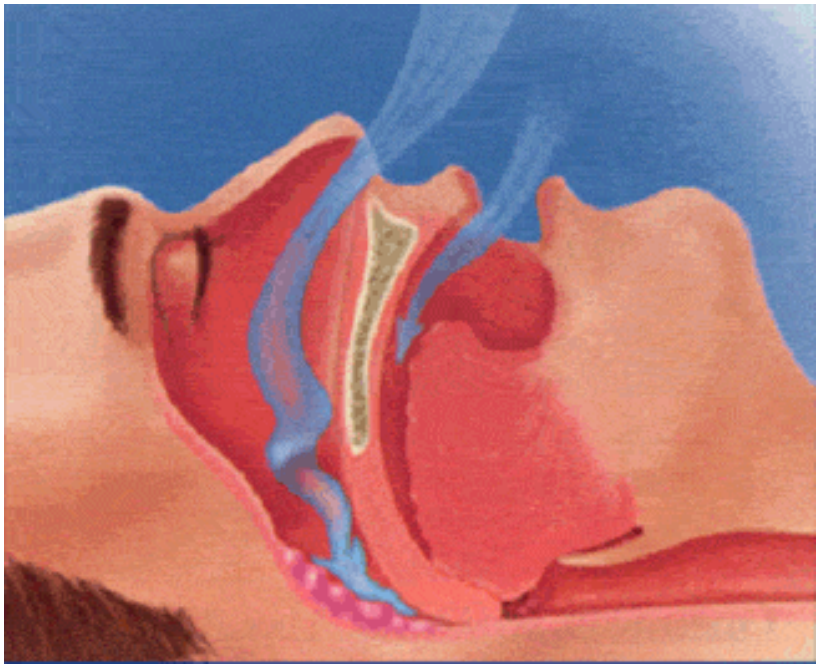
Interpreting Sleep Study Reports

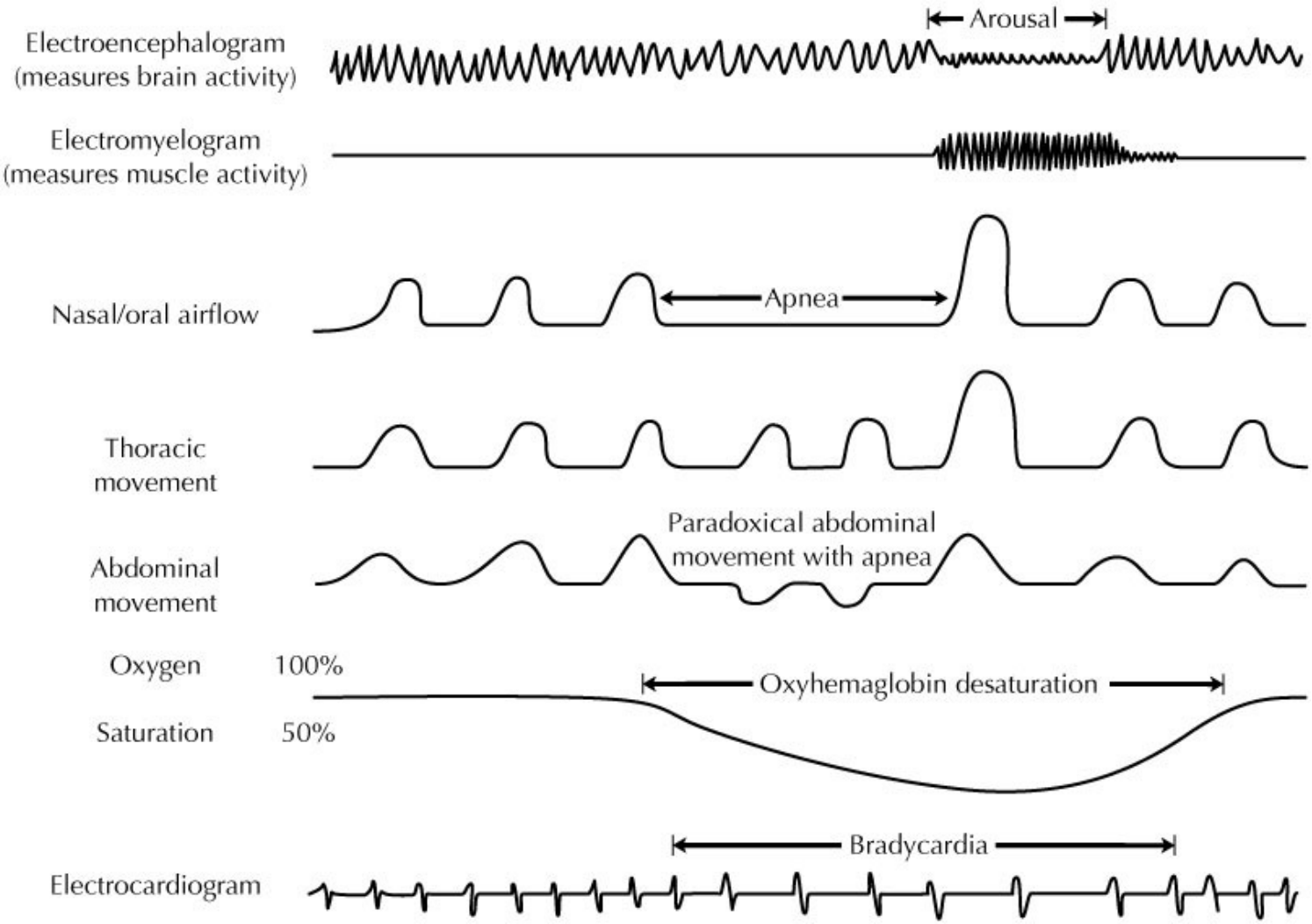
Obstructive Sleep Apnea

- *Obstructive sleep apnea*: repeated closure or narrowing of upper airway reducing airflow



- **Apnea**: total cessation of air flow for 10 sec
- **Hypopnea**: 10 sec of reduced air flow
- Obstructive respiratory events are associated with snoring, thoracoabdomnial paradox & increasing effort

Polysomnogram (PSG)



Scoring Criteria: Respiratory Events

- <u>Hypopnea definition</u>
- ↓ flow ≥ 30% from baseline for at least 10 seconds
- *1A. (AASM*) with 3% O_2 desaturation OR arousal
  - ✓ *Requires EEG monitoring*
- *1B. (CMS*) with 4% O_2 desaturation

✓ *Amenable to portable studies*

- <u>Respiratory Effort Related Arousal (RERA)</u>
- Flattening of inspiratory portion of nasal pressure (or PAP flow) with increasing respiratory effort leading to arousal
- No associated desaturation

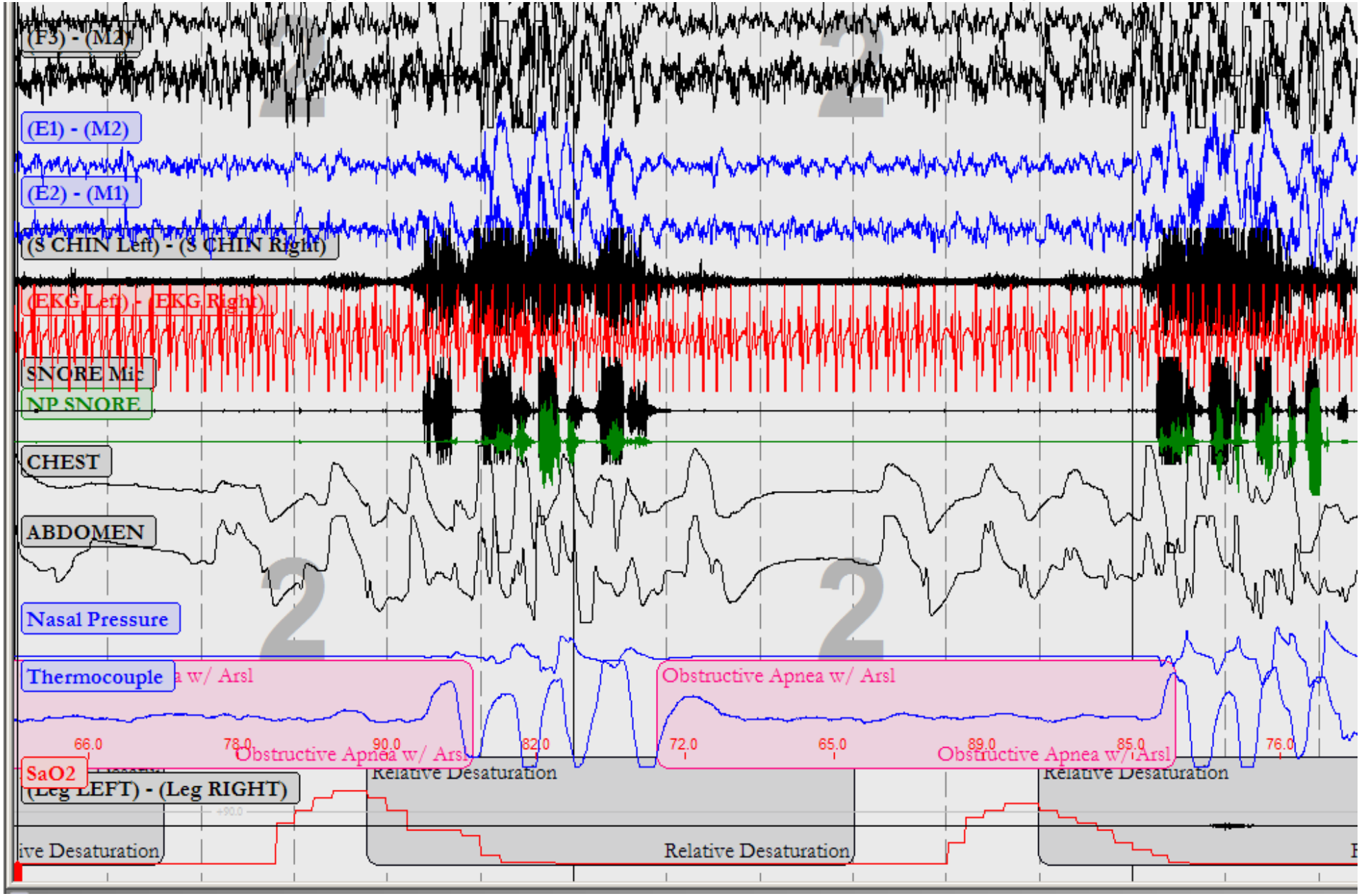
✓ *Requires EEG monitoring*

Apnea Hypopnea Index

- AHI = (# apneas + # hypopneas) / sleep hours
  - AHI < 5 normal
  - AHI 5 – 15 mild
  - AHI 15 – 30 moderate
  - AHI > 30 severe

- RDI = (# apneas + # hypopneas + # RERAs) / sleep hours
  - Can be large difference in AHI vs. RDI if young, thin patient who is less likely to desaturate by 4% with events
  - *Treatment not covered by Medicare if AHI < 5 but some insurances accept RDI >5 (with AHI < 5) with symptoms*

PSG Epoch: Obstructive Apneas



In-lab PSG Data

Respiratory Data:

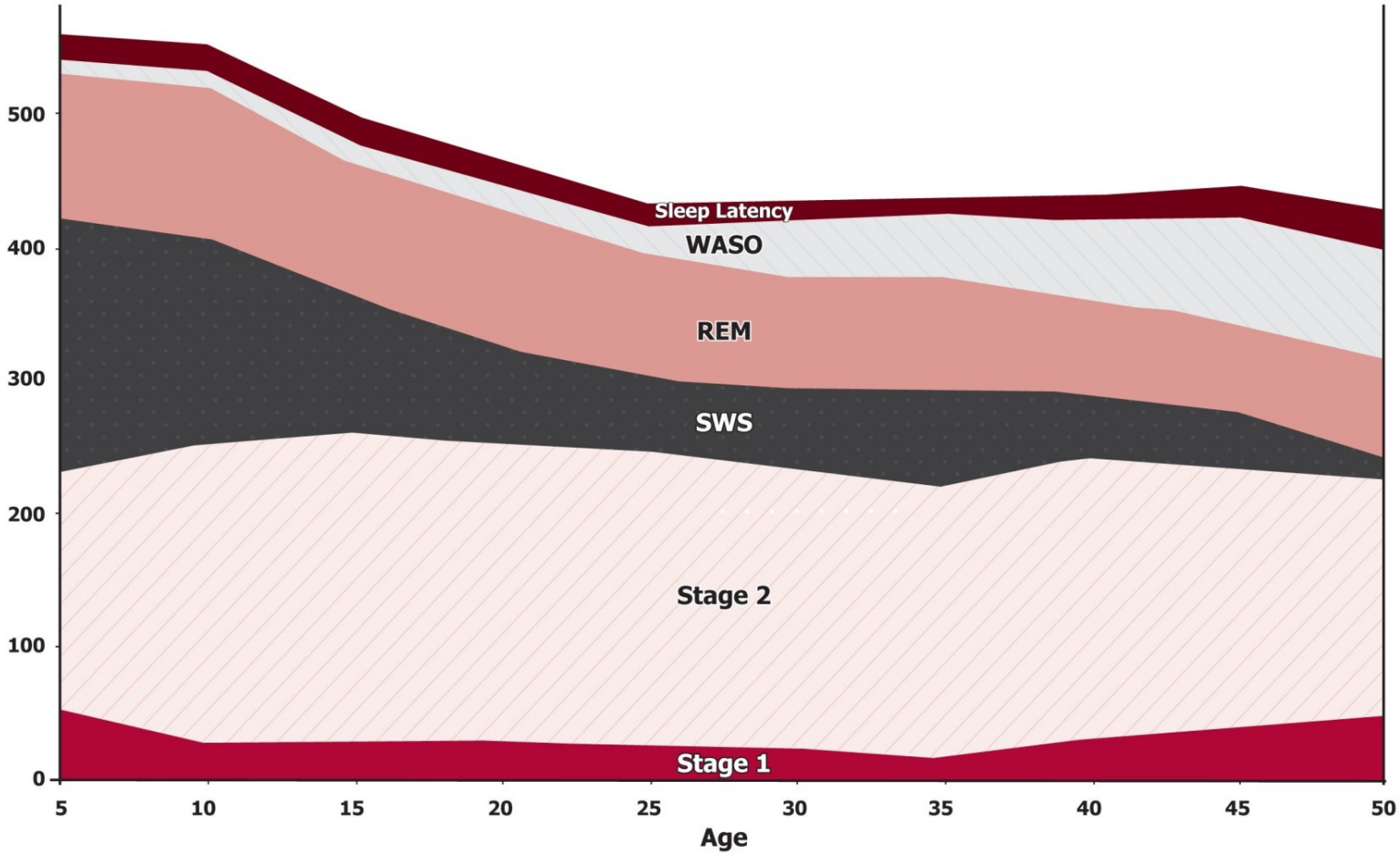
- # Central, obstructive apneas, hypopneas & RERAs
  - AHI & RDI by position and sleep stage
  - Central apnea index & if Cheyne-Stokes pattern
- Oximetry:
  - Oxygen Desaturation Index
  - Mean O_2 saturation & nadir
- Hypoxemic burden
  - Cumulative % of sleep time spent under 90%

In-lab PSG Data

EEG Data:

- Sleep efficiency & latency
  - Normal 80% efficient
  - Latency < 30 min, REM latency 60-120 min
- Sleep stages & architecture
  - Normal about 5% stage N1, 50% N2, 20% N3 (slow wave sleep) and 20-25% REM
- Arousal Index (AI): sleep disruption
  - Normal AI < 10-25 (large variation by age)
- Norms are all age dependent
  - in general less REM & SWS, more arousals, WASO and lower sleep efficiency as age
- EEG abnormalities
  - Epileptiform activity, alpha intrusion

Sleep Architecture Over Lifespan

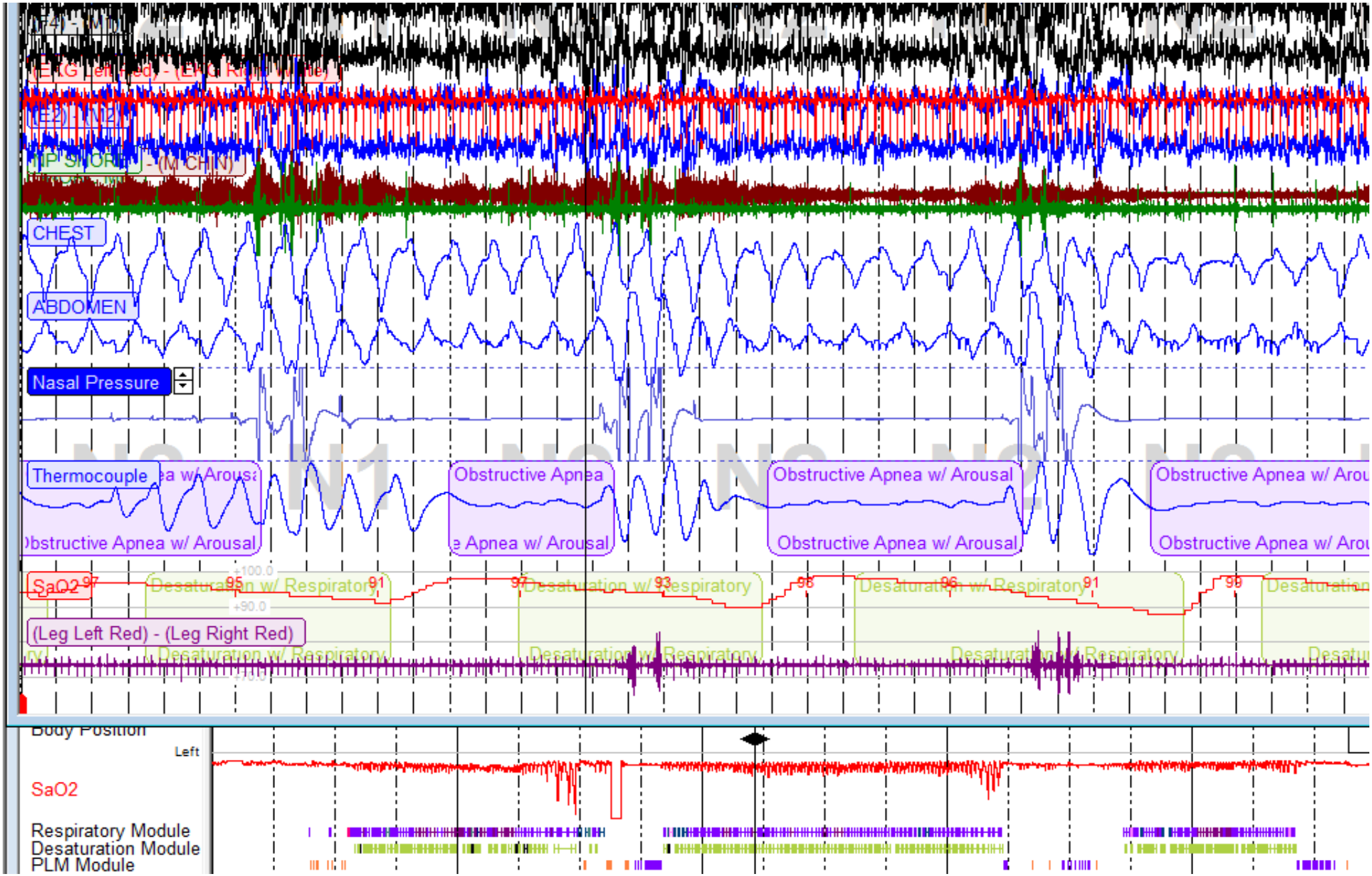


In-lab PSG Data

EMG Data & Video

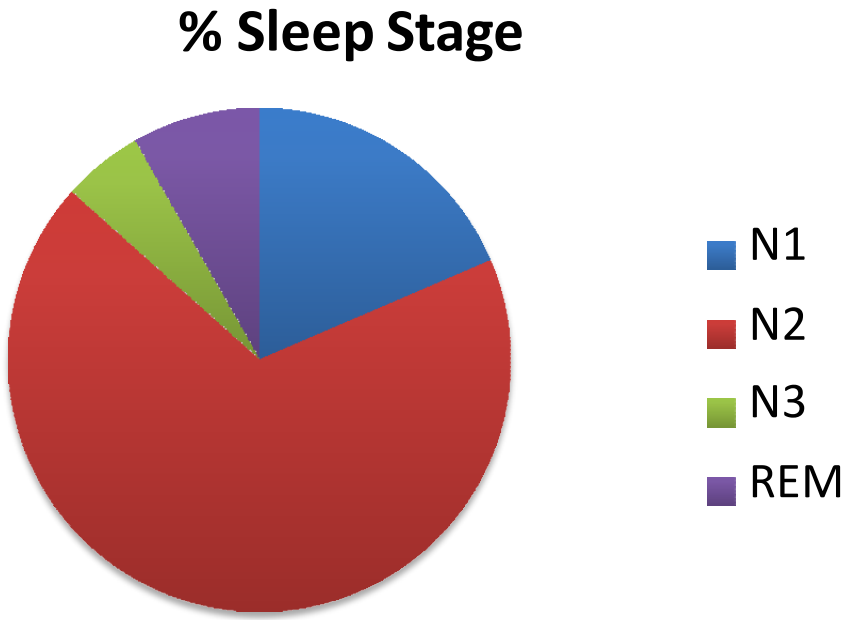
- Limb Movements
  - periodic limb movements index in wake & sleep
    - Normal PLMI < 15 adults
  - Movements during REM (loss of atonia)
- Parasomnias
  - Sleep walking, talking
  - Bruxism
  - REM sleep behavior disorder

Classic OSA (300 sec)



Sample PSG Results

- Sleep Architecture:
  - Sleep latency 13 min
  - Sleep efficiency 64%
  - WASO 28%
  - REM latency 143 min
- Arousal index 53
  - Predominantly respiratory
- Limb Movements
  - PLM index 7



Sleep Study Sample Report

- EEG Data: sleep architecture & arousals

Sleep Summary – Whole Night:

Time at Lights Off	21:50:57	Sleep Onset Latency (SL)	27.8 min.
Time at Lights On	05:50:42	Number of Stage N1 Shifts	36
Total Recording Time (TRT)	479.8 min.	Number of Stage Shifts	206
Sleep Period Time (SPT)	452.0 min.	Number of Awakenings	17
Total Sleep Time (TST)	413.5 min.		
Sleep Efficiency (SE)	86.2%	REM Latency	141.0 min.

Sleep Stage Summary – Whole Night:

Stage	Duration (min)	% TST	% SPT	Latency (min)
WASO	38.5	-	8.5	-
Stage N1	30.0	7.3	6.6	0.0
Stage N2	242.0	58.5	53.5	2.0
Stage N3	64.5	15.6	14.3	22.5
Stage REM	77.0	18.6	17.0	141.0

Sleep Continuity – Whole Night:

Source of Arousals	NREM Count	NREM Index	REM Count	REM Index	Total Count	Total Index
Spontaneous	0	0.0	0	0.0	0	0.0
Apneas / Hypopneas	72	12.8	31	24.2	103	14.9
RERAs	45	8.0	7	5.5	52	7.5
Snoring	0	0.0	0	0.0	0	0.0
PLM / Limb Mvmnts	0	0.0	0	0.0	0	0.0
Total Arousals	**117**	**20.9**	**38**	**29.6**	**155**	**22.5**

Sample PSG Results: OSA

- Respiratory Data:
  - Apnea Hypopnea Index: **AHI 17**
    - 12 obstructive apneas, 45 hypopneas
    - RERA index 34
  - Oxygenation Desaturation Index: ODI 13
    - Nadir O_2Saturation: 86%
    - Hypoxemic Burden: 13% of study O_2 sat < 90%
  - Most severe supine, REM sleep (AHI 53)
  - **Total RDI: 55**

Sample PSG Report

- Events by sleep stage & position

Respiratory Summary – Pre-Treatment:

Types of Respiratory Events		
Respiratory Events	**Number**	**Index**
Obstructive Apneas	65	22.3 /hr
Mixed Apneas	0	0.0 /hr
Central Apneas	0	0.0 /hr
Total Apneas	**65**	**22.3 /hr**
Total Hypopneas*	**48**	**16.5 /hr**
Apneas + Hypops*	**113**	**38.9 /hr**

Respiratory Effort Related Arousal (RERA) Events		
Parameter	**Total**	**Index**
Total:	24	8.3
Non-REM:	23	8.3
REM:	1	6.7
Supine:	24	8.3
Lateral:	N/A	N/A
Prone:	N/A	N/A

Oxygen Saturation Summary – Pre-Treatment:

Mean SaO2:	95.2%	Lowest SaO2:	79.0%
% TST SaO2 < 90%:	2.3%	# Desaturation 4% or >:	91
% TST SaO2 < 89%:	1.7%	Desaturation Index:	31.3
Minutes SaO2 < 90%:	4.0	NREM Desaturations Index:	28.6
Minutes SaO2 <= 88%:	5.5	REM Desaturations Index:	80.0

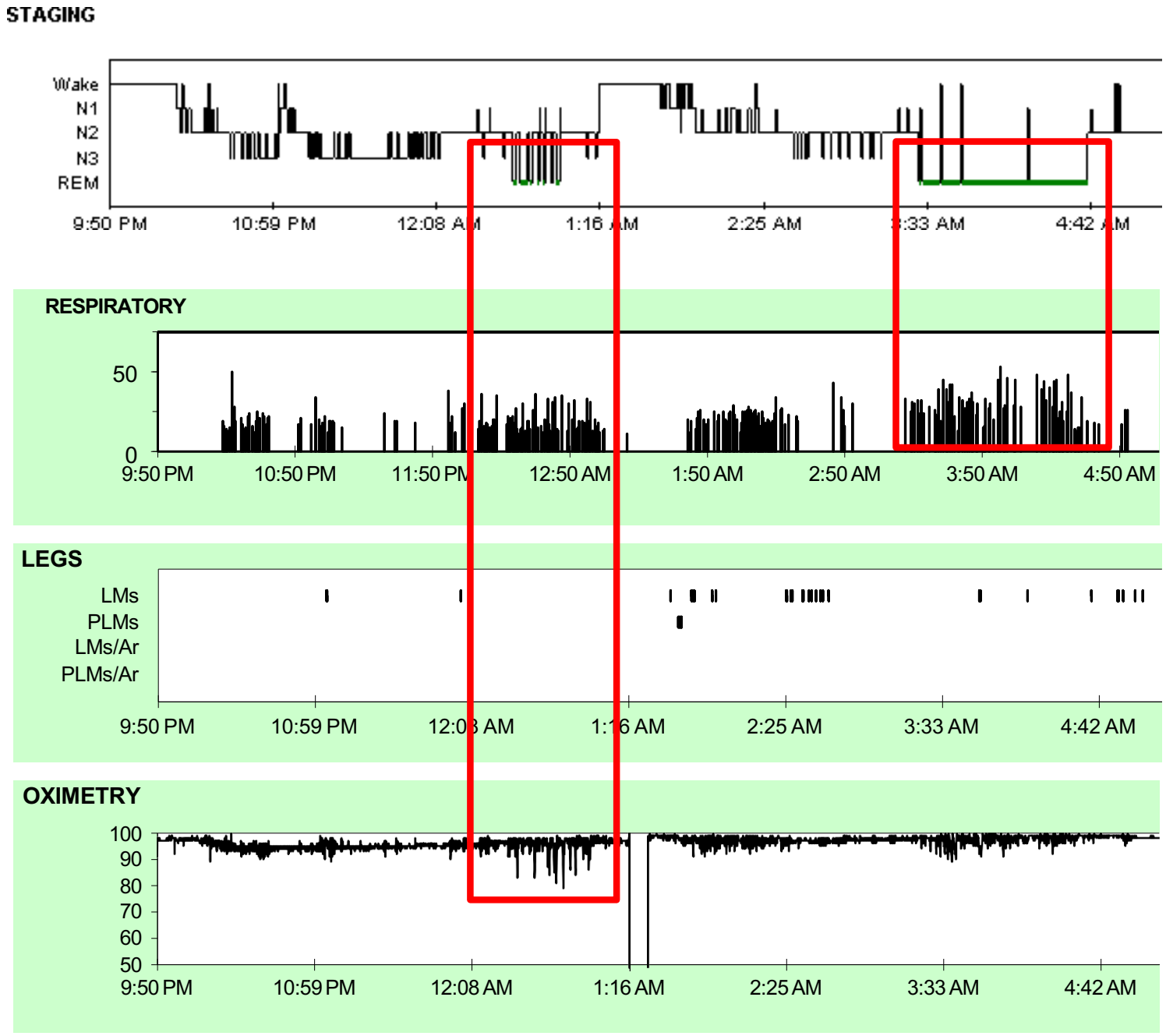
Respiratory Events by Position

TST in Position: % of TST	Supine		Prone		Left		Right		Upright	
	206.9 min.		0.0 min.		154.1 min.		29.5 min.		0.0 min.	
	53.0%		0.0%		39.5%		7.6%		0.0%	
	Number	Index	Number	Index	Number	Index	Number	Index	Number	Index
Obstructive Apneas	2	0.6	N/A	N/A	7	2.7	0	0.0	N/A	N/A
Mixed Apneas	0	0.0	N/A	N/A	0	0.0	0	0.0	N/A	N/A
Central Apneas	1	0.3	N/A	N/A	1	0.4	0	0.0	N/A	N/A
Total Apneas	3	0.9	N/A	N/A	8	3.1	0	0.0	N/A	N/A
Total Hypopneas	80	23.2	N/A	N/A	56	21.8	10	20.3	N/A	N/A
Apneas + Hypops	83	24.1	N/A	N/A	64	24.9	10	20.3	N/A	N/A

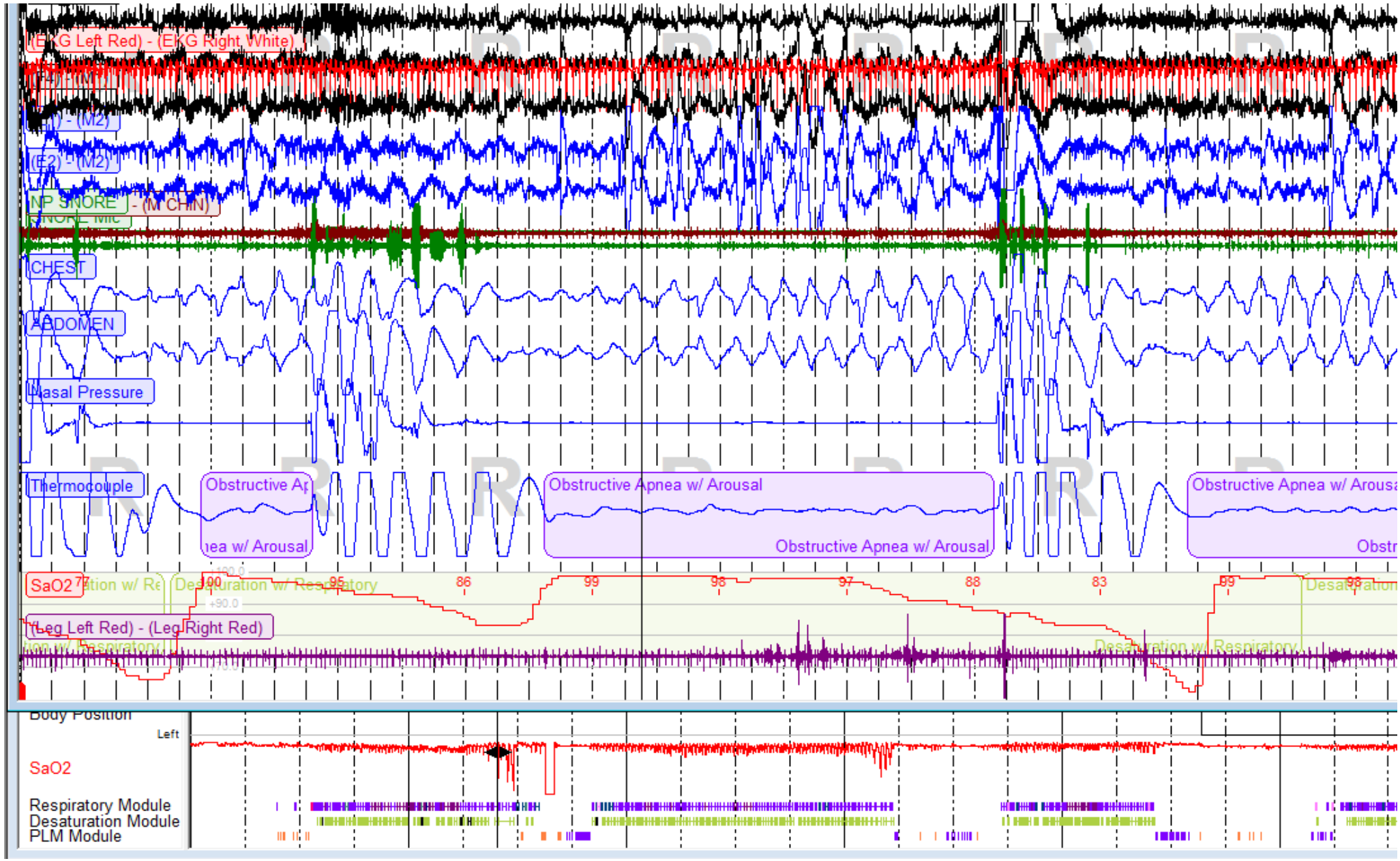
NREM TST in Position: % of TST:	Supine	Prone	Left	Right	Upright	Total
	189.4	0.0	125.6	7.5	0.0	322.5
	48.5%	0.0%	32.2%	1.9%	0.0%	82.6%
Obstructive Apneas	2	N/A	6	0	N/A	8
Mixed Apneas	0	N/A	0	0	N/A	0
Central Apneas	1	N/A	1	0	N/A	2
Total Apneas	3	N/A	7	0	N/A	10
Total Hypopneas	60	N/A	44	0	N/A	104
Apneas + Hypops	63	N/A	51	0	N/A	114
AHI	20.0	N/A	24.4	0.0	N/A	21.2

REM TST in Position: % of TST:	Supine	Prone	Left	Right	Upright	Total
	17.5	0.0	28.5	22.0	0.0	68.0
	4.5%	0.0%	7.3%	5.6%	0.0%	17.4%
Obstructive Apneas	0	N/A	1	0	N/A	1
Mixed Apneas	0	N/A	0	0	N/A	0
Central Apneas	0	N/A	0	0	N/A	0
Total Apneas	0	N/A	1	0	N/A	1
Total Hypopneas	20	N/A	12	10	N/A	42
Apneas + Hypops	20	N/A	13	10	N/A	43
AHI	**68.6**	N/A	27.4	27.3	N/A	**37.9**

Sample Hypnogram

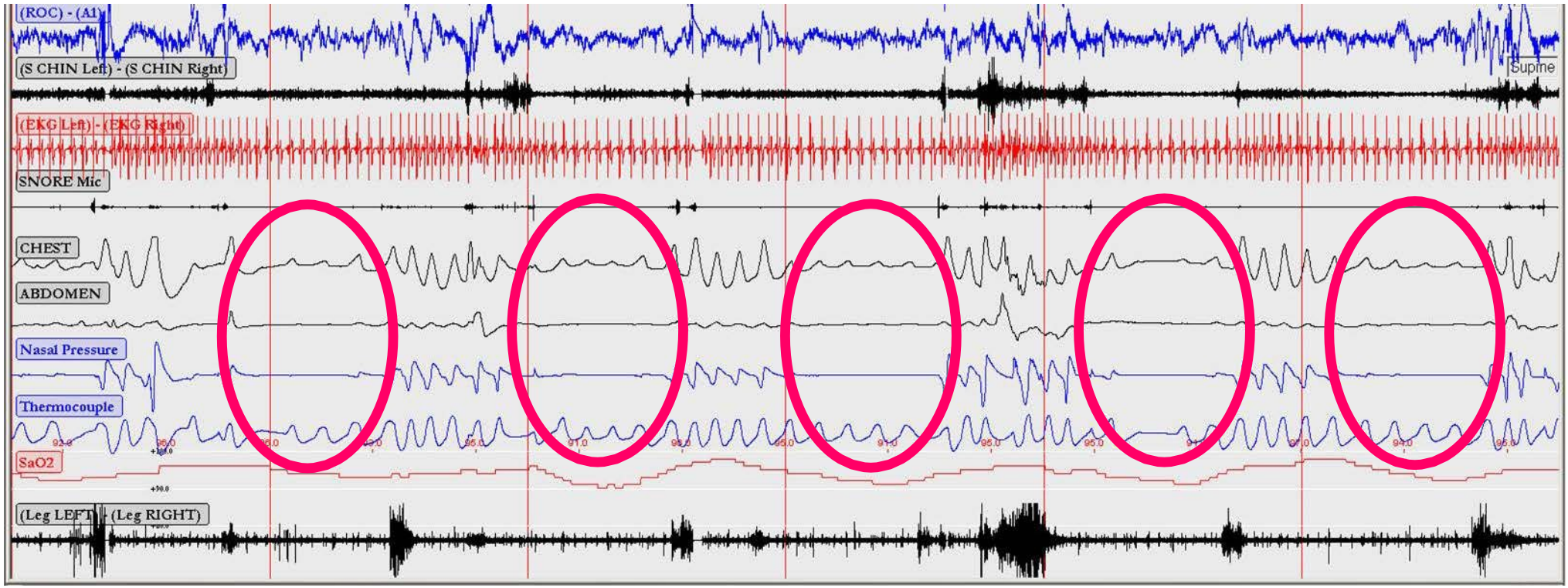


Dramatic OSA in REM



PSG: 120sec Epoch

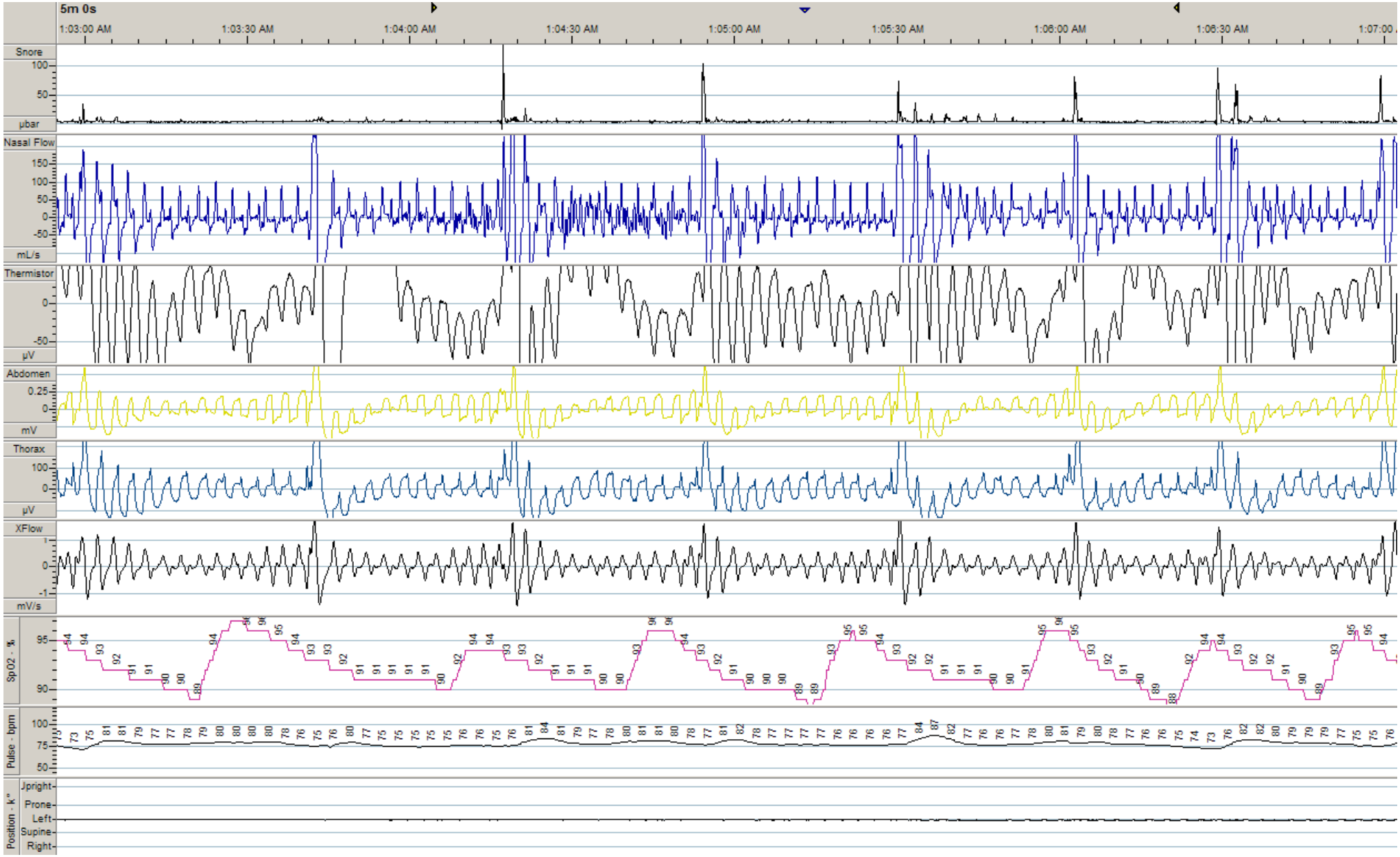
- Obstructive hypopneas/ RERAs with clear arousals but not consistent desaturation



Home Sleep Study (OCST)

- Respiratory data only (estimated AHI, ODI) calculated from recording time
  - Underestimates AHI as recording time > time asleep
  - Problematic if insomnia
- No EEG to determine sleep or arousal
  - No arousal associated hypopneas scored
  - No respiratory effort related arousals (RERAs)
  - No information by sleep stage (REM/NREM or if asleep)
- Higher rates of technical failure
- Appropriate for high likelihood OSA & no other sleep disorders or respiratory/cardiac disease

Home Study Tracing



Sample OCST Results

- Total recording time: 423 minutes
- Supine sleep: 34%
- AHI 8.4
  - 3 obstructive apneas, 2 central apneas
- Oximetry
  - ODI 7
  - Nadir saturation 87%, mean 94%

- *Same patient as in sample PSG but lower AHI estimated b/c of poor sleep efficiency & less REM*

Summary

- In lab PSG provides details regarding EEG, EMG to give more complete evaluation of sleep disorder
- When interpreting sleep study results, remember to consider:
  - % supine, REM sleep captured
  - AHI often underestimated in OCST
  - RDI vs. AHI & hypopnea criteria used