

# EEG changes and Motor Activity in Polysomnography

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# References

Movement Disorders in Sleep and Medication  
Effects

Max Hirshkowitz, PhD

Atlas of Polysomnography 2<sup>nd</sup> ed

Geyer, Carney, Payne

# Objectives

- Recognize the normal and abnormal motor activity in a polysomnogram
- Recognize the changes commonly seen in REM behavior disorder
- Recognize seizure activity and EEG changes
- Understand the value of polysomnography beyond the respiratory changes

# Normal Motor Activity

- Postural shifts
- Body and limb movements
- Physiologic fragmentary myoclonus



# Abnormal Motor Activity

- Motor parasomnias
- Sleep-related movement disorders
- Isolated sleep-related motor symptoms
- Nocturnal seizures
- Miscellaneous nocturnal motor hyperactivity

NREM, REM, SWS

- SW, ST, CA, NM, NT
- RWA, RBD,
- RLS, PLMD, RMD
- SRB, SRLC, SRED
- GTC, TLE, NFLE,
- ADNFLE, EPC
- RISP, FFI



--- OMG ---

# Motor Parasomnias

- Non-REM
  - Confusional arousals
  - Sleepwalking
  - Sleep terrors
- REM
  - REM behavior disorder
  - Nightmares
  - Recurrent isolated sleep paralysis

# Other Motor Parasomnias

- Sleep related eating disorder
- Sleep-related groaning
- Sleep-related disassociative disorders

# Sleep-Related Movement Disorders

- RLS/PLMD
- Sleep-related leg cramps
- Sleep-related bruxism
- Sleep-related rhythmic movement disorder

# Isolated Sleep-Related Motor Symptoms

- Sleep talking
- Sleep starts (hypnic jerks)
- Hypnagogic foot tremor
- Alternating leg muscle activity
- Excessive fragmentary myoclonus

# Nocturnal Seizures

- True nocturnal seizures
- Tonic seizures
- Benign rolandic seizure
- Nocturnal frontal lobe epilepsy
- Autosomal dominant nocturnal frontal lobe epilepsy
- Nocturnal temporal lobe epilepsy
- Continuous spike waves during SWS  
(electrical status epilepticus of sleep)

# Diurnal seizures

- Juvenile myoclonic epilepsy
- Generalized tonic-clonic seizure on awakening
- Partial complex seizures
- Epilepsia partialis continua



# Miscellaneous Nocturnal Motor Activity

- Drug-induced nocturnal dyskinesias
- Movements associated with sleep apnea
- Nocturnal panic attacks
- PTSD
- Fatal familial insomnia

# Movement Disorders That May Persist in Sleep

- Tourette's syndrome
- Hemifacial spasm
- Palatal myoclonus
- Tremor
- Chorea
- Dystonia
- Hemiballismus

Not Just Prescriptions !!



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## Rx provoking parasomnias & movement disorders

<b>Sleepwalking</b>	<b>Bruxism</b>	<b>RBD</b>	<b>PLMD/RLS</b>
BZDs & BZRAs	TCA's	TCA's	TCA's
Traditional Neuroleptics	Traditional Psychostimulants	SSRIs & SNRIs	SSRIs & SNRIs
Diphenhydramine	DA Agonists (PD Rx)	L-DOPA	L-DOPA
Lithium	Cocaine	Lithium	Lithium
Methaqualone	Alcohol		Caffeine
Propranolol			Terbutaline
Methylphenidate			Nifedipine
			Antihistamines

# Rx provoking/exacerbating motor hyperactivity & involuntary movements #1

Myoclonus		Chorea	
Opiates & opioids	SSRIs, SNRIs, TCAs	Methsuximide & Ethosuximide	Oral Contraceptives
Lithium	MAOIs	Primidone	Flecainide
Traditional Neuroleptics	Trazodone	Traditional psychostimulants	Traditional Neuroleptics
Buspirone	Cocaine	Phenytoin	Dissulfiram
Verapamil		Carbamazepine	Trazodone
Nifedipine		Cocaine	Anticholinergics
Penicillin		Lithium	Cimetidine
Cephalosporins		TCAs	Digoxin
		Phenobarbital	Oxymetholone



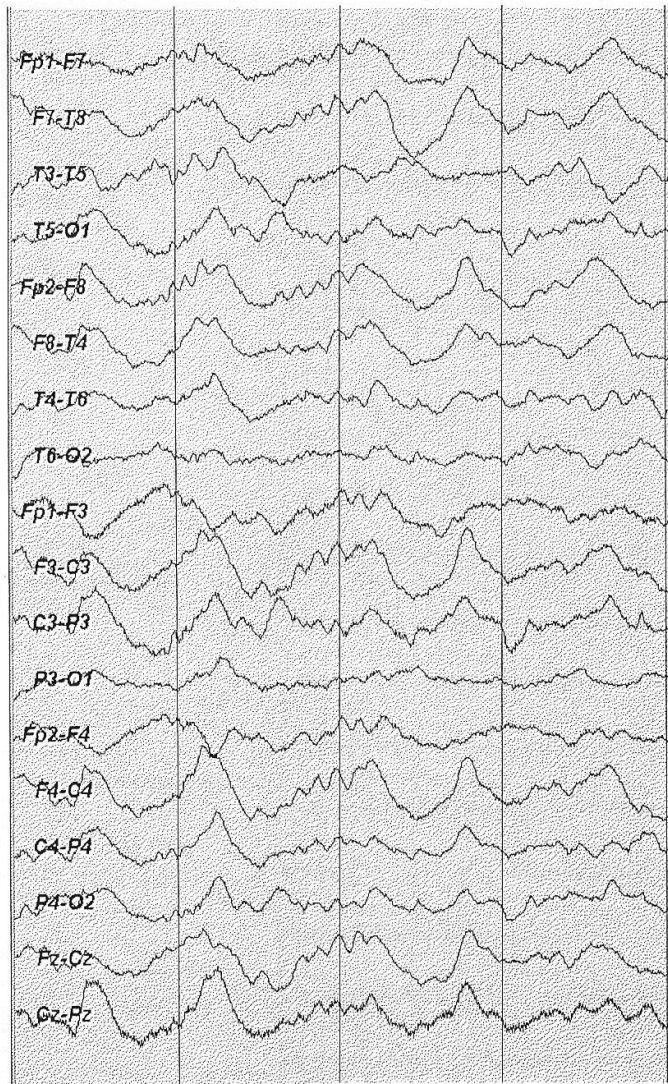
# Rx provoking/exacerbating motor hyperactivity & involuntary movements #2

<b>Dystonia</b>		<b>Tremor</b>
Doxepin	Diazepam	Lithium
Amitriptyline	Cocaine	MAOI
Traditional Neuroleptics	Traditional psychostimulants	Traditional psychostimulants
Lithium	Verapamil	DA receptor blockers
Prochlorperazine	Cinnarizine	DA depleters
Promethazine	Flunarizine	Beta agonists
Metoclopramide	Traynlcypromine	Valproic acid
Molindeone	Amoxapine	SSRI & SNRI
Phenytoin	Disulfiram	
Chloroquine	Cimetidine	
Amodiaquine	H2 blockers	

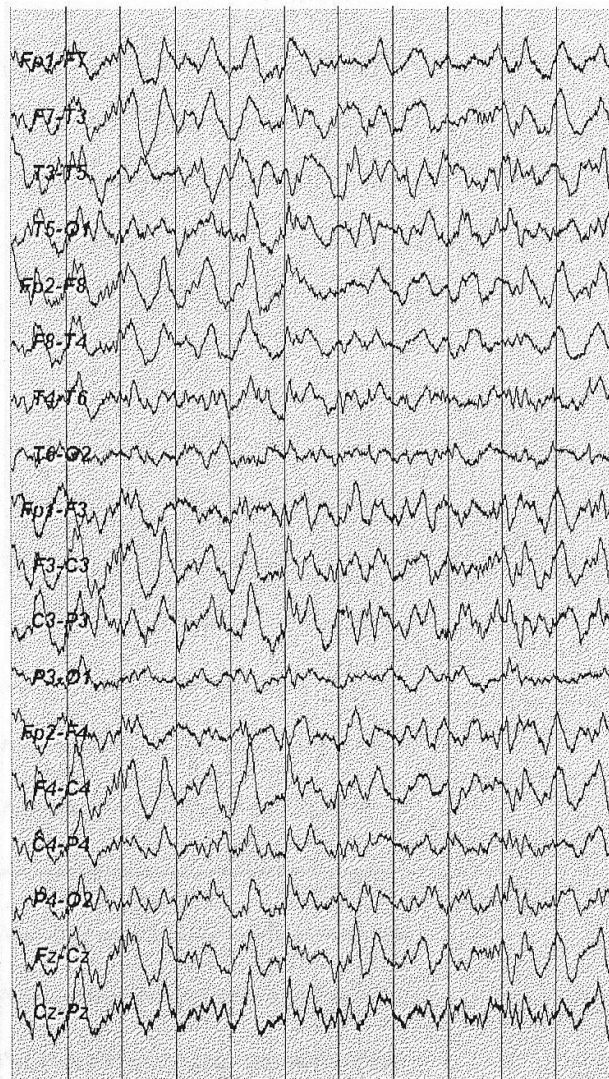
# Rx provoking/exacerbating motor hyperactivity & involuntary movements #3

Akathisia		Tics	Oral/facial Dyskinesias
Traditional neuroleptics	Promethazine	Traditional neuroleptics	Traditional neuroleptics
Midazolam	Droperidol	Carbamazepine	Metoclopramide
Cyproheptadine	Metoclopramide	Pemoline	Prochlorperazine
Methysergide	Prochlorperazine	L-DOPA	Antihistamines
Buspirone		Psychostimulants	Chlorpheniramine
Diltiazem		Cocaine	Brompheniramine
Cinnarizine		TCA's	Phenindamine
Flunarizine			Verapamil
Alcohol			Ethanol withdrawal
Amoxapine			Anticholinergics





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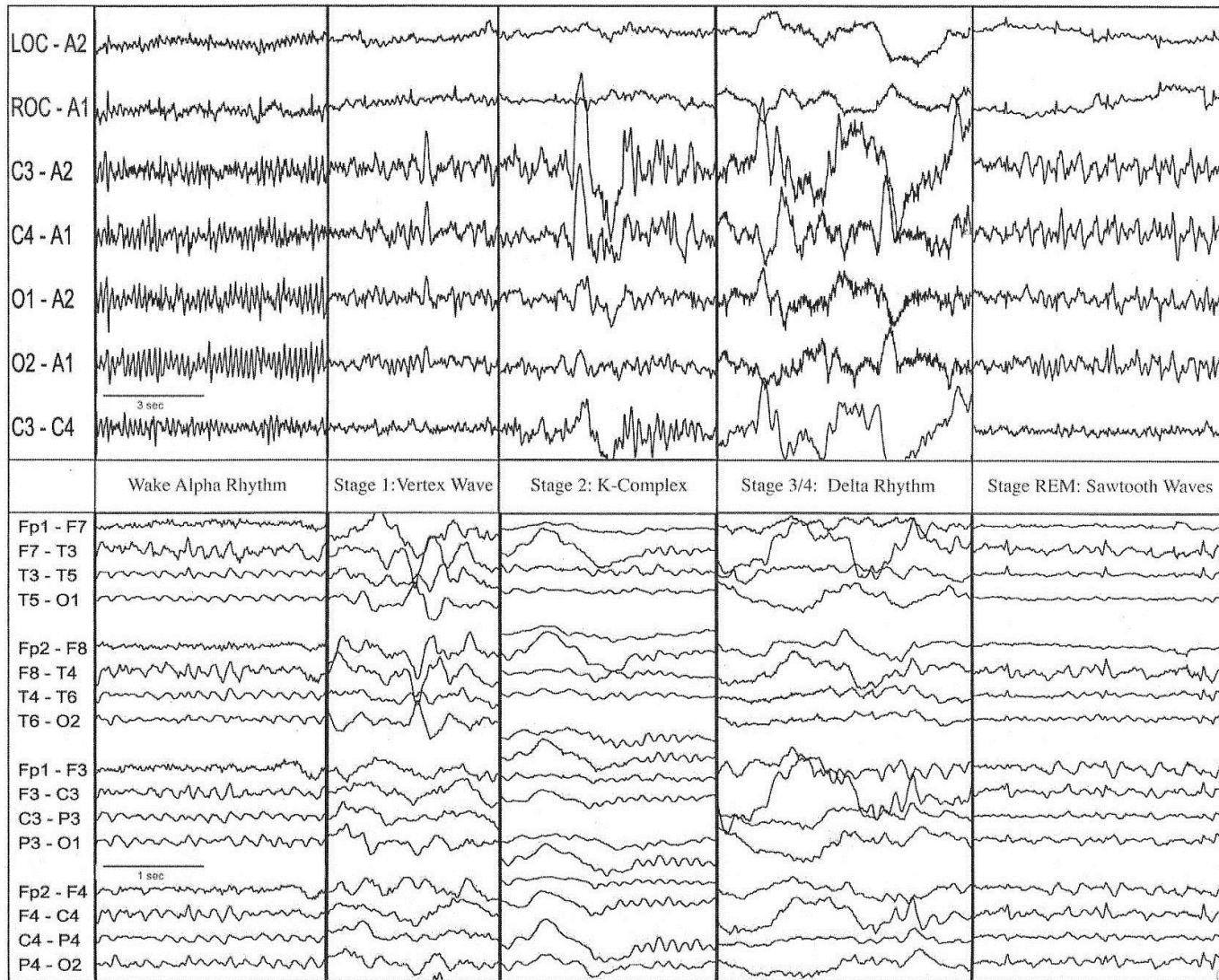
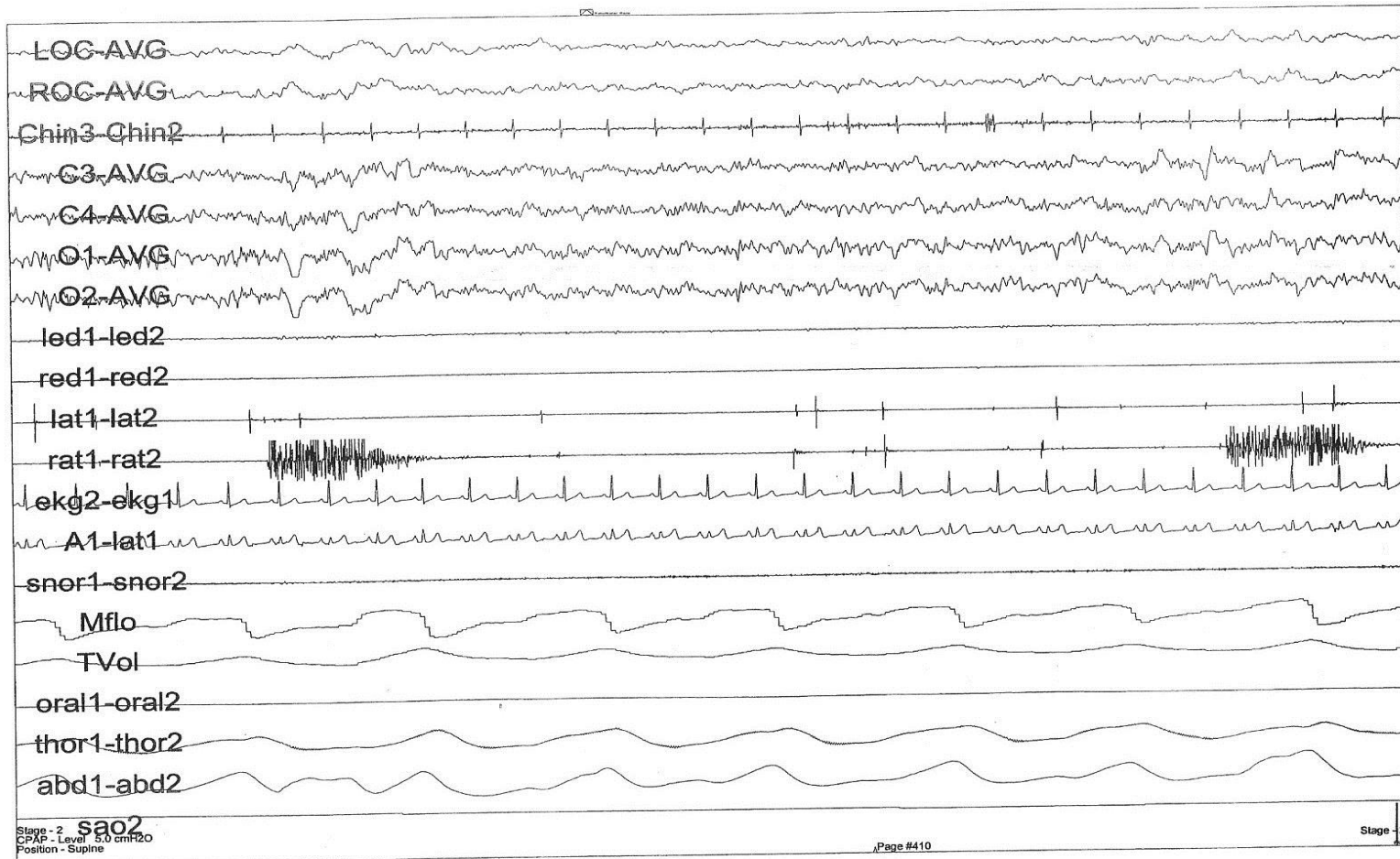


FIGURE 8-5 ■ A comparison of normal awake and asleep patterns in typical PSG and long bipolar EEG montages. Note differing paper speeds.



**FIGURE 5-4** Polysomnogram: CPAP and PLM montage; 30-second page.

*Clinical:* 68-year-old man with obstructive sleep apnea and peripheral neuropathy.

*Staging:* Stage N2 sleep.

*Respiratory:* Normal respirations.

*EMG:* Right periodic leg movements and fragmentary myoclonus in both right and left leg channels.



**FIGURE 5-5 Polysomnogram: Standard montage; 30-second page.**

*Clinical:* 64-year-old man with excessive daytime sleepiness and frequent nocturnal leg movements.

*Staging:* Stage N2 sleep.

*Respiratory:* Effort increases with the arousal.

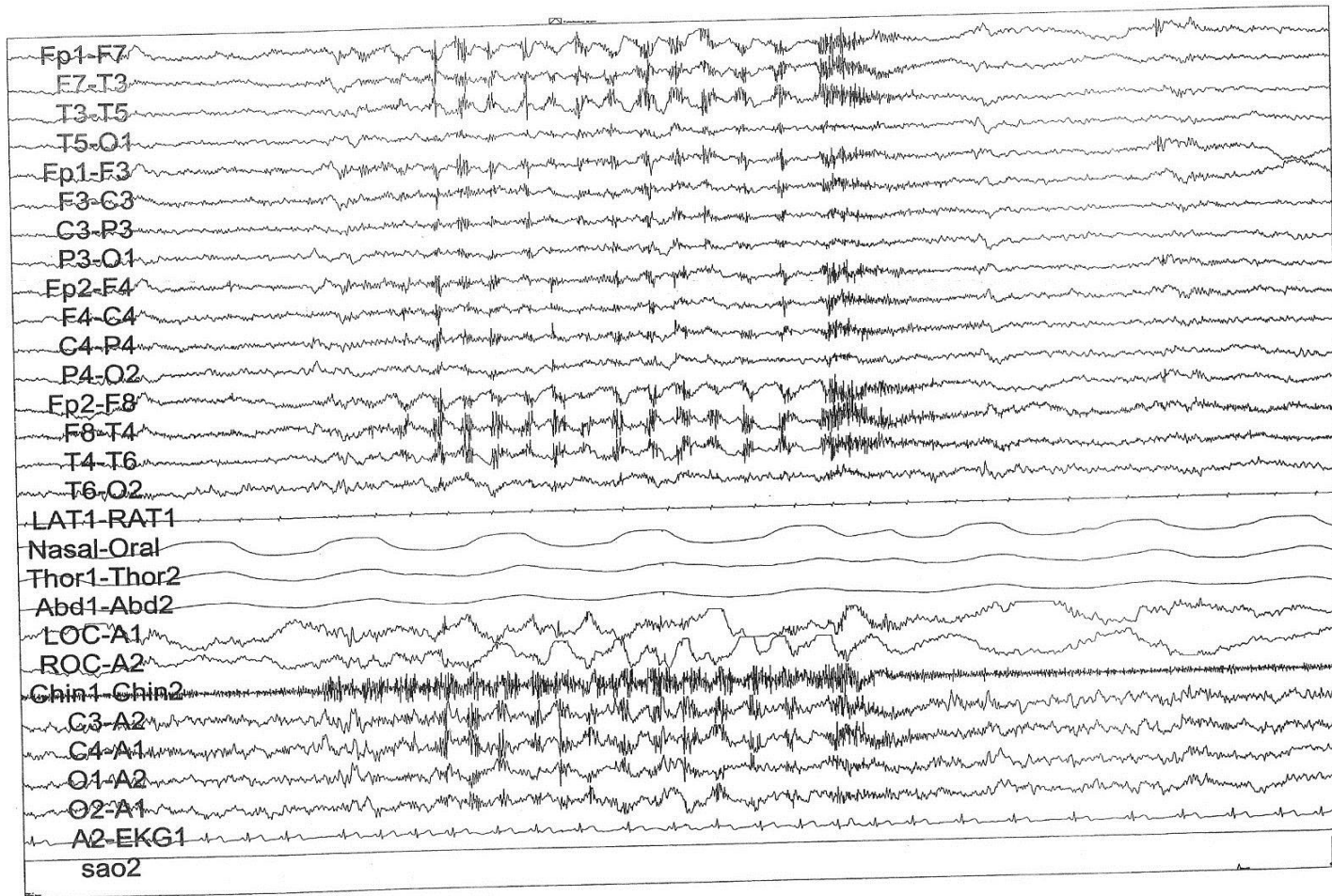
*EMG:* Bilateral periodic leg movements with an associated arousal.

# PLMS and Sleep Disorders

## PLMI>5

- RLS: 80% (88% 2 night study)
- Narcolepsy: 65%
- RBD: 71%
- OSA: 27%

Montplaisir 2000, Fry 1989, Brillelmann 1997



**FIGURE 6-1** Polysomnogram: Expanded EEG montage; 30-second page.

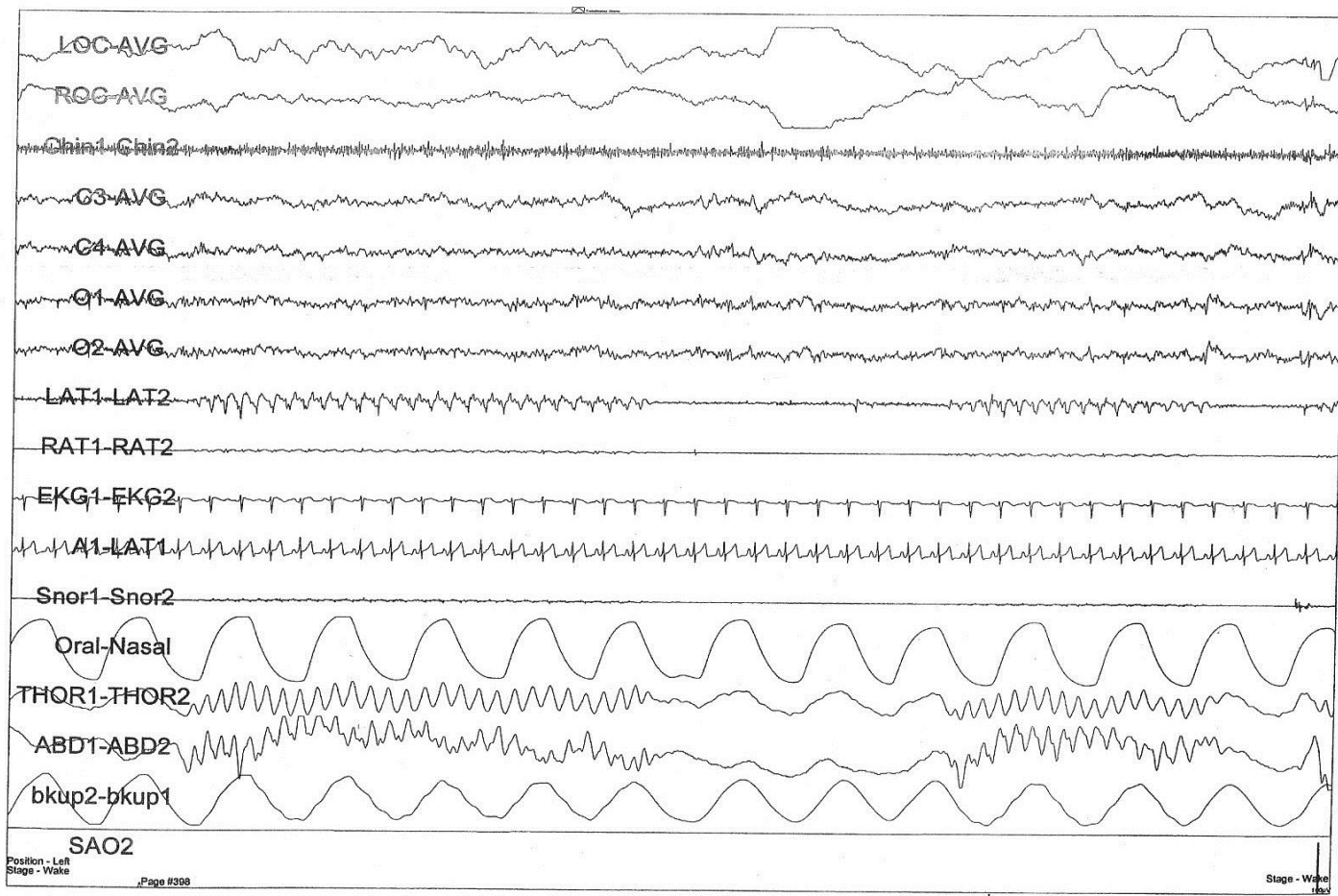
*Clinical:* 41-year-old man with witnessed apneas and tooth grinding.

*Staging:* Stage N1 sleep.

*Respiratory:* Normal respirations.

*Behavior:* Bruxism. Bursts of EMG activity occur at a rate of about 1/second in the EEG, chin EMG, and EOG channels.





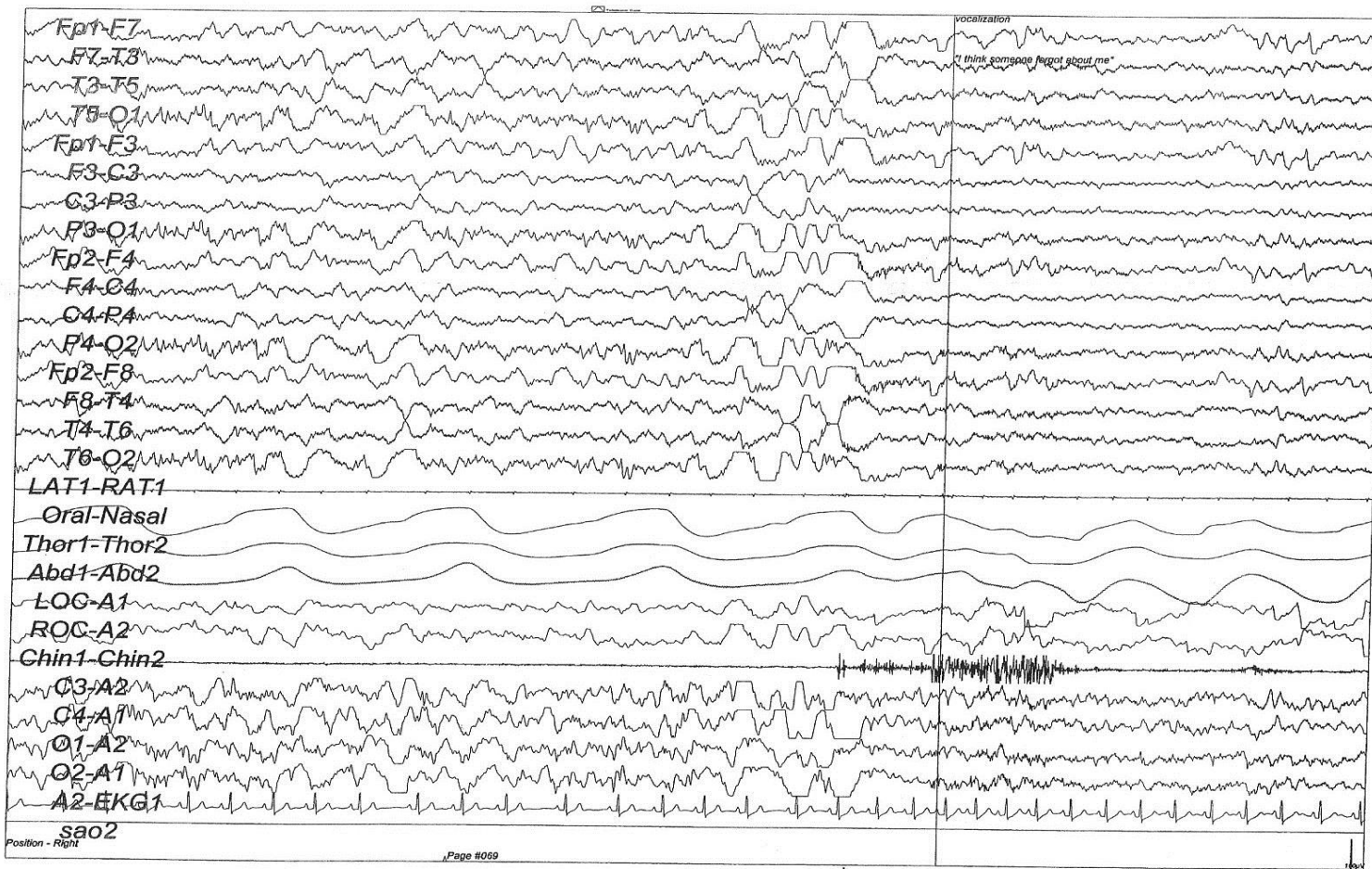
**FIGURE 6-3 Polysomnogram: Standard montage; 30-second page.**

*Clinical:* 47-year-old woman with excessive daytime sleepiness.

*Staging:* Stage N1 sleep.

*Respiratory:* Normal respirations.

*Behavior:* Movements of the left leg (\*) occur rhythmically at a rate of about 1/second, characteristic of rhythmic movement disorder. Movement artifact is evident in the thoracic and abdominal channels.



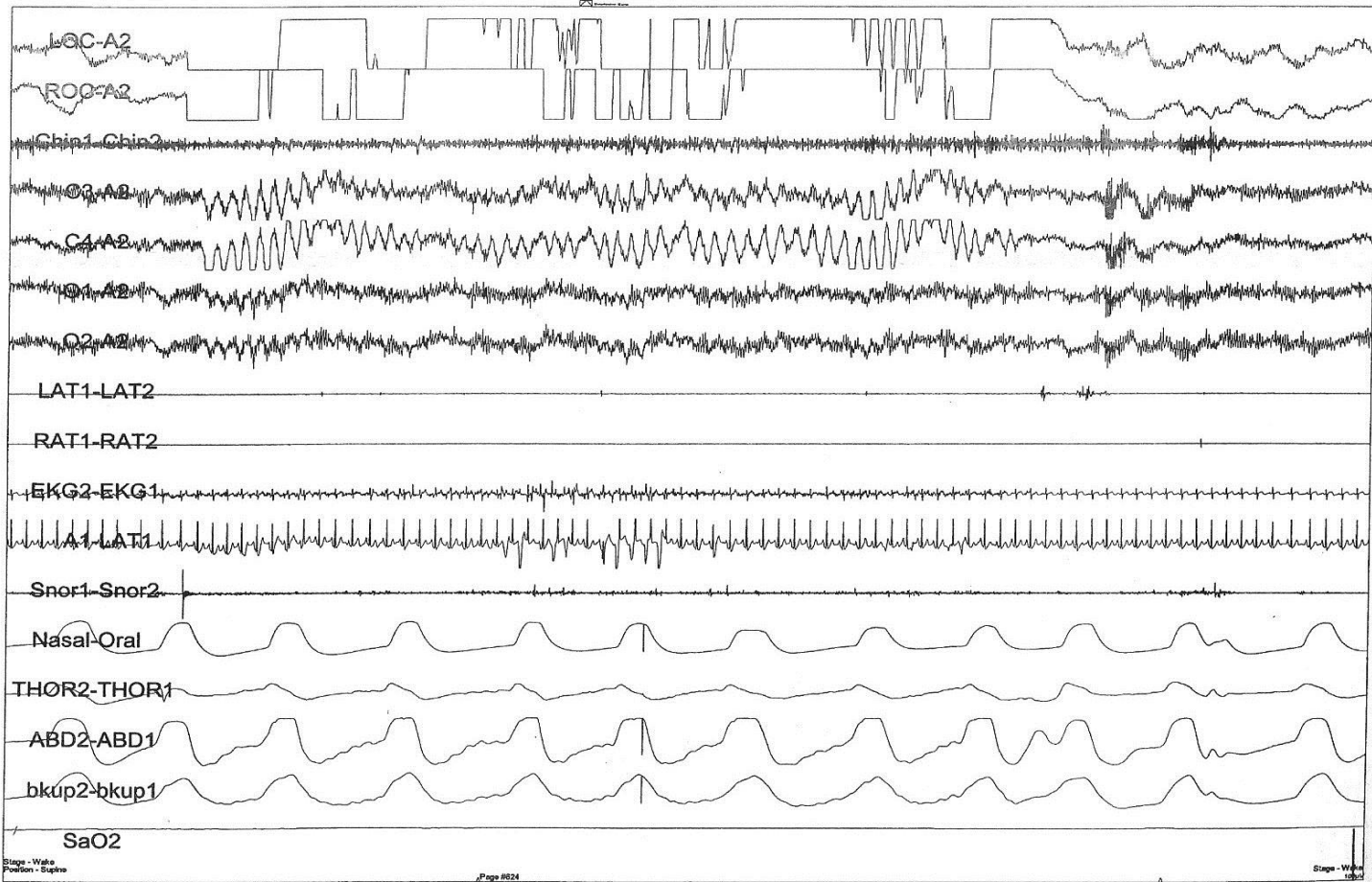
**FIGURE 6-6** Polysomnogram: Expanded EEG montage; 30-second page.

*Clinical:* 38-year-old woman with sleep talking.

*Staging:* Stage N3 sleep.

*Respiratory:* Normal respirations.

*EEG:* Spontaneous arousal (\*) from stage N3 sleep associated with sleep talking. The EEG following the arousal consists of a mixture of theta and delta frequencies.



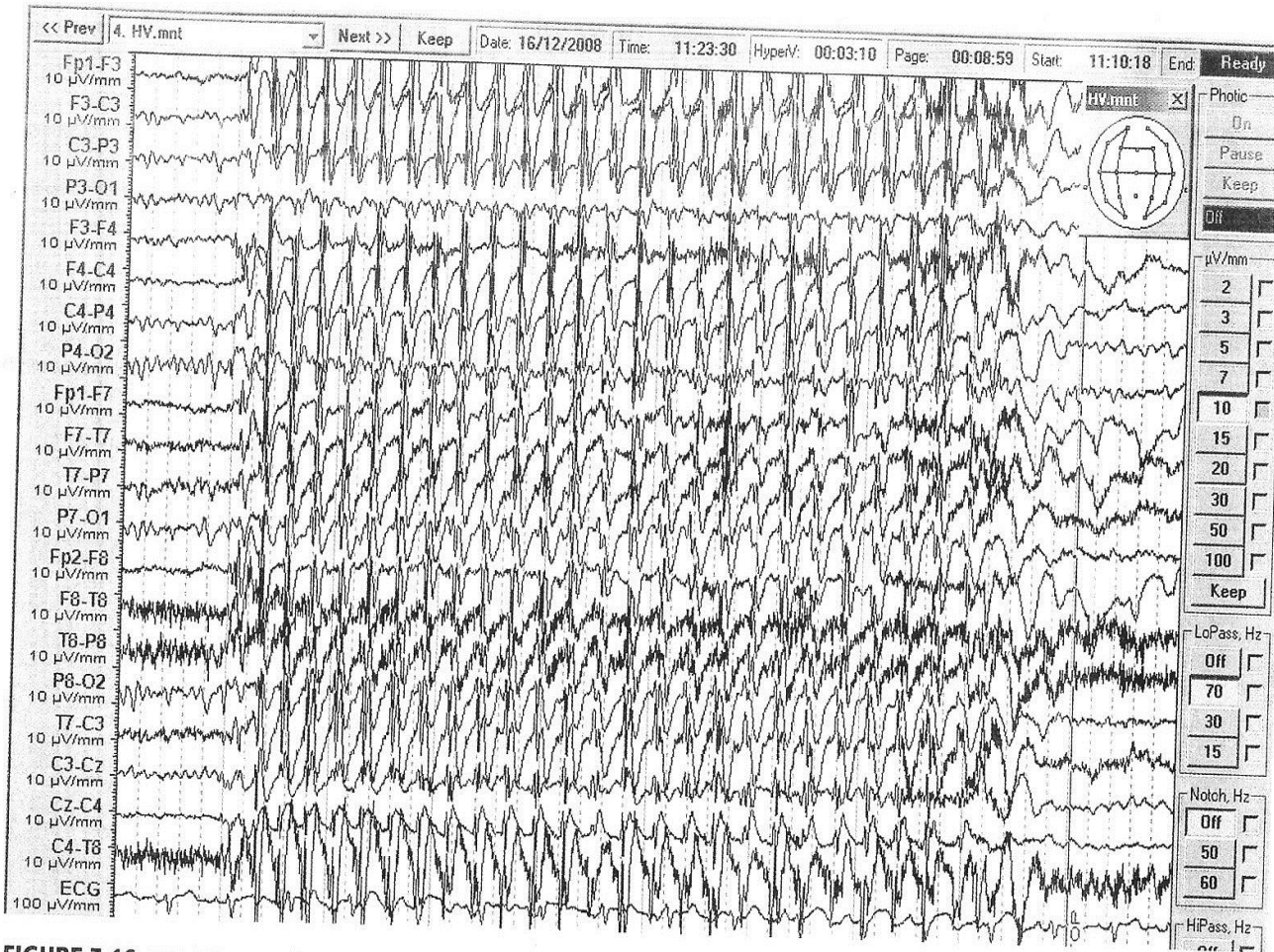
**FIGURE 8-7** Polysomnogram: Standard montage; 30-second page.

*Clinical:* 32-year-old man with loud snoring and excessive daytime sleepiness.

*Staging:* Stage wake.

*Artifact:* Rhythmic face rubbing artifact.



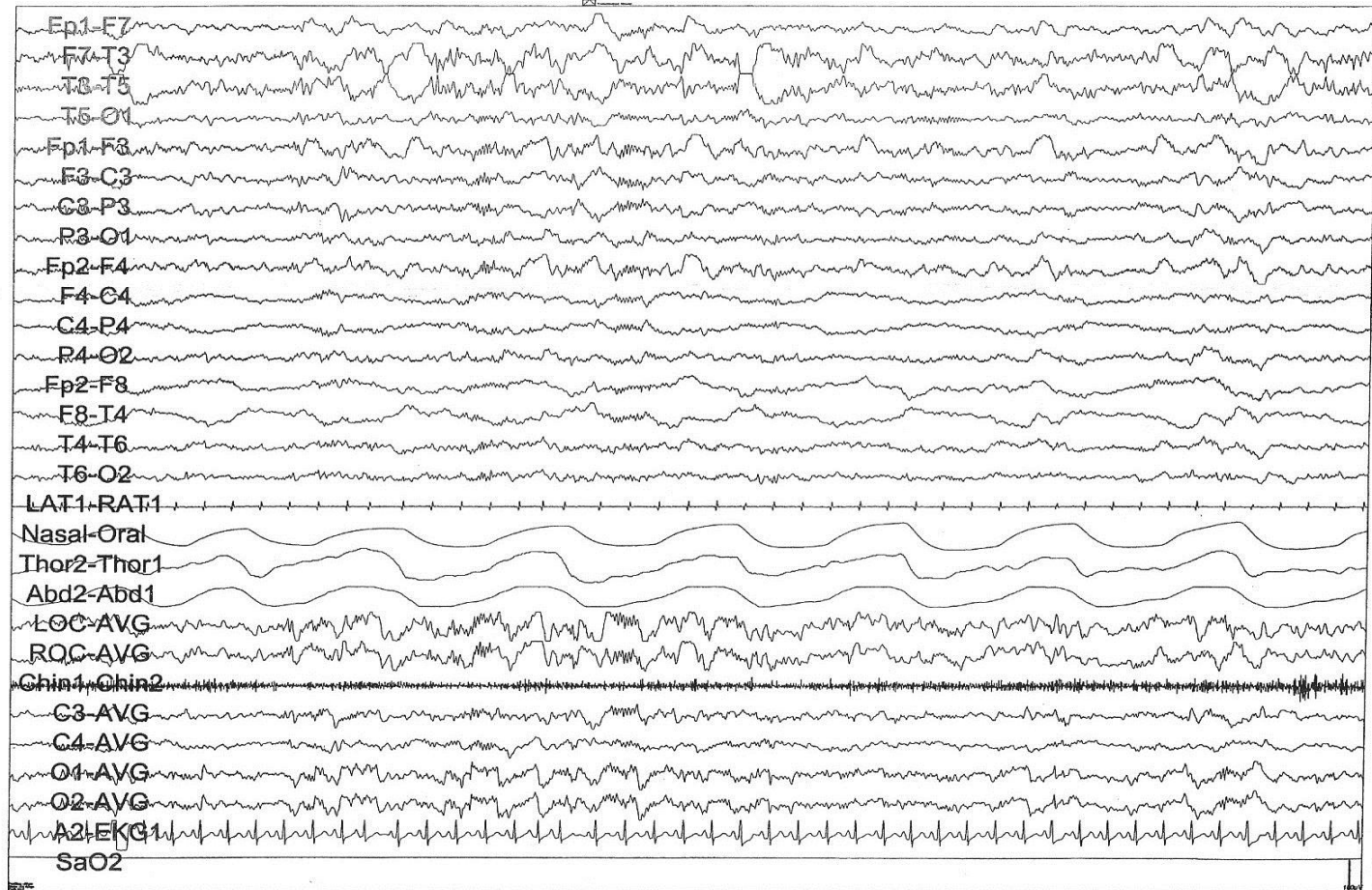


**FIGURE 7-16** EEG; 10-second page.

*Clinical:* 8-year-old boy with episodes of staring.

*Staging:* Stage wake.

*EEG:* Generalized 3 Hz spike and wave discharges.



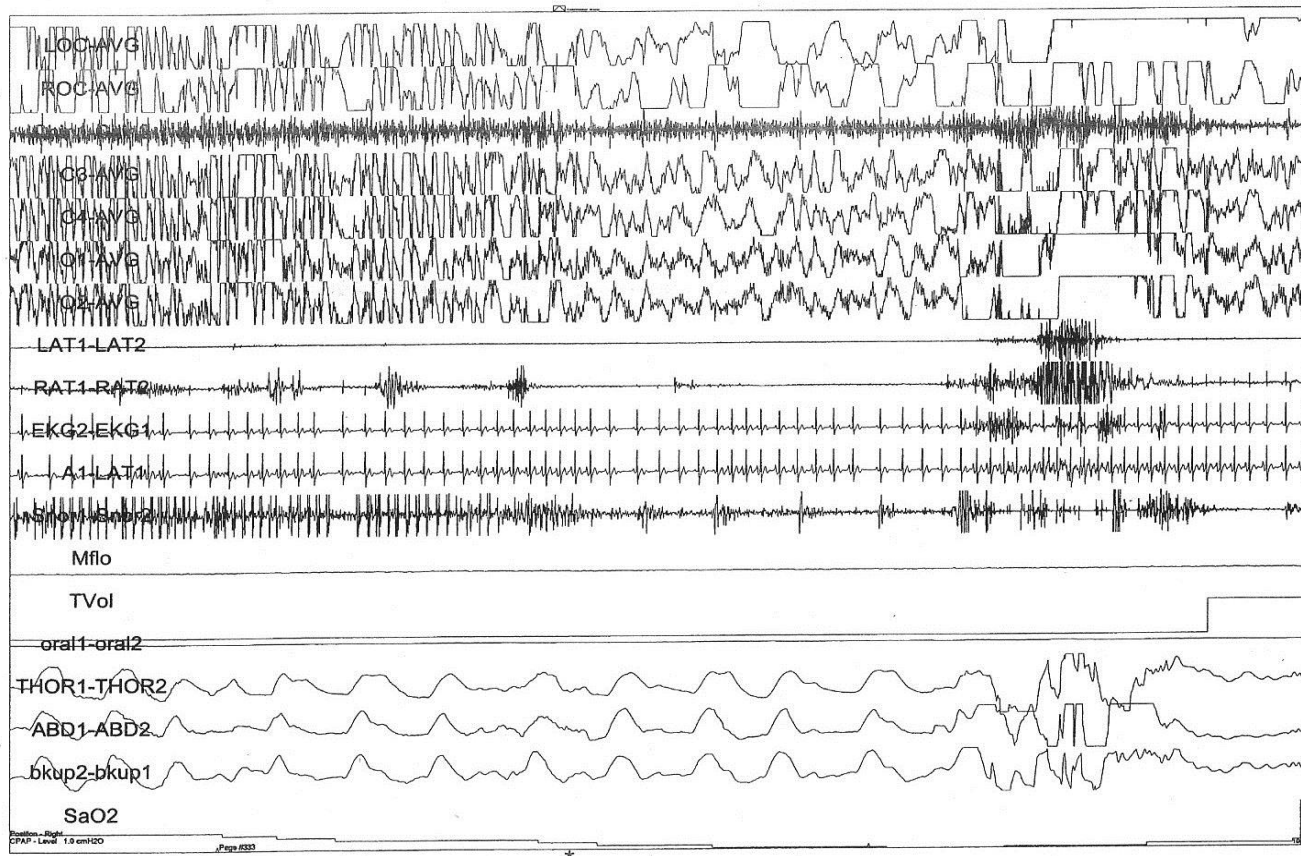
**FIGURE 7-15** Polysomnogram: Expanded EEG montage; 30-second page.

*Clinical:* 49-year-old woman status post left frontotemporal arteriovenous malformation resection with excessive daytime sleepiness and disrupted sleep.

*Staging:* Stage N2 sleep.

*Respiratory:* Normal respirations.

*EEG:* Left hemisphere breach rhythm with higher amplitude and higher frequency EEG activity especially over the frontotemporal regions.



**FIGURE 7-11** Polysomnogram: CPAP montage; 30-second page.

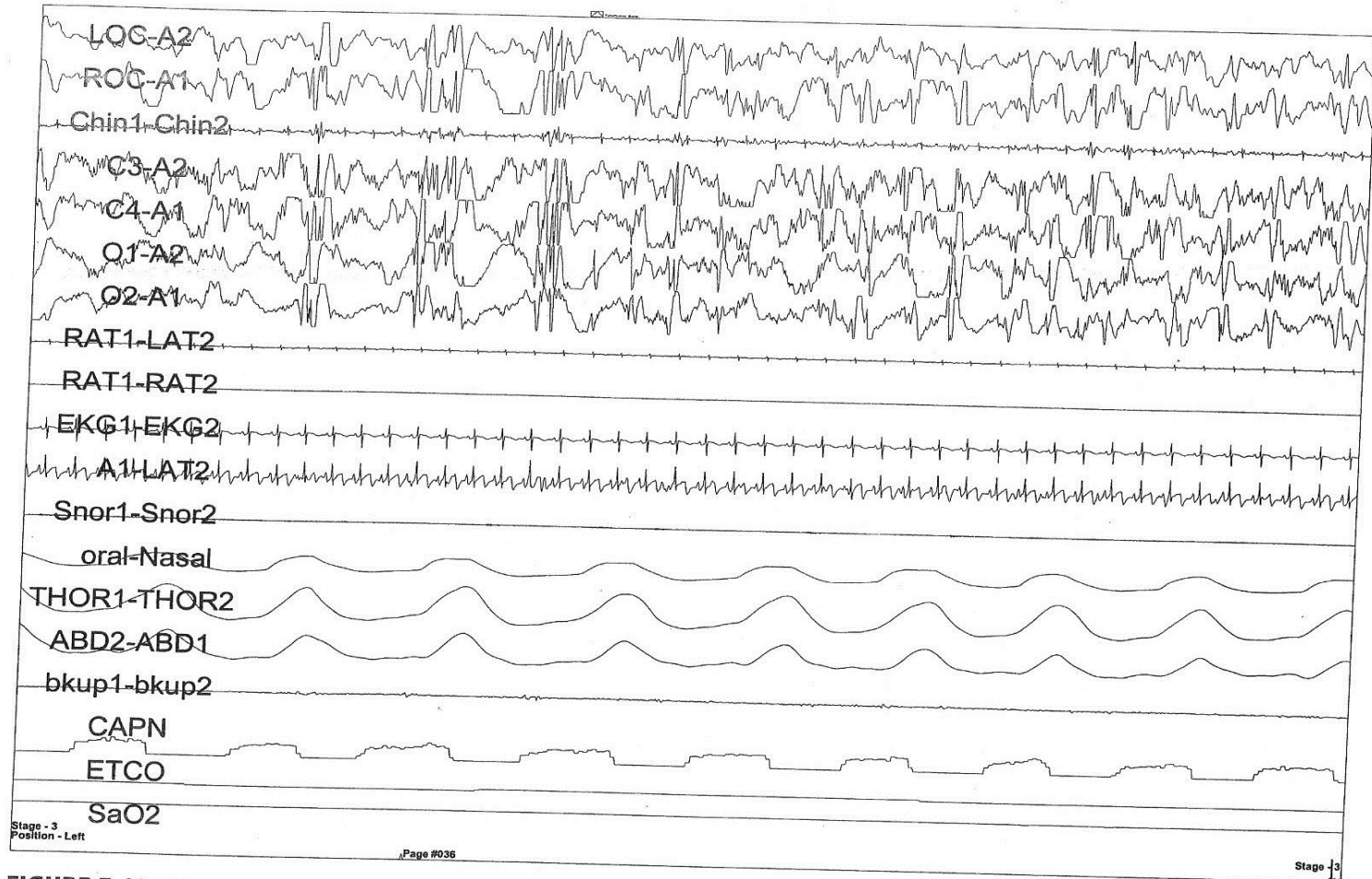
*Clinical:* 17-year-old man with epilepsy and obstructive sleep apnea.

*Staging:* Unable to accurately stage because of generalized spike and wave discharges during this generalized tonic-clonic seizure and subsequent postictal slowing.

*Respiratory:* Ictal and postictal obstructive apnea associated with an arousal and an oxygen desaturation.

*EEG:* Generalized spike and wave discharges. At the end of the seizure (\*), there is generalized delta activity during the postictal phase.

*Artifact:* The tidal volume channel has artifact caused by the mask being pulled from the patient's face during postictal confusion.



**FIGURE 7-10** Polysomnogram: Standard montage with CO<sub>2</sub> monitoring; 30-second page.

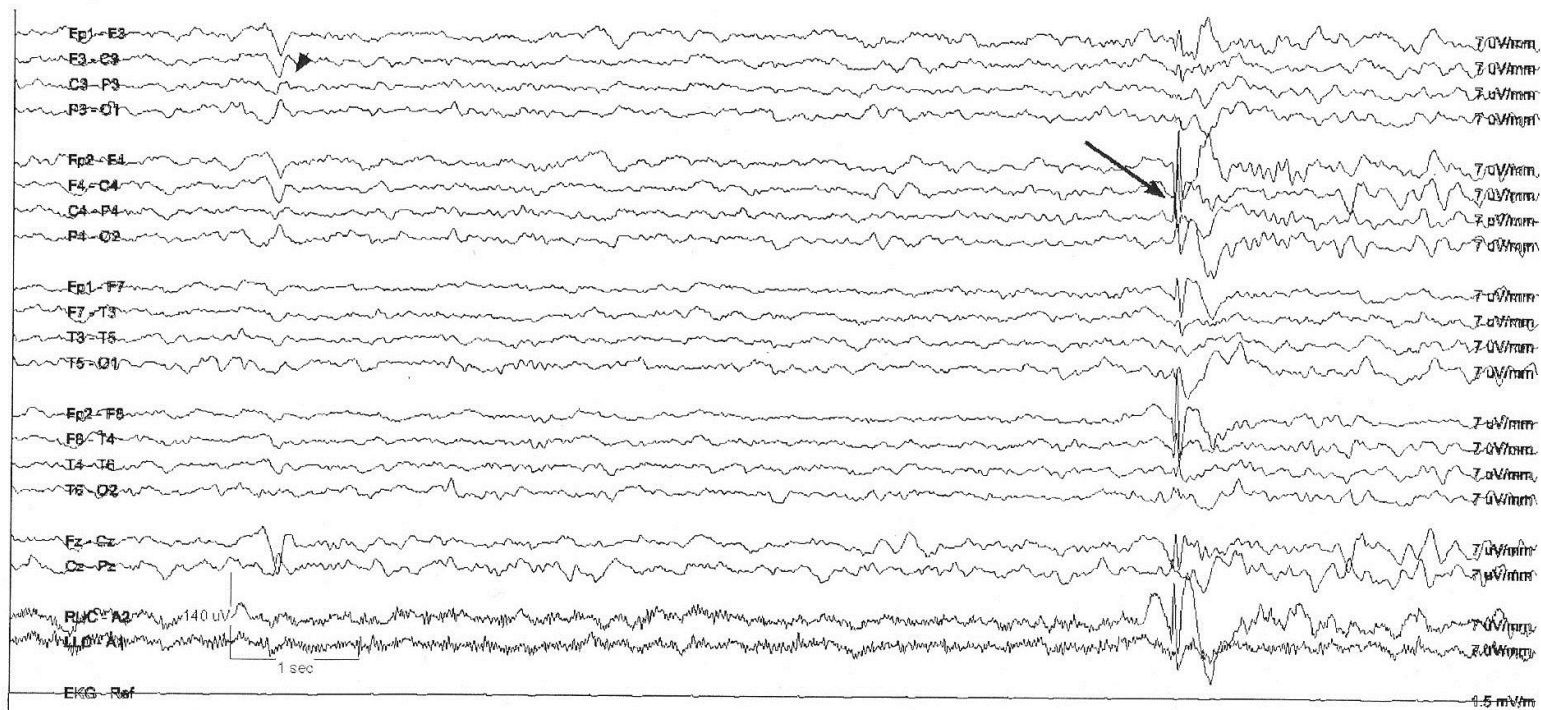
*Clinical:* 7-year-old boy with symptomatic generalized epilepsy and episodes of apnea.

*Staging:* Stage N3 sleep. Staging is difficult with such severe EEG abnormalities.

*Respiratory:* Normal respirations.

*EEG:* Multifocal independent spike and wave discharges and generalized spike and wave discharges.



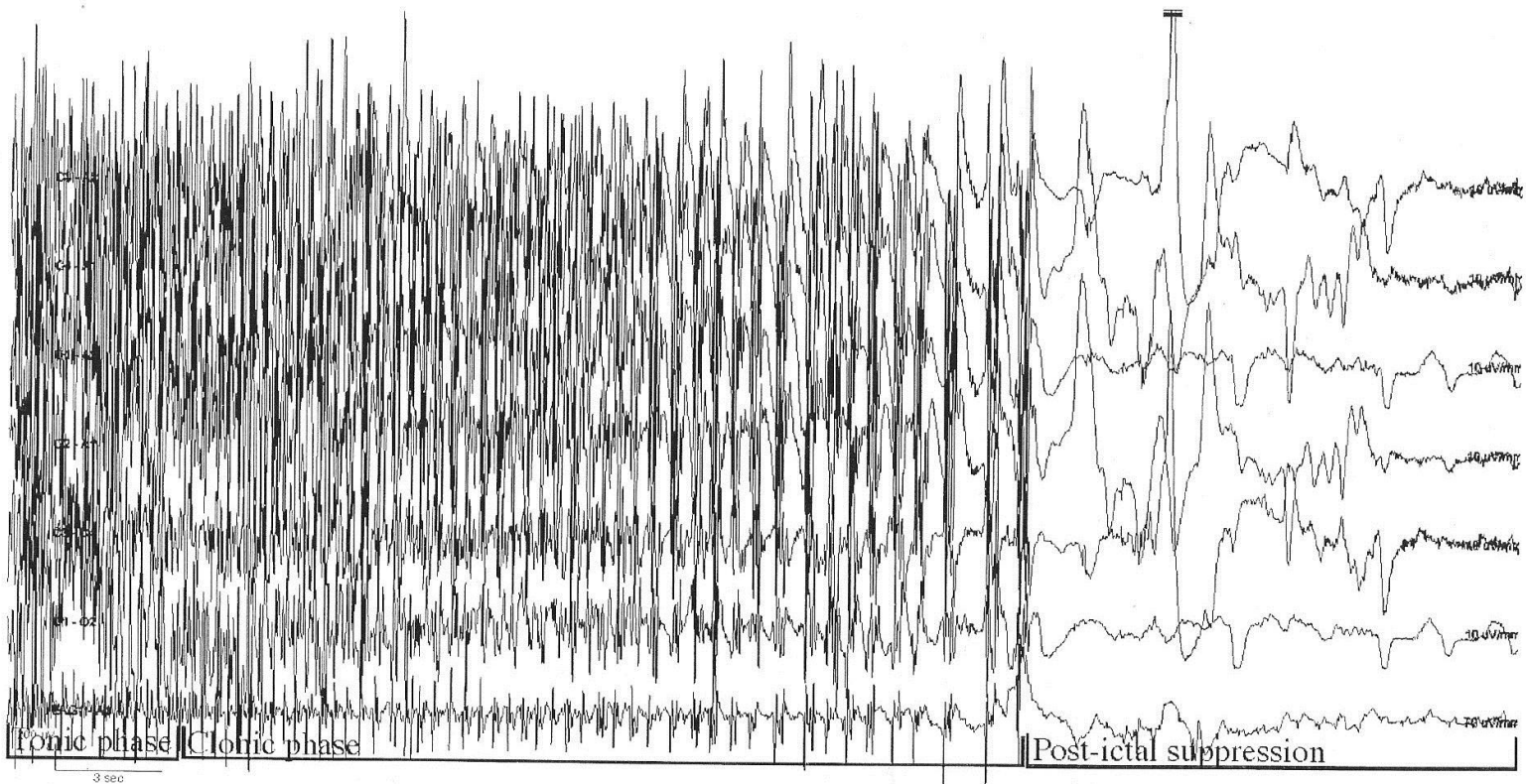


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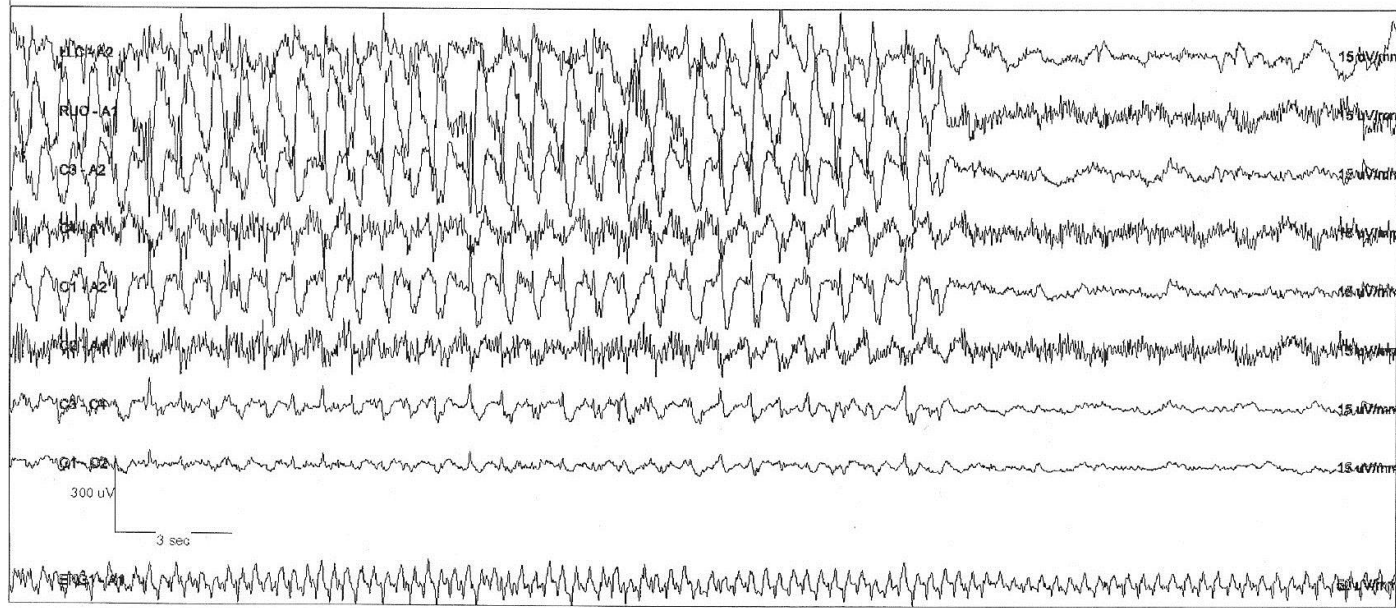
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 **TEK**

**FIGURE 8-9** ■ Vertex waves (short arrows) and focal spike-wave (longer arrow) during the same recording, on both PSG (above) and EEG long bipolar (below) montages. Epileptiform activity is often activated during sleep, thus making differentiation of spikes from normal sleep architecture difficult but important. Identification is easier when using a full EEG montage.



**FIGURE 8-11** ■ Relatively short GTC using a typical PSG montage. Rapid clinical onset caused muscle artifact to obscure EEG evidence of the seizure, but the pattern of muscle artifact matches clinical phenomena. The densest muscle artifact occurs during the tonic phase of the seizure, with a progressively relenting on-off muscle pattern matching each clonic movement. The actual onset of the seizure may have been heralded by a number of myoclonic activity (arrows). This rapid onset may be due either to a primary generalized epilepsy syndrome or a rapidly secondarily generalized partial-onset seizure. These seizures can be overlooked as simple arousal and muscle artifact, with the only EEG correlate being postictal slowing and attenuation that is diffuse in this case but, if focal, may indicate partial onset.



**FIGURE 8-13 A** ■ Right temporal seizure in typical PSG montage. Despite an absence of temporal coverage, the ear references (A1-A2) pick up temporal activity. Here, the rhythmic discharge contaminates the A2 reference; all channels referred to A2 (LLC-A2, C3-A2, O1-A2) demonstrate the seizure activity, potentially appearing left hemispheric. The same seizure is shown in Figure 8-13B, localizing to the right inferior temporal region. Note the evolution and abrupt offset of the rhythmic activity.

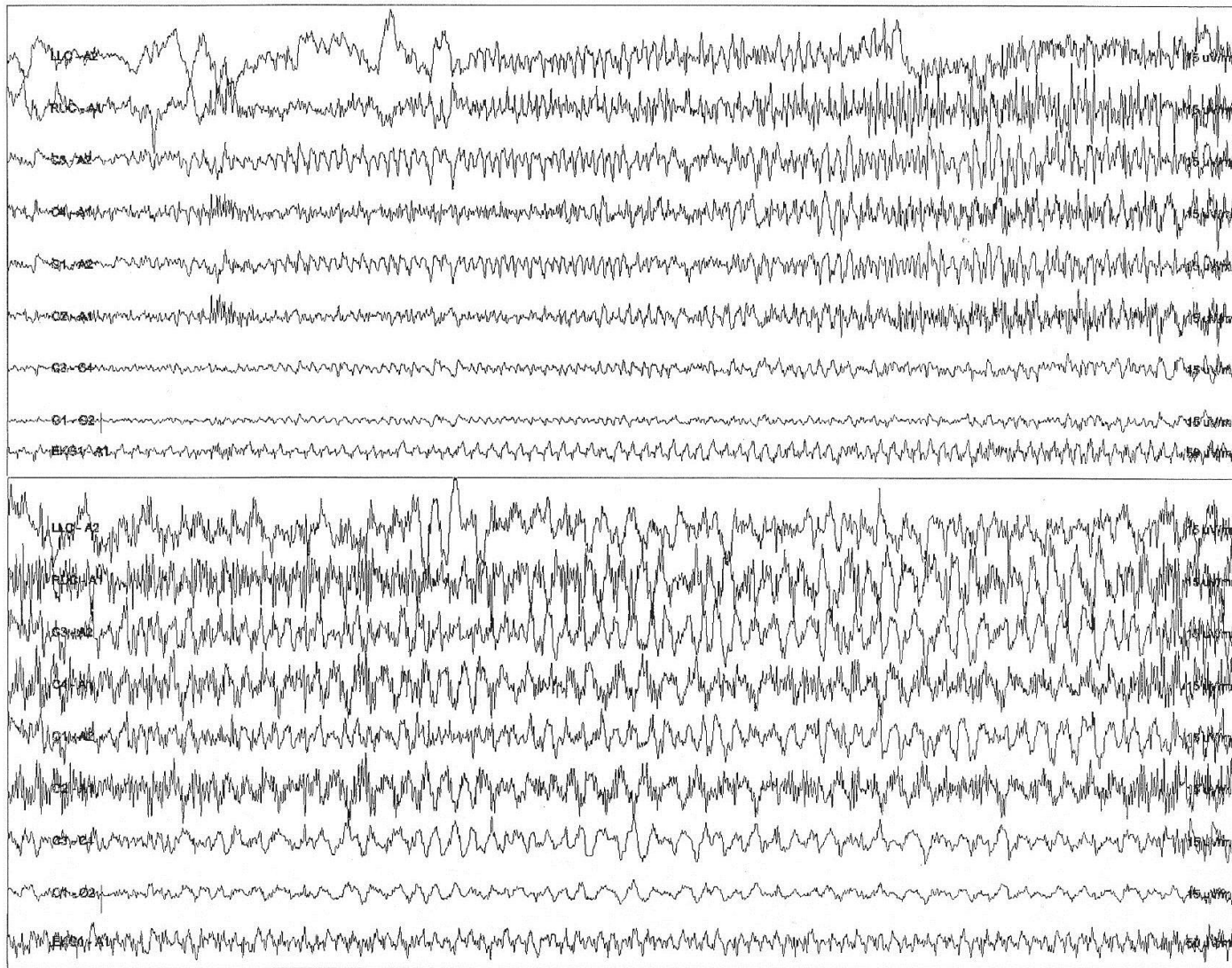
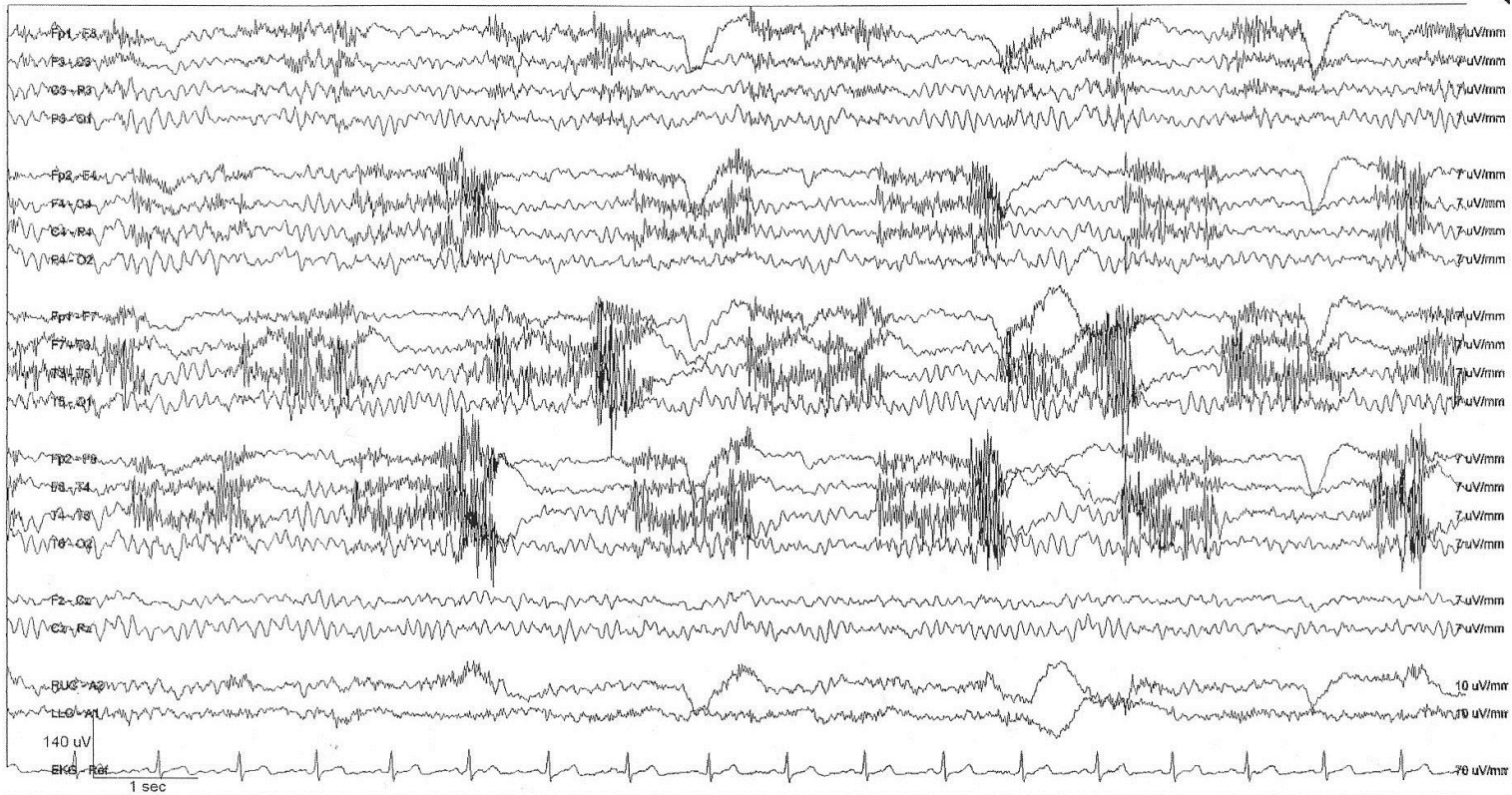
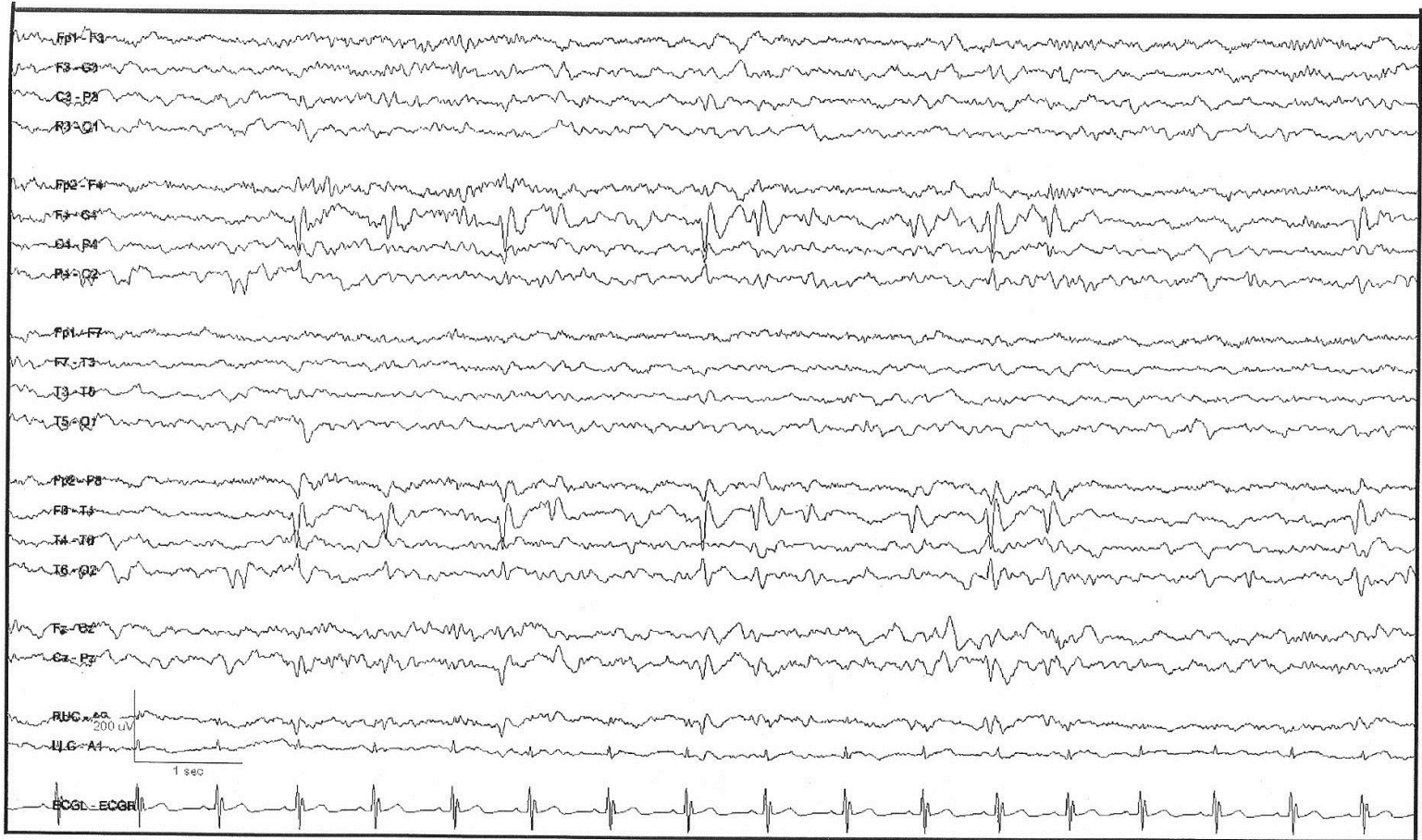


FIGURE 8-13 A ■ Continued.

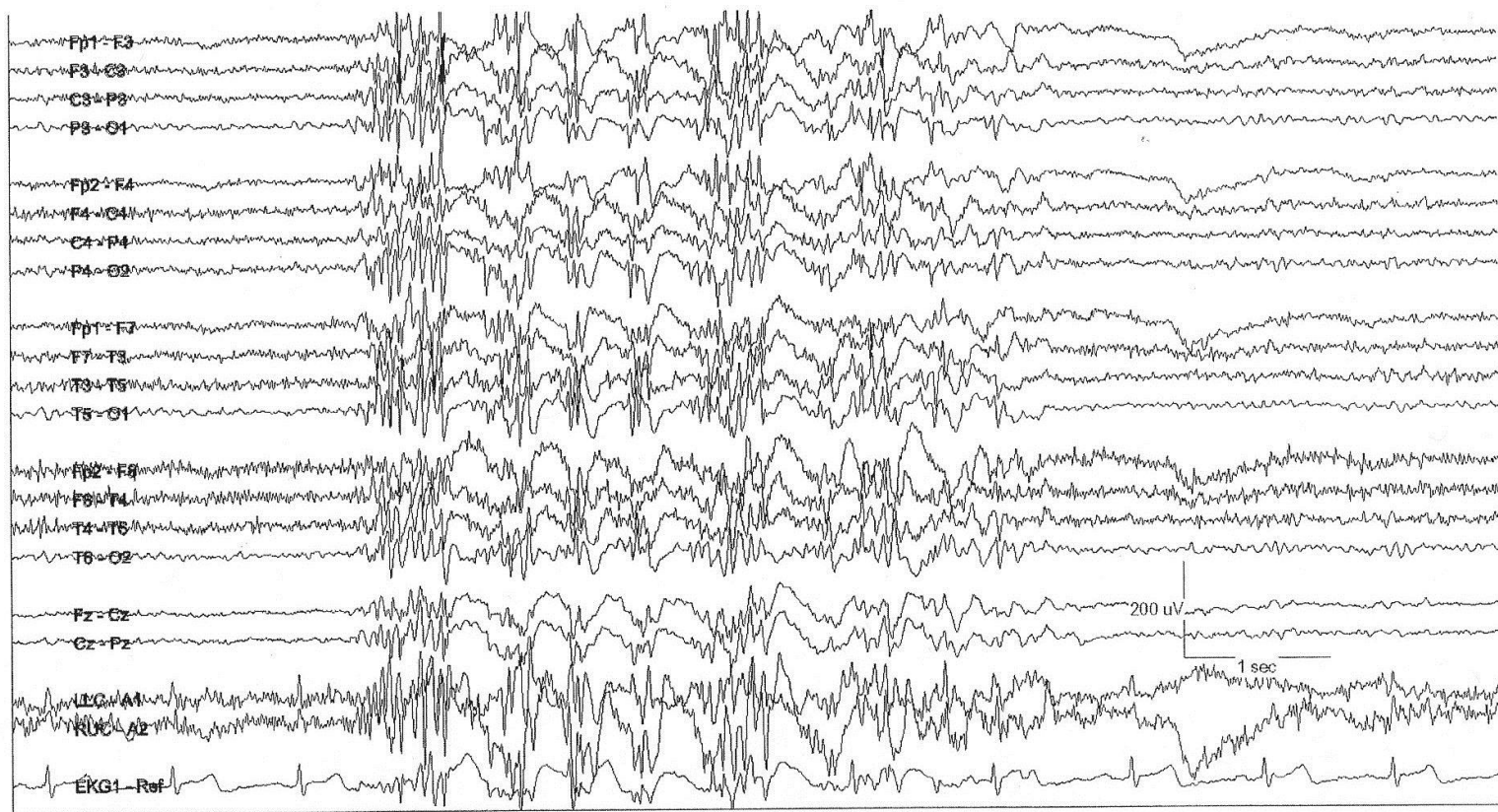




**FIGURE 8-17** ■ Bruxism. This child exhibits the typical checkerboard pattern of muscle artifact alternating between left and right sides, seen in long bipolar montage. The pattern could not be identified using a typical PSG montage. Bruxism is typically seen during sleep; however, this child is awake (note eye blinks) but developmentally delayed.



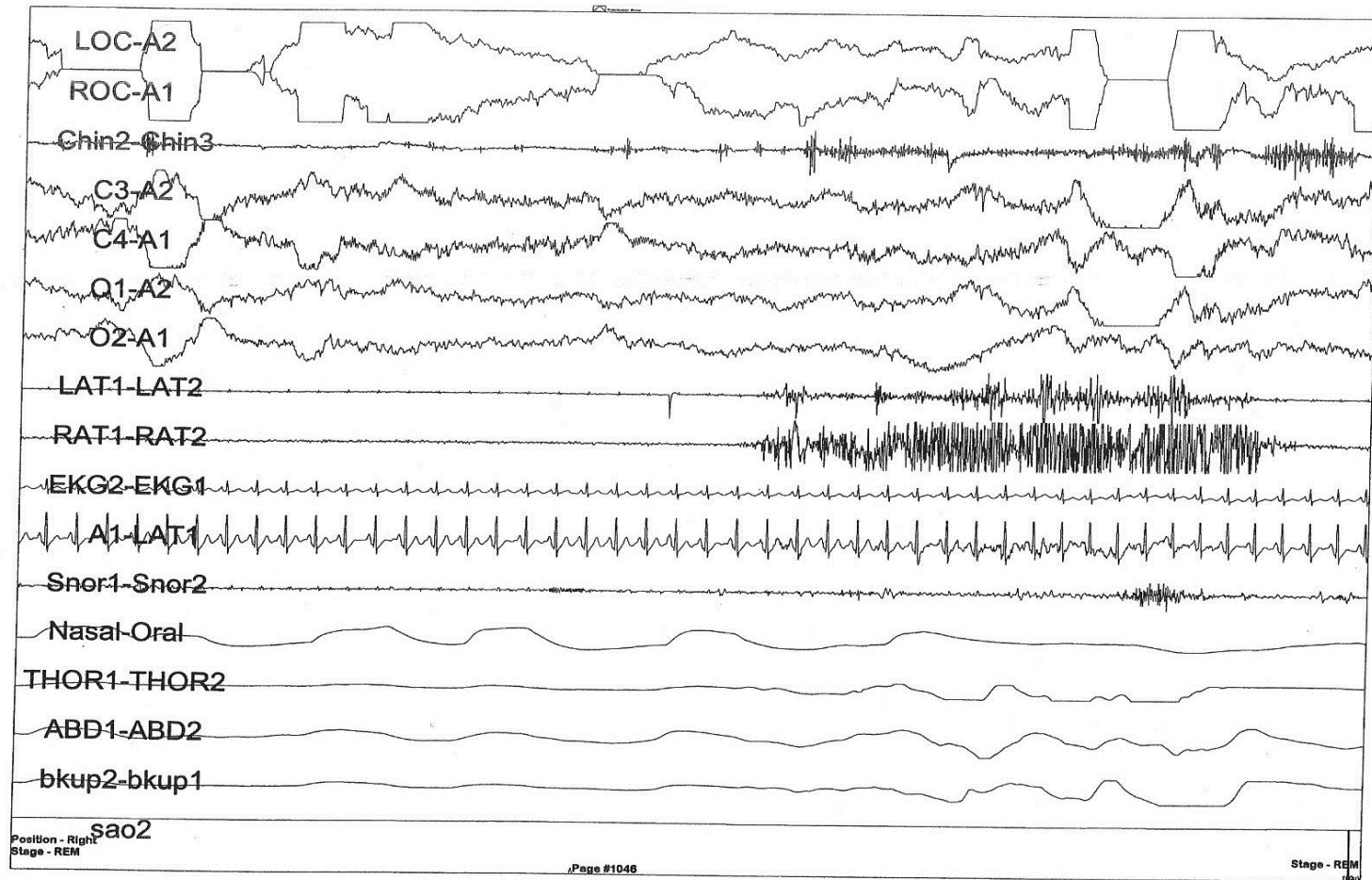
**FIGURE 8-14** ■ Benign epileptiform centro-temporal spikes (BECTS). Simply configured, triangular spike discharges in a 10-year-old boy are classic findings in the self-limited Rolandic epilepsy syndrome. These are difficult to identify on PSG (above), but are clear on EEG montage (below).



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Page 1

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**FIGURE 8-10** ■ Burst of generalized epileptiform activity, consisting of polyspikes, and polyspike-wave complexes. Seen in typical PSG montage and reading speed (above) and EEG reading speed in long bipolar montage (below). Polyspike waves are typical of a generalized epilepsy syndrome, including juvenile myoclonic epilepsy.



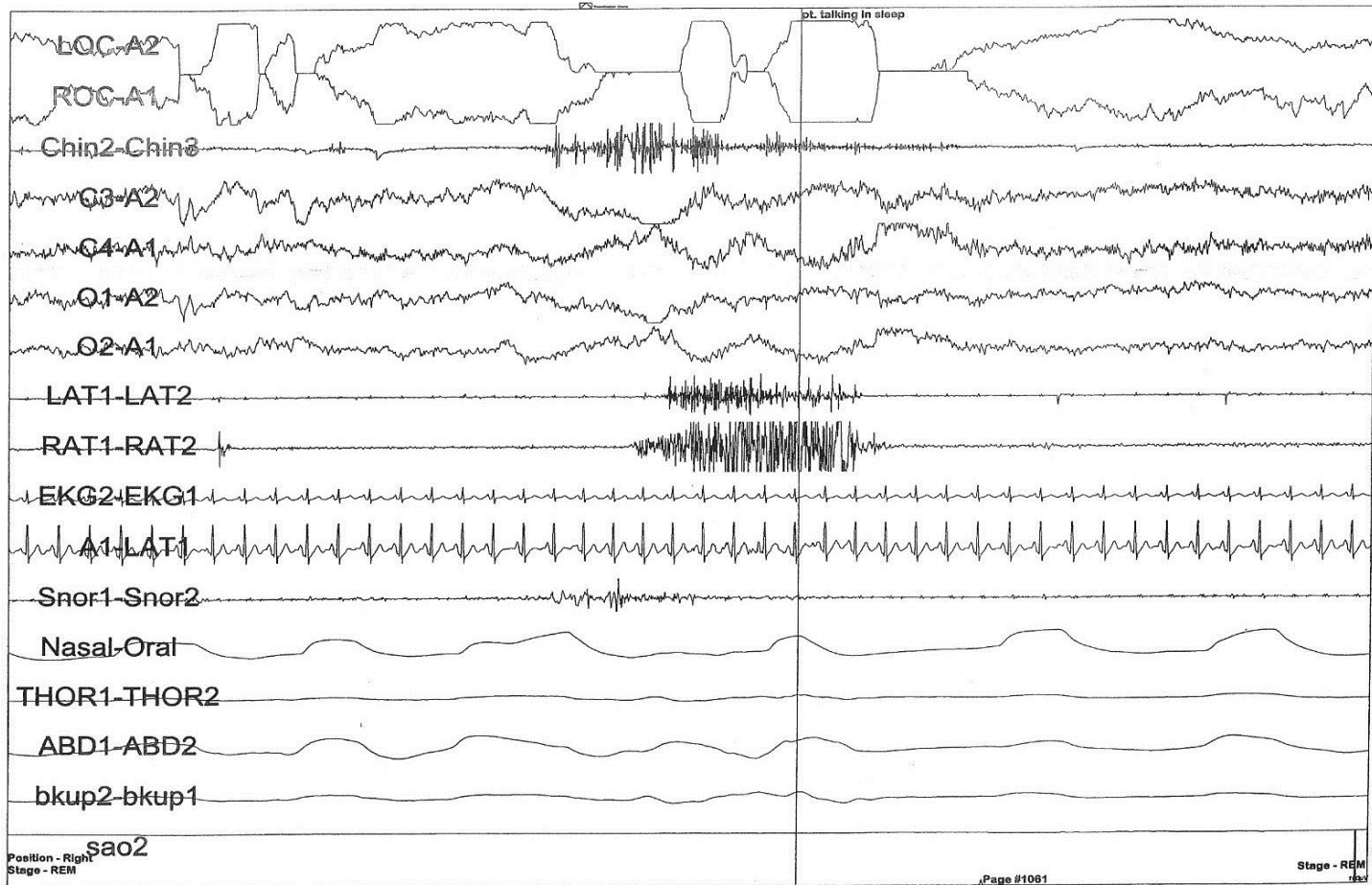
**FIGURE 6-14** Polysomnogram: Standard montage; 30-second page.

*Clinical:* 62-year-old man with a history of "fighting in his sleep."

*Staging:* Stage R sleep with rapid eye movements.

*Respiratory:* Normal respirations.

*EMG:* Markedly increased chin EMG tone and leg movements during REM sleep. During this REM period, the patient talked, screamed, and made punching and thrashing movements. The behaviors and polysomnographic features are typical of REM sleep behavior disorder.



**FIGURE 6-13** Polysomnogram: Standard montage; 30-second page.

*Clinical:* 62-year-old man with a history of fighting behavior in his sleep.

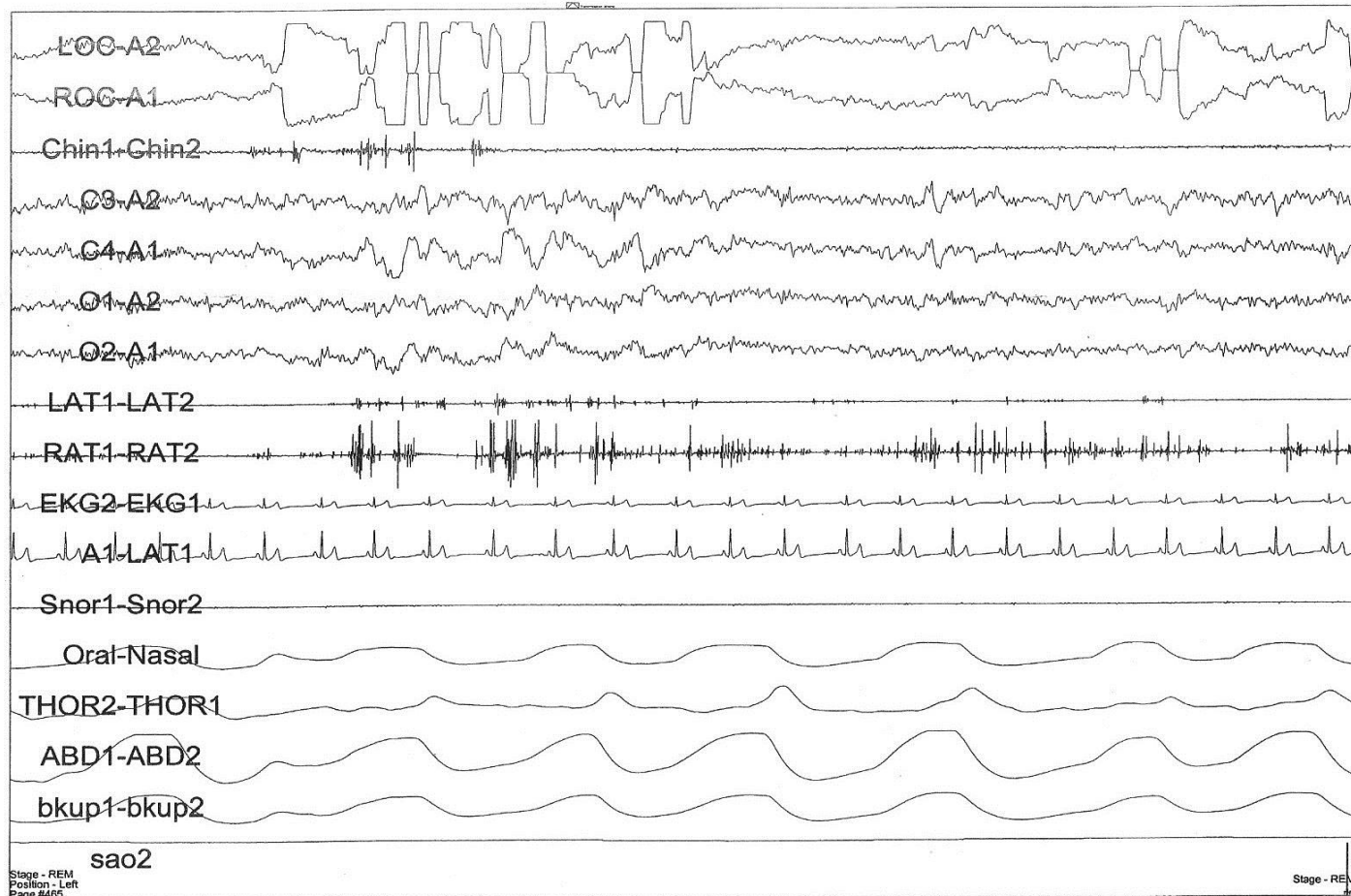
*Staging:* Stage R sleep with rapid eye movements.

*Respiratory:* Normal respirations.

*EMG:* Transiently increased chin EMG tone with leg movements and talking during REM sleep.

The behaviors and polysomnographic features are typical of REM sleep behavior disorder.





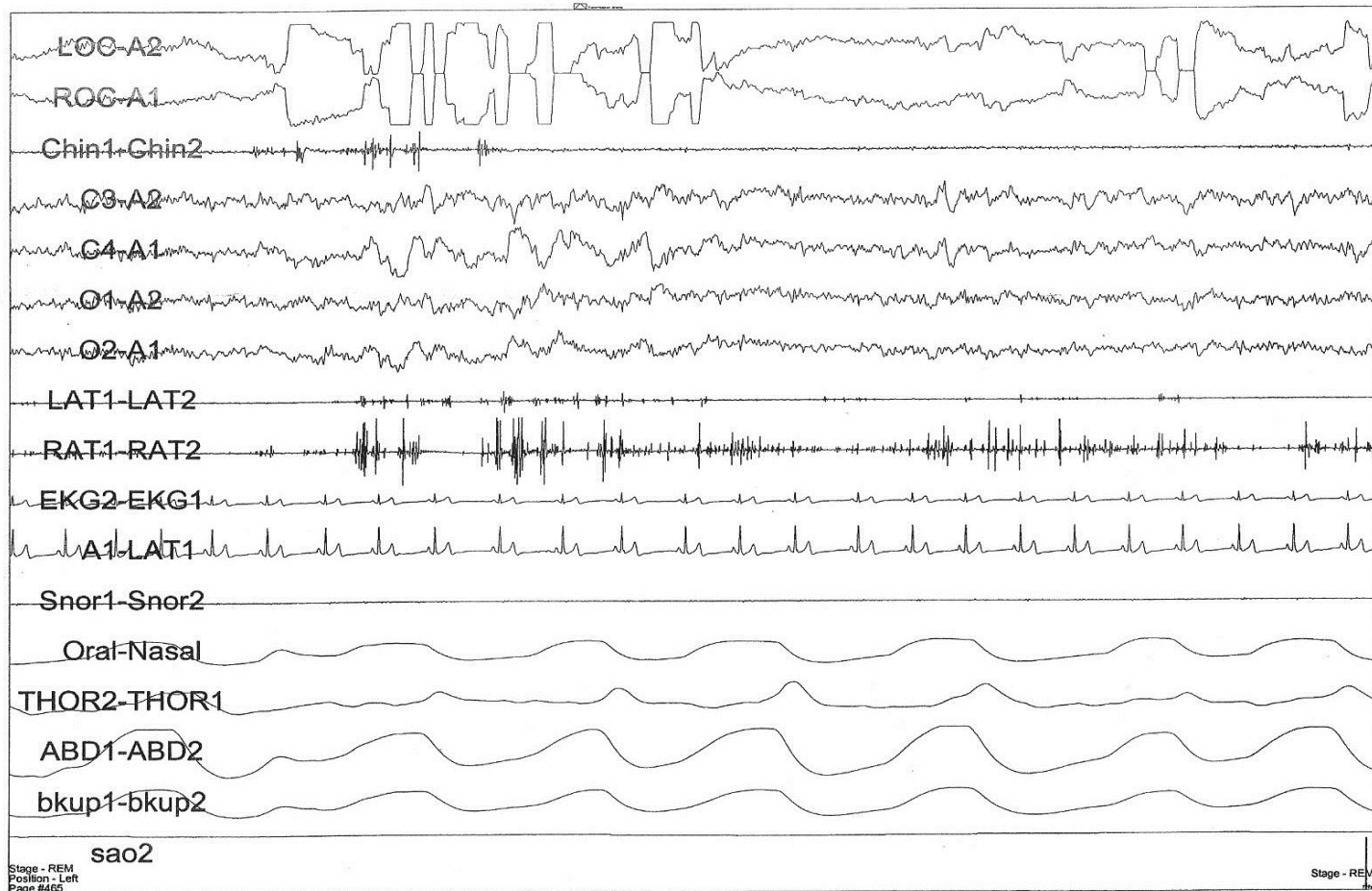
**FIGURE 6-10** Polysomnogram: Standard montage; 30-second page.

*Clinical:* 63-year-old man with excessive daytime sleepiness and mild parkinsonism.

*Staging:* Stage R sleep with bursts of rapid eye movements.

*Respiratory:* Mildly irregular breathing accompanying the bursts of rapid eye movements.

*EMG:* Phasic EMG activity which is most prominent in the right leg. The amount of activity is excessive for an adult. Epochs of REM sleep with excessive phasic EMG activity are common in patients with REM sleep behavior disorder.



**FIGURE 6-10** Polysomnogram: Standard montage; 30-second page.

*Clinical:* 63-year-old man with excessive daytime sleepiness and mild parkinsonism.

*Staging:* Stage R sleep with bursts of rapid eye movements.

*Respiratory:* Mildly irregular breathing accompanying the bursts of rapid eye movements.

*EMG:* Phasic EMG activity which is most prominent in the right leg. The amount of activity is excessive for an adult. Epochs of REM sleep with excessive phasic EMG activity are common in patients with REM sleep behavior disorder.

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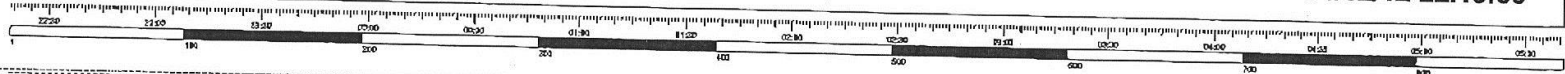


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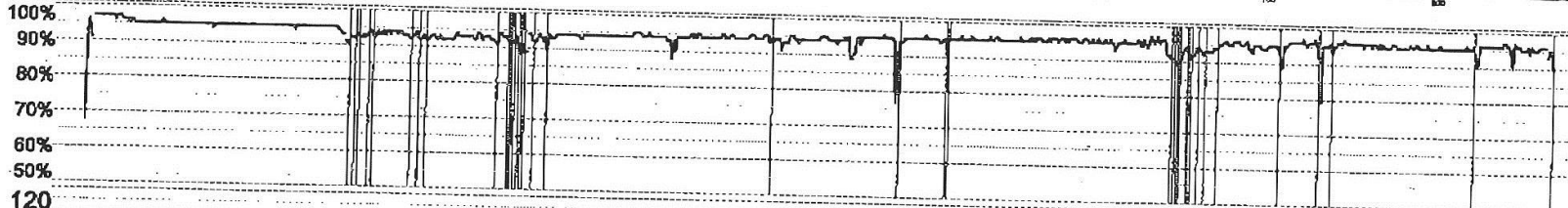
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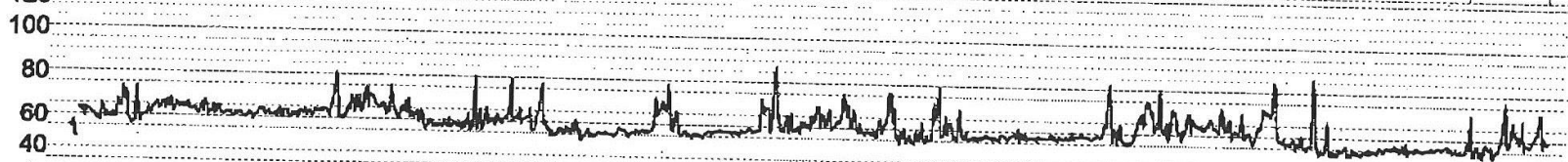
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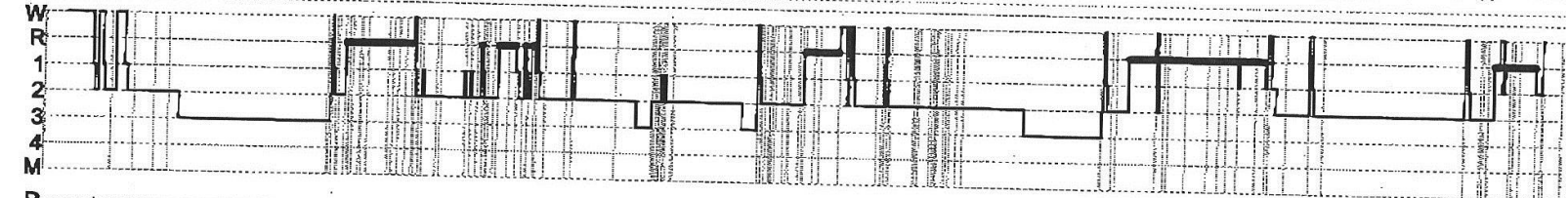
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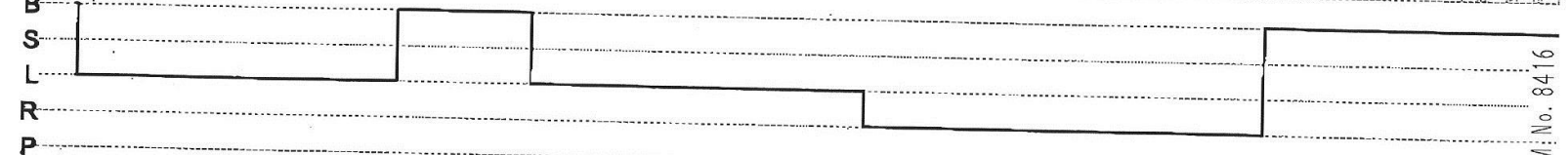
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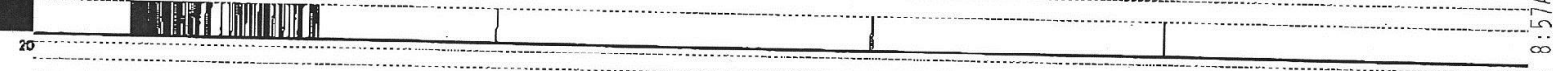
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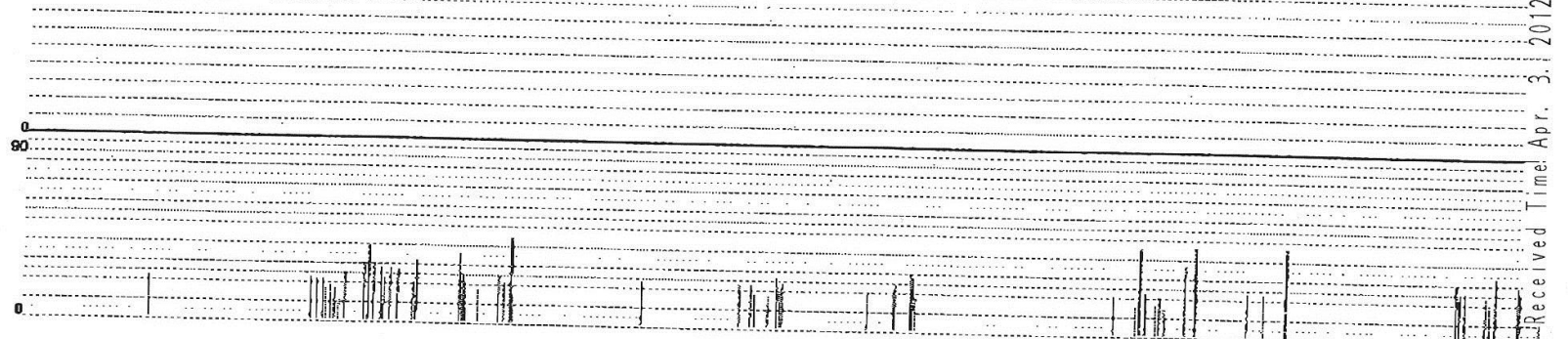
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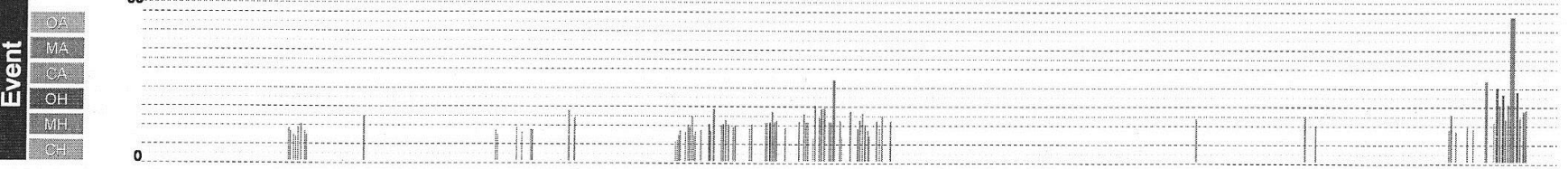
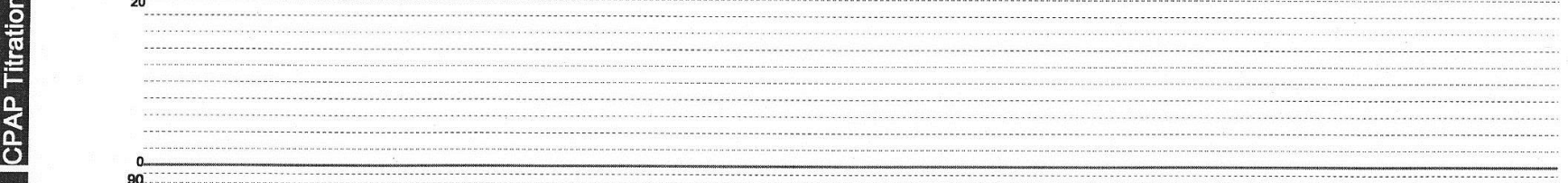
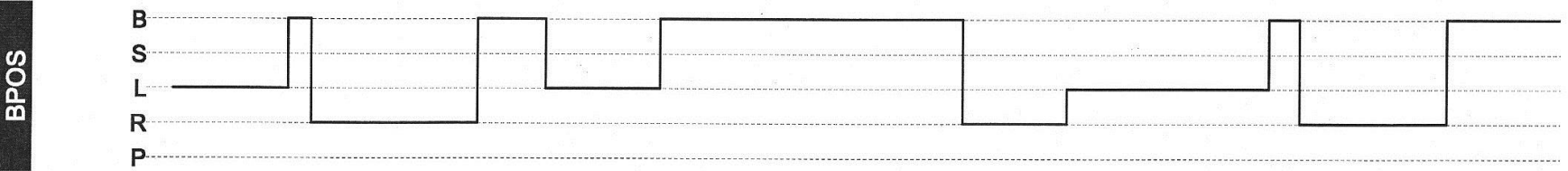
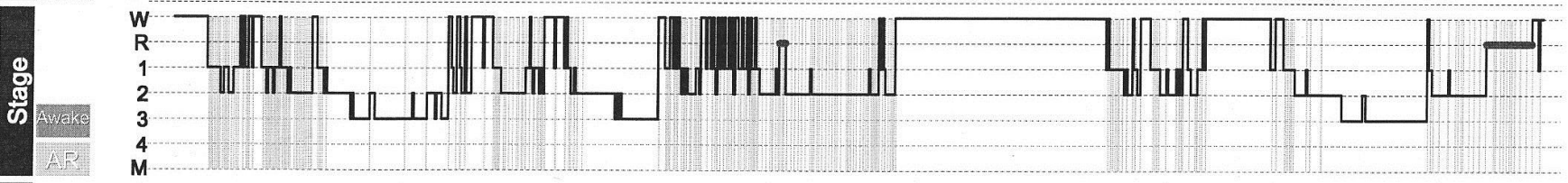
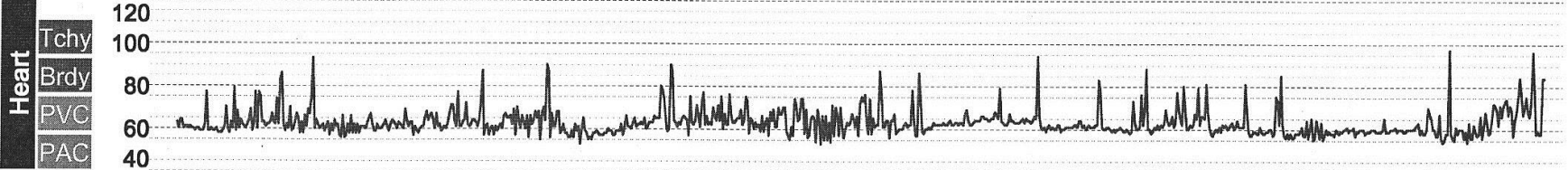
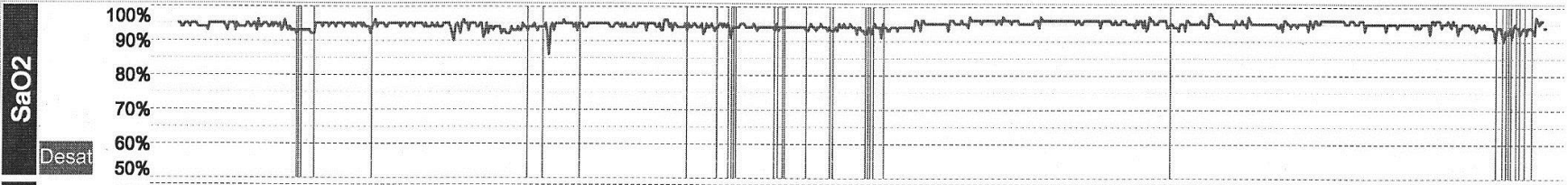
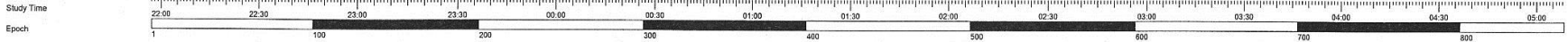
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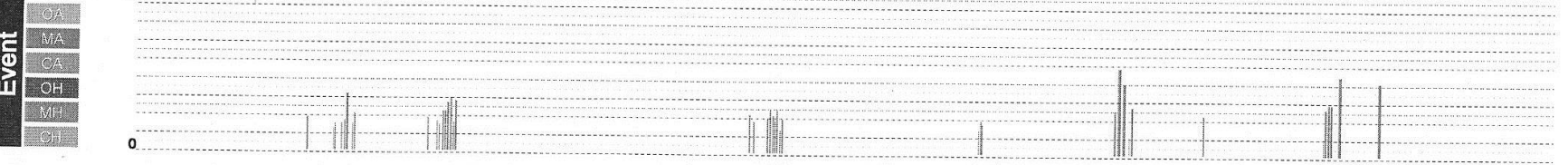
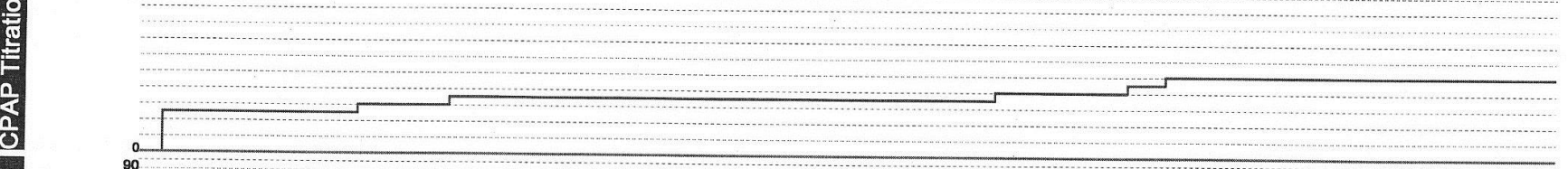
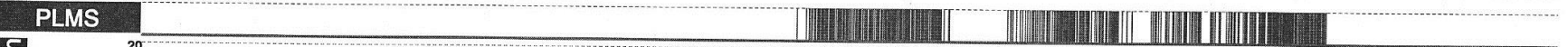
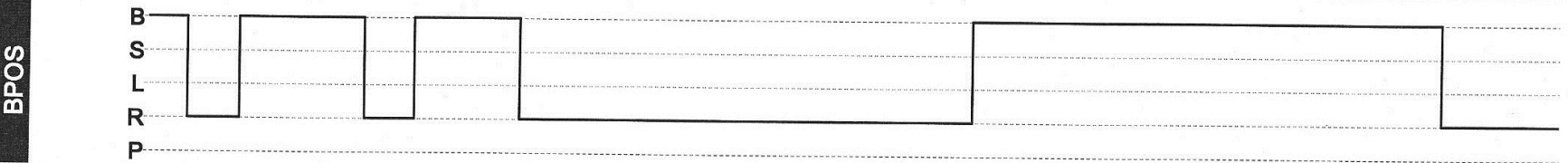
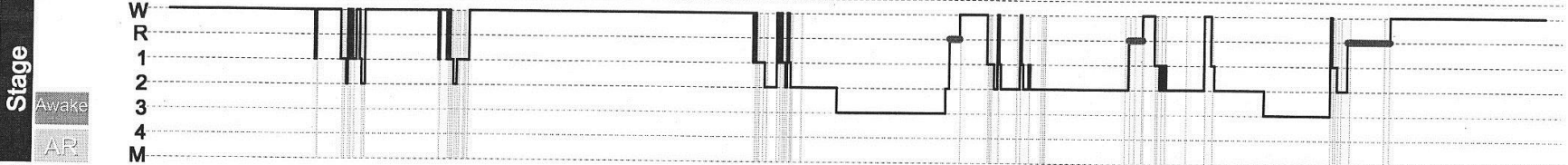
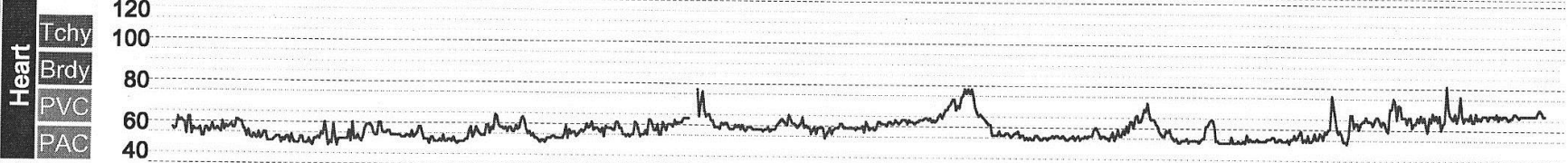
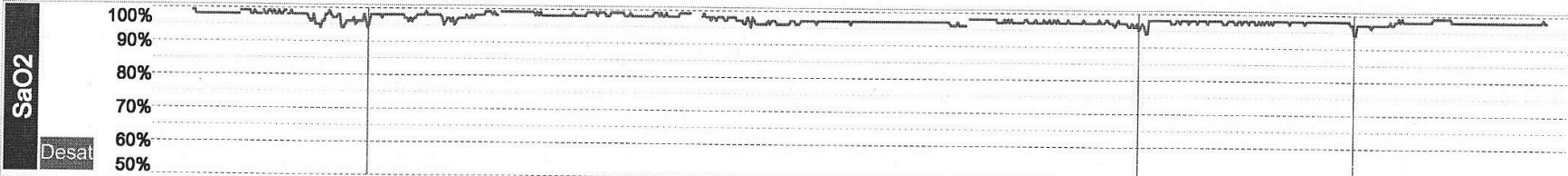


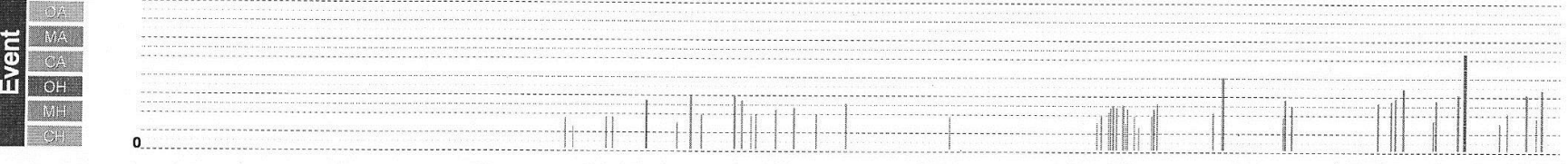
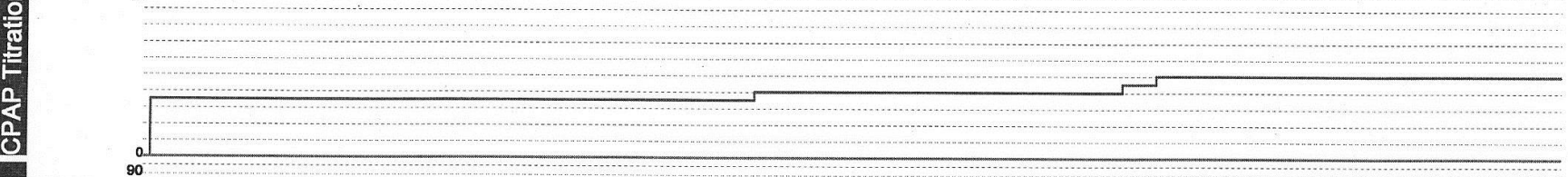
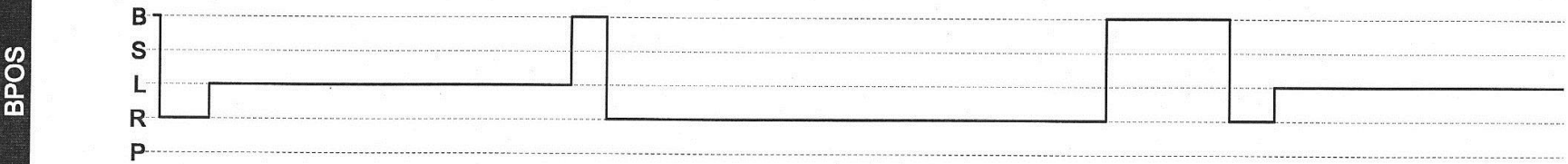
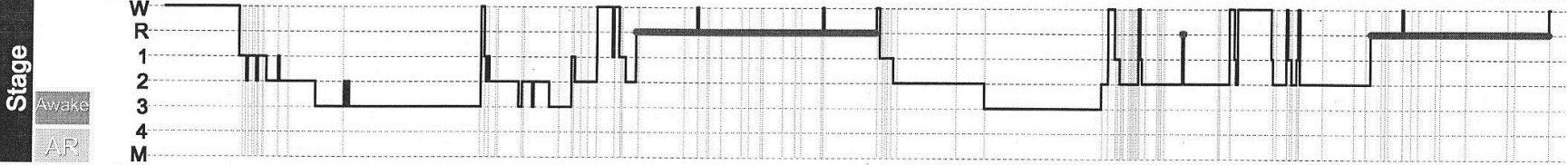
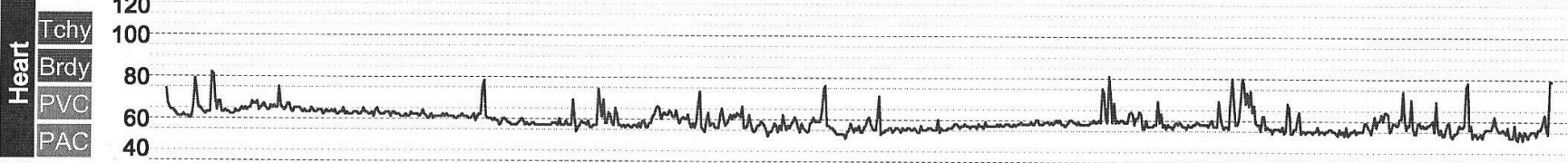
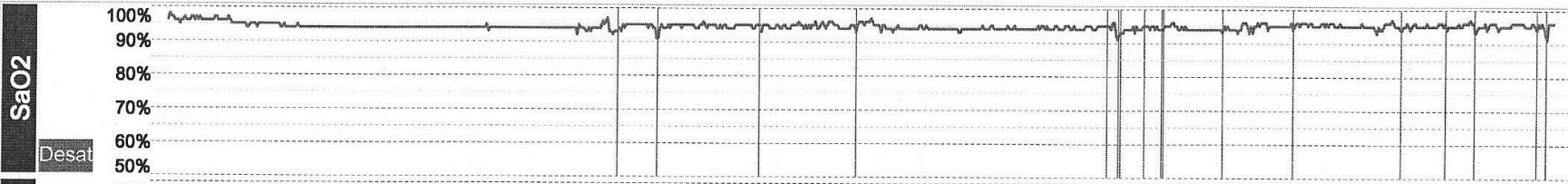
EM 5

820791: ~~Stephenson, Cameron M~~

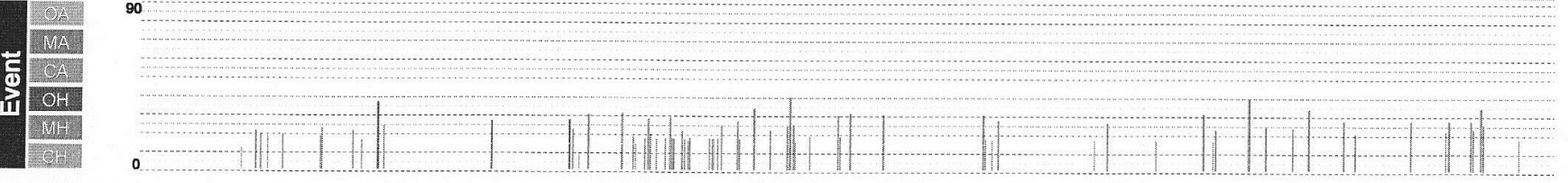
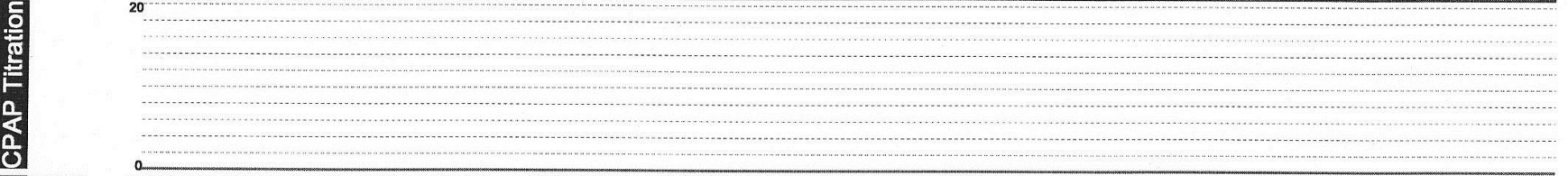
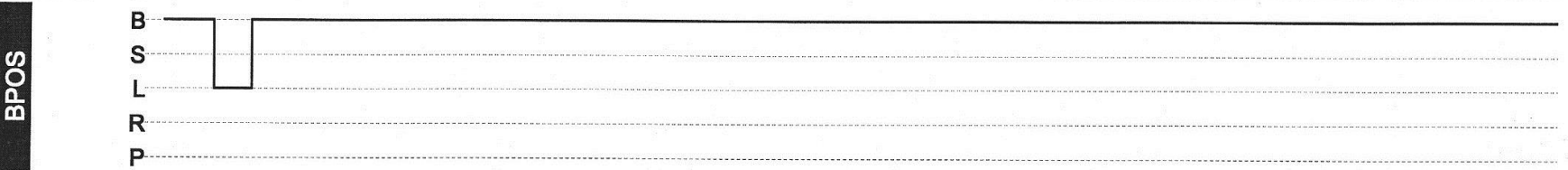
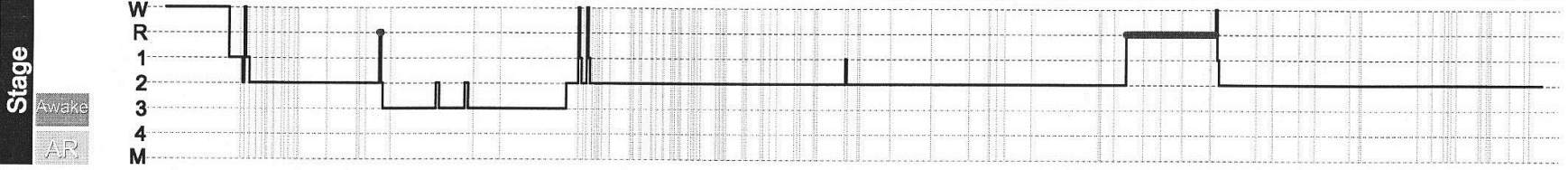
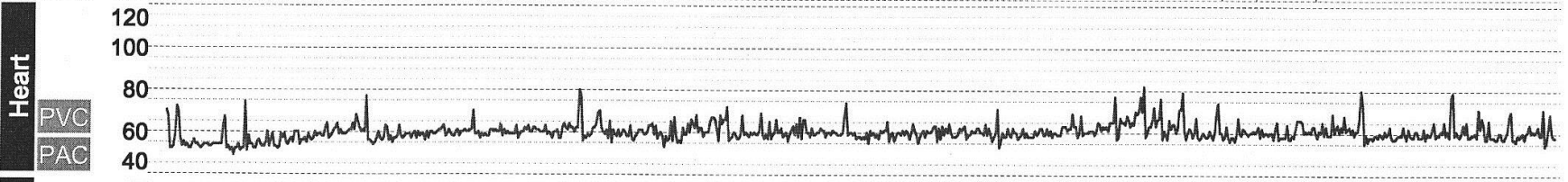
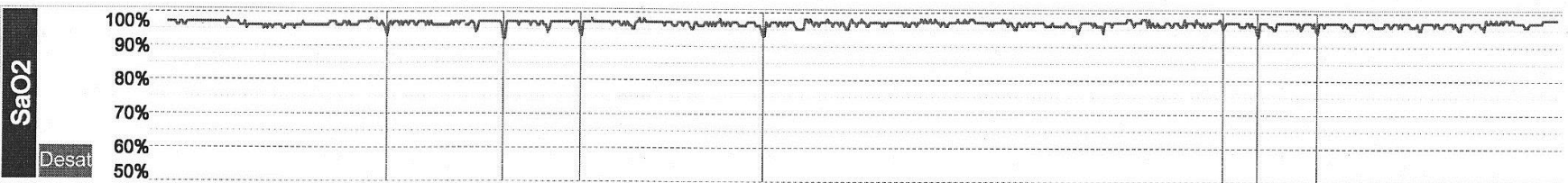
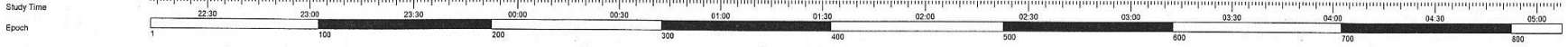
03/29/12 21:57:00

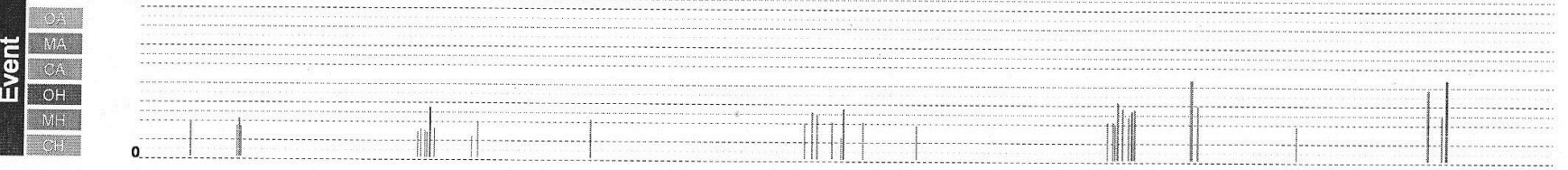
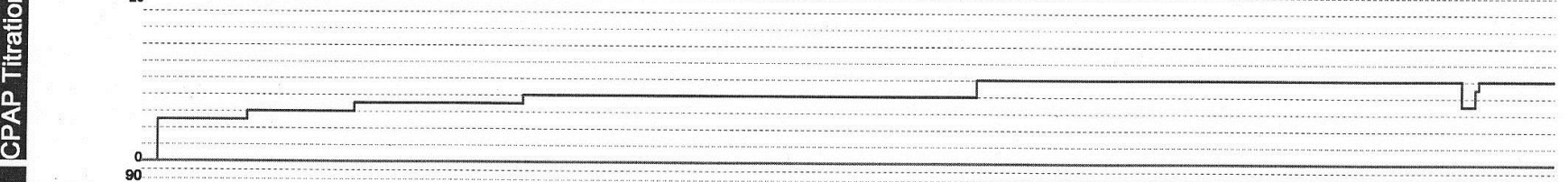
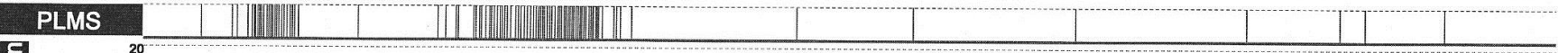
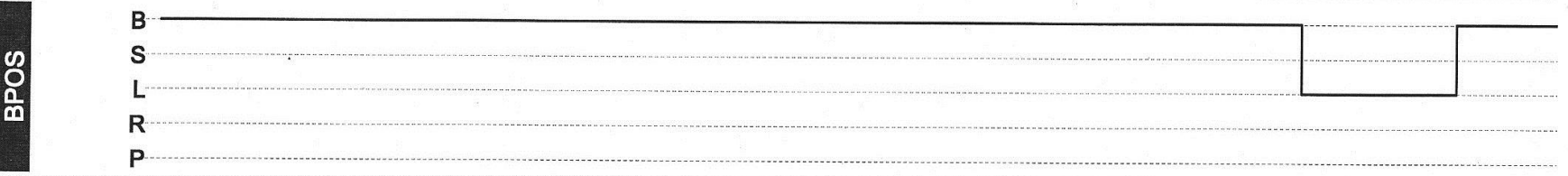
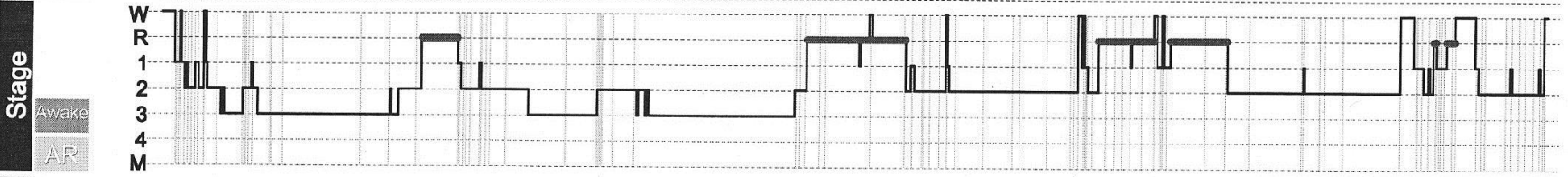
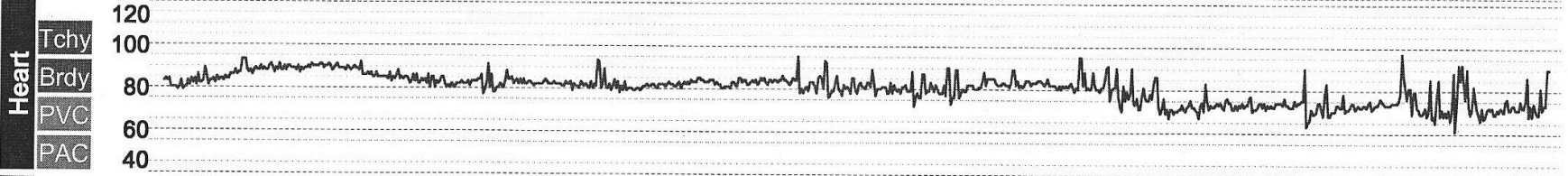
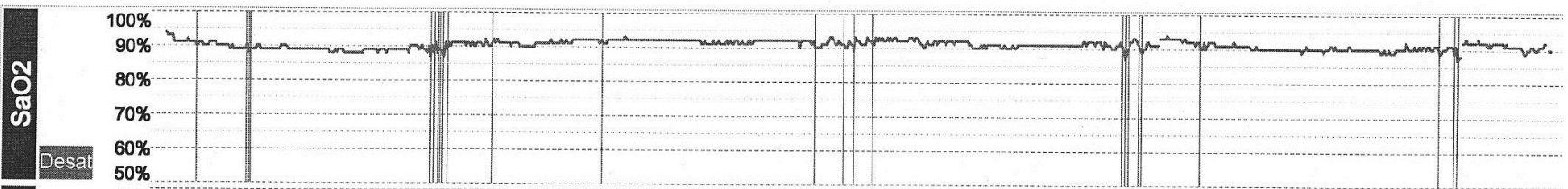
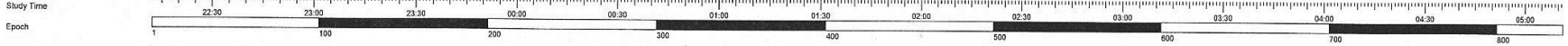














251378: ~~Trevino, Walter S~~ WT

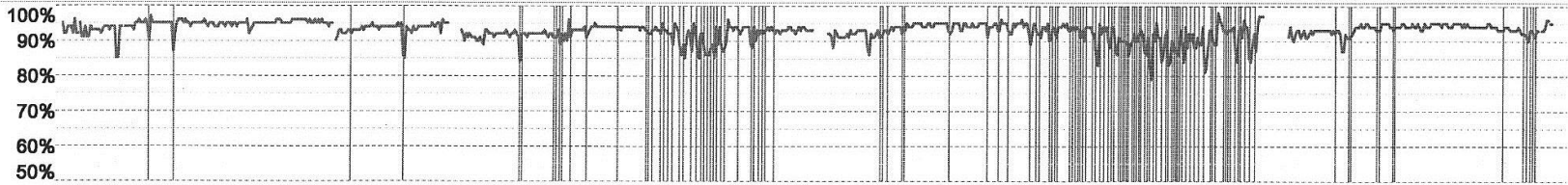
03/23/12 22:36:00

Study Time  
Epoch



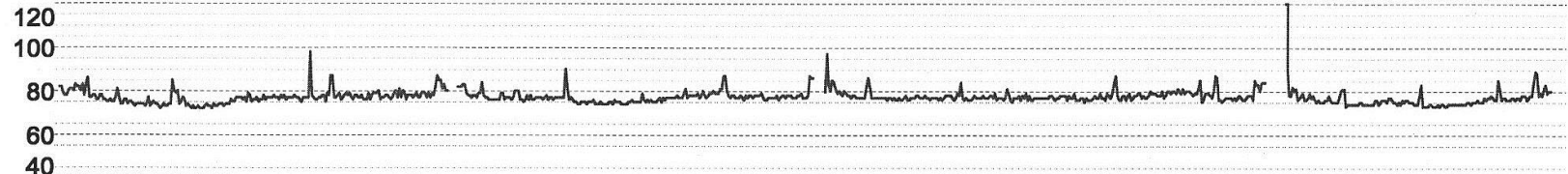
SaO2

Desat



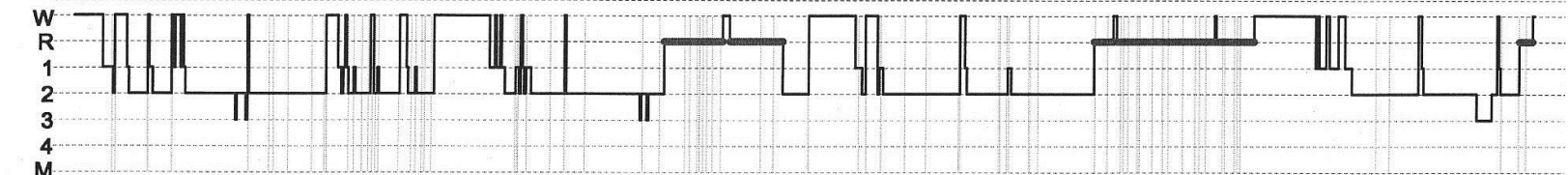
Heart

Tchy  
Brdy  
PVC  
PAC

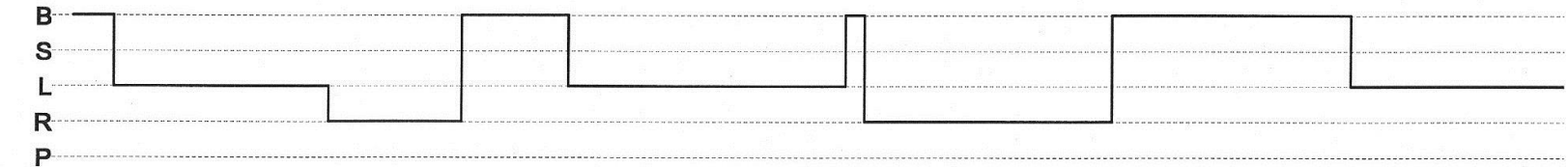


Stage

Awake  
AR



BPOS

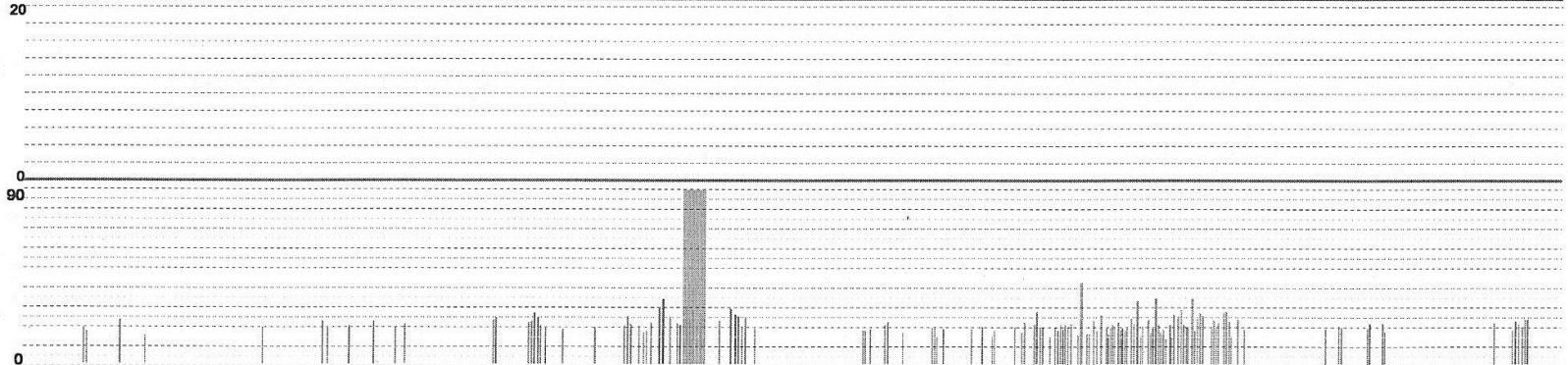


PLMS



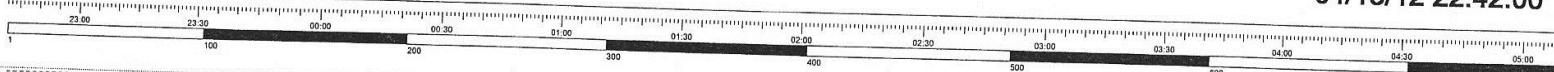
CPAP Titration

OA  
MA  
CA  
OH  
MH  
CH

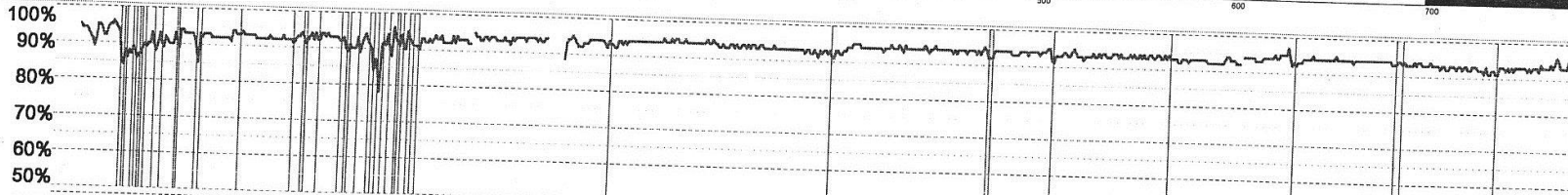


Study Time

Epoch



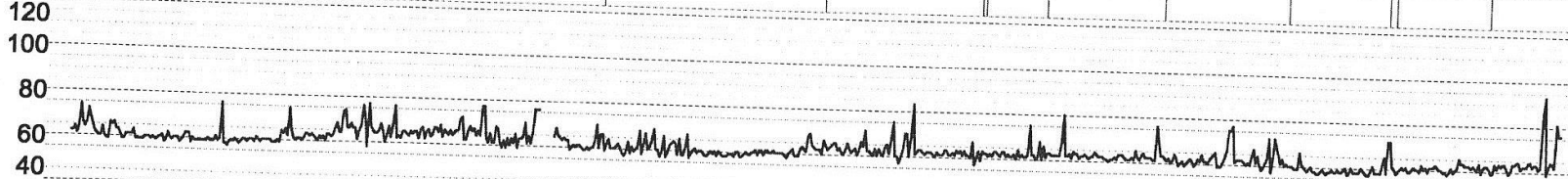
SaO2



Desat

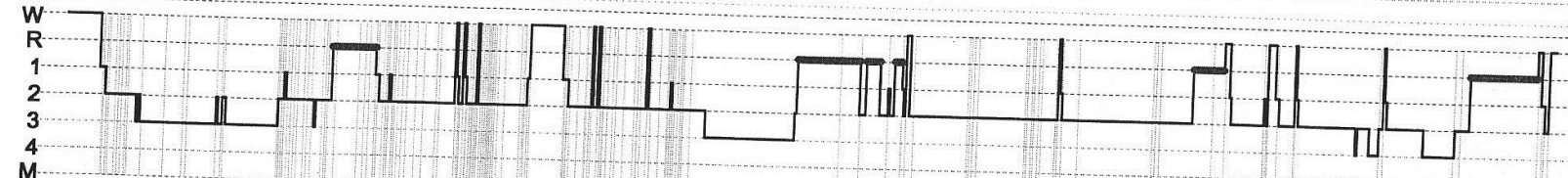
Heart

Tchy  
Brdy  
PVC  
PAC

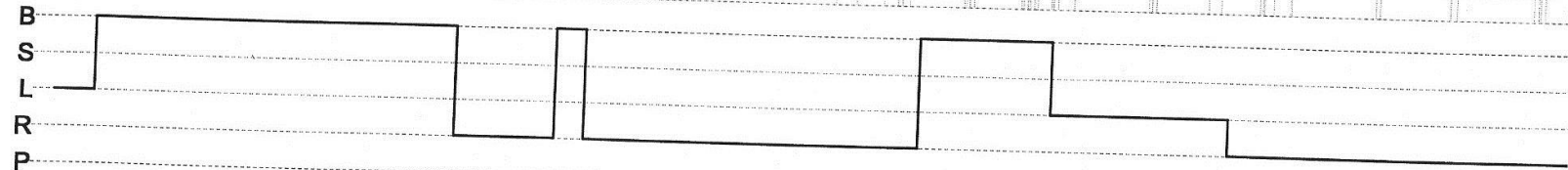


Stage

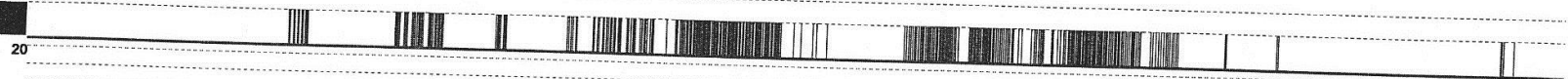
Wake  
AR



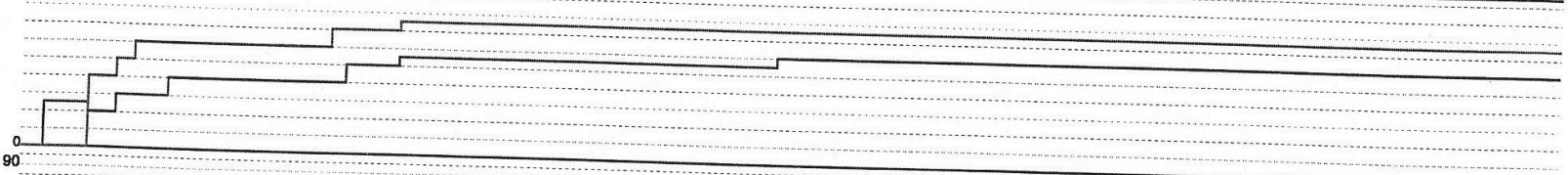
BPOS



PLMS



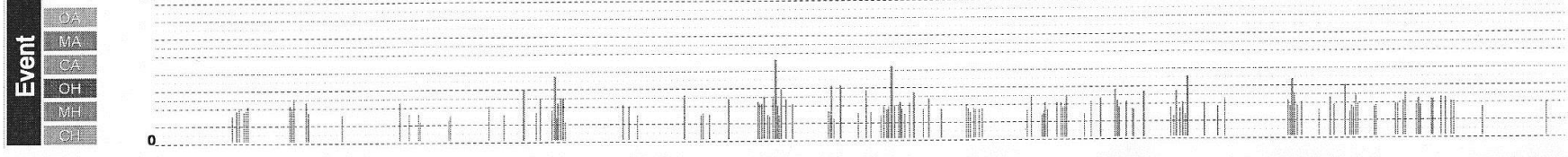
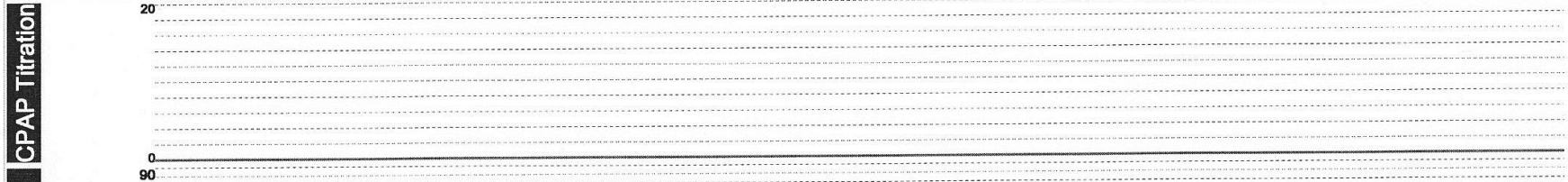
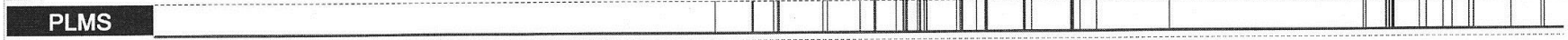
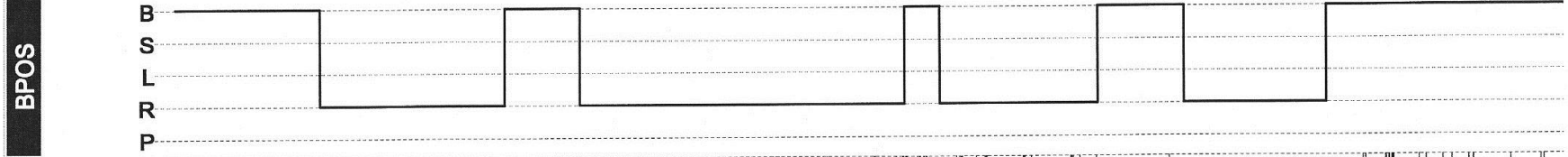
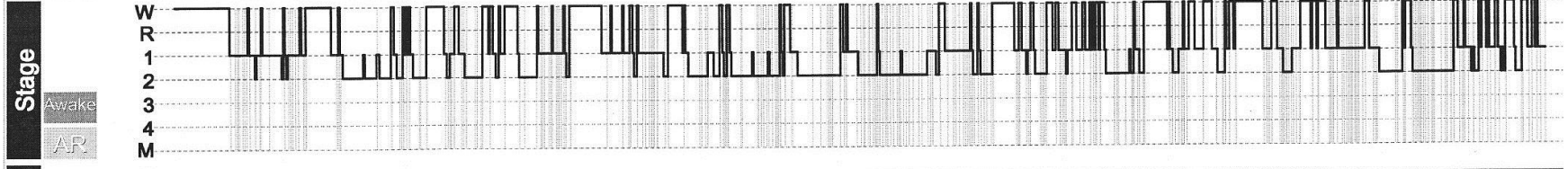
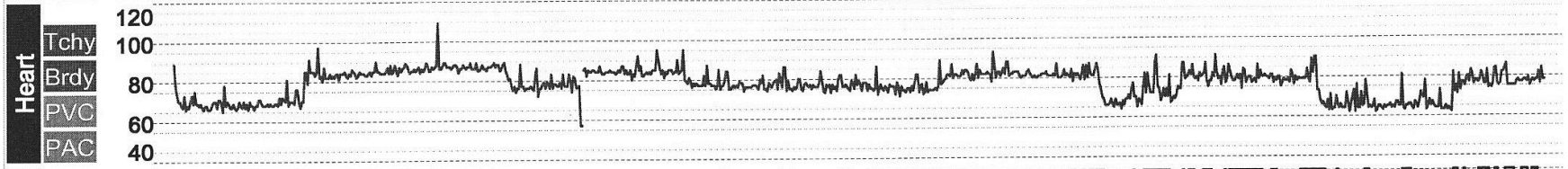
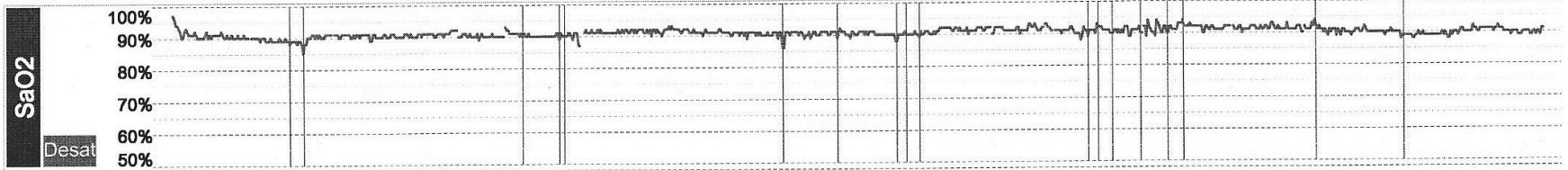
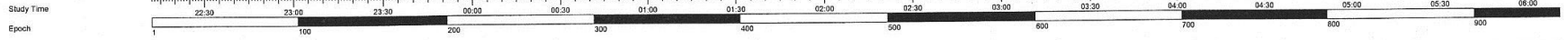
CPAP Titration



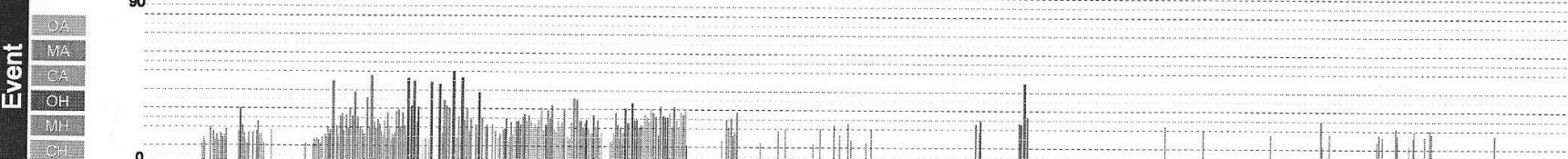
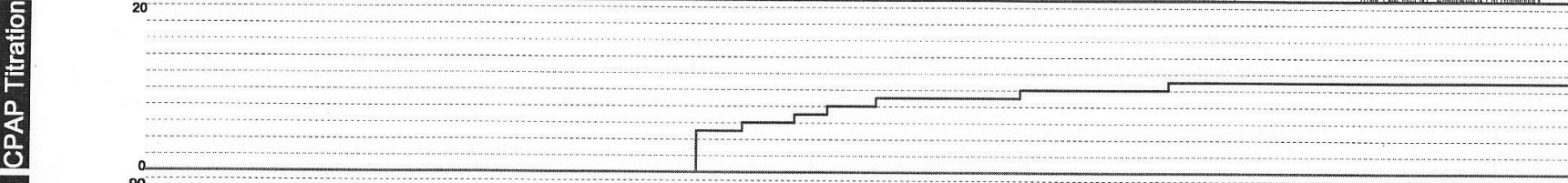
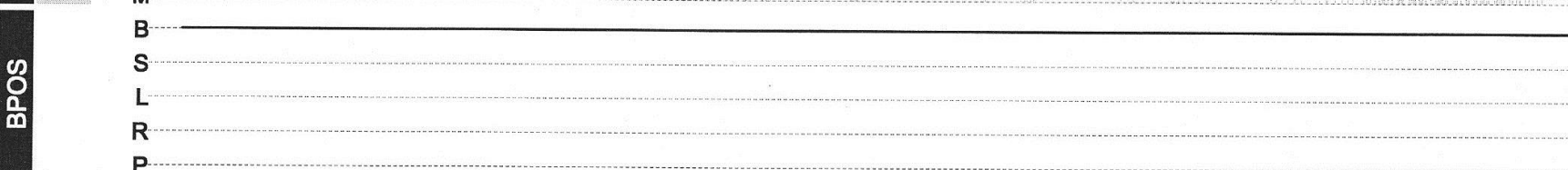
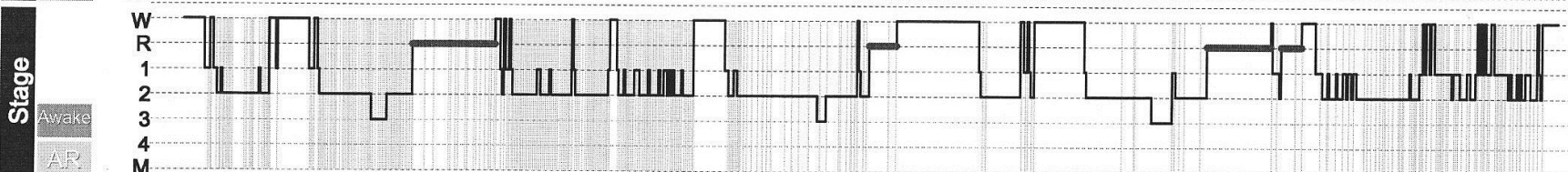
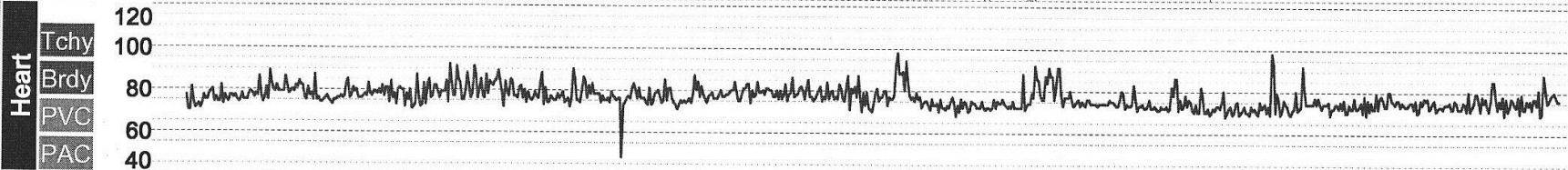
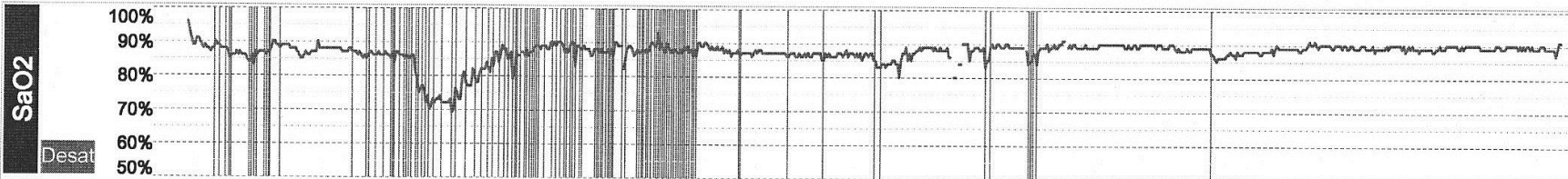
Event

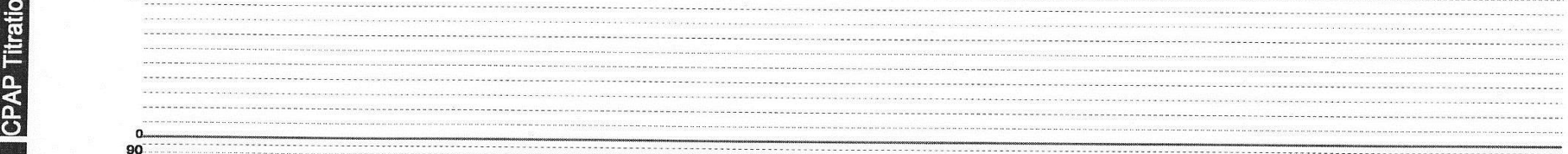
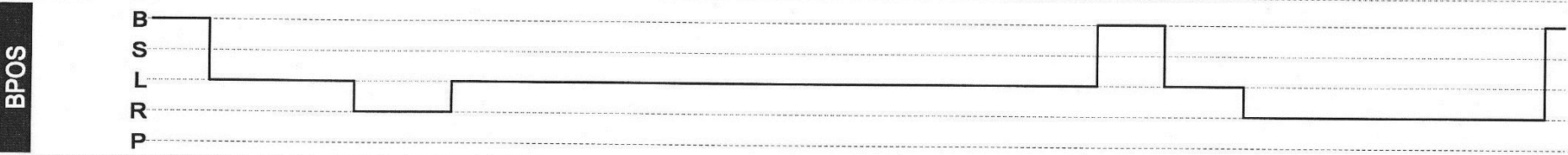
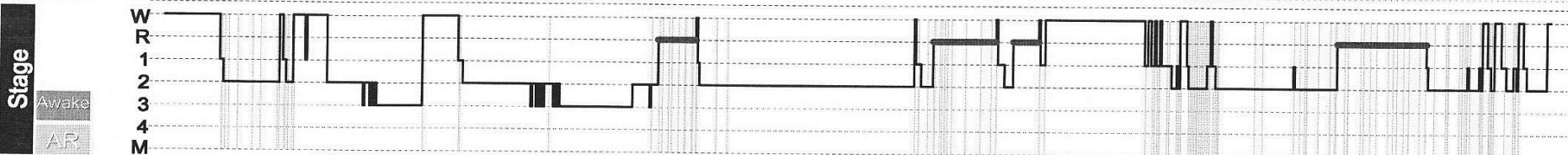
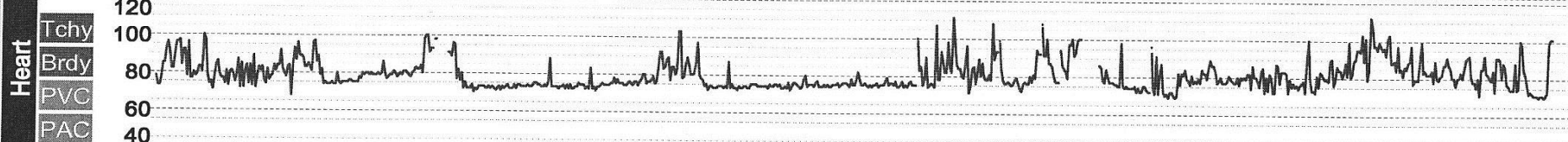
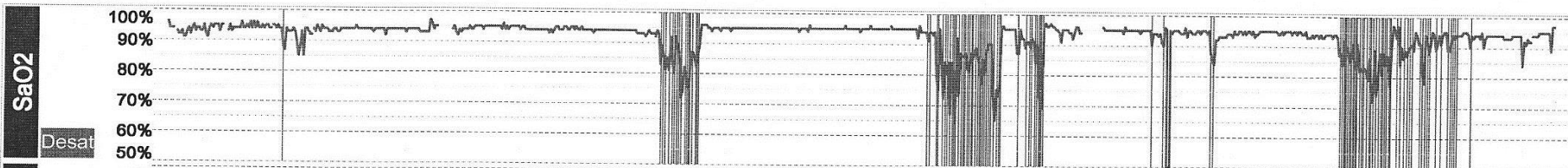
OF  
MA  
CA  
OH  
MH  
CH









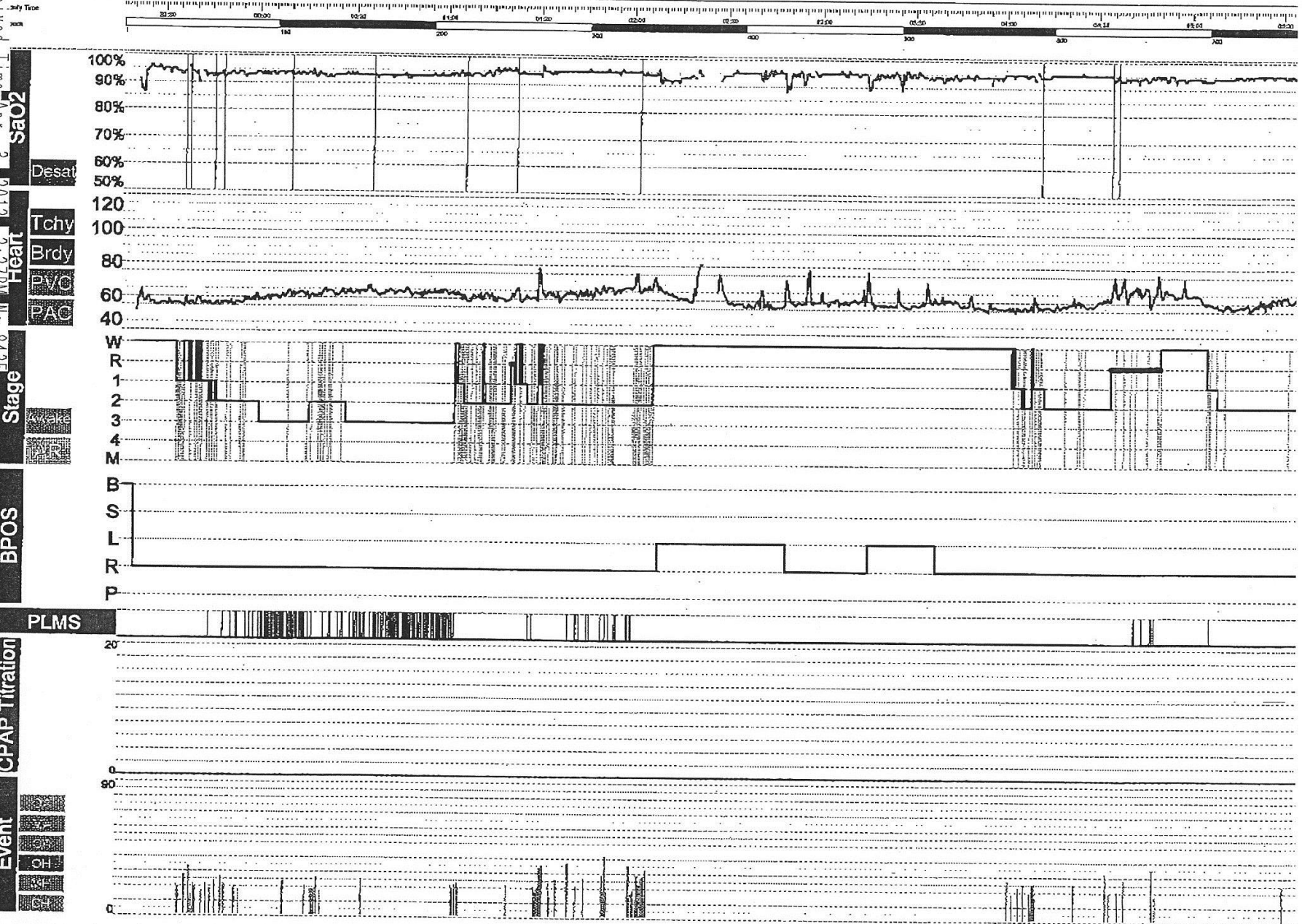




821041 ~~XXXXXXXXXX~~ JL

04/02/12 23:16:00

Received Time: Apr. 3, 2012 2:27 PM No. 8433



Event

CPAP Titration

PLMS

BPOS

Stage

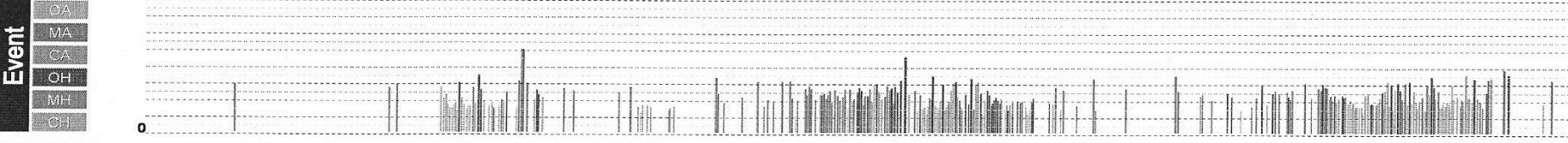
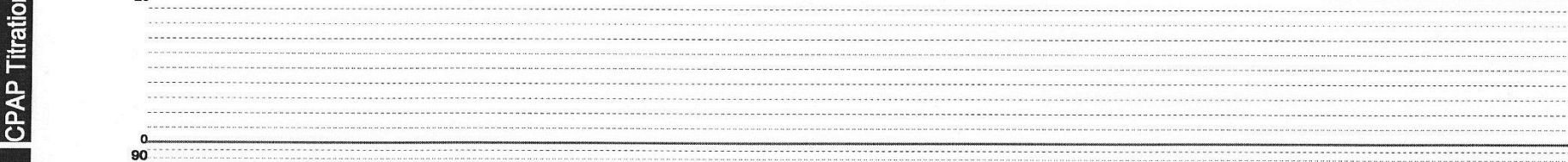
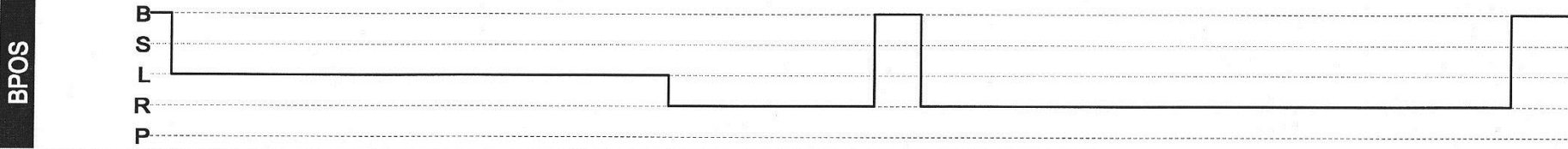
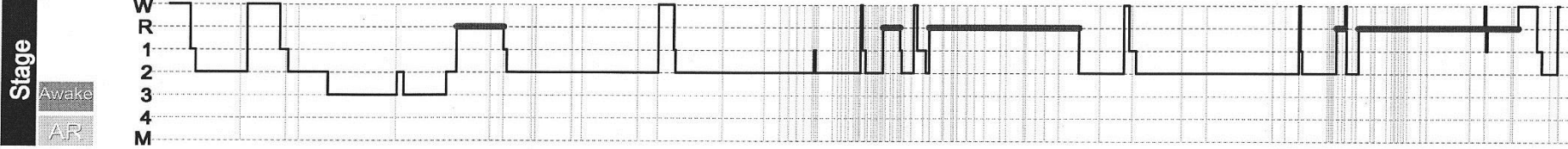
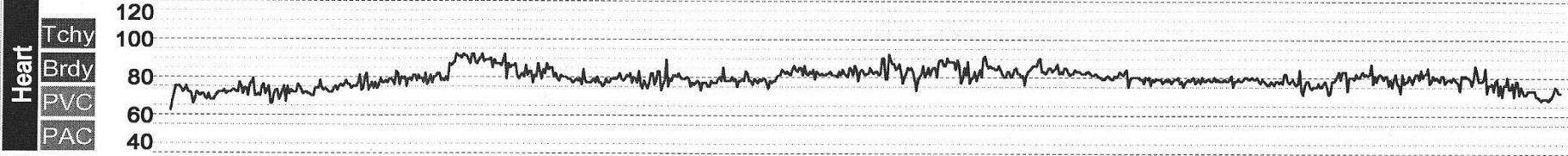
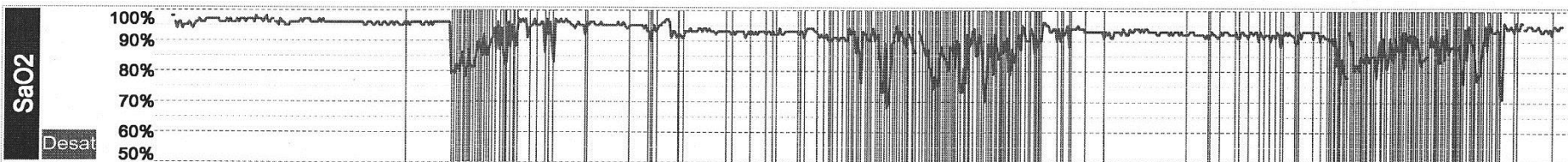
Hear

Desat

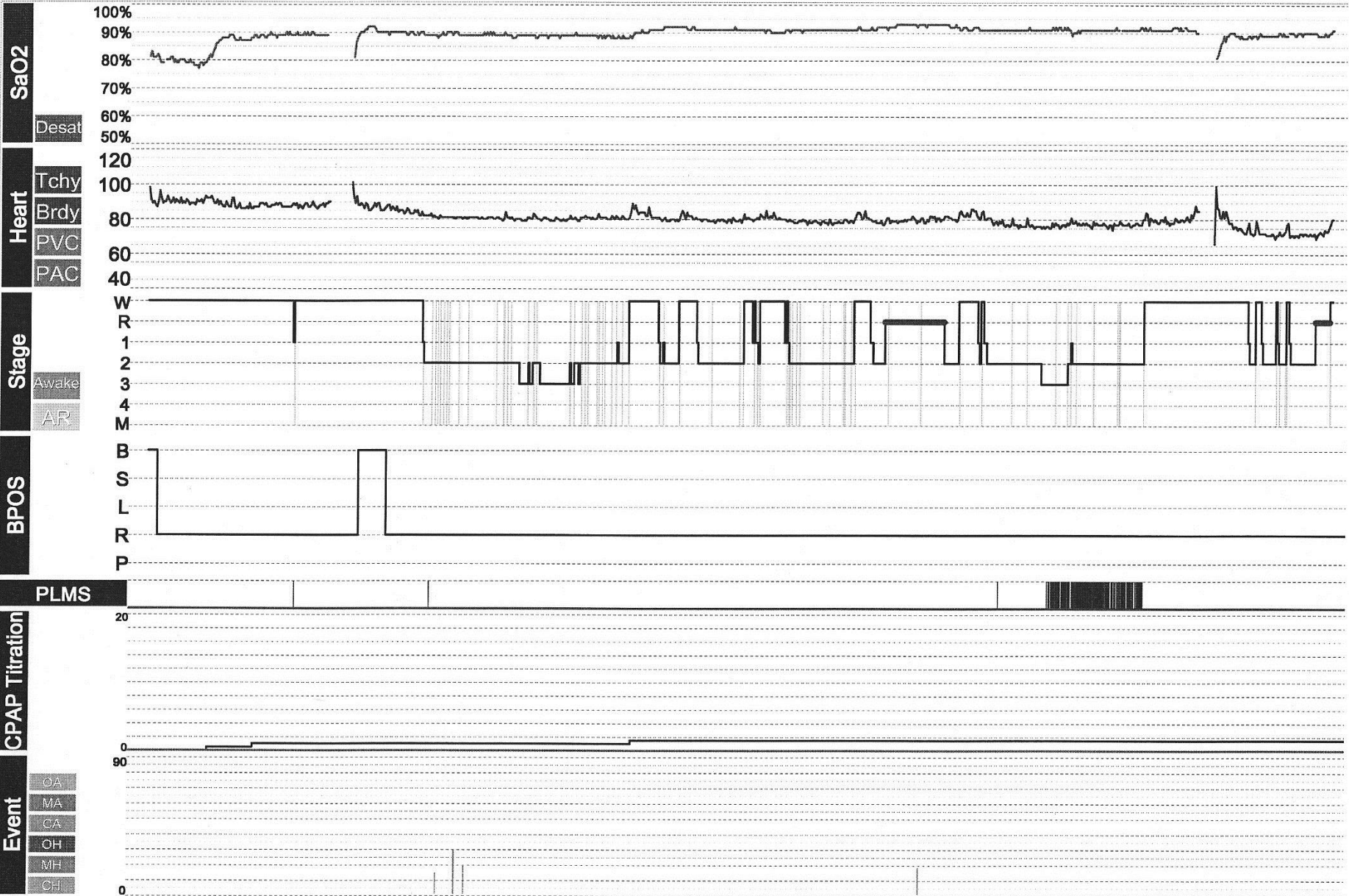
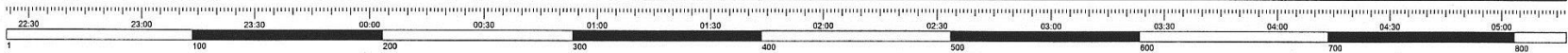
SAO2

821171: ~~Gregory, David~~. DG

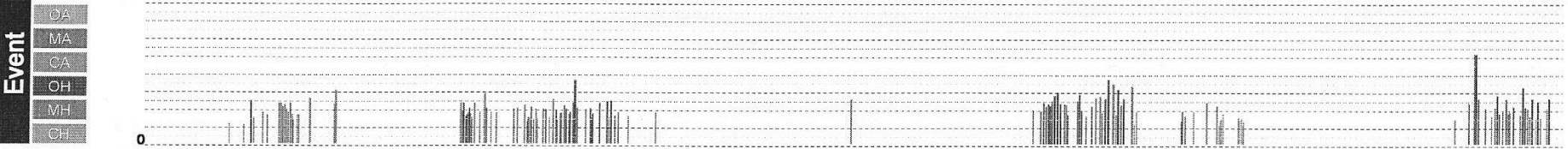
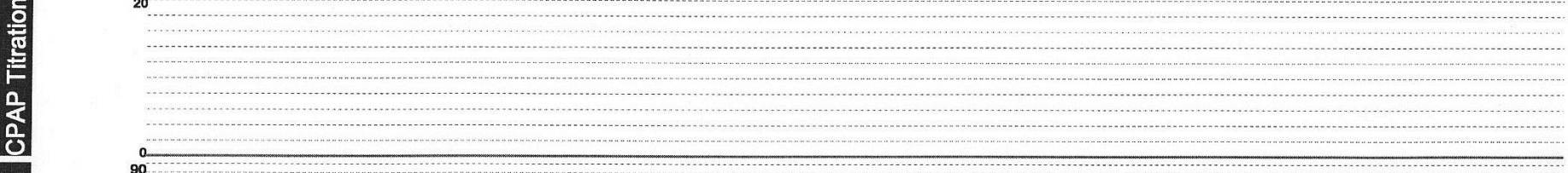
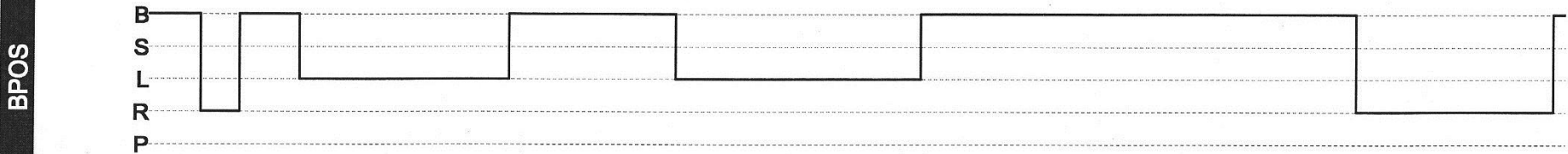
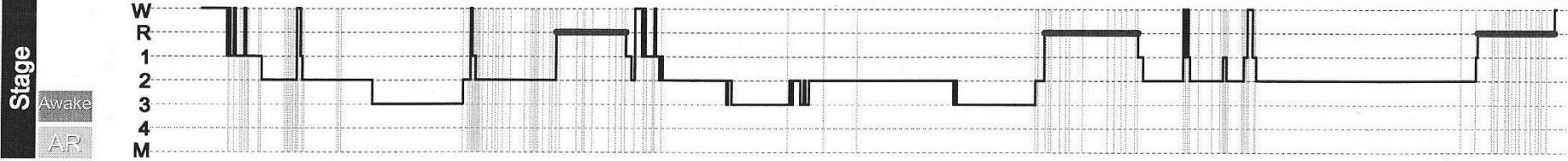
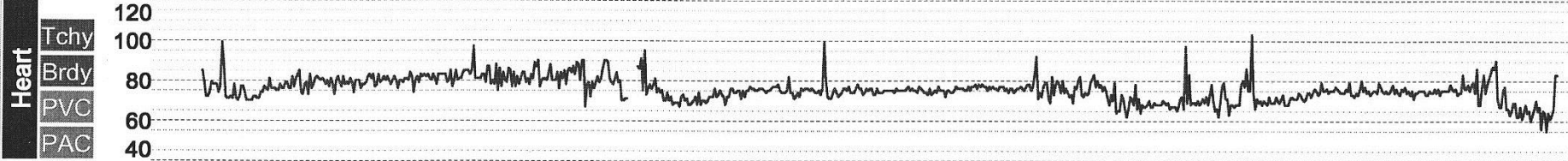
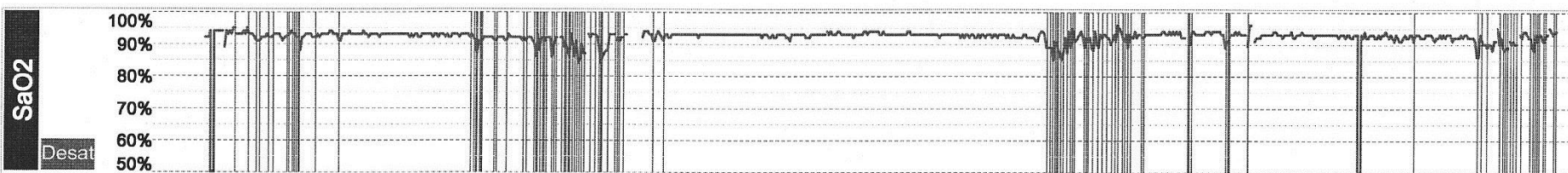
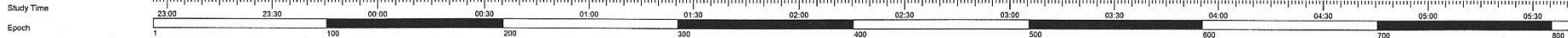
04/05/12 22:45:00



Study Time  
Epoch



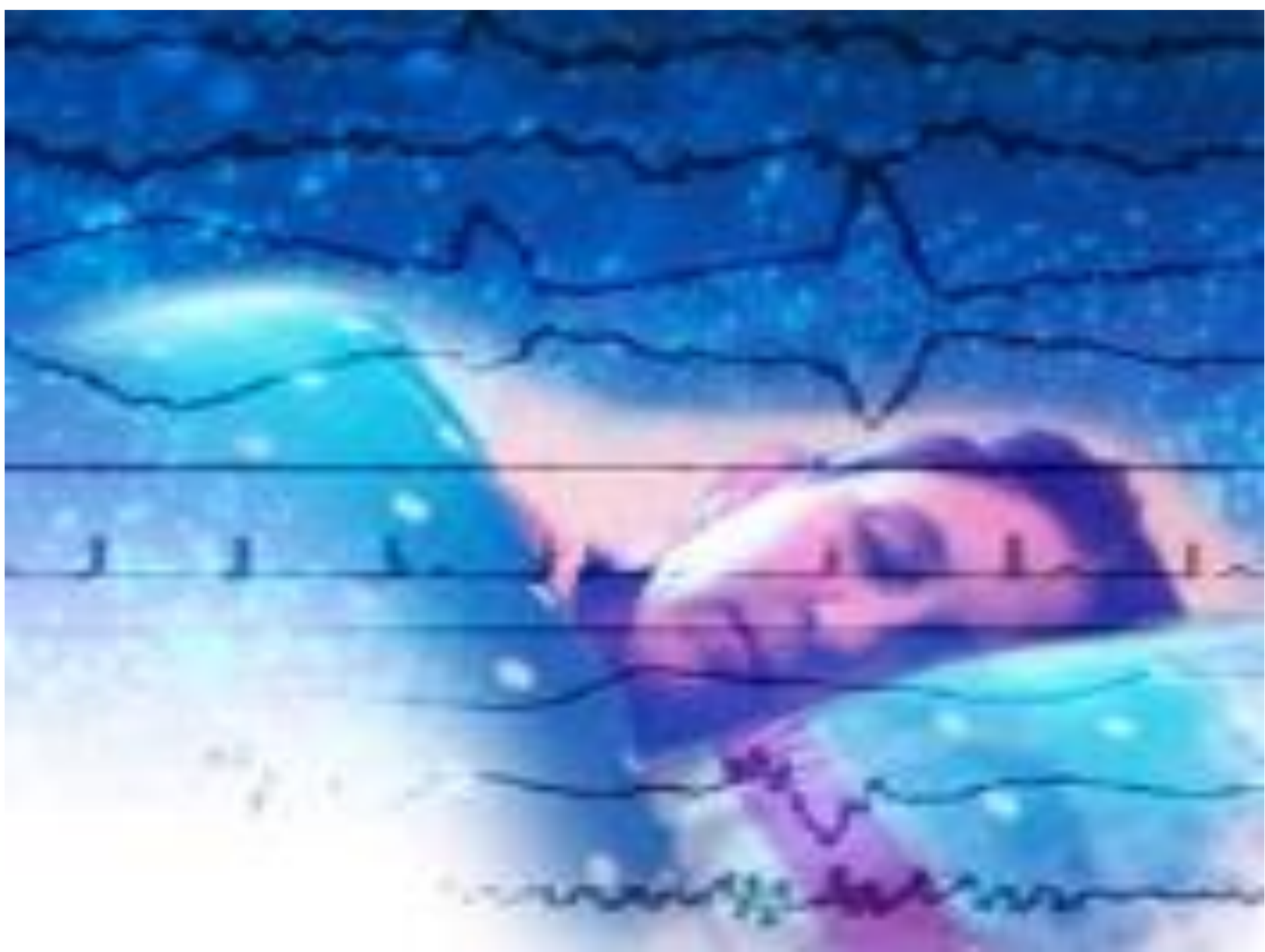






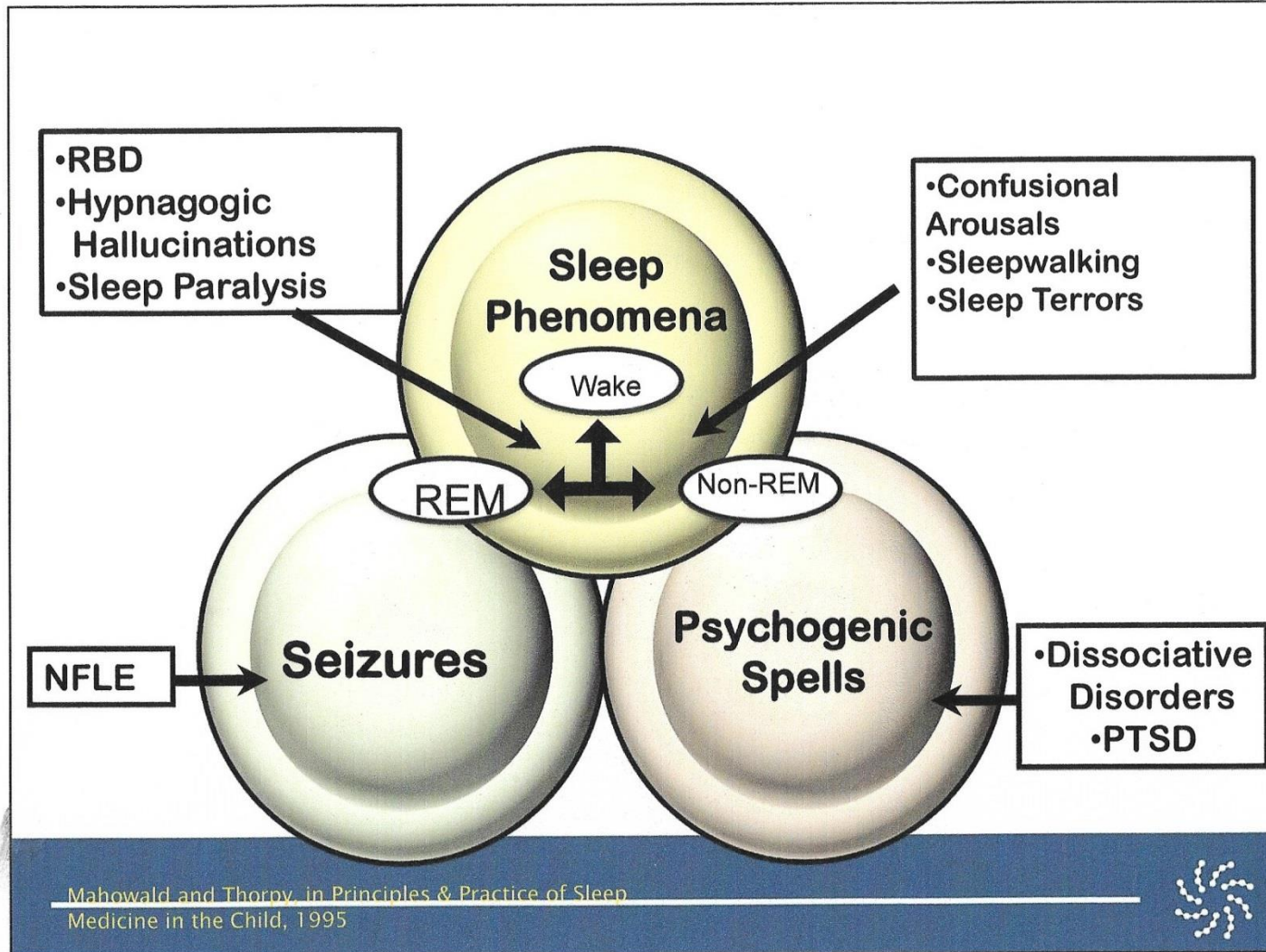








**BAPTIST HEALTH NEUROLOGY**







No Conflicts of Interest

THE ANSWER MAY NOT BE AT THE BEACH.  
BUT SHOULDN'T WE AT LEAST CHECK?







**REACH OUT  
BUT KEEP YOUR BALANCE**



Learn to See,  
as well as  
To Look

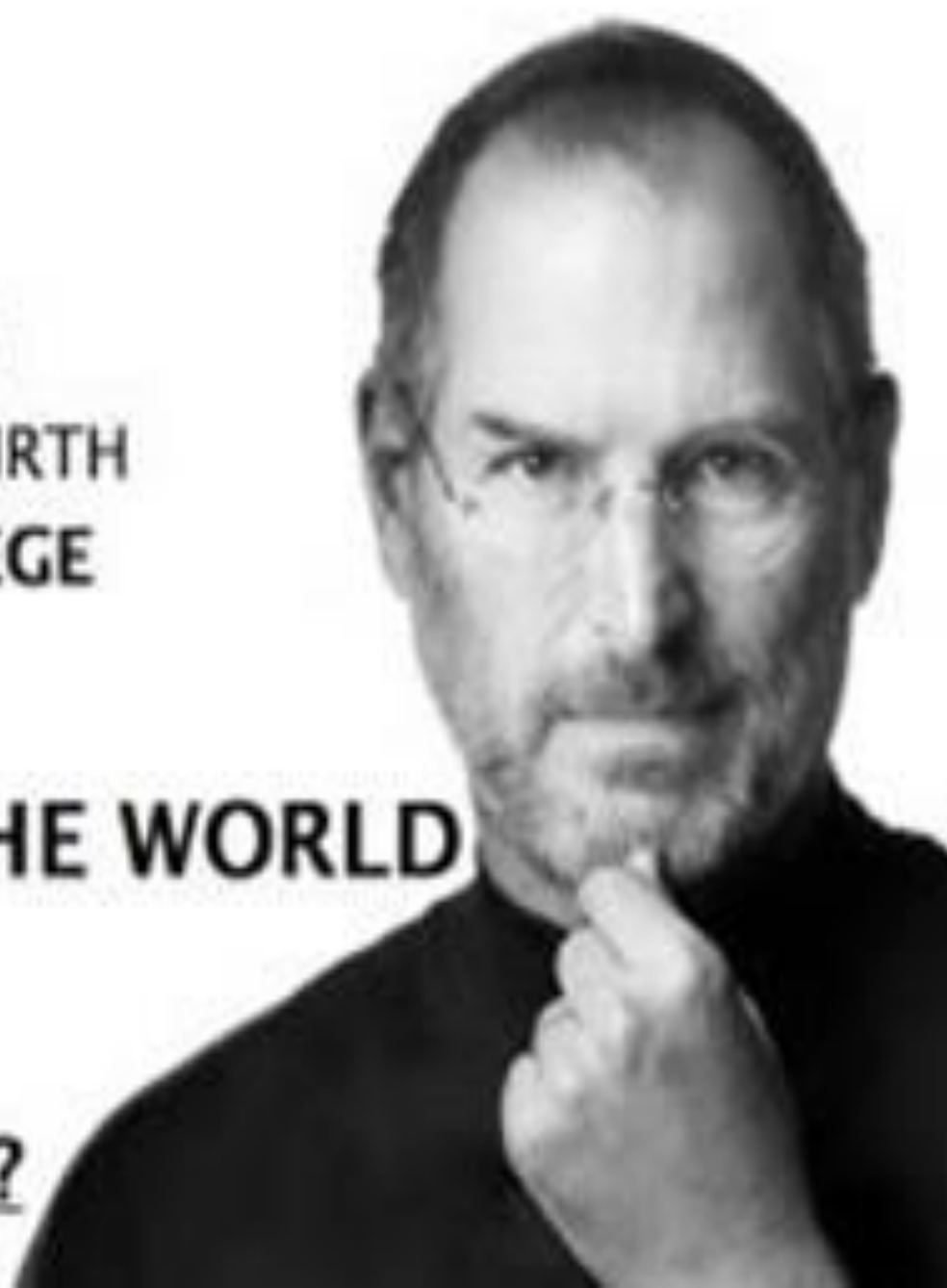


**Steve Jobs**

**BORN OUT OF WEDLOCK  
PUT UP FOR ADOPTION AT BIRTH  
DROPPED OUT OF COLLEGE**

**THEN CHANGED THE WORLD**

**WHAT'S YOUR EXCUSE?**



Questions ?

THANK YOU

