

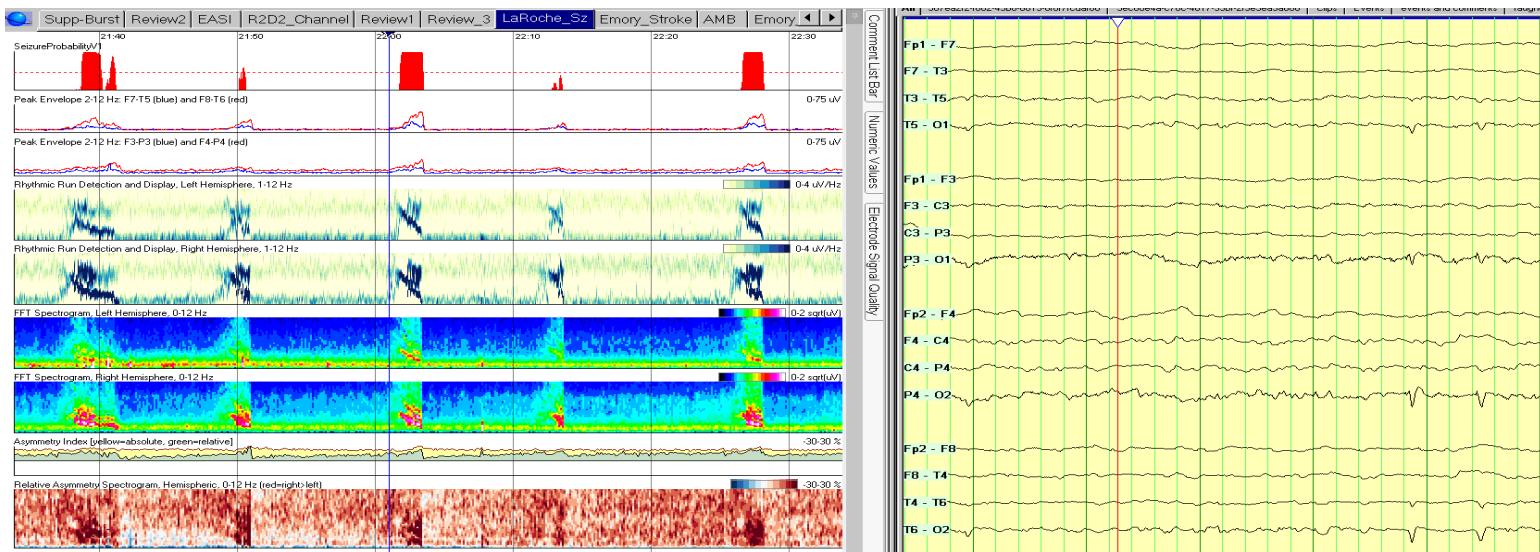
Greetings from The American Clinical Neurophysiology Society (ACNS)



International Congress of Clinical Neurophysiology

Washington DC USA

May, 2018



ICU EEG Monitoring: Overview, Indications, Guidelines

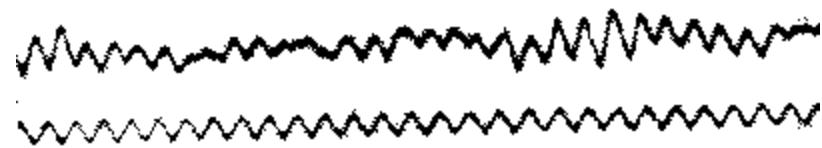
Suzette M LaRoche, MD

Mission Health Epilepsy Center

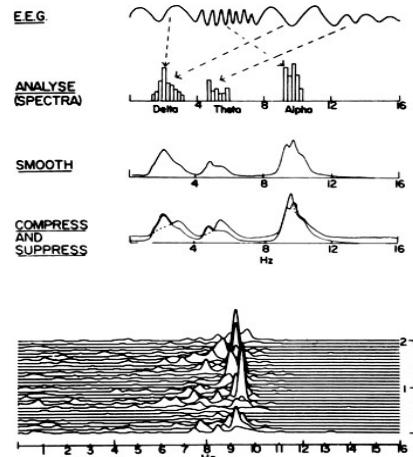
Asheville, North Carolina

Outline

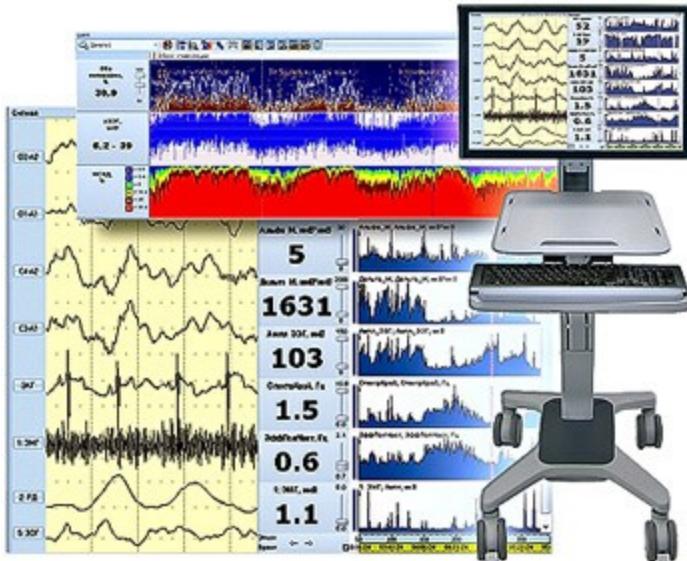
- Indications
- Guidelines
- Critical Care EEG Monitoring Consortium



1929



1960-1980s



2000- today

Why Continuous EEG?



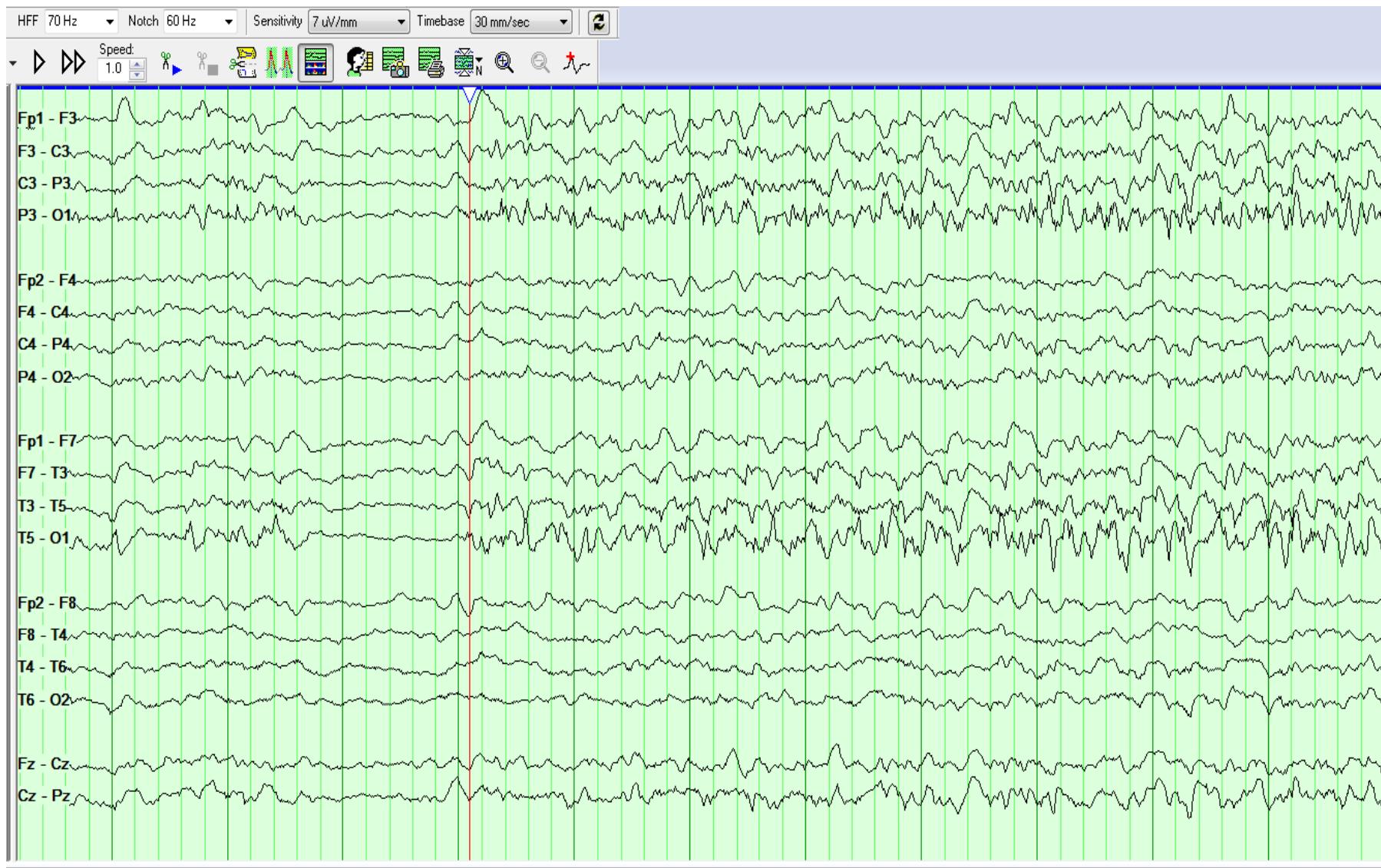
Why Continuous EEG in the NICU?

- Detect subclinical seizures
- Characterize spells or movements
- Monitor burst-suppression/ Assess sedation level
- Prognostic information
- Detect focal or diffuse ischemia

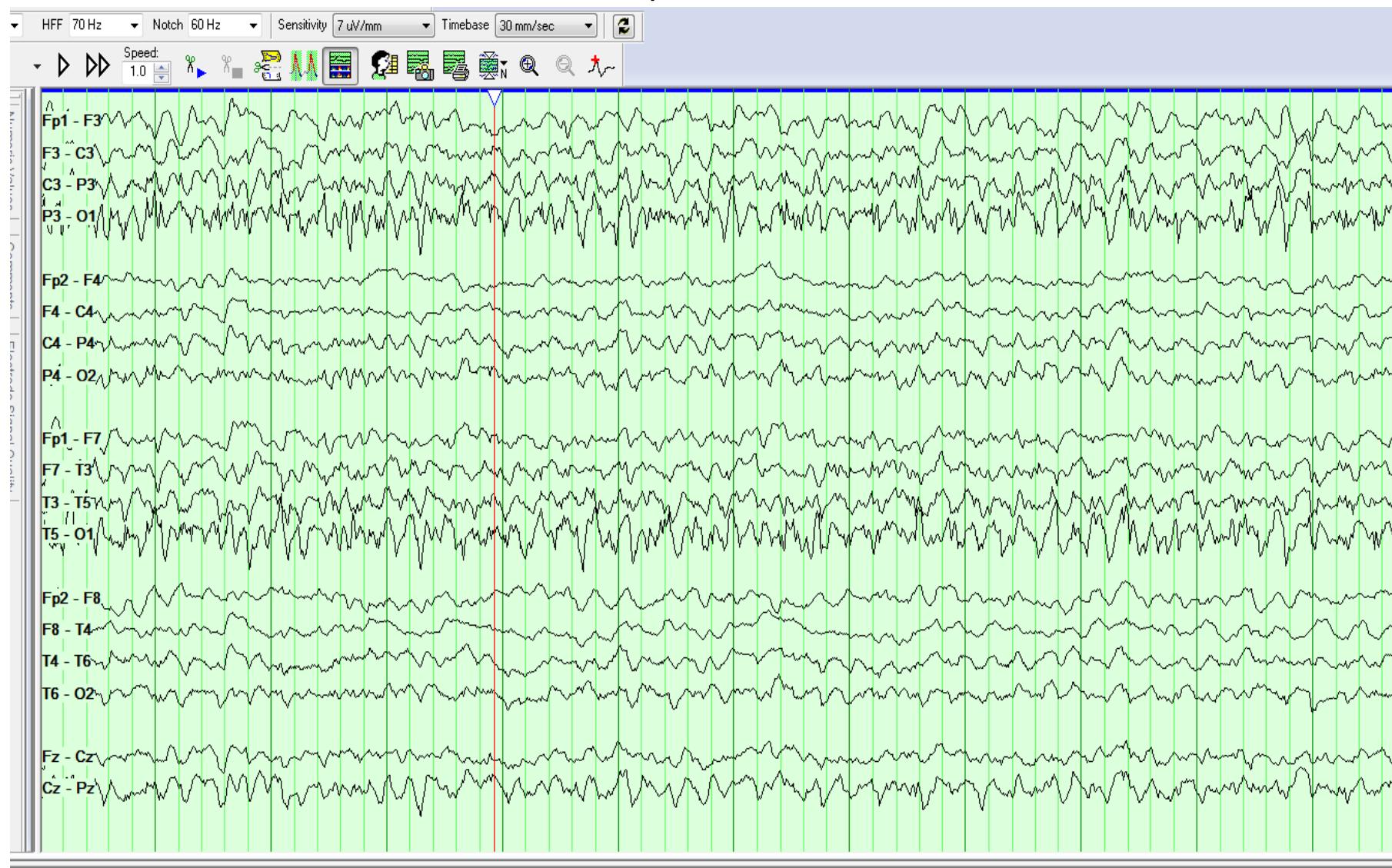
Case

- 81 yo woman with 2 days of headache, speech disturbance, “mixing words up”, and mild right side weakness
- PMHx: Hypertension, Type 2 diabetes, Remote deep vein thrombosis
- Medications: Warfarin (INR 1.6)
- Neurological Exam: Difficulty following commands, decreased movement of the right arm and leg
- Head CT: Small left posterior frontal intracranial hemorrhage

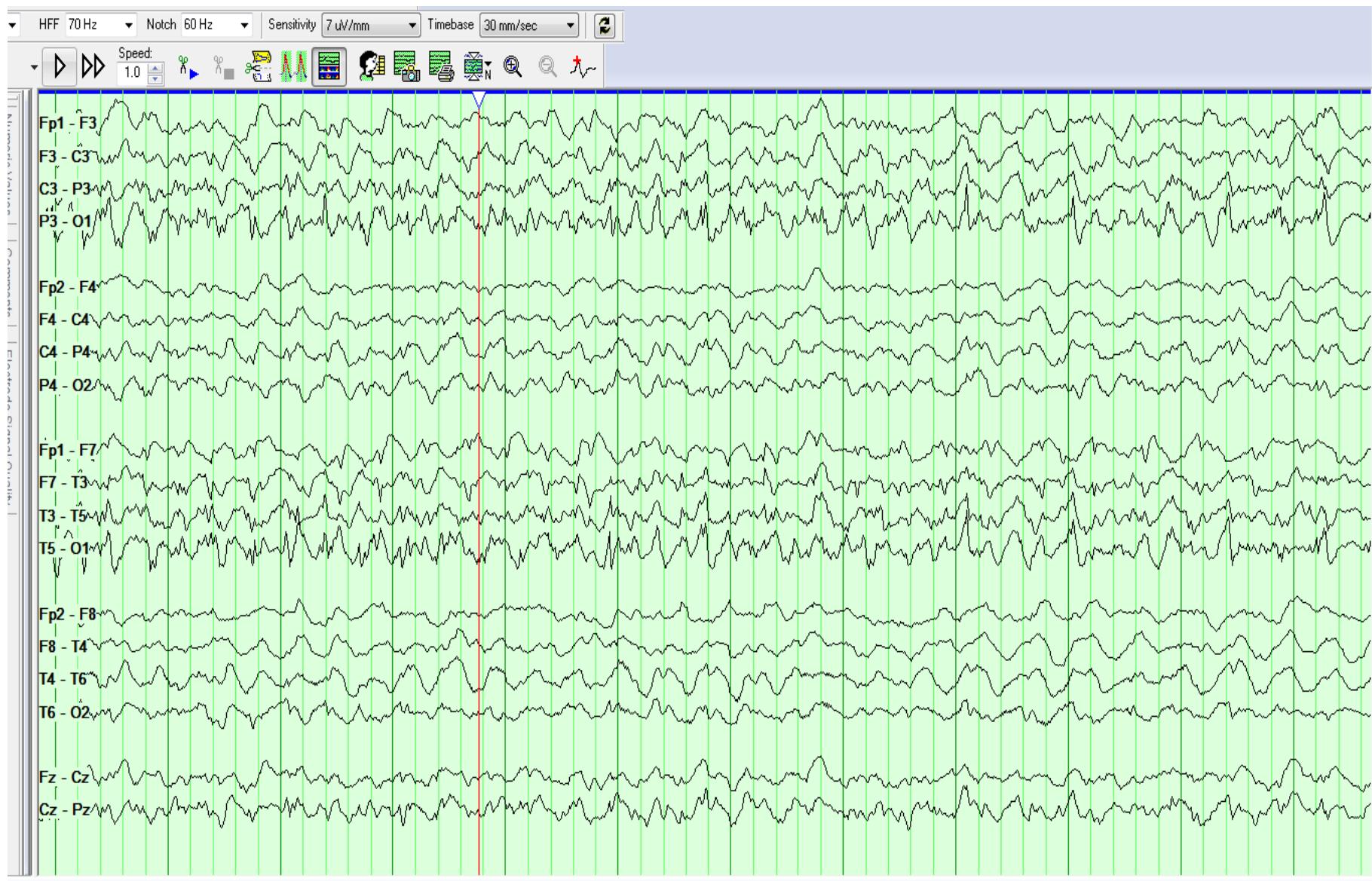
EEG



EEG, cont'd

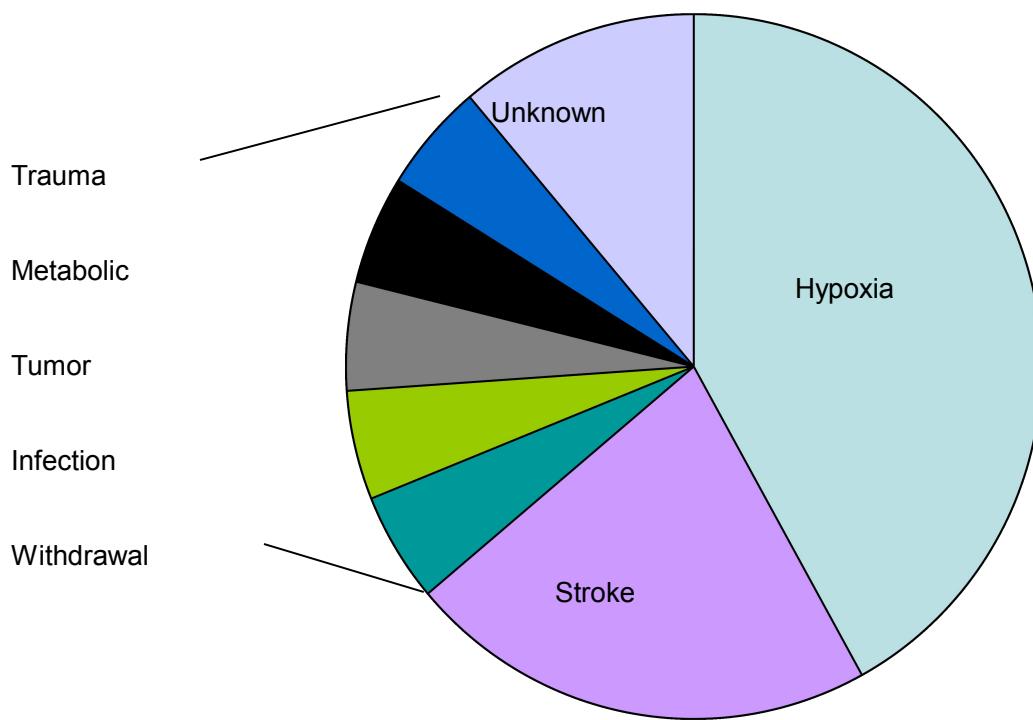


Left hemisphere seizures- Subclinical

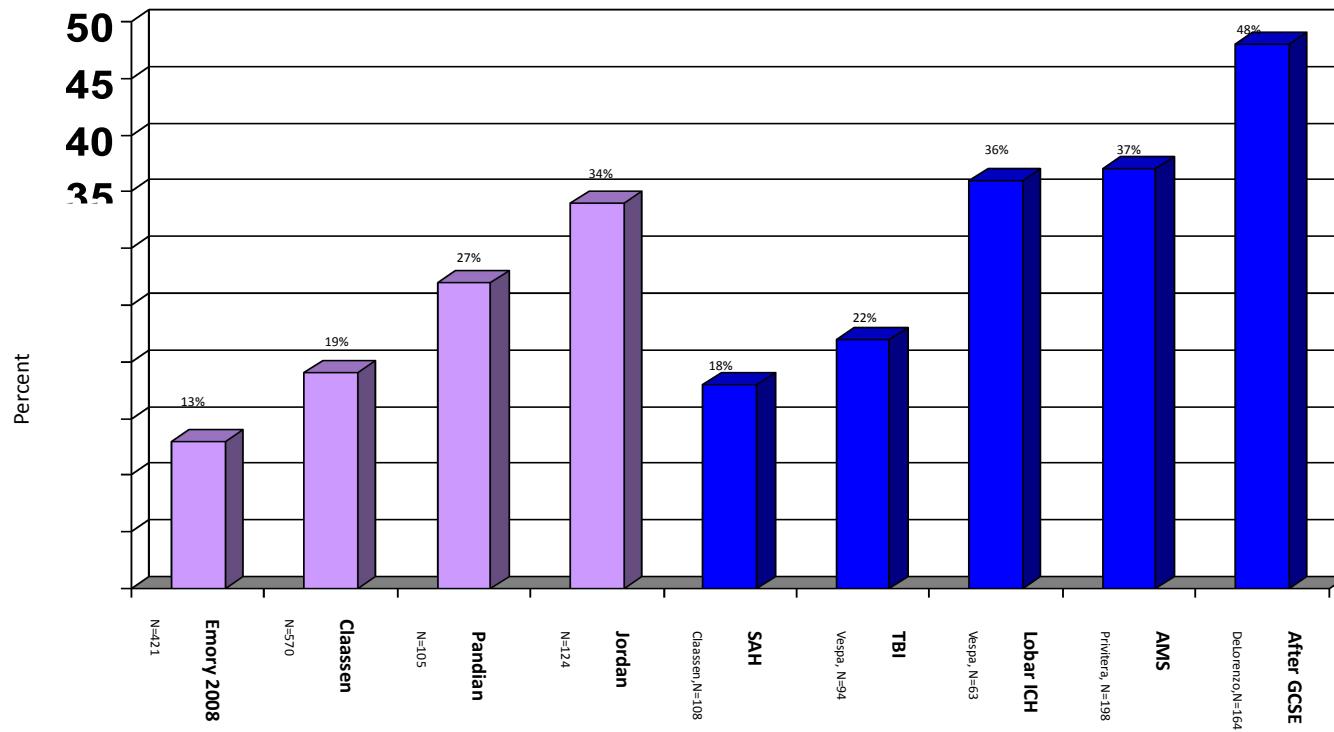


Subclinical Seizures in Coma

- 236 patients in coma and NO clinical signs of seizure
- EEG recording at least 30 minutes
- 19 (8%) in non-convulsive status epilepticus



Detecting Subclinical Seizures by EEG Monitoring

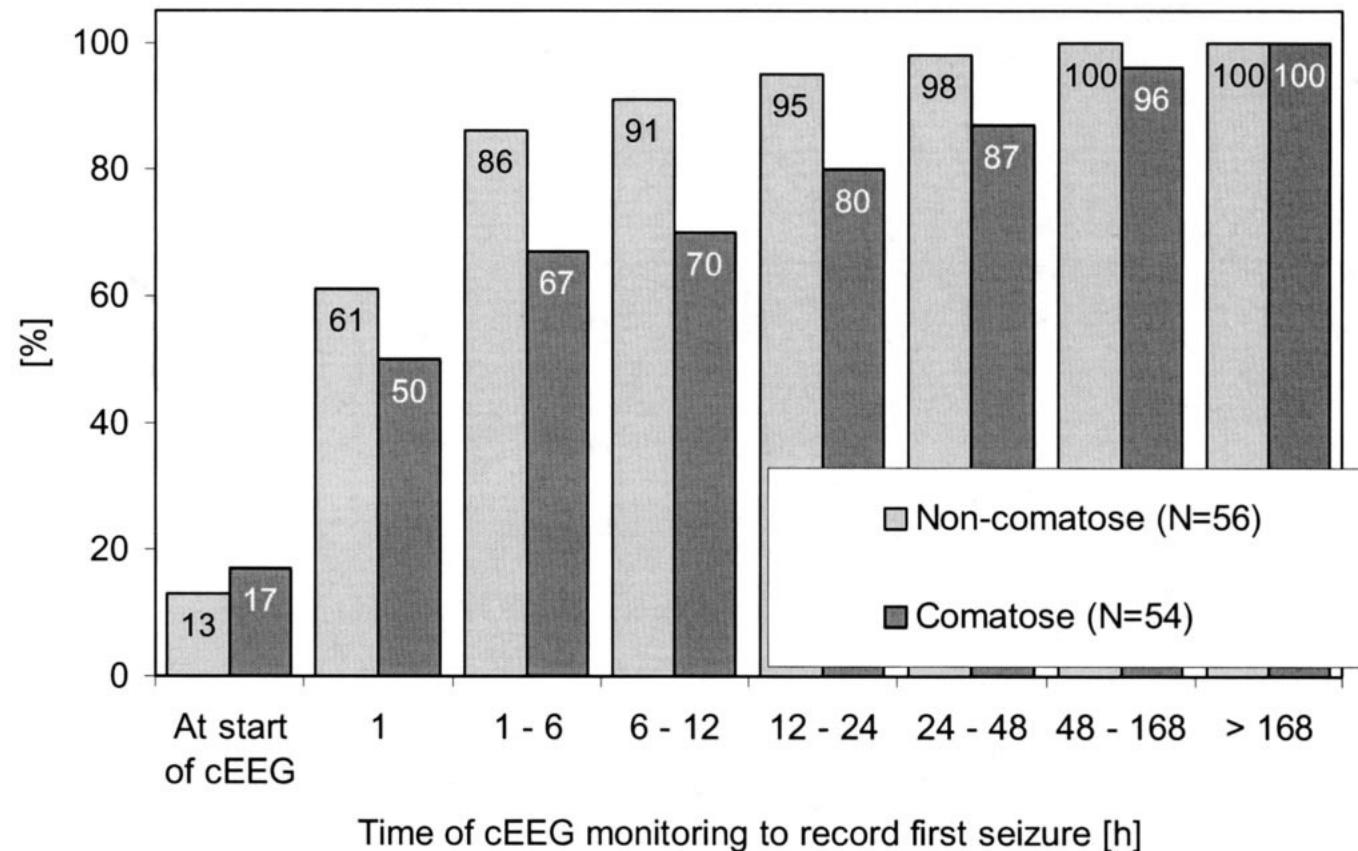


Indications

High Risk of Seizures:
Adults and Children

	Seizures on cEEG (Yes = 110; No = 460)	p value
Acute Structural Lesion	58% vs. 62%	NS
Clinical seizures before EEG	52% vs. 25%	<0.001
Coma	49% vs. 9%	<0.001
Hx of Epilepsy	26% vs. 15%	0.016
Age < 18	24% vs. 10%	<0.001
Lateralized PDs	40% vs. 11%	<0.001
Burst suppression	32% vs. 3%	<0.001
Generalized PDs	17% vs. 6%	<0.001

Time to First Seizure with cEEG

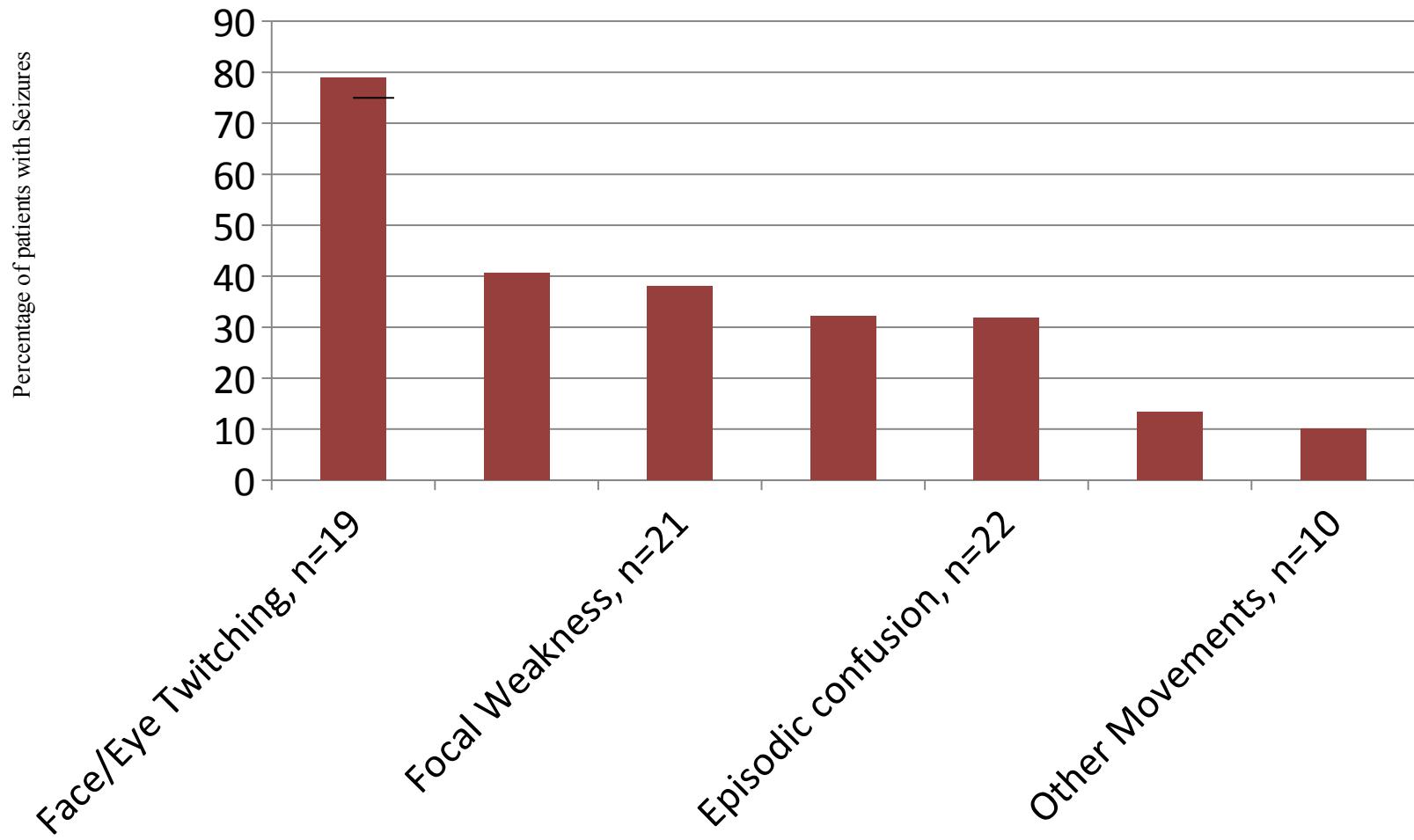


Movements in the ICU: Head Rocking



Indications

cEEG to Characterize Spells/Movements



High dose sedatives: Complete EEG Suppression



Indications

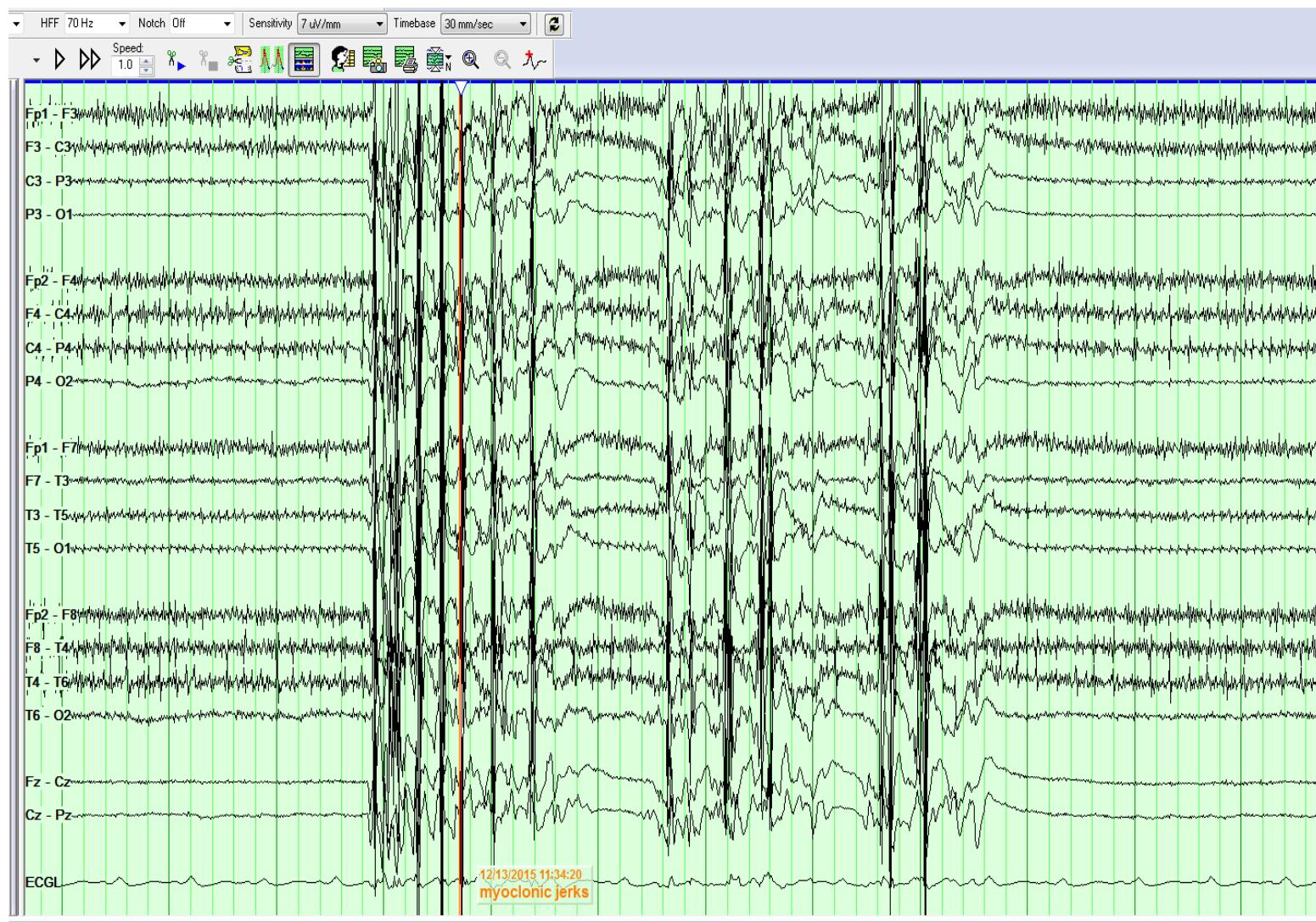
Low Risk of Seizures:

cEEG for Patients Undergoing Pharmacological Paralysis

	Paralytic YES N=64 (%)*	Paralytic NO N=1243 (%)	p value
Seizures	0 (0)	208 (16.7%)	<0.001
Good Outcome= Home or Rehab	4(6.4)	636(51.2)	<0.001
Days of cEEG	8.8	2.9	

*SAH 61%, ICH 12.5%, AIS 7.8%

Myoclonus with Burst Suppression



EEG Classification for Comatose Patients: Before Hypothermia for Cardiac Arrest

Synek, 1988

Young, 1997

Grade 1: alpha>theta

Grade 2: mostly theta;
+/- reactivity

Grade 3: mostly delta

FIRDA, +/- reactivity, spindle coma

Grade 4: Burst- suppression

~~alpha coma, theta coma,~~

low voltage

Grade 5: Isoelectric

Grade 1: Delta/theta

Grade 2: Triphasic waves

Grade 3: Burst-suppression

Grade 4: Alpha/Theta/Spindle coma
+/-reactive

Grade 5: Epileptiform activity

Grade 6: Suppression

77% Agreement, k= 0.75

80% Agreement, k= 0.90

Findings Predictive of Poor Outcome Following Therapeutic Hypothermia (TH)

- Rossetti et al, Neurology, 2012 (during TH), n=61; CEEG in 29/61
 - **Non-reactive**
 - Discontinuous background/ **Burst-suppression**
- Crepeau et al, Neurology, 2013 (during TH and return of NT), n=51
 - **Non-reactive**
 - **Burst-Suppression** or suppression (<10 uV)
 - GPDs
 - Seizures or Status Epilepticus
- Soholm et al, Resuscitation, 2014 (median 3 days), n=219
 - **Non-reactive**
 - **Burst-suppression/ suppression**

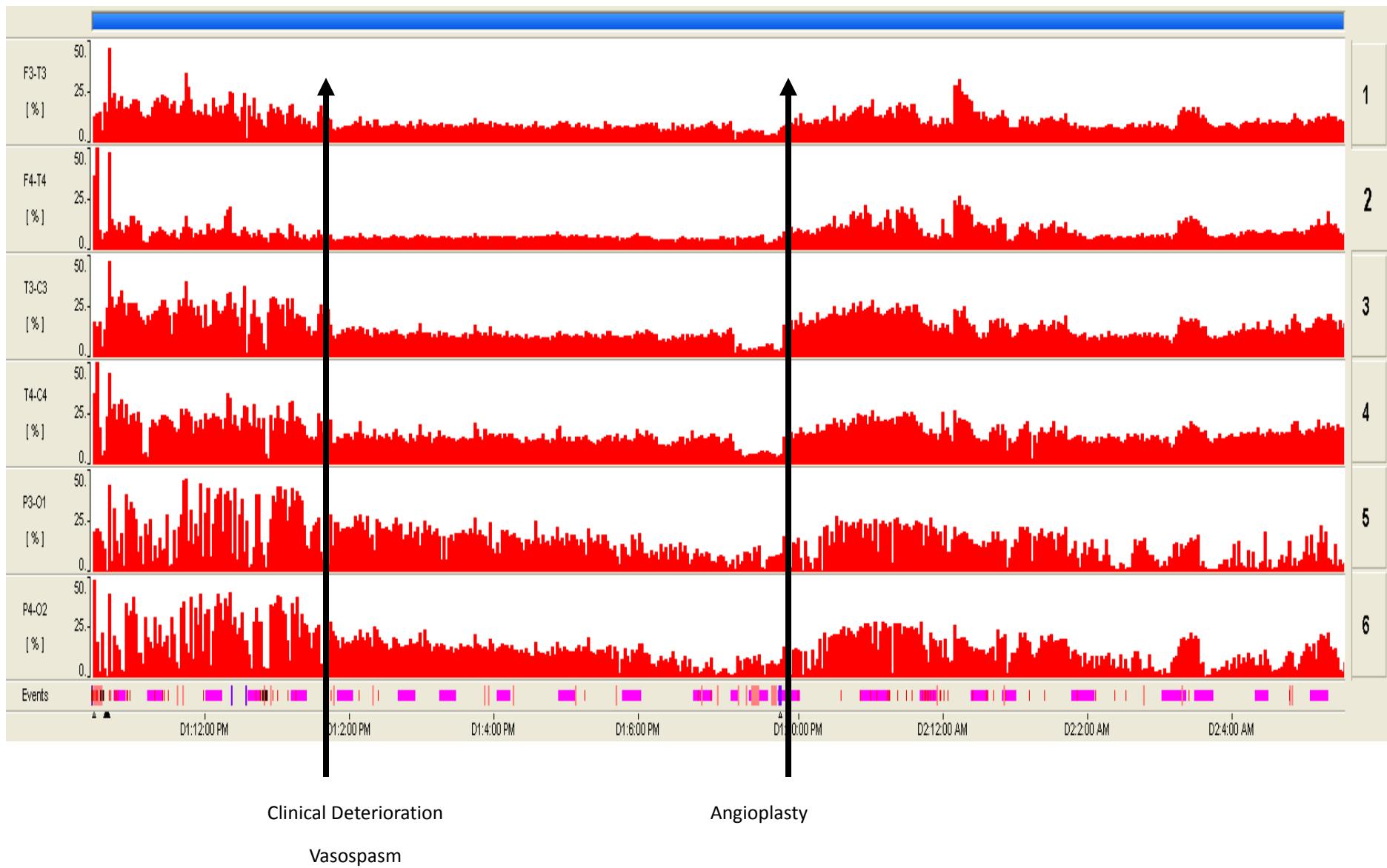
Indications

Cerebral Ischemia

- EEG changes occur within 5 minutes of acute ischemia
 - Superior imaging techniques
 - Reversible stage

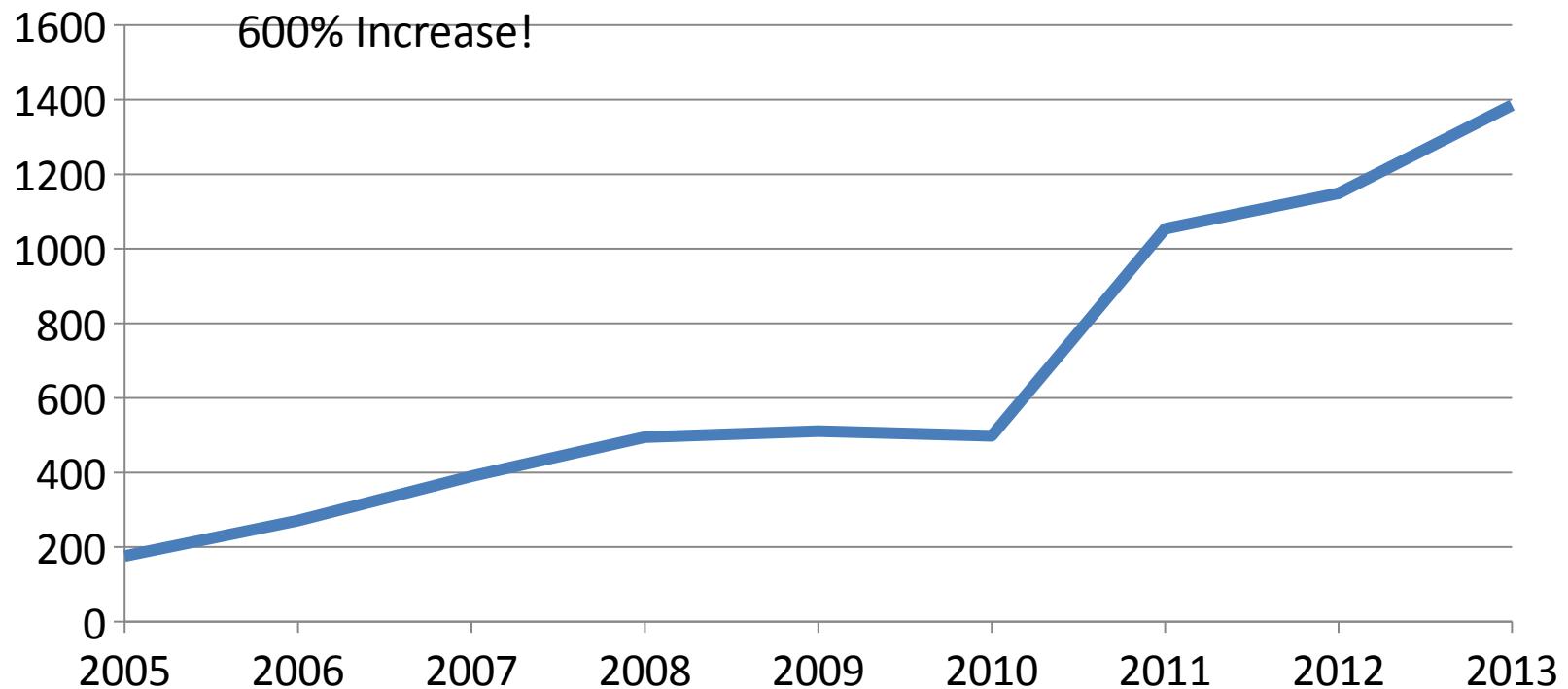
ml/100g/min	EEG change	Reversibility
35-70	Normal	No injury
25-35	Loss of beta	Reversible
18-25	Theta slowing	Reversible
12-18	Delta slowing	Reversible
< 8-10	Supression	Irreversible

Alpha Variability: 57 yo SAH from Right ACA Aneurysm



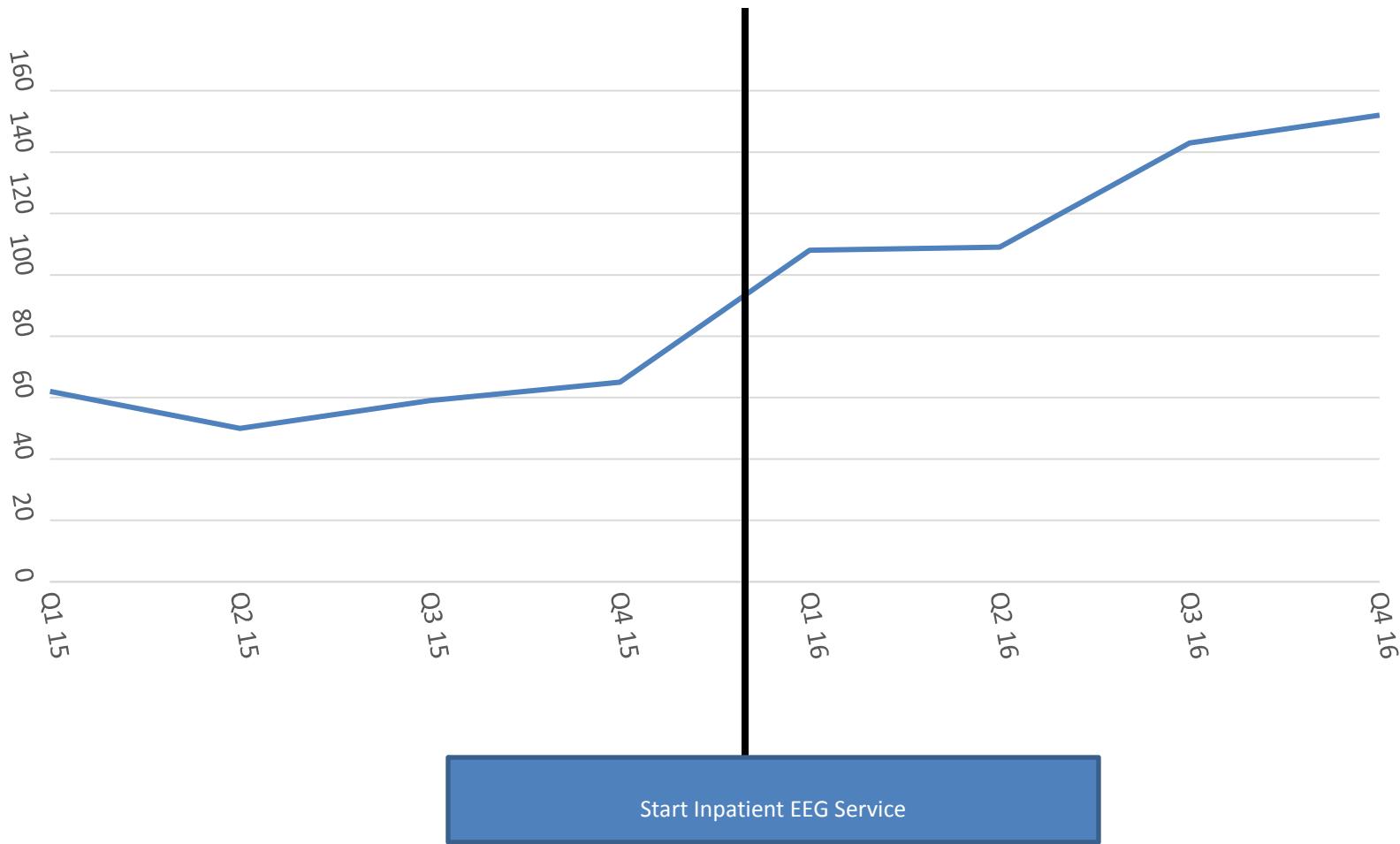
ICU EEG Volume 2005-2013

Total Patients: Emory University



ICU EEG Volume 2015-2016

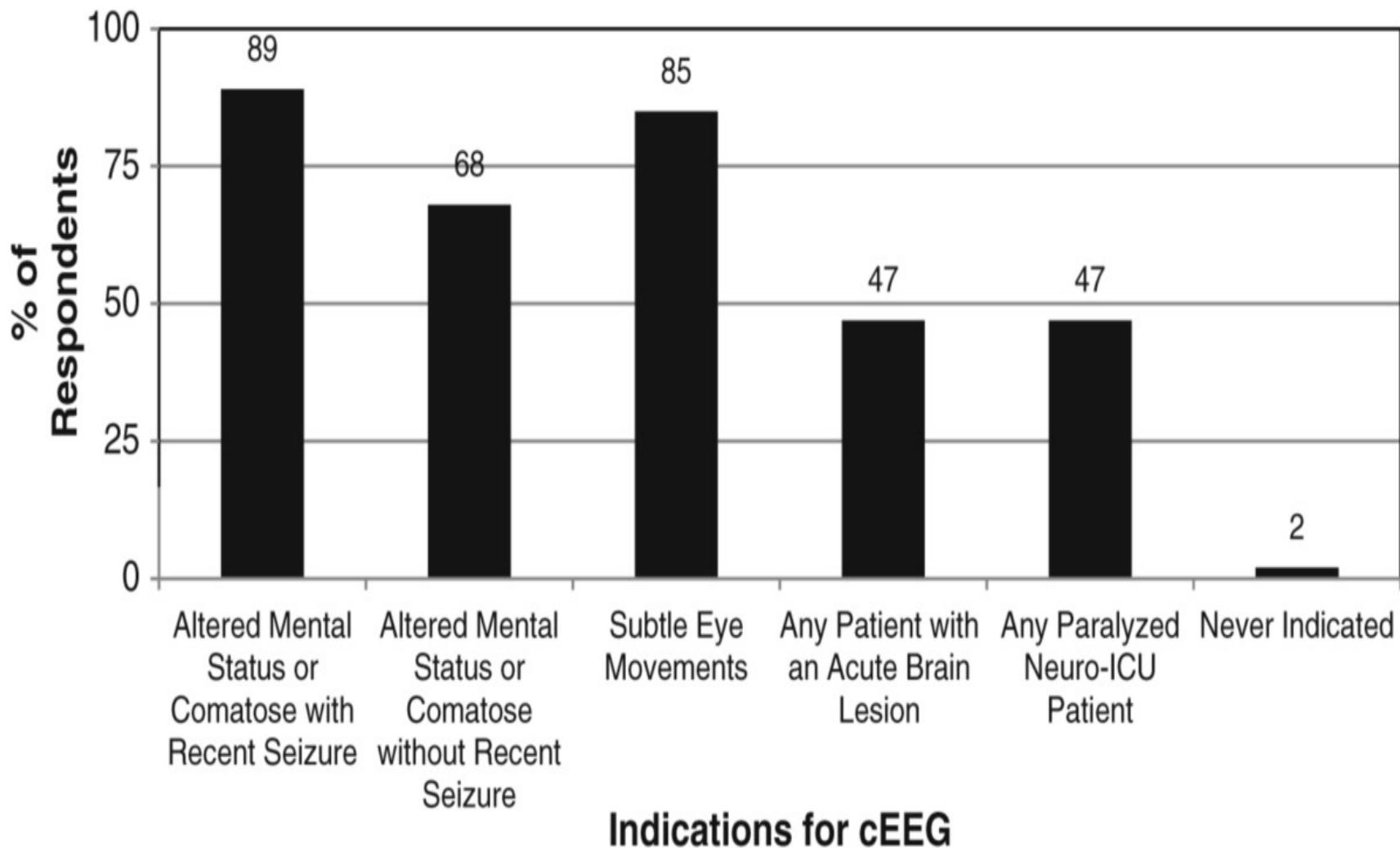
Total Patients: Mission Health, North Carolina



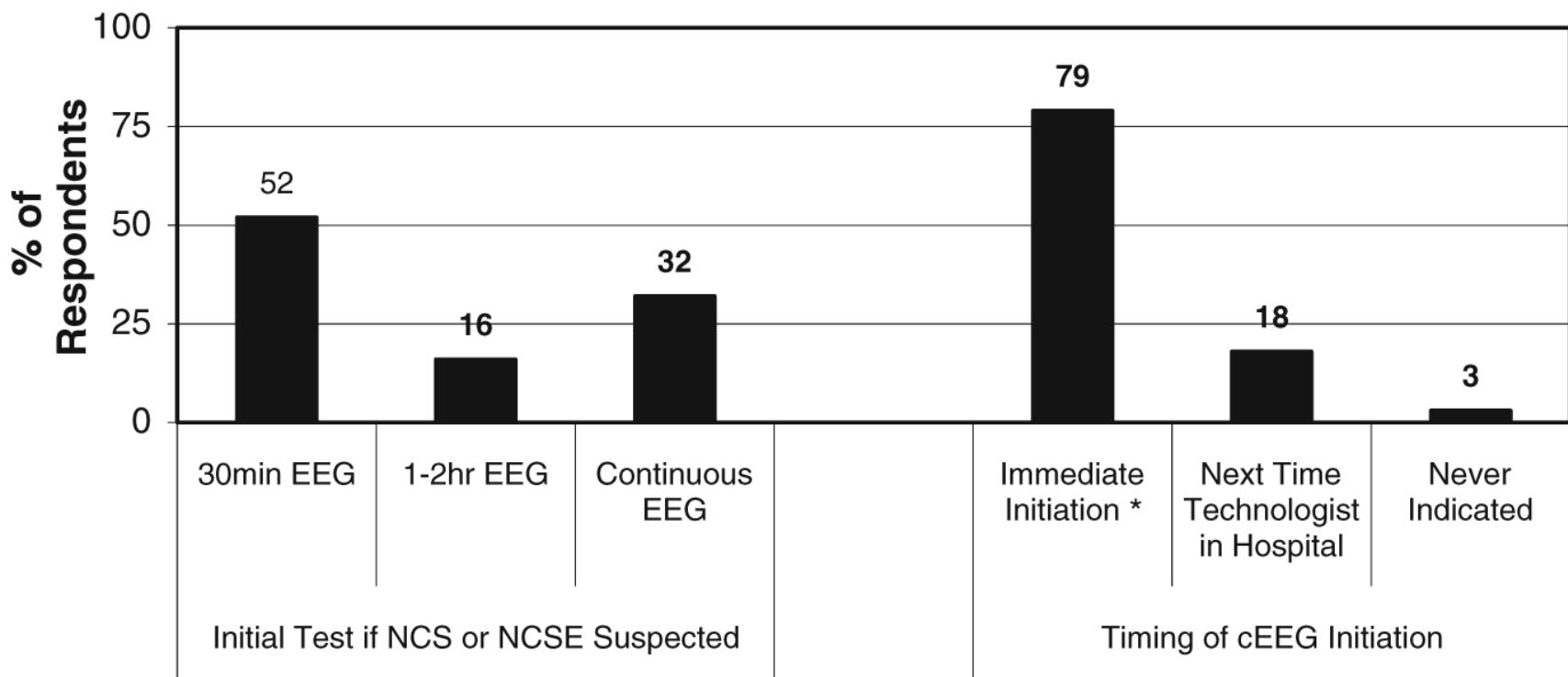
Why do we need protocols and guidelines?

- EEG monitoring is Expensive
- Resources are widely variable, demand from ICU is increasing
- Not enough EEG staff
- Technically difficult
- Leverage administration for resources

Indications for ordering cEEG



EEG Type and Urgency



Survey cEEG in Adults

cEEG resources

- **cEEG always available** **48%**
- cEEG almost always available 35%
- Insufficient EEG techs 15%
- Insufficient EEG machines 13%
- Insufficient neurophysiologists 4%
- EEG technologist availability
- **24/7 in house** **26%**
- 24/7 available, but not always in house 60%
- Weekdays, daytime hours only 3%
- 7 days a week, daytime hours only 11%

ACNS Consensus Statement: Adults and Pediatrics

INVITED REVIEW

Consensus Statement on Continuous EEG in Critically Ill Adults and Children, Part I: Indications

Susan T. Herman, Nicholas S. Abend,† Thomas P. Bleck,‡ Kevin E. Chapman,§ Frank W. Drislane,* Ronald G. Emerson,|| Elizabeth E. Gerard,¶ Cecil D. Hahn,# Aatif M. Husain,**†† Peter W. Kaplan,‡‡ Suzette M. LaRoche,§§ Marc R. Nuwer,||| Mark Quigg,¶¶ James J. Riviello,## Sarah E. Schmitt,*** Liberty A. Simmons,††† Tammy N. Tsuchida,‡‡‡ and Lawrence J. Hirsch§§§*

Consensus Statement on Continuous EEG in Critically Ill Adults and Children, Part II: Personnel, Technical Specifications, and Clinical Practice

Susan T. Herman, Nicholas S. Abend,† Thomas P. Bleck,‡ Kevin E. Chapman,§ Frank W. Drislane,* Ronald G. Emerson,|| Elizabeth E. Gerard,¶ Cecil D. Hahn,# Aatif M. Husain,**†† Peter W. Kaplan,‡‡ Suzette M. LaRoche,§§ Marc R. Nuwer,||| Mark Quigg,¶¶ James J. Riviello,## Sarah E. Schmitt,*** Liberty A. Simmons,††† Tammy N. Tsuchida,‡‡‡ and Lawrence J. Hirsch§§§*

ACNS Consensus Statement Indications

- Diagnosis of non convulsive seizures and status
- Assess treatment of non convulsive seizures
- Diagnosis of paroxysmal events
- Detection of ischemia
- Monitoring sedation/ high dose sedatives
- Assess prognosis

ACNS Consensus Statement Technical Specifications

- Qualifications and responsibilities
 - ICU Electroencephalographer
 - ICU Neurodiagnostic Technologists (NDT)
- CEEG Monitoring Equipment
 - Electrodes
 - Acquisition Equipment/ video/ QEEG software
 - Central Monitoring and Review Equipment
 - Networking/ Remote access/ Data storage

ACNS Consensus Statement CEEG Clinical Practice

- Patient selection and triage
- Initiation of CEEG
 - Timing, electrode application, montages
- Daily Maintenance
 - Electrodes, infection control, scalp breakdown, reactivity
- Quantitative EEG techniques
- Bedside EEG monitoring
- EEG review, interpretation, reports

Institutional Protocols

- Indications/Patient Selection
 - Triage “high risk” patients
- Who Can Order CEEG?
 - May differ based on day/time
- Duration of Monitoring
- Technical Aspects
 - Standardize electrodes, maintenance
- Reporting and Communication

Critical Care EEG Monitoring Research Consortium

- Founded in 2008
 - Grown from 8 sites to >40, neonatal, peds, adult
- Infrastructure funding
- Leadership council, bylaws, data share agreements
- Standardized Terminology
- Development of Multicenter Database



American Clinical Neurophysiology Society's Standardized Critical Care EEG Terminology: 2012 version

L. J. Hirsch, S. M. LaRoche, N. Gaspard, E. Gerard, A. Svoronos, S. T. Herman, R. Mani, H. Arif, N. Jette, Y. Minazad, J. F. Kerrigan, P. Vespa, S. Hantus, J. Claassen, G. B. Young, E. So, P. W. Kaplan, M. R. Nuwer, N. B. Fountain, and F. W. Drislane

Main Term #1
Generalized
G
Lateralized
L
Bilateral Independent
BI
Multifocal
Mf

Main Term #2
Periodic Discharges
PD s
Rhythmic Delta Activity
RDA
Spike-wave
SW

Journal of Clinical Neurophysiology Volume 30, Number 1, 2013

EEG Monitoring Day

Approved Data for Reporting Approved for Final Reporting

Submit to CCEMRC Summary data only
 If required, informed consent granted for:
 EEG Session Yes FOLLOW-UP

Generate Report

EEG Monitoring

Start: Date 1/7/2013 Time 07 : 00
 End Date 1/8/2013 Time 07 : 00

First day of session?
 Interruptions
 EEG type (billing code) Continuous ICU (inpt, video), 12-24 hrs
 Procedure # 13-010

Patient

MRN 12345678
 Name (First/Middle/Last): Susan B Tester
 DOB 1/1/1950
 Patient type Adult (18+)
 Gestational age (weeks)
 Weight (kg)
 Gender Female

Clinical Info

Primary neurological dx SAH
 Secondary dx(s) IVH, Hydrocephalus
 Primary indication f/EEG Diagnosis of non-convulsive seizures
 Specify
 Secondary indication(s) Detect ischemia

EEG Monitoring Day

Technical Info

of EEG channels 16
 Skill defect Location: left temporal
 Video Yes
 Digital analysis Yes Bill using 95957
 Location Both
 Measures used Alpha/delta ratio
 Alpha variability
 Amplitude
 Compressed spectral array
 Rhythmicity

Specify
 Deviations f/standard montage
 Electrode type Disk, plastic
 Specify
 Sphenoidal placement?
 Compatible with CT MRI
 Collodion
 EC2
 Paste
 Other Specify

EEG Results (epochs)

Add Epoch Start Date 1/7/2013 Time 07 : 00
 End Date 1/8/2013 Time 07 : 00
 Copy Epoch
 Del Epoch
 Epoch 1
 Meds/Treatments Back
 AEDs administered during the epoch
 Other seizure treatments administered
 Sedatives administered during the epoch
 Pharmacological paralytic
 Paralytic indication
 Therapeutic hypothermia
 Indication

EEG Monitoring Day

EEG Results (epochs)

Add Epoch Start Date 1/7/2013 Time 07 : 00
 End Date 1/8/2013 Time 07 : 00
 Copy Epoch
 Del Epoch
 Epoch 1
 Meds/Treatments Background Seizures/IEDs/Patterns Sleep/EKG/Activation Digital Analysis

EEG picked up non-epileptic events previously suspected to be seizures
 Specify
 No
 Yes
 Date 1/7/2013 Time 00 : 00
 Rhythmic evolving activity No clinical signs

Any definite epileptic seizures
 First seizure
 Seizure type(s) & description
 Date 1/7/2013 Time 00 : 00
 BRD type(s) & description

Any brief rhythmic discharges (BRDs)
 First BRD
 BRD type(s) & description
 Date 1/7/2013 Time 00 : 00

Sporadic EDs
 Discharge type(s)
 Discharges normal?
 Yes
 Lateralized L temporal Occasional

Rhythmic/periodic patterns
 First pattern
 Pattern type(s) & description
 Date 1/7/2013 Time 00 : 00
 Lateralized (L) Periodic discharge (PD)

Items in red are REQUIRED

Summary

- Continuous EEG monitoring is essential for detection of non-convulsive seizures which are common in comatose patients
- cEEG is also useful for evaluation of spells/movements and ischemia detection
- Multicenter research is the key to better understanding the role of cEEG in management of critically ill patients