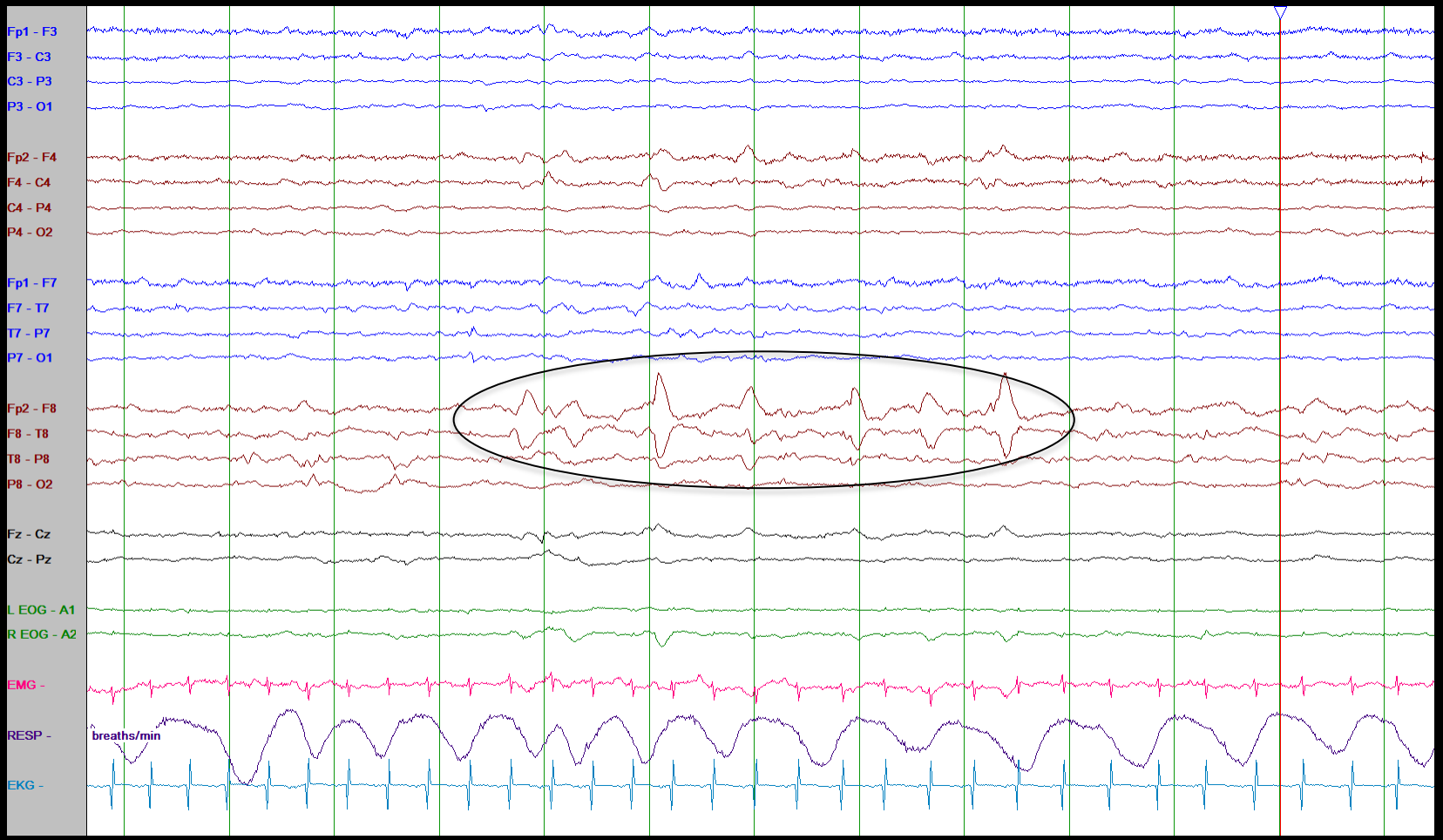


2 week old ex-37 weeker

Dysmaturity

- Indicates a lag of at least 2 weeks for the neonates post-menstrual age.
- The pathophysiology is unknown.
- Persistent dysmaturity on serial EEGs associated with increased risk of abnormal neurological outcome.
- Always make sure you have the correct PMA!

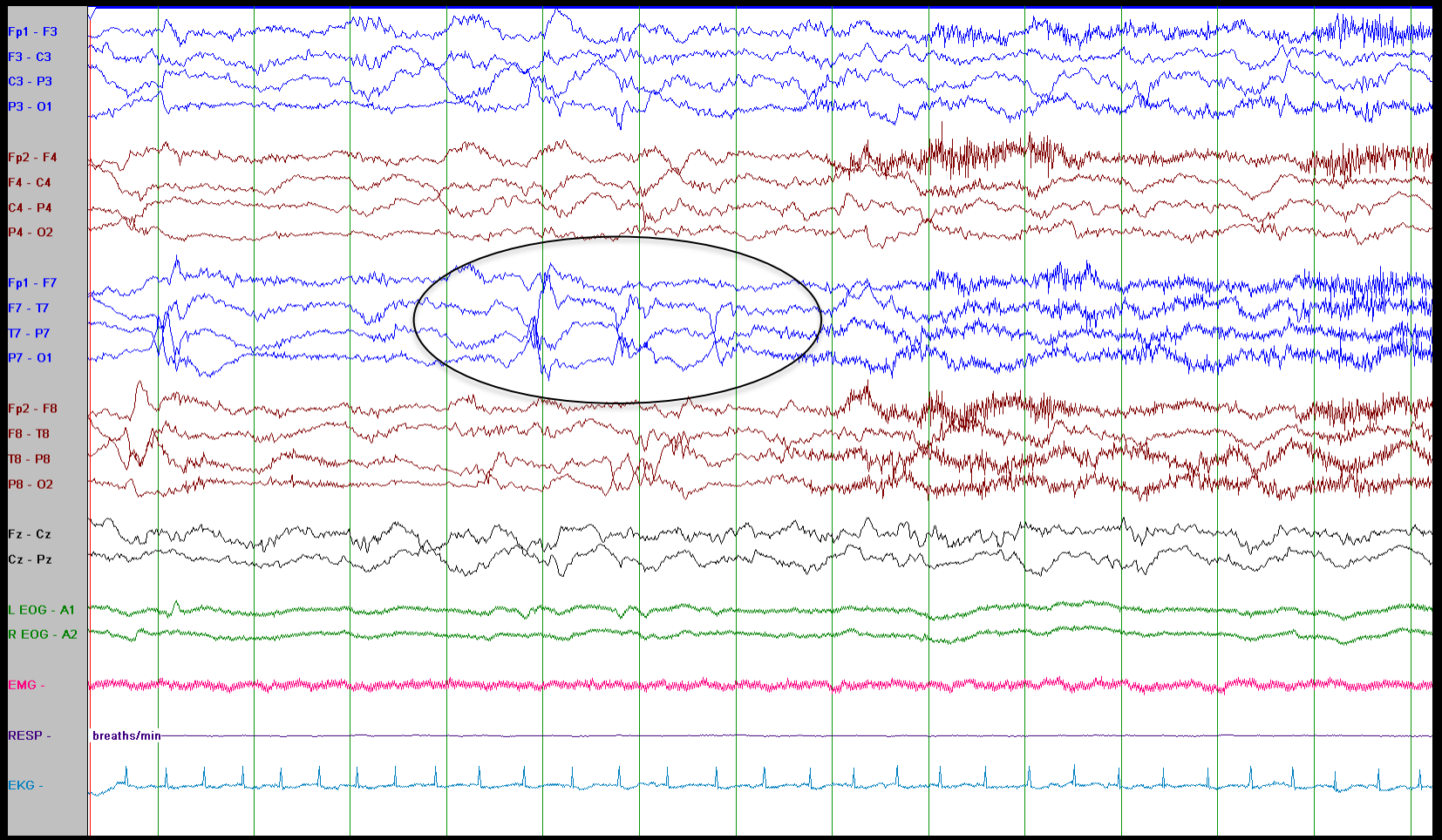
Positive sharp waves



Positive Sharp Waves (Positive Rolandic waves)

- Associated with IVH and periventricular leukomalacia.
- Typically located in the central and vertex regions.
- Some studies suggest that < 3 per hour (premature) and < 1.5 per hour (term) may be normal.
- Do not suggest epileptogenicity.

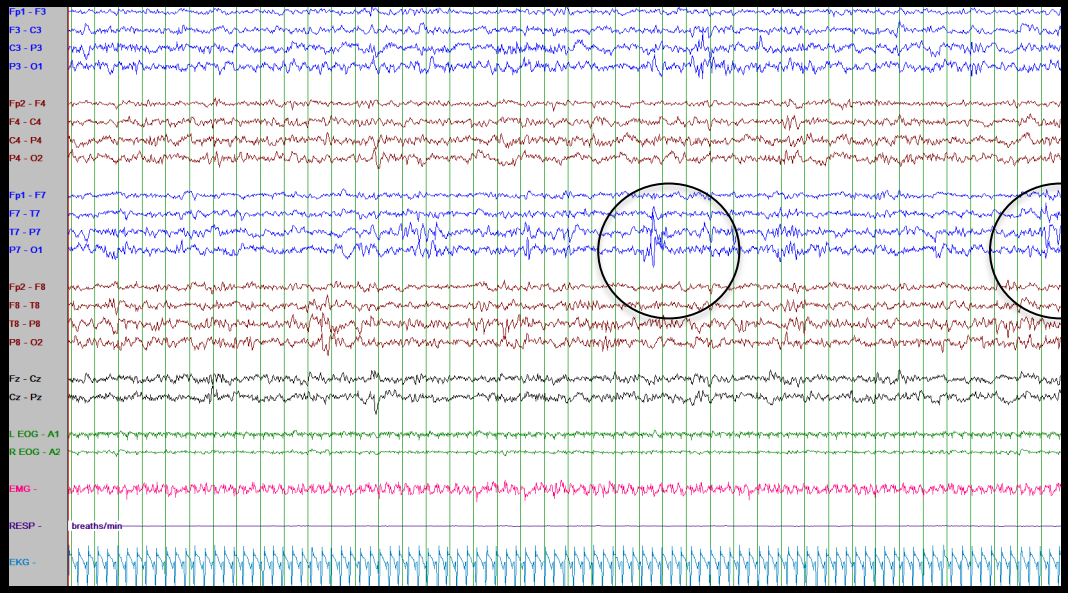
Brief Rhythmic Discharges



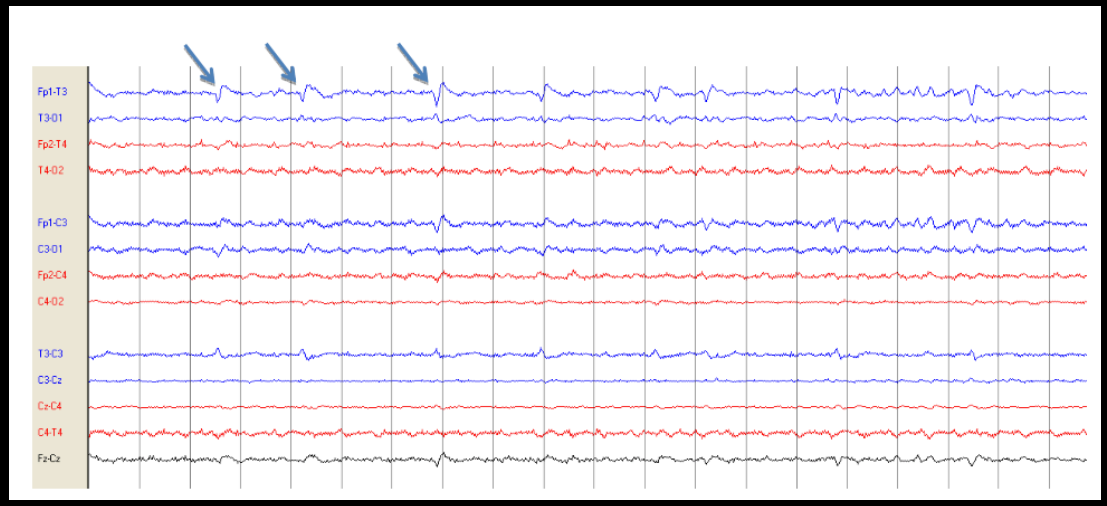
BRDs

- **B**rief **R**hythmic **D**ischarges with a duration of less then 10 seconds.
- The prevalence is higher in preterm and high risk newborns.
- Clinical significance is not well understood.
- Has been associated with seizures and with poor neurodevelopmental outcome

Oliveira AJ et al, Clin Neurophysiol 2000



Focal sharp transients

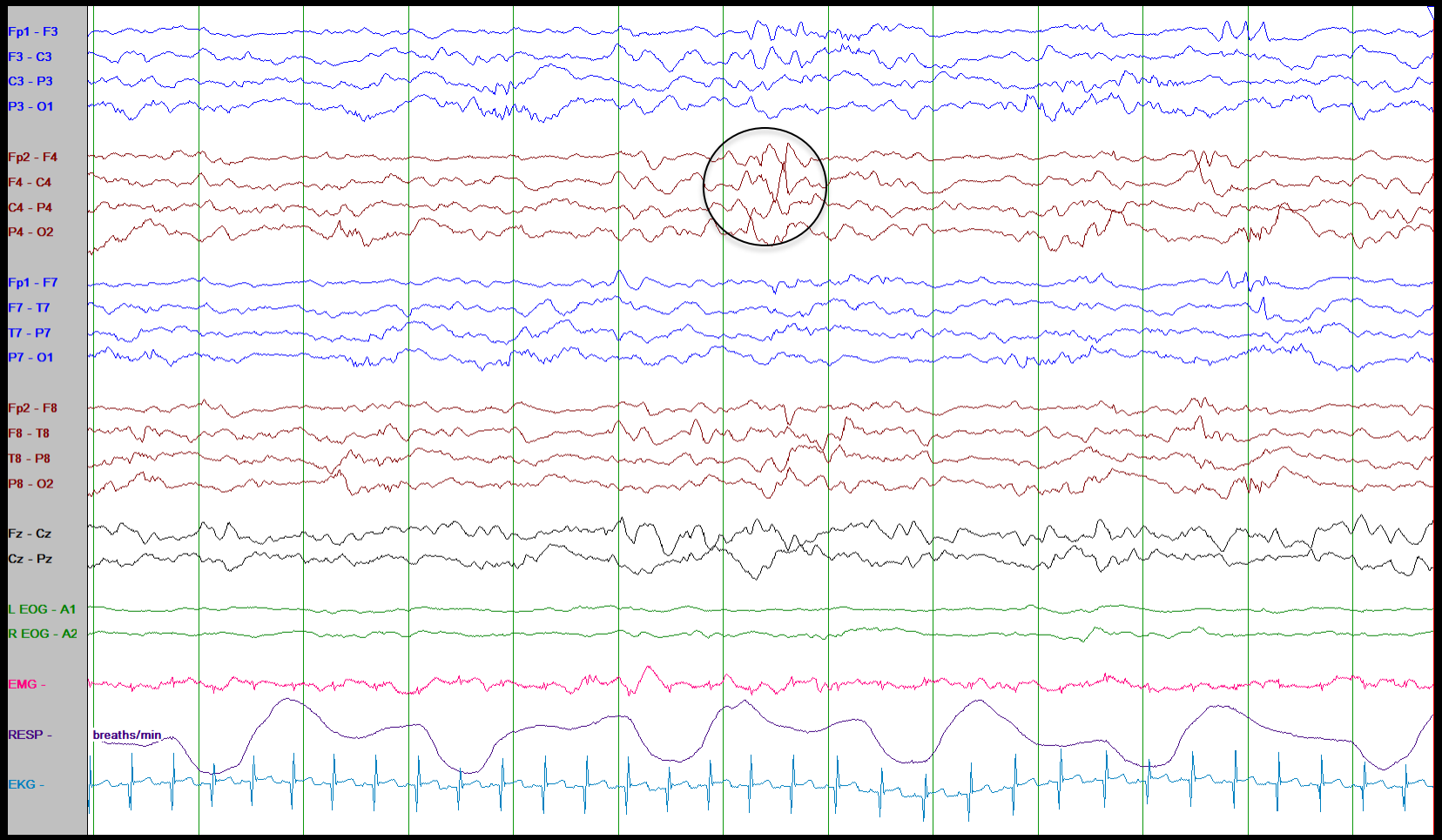


Tsuchida et al ACNS guidelines

children's MEDICAL CENTER

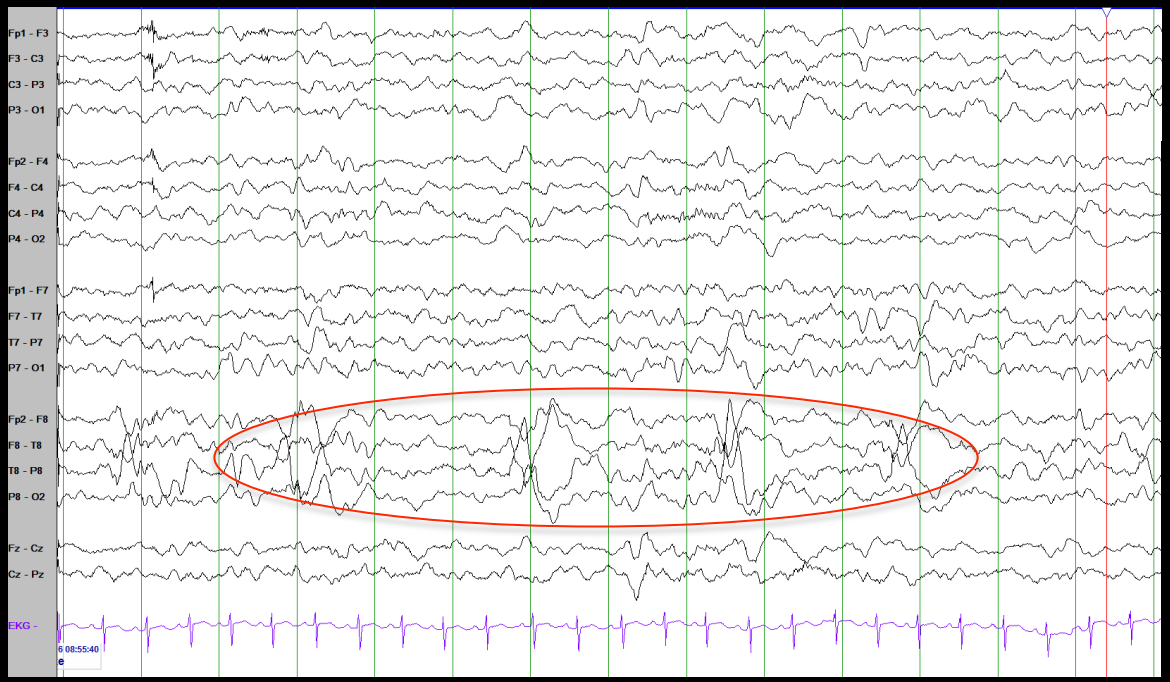
SOUTHWESTERN MEDICAL CENTER

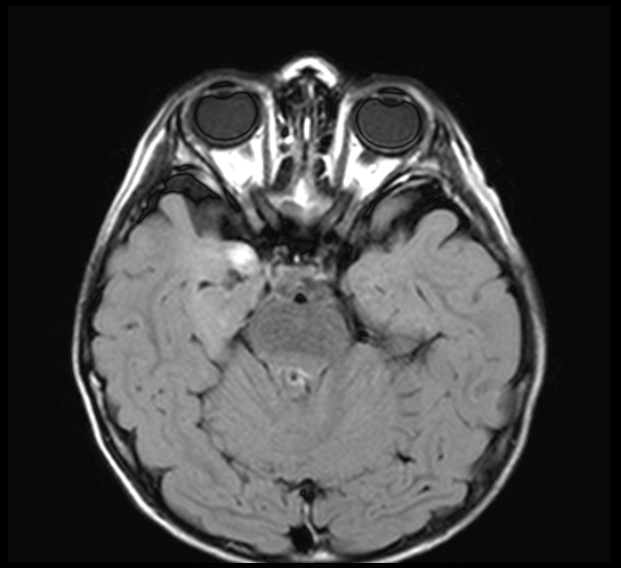
Physiologic frontal sharp transients



Sharp transients

- Neonates it is important to differentiate normal from abnormal transients.
- Abnormal sharp transients > 11 (preterm) and >13 per hour (term).
- Persistent focal abnormalities is considered abnormal and suggest focal brain injury.

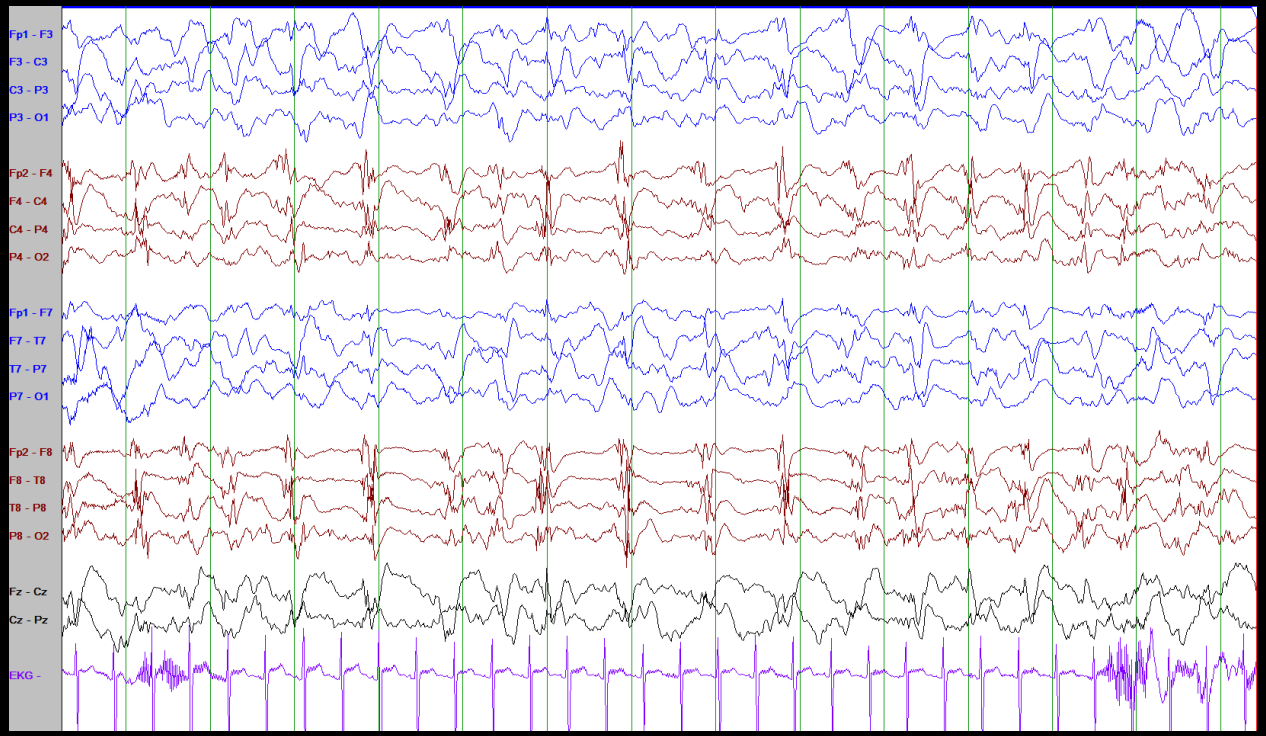




children's MEDICAL CENTER

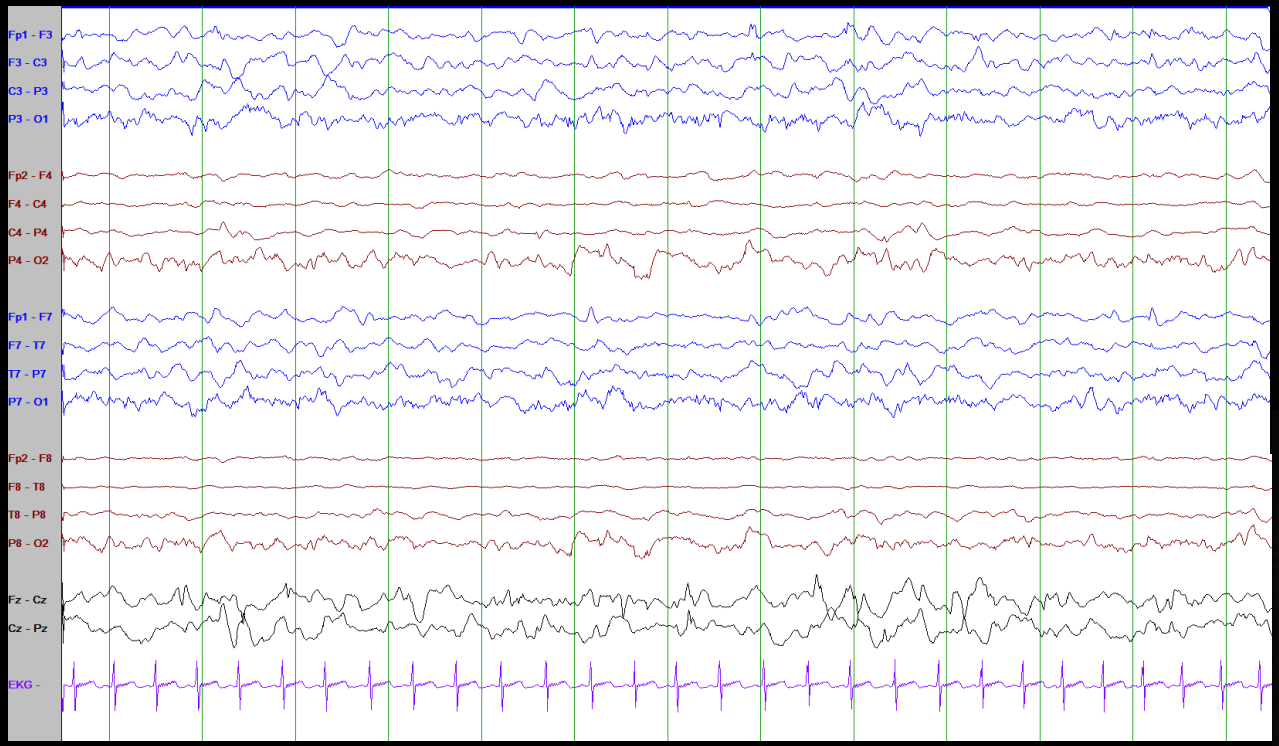
UT SOUTHWESTERN MEDICAL CENTER

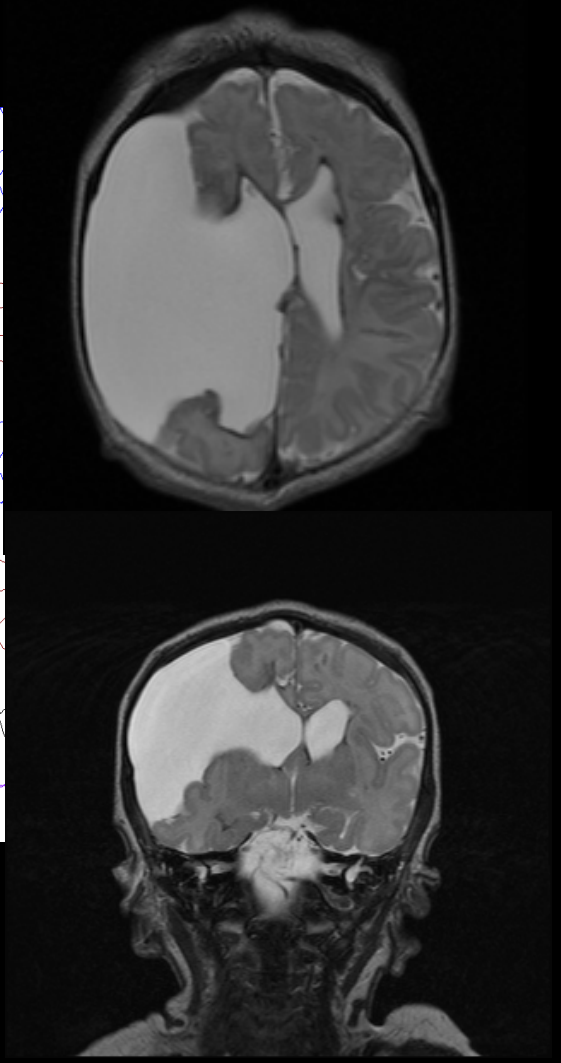
R Lateralized Periodic Discharges (LPDs)



Typically seen in HSV encephalitis

Asymmetry

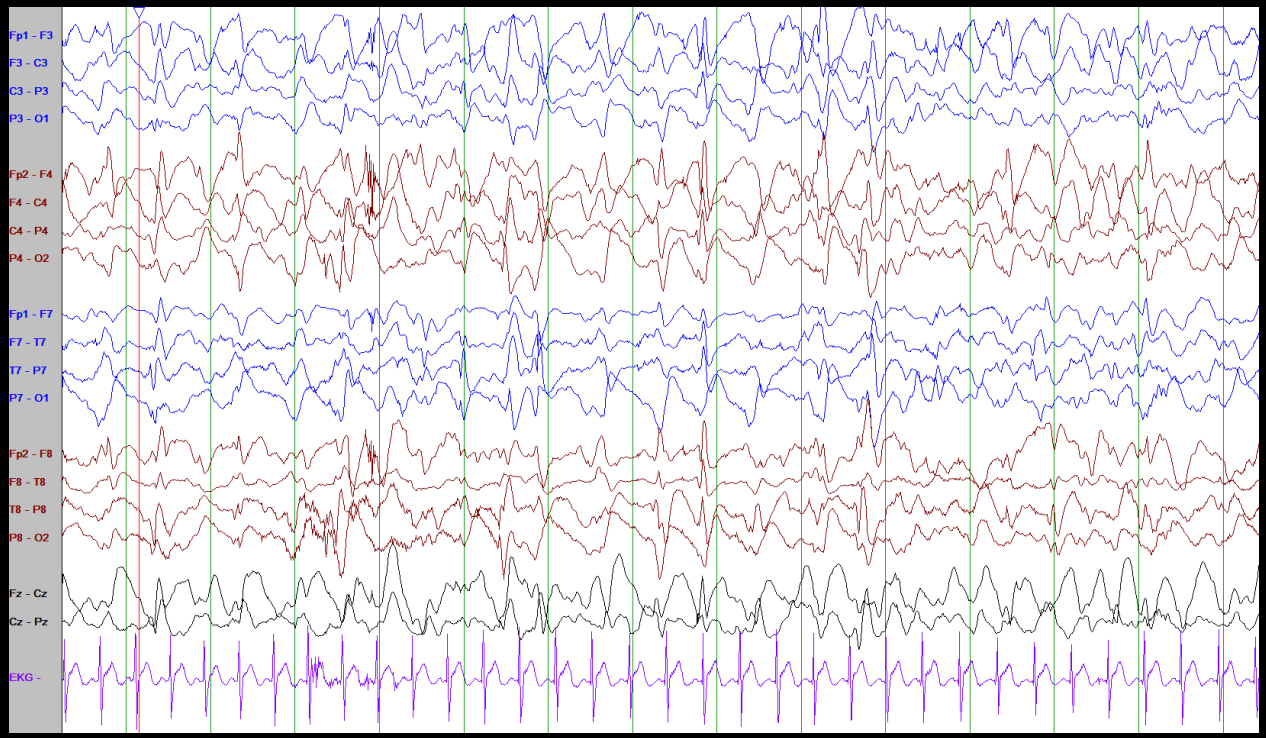




Asymmetry

- The persistence of more than a 50% difference in voltages between homologous regions of the two hemispheres.
- Suggest a focal lesion (hemorrhage, cerebral malformation).

Abnormal background

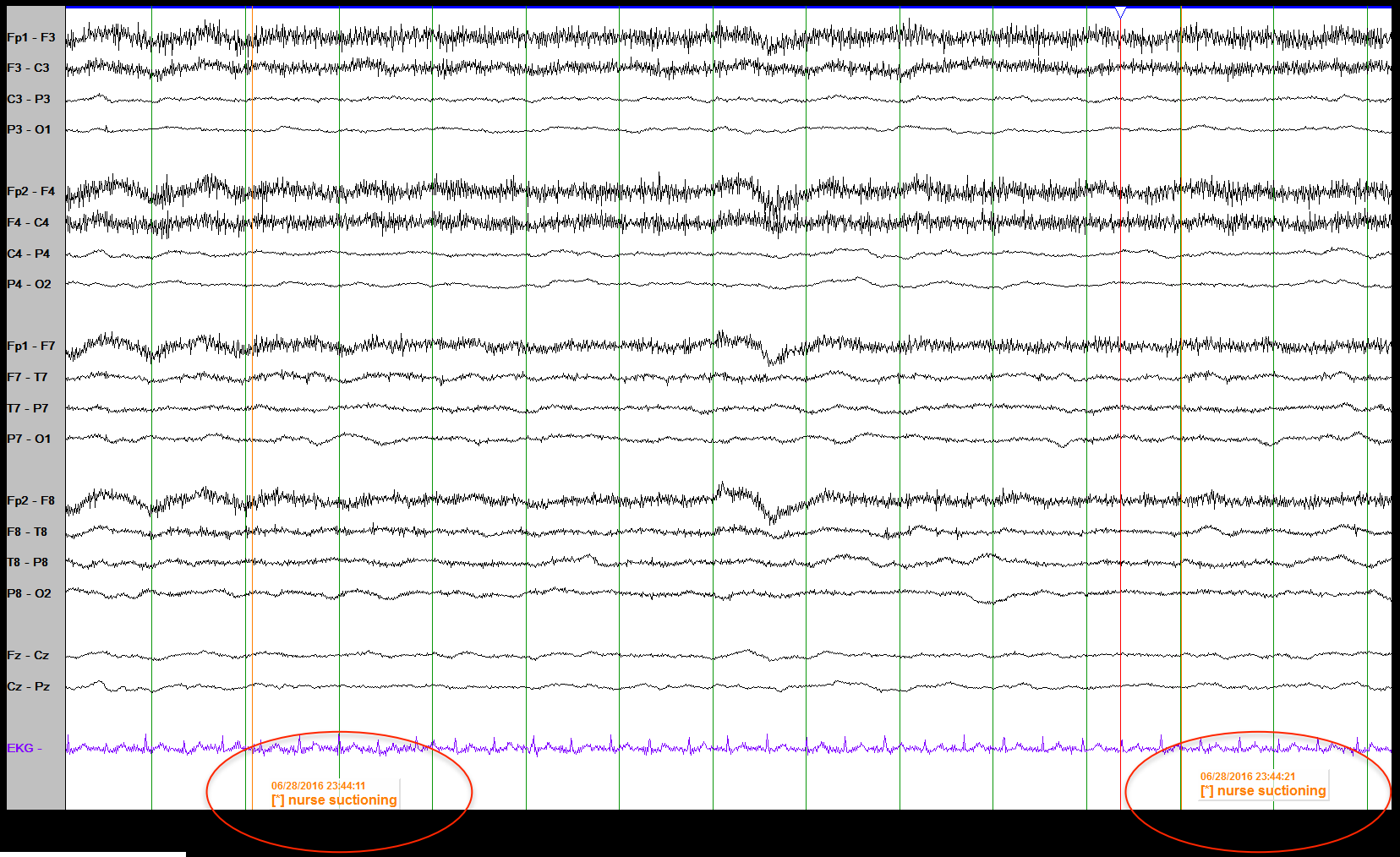


Associated with an increased risk of seizures and poor neurodevelopmental outcome.

Outcome in Status epilepticus

- Several studies have determine that the underlying etiology is the main predictor of morbidity and mortality in children with SE.
- Further predictors of mortality were:
  - Type of seizures (generalized convulsive SE)
  - Specific EEG patterns (periodic epileptic discharges, multifocal discharges, burst suppression, and suppression of basic activity)

Lack of reactivity



Reactivity

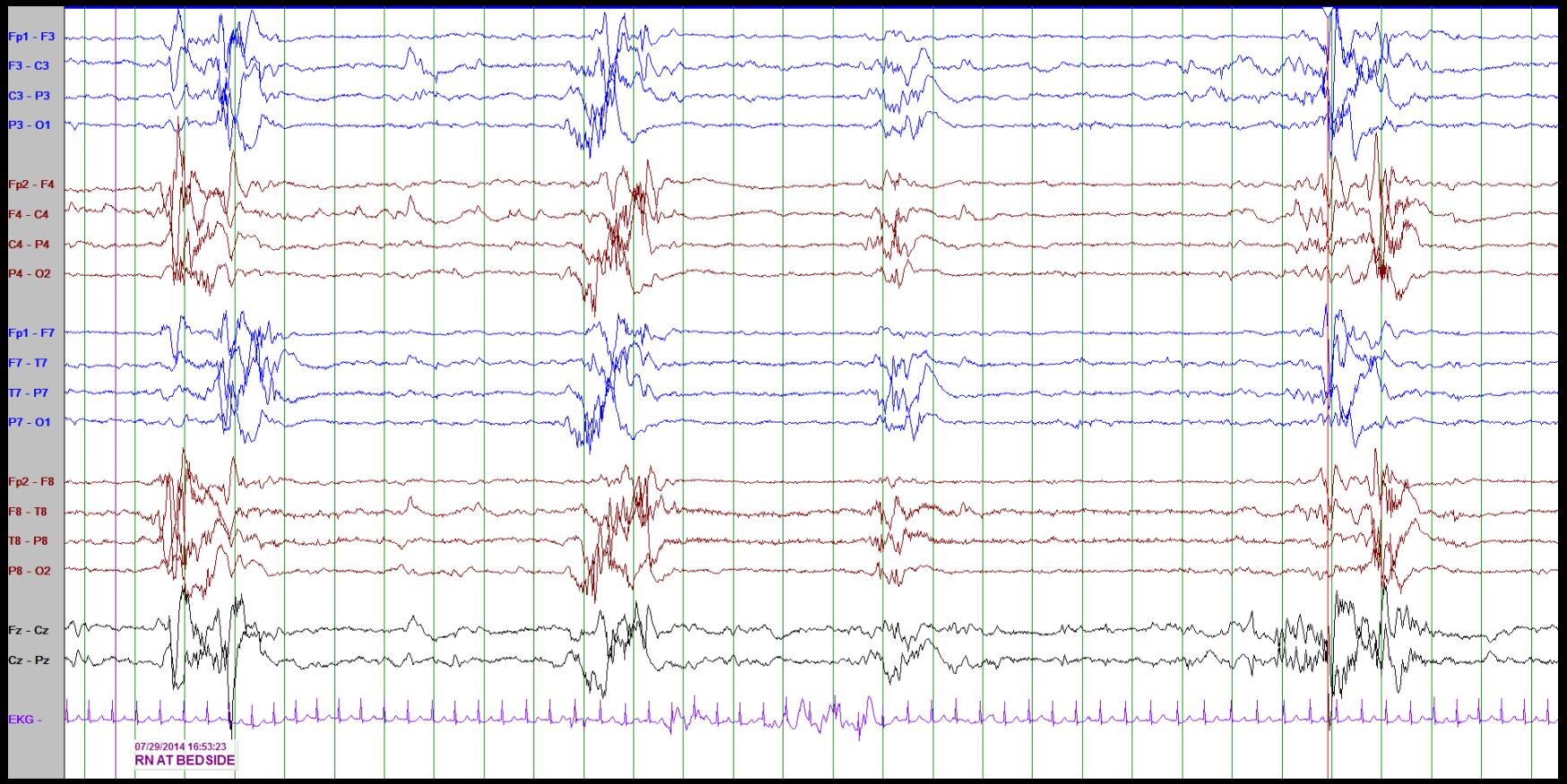
- Cerebal EEG response to external stimulation.
- Movement and EMG artifact may be induced.

Lack of reactivity

- Retrospective study in comatose patients 2m -18y.
- Determine whether reactivity was associated with a better outcome.
- Thirty-three patients had EEGs within 72 hours after the onset of coma.
  - 14 were reactive
  - 19 were nonreactive
- Among the nonreactive EEG, 13 (65%) had unfavorable outcome, which included 10 deaths and all the survivors had residual neurological impairment.
- Among the reactive EEG outcome was unfavorable in 4.

Ramachandrannair et al, Pediatr Neurol. 2005 Nov;33(5):345-9

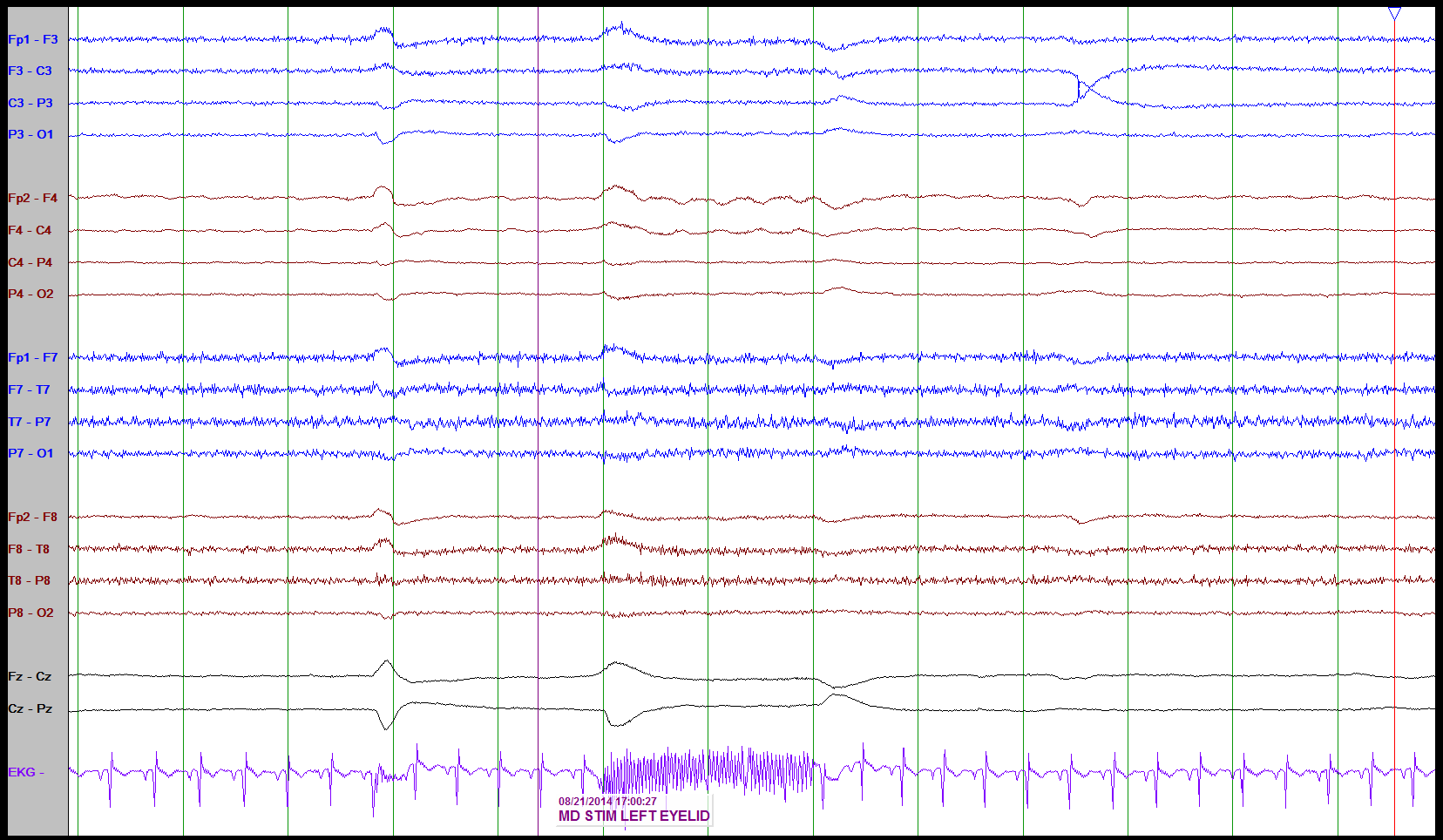
Burst- Suppression



Burst Suppression

- Burst of high voltage activity lasting 1-10 sec. followed by IBI of voltage attenuation (<5microV).
- The pattern is invariant and persist through sleep and wakefulness.
- Associated with poor prognosis including severe neurological deficits and death.
- Etiologies: HIE, CNS infection, nonketotic hyperglicinemia, hypothermia, anesthetics.

Low voltage suppressed

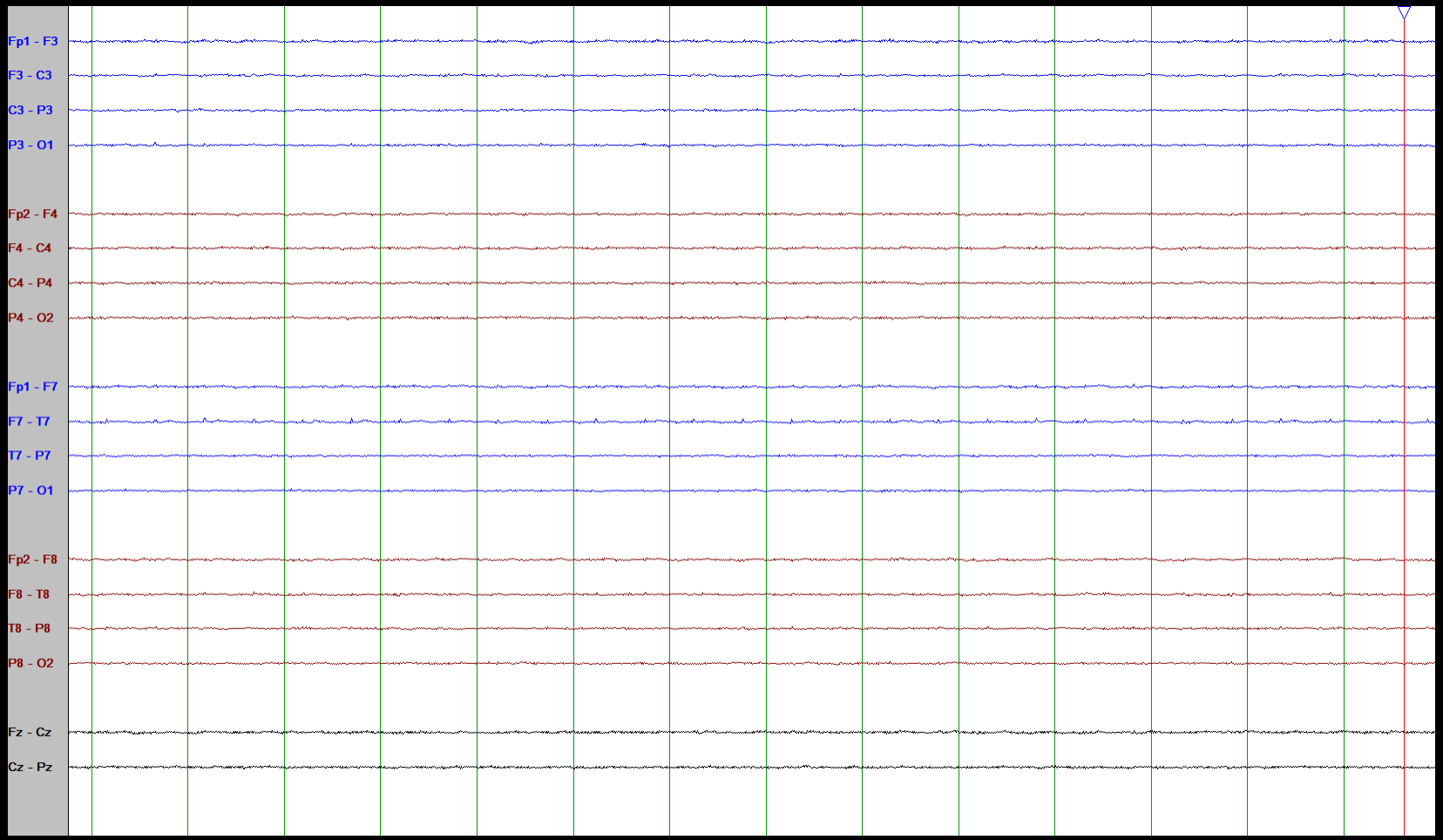


Low voltage suppressed

- Persistently low voltage activity <10 uV, invariant and unreactive without normal background features.

- This pattern suggest severe neurological injury or dysfunction.

Electro-cerebral inactivity



Electrocerebral inactivity (ECI)

- Absence of any discernible cerebral electrical activity > or = 2 uV at a sensitivity of 2uV/mm.
- In the absence of hypothermia or heavy sedatives this EEG carries a grave prognosis including death.
  - Pezzani et al 1986, in 80 FT newborns who had EEGs within 24 hrs after birth, 19 had ECI and 17 (90%) died.

Predicting outcome on a single EEG feature is discouraged as certain abnormal EEG findings may be transient.

Summary

- Assessing prognosis based on EEG is challenging always take into account:
  - Clinical history
  - Medications
  - Laboratory findings
- When in doubt serial EEGs may be useful.

References

- Almubarak, S. **Long-term clinical outcome of neonatal EEG findings.** Journal of clinical neurophysiology 2011. Volume 28 (2): 185-189
- Tsuchida et al. **ACNS Standardized EEG Terminology and Categorization for the Description of Continuous EEG Monitoring in Neonates**
- Ramachandrannair, R. et al. **Reactive EEG Patterns in Pediatric Coma**, Pediatr Neurol. 2005 Nov;33(5):345-9.
- Holmes & Lombroso 1993. **Prognostic value of background patterns in the neonatal EEG.** J Clin Neurophysiol. 1993 Jul;10(3):323-52.
- J. Sonck, G. Laureys and D. Verbeelen. **The neurotoxicity and safety of treatment with cefepime in patients with renal failure.** Nephrol Dial Transplant (2008) 23: 966–970