New technology: refractory status epilepticus

Krisnachai Chomtho MD DCH MRCPCH
Assistant professor in pediatric neurology
Faculty of Medicine, Chulalongkorn University

Updates in technology & treatment modalities

- SE guidelines review
- Diagnostic technology
  - quantitative EEG analysis
  - automatic seizure detection
- Emerging treatment modalities
  - therapeutic hypothermia
  - neurostimulation: VNS,DBS,TMS,RNS
  - electroconvulsive treatment

A definition and classification of status epilepticus – Report of the ILAE Task Force on Classification of Status Epilepticus

*†‡Eugen Trinka, §Hannah Cock, ¶Dale Hesdorffer, #Andrea O. Rossetti, **Ingrid E. Scheffer, ††Shlomo Shinnar, ‡‡Simon Shorvon, and §§Daniel H. Lowenstein

Epilepsia, 56(10):1515–1523, 2015
doi: 10.1111/epi.13121

"a condition resulting either from the failure of the mechanisms responsible for seizure termination or from the initiation of mechanisms, which lead to abnormally, prolonged seizures (after time point t1). It is a condition, which can have long-term consequences (after time point t2), including neuronal death, neuronal injury, and alteration of neuronal networks, depending on the type and duration of seizures."

Operational dimensions

- T1 – prolonged seizure
- T2 – risk of damage

	T1	**T2**
Tonic-clonic	5	30
Focal	10	> 60
Absence	10-15	unknown

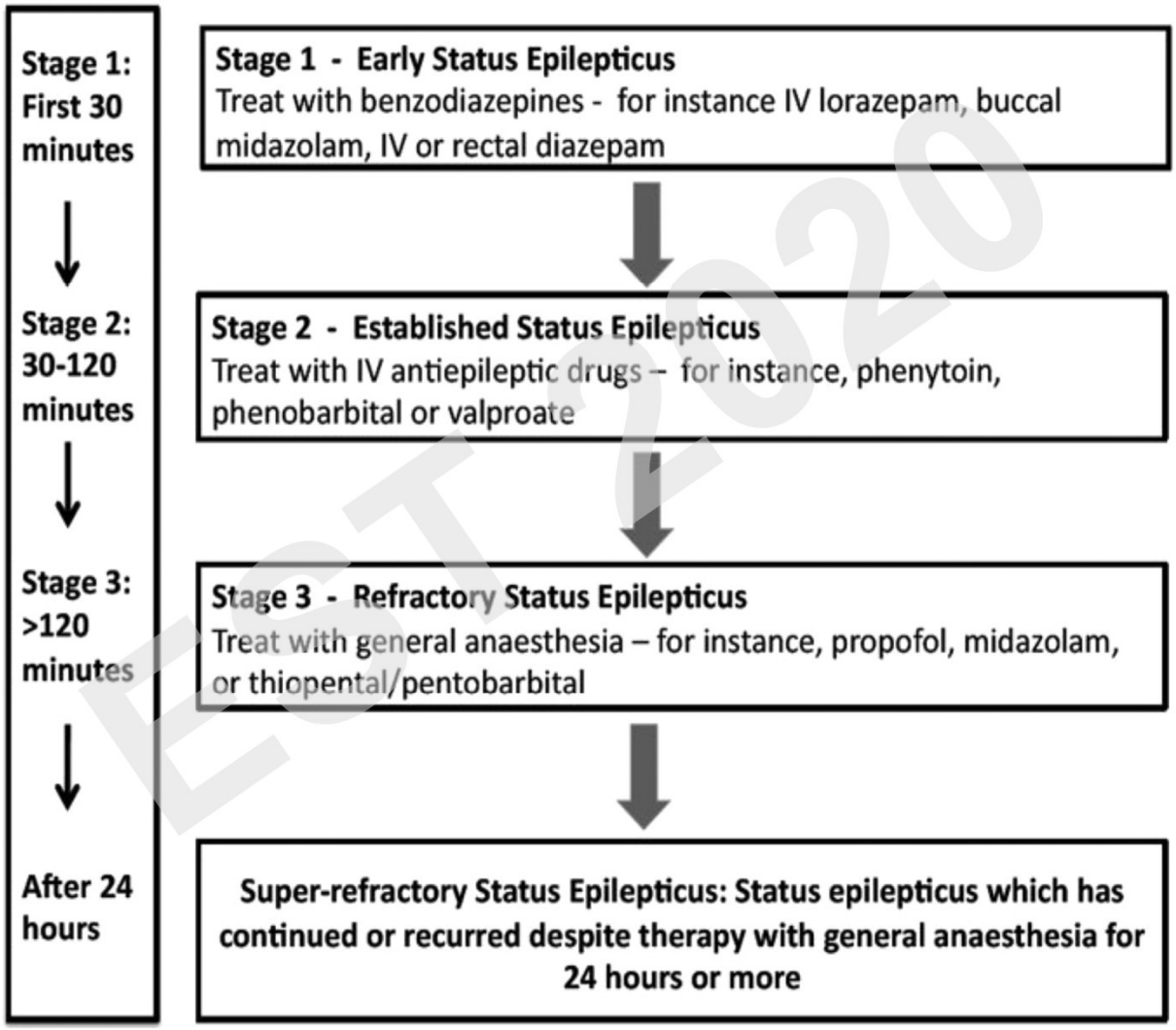
Treatment guidelines

- NICE 2011
- AES 2016
- Thai 2016
- Others

→ Similar approach

→ Different intervention time and drug dose

Stages of SE

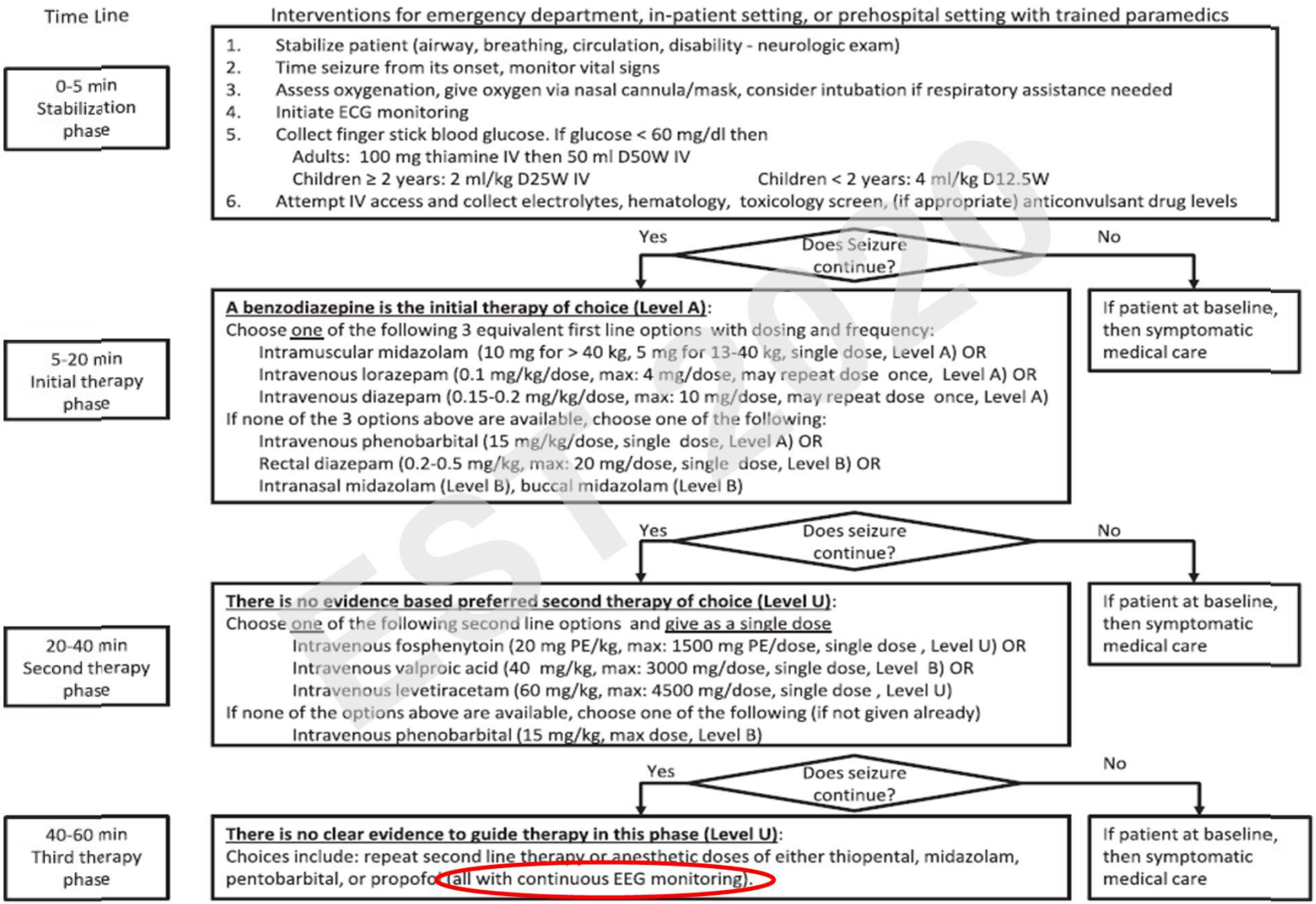


The treatment of super-refractory status epilepticus: a critical review of available therapies and a clinical treatment protocol. Brain. 2011;134(10):2802-2818

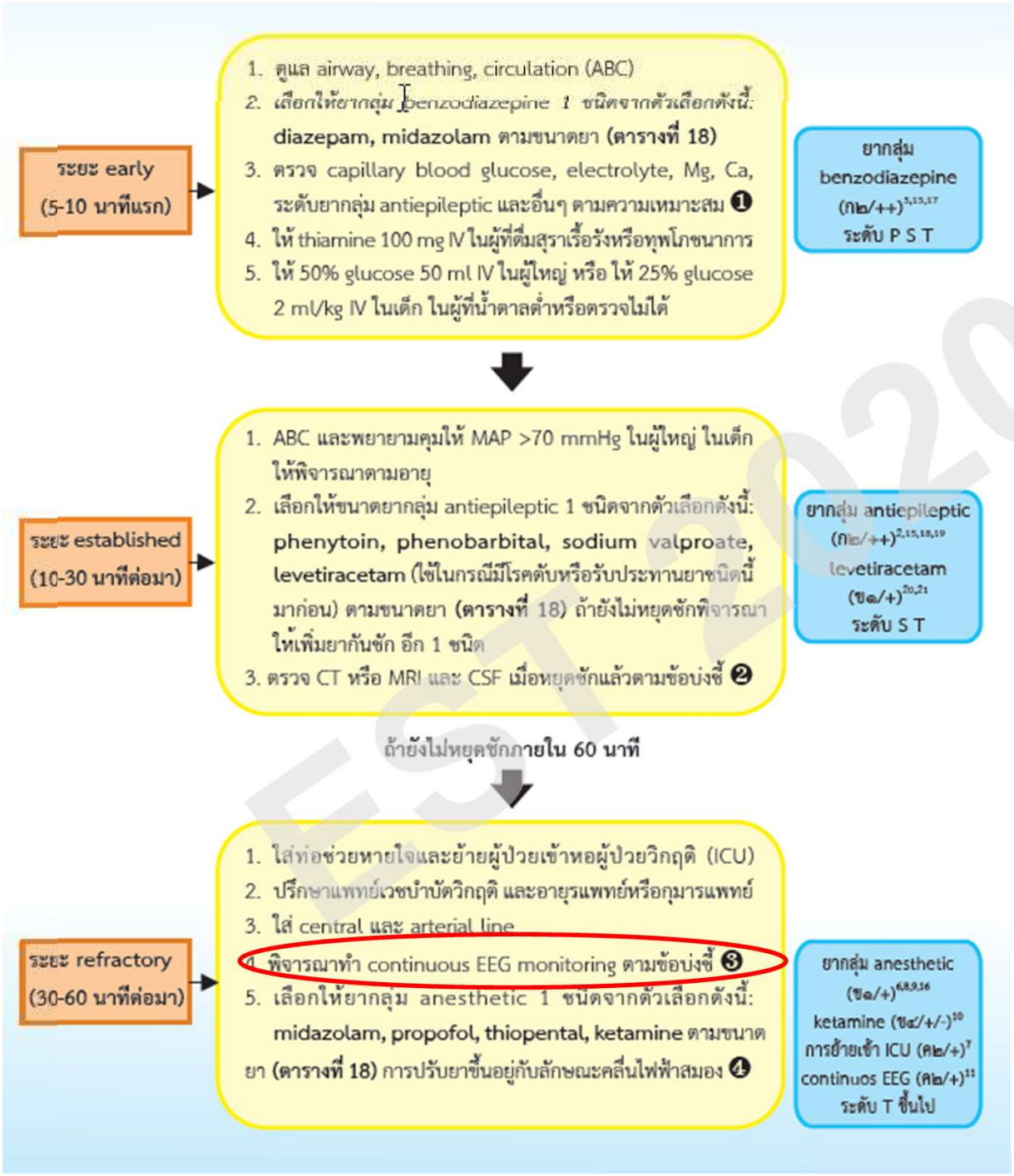
NICE

Time	Seizure starts	Confirm clinically that it is an epileptic seizure
0 mins (1st step)	**Check ABC, high flow O_2 if available** **Check blood glucose**	
5 mins (2nd step)	Midazolam 0.5 mg/kg buccally or Lorazepam 0.1 mg/kg if intravenous access established	Midazolam may be given by parents, carers or ambulance crew in non-hospital setting
15 mins (3rd step)	Lorazepam 0.1 mg/kg intravenously	This step should be in hospital Call for senior help Start to prepare phenytoin for 4th step Re-confirm it is an epileptic seizure
25 mins (4th step)	Phenytoin 20 mg/kg by intravenous infusion over 20 mins or (if on regular phenytoin) Phenobarbital 20 mg/kg intravenously over 5 mins	Paraldehyde 0.8 ml/kg of mixture may be given after start of phenytoin infusion as directed by senior staff Inform intensive care unit and/or senior anaesthetist
45 mins (5th step)	Rapid sequence induction of anaesthesia using thiopental sodium 4 mg/kg intravenously	Transfer to paediatric intensive care unit

AES



Evidence-Based Guideline: Treatment of Convulsive Status Epilepticus in Children and Adults: Report of the Guideline Committee of the American Epilepsy Society. Epilepsy Currents, Vol. 16, No. 1 2016 pp. 48–61


ระยะ early
(5-10 นาทีแรก)
1. ดูแล airway, breathing, circulation (ABC)
2. เลือกให้ยากลุ่ม benzodiazepine 1 ชนิดจากตัวเลือกดังนี้: diazepam, midazolam ตามขนาดยา (ตารางที่ 18)
3. ตรวจ capillary blood glucose, electrolyte, Mg, Ca, ระดับยากลุ่ม antiepileptic และอื่นๆ ตามความเหมาะสม ❶
4. ให้ thiamine 100 mg IV ในผู้ที่ดื่มสุราเรื้อรังหรือทุพโภชนาการ
5. ให้ 50% glucose 50 ml IV ในผู้ใหญ่ หรือ ให้ 25% glucose 2 ml/kg IV ในเด็ก ในผู้ที่น้ำตาลต่ำหรือตรวจไม่ได้
ยากลุ่ม benzodiazepine (ก๒/++)[5,15,17] ระดับ P S T
ระยะ established
(10-30 นาทีต่อมา)
1. ABC และพยายามคุมให้ MAP >70 mmHg ในผู้ใหญ่ ในเด็กให้พิจารณาตามอายุ
2. เลือกให้ขนาดยากลุ่ม antiepileptic 1 ชนิดจากตัวเลือกดังนี้: phenytoin, phenobarbital, sodium valproate, levetiracetam (ใช้ในกรณีมีโรคตับหรือรับประทานยาชนิดนี้มาก่อน) ตามขนาดยา (ตารางที่ 18) ถ้ายังไม่หยุดชักพิจารณาให้เพิ่มยากันชัก อีก 1 ชนิด
3. ตรวจ CT หรือ MRI และ CSF เมื่อหยุดชักแล้วตามข้อบ่งชี้ ❷
ยากลุ่ม antiepileptic (ก๒/++)[2,15,18,19] levetiracetam (ข๑/+)[20,21] ระดับ S T
ถ้ายังไม่หยุดชักภายใน 60 นาที
ระยะ refractory
(30-60 นาทีต่อมา)
1. ใส่ท่อช่วยหายใจและย้ายผู้ป่วยเข้าหอผู้ป่วยวิกฤติ (ICU)
2. ปรึกษาแพทย์เวชบำบัดวิกฤติ และอายุรแพทย์หรือกุมารแพทย์
3. ใส่ central และ arterial line
4. พิจารณาทำ continuous EEG monitoring ตามข้อบ่งชี้ ❸
5. เลือกให้ยากลุ่ม anesthetic 1 ชนิดจากตัวเลือกดังนี้: midazolam, propofol, thiopental, ketamine ตามขนาดยา (ตารางที่ 18) การปรับยาขึ้นอยู่กับลักษณะคลื่นไฟฟ้าสมอง ❹
ยากลุ่ม anesthetic (ข๑/+)[6,8,9,16] ketamine (ข๔/+/-)[10] การย้ายเข้า ICU (ค๒/+)[7] continuos EEG (ค๒/+)[11] ระดับ T ขึ้นไป

Thai CPG

Thai CPG

ในระยะ refractory continuous status epilepticus ❸

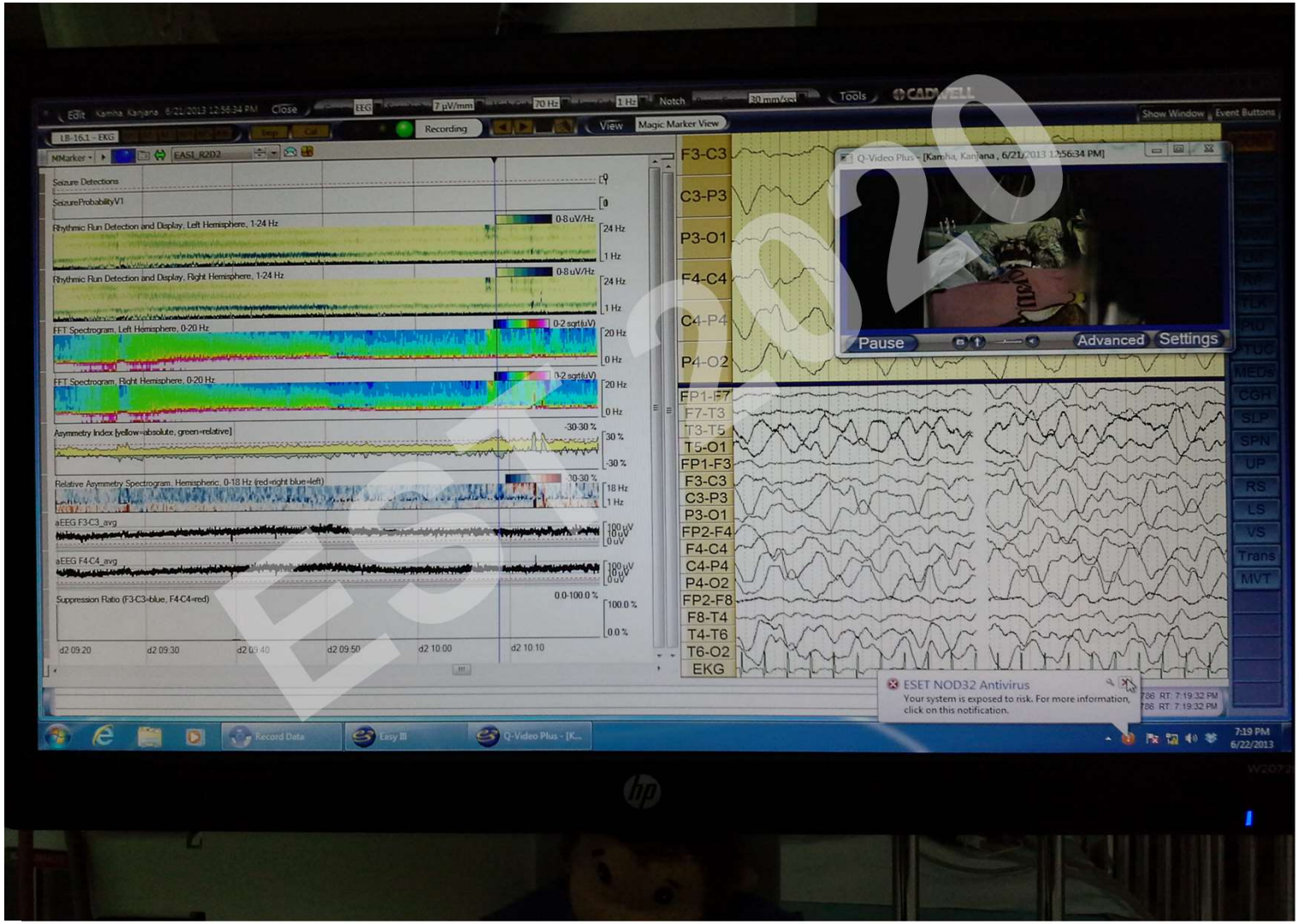
พิจารณาทำ EEG monitoring ในผู้ป่วยดังต่อไปนี้

1. ยังมีอาการชักอยู่ เนื่องจากต้องใช้คลื่นไฟฟ้าสมองเป็นตัวประเมินการให้ยากลุ่ม anesthetic agents
2. หยุดชักได้แล้วแต่ผู้ป่วยยังไม่รู้สึกตัวภายใน 24 ชั่วโมง (ผู้ป่วย convulsive SE หลังหยุดชักสามารถพบภาวะ non-convulsive SE หรือ subclinical SE ได้ร้อยละ 20)

การปรับขนาดยากลุ่ม anesthetic agents ❹

การปรับขนาดยากลุ่มนี้จะดูตามการเปลี่ยนแปลงของคลื่นไฟฟ้าสมองบน continuous EEG monitoring โดยเป้าหมายหลักในการใช้ยากลุ่มนี้ คือ 1) หยุด seizure activity ร่วมกับ 2) คลื่นไฟฟ้าสมองมีลักษณะเป็น burst suppression (ประกอบไปด้วย burst ซึ่งมีลักษณะ high amplitude polymorphic activity และ interburst ซึ่งมีลักษณะเป็น suppression) ควบคุมให้ระยะเวลา interburst interval อยู่ในช่วง 5-15 วินาทีต่อเนื่องเป็นระยะเวลา 24 ชั่วโมง

cEEG


Seizure Detections
SeizureProbabilityV1
Rhythmic Run Detection and Display, Left Hemisphere, 1-24 Hz
Rhythmic Run Detection and Display, Right Hemisphere, 1-24 Hz
FFT Spectrogram, Left Hemisphere, 0-20 Hz
FFT Spectrogram, Right Hemisphere, 0-20 Hz
Asymmetry Index [yellow=absolute, green=relative]
Relative Asymmetry Spectrogram, Hemispheric, 0-18 Hz (red=right blue=left)
aEEG F3-C3_avg
aEEG F4-C4_avg
Suppression Ratio (F3-C3-blue, F4-C4-red)
F3-C3
C3-P3
P3-O1
F4-C4
C4-P4
P4-O2
FP1-F7
F7-T3
T3-T5
T5-O1
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
FP2-F8
F8-T4
T4-T6
T6-O2
EKG
Pause
Advanced
Settings
ESET NOD32 Antivirus
Your system is exposed to risk. For more information, click on this notification.
7:19 PM
6/22/2013

Why qEEG ?

- cEEG – 24 h at 15 s/page = 5760 pages
- Monitoring SRSE can last several days

→ Problem

qEEG analysis

- parameters calculated for a brief epoch of EEG data
- Then plotted versus time

- Less reviewer's burden
- Easy pattern recognition for on-site doctors

→ Allow preliminary interpretation

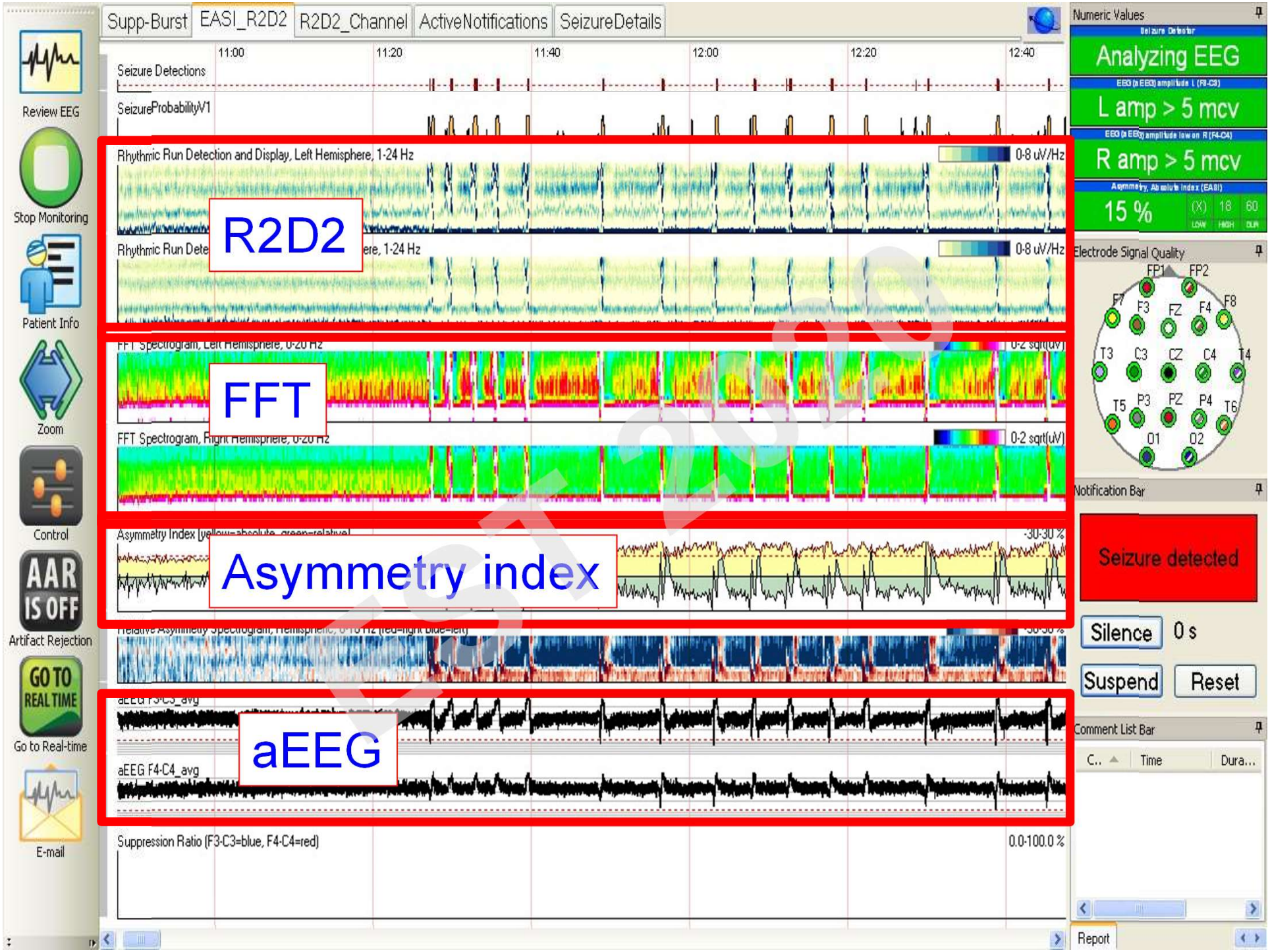
Time-domain analysis

→ how EEG amplitude varies over time

- Amplitude-integrated EEG (aEEG)
- Envelope Trend Analysis
- Burst suppression ratio (BSR)

Frequency-domain analysis

- Fourier analysis (or spectral analysis)
- Power (amplitude squared (r^2) of the Fourier series)
- Compressed Spectral Array
- Power Ratios
- Asymmetry Index (power in a given frequency band in the right VS left)
- Rhythmic Spectrogram


Review EEG
Stop Monitoring
Patient Info
Zoom
Control
AAR IS OFF
Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
Supp-Burst
EASI_R2D2
R2D2_Channel
ActiveNotifications
SeizureDetails
11:00
11:20
11:40
12:00
12:20
12:40
Seizure Detections
SeizureProbabilityV1
Rhythmic Run Detection and Display, Left Hemisphere, 1-24 Hz
0-8 uV/Hz
R2D2
FFT Spectrogram, Left Hemisphere, 0-20 Hz
FFT
FFT Spectrogram, Right Hemisphere, 0-20 Hz
0-2 sqrt(uV)
Asymmetry Index
-30-30 %
Asymmetry index
aEEG F3-C3_avg
aEEG F4-C4_avg
aEEG
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
Numeric Values
Seizure Detector
Analyzing EEG
L amp > 5 mcv
R amp > 5 mcv
Asymmetry, Absolute Index (EASI)
15 %
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Seizure detected
Silence
0 s
Suspend
Reset
Comment List Bar
C..
Time
Dura...
Report

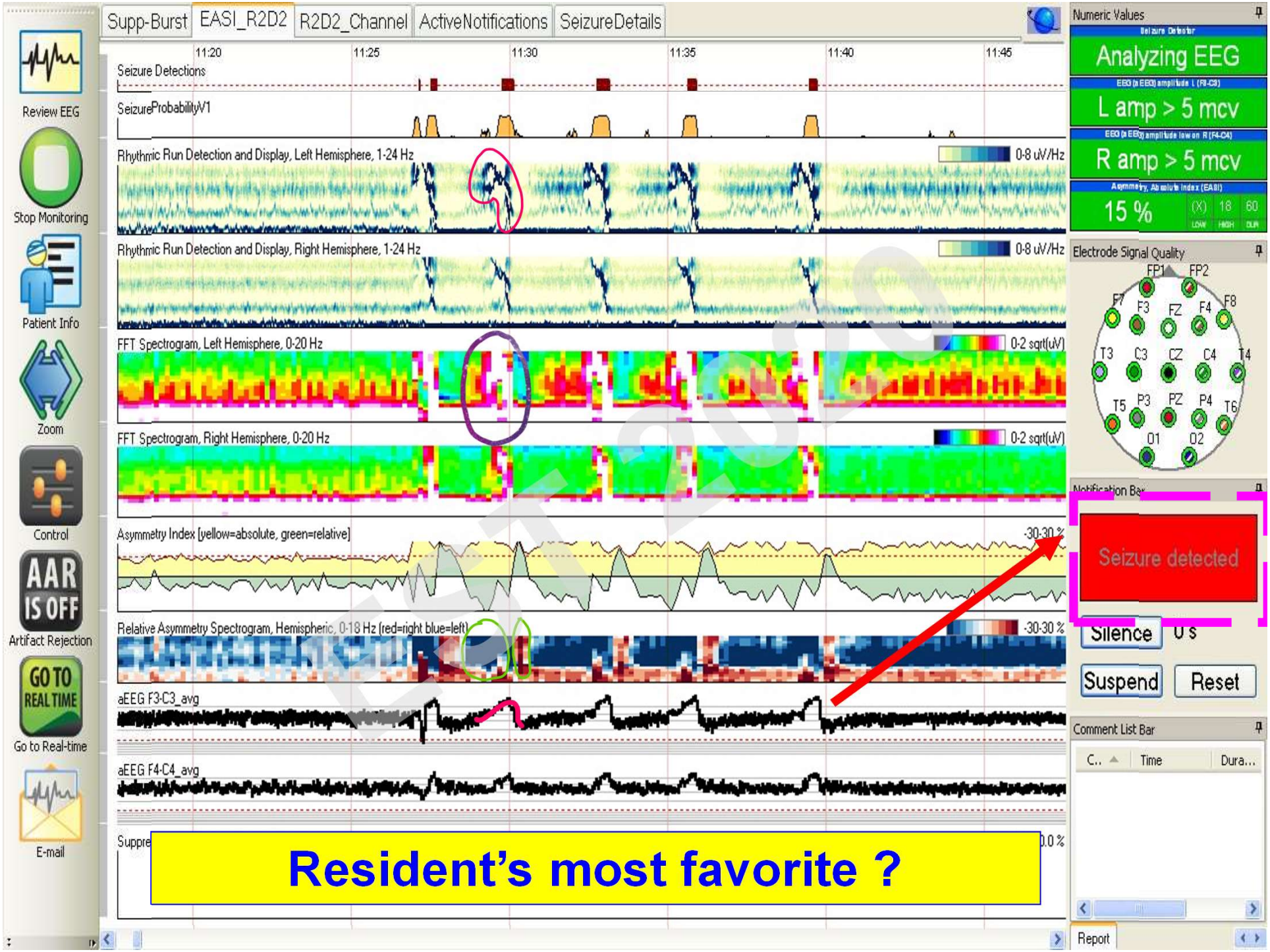
qEEG & Sz detection

- Change in amplitude/ frequency/ rhythmicity

- Sensitivity 41-89%
- False positive rate 5-39
- Accuracy affected by many variables

→ Better used as a screening to selectively review raw EEG

Swisher C. (2017) QEEG in Seizure Detection. In: Husain A., Sinha S. (eds) Continuous EEG Monitoring. Springer, Cham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EASI_R2D2
R2D2_Channel
ActiveNotifications
SeizureDetails
Review EEG
Stop Monitoring
Patient Info
Zoom
Control
AAR IS OFF
Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
11:20
11:25
11:30
11:35
11:40
11:45
Seizure Detections
SeizureProbabilityV1
Rhythmic Run Detection and Display, Left Hemisphere, 1-24 Hz
0-8 uV/Hz
Rhythmic Run Detection and Display, Right Hemisphere, 1-24 Hz
0-8 uV/Hz
FFT Spectrogram, Left Hemisphere, 0-20 Hz
0-2 sqrt(uV)
FFT Spectrogram, Right Hemisphere, 0-20 Hz
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-30-30 %
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aEEG F3-C3_avg
aEEG F4-C4_avg
Numeric Values
Analyzing EEG
L amp > 5 mcv
R amp > 5 mcv
15 %
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T4
T5
P3
PZ
P4
T6
O1
O2
Seizure detected
Silence
0 s
Suspend
Reset
Comment List Bar
Time
Report
Resident's most favorite ?

automated seizure detection

- Raw EEG processed by various algorithms
- Sensitivity 33-93%

- Commercial software (persyst 12)

→Sensitivity 76%, false positive rate 0.9/h

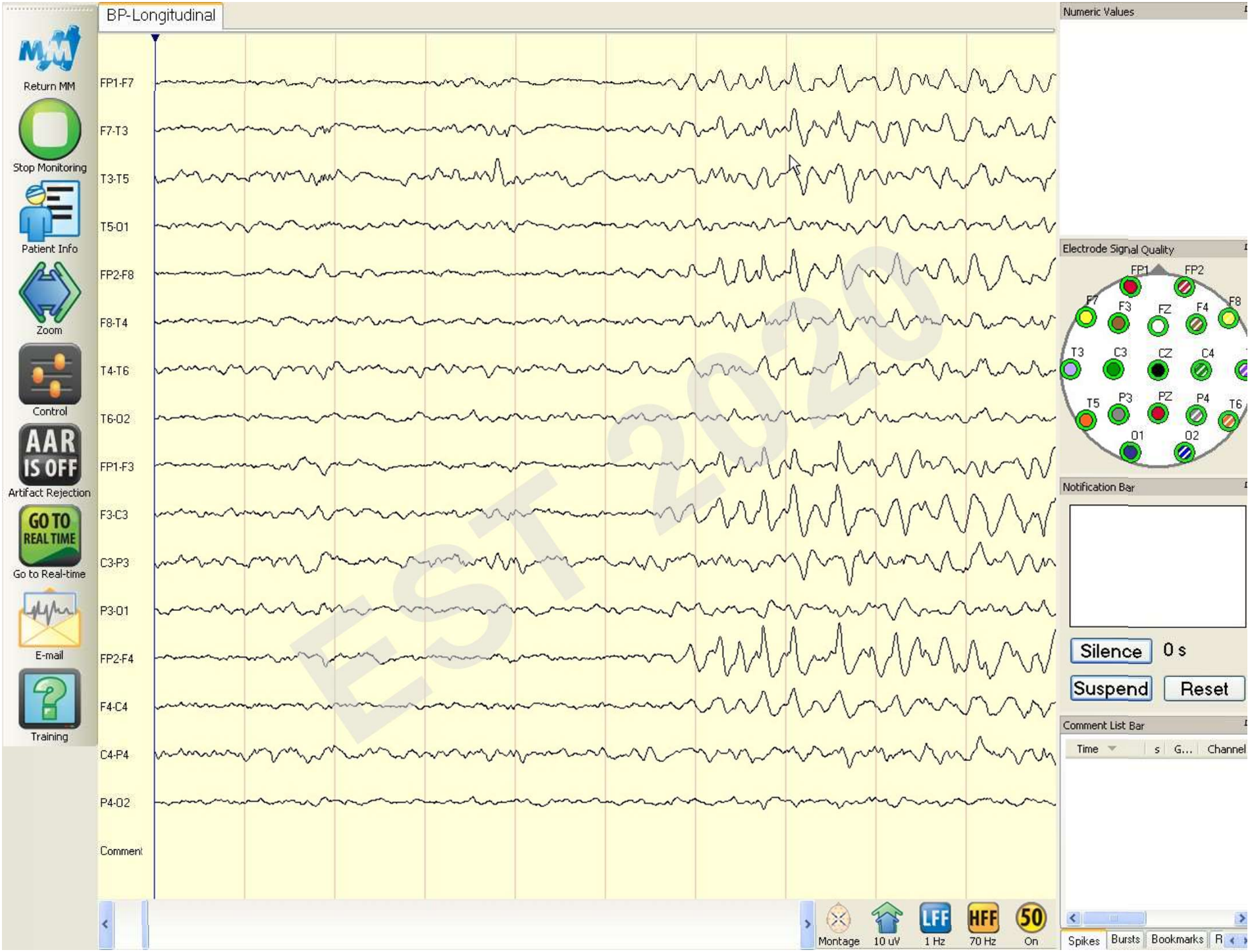
- Accuracy affected by many variables

Swisher C. (2017) QEEG in Seizure Detection. In: Husain A., Sinha S. (eds) Continuous EEG Monitoring. Springer, Cham

qEEG example

- 11 years old girl
- intractable epilepsy
- on LVT, TPM, Clobazam
- Phenytoin allergy

- tonic Sz 1-2 /week
- today - Sz increased to 20-30/d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Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
Training
BP-Longitudinal
FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
Comment
Montage
10 uV
LFF
1 Hz
HFF
70 Hz
50
On
Numeric Values
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
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C3
CZ
C4
T5
P3
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P4
T6
O1
O2
Notification Bar
Silence
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Suspend
Reset
Comment List Bar
Time
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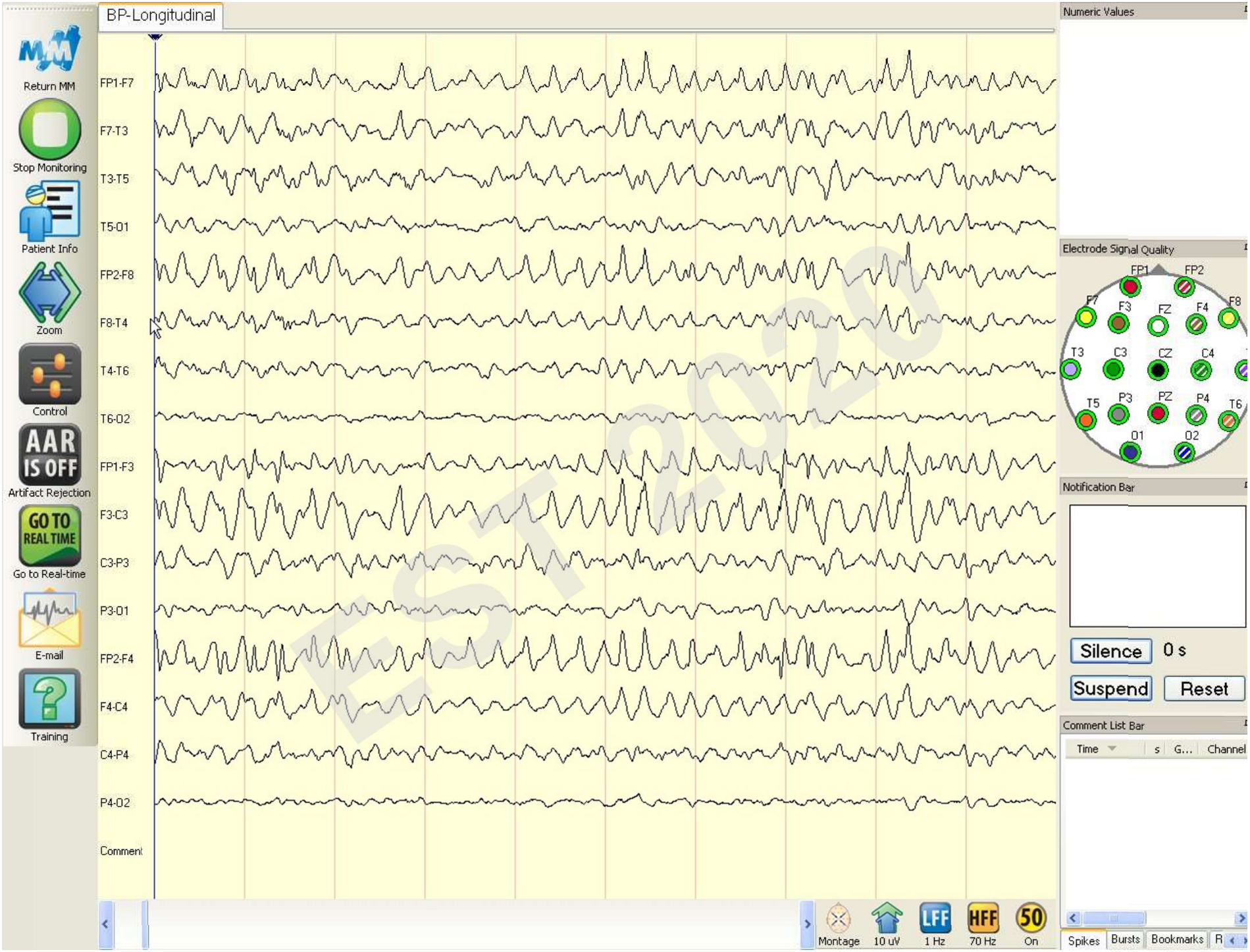
EST 2020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Training
FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
Comment
Montage
10 uV
1 Hz
70 Hz
On
Numeric Values
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
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C3
CZ
C4
T5
P3
PZ
P4
T6
O1
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Notification Bar
Silence
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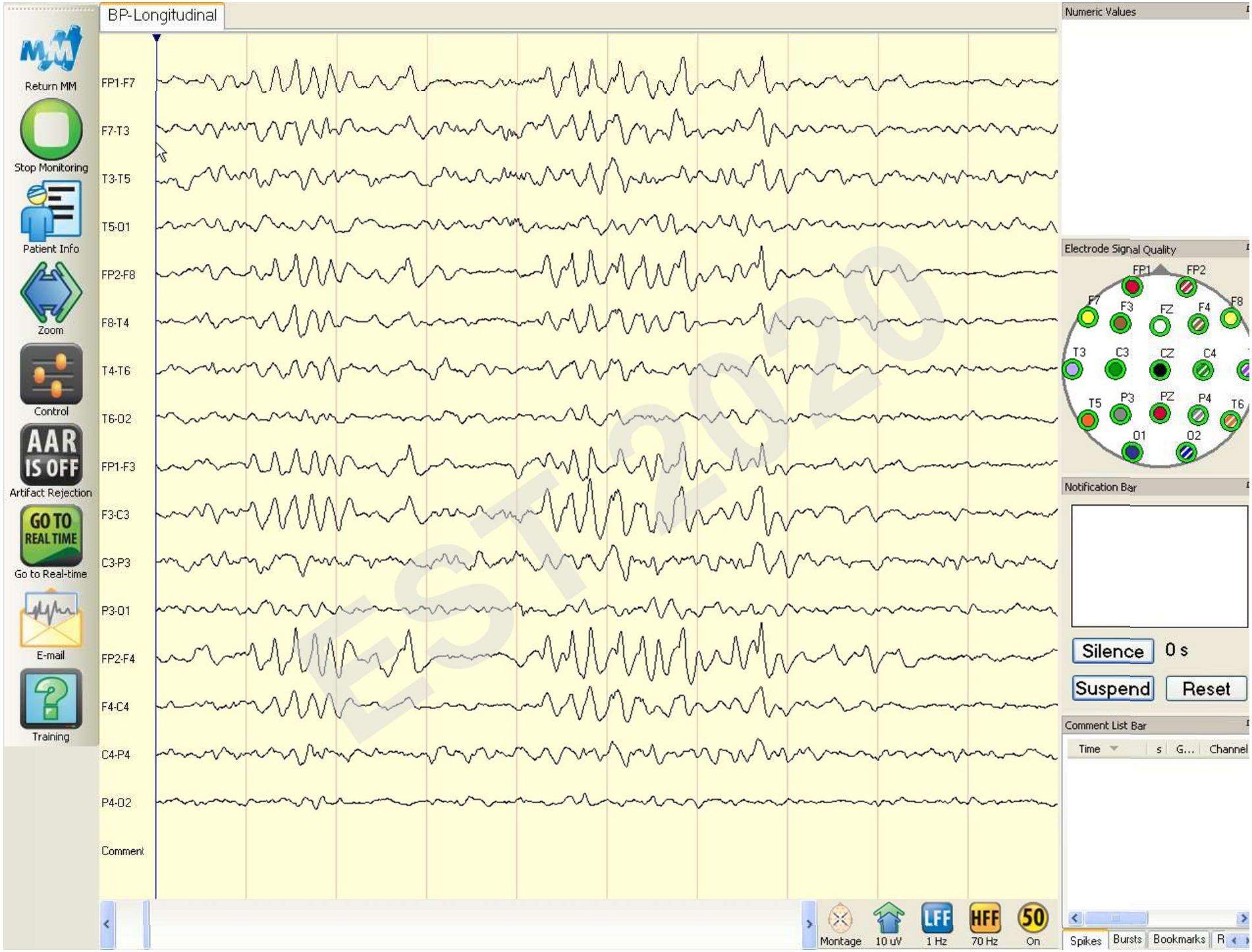
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FP1-F7
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T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
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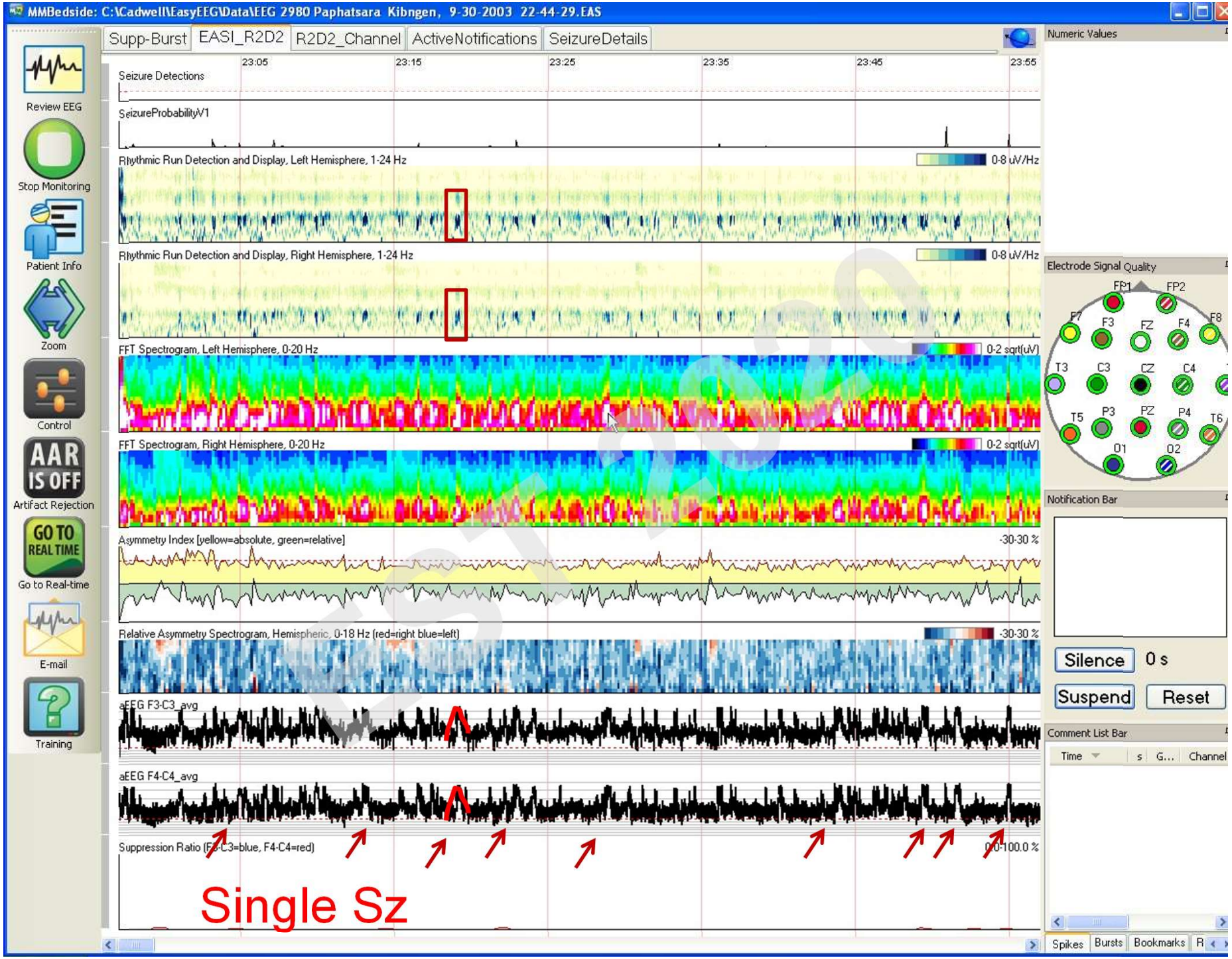
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EASI_R2D2
R2D2_Channel
ActiveNotifications
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23:05
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Seizure Detections
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aEEG F4-C4_avg
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Single Sz
Numeric Values
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F3
FZ
F4
F8
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C3
CZ
C4
T5
P3
PZ
P4
T6
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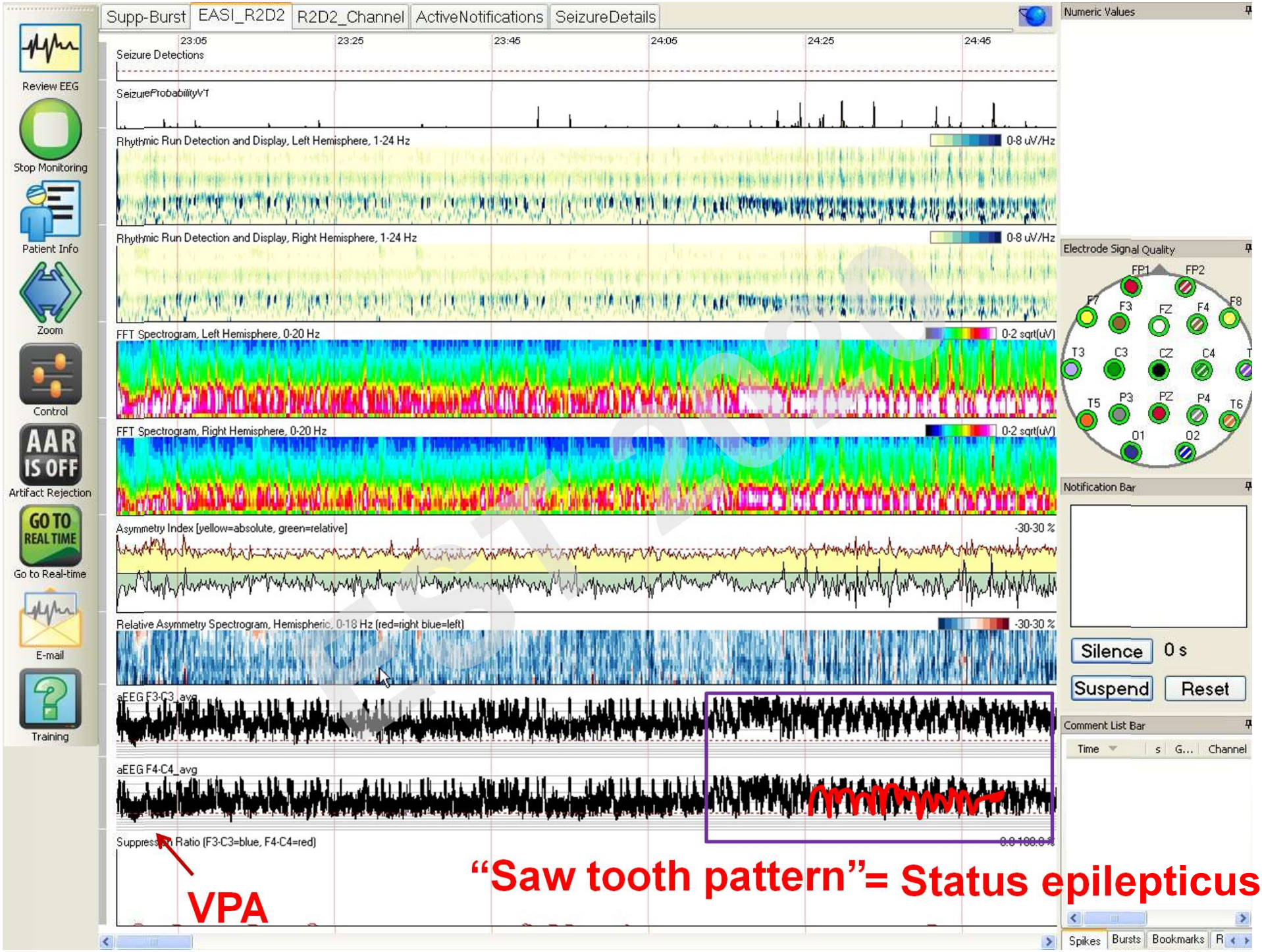
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aEEG F4-C4_avg
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
VPA
“Saw tooth pattern”= Status epilepticus
Numeric Values
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Silence
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Suspend
Reset
Comment List Bar
Time
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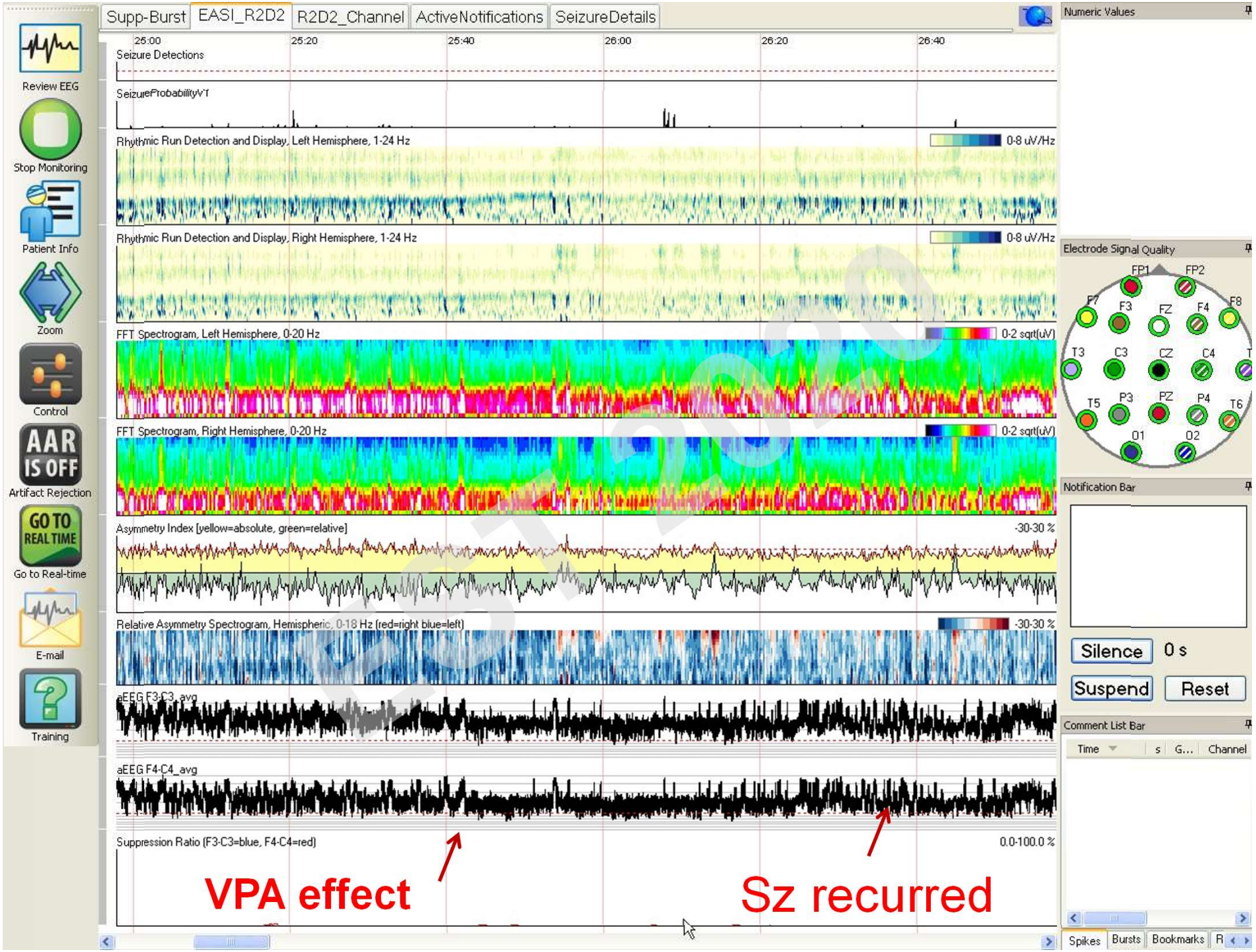
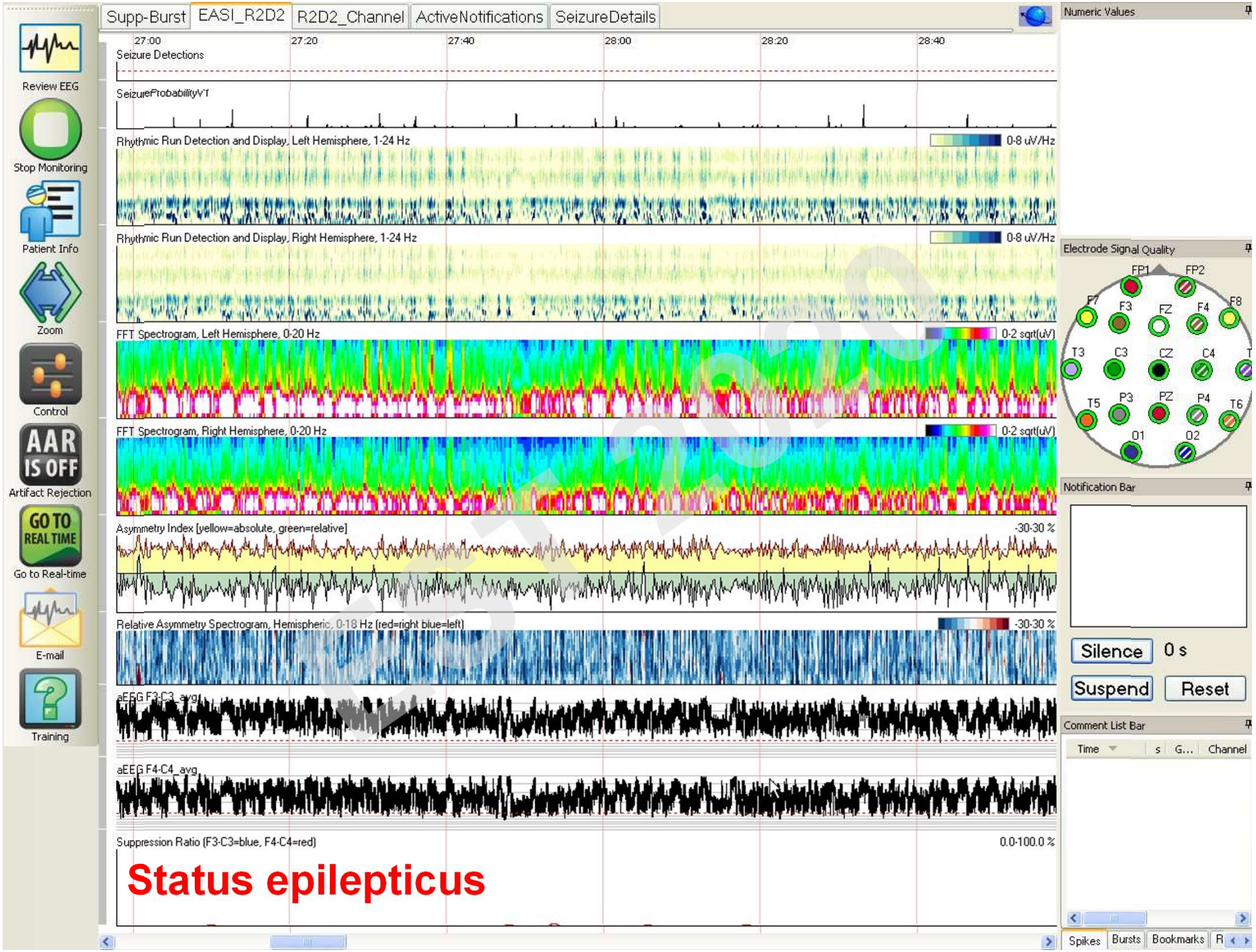
G...
Channel
Spikes
Bursts
Bookmarks


Review EEG
Stop Monitoring
Patient Info
Zoom
Control
AAR IS OFF
Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
Training
Supp-Burst
EASI_R2D2
R2D2_Channel
ActiveNotifications
SeizureDetails
25:00
25:20
25:40
26:00
26:20
26:40
Seizure Detections
SeizureProbabilityVT
Rhythmic Run Detection and Display, Left Hemisphere, 1-24 Hz
0-8 uV/Hz
Rhythmic Run Detection and Display, Right Hemisphere, 1-24 Hz
0-8 uV/Hz
FFT Spectrogram, Left Hemisphere, 0-20 Hz
0-2 sqrt(uV)
FFT Spectrogram, Right Hemisphere, 0-20 Hz
0-2 sqrt(uV)
Asymmetry Index [yellow=absolute, green=relative]
-30-30 %
Relative Asymmetry Spectrogram, Hemispheric, 0-18 Hz (red=right blue=left)
-30-30 %
aEEG F3-C3_avg
aEEG F4-C4_avg
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
VPA effect
Sz recurred
Numeric Values
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Silence
0 s
Suspend
Reset
Comment List Bar
Time
s
G...
Channel
Spikes
Bursts
Bookmarks


Supp-Burst
EASI_R2D2
R2D2_Channel
ActiveNotifications
SeizureDetails
Numeric Values
27:00
27:20
27:40
28:00
28:20
28:40
Seizure Detections
SeizureProbabilityVT
Rhythmic Run Detection and Display, Left Hemisphere, 1-24 Hz
0-8 uV/Hz
Rhythmic Run Detection and Display, Right Hemisphere, 1-24 Hz
0-8 uV/Hz
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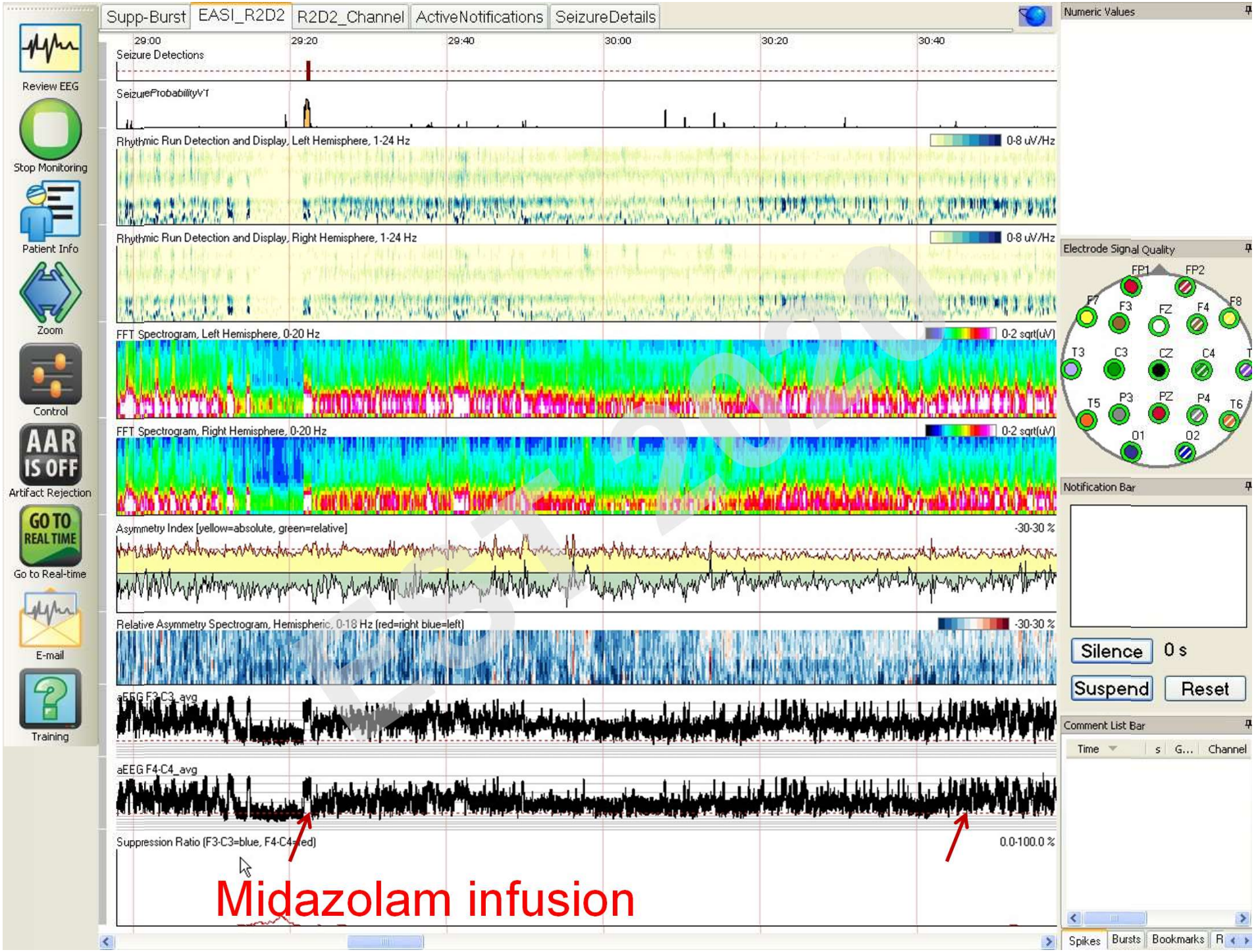
Relative Asymmetry Spectrogram, Hemispheric, 0-18 Hz (red=right blue=left)
-30-30 %
aEEG F3-C3_avg
aEEG F4-C4_avg
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
Status epilepticus
Review EEG
Stop Monitoring
Patient Info
Zoom
Control
AAR IS OFF
Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
Training
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Silence
0 s
Suspend
Reset
Comment List Bar
Time
s
G...
Channel
Spikes
Bursts
Bookmarks


Supp-Burst
EASI_R2D2
R2D2_Channel
ActiveNotifications
SeizureDetails
Numeric Values
Review EEG
Stop Monitoring
Patient Info
Zoom
Control
AAR IS OFF
Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
Training
29:00
29:20
29:40
30:00
30:20
30:40
Seizure Detections
SeizureProbabilityVT
Rhythmic Run Detection and Display, Left Hemisphere, 1-24 Hz
0-8 uV/Hz
Rhythmic Run Detection and Display, Right Hemisphere, 1-24 Hz
0-8 uV/Hz
FFT Spectrogram, Left Hemisphere, 0-20 Hz
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0-2 sqrt(uV)
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-30-30 %
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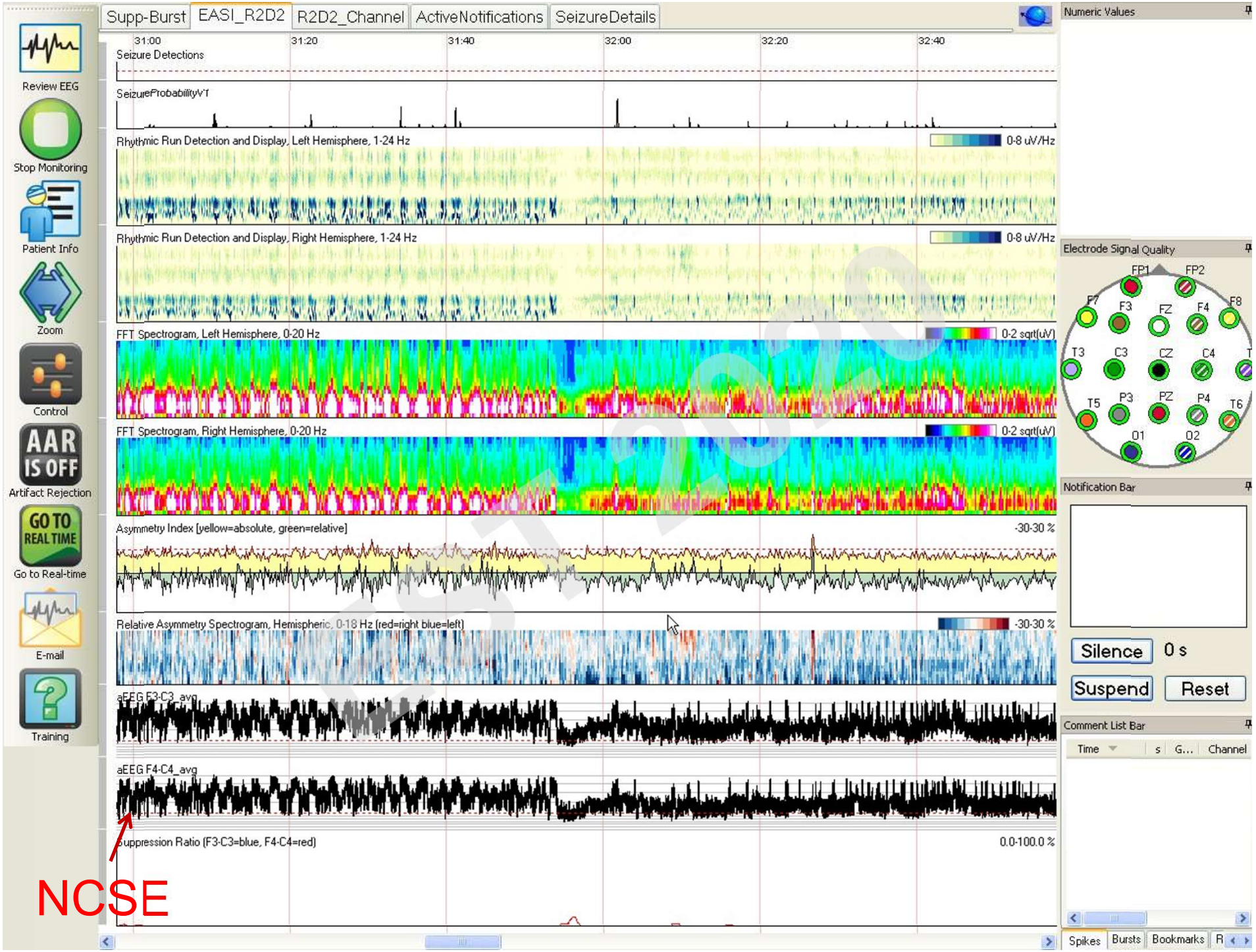
-30-30 %
aEEG F3-C3_avg
aEEG F4-C4_avg
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
Midazolam infusion
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Silence
0 s
Suspend
Reset
Comment List Bar
Time
s
G...
Channel
Spikes
Bursts
Bookmarks


Supp-Burst
EASI_R2D2
R2D2_Channel
ActiveNotifications
SeizureDetails
Numeric Values
31:00
31:20
31:40
32:00
32:20
32:40
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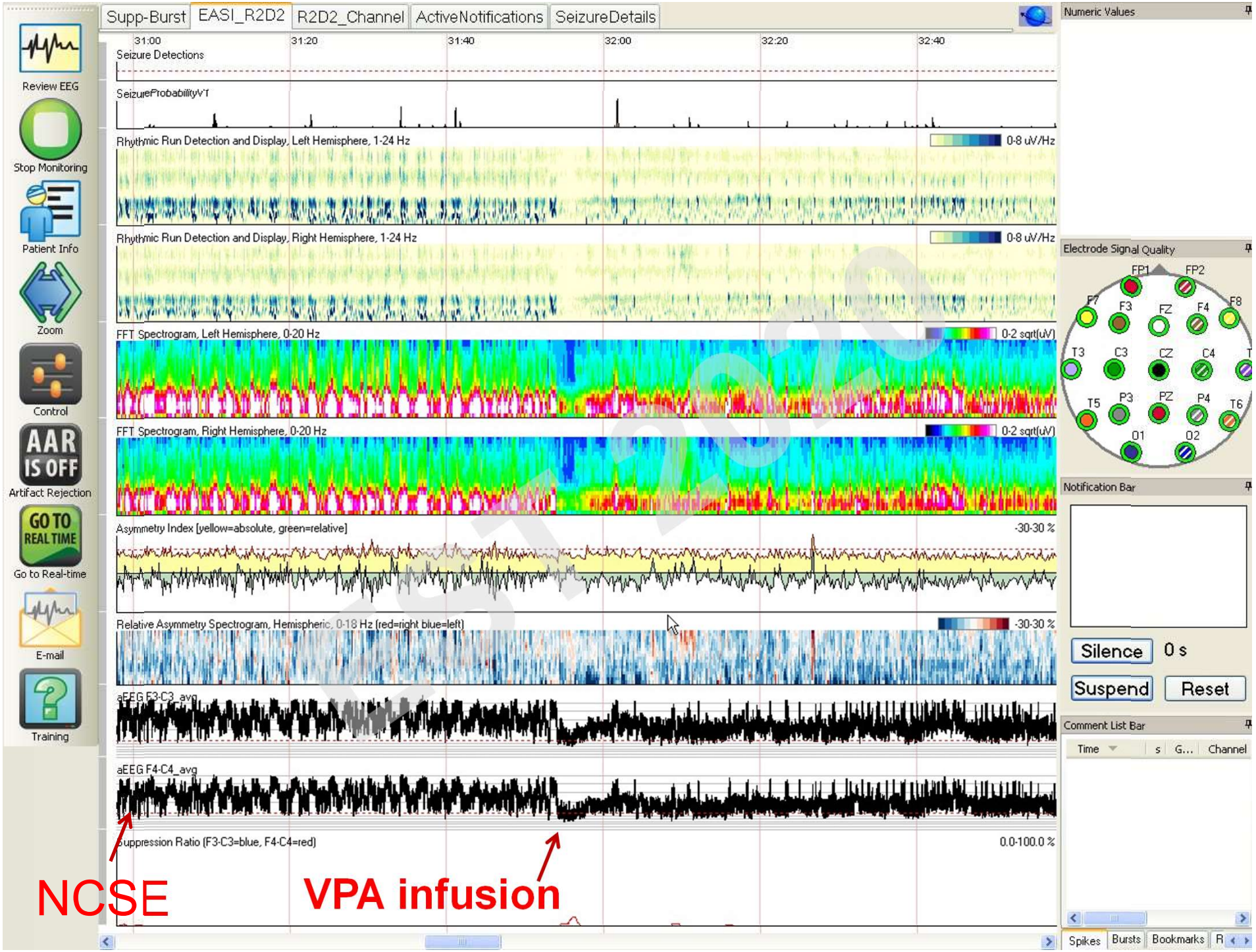
-30-30 %
aEEG F3-C3_avg
aEEG F4-C4_avg
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
Review EEG
Stop Monitoring
Patient Info
Zoom
Control
AAR IS OFF
Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
Training
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Silence
0 s
Suspend
Reset
Comment List Bar
Time
s
G...
Channel
Spikes
Bursts
Bookmarks
NCSE


Supp-Burst
EASI_R2D2
R2D2_Channel
ActiveNotifications
SeizureDetails
Numeric Values
31:00
31:20
31:40
32:00
32:20
32:40
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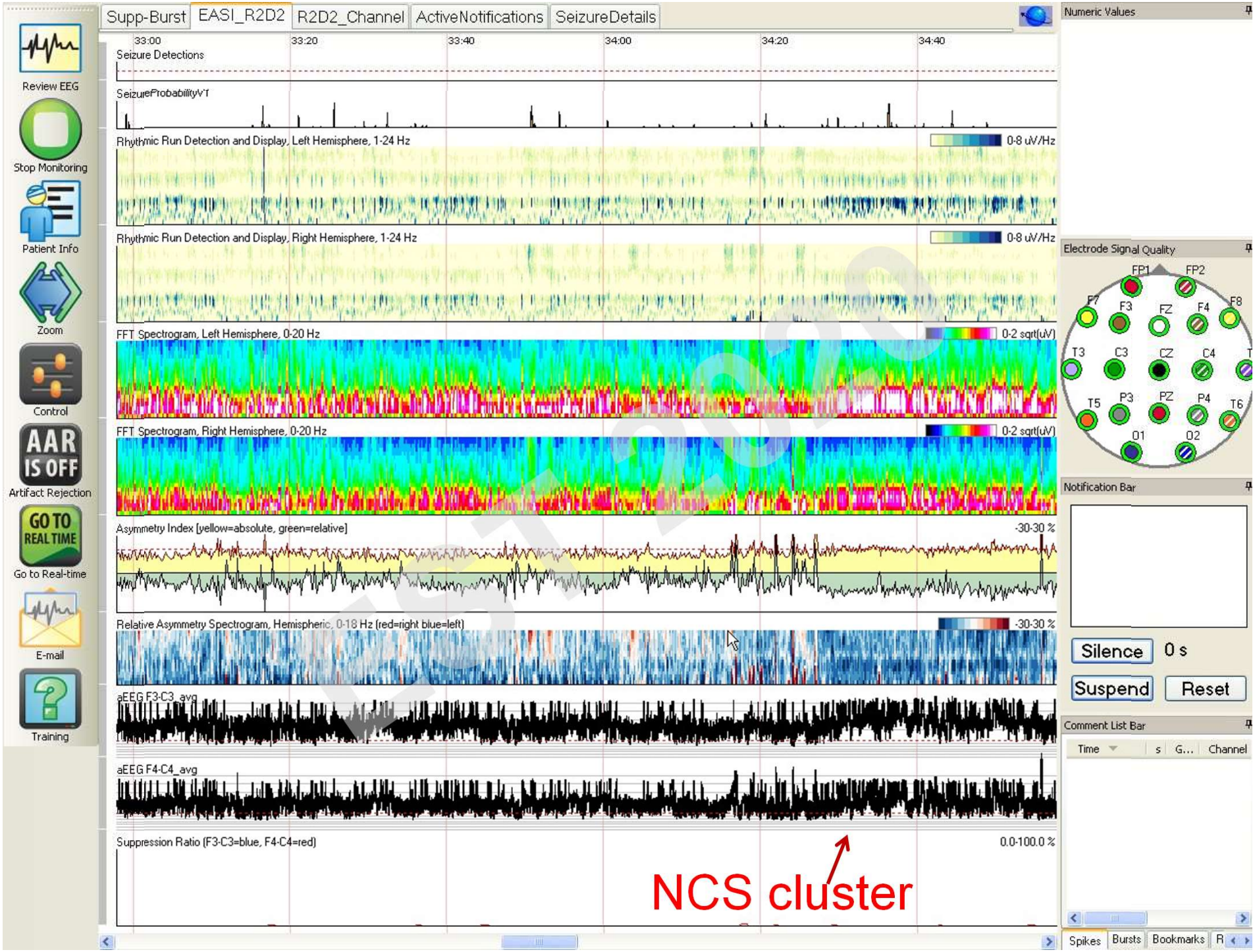
aEEG F3-C3_avg
aEEG F4-C4_avg
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
Review EEG
Stop Monitoring
Patient Info
Zoom
Control
AAR IS OFF
Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
Training
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Silence
0 s
Suspend
Reset
Comment List Bar
Time
s
G...
Channel
Spikes
Bursts
Bookmarks
NCSE
VPA infusion


Supp-Burst
EASI_R2D2
R2D2_Channel
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0-2 sqrt(uV)
Asymmetry Index [yellow=absolute, green=relative]
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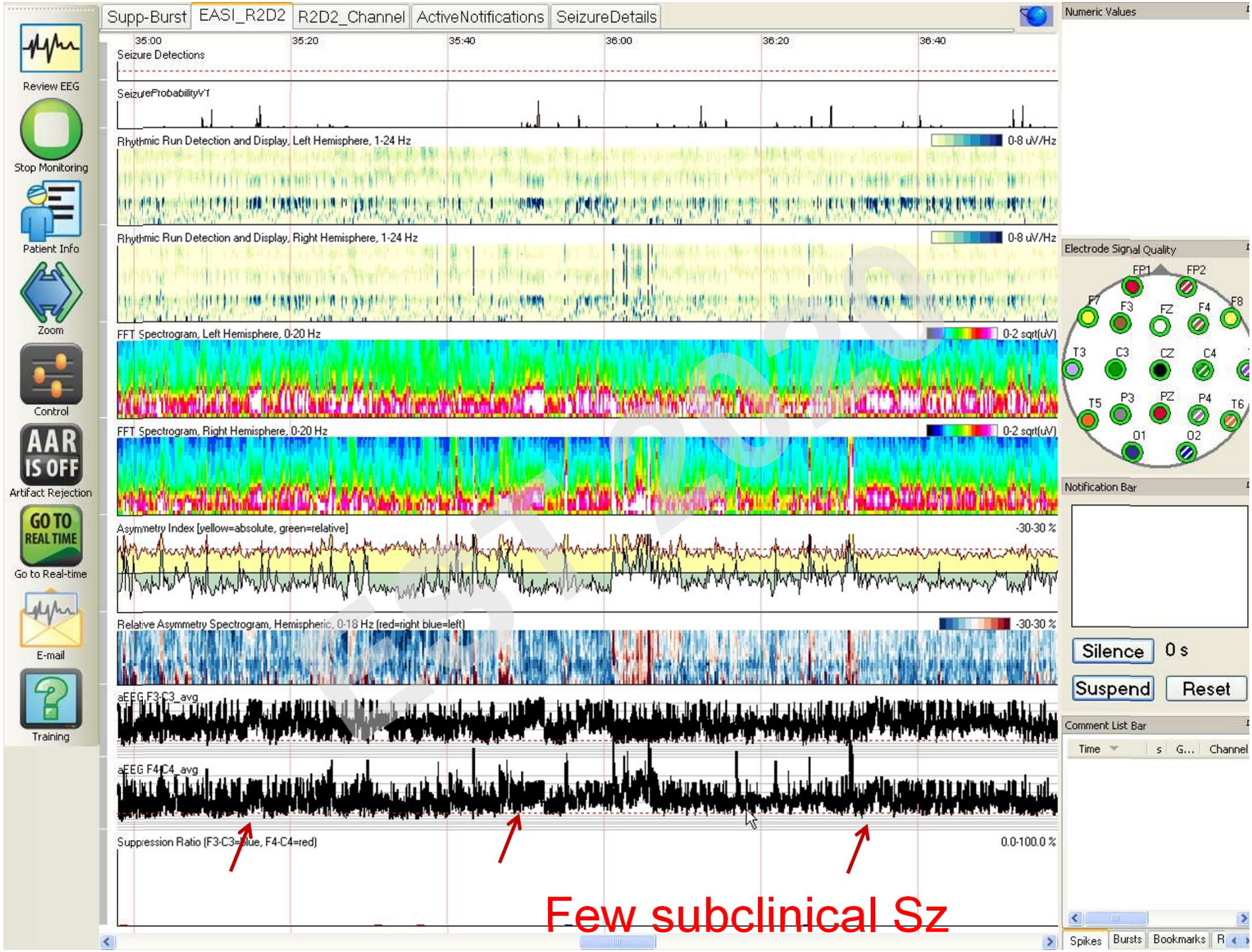
Relative Asymmetry Spectrogram, Hemispheric, 0-18 Hz (red=right blue=left)
-30-30 %
aEEG F3-C3_avg
aEEG F4-C4_avg
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
NCS cluster
Review EEG
Stop Monitoring
Patient Info
Zoom
Control
AAR IS OFF
Artifact Rejection
GO TO REAL TIME
Go to Real-time
E-mail
Training
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Silence
0 s
Suspend
Reset
Comment List Bar
Time
s
G...
Channel
Spikes
Bursts
Bookmarks


Supp-Burst
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-30-30 %
aEEG F3-C3_avg
aEEG F4-C4_avg
Suppression Ratio (F3-C3=blue, F4-C4=red)
0.0-100.0 %
Few subclinical Sz
Numeric Values
Electrode Signal Quality
FP1
FP2
F7
F3
FZ
F4
F8
T3
C3
CZ
C4
T5
P3
PZ
P4
T6
O1
O2
Notification Bar
Silence
0 s
Suspend
Reset
Comment List Bar
Time
s
G...
Channel
Spikes
Bursts
Bookmarks

case

- weaning Midazolam after 48 h

→ Sz recur

→ AED added → still failed weaning

→ Superrefractory SE

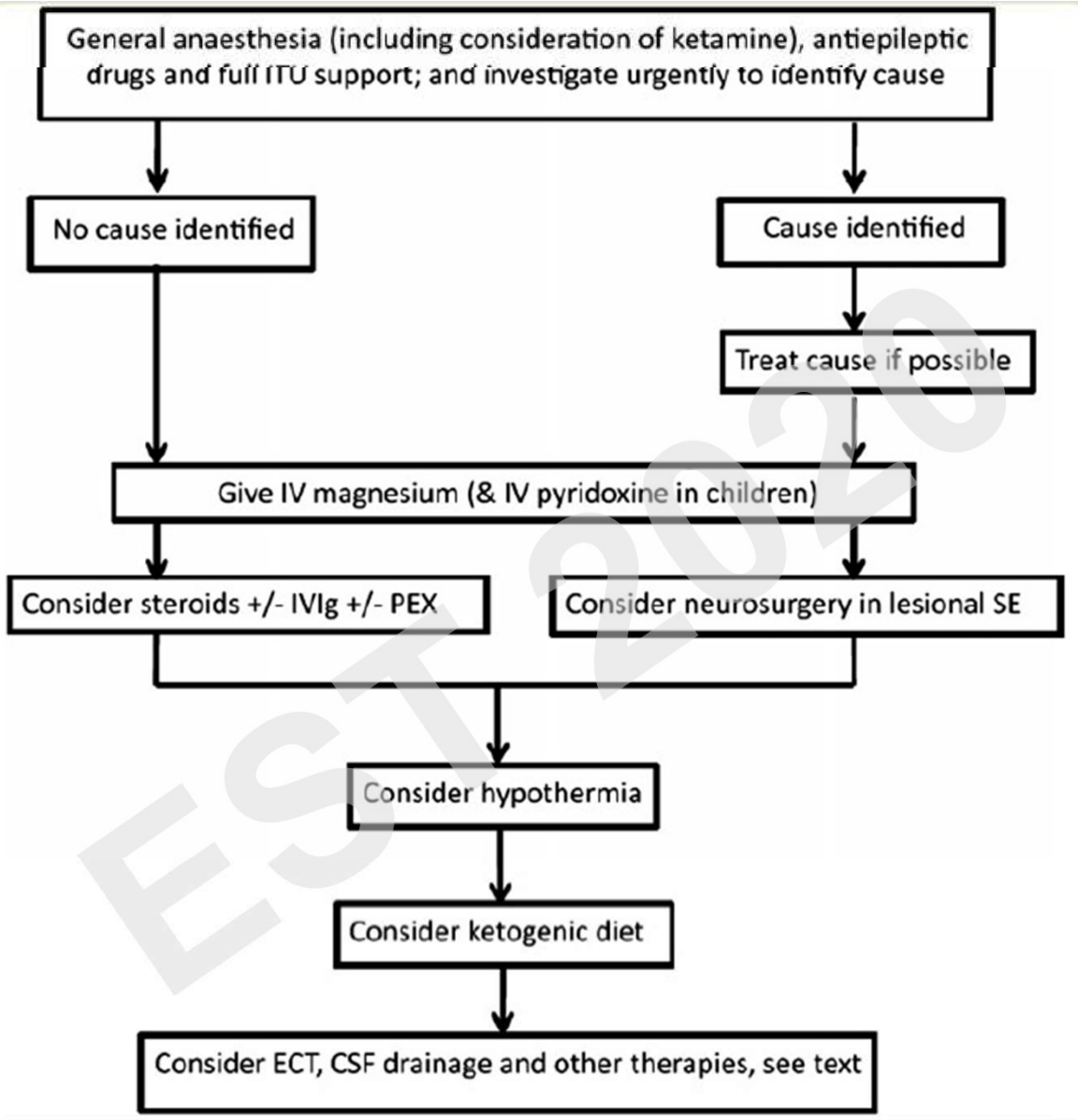
- Parenteral Ketogenic induction

→ Off Midazolam & VPA infusion

super-refractory SE

status epilepticus that

- continues or recurs 24 h or more after the onset of anaesthetic therapy
- recurs on the reduction/withdrawal of anaesthesia



The treatment of super-refractory status epilepticus: a critical review of available therapies and a clinical treatment protocol. Brain. 2011;134(10):2802-2818

SRSE

- Any AED you can get
- Anesthetics(continuous infusion/ inhaled)
- ImmunoRx: Steroid/IVIG/Plasmapharesis
- Mg
- Ketogenic diet: enteral & parenteral
- Surgery
- Therapeutic hypothermia
- Neurostimulation: VNS/DBS/RNS/TMS/ECT

RSE/SRSE & Therapeutic hypothermia

- Anecdotal evidence from small case series
- systematic review- 62.5% Sz cessation (n=40)
- HYBERNATUS

- multicentre,open-label RCT(n=270)

- No significant difference in Glasgow outcome score at 90 days (43% VS 49%)

- Zeiler FA, Zeiler KJ, Teitelbaum J, Gillman LM, West M. Can J Neurol Sci 2015;42:221–9.
- Legriel S, Lemiale V, Schenck M, Chelly J, Laurent V, Daviaud F, et al. N Engl J Med 2016;375:2457–67.

RSE/SRSE & VNS

- Anecdotal evidence from small case series
- systematic review 2015 (n=28) 76% Sz cessation in generalized

- 26% Sz cessation in focal

- systematic review 2019

- 74% Sz cessation (n=38)

- Zeiler FA, Zeiler KJ, Teitelbaum J, Gillman LM, West M.. Epilepsy Res 2015;112:100–13.
- Dibu e-Adjei, Trinka E et al. Brain Stimulation 2019; 1101-1110

RSE/SRSE & DBS/ TMS/ RNS

- DBS – a few case reports of RSE cessation from ATN, centromedian DBS
- TMS – systematic review (n=21)
  - 23.8% partial and 47.6% complete response
  - 73.3% recurrence
- RNS – 1 case report – adult with FCD, SRSE ceased in 15 d

- E. Trinka, F. Brigo . Epilepsy & Behavior 2019; 101:1-6
- Ernst L, et al. J Clin Neurophysiol 2019;36:242–5.
- Zeiler F, et al. Epilepsy Res Treat 2015:678074.

RSE/SRSE & ECT

- Anecdotal evidence from case reports and small case series
- systematic review (n=19)
  - 21.0% partial response
  - 36.8 % complete response

- E. Trinka, F. Brigo . Epilepsy & Behavior 2019; 101:1-6
- Zeiler Faet al. Seizure 2016;35:23–32.

Take-home

- qEEG – save time & allow quick response, but should be confirmed by raw EEG
- Automated seizure detection – sensitivity affected by many factors
- TH – no supporting evidence from recent RCT
- VNS/RNS/DBS/ECT – anecdotal evidence from systemic reviews of low level studies

Thank you

for your attention