

# The A, B, Cs of Sleep Studies

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# Objectives

- Understand and describe signs and symptoms of OSA (obstructive sleep apnea) in children
- Understand and describe the examination findings in OSA
- Understand and describe the indications for sleep studies in children
- Understand and describe the components of a sleep study
- Understand and describe the information obtained during a sleep study
- Understand and evaluate a sleep study report

# OSAS - Introduction

- Recurrent episodes of partial to complete obstruction
  - Disruption of ventilation, sleep patterns
- 2 to 6 year olds
- Adenotonsillar hypertrophy
- Craniofacial, neuromuscular problems
- Obesity is also a risk factor- older children, residual OSA after T & A

# Symptoms of OSAS

- Diurnal: Neurobehavioral symptoms
  - Difficulty waking, irritable in am
  - Excessive daytime sleepiness
  - Hyperactivity; poor impulse control
  - Aggressiveness
  - Decreased attention span; learning problems
  - School failure
  - Shyness/social withdrawal



# Symptoms of OSAS

- Nocturnal
- Snoring, gasping, snorting, choking
- Pauses in snoring
- Increased effort-retractions, paradox
- Restless sleep
- Sweating
- Unusual sleep positions





*Worth* 1000.com

# Screening for OSA

- Symptoms
  - Snoring, gasping, choking, observed apnea
  - Restlessness, kicking,
- Examination
  - BMI, neck circumference
  - Upper airway crowding, Mallampati, tonsil size
- Downstream symptoms/issues
  - Non restorative sleep, behavior/school issues
- Epworth for kids
- STOP BANG in adults
  - Snoring BMI
  - Tired Age (> 50 years)
  - Observed apnea Neck circumference
  - Elevated BP Gender (male)

# Indications for Polysomnography

- Polysomnography (PSG)=sleep study
- Evaluation of
  - Sleep disordered breathing
  - Snoring-history of snoring alone does not indicate OSA
  - Excessive daytime sleepiness
  - Nocturnal events
  - Unexplained RVH
  - Nocturnal hypoxemia, hypoventilation



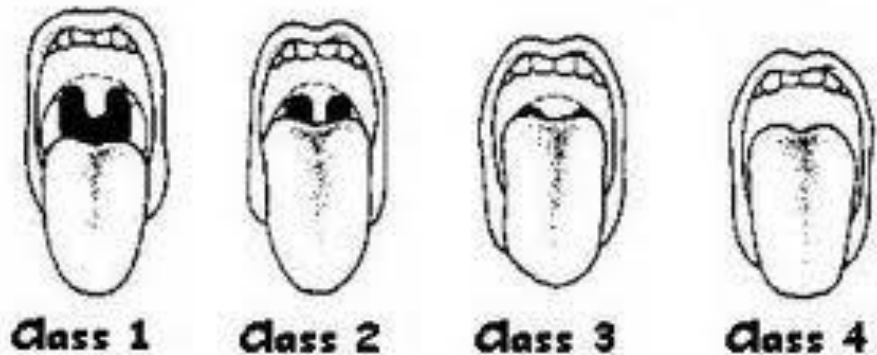
# Indications for Polysomnography

- Objective assessment of sleep disordered breathing (SDB)
- Response to therapy for underlying problem
- Starting positive pressure therapy
- Compare to patient complaints



# Sleep Issues from Peds Clinic

- OSA
  - Symptoms of snoring, gasping, choking
  - Daytime sleepiness
  - Enlarged tonsils and/or adenoids
- Oropharyngeal crowding
  - Mallampati 3 or 4
  - High arched palate



# Sleep Issues from Pediatric Clinic

- Cranofacial abnormalities
  - Pierre Robin
  - Achondroplasia
  - Crouzons
  - Micrognathia, retrognathia

# Epidemiology of OSAS

- Primary snoring vs. OSAS
  - 7-13% vs. 1-3%
- Peaks at age 2-7 years
  - Lymphoid hyperplasia
- Second peak in adolescence-obesity
- Prepubertal male=female
- History alone does not distinguish OSAS from primary snoring



# Risk Factors for OSAS

- Adenotonsillar hypertrophy
- Craniofacial abnormalities
  - Syndromes-Pierre-Robin, Hunter's, Achondroplasia,
  - Mid face hypoplasia, jaw issues, choanal atresia
- Trisomy 21
- Hypotonia/neuromuscular disorders
- Chronic allergies/asthma

# Risk Factors for OSAS

- Gastroesophageal reflux
- Repaired cleft palate
- Obesity
  - Adipose tissue in neck
  - Pharyngeal fat pads
  - Congenital syndromes-Prader-Willi

# Diagnosis of OSAS

- Polysomnography - gold standard
  - Overnight, no sedation
- Apnea hypopnea index
  - Number of events/hours of sleep
  - AHI, RDI
- Oxygen desaturation
- Elevated CO<sub>2</sub>
- Increased arousals



# Components of PSG

- Sleep staging/nocturnal events
  - EEG, EOG, chin EMG
  - EEG arousals during sleep
- Respiratory effort
  - Chest and abdominal belts
- Airflow
  - Nasal pressure, thermistor, capnograph
- Heart rate





# Components of PSG

- Oxygen and carbon dioxide levels
  - Arterial oxygen saturation, CO<sub>2</sub> – end tidal CO<sub>2</sub> or transcutaneous CO<sub>2</sub>
- Arm and leg movements
  - EMG on legs, sometimes on arms
- Video recording
- Evaluation of sleep quality and sleep stages
- Evaluation of respiratory events

# Sleep Architecture

- Sleep latency-length of time to fall asleep
- Sleep efficiency-how much of time in bed spent asleep
- Sleep stages achieved
  - Time spent in various stages
  - Was dream sleep achieved?
  - Normal progression through stages
  - Timing of events i.e. night terrors, sleep walking, nightmares

# Respiratory Events

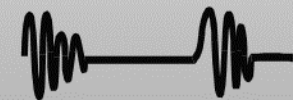
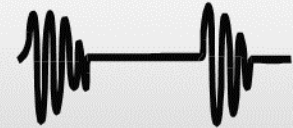
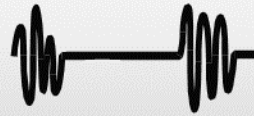
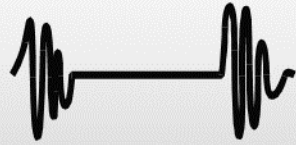
- Apnea-cessation of airflow, ↓ in flow by 90% or more
- Hypopnea-↓ in flow by 30% from baseline with resulting change, i.e. arousal, leg movement, ↓O<sub>2</sub> or ↑CO<sub>2</sub>
- Central-no effort
- Obstructive-effort with ↓ or absent flow
- Mixed-both, usually starts with central

# Apnea patterns

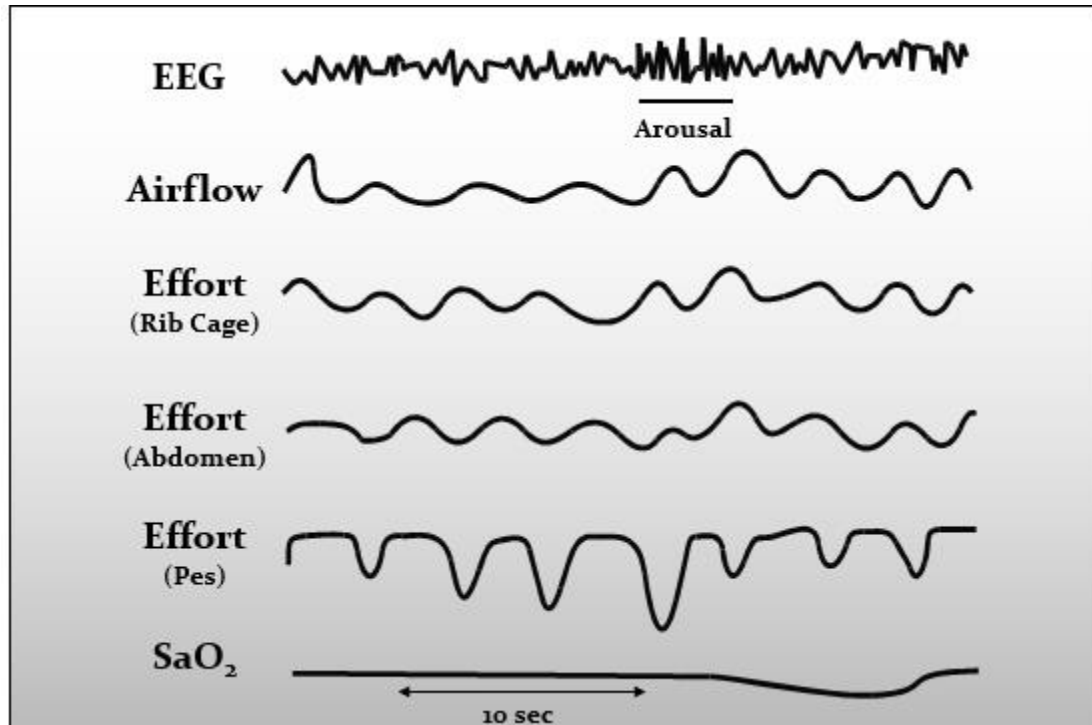
**Obstructive**

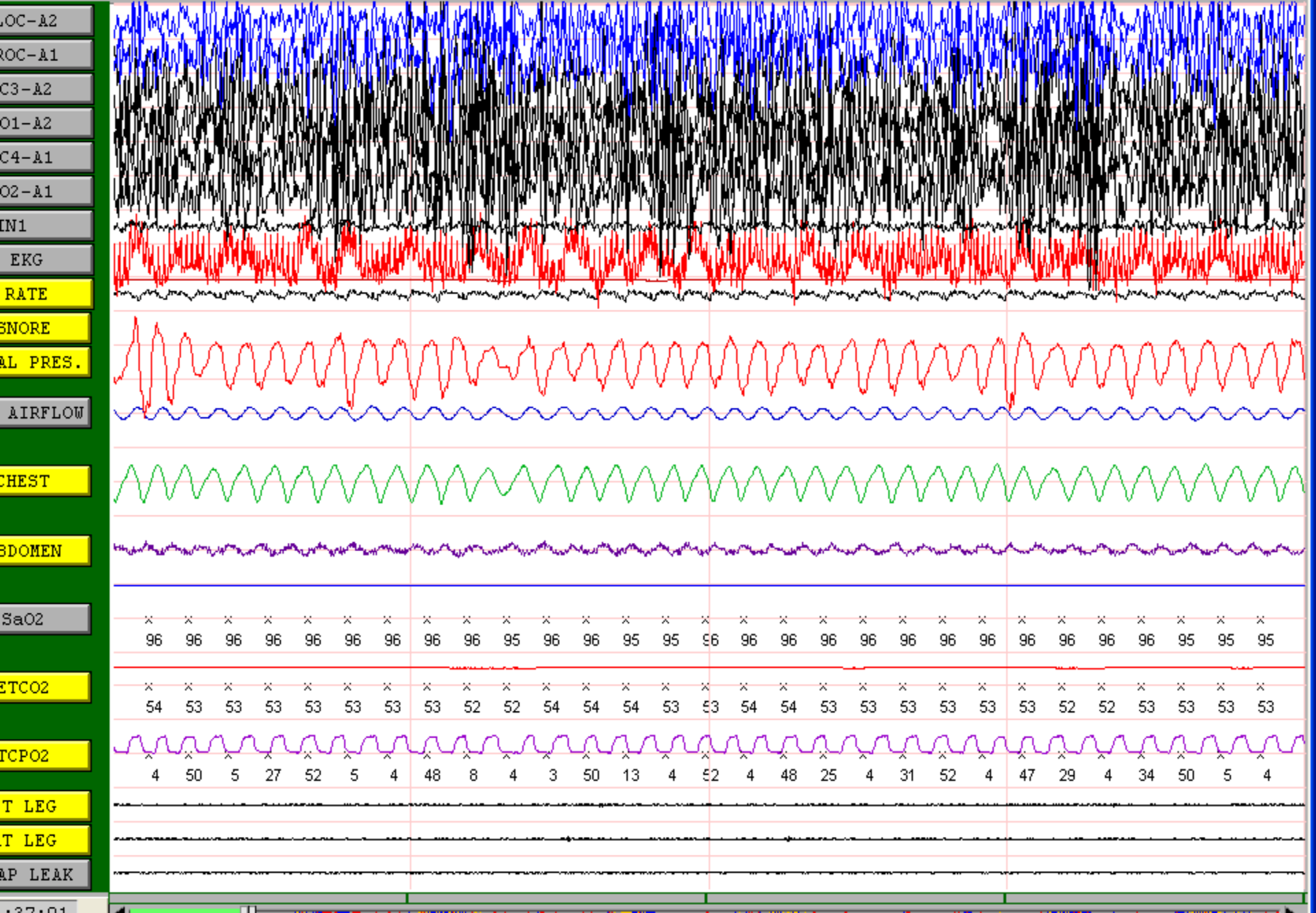
**Mixed**

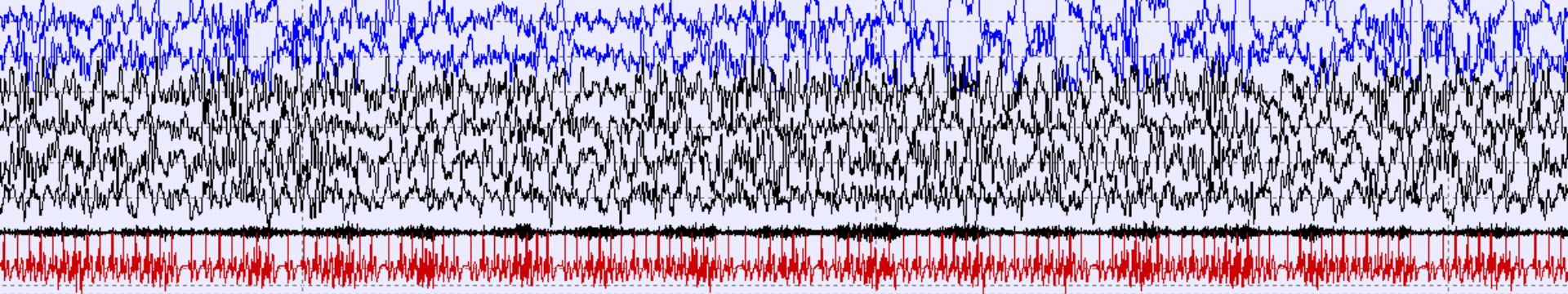
**Central**



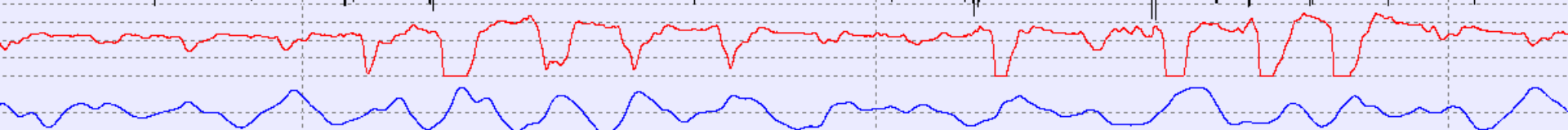
# Obstructive Hypopnea



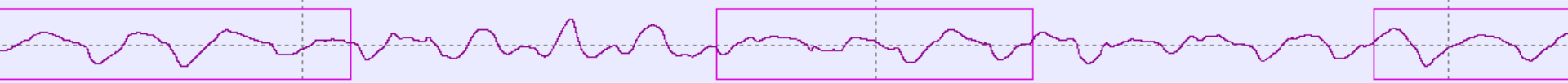
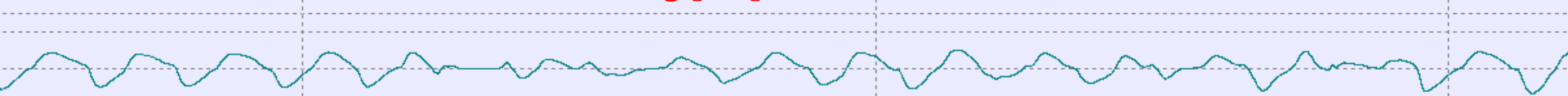




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**Obstructive hypopneas**

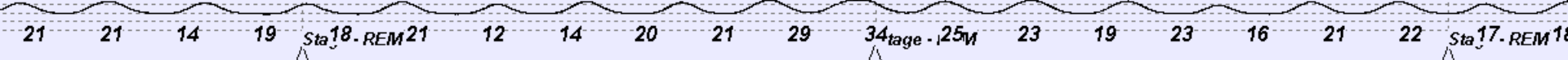


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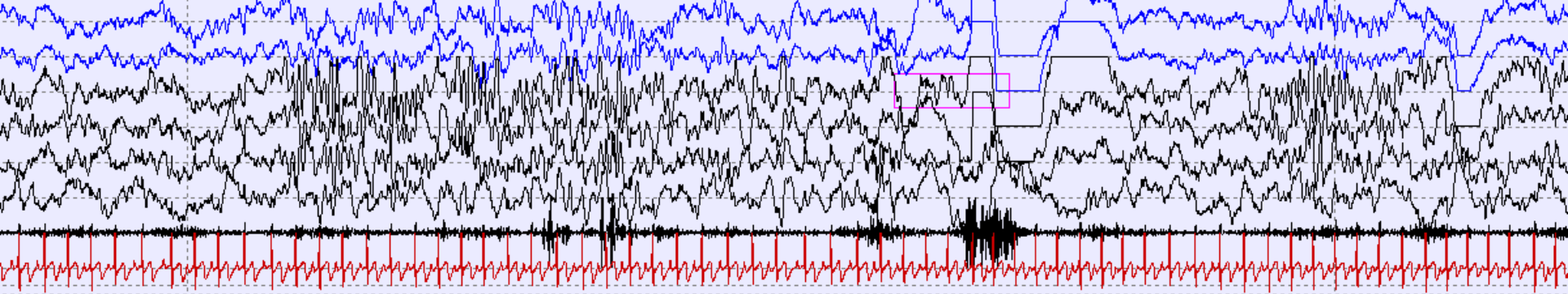
45 44 46 47 46 44 45 43 43 44 45 46 51 51 52 52 51 47 46 45 44

0 0

21 21 14 19 Sta18-REM21 12 14 20 21 29 34 tage -125M 23 19 23 16 21 22 Sta17-REM1



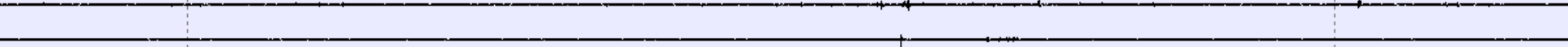
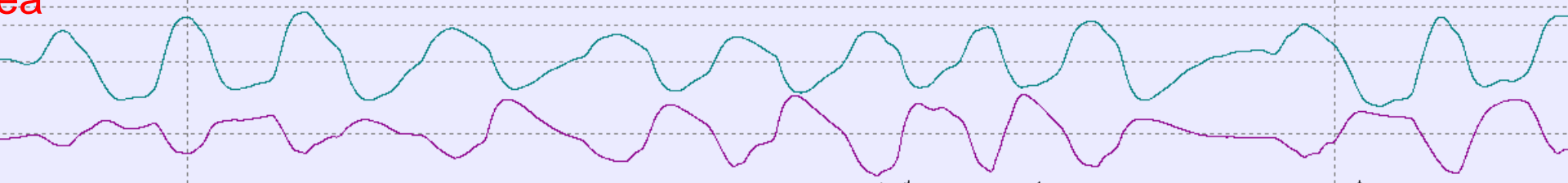




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**Obstructive apneas**



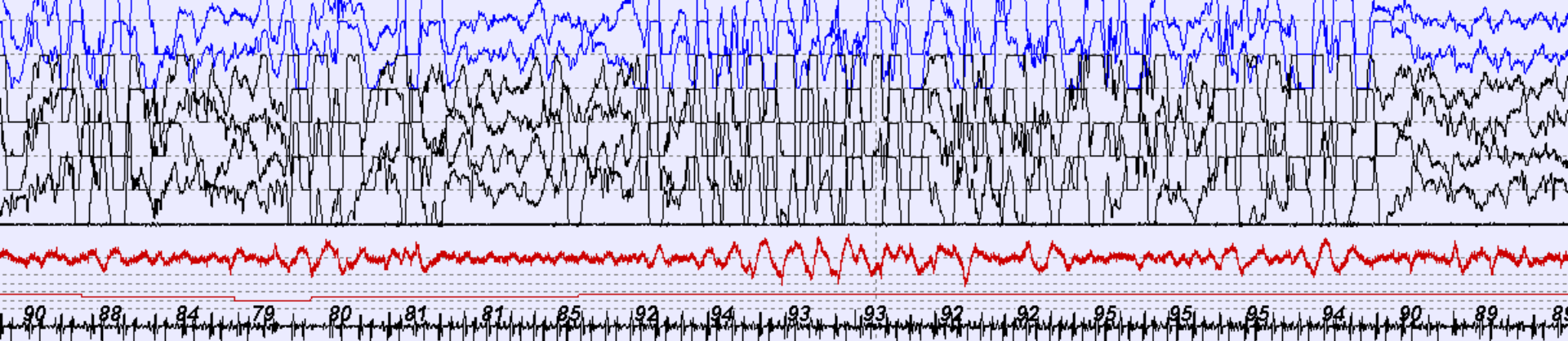
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35 35 35 35 35 37 38 38 38 42 42 42 40 42 42 42 42 42 42 42 42

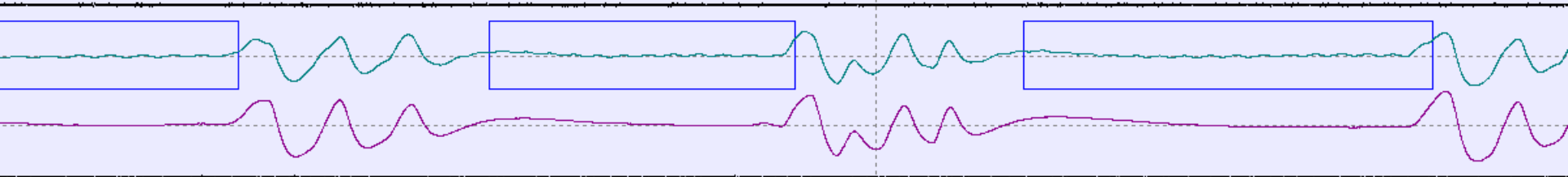
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6 4 3<sub>stage - 10M</sub> 23 32 22 38 43 12 7 21 33 12 4 3 3 2<sub>stage - F3M</sub> 3 3



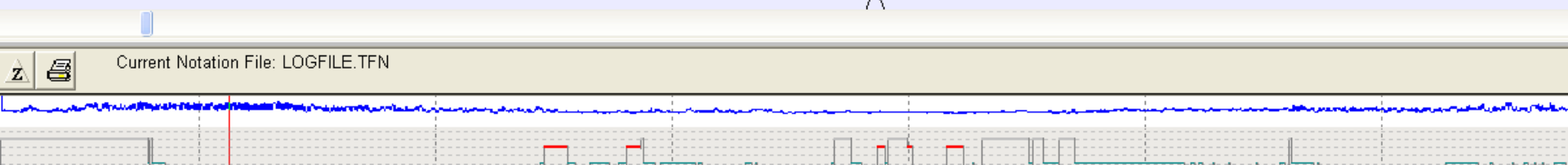


Central apneas



78	75	74	74	73	73	73	72	71	74	79	78	82	88	90	85	79	81	87	91	92	
31	31	31	32	32	31	32	32	31	31	31	32	32	31	31	32	31	31	31	31	31	31
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4

\* Desaturation - Dur: 23.0 sec. - Min 71.0 % - Drop 20.2 %

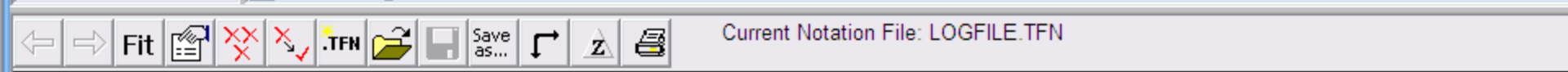
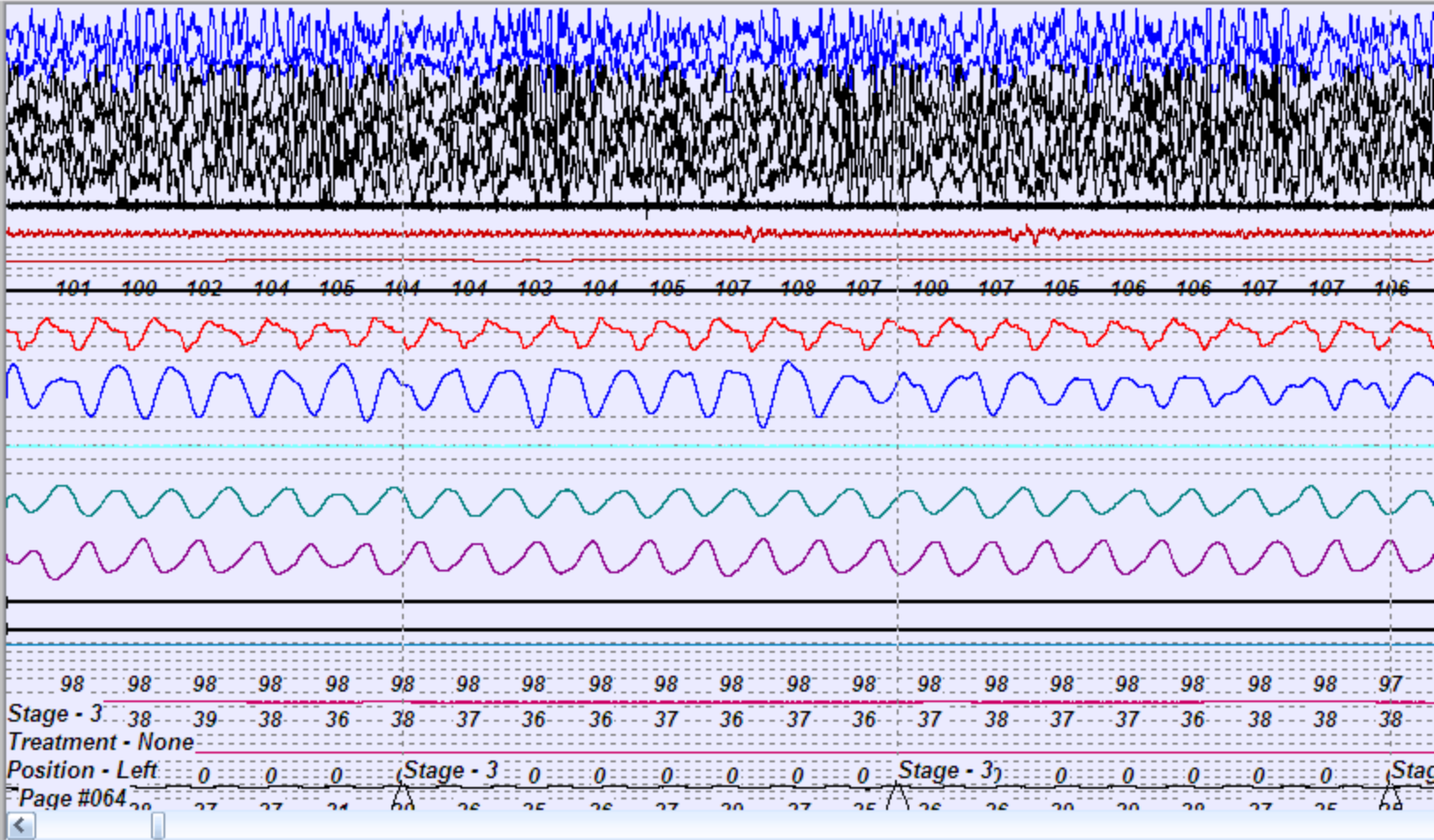


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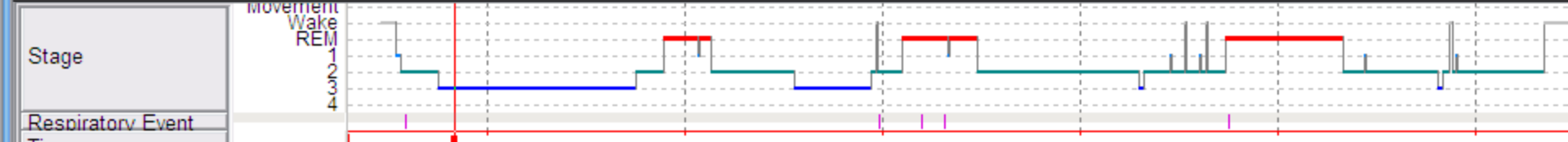
Position: Left Epoch: 64 PAP: SupO2:



- E1-M2
- E2-M2
- C3-M2
- O1-M2
- C4-M1
- O2-M1
- ICHIN1-CHIN2
- EKG1-EKG2
- HR
- ISNORE1
- NPRES
- IAIRFLOW
- CFLOW
- ICHEST1
- IABDI
- ILAT1
- IRAT1
- SaO2
- ETCO2
- leak
- PLETH



Current Notation File: LOGFILE.TFN



# QUESTIONS?



# Sleep Study Report

- Sleep Architecture
  - Sleep latency-how long to fall asleep < 20-30 minutes usually
  - Sleep efficiency-how much of total time in bed was spent asleep usually  $\geq 90\%$
  - REM latency-time from sleep onset to start of REM sleep, if shortened c/w narcolepsy,  $\downarrow$ TST
  - Time spent in different sleep stages-did they get into REM sleep?

# Sleep Study Report

- Arousal information
  - Total vs those related to respiratory events or leg movements
  - Index means # events/hours of sleep
- Respiratory event information
  - AHI=apnea-hypopnea index
    - Includes central and obstructive events
    - Data on actual CA, MA, OA, hypopneas also given

# Sleep Study Report

- AHI normal values different in kids vs adults
  - Kids : nl < 1.4, mild 1.4-5, moderate 5-10, severe > 10
  - Adults: nl < 5, mild 5-15, moderate 15-30, severe > 30
- Minimum oxygen saturation
- Periodic leg movement information
  - Number of movements, index and arousal number
  - PLMI > 5 abnormal in children, > 15 abnormal in adults
- Should also be an interpretation-if not it has not been read by sleep physician

**Monitoring:** Frontal, Central, and Occipital EEG, right and left EOG, chin EMG, EKG, Airflow (nasal-oral airflow by thermal sensor), Nasal pressure, Respiratory effort (RIP), Arterial oxygen saturation, and Right and Left Leg EMG. Sleep is staged in 30 second epochs using AASM criteria. Hypopneas scored with  $\geq 4\%$  desaturation.

**Lights out: 09:56:42 PM**

**Lights on: 06:10:21 AM**

<b>Sleep Architecture</b>		
Total Recording Time	(min)	493
Total Sleep Time	(min)	320
Sleep Efficiency	(%)	64.9%
Sleep Latency	(min)	71
REM Latency	(min)	222

Decreased sleep efficiency  
Prolonged sleep latency  
Prolonged REM latency



## SLEEP STAGES:

Wake After Sleep	(min)	102	(% of TST)
Stage N1	(min)	3.5	1.1
Stage N2	(min)	248.5	77.5
Stage N3	(min)	4.5	1.4
Stage REM	(min)	64.0	20.0

Increased wake after sleep onset

Increased stage N2 sleep

Decreased stage N3 sleep

Appropriate amount of REM sleep depending on age

## Arousal Index (ArI) Summary (#hour)

Total ArI	Apn + Hyp ArI	Snore ArI	PLM ArI	Spontaneous ArI
35.8	31.5	0.0	0.0	4.3

Respiratory Events		AHI = Apnea + Hyp index	
AHI (/hr)	72.8	Obstructive Apneas (#)	201
AHI NREM (/hr)	85.4	Mixed Apneas (#)	9
AHI REM (/hr)	22.5	Central Apneas (#)	2
AHI Supine (/hr)	83.2	Hypopneas (#)	177
AHI Non - Supine (/hr)	63.7		
% TST on Back (/hr)	46.8		

Elevated arousal index

Most arousals related to respiratory events

Very elevated AHI (number of apneas + hypopneas/hours of sleep)

Most events were obstructive

## Oximetry during Sleep ( SaO2 = arterial oxygen saturation)

Min SaO2 NREM (%)	74.0
Min SaO2 REM (%)	81.0
Desaturations TST (#)	299.0
Avg SaO2 at Desat (%)	97.0
NREM SaO2 <=88% (min)	36.8
REM SaO2 <=88% (min)	1.1

## Periodic Leg Movement (PLM) Summary

PLM (#)	0	PLM Index (/hr)	0.0
PLM Arousal (#)	0	PLM AI (/hr)	0.0

Heart Rate Analysis	Wake	NREM	REM
Avg Heart Rate (BPM)	67	54	52
Min Heart Rate (BPM)	44	43	40
Max Heart Rate (BPM)	102	87	78

Many desaturations

Saturation very low in both REM and NREM sleep

Over 36 minutes with sats < 88%

No PLMs

Heart rate acceptable depending on age

History: 14 yo with snoring, restlessness, kicking and a history of OSA (AHI 89 on previous PSG). Patient has difficulty using PAP. The family reported an average night with medications including Nasonex, Claritin and Singulair.

Snore: mild to loud

Cardiac: regular rhythm, variable rate

Leg movements: noted during wakefulness and with events

Sleep stage analysis: Decreased sleep efficiency noted with prolonged sleep latency, increased wakefulness, prolonged REM latency, increased n2 sleep and decreased N3 sleep.

Impression: Baseline oxygen saturation 99%, CO2 33-36 torr with sats < 90% for ~50% of the TST and CO2 > 40 torr for < 5% of the TST. Patient was studied on RA and oxygen at 1 L/min and 2 L/min. Rare central apneas noted that were not prolonged and resulted in desats to 91%. On RA many obstructive events noted resulting in arousals, leg movements and desats to 74%. Events occurred back to back with prolonged hypoxemia. On oxygen, obstructive events were ongoing with ongoing hypoxemia that was less profound. Events prolonged on RA and oxygen. Average duration of events appeared to be prolonged on oxygen. AHI 72.8, 0.4 due to central events.

## Review of history

Comment on snoring, cardiac findings, leg movements and sleep architecture

Impression – summary of what happened during sleep study including response to interventions

Final Impression: Severe OSA with sleep disruption, desaturation and prolonged hypoxemia. On oxygen events persisted with ongoing hypoxemia.

Final impression of findings with some suggestions if appropriate

# QUESTIONS?



# IMPORTANT POINTS

- Indications for sleep studies (polysomnography)-evaluation of
  - Sleep disordered breathing, snoring
  - Excessive daytime sleepiness
  - Nocturnal events
  - Unexplained RVH
  - Nocturnal hypoxemia, hypoventilation
- Components of a sleep study
  - Sleep staging/nocturnal events
  - EEG, EOG, chin EMG
  - Respiratory effort
  - Chest and abdominal belts
  - Airflow
  - Nasal pressure, thermistor, capnograph

# IMPORTANT POINTS

- Components of a sleep study
  - Oxygen and carbon dioxide levels
  - Arterial oxygen saturation, ETCO<sub>2</sub>, TcPCO<sub>2</sub>
  - EMG on legs, sometimes on arms – arm and leg movements
  - Video recording
  - Evaluation of sleep quality and sleep stages
  - Evaluation of respiratory events
- Information included in sleep study report
  - Sleep architecture and arousals from sleep
  - Gas exchange
  - Respiratory events
  - Movements during sleep
  - Nocturnal events, possibly abnormal EEG
- Look at the details!



Questions?

