Maturazione EEG

09:15 – 10:00	Ontogenesi EEG – *A. Suppiej*
10:00 – 10:45	Pattern EEG patologici nel neonato pretermine/a termine – *S. Lori*
10:45 – 11:30	EEG nel bambino: peculiarità rispetto all'adulto – *P. Lanteri*
11:30 – 12:00	Pausa
12:00 – 13:00	Crisi epilettiche ed epilessie neonatali. Interpretazione della VideoEEG poligrafica *M. Mastrangelo*

Pattern EEG patologici nel neonato pretermine/a termine

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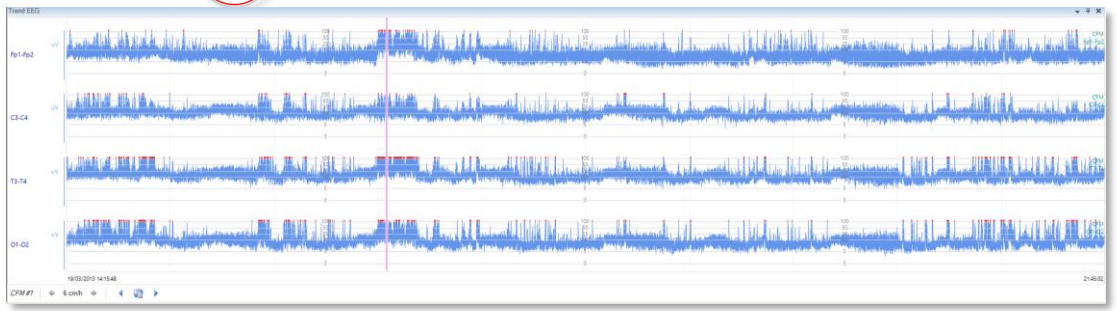
Gruppo di Studio di Neurofisiologia Pediatrica

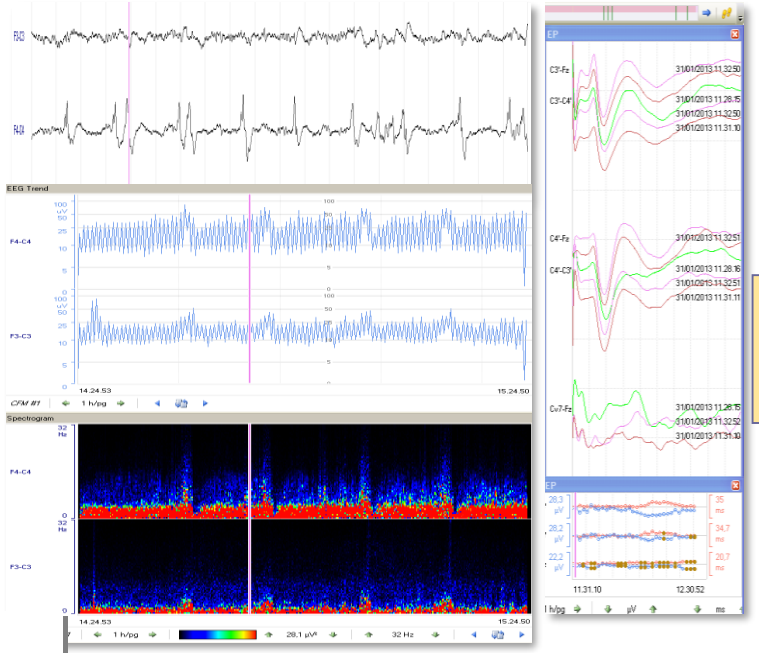
EEG poligrafico con Video

- **TECNICA STANDARDIZZATA**

  "Gold standard"

aEEG





SEP Continuo «Trend»

Valutazione multimodulare

Pattern eeg

Età Gestazionale

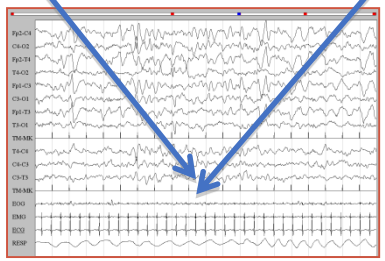
Prematuro
"Near Term"
Termine

Stati comportamentali

andamento ciclico e prevedibile

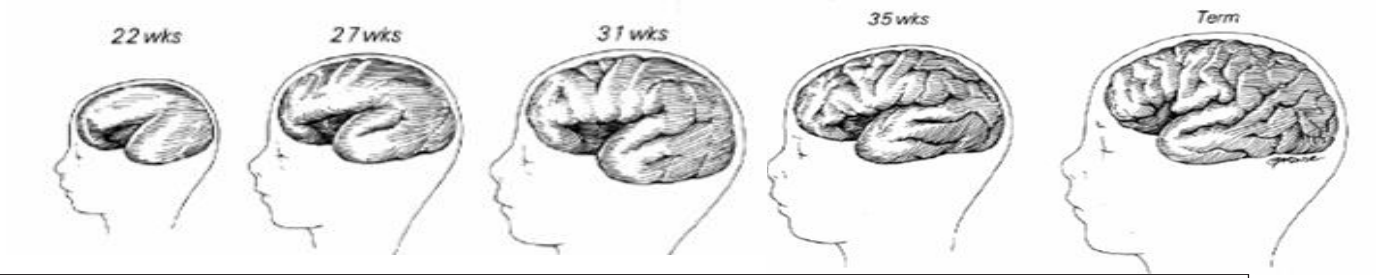
correlati a modificazioni del *respiro*, del *movimento*, del *pianto*.

ATTIVITÁ ELETTRICA CORTICALE



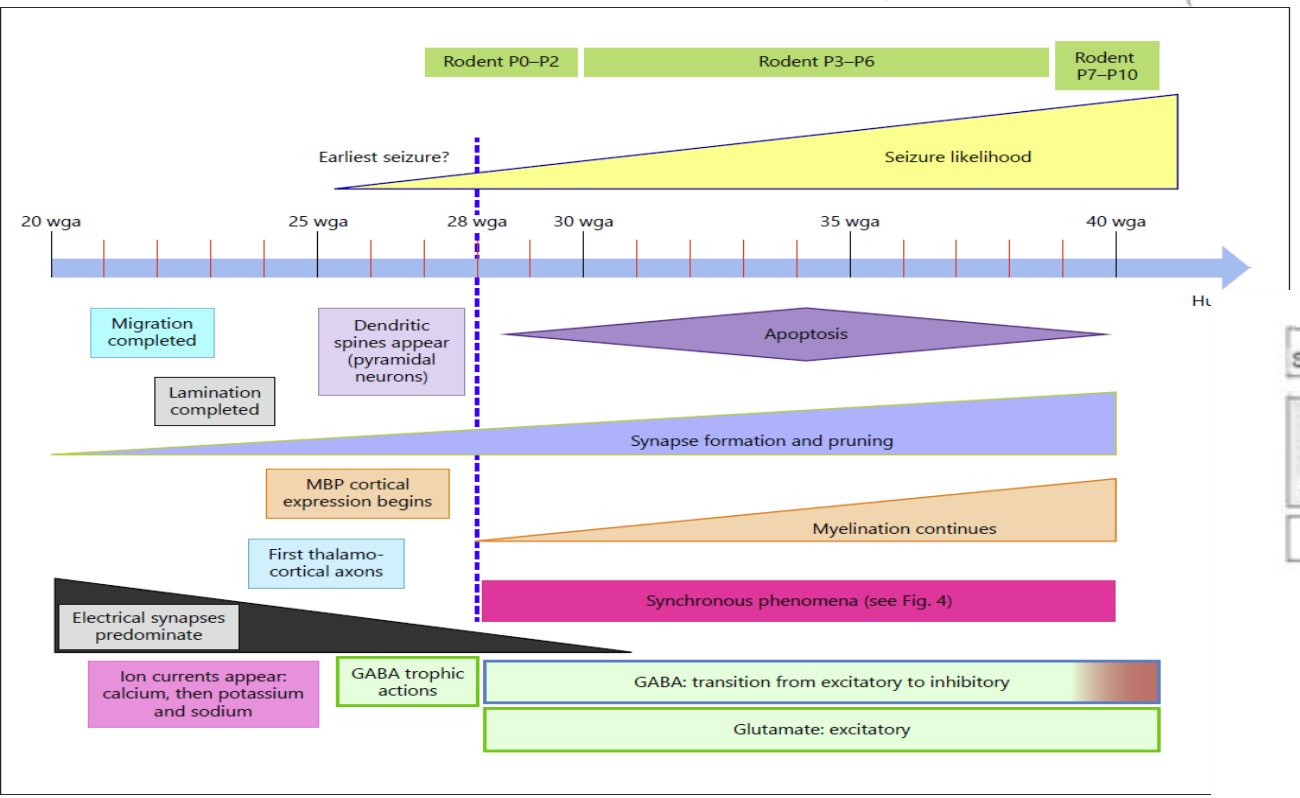
- **STATO 1**: **SONNO CALMO** occhi chiusi, arti parzialmente flessi, respiro regolare, non movimenti spontanei.
- **STATO 2** : **SONNO ATTIVO** occhi chiusi , movimenti oculari visibili, respiro irregolare, piccoli movimenti (suzione-smorfie), isolati movimenti spontanei
- **STATO 3**: **VEGLIA TRANQUILLA** occhi aperti, arti inflessione sia in adduzione che in abduzione, pugni chiusi, arti inferiori poco sollevati dal piano, attività motoria minima.
- **STATO 4** : **VEGLIA ATTIVA** occhi aperti, attività motoria ampia, anarchica, scomposta , asimmetrica, mani aperte-chiuse, pedala mento.
- **STATO 5**: **VEGLIA AGITATA** pianto, movimenti intensi

Biomarcatori neurofisiologici in età neonatale:
FONDAMENTALE E NECESSARIA LA CONOSCENZA DEI PROCESSI MATURATIVI FISIOLOGICI



- ✓ Rapido sviluppo
- ✓ Notevole Differenziazione
- ✓ Grande Plasticità

Carrasco/Stafstrom
Dev Neurosci
DOI: 10.1159/000497471



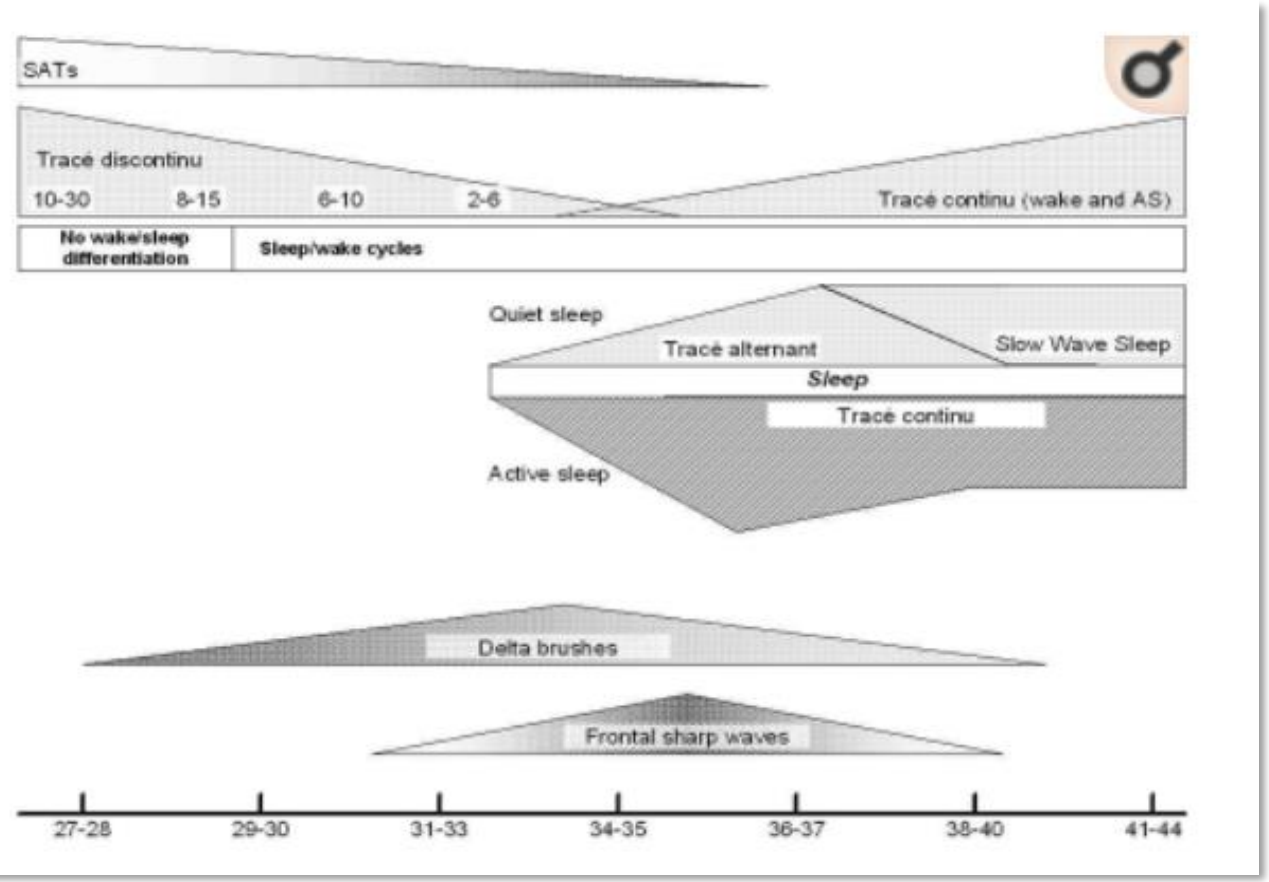


Table 11.1 Developmental EEG patterns and behavioral states

Adapted from Lombroso [12], Tharp [27], Anders et al. [28], Kellaway [29], Ferrari et al., [30] Mastrangelo et al., [31], André et al. [32]
[a]Both for the specific waveforms and patterns, refer to the following iconography (Figs. 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9, 11.10, 11.11, 11.12, 11.13, 11.14, 11.15, 11.16, 11.17, 11.18, 11.19, 11.20, 11.21, 11.22, 11.23, 11.24, 11.25, 11.26, 11.27, 11.28, 11.29, 11.30, 11.31, 11.32, 11.33, and 11.34)

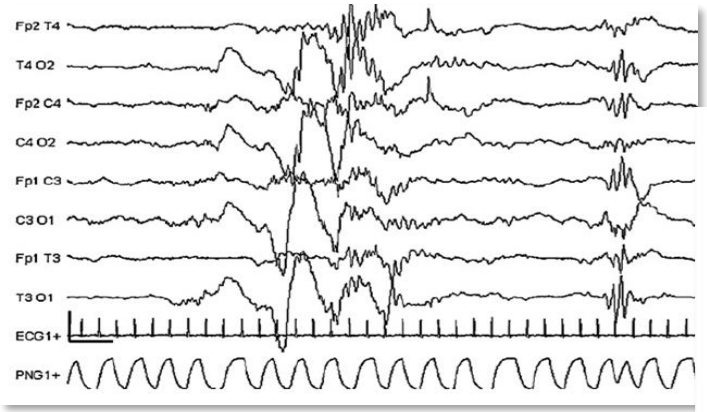
Conceptional age (week)	Specific waveforms[a]	Continuity of electrical activity and specific patterns[a]	Behavioral state
24–27	Hypersynchronous bursts Occipital delta of 0.5–1 Hz Infrequent central (occipital) delta brushes	Discontinuous tracing No reactivity to stimulation	Undetermined state
28–31	Occipital delta Central delta brushes Rhythmic temporal theta activity Sharp temporal theta bursts	Discontinuous tracing Electrical activity becomes continuous during active sleep No reactivity to stimulation	Active sleep (Wake±/Quiet sleep±)
32–34	Frequent occipital-temporal delta brushes Synchronous occipital delta Rhythmic temporal and alpha bursts Both positive and negative, temporal and Rolandic sharp waves	Discontinuous tracing (in quiet sleep) Continuous tracing in active sleep Inconstant reactivity to stimulation	Active sleep (Wake±) (Quiet sleep±)
35–37	Encoches frontales ASD[b] (infrequent) Infrequent occipital delta brushes Multifocal slow sharp waves	Activité moyenne LVI[c] Tracé alternant Reactive to stimulation	Wake Active sleep Quiet sleep Undetermined/ transitional sleep
38–44	Encoches frontales ASD[b] Isolate Rolandic and temporal sharp waves	Activité moyenne Mixed activity LVI[c] Tracé alternant HVS[d] Reactive to stimulation	Wake Active sleep Quiet sleep Transitional sleep

Landmark maturativi dell'EEG

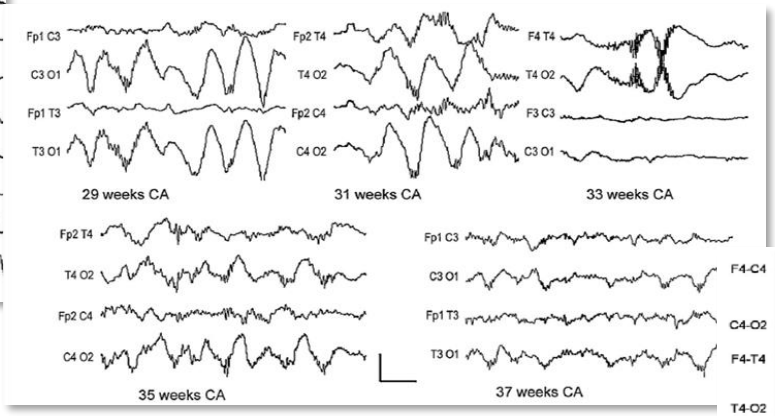
aEEG

Attività di fondo «background» da discontinuo (<32 w) a continuo (>32 w)

- ✓ Livello di continuità (<<<<IBI - 35 w)
- ✓ Cicli sonno/veglia (29w)
- ✓ Ampiezza minima del segnale (<5uV>)
- ✓ Differenza di ampiezza burst/intervalli interburst (<<< span)



Temporal sawtooth -Maturazione dei Delta-brushes

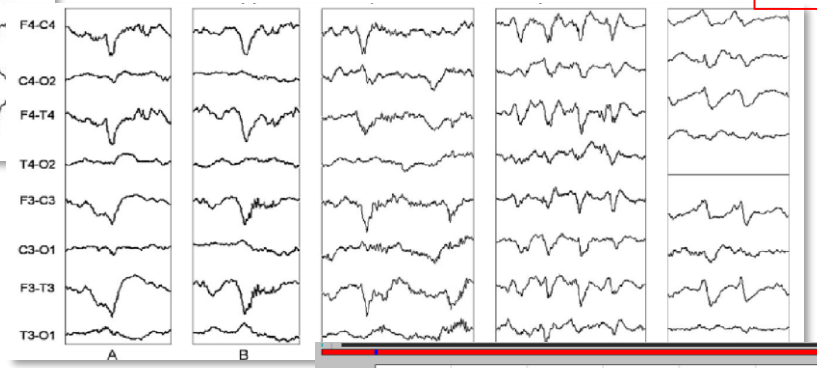


27-38 w

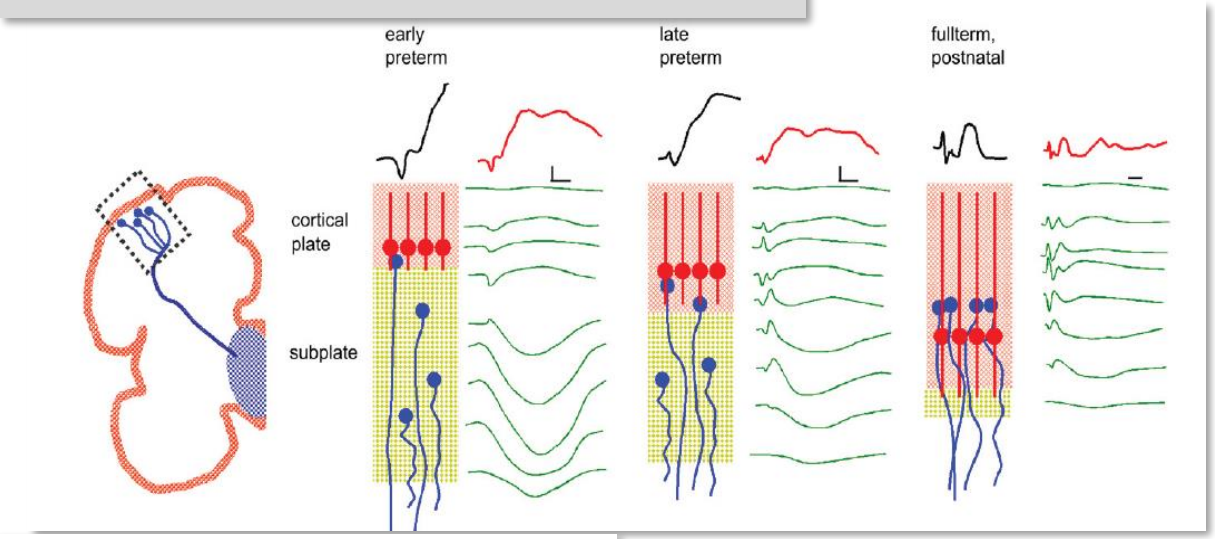
Gradiente maturativo

Maturazione delle Encoches frontali

31-40 w



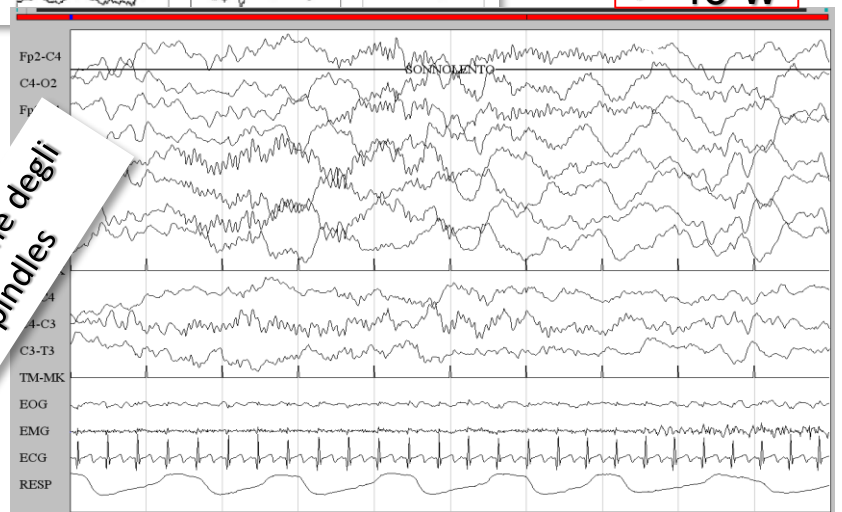
Landmark maturativi del PES



Seminars in Fetal & Neonatal Medicine (2006) 11, 464–470

> 40 w

Maturazione degli Spindles



Standardized computer-based organized reporting of EEG: SCORE – Second version

HIGHLIGHTS

Normale

Patologico

Properties scored for the neonatal ongoing activity.

Continuity	Normal continuity Normal discontinuity (insert values for burst duration and suppression duration) Tracé alternant *(only for "asleep" and > 30 weeks)* (insert values for burst duration and suppression duration) Excessive background discontinuity (insert values for burst duration and suppression duration) Burst-suppression *(only for > 30 weeks)* (insert values for burst duration and suppression duration) Electrocerebral inactivity
Synchrony	Mostly synchronous Mostly asynchronous
Variability (lability)	No Yes Unclear
Reactivity	No Yes Unclear
Amplitude	Normal Borderline low Borderline high Abnormal low Abnormal high
Significance	Considered normal for age No definite abnormality Considered not normal for age

Polygraphic channels.

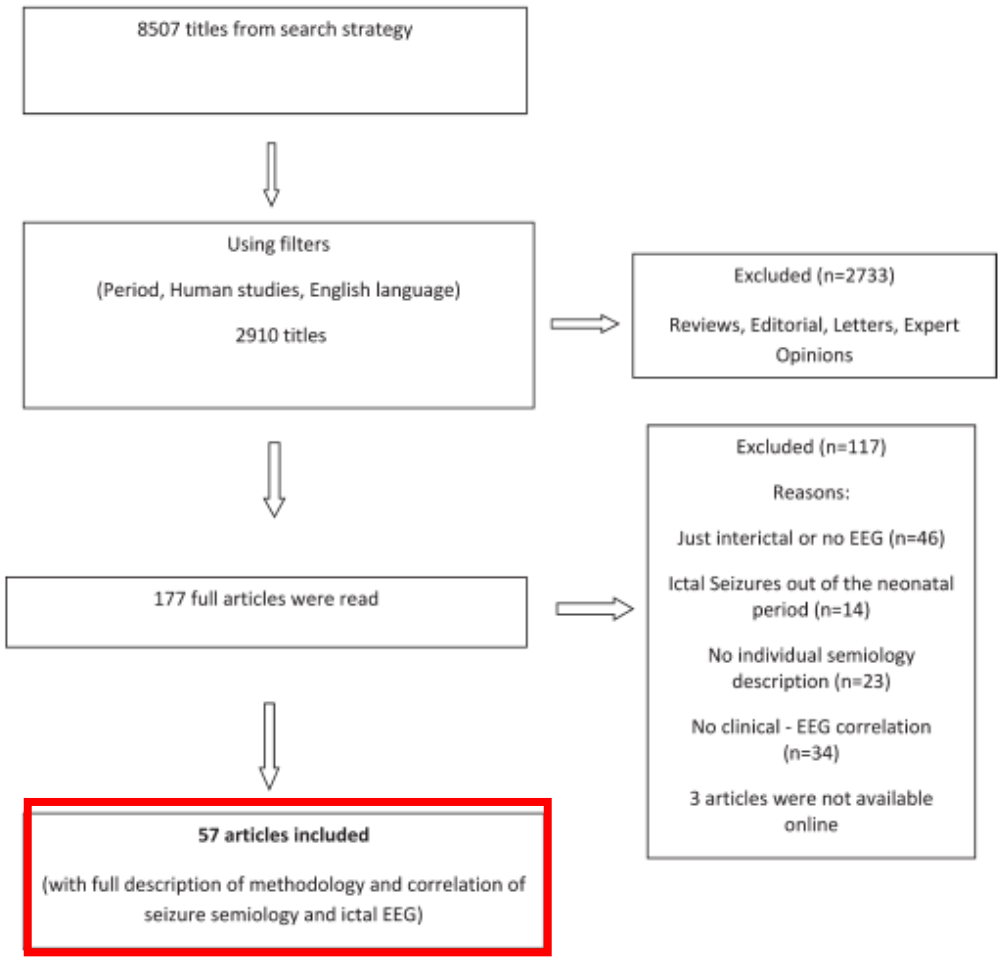
Respiration sensors	Apnoea Hypopnoea Apnoea-hypopnoea index (numerical value entered) Periodic respiration Tachypnoea (numerical value for cycles / minute) Oxygen saturation (+ free text) Other (+free text)
ECG	Normal rhythm Arrhythmia Asystolia Bradycardia (numerical value for frequency) Extrasystole Ventricular Premature Depolarization Tachycardia (numerical value for frequency) Other (+ free text) QT period (+ free text) ECG not recorded
EMG	Myoclonus Negative myoclonus Myoclonus – rhythmic (numerical value for frequency) Myoclonus – arrhythmic Myoclonus – synchronous Myoclonus – asynchronous PLMS (Periodic Limb Movements in Sleep) Spasm Tonic contraction Asymmetric activation of EMG – right first Asymmetric activation of EMG – left first Other (+ free text) Side and name of muscle

Neonatal seizures: Is there a relationship between ictal electroclinical features and etiology? A critical appraisal based on a systematic literature review

DOI: 10.1002/epi4.12298

NUNES ET AL.

Search strategy



Key Points

- Specific etiologies of neonatal seizures may be associated with distinct clinical features and these associations might be useful in countries with limited resources
- Specific electroclinical patterns may help in the recognition of the etiology of neonatal seizures
- Widespread use of the Neonatal Task Force proposal should be helpful for collecting data in future studies

TABLE 3 Seizures etiology × semiology

	Clonic	Tonic	Myoclonic	Automatisms	Spasms	Sequential	Autonomic
Etiology/seizure classification, n (%)							
HIE (n = 6)	1 (16.7%)	0 (0.0%)	0 (0.0%)	1 (16.7%)	0 (0.0%)	1 (16.7%)	3 (50.0%)
Cortical malformations (n = 3)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (66.7%)	1 (33.3%)
CNS infection (n = 4)	3 (75.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (25.0%)	0 (0.0%)
Metabolic disorders							
Electrolyte imbalance (n = 3)	1 (33.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	1 (33.3%)
Inborn errors of metabolism (n = 3)	0 (0.0%)	0 (0.0%)	3 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Vitamin-related disorders (n = 11)	2 (18.2%)	0 (0.0%)	2 (18.2%)	0 (0.0%)	0 (0.0%)	7 (63.6%)	0 (0.0%)
Withdrawal (n = 2)	1 (50.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Genetic disorders							
Channelopathy (n = 67)	5 (7.5%)	26 (38.8%)	3 (4.5%)	0 (0.0%)	0 (0.0%)	33 (49.3%)	0 (0.0%)
Chromosomal disorder (n = 3)	1 (33.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	1 (33.3%)
Other gene disorders (n = 7)	2 (28.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (28.6%)	3 (42.9%)	0 (0.0%)
Vascular disorders							
Stroke (n = 25)	18 (72.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (20.0%)	2 (8.0%)
Hemorrhage (n = 8)	2 (25.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (25.0%)	4 (50.0%)
Unknown Undetermined/ (n = 9)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (11.1%)	6 (66.7%)	2 (22.2%)

CNS, central nervous system.

TABLE 4 Etiology vs EEG

	EEG n (%)			
	Focal	Multifocal	Burst-suppression	Generalized
Etiology (n)				
Hypoxic-ischemic encephalopathy (n = 6)	4 (66.7%)	2 (33.3%)	0 (0.0%)	0 (0.0%)
Cortical malformations (n = 3)	2 (66.7%)	1 (33.3%)	0 (0.0%)	0 (0.0%)
CNS infection (n = 4)	1 (25.0%)	3 (75.0%)	0 (0.0%)	0 (0.0%)
Metabolic/vitamins disorders (n = 19)				
Electrolyte imbalance (n = 3)	3 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Inborn errors of metabolism (n = 3)	0 (0.0%)	0 (0.0%)	3 (100%)**	0 (0.0%)
Vitamin-related disorders (n = 11)	1 (9.1%)	7 (63.6%)	3 (27.3%)*	0 (0.0%)
Withdrawal (n = 2)	2 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Genetic disorders				
Channelopathies (n = 67)	10 (14.9%)	22 (32.8%)	34 (50.7%)	1 (1.5%)
Chromosomal disorder (n = 3)	0 (0.0%)	3 (100%)	0 (0.0%)	0 (0.0%)
Other gene disorders (n = 7)	1 (14.3%)	0 (0.0%)	6 (85.7%)*	0 (0.0%)
Vascular disorders				
Stroke (n = 25)	22 (88.0%)	2 (8.0%)	1 (4.0%)	0 (0.0%)
Hemorrhage (n = 8)	7 (87.5%)	1 (12.5%)	0 (0.0%)	0 (0.0%)
Undetermined/unknown (n = 9)	3 (33.3%)	5 (55.6%)	1 (11.1%)*	0 (0.0%)

CNS, central nervous system. Burst-suppression was described as an ictal pattern *in 2 neonates (one with vitamin-related disorder and one with unknown etiology) an as an interictal pattern **in eight (3 with inborn errors of metabolism, 3 with other gene disorders, and 2 with vitamin-related disorders); in the remaining cases, it wa not clearly defined as an ictal or interictal pattern/background abnormality.

Seizure semiology/EEG

	Focal	Multifocal	Generalized	Burst-suppression
Clonic (n = 36)	22 (61.1%)	8 (22.2%)	1 (2.8%)	5 (13.9%)
Tonic (n = 26)	3 (11.5%)	8 (30.8%)	0 (0.0%)	15 (57.7%)
Myoclonic (n = 9)	2 (22.2%)	0 (0.0%)	0 (0.0%)	7 (77.8%)*,**
Automatisms (n = 1)	1 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Spasms (n = 3)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (100%)*
Sequential (n = 62)	16 (25.8%)	28 (45.2%)	0 (0.0%)	18 (29.0%)**
Autonomic (n = 14)	12 (85.7%)	2 (14.3%)	0 (0.0%)	0 (0.0%)

Burst-suppression was described as an ictal pattern* in one neonate with myoclonic seizures and in one with spasms; as an interictal pattern** in 4 with myoclonic and four with sequential seizures; for the others it was not clearly defined as ictal or interictal pattern/background abnormality.

PLASTICITA' CEREBRALE

SOTTOGRUPPI DI ETA'

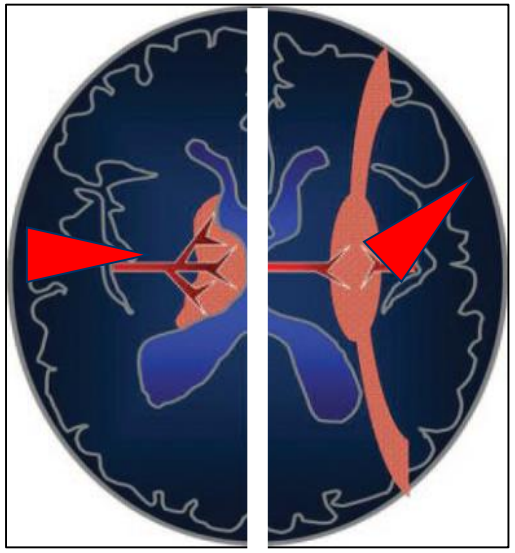
IMMATURITA' STRUTTURALE E FUNZIONALE

LIVELLO DI VIGILANZA

VARIAZIONI TOPOGRAFICHE

PREMATURO

segue un modello vascolare ventriculopeto e l'ipoperfusione provoca un danno nella sostanza bianca periventricolare .



A TERMINE

Il modello vascolare è ventricolofugo e la zona colpita durante l'ipoperfusione è più periferica con un danno alla sostanza grigia o alla bianca subcorticale e parasagittale .

REVIEW Open Access

Symptomatic seizures in preterm newborns: a review on clinical features and prognosis

Carlotta Spagnoli[1], Raffaele Falsaperla[2*], Michela Deolmi[3], Giovanni Corsello[4] and Francesco Pisani[5]

Abstract

Neonatal seizures are the most common neurological event in newborns showing higher prevalence in preterm than in full-term infants. In the majority of cases they represent acute symptomatic phenomena, the main etiologies being intraventricular haemorrhage, hypoxic-ischemic encephalopathy, central nervous system infections and transient metabolic derangements.

Current definition of neonatal seizures requires detection of paroxysmal EEG-changes, and in preterm newborns the incidence of electrographic-only seizures seems to be particularly high, further stressing the crucial role of electroencephalogram monitoring in this population. Imaging work-up includes an integration of serial cranial ultrasound and brain magnetic resonance at term-equivalent age. Unfavourable outcomes following seizures in preterm infants include death, neurodevelopmental impairment, epilepsy, cerebral palsy, hearing impairment. As experimental evidence suggests a detrimental role of seizures per se in determin outcome, they should be promptly treated with the aim to reduce seizure burden and long-term However, neonatal seizures show low response to conventional anticonvulsant drugs, and this is evident in preterm newborns, due to intrinsic developmental factors. As a consequence, as litera provide any specific guidelines, due to the lack of robust evidence, off-label medications are ofte in clinical practice.

Keywords: Seizures, Newborn, Outcome, Prognosis, Treatment

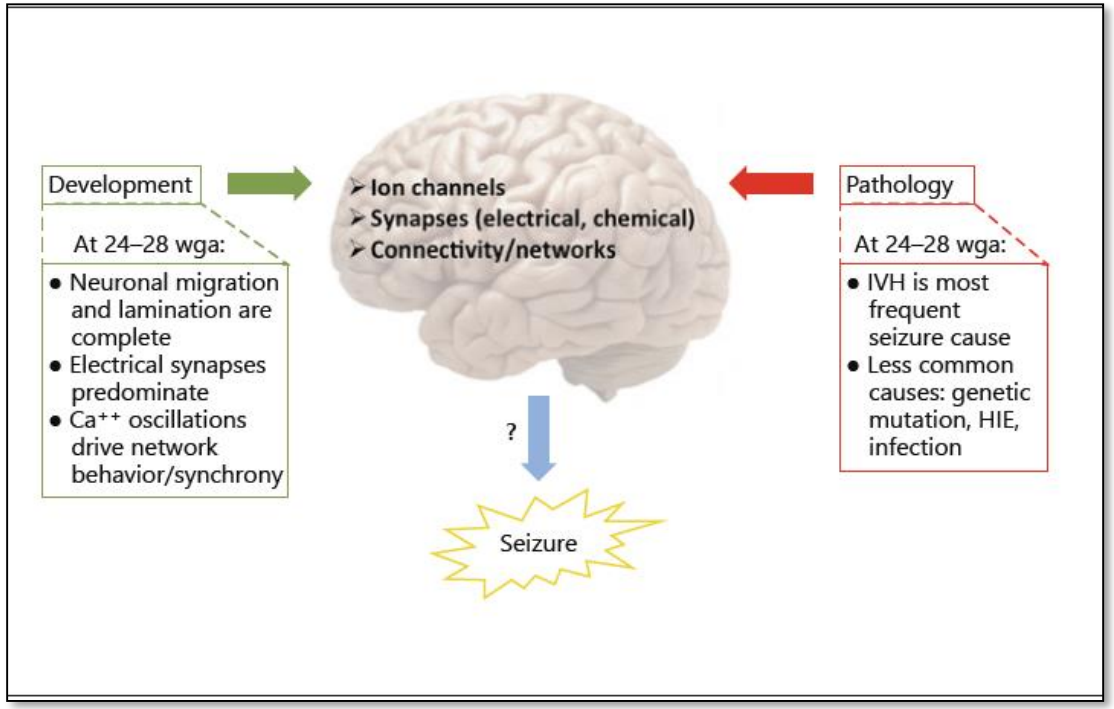
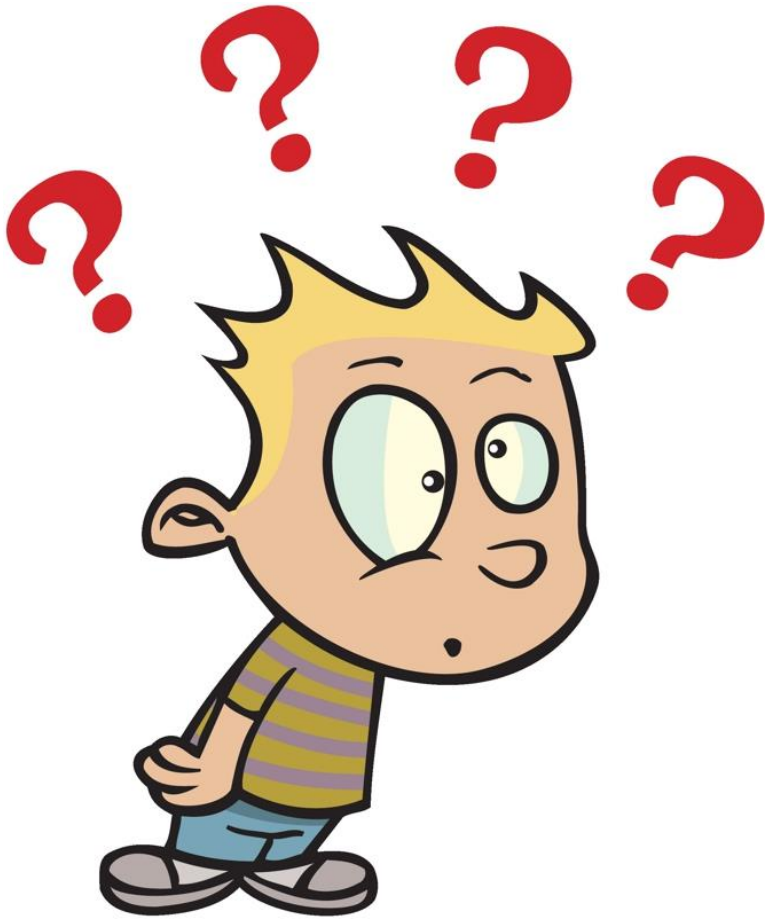


Table 1. Seizure features in extremely preterm infants that require pathophysiological explanation

Observation	Physiological correlate	Selected Ref.
Reported incidence varies	Different methods of recording, varied populations studied	5, 18, 32
Focal onset of seizures Occipital > frontal	Limited ability to propagate seizure activity Earlier maturation of occipital region	17, 18
Most seizures are subclinical (>50%) Subtle differences from normal movements Neurophysiological differences	Inadequate coupling of discharges to motor system Effects of GABAergic drugs	9, 15, 17
Shorter seizures	Limited ability to sustain seizure activity	9, 13, 17
Higher mortality	Multifactorial; sicker infants	5, 15
Delayed diagnosis	Less protocolized evaluations Sickest infants get EEGs Limited knowledge about seizures at this age Lower accuracy of aEEG	5, 27, 33
Etiology: ICH, infection > HI	Fragility of cerebral vasculature	5, 15, 53

GABA, γ-aminobutyric acid; ICH, intracerebral hemorrhage; HI, hypoxia-ischemia; EEG, electroencephalogram; aEEG, amplitude-integrated EEG.

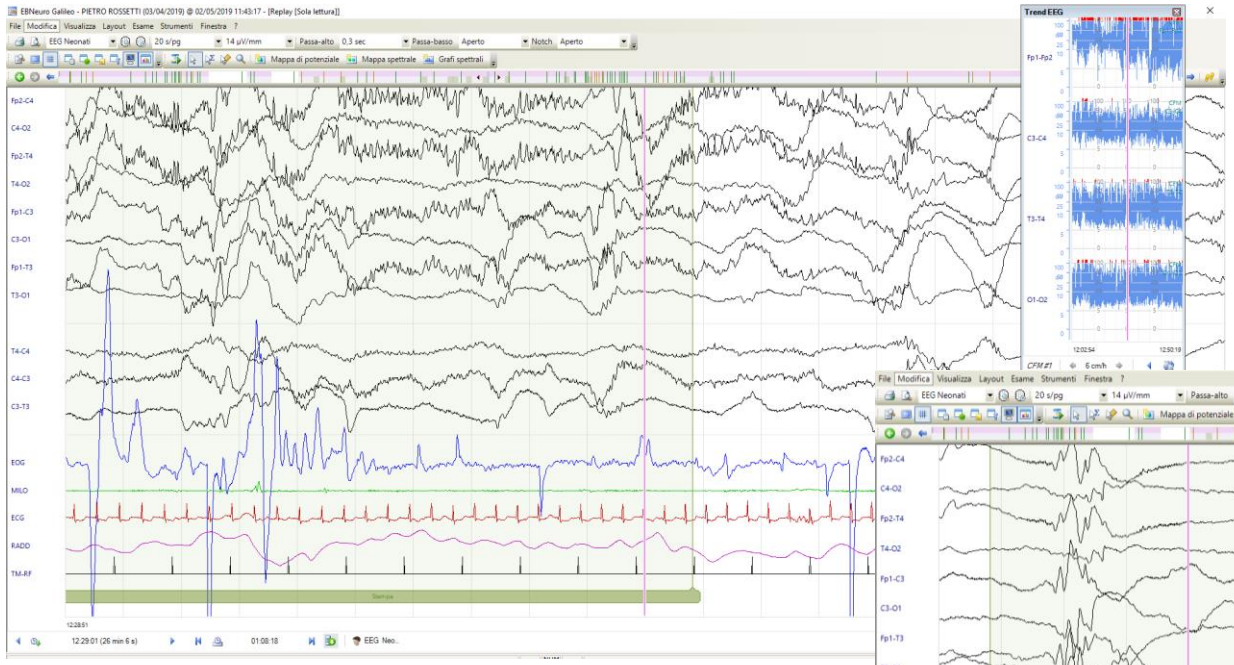
In pratica…… nel pretermine….



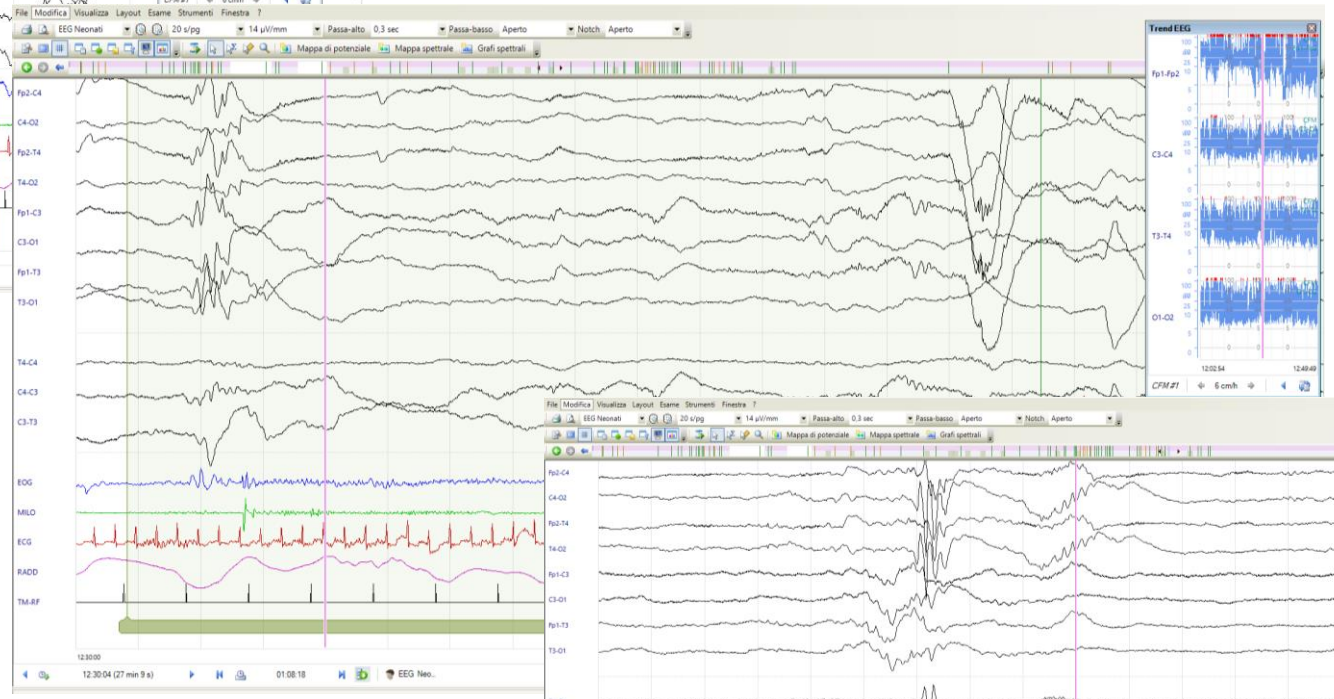
R.P. M 29 w (25 w sepsi)

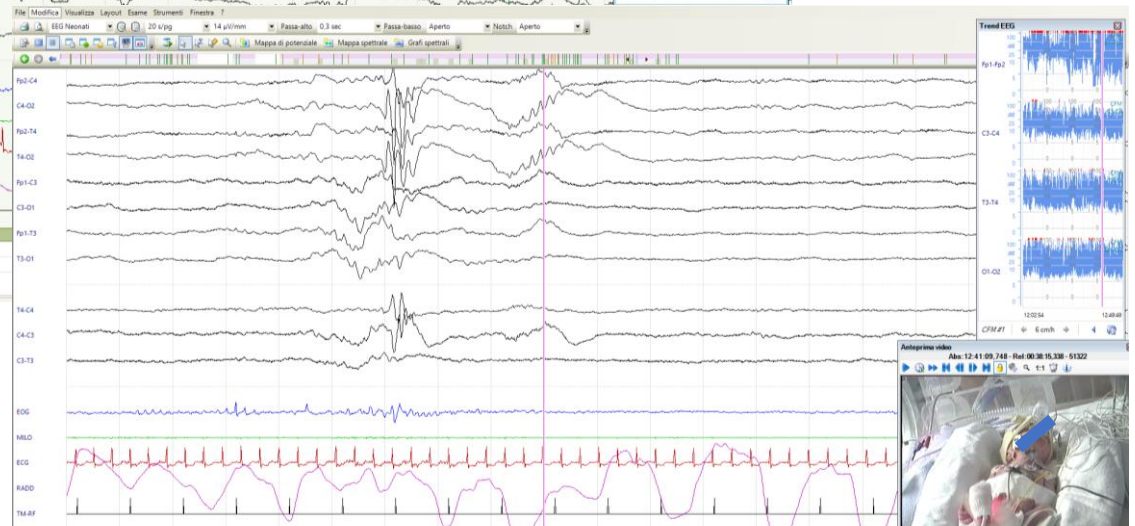
Most seizures are subclinical (>50%)
Subtle differences from normal movements
Neurophysiological differences

Inadequate coupling of discharges to motor system
Effects of GABAergic drugs



Artefatti da movimento in neonato con
Movimenti afinalistici non epilettici
Background discontinuo

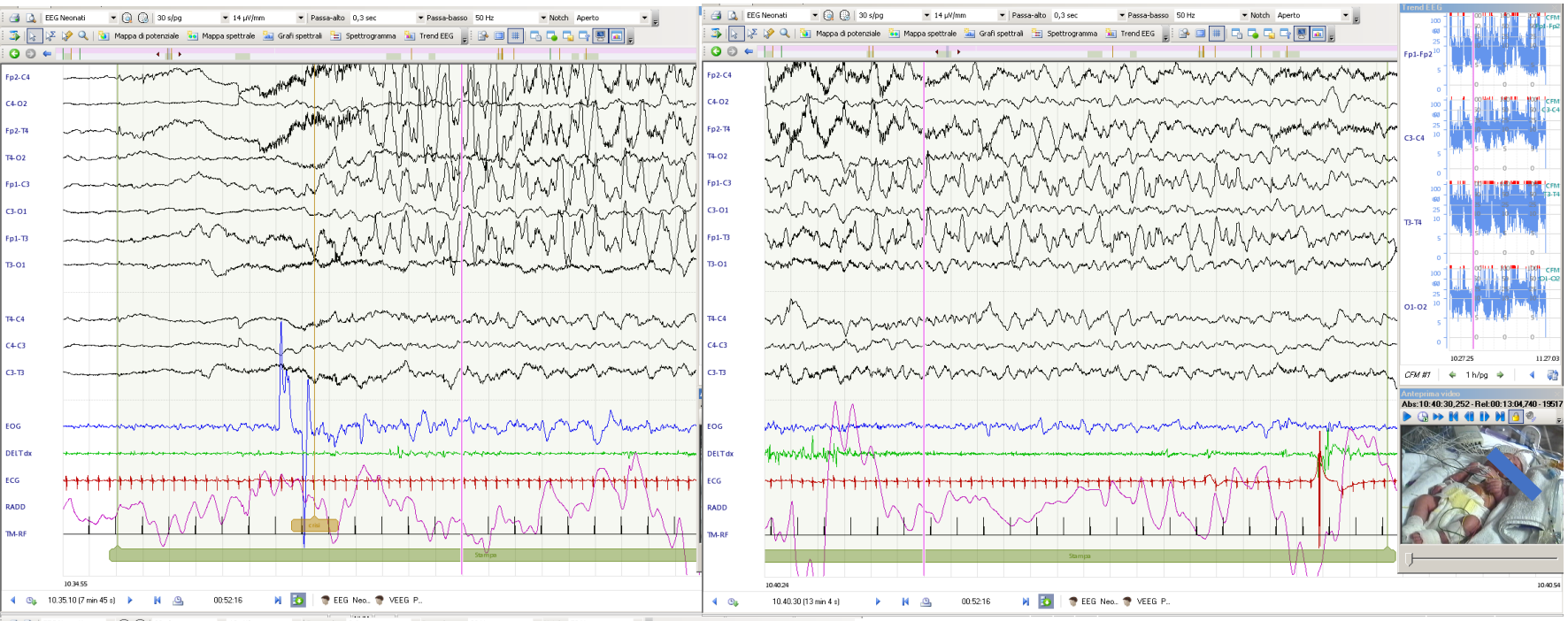




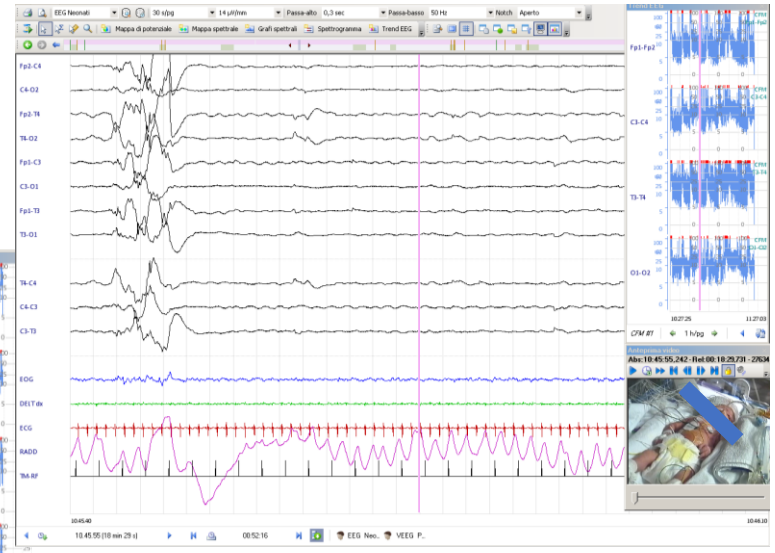
VG M 32w (28+1 w) – agenesia corpo calloso S. Othahara

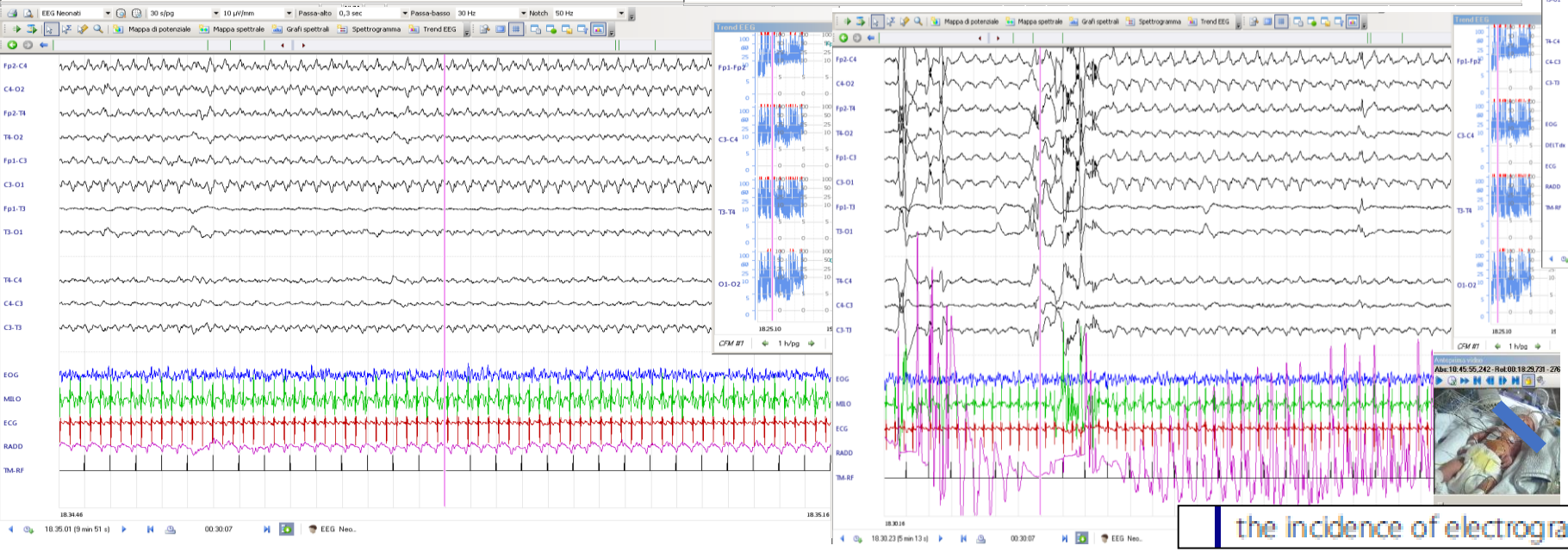
Shorter seizures

Limited ability to sustain seizure activity



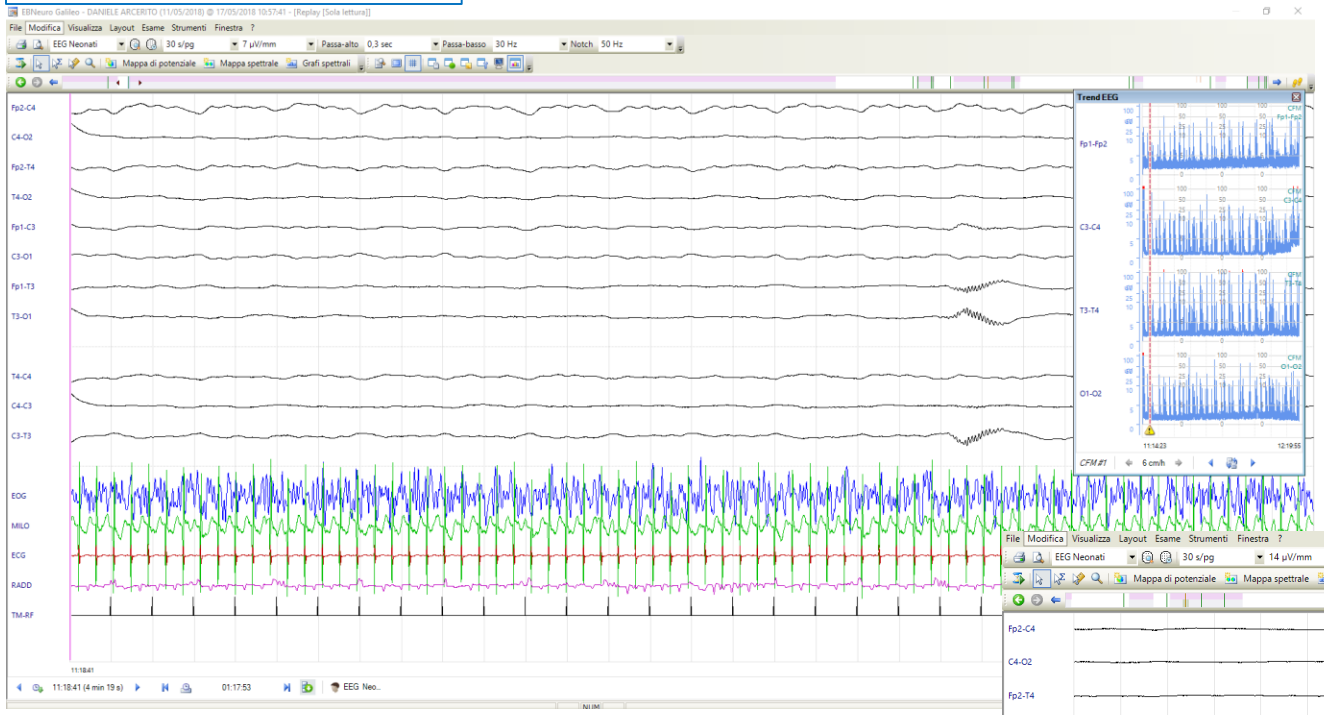
Background discontinuo non adeguato a EPM (vd aEEG)





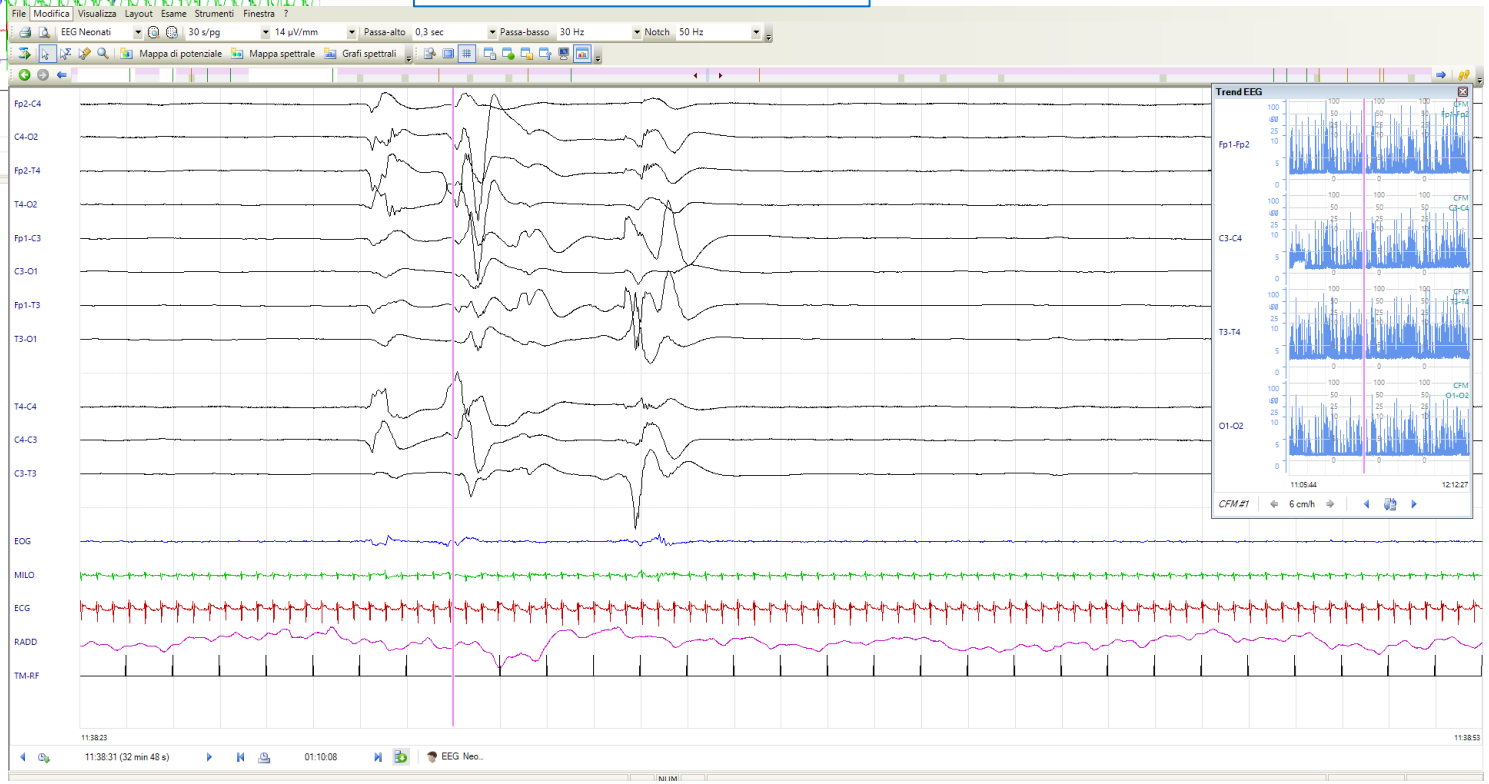
the incidence of electrographic-only seizures seems to be particularly high,

A.D. M 23 w - IVH IV°



Background discontinuo→
Ipovoltato, non adeguato a EPM (vd aEEG)

A.D. M 26 w - IVH IV°



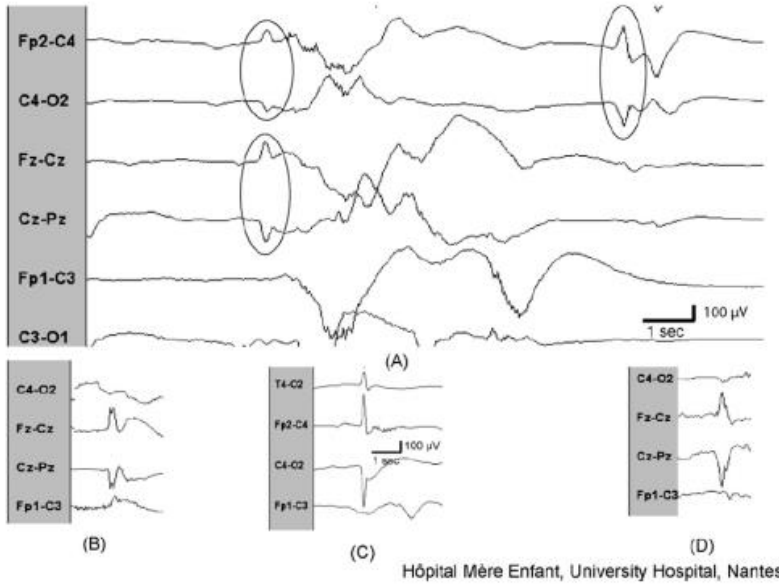


Figure 10 Samples PRS type A of various morphologies, (A): simple, low voltage PRS, (B): PRS mixed with rapid rhythms, (C): high voltage PRS, (D): hooked PRS.

Probabile correlazione con Danno della SB <34w

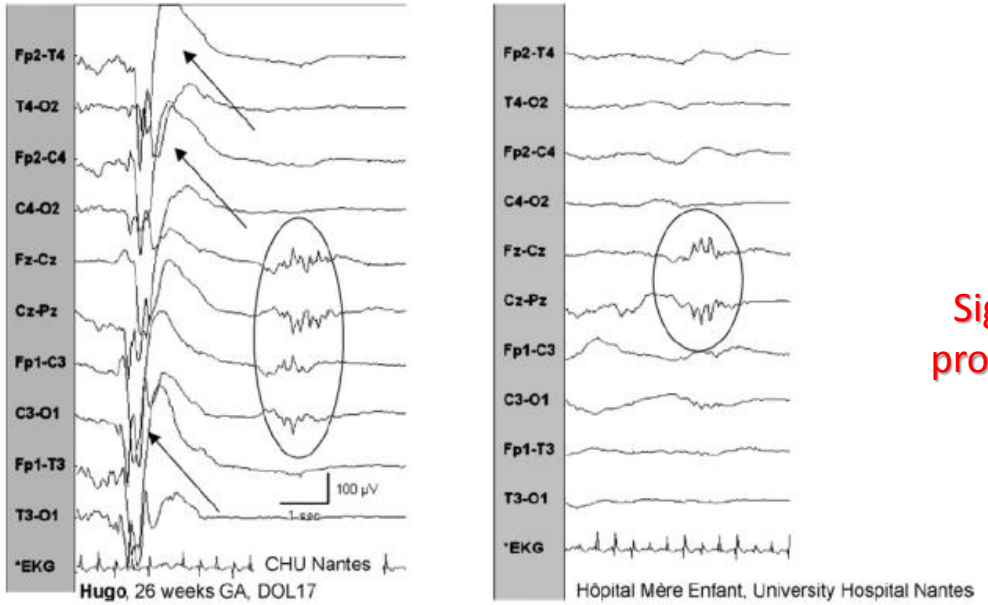


Figure 11 EEG recorded at PMA of 28 weeks + 3 days: PRS type B obvious on the median line (circles), note the deformed high-voltage frontal delta waves.

Significato prognostico? >34w

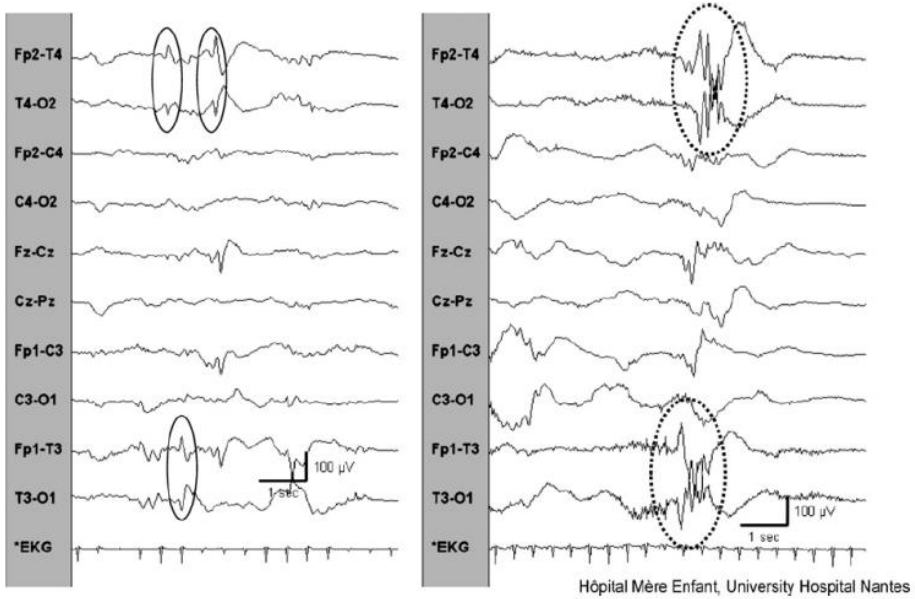


Figure 12 PTS isolated (continuous circles) or mixed with rhythmic temporal theta rhythms (dot circle).

31-33 w

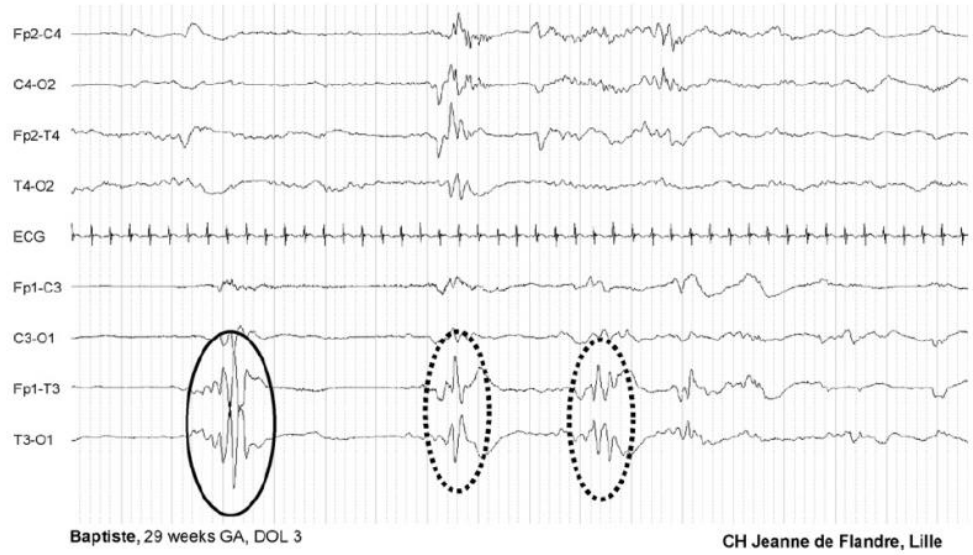
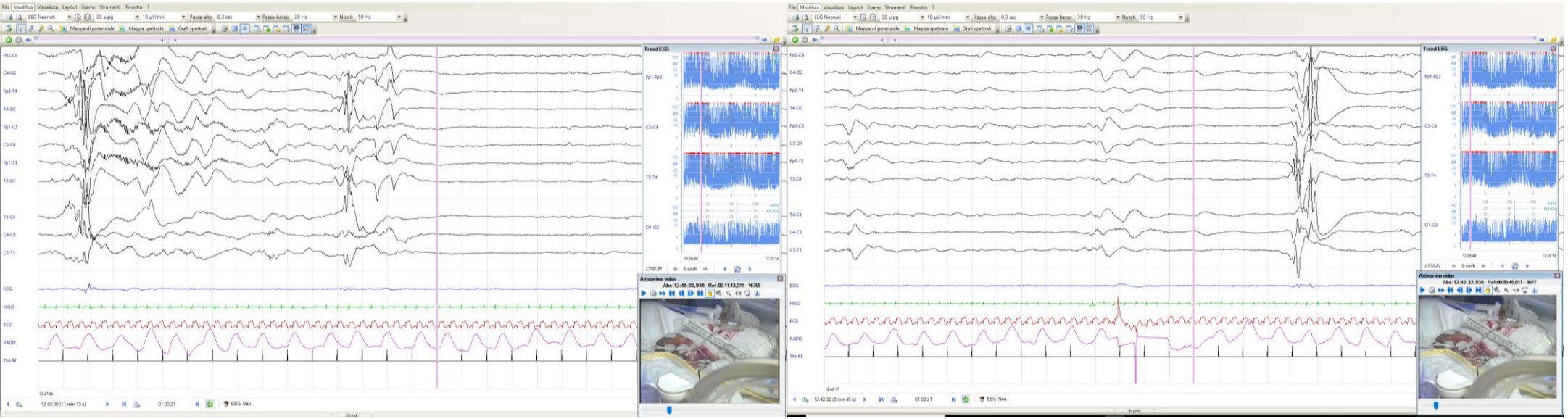


Figure 13 EEG recorded at PMA of 29 weeks + 3 days: left rhythmic temporal theta rhythms (continuous circle) followed by two left positive PTS (dot circle).

R.M. M 27 w IVH III°



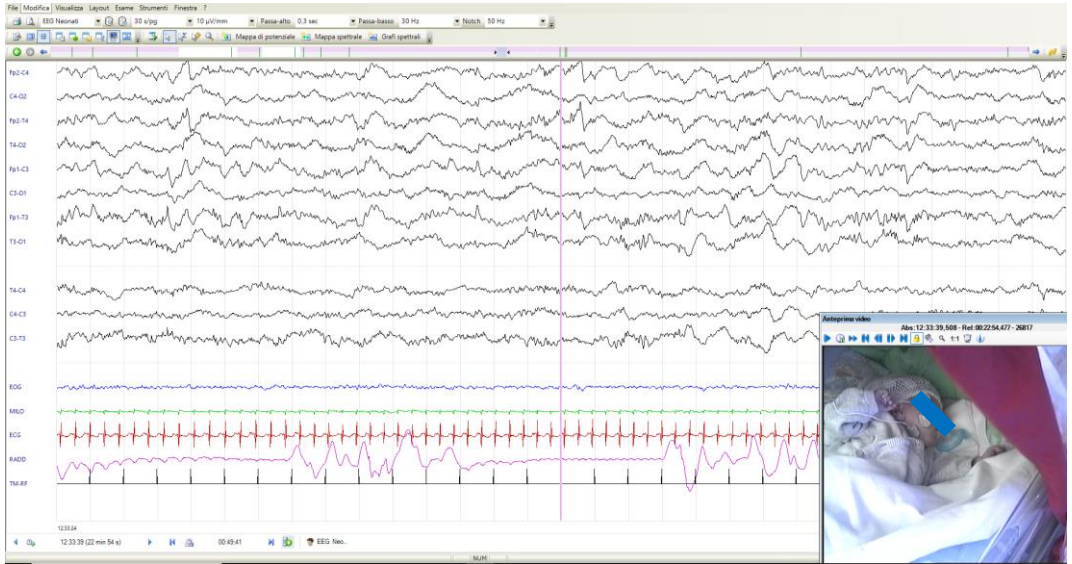
Background discontinuo (IBI e bursts) consono a 27w, Vd aEEG

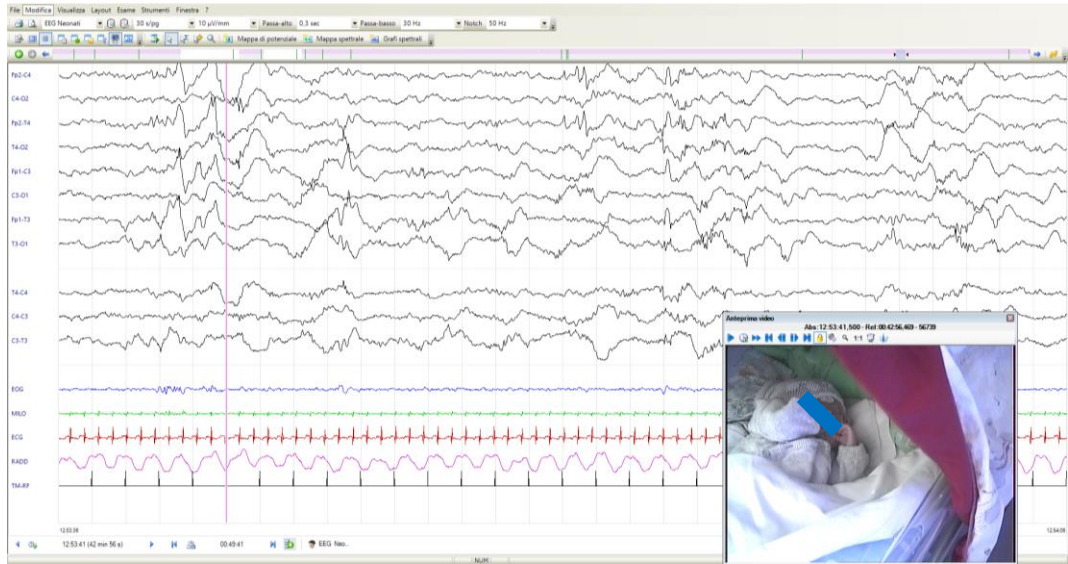
Background discontinuo (IBI e bursts) consono a 27w, Vd aEEG

R.M. M 40+6 w (IVH III°)

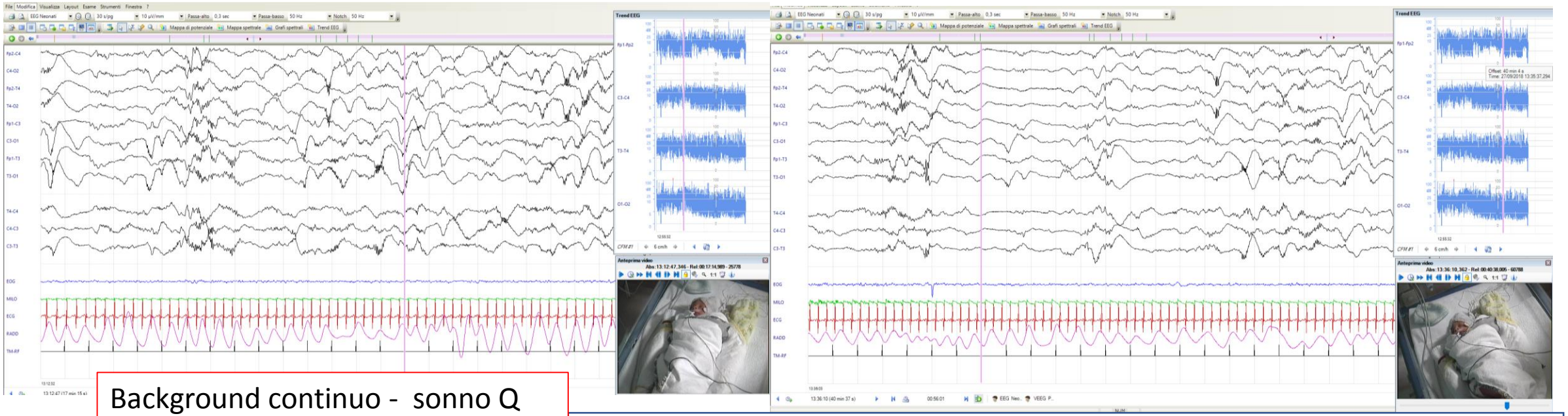
Background continuo con fasi sonno consono a EPM

(onde lente posteriori sn verosimile artefatto da posizione)





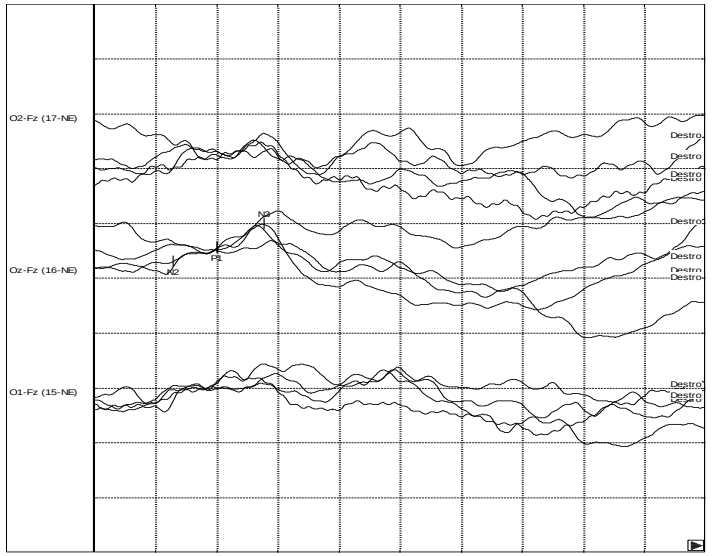
F.A. M 33+3 w (29 w EG LVP)

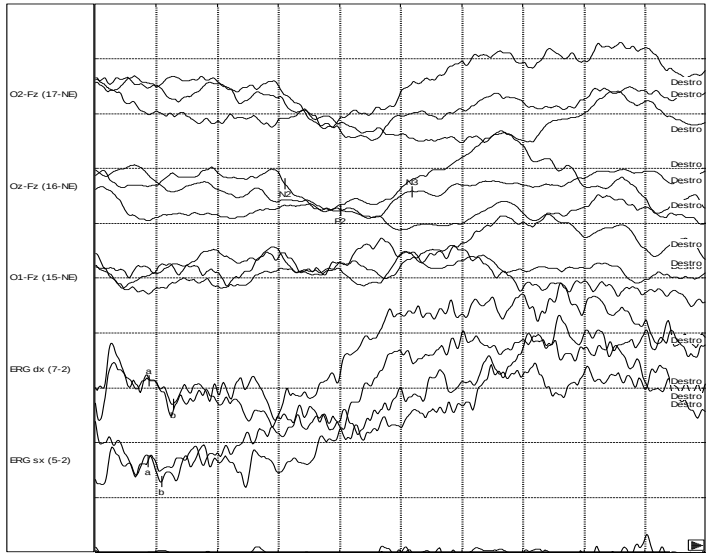


Background continuo - sonno Q consono a 33w, Vd aEEG

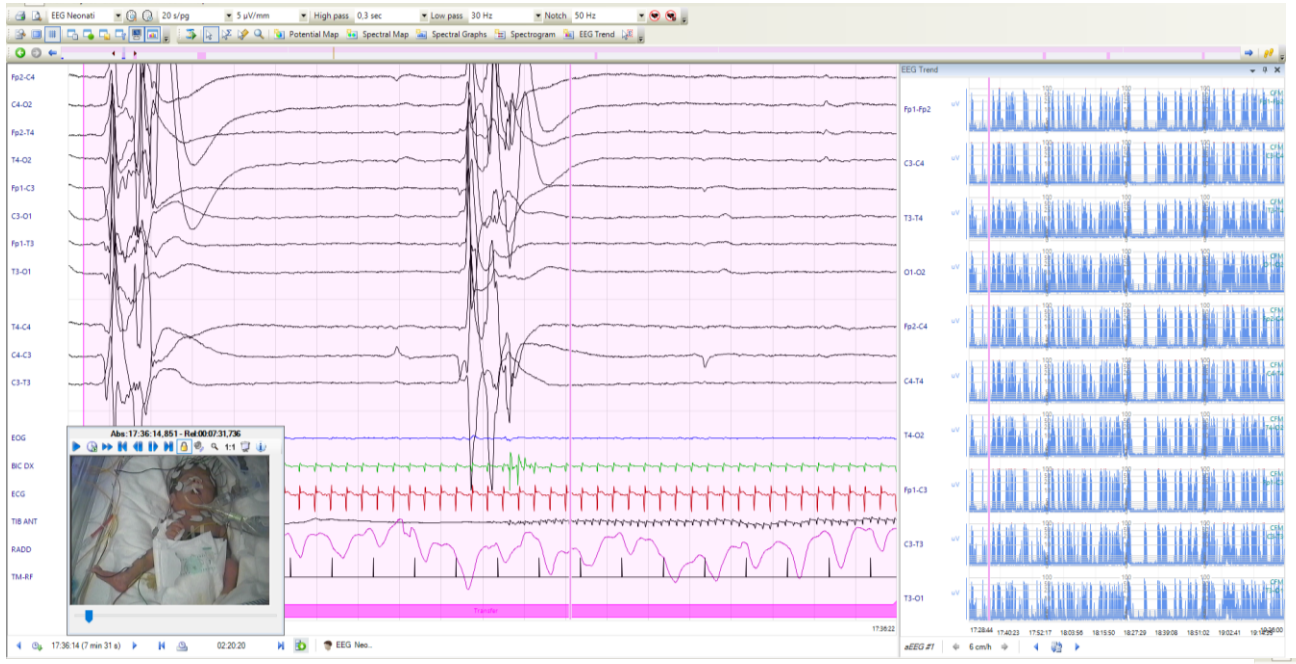
PEV – PEV+ERG a 33 e 35 w

PEV nei limiti della norma

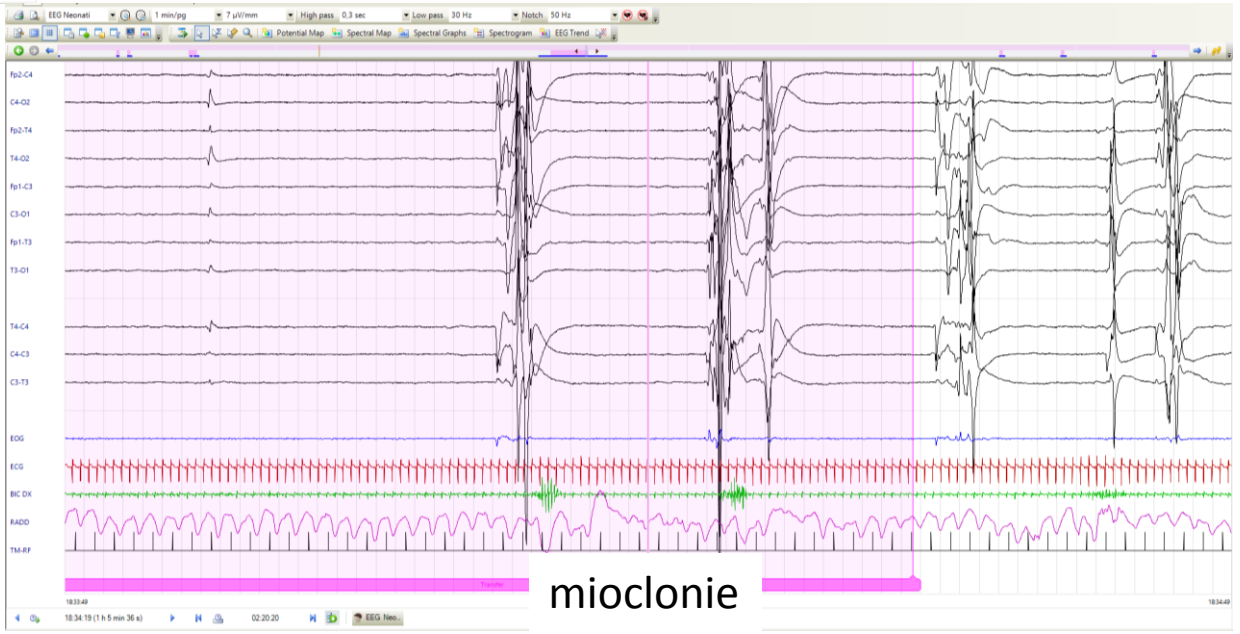




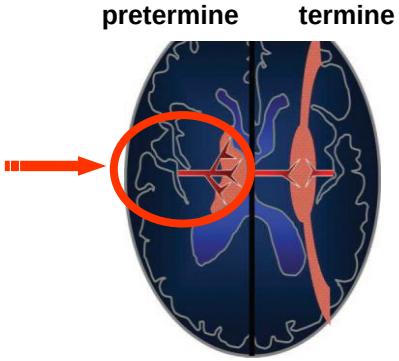
C.M.. M 27+4 w - 29 w EME



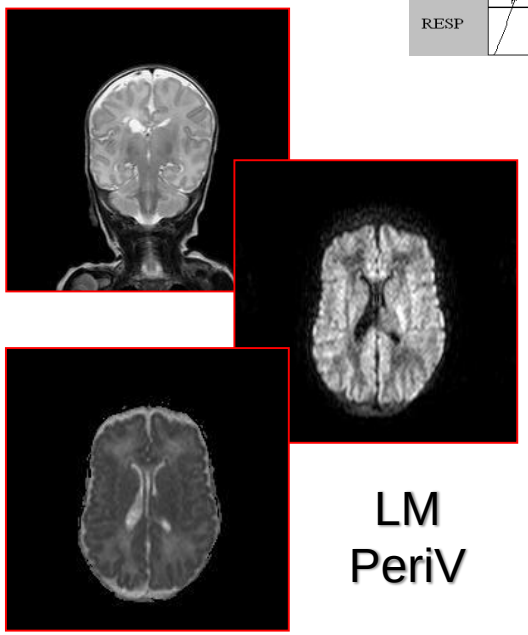
Background Suppression Burst
(IBI prolungate e bursts patologiche)
Vd aEEG



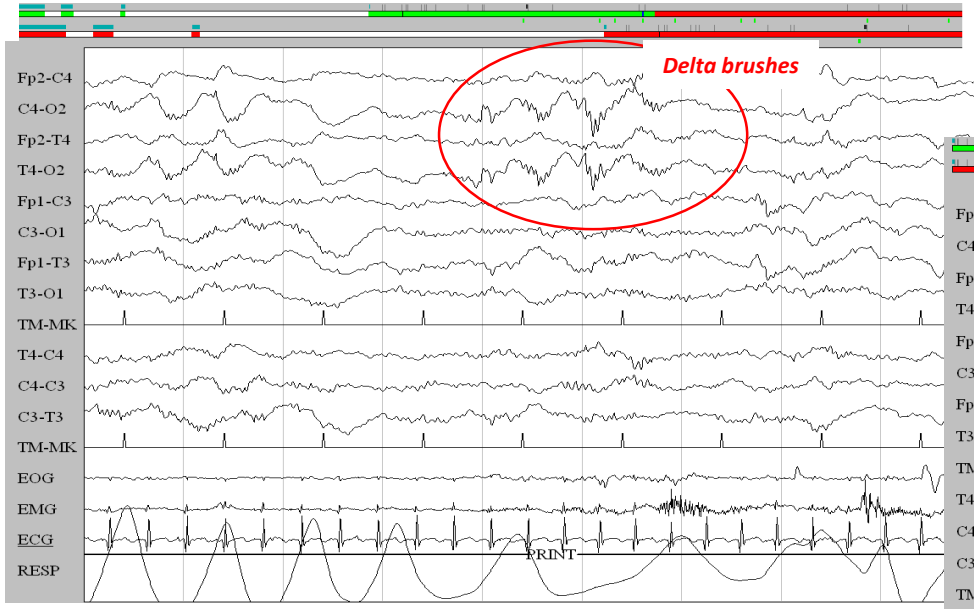
mioclonie



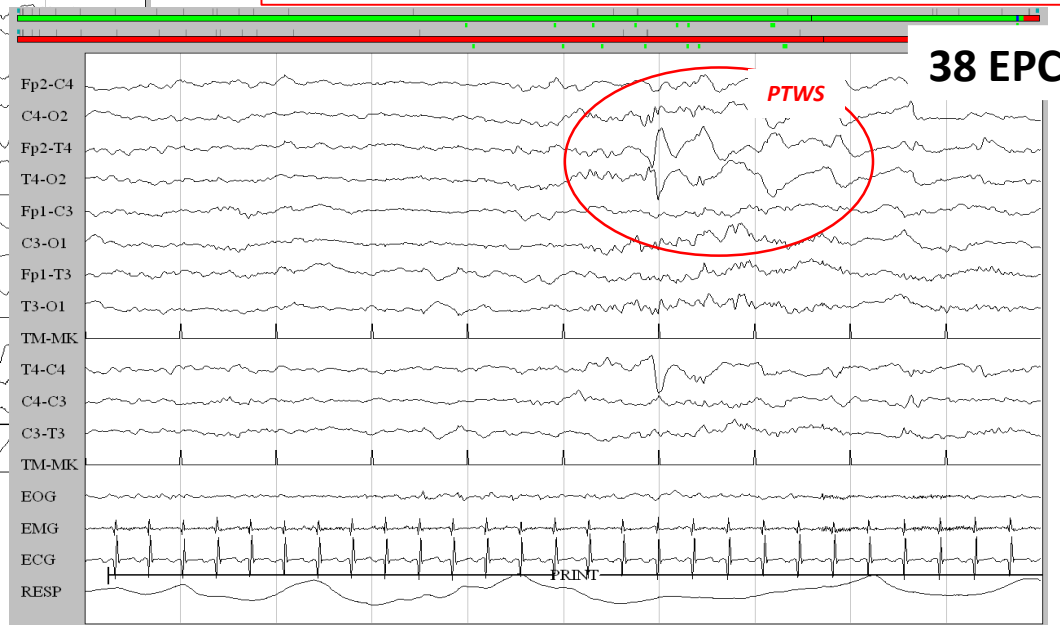
T.E. ♀
28 EG



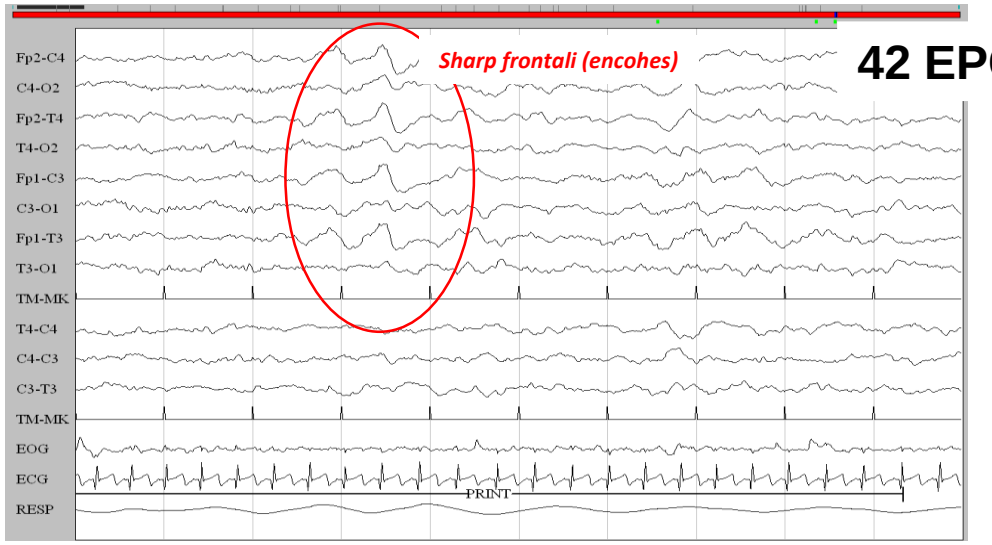
LM
PeriV



Background continuo – asimmetrico
Elementi non consoni a EPM in progressione maturativa



Background continuo
– netta riduzione asimmetria –
in progressione maturativa ma
«indietro» rispetto a EPM



Pathological features of neonatal EEG in preterm babies born before 30 weeks of gestationnal age

S. Nguyen The Tich et al.

Neurophysiologie Clinique/Clinical Neurophysiology (2007) **37**, 325—370

3.1. Moderate abnormalities

These are diagnosed when one or more of the following characteristics is noted:

- immature EEGs for the PMA (when the patterns are those of a normal child at least 2 weeks younger);
- generalized low voltage with normal background activity;
- low voltage or persistent asymmetry <50%;
- excessive asynchrony for age;
- poorly-developed occipital delta with preservation of characteristic patterns of PMA.

3.2. Major EEG abnormalities

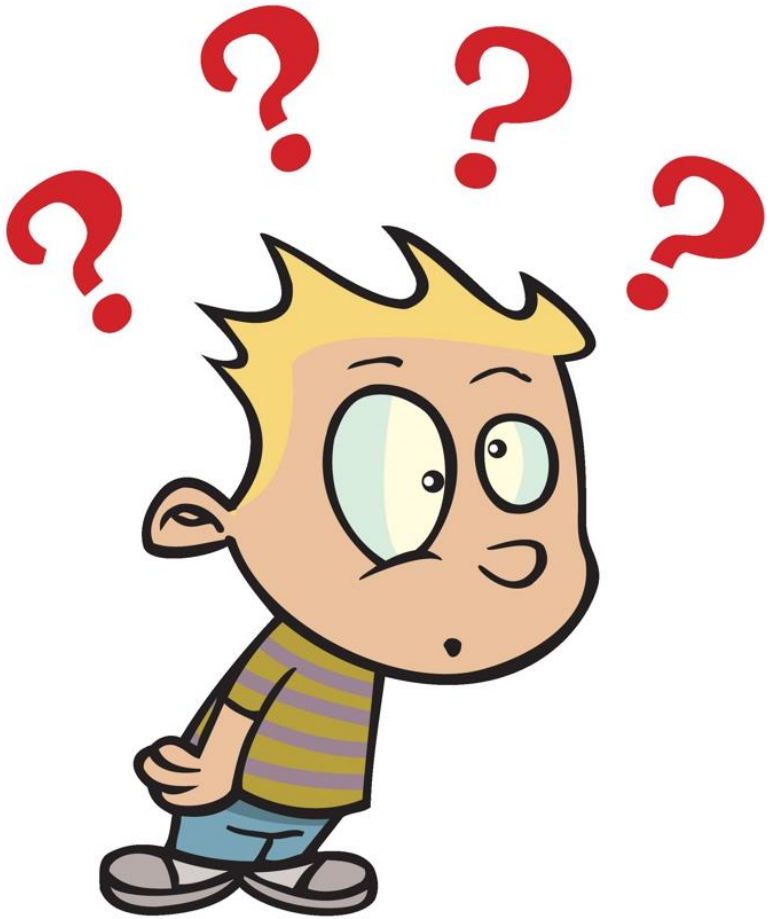
These are considered when one or more of the following characteristics is noted:

- isoelectric tracing;
- positive rolandic sharp waves;
- ictal discharges;
- paroxysmal tracing (periodic burst of abnormal cerebral activity on an isoelectric background not affected by stimuli and persistent throughout the entire recording);
- interhemispheric asynchrony;
- persistent asymmetry >50%;

Table 2 Grades of acute-stage abnormalities [67].

Continuity	Frequency	Voltage
Grade I Prolonged interburst interval	Attenuated beta/alpha/theta	
Grade II		Mildly low voltage Delta voltage <200 μV
Grade III Decreased continuous pattern Continuous period of activity >20 s less than 10% of the whole recording		
Grade IV Absent continuous pattern. No sleep states cycling	Delta activity only	Moderately low voltage. Most between 20 and 50 μV, rare waves between 50 and 100 μV
Grade V		Very low voltage/flat

In pratica…… nel neonato a termine ….

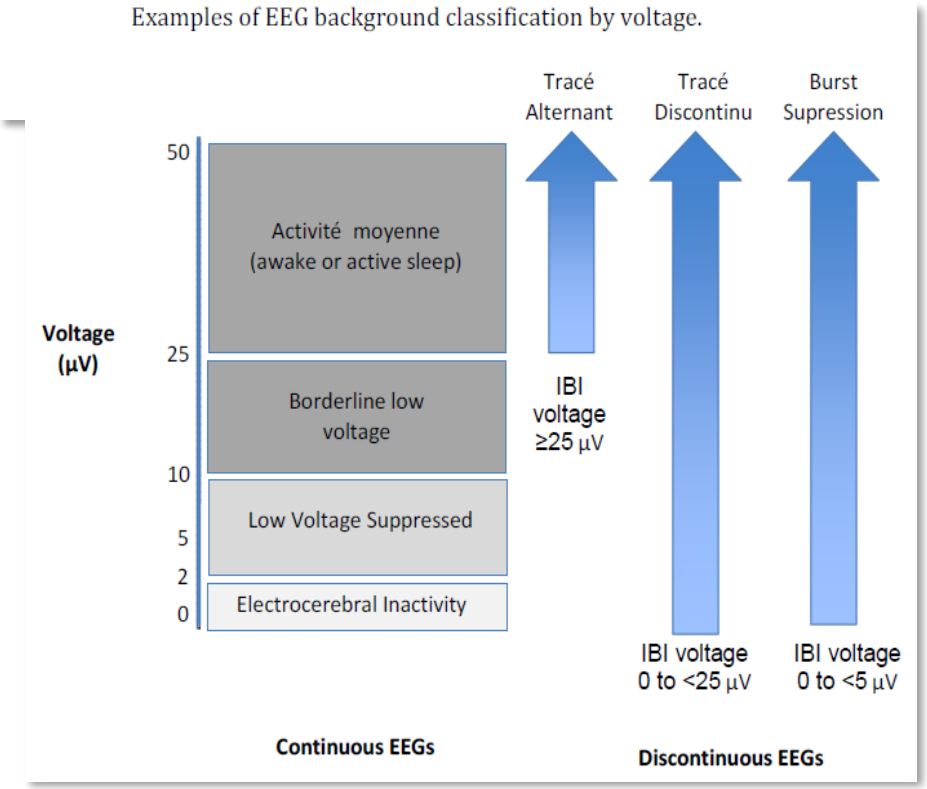


ACNS Standardized EEG Terminology and Categorization for the Description of Continuous EEG Monitoring in Neonates
Report of the American Clinical Neurophysiology Society
Critical Care Monitoring Committee

EEG BACKGROUND

- Continuity
  - Normal Continuity
  - Normal Discontinuity
  - Excessive Discontinuity
  - Burst Suppression
- Symmetry
- Synchrony
- Voltage
  - Normal voltage
  - Borderline low voltage
  - Abnormally low voltage
    - Low Voltage Suppressed
    - Electrocerebral inactivity
- Variability
- Reactivity
- Dysmaturity

Examples of EEG background classification by voltage.



aEEG

Continuo
Modulato (S-W)
Span è contenuto (>5<25)

NORMAL GRAPHOELEMENTS

- Monorhythmic Delta Activity
- Delta Brushes
- Rhythmic Temporal Theta
- Anterior Dysrhythmia
- Encoches Frontales

EEG TRANSIENT PATTERNS

- Negative Sharp Wave Transients
  - Physiologic Negative Sharp Waves
  - Abnormal Negative Sharp Waves
- Positive Sharp Transients
- Brief Rhythmic Discharges (BRD)

RHYTHMIC AND PERIODIC PATTERNS OF UNCERTAIN SIGNIFICANCE

- Pattern
  - Periodic discharges (PD)
  - Rhythmic delta activity (RDA)
- Duration
- Location
  - Lateralized (L)
    - Focal
    - Hemispheric- left (LH), right (RH)
    - Bilateral asymmetric
  - Diffuse (D)
  - Bilateral Independent (BI)
  - Multifocal (Mf)
- Modifiers (subset of ACNS Standardized Critical Care EEG Terminology 2012)
  - Duration
  - Polarity
  - Sharpness

. Examples illustrating the contrasts between tracé discontinu, tracé alternant, excessive discontinuity, and burst suppression. EEG tracings courtesy of Clancy, RR and Wusthoff, CJ. Brain monitoring: Normal Neonatal EEG. Moberg Multimedia. Ambler, PA. 2011.

EEG BACKGROUND

- Continuity
  - Normal Continuity
  - Normal Discontinuity
  - Excessive Discontinuity
  - Burst Suppression

Figure 2b. In this example of tracé alternant, however, there is an alternating pattern of high and low voltages, but no periods that are consistently suppressed. There are no artifacts from EMG activity or movement and the respiratory pattern is quite regular.

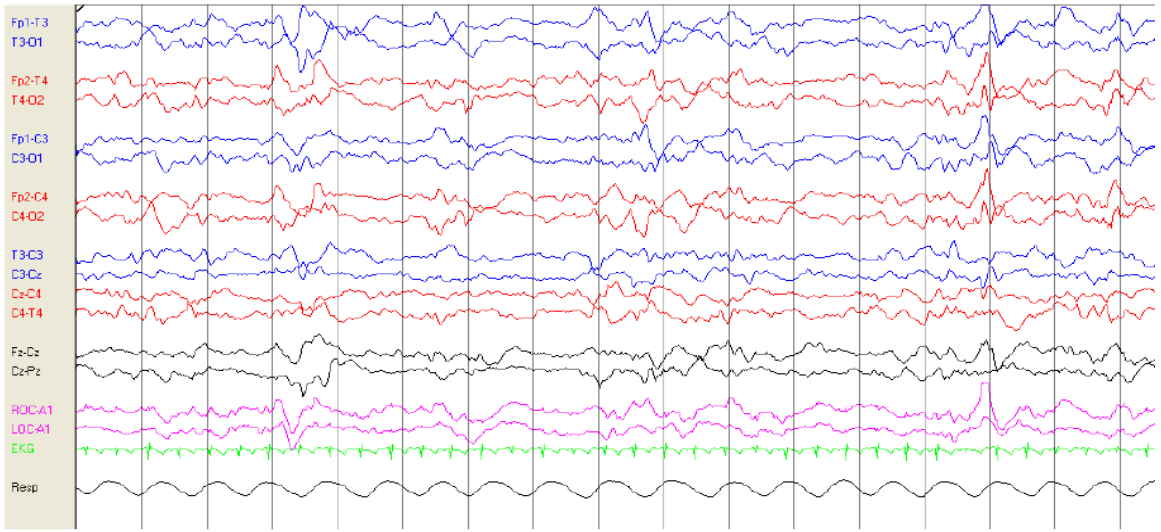


Figure 2a. In tracé discontinu the bursts are separated by very low voltage, suppressed interburst intervals. There are no artifacts from EMG activity or movement and the respiratory pattern is quite regular.

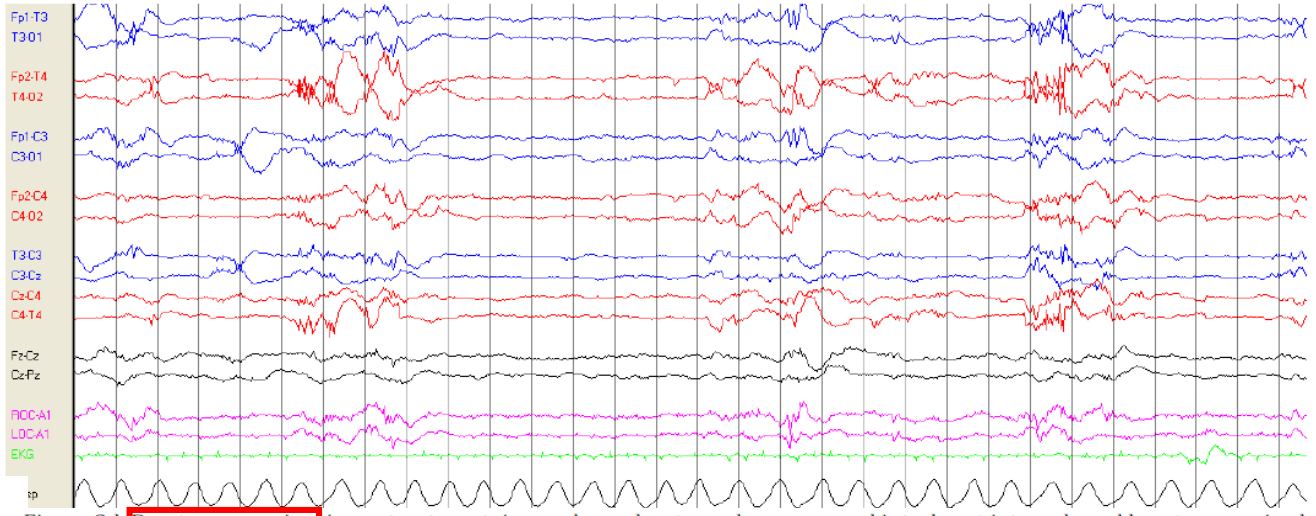


Figure 2c. This excessively discontinuous record from a term infant with an acute encephalopathy shows prolonged interburst intervals, though with some normal features present during bursts, such as the conspicuous encoche frontale seen near its onset (arrow).

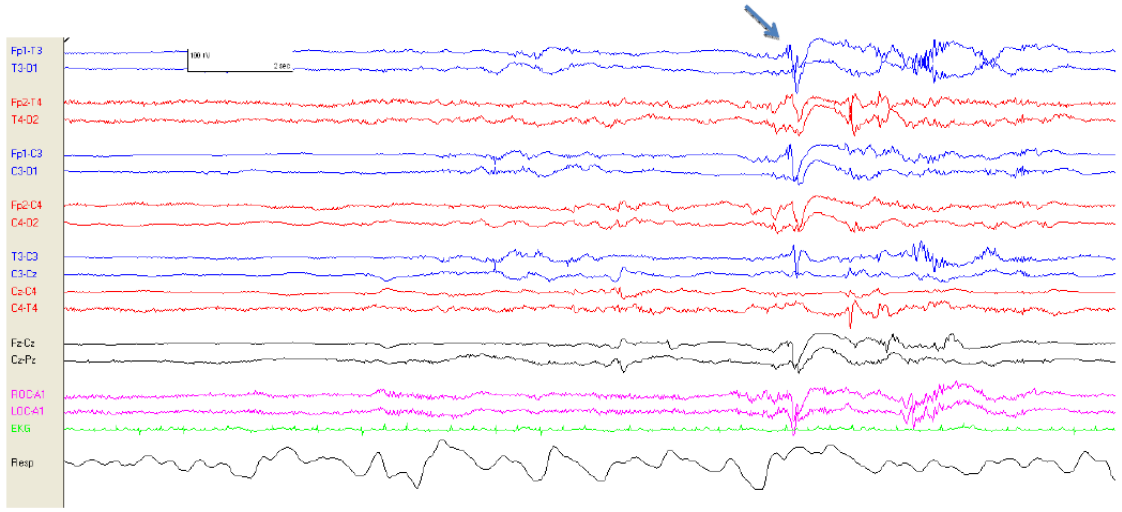
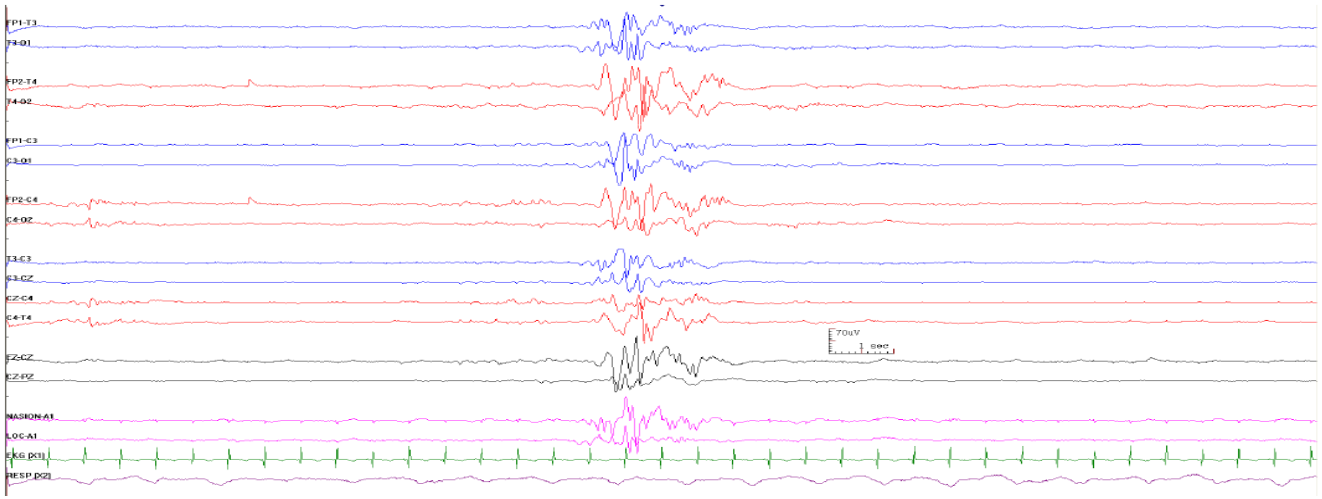
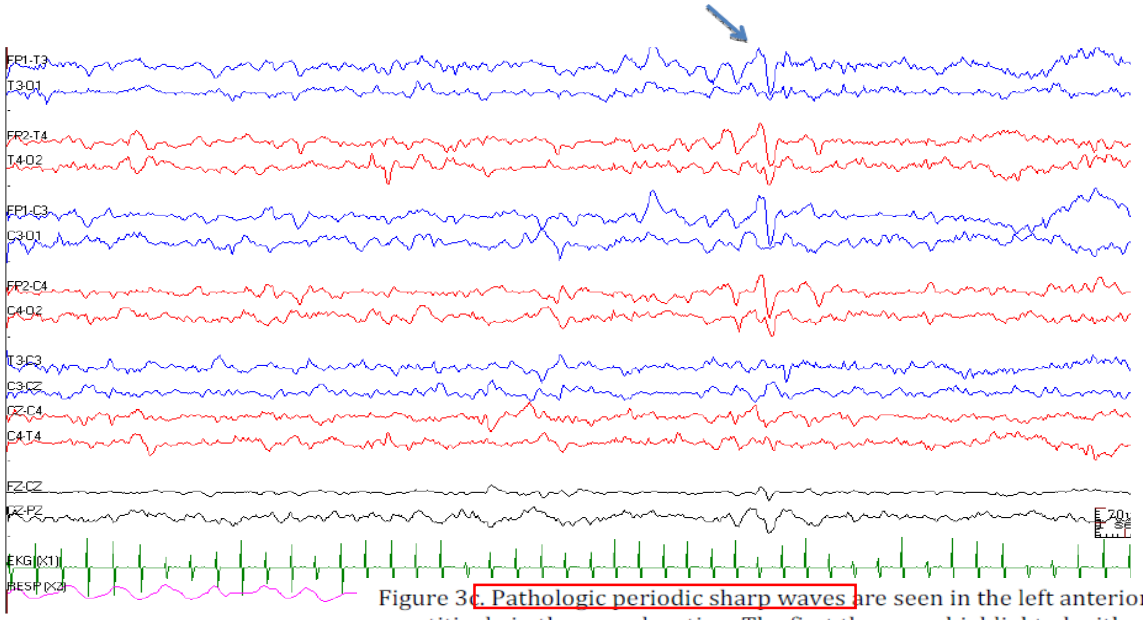


Figure 2d. Burst suppression, in contrast, contains prolonged, extremely suppressed interburst intervals and bursts comprised exclusively of abnormal electrical activity.



Examples illustrating the contrasts between encoches frontales, physiologic sharp waves, and pathologic sharp waves.

Figure 3a. Encoches frontales are present and synchronous in both frontal regions.



NORMAL GRAPHOELEMENTS

- Monorhythmic Delta Activity
- Delta Brushes
- Rhythmic Temporal Theta
- Anterior Dysrhythmia
- Encoches Frontales

Figure 3b. A physiologic sharp wave is seen in the 13th second on this page, in the right mid-temporal region (T4).

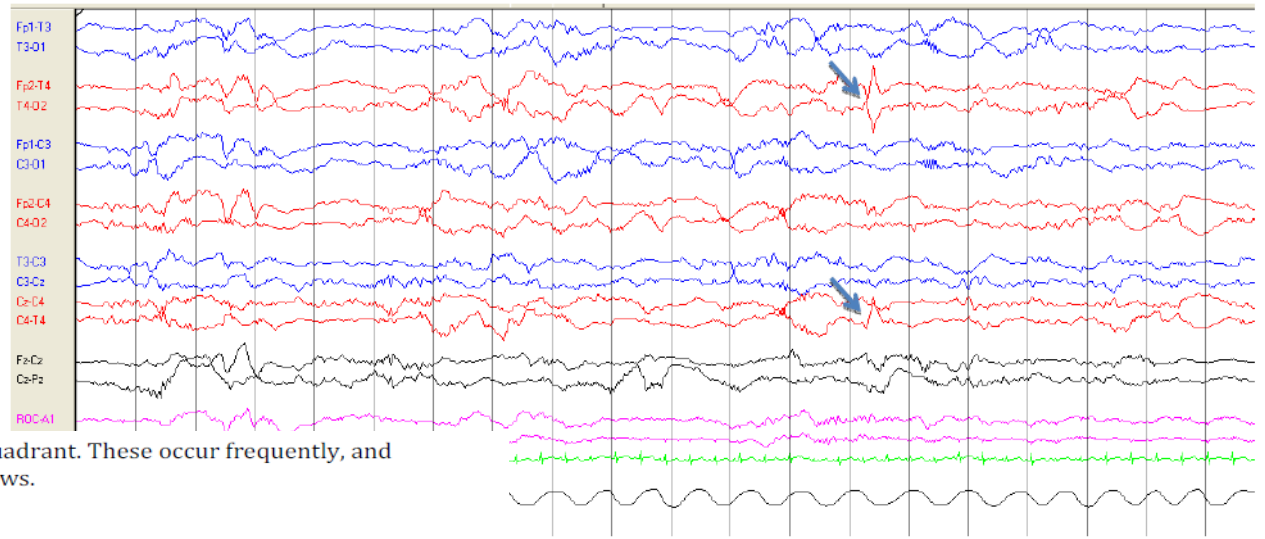
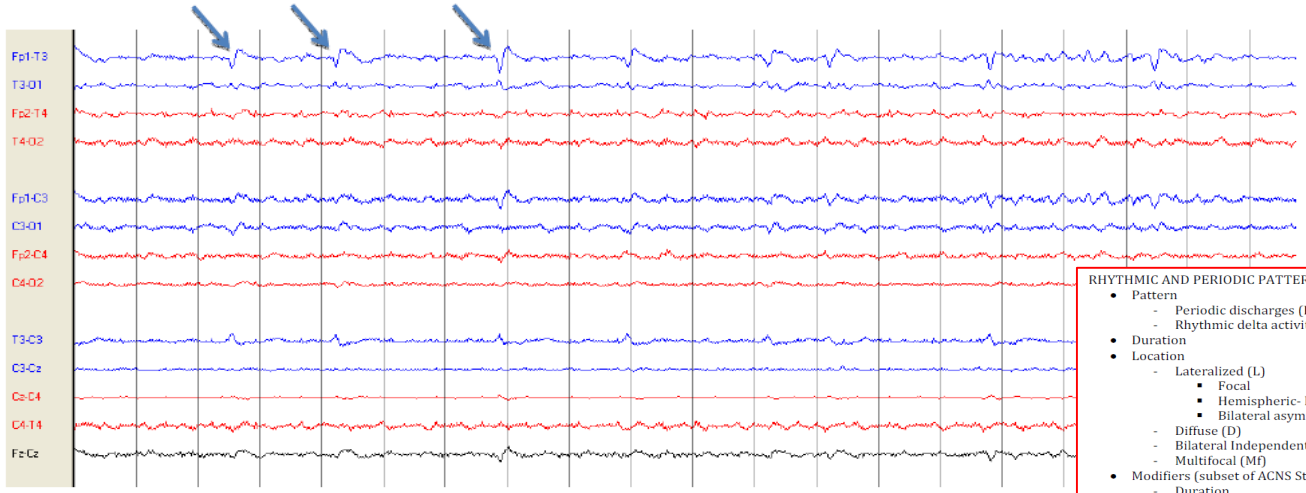


Figure 3c. Pathologic periodic sharp waves are seen in the left anterior quadrant. These occur frequently, and repetitively in the same location. The first three are highlighted with arrows.



RHYTHMIC AND PERIODIC PATTERNS OF UNCERTAIN SIGNIFICANCE

- Pattern
  - Periodic discharges (PD)
  - Rhythmic delta activity (RDA)
- Duration
- Location
  - Lateralized (L)
    - Focal
    - Hemispheric- left (LH), right (RH)
    - Bilateral asymmetric
  - Diffuse (D)
  - Bilateral Independent (BI)
  - Multifocal (Mf)
- Modifiers (subset of ACNS Standardized Critical Care EEG Terminology 2012)
  - Duration
  - Polarity

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Benign and severe early-life seizures: a round in the first year of life

Piero Pavone[1*], Giovanni Corsello[2], Martino Ruggieri[1], Silvia Marino[3], Simona Marino[3] and Raffaele Falsaperla[3]

Abstract

Background: At the onset, differentiation between abnormal non-epileptic movements, and epileptic seizures presenting in early life is difficult as is clinical diagnosis and prognostic evaluation of the various seizure disorders presenting at this age. Seizures starting in the first year of life including the neonatal period might have a favorable course, such as in infants presenting with benign familial neonatal epilepsy, febrile seizures simplex or acute symptomatic seizures. However, in some cases, the onset of seizures at birth or in the first months of life have a dramatic evolution with severe cerebral impairment. Seizure disorders starting in early life include the "epileptic encephalopathies", a group of conditions characterized by drug resistant seizures, delayed developmental skills, and intellective disability. This group of disorders includes early infantile epileptic encephalopathy also known as Ohtahara syndrome, early myoclonic encephalopathy, epilepsy of infancy with migrating focal seizures, infantile spasms syndrome (also known as West syndrome), severe myoclonic epilepsy in infancy (also known as Dravet syndrome) and, myoclonic encephalopathies in non-progressive disorder.

Here we report on seizures manifesting in the first year of life including the neonatal period. Conditions with a benign course, and those with severe evolution are presented. At this early age, clinical identification of seizures, distinction of each of these disorders, type of treatment and prognosis is particularly challenging.

The aim of this report is to present the clinical manifestations of each of these disorders and provide an updated review of the conditions associated with seizures in the first year of life.

Keywords: Infantile epilepsy, Epileptic encephalopathies, Early onset seizures, Seizures

M.B. M 40+4 w Crisi

Background continuo, vd aEEG –modulato-

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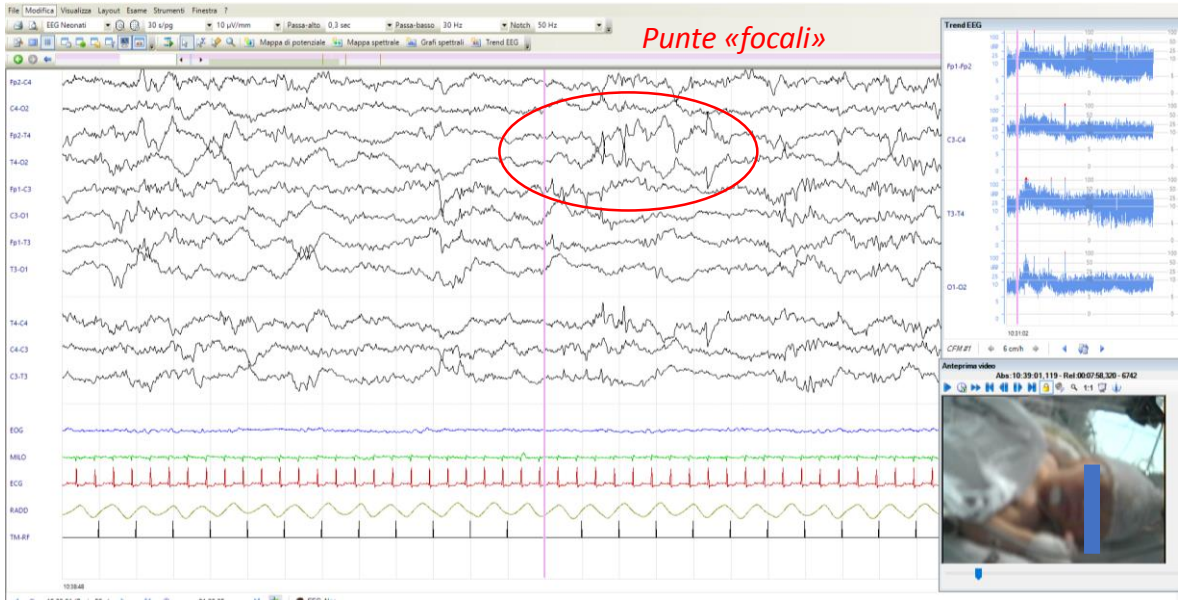
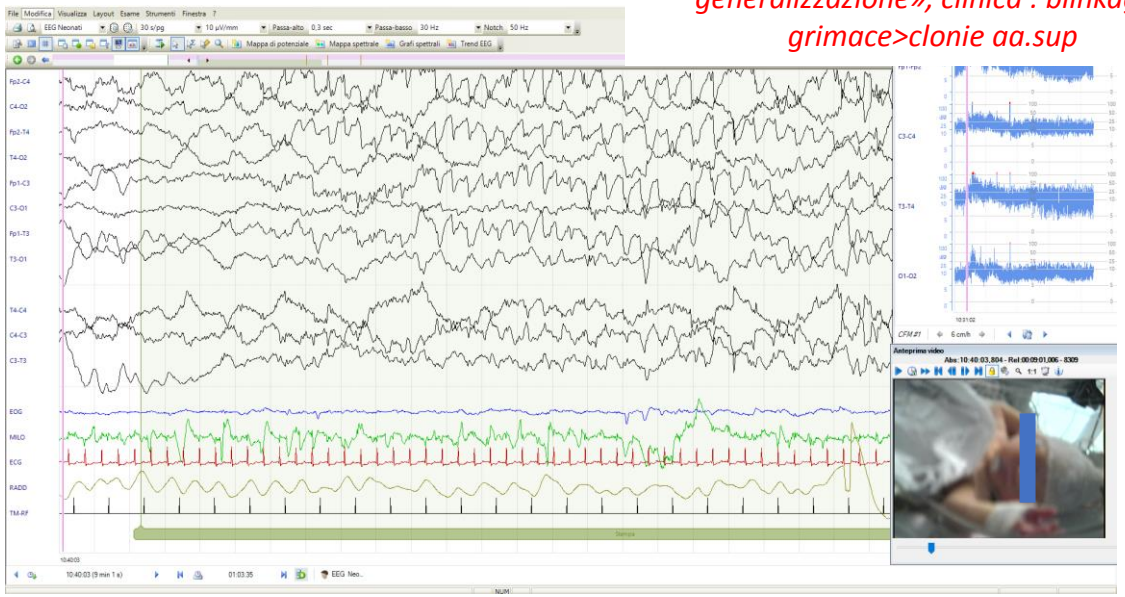
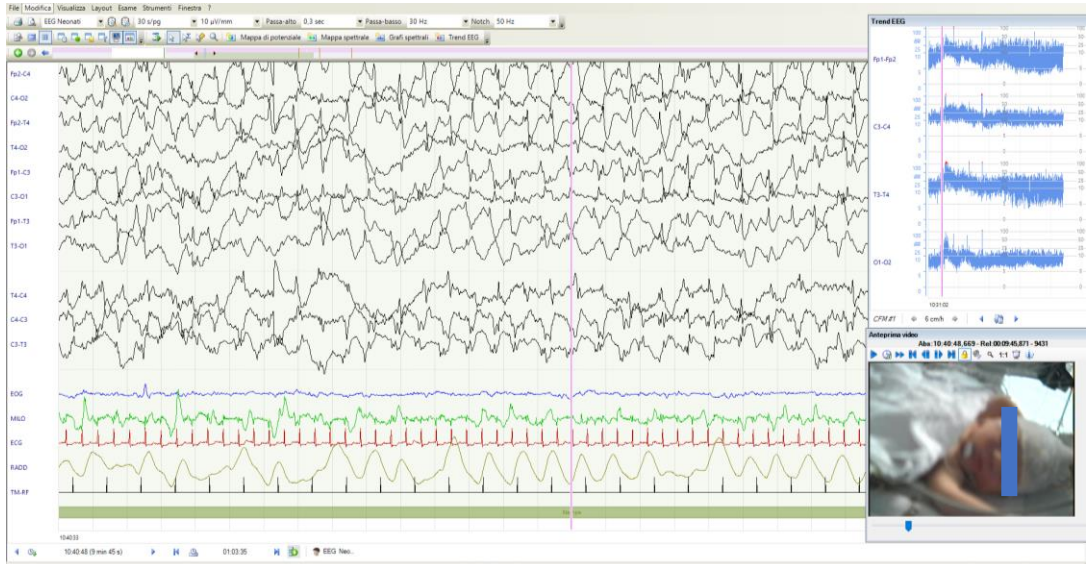
Benign and severe early-life seizures: a round in the first year of life

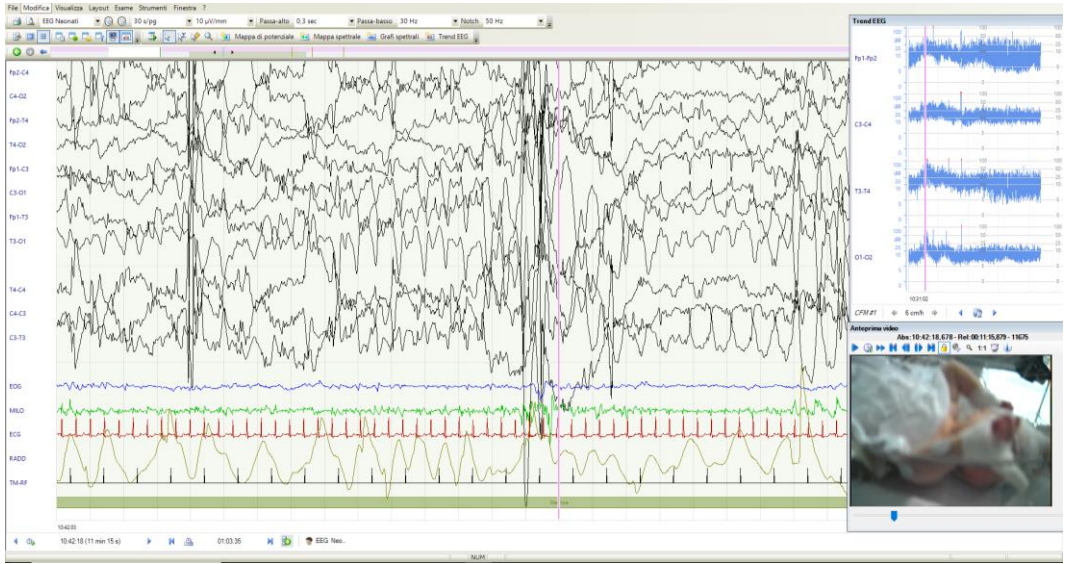
Punte «focali»



Crisi elettrica «bi-focale con succesiva generalizzazione», clinica : blinkage> grimace>clonie aa.sup







M.B. M 2 mesi

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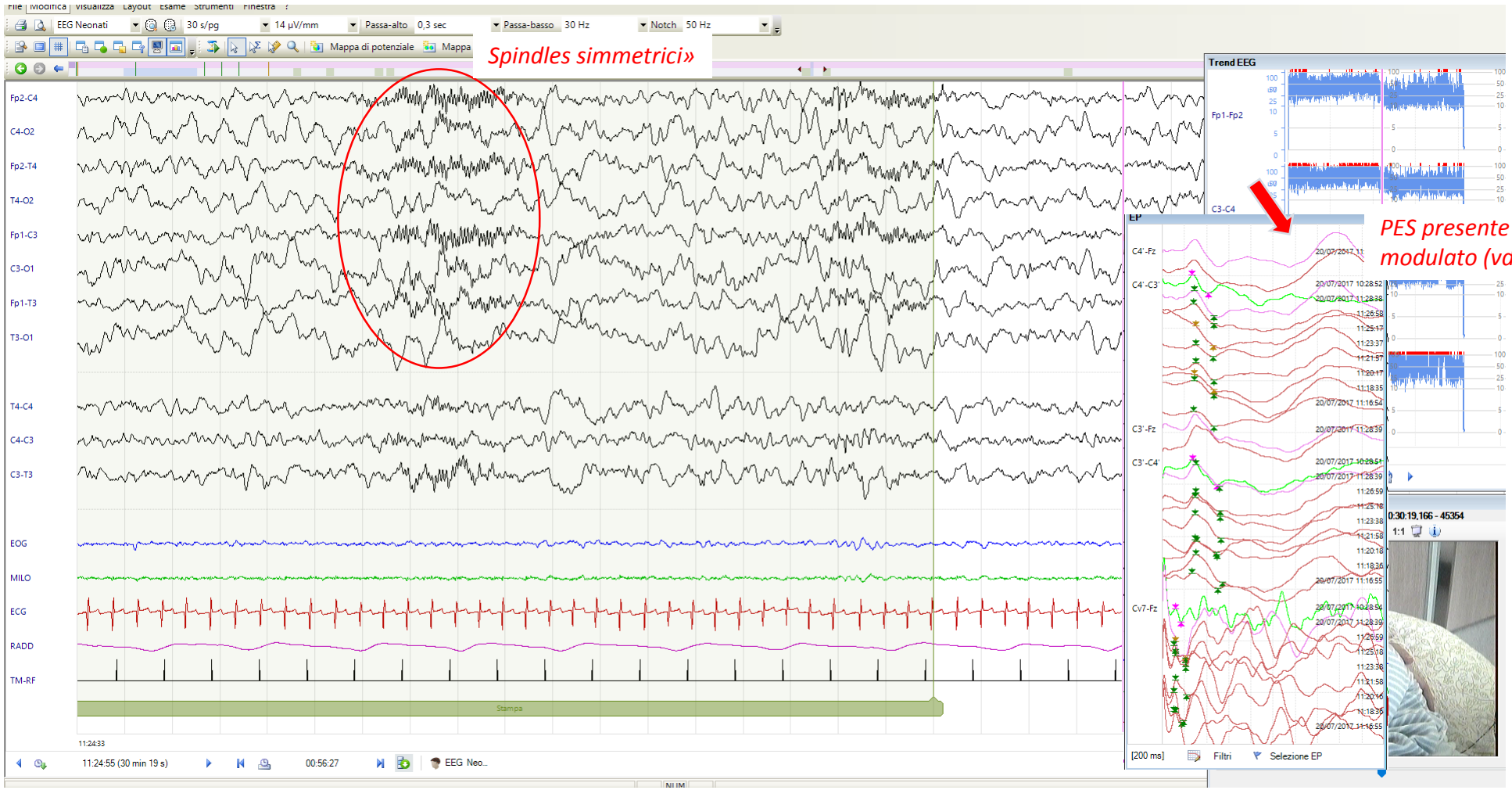
Benign and severe early-life seizures: a round in the first year of life



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Benign and severe early-life seizures: a round in the first year of life

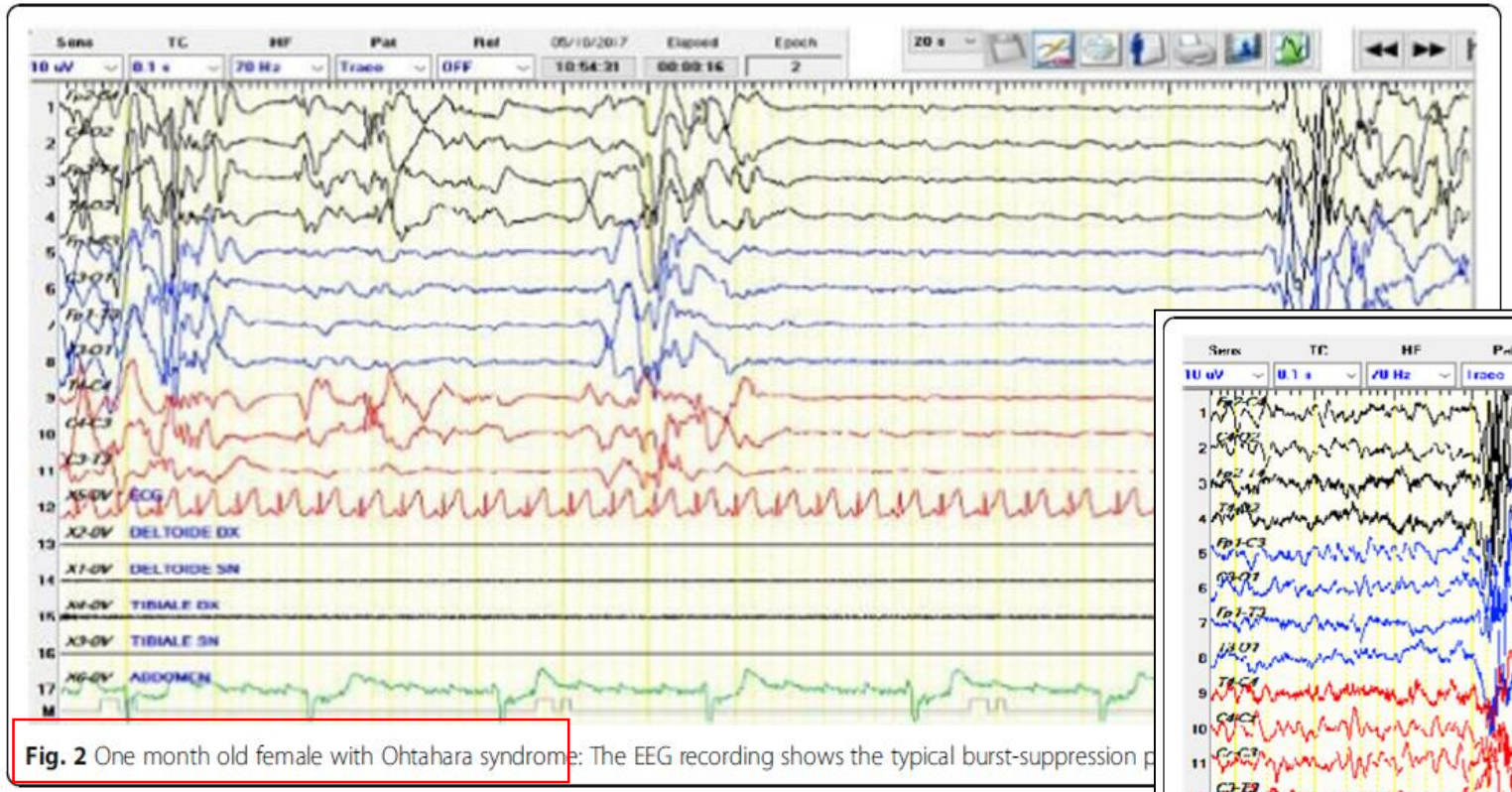


Fig. 2 One month old female with Ohtahara syndrome: The EEG recording shows the typical burst-suppression p

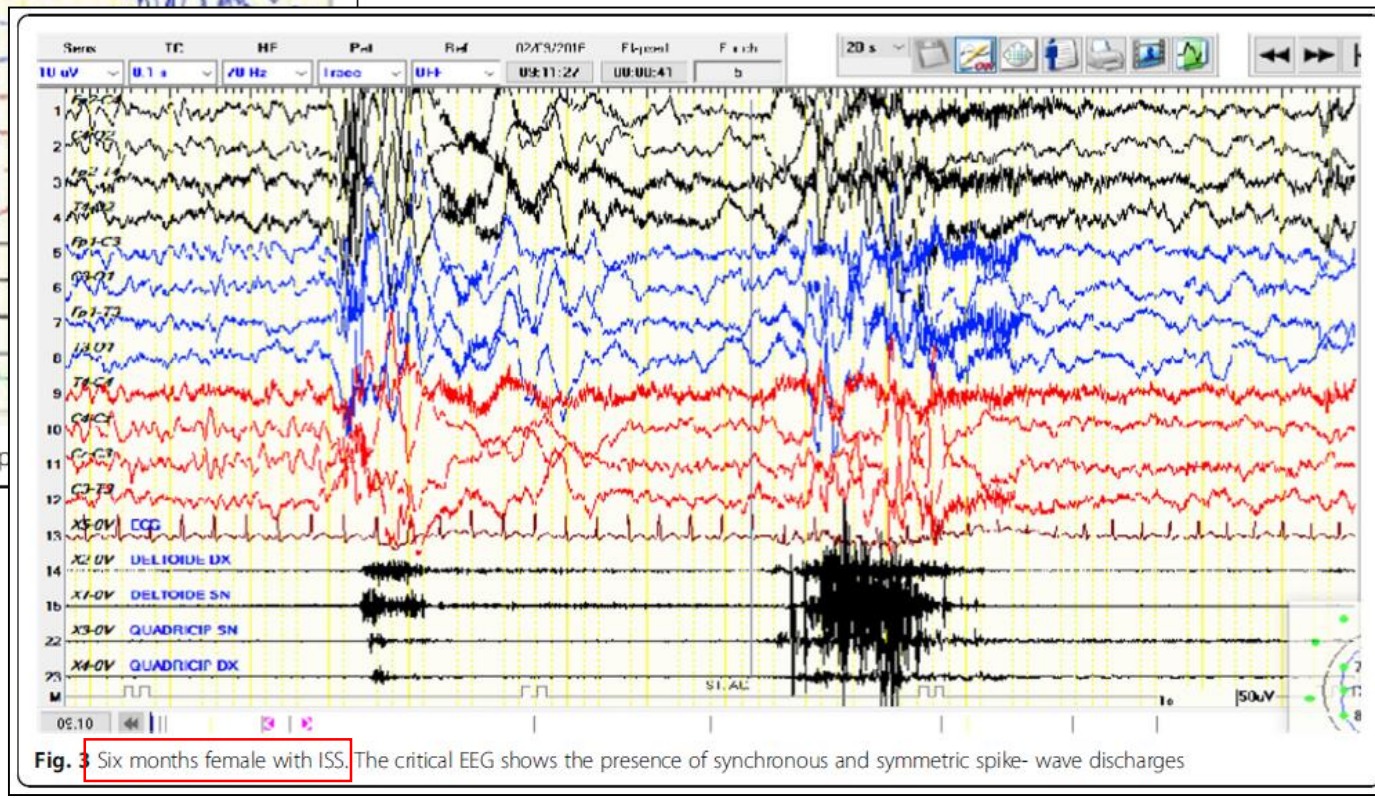
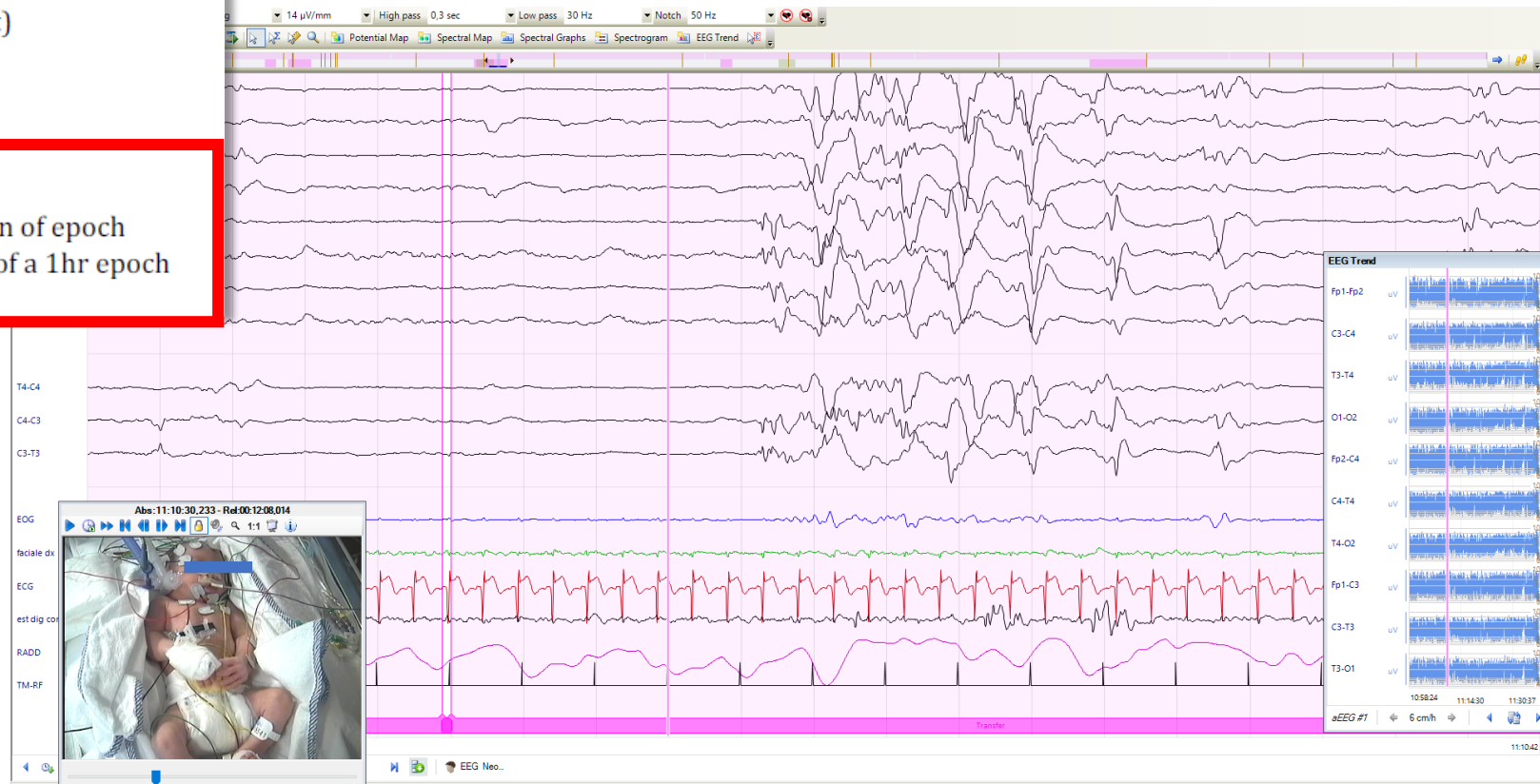


Fig. 3 Six months female with ISS. The critical EEG shows the presence of synchronous and symmetric spike- wave discharges

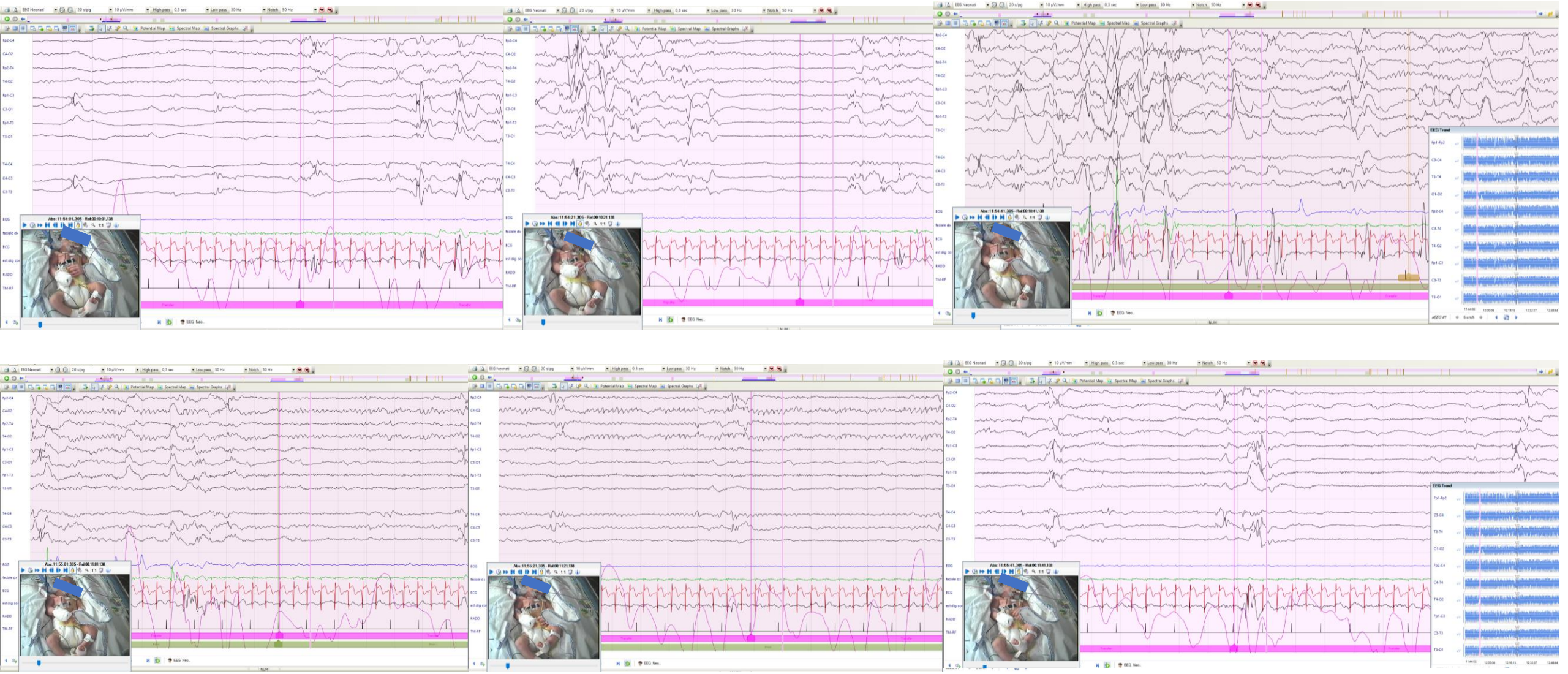
SEIZURES AND STATUS EPILEPTICUS

- Seizures
  - Duration ≥ 10 seconds
  - Location
    - Diffuse (D)
    - Lateralized (L)
      - Hemispheric- left (LH), right (RH)
    - Focal
      - Frontal (F)
      - Central (C)
      - Temporal (T)
      - Occipital (O)
      - Vertex (Z)
      - Quadrant- anterior (Ant), posterior (Post)
    - Bilateral Independent (BI)
    - Multifocal (Mf)
    - Migrating (Mig)
  - Seizure Burden
    - Number of seizures per hour or
    - Summed duration of seizures divided by duration of epoch
- Status Epilepticus- summed duration of seizures totals ≥ 50% of a 1hr epoch

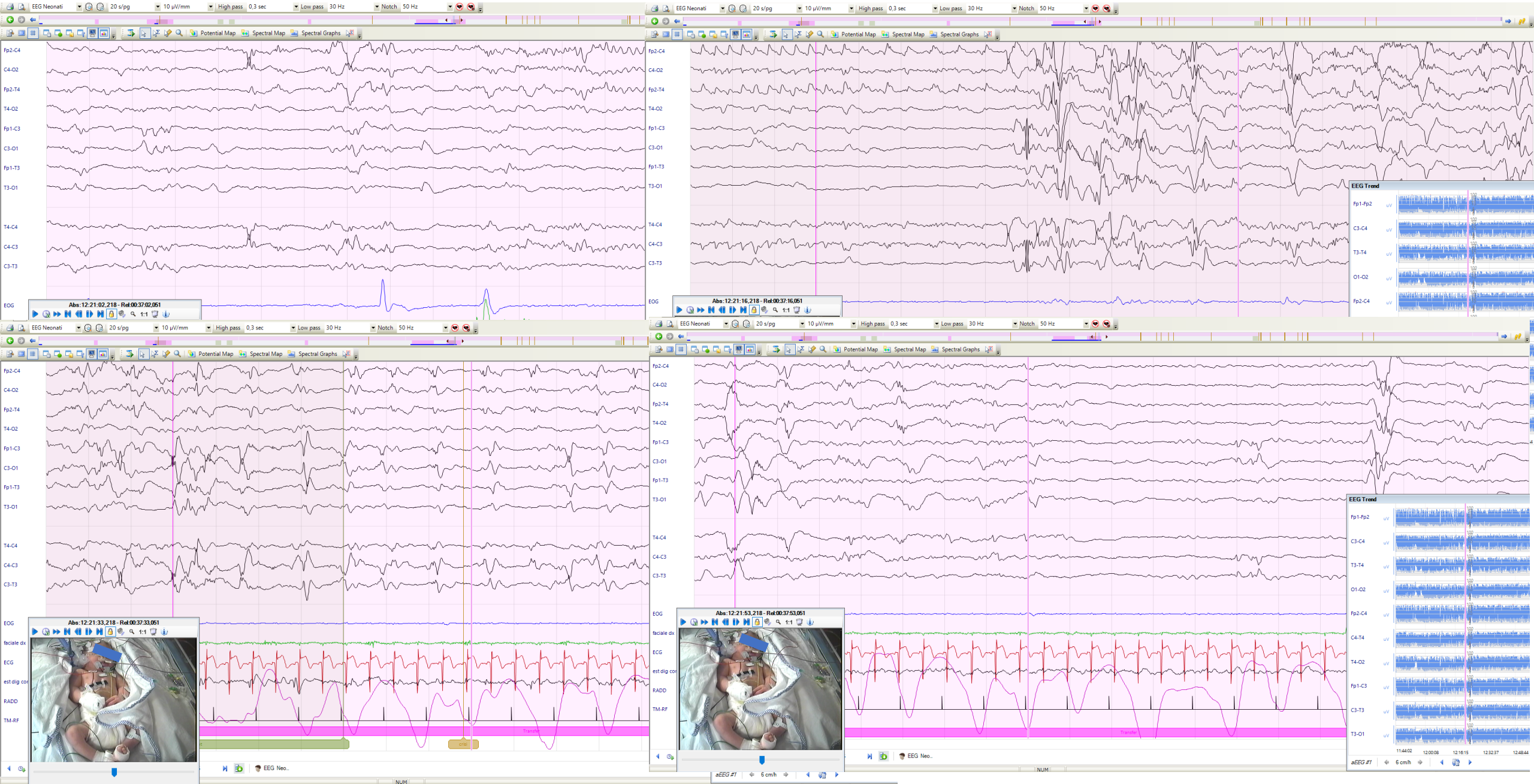
23.7 - Ohtahara



Seizures Burden: ….calcolo (long-monitoring)



....segue


EEG Neonati
20 s/pg
10 µV/mm
High pass 0,3 sec
Low pass 30 Hz
Notch 50 Hz
Potential Map
Spectral Map
Spectral Graphs
Fp2-C4
C4-O2
Fp2-T4
T4-O2
Fp1-C3
C3-O1
Fp1-T3
T3-O1
T4-C4
C4-C3
C3-T3
EOG
Abs:12:21:02,218 - Rel:00:37:02,051
Abs:12:21:16,218 - Rel:00:37:16,051
EEG Trend
Fp1-Fp2
C3-C4
T3-T4
O1-O2
Fp2-C4
faciale dx
ECG
est dig cor
RADD
TM-RF
Abs:12:21:33,218 - Rel:00:37:33,051
Abs:12:21:53,218 - Rel:00:37:53,051
EEG Neo..
6 cm/h

A.W.L.M. F 39+2 w SE

Background discontinuo non adeguato a EG
Crisi focali «basculanti»; deviazione sguardo e versione del capo

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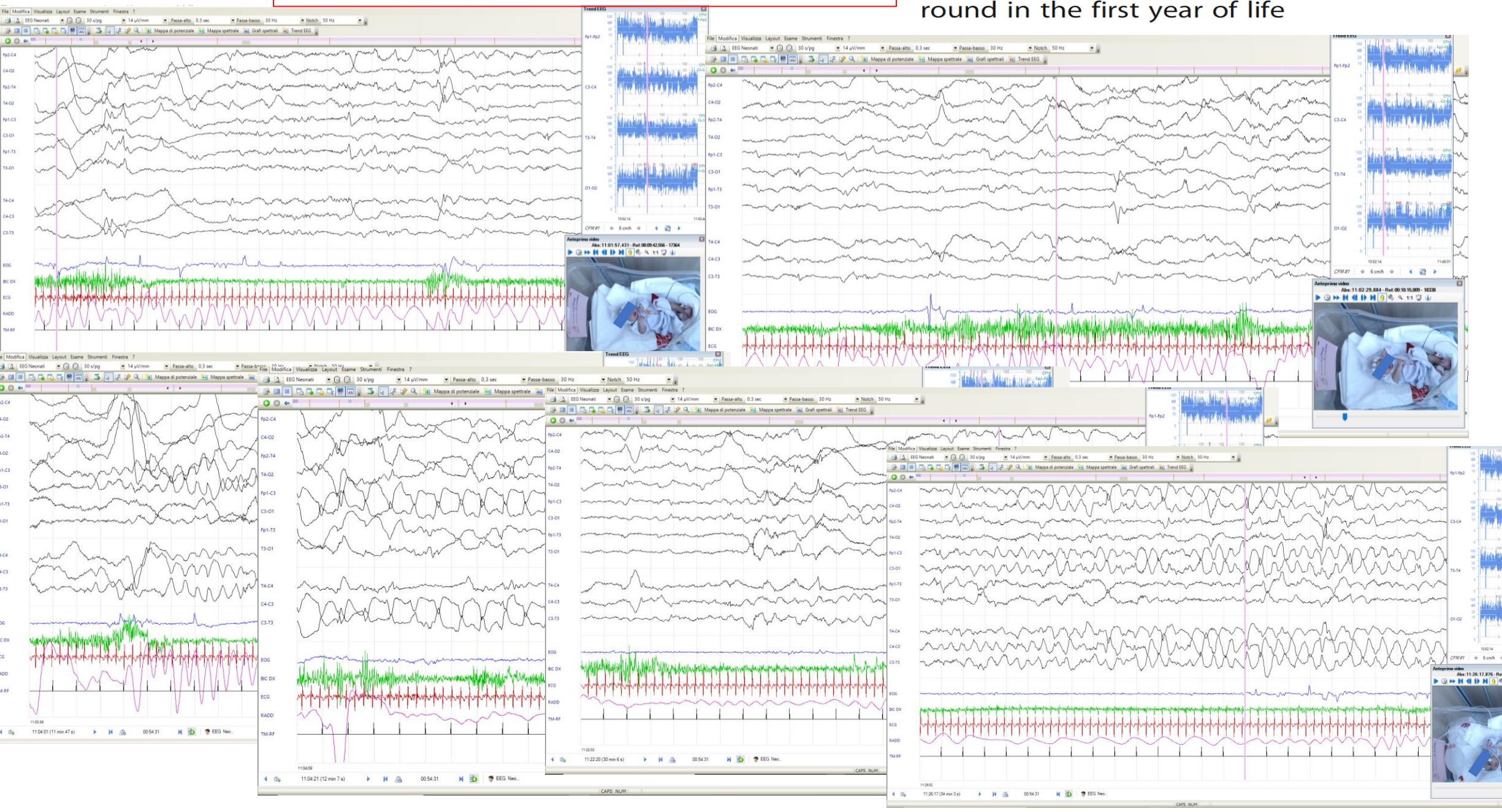
Benign and severe early-life seizures: a round in the first year of life



Benign and severe early-life seizures: a round in the first year of life

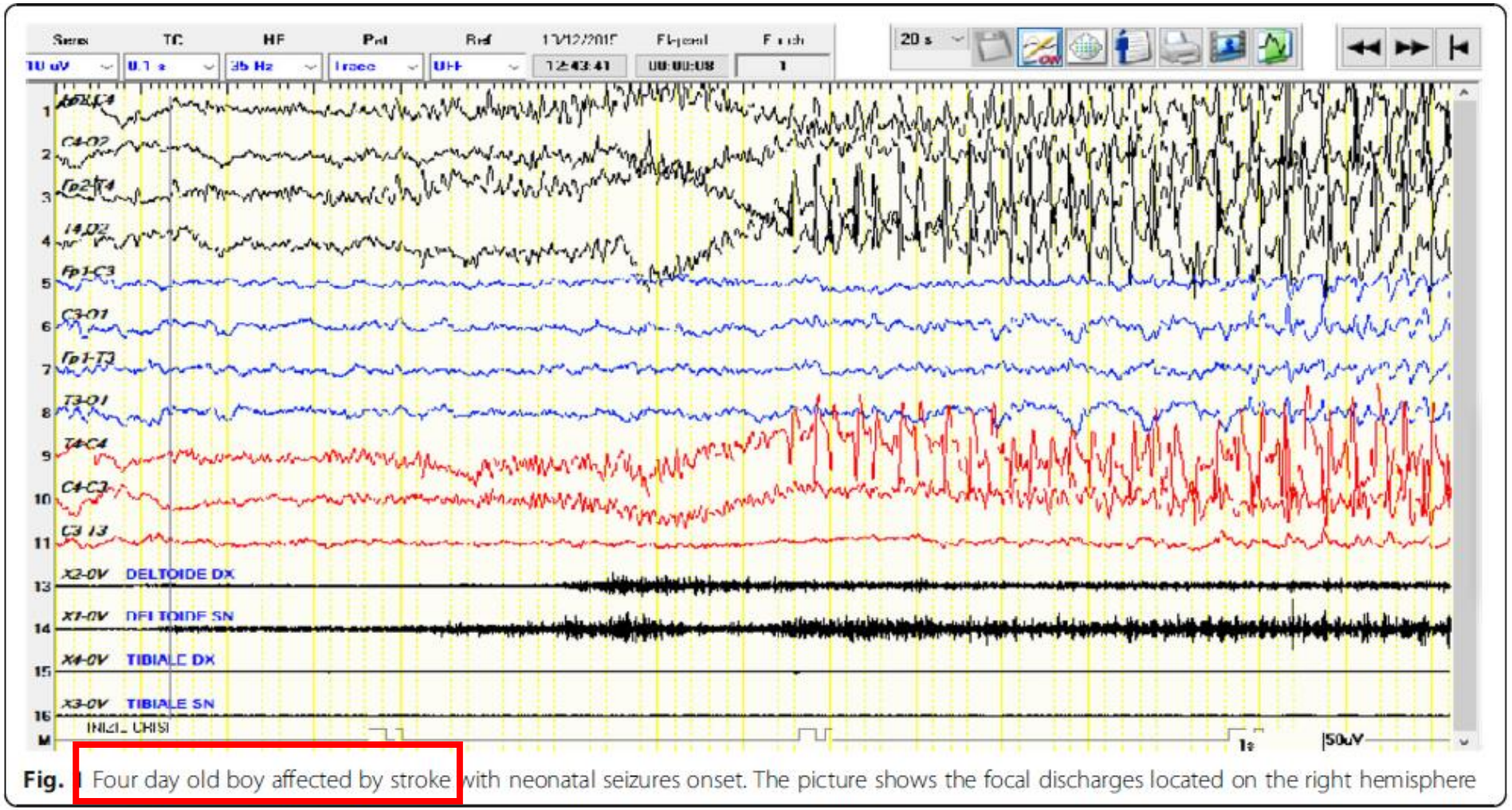
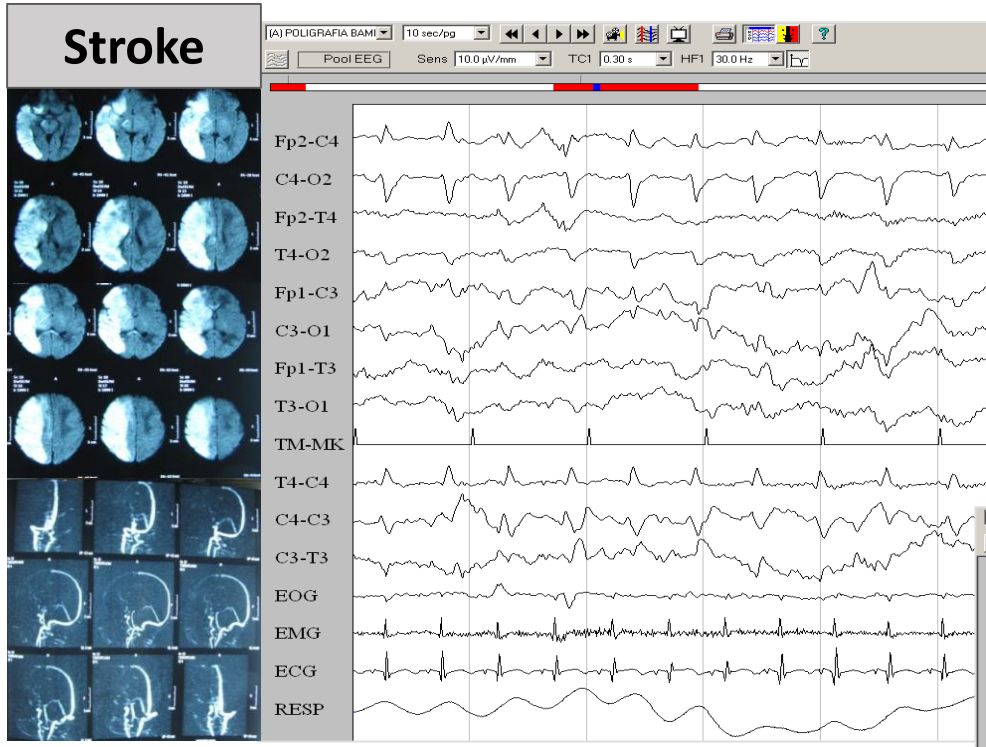


Fig. 1 Four day old boy affected by stroke with neonatal seizures onset. The picture shows the focal discharges located on the right hemisphere

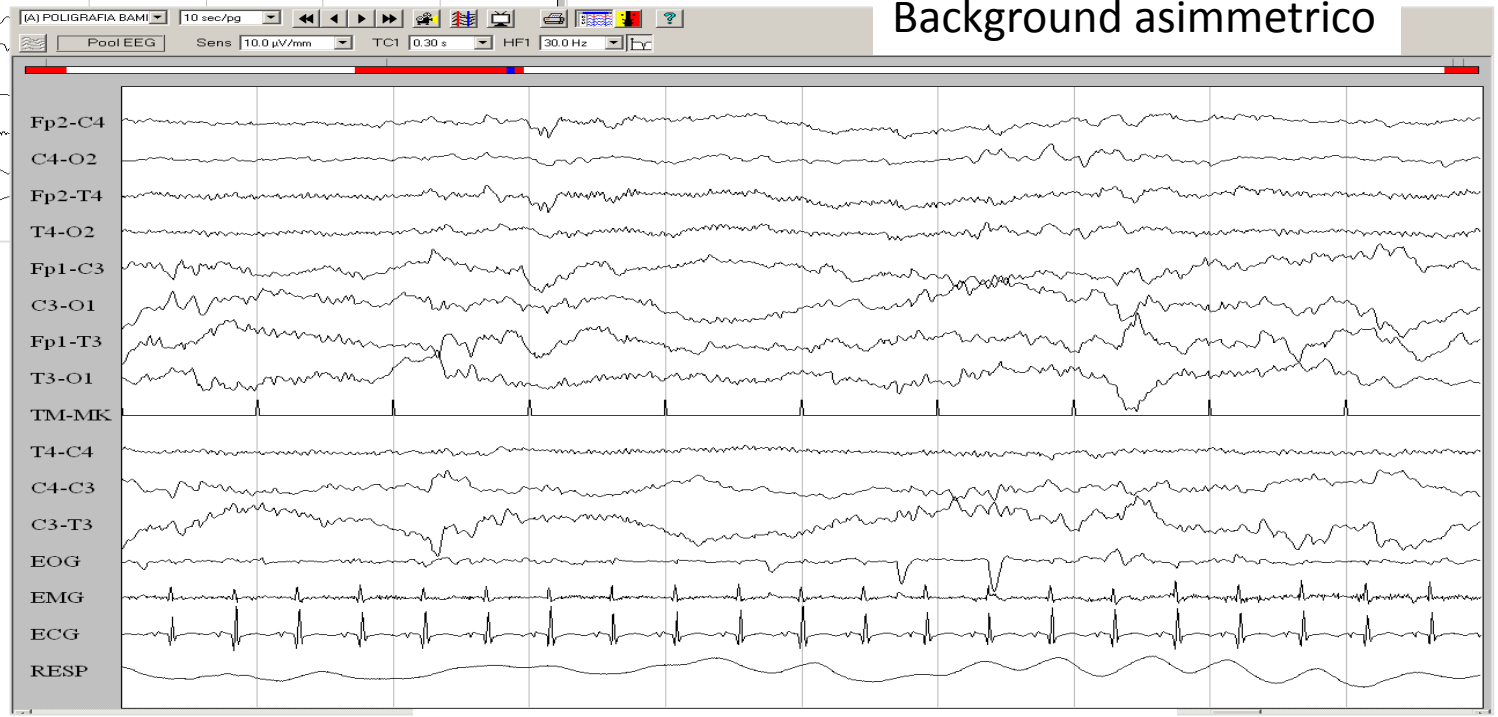
EG 39+3- IA 5-7 Ph f 7.2



Crisi focale – lato stroke

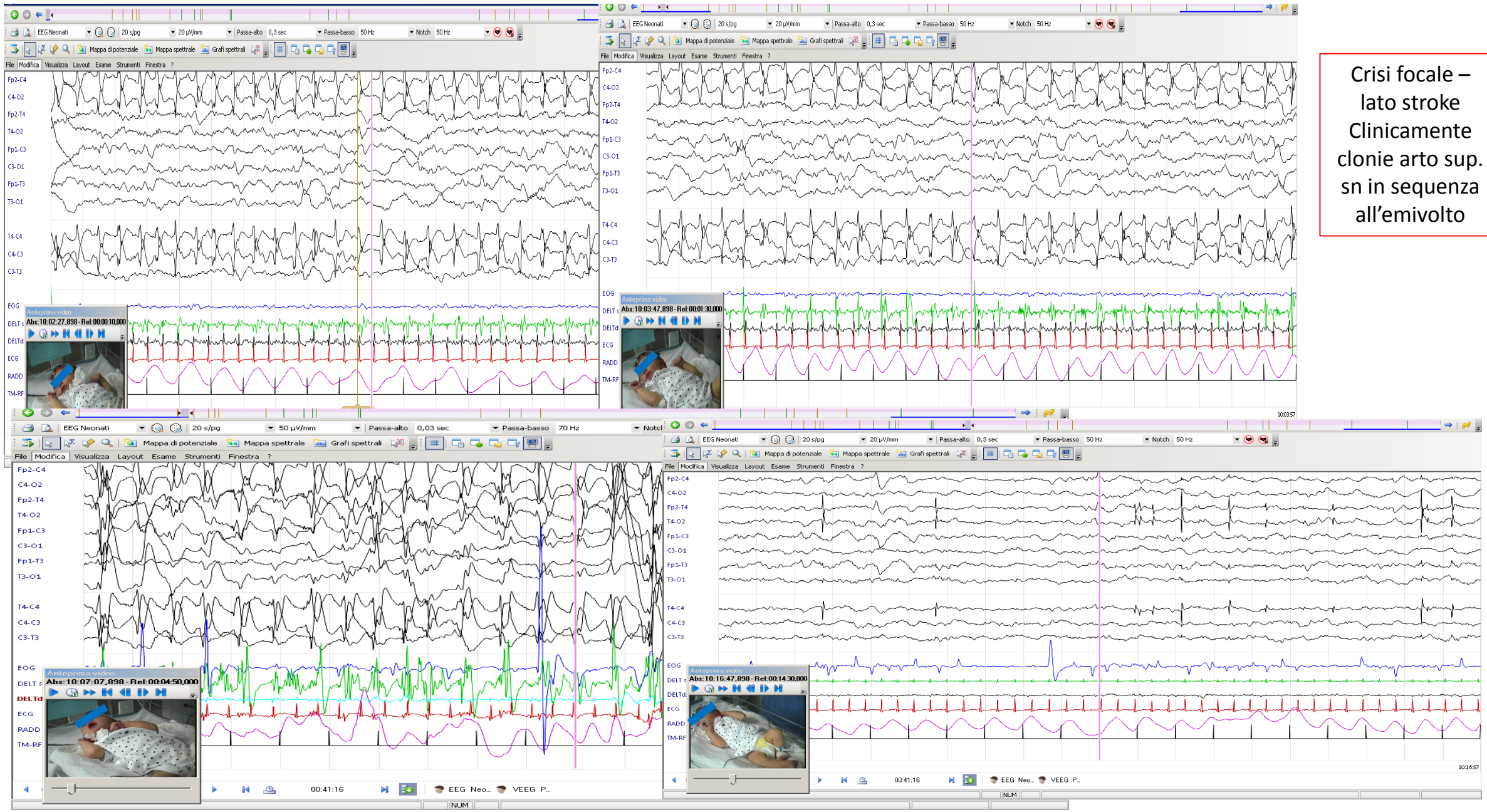
vEEG 39+5

Background asimmetrico



vEEG 5m

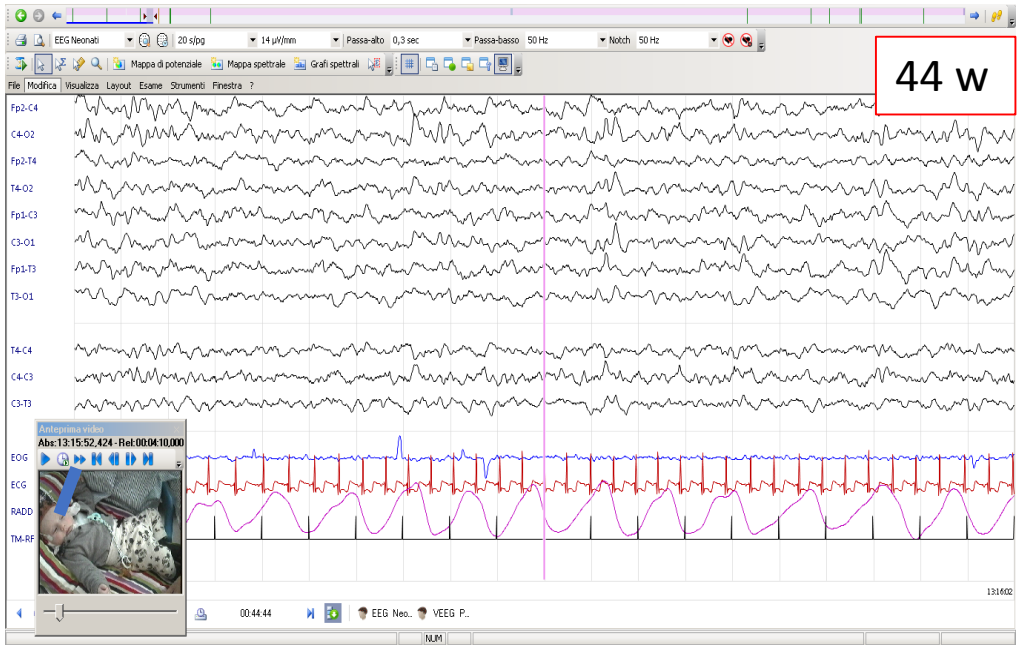
M. 38w – esame a 12 h dalla nascita

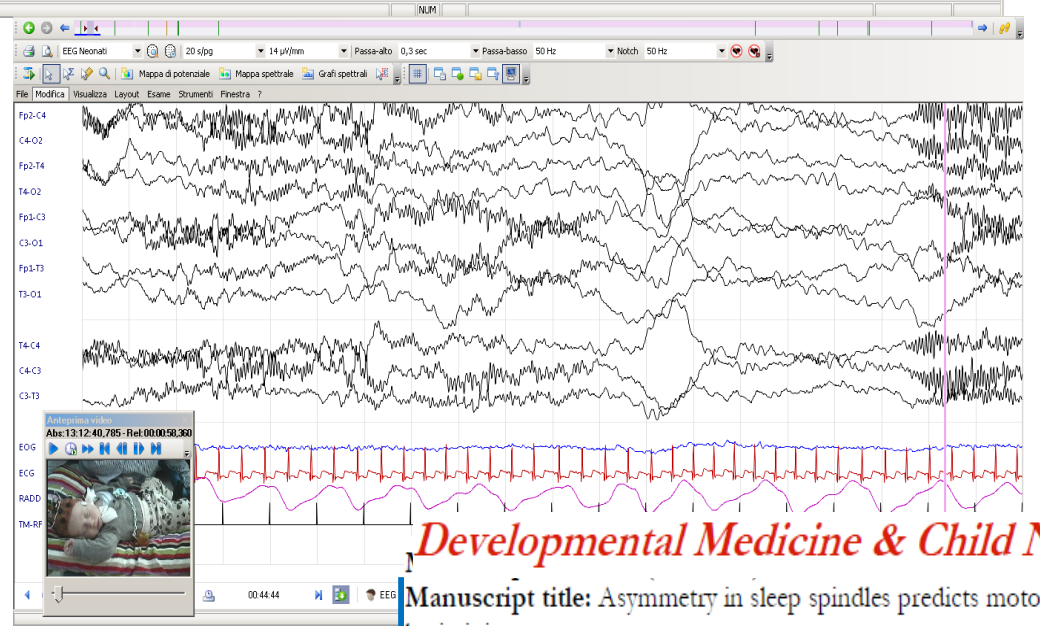


Crisi focale – lato stroke
Clinicamente clonie arto sup. sn in sequenza all'emivolto

M. 38w – esame a 72 h dalla nascita

Background continuo,
Con elementi fisiologici (sharp w-encoches)
S-V (vd aEEG); PES presente, simmetrico modulato.





Background continuo,
Con elementi fisiologici
S-V
Spindles simmetrici

In press

Developmental Medicine & Child Neurology

Manuscript title: Asymmetry in sleep spindles predicts motor outcome in infants with unilateral brain injury

Encefalopatia Ipossico-Ischemica

Neonati di EG ≥ 35 settimane e peso ≥ 1800 g che abbiano meno di 6 ore di vita.

Tutti i punti nascita

A. Ipossia intrapartum *(basta un solo criterio)*

- Apgar ≤ 5 a 10' *oppure*
- rianimazione a 10' *oppure*
- acidosi fetale o neonatale
  - -pH ≤ 7 *oppure*
  - -BE ≥ 12 mmol/l

A. Encefalopatia ipossico-ischemica

E.O.N Sarnat II/III
Tra 30 e 60 minuti di vita

Spegnere il lettino; eventuale trasferimento

Centri di riferimento

A. Criteri aEEG/EEG

Criteri soddisfatti < 6 ore di vita

IPOTERMIA 72 ore

RACCOMANDAZIONI PER L'ASSISTENZA AL NEONATO CON ENCEFALOPATIA IPOSSICOISCHEMICA CANDIDATO AL TRATTAMENTO IPOTERMICO G.Ancora, G.Pomero, F.Ferrari SIN

Allegato 1: Esame obiettivo neurologico

halak LF et al, *Paediatrics* 2003; 111:351-357; Shankaran S et al, *N Engl J Med* 2005;353:1574-84)

(da effettuarsi tra 30 e 60 minuti di vita, tra 6 e 24 ore, in 3° e 7° giornata)

Livello di coscienza

- Iperallerta *(neonati in piena veglia con difficoltà a dormire,occhi spalancati, sembrano 'fissare' e presentano ridotto ammiccamento)* ☐
- Letargia *(la risposta agli stimoli è completa ma ritardata, con una soglia aumentata; c'è una riduzione dei movimenti spontanei)* ☐
- Stupore/coma *(c'è risposta solo a stimoli energici e il tipo di risposta consiste in una retrazione delle estremità o nell'assunzione di una postura decerebrata; assenza di riflessi corneali; spesso c'è necessità di assistenza respiratoria)* ☐

Motilità

Normale/aumentata/tremori ☐
Ridotta ☐
Assente ☐

Postura

Normale ☐
Flessione distale/completa estensione *(atteggiamento delle braccia con flessione ai polsi e estensione ai gomiti, in genere accentuata da stimolazione)* ☐
Decerebrata *(atteggiamento rigido con flessione ai polsi, estensione ed intrarotazione delle braccia, estensione delle gambe e flessione forzata plantare dei piedi, opisto* ☐

Tono assiale (valutato alla manovra di trazione e/o in sospensione ventrale)

Normale ☐
Ipotonia (Fig. 1 a,b) ☐
Flaccidità ☐

Riflessi primitivi (riflesso di Moro e/o riflesso di suzione)

Normale/esagerato ☐
Deboli /incompleti (Fig. 2 a,b) ☐
Assenti ☐

6. **Disfunzione autonomica delle pupille**

Assente ☐
Miosi ☐
Midriasi, deviazione o reattività assente ☐

Sarnat

Grado I (lieve)	Grado II (moderata)	Grado III (grave)
Ipereccitabilità: irritabilità, tremori, veglia protratta	Letargia, convulsioni nel 70%	Coma, convulsioni
Tono normale o aumentato	Ipotonia	Ipotonia importante
Midriasi	Miosi	Riflesso pupillare torpido o assente
EEG normale	EEG patologico	EEG patologico: riduzione attività di fondo, "burst suppression"

Encefalopatia Ipossico-Ischemica

Awal 2017

Recommended definitions of EEG background feature.

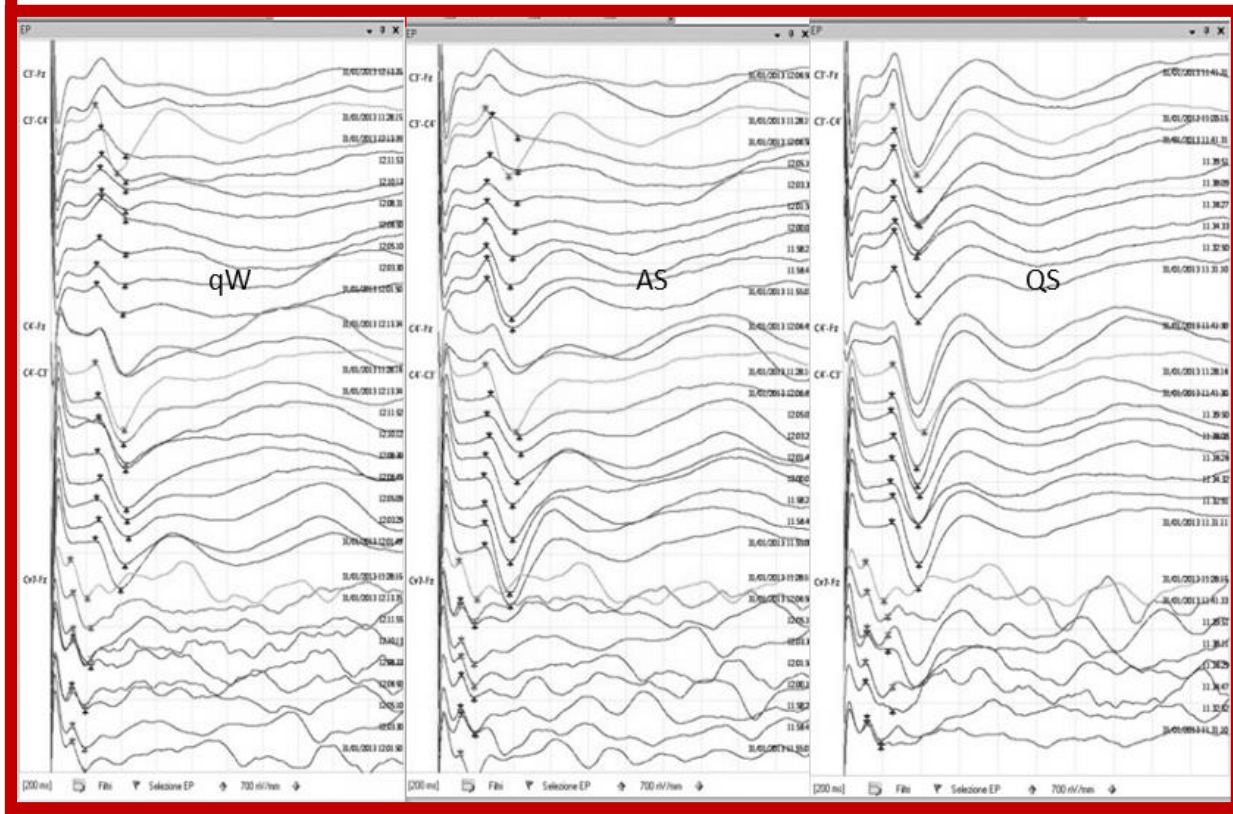
Patterns	Amplitude, duration or characteristics of EEG activity*
CNV[&]	Continuous background activity with voltage 10–25 (−50) μV but without sleep stages
DNV	Discontinuous trace, with voltage predominantly >5 μV
Burst suppression[#]	High voltage (>30 μV) delta (0.4–4 Hz) and theta (4–8 Hz) activities lasting 1–10 s with suppressed activity of <5 μV lasting >2 s
Modified burst suppression	High voltage (>30 μV) delta (0.4–4 Hz) and theta (4–8 Hz) activities lasting 1–10 s with suppressed activity of >5 μV lasting >2 s
Asymmetry	Consistent asymmetry by 20–50% between homologous areas of the brain can be treated as abnormal. Asymmetry should be present in all states (Holmes and Lombroso, 1993)
Asynchrony	Bursts are classified 'asynchronous' if their onset between hemisphere is separated by >1.5 s and exist unequally between the hemisphere. To measure asynchrony, 5 consecutive minute should be used (Holmes and Lombroso, 1993)
Low voltage	Continuous background patterns around 5 μV throughout the record
Flat trace	Mainly inactive (isoelectric tracing) with consistently <5 μV

SEP c

DEVELOPMENTAL MEDICINE & CHILD NEUROLOGY ORIGINAL ARTICLE

Multimodal neurophysiological monitoring in healthy infants born at term: normative continuous somatosensory evoked potentials data

SILVIA LORI[1] | SIMONETTA GABBANINI[1] | MARIA BASTIANELLI[1] | GIOVANNA BERTINI[2] | IURI CORSINI[2] | CARLO DANI[2]

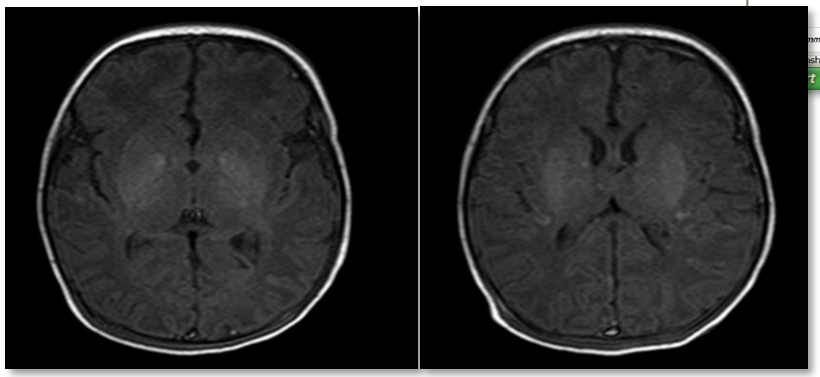


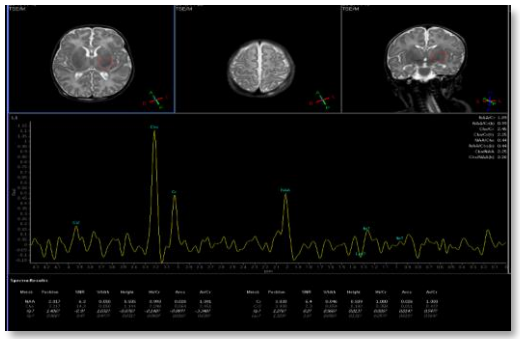
40+6 ♂

pHF 6,7
IA 2-5-7

Asfissia–SS 2/3
HP

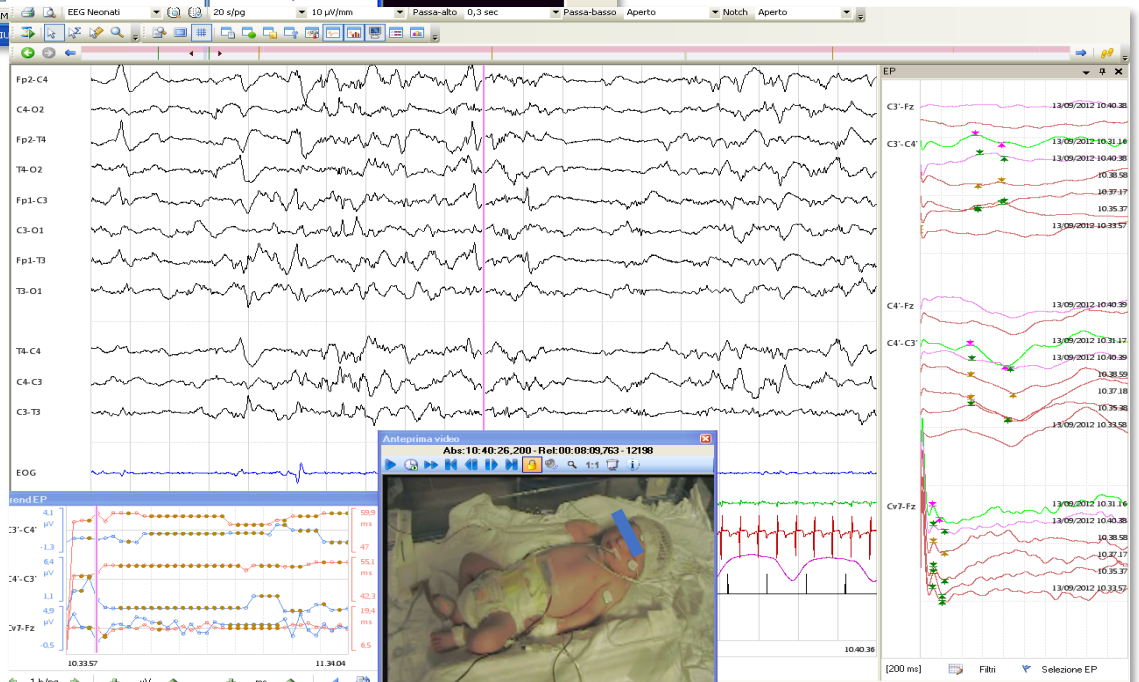
IR 0,48





HyTh

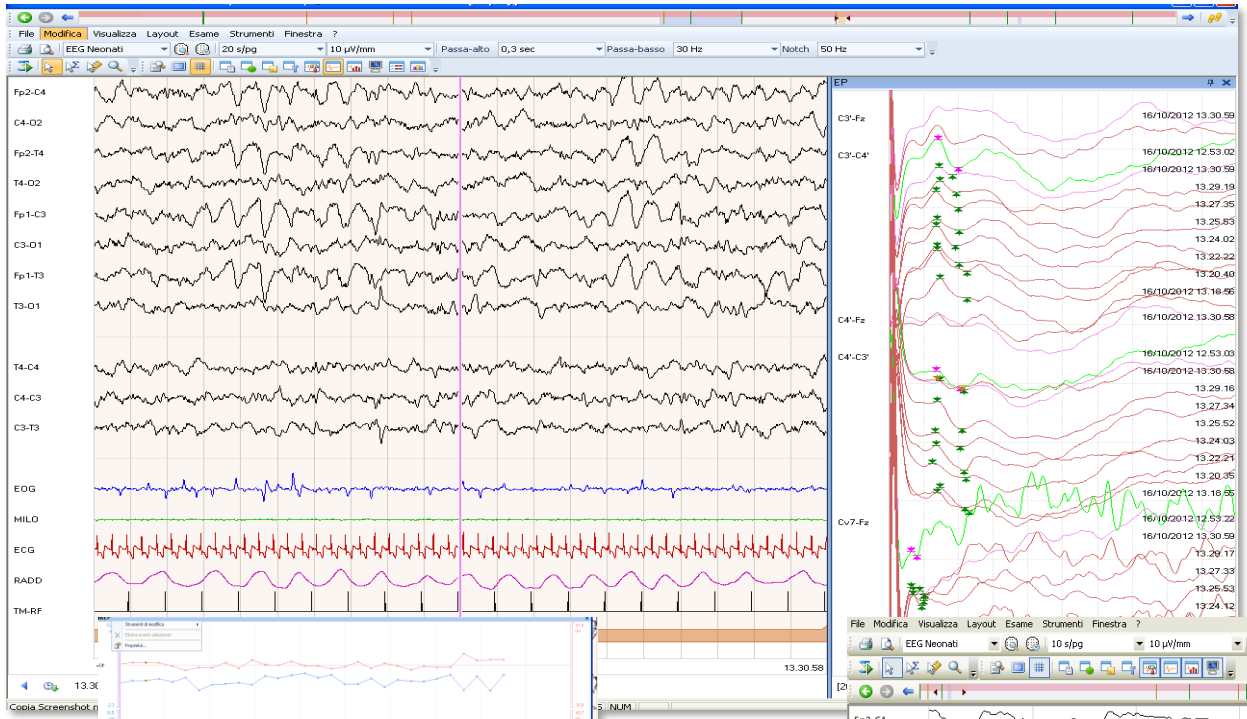
NTh <10g

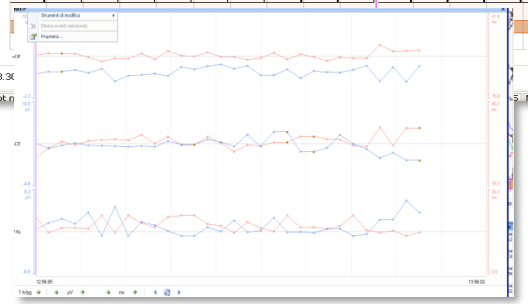


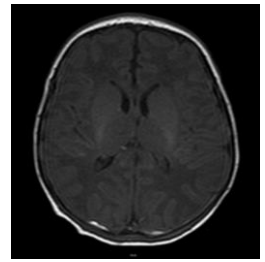
40+2 ♂

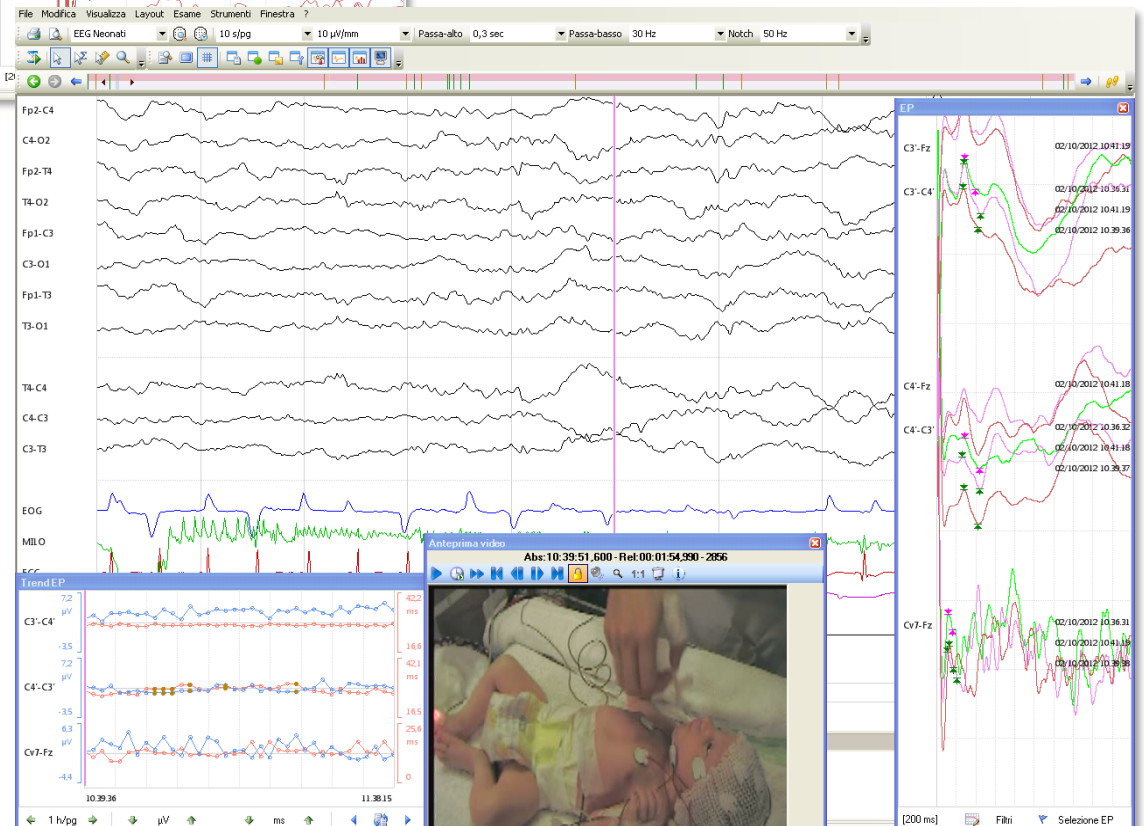
pH F 6,7
IA 0-1-3
ACR-SS 2/3
HP

IR normale





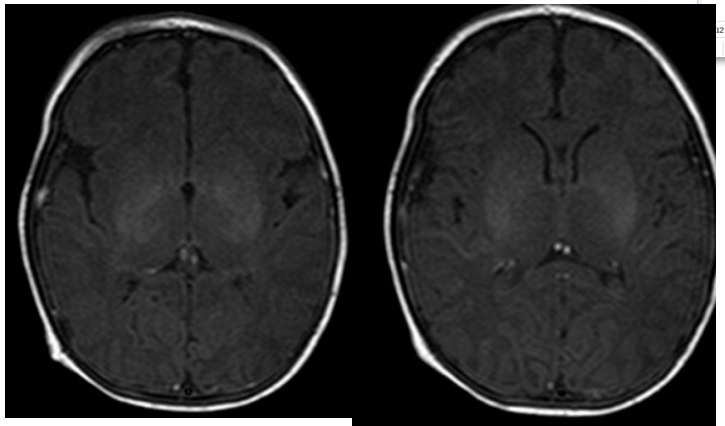


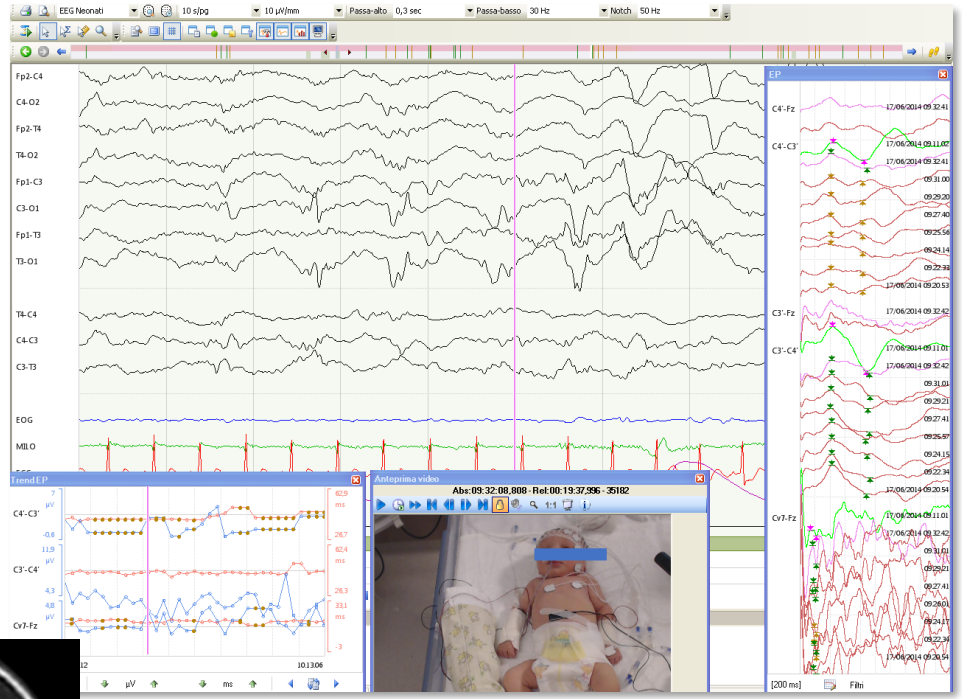


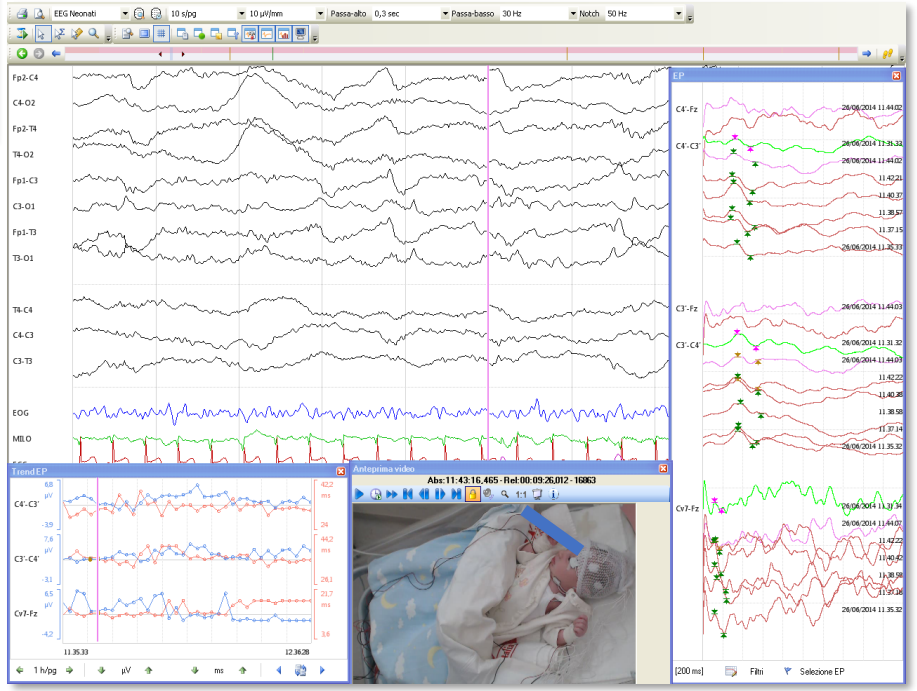
40 ♀

pH F *7,0*
IA 3-7
Asfissia-SS1/2
HP

IR 0,57→ N



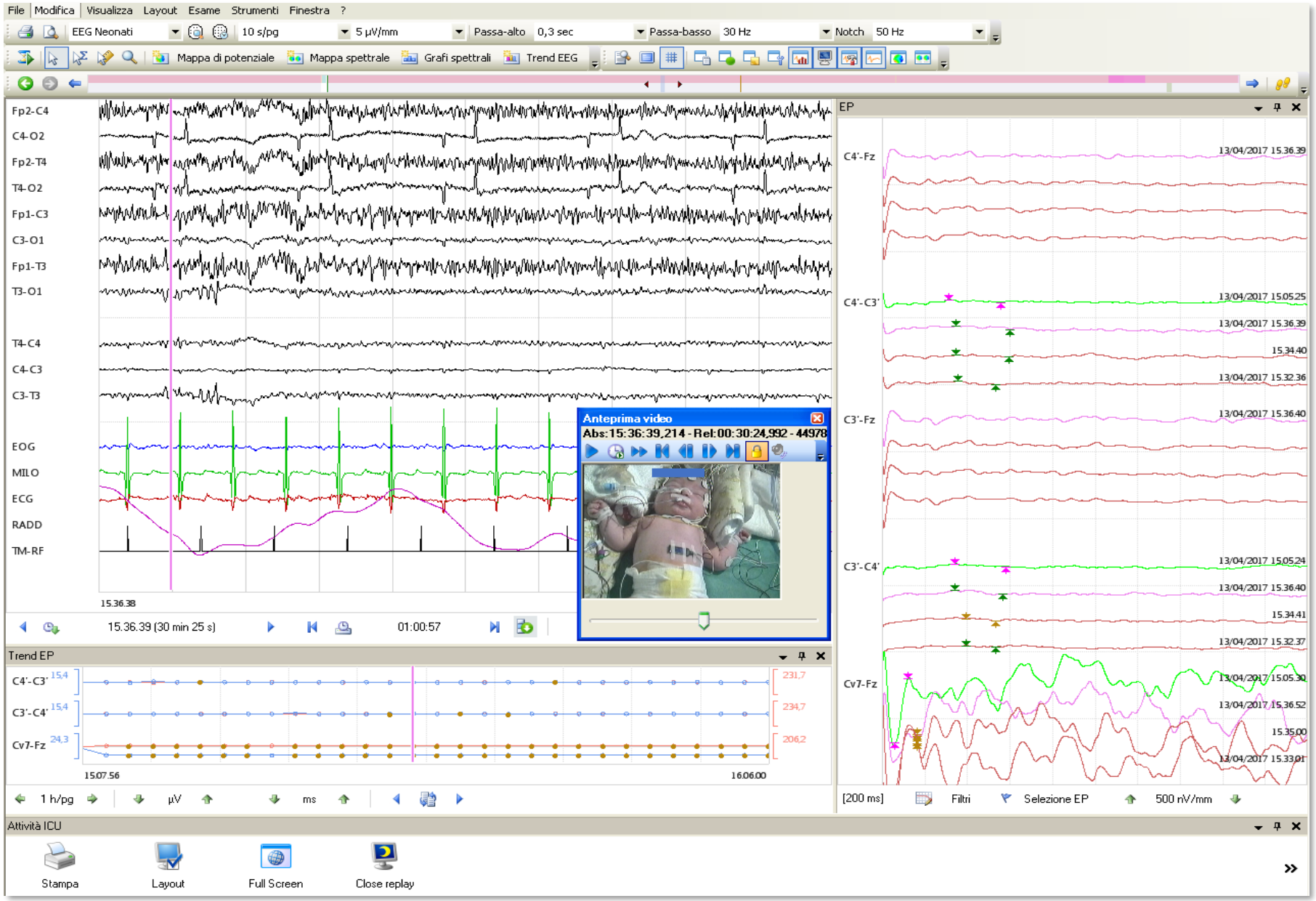




Insulto “lieve”
pH funicolare basso

39 ♀
IA 5/6
pH 6,9-latt 22-
SBE -27,3
ACR SS 1-2
HP

IR 0,46



Attenzione a ……

artefatti

TABLE 1. Common Artifacts in Preterm EEG That May Be Mistaken for Epileptic Activity

Artifact Type	Location	Falsely Interpreted as	Identified by
Pulse	Generalized with varying predominance	Sharp waves or ictal activity, especially if asymmetric	Matching with ECG activity as recorded by ECG electrodes
Fontanelle	Mostly focal at Cz, Fz, C3, and C4	Sharp waves or ictal over central regions	Synchronicity with ECG, no temporal evolution
Breathing	Focal most frequent occipital, sometimes generalized	1–2 Hz low frequency seizure activity	Synchronicity with breathing movements
Sucking	Rhythmic activity mostly temporal	Ictal activity*	Video, mouth movement
Hiccups	High amplitude sharps, generalized or focal depending on patients head position	Ictal activity*	Video, hiccup without other clinical features
Patting	High amplitude sharps, generalized or focal depending on patients head position	Ictal activity*	Video

*Misinterpretation of artifacts such as sucking, hiccups, and patting for ictal activity is most likely if the activity causes a focal artifact and shows temporal evolution over time.
ECG, electrocardiogram.

In the NICU, studies on effects of drugs on EEG were conducted with phenobarbitone, morphine and synthetic opioids, and midazolam.

The drug effects on EEG can be synthesized as following

1) whatever the type of recording:
   - loss of fluctuations of normal background activity regarding to GA;
   - increasing of discontinuity compared to the standard for PMA, related to two factors, number and mean duration of IBIs;
   - complete reversibility of the EEG alterations after the withdrawal of drugs;
2) with conventional analog or digital EEG, which is the only method that gives morphological informations, other items can be pointed out:
   - persistence of physiological patterns and criteria of PMA;
   - presence of pathological patterns as typical PRS that persist during analgesia or sedation;
   - myoclonus related to benzodiazepine that may be differentiated from epileptic electroclinical manifestations by simultaneous EEG recording.

farmaci

Drugs modified most background tracings, without suppressing sharp waves and critical discharges.

In practice, it is very important in preterms as in every neonate to know the drugs administered and their dose as well as the exact time of administration (mostly for bolus) and the duration of use. These information are necessary in order to analyse the EEG with maximal accuracy and reliability in this clinical and therapeutic context.

Referto VEEG

template

✓ Dati clinico-anmestici: EG – EPC; motivo esame; farmaci neurosedativi

✓ Descrizione tracciato EEG:

- Attività di fondo
- Elementi fisiologici vs elementi patologici
- Asincronia/Asimmetria

Background

- Attività epilettiforme intercritica
- Attività epilettiforme critica: elettrica vs elettro-clinica
  - descrizione tipologia/durata crisi («concetto Seizure Burden»)

Attività Epilettica

✓ Descrizione manifestazioni cliniche (Video)

- Se EEG correlate
- Se Non-EEG correlate

Manifestazioni cliniche

✓ Poligrafia

- Apnee/ipopnee (se presenti)
- EMG, ECG

Attività extracorticali

❖ Conclusioni: **B, AE (SB), Mc, Ae**

Referto SEP-c

template

✓ Dati clinico-anamnestici: EG – EPC; motivo esame; farmaci neurosedativi

✓ Descrizione Esame SEP-c

- Presenza/assenza componente cervicale (N13), riportare latenza ms
- Presenza/assenza componenti corticali: N1 e P1, riportare latenze ms – ampiezze ms per emisfero
- Presenza/assenza modulazione

❖ Conclusioni: **N, NnM, I-Hy, A, AA**

Take home message

- ✓ Conoscere i pattern maturativi è fondamentale
- ✓ per interpretare l'EEG

- ✓ «Background» indirizza su encefalopatia SI/NO

- ✓ Pattern critici spesso focali/multifocali *(concetto «SB»)*

- ✓ Manifestazioni motorie «minime»

MONITORAGGIO VEEG RACCOMANDATO!!

+ SEP auspicabile….

- **Proviamo ad interpretare?.....**

Stato d'animo