SLEEP 101 : THE BASICS
INTERPRETING PSG REPORTS

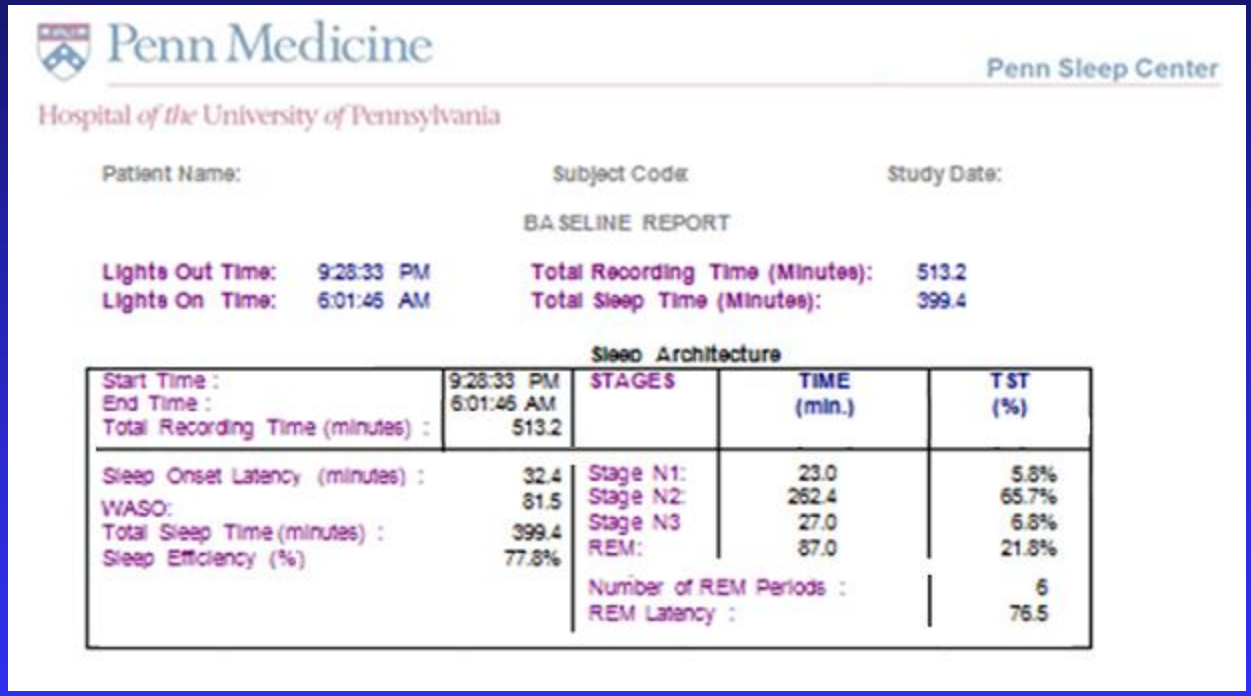
WHY BOTHER ?

WHY BOTHER

- IN CLINICAL PRACTICE SOME LARGE PERCENTAGE OF SUBJECTS WILL HAVE HAD SUCH STUDIES
- MAY INFORM WHETHER CBT-I SHOULD BE USED, DELAYED, OR MODIFIED
- MAY SUGGEST THAT DAYTIME SLEEPINESS BE MANAGED MORE AGGRESSIVELY
- MAY SUGGEST ALTERNATIVE DIAGNOSES THAT MAY, OR MAY NOT, ELIMINATE INSOMNIA IF TREATED (ESP. WHEN MIDDLE INSOMNIA)

BASICS

PSG ASSESSMENT OF SLEEP CONTINUITY & ARCHITECTURE



Penn Medicine

Penn Sleep Center

Hospital of the University of Pennsylvania

Patient Name: Subject Code: Study Date:

BASELINE REPORT

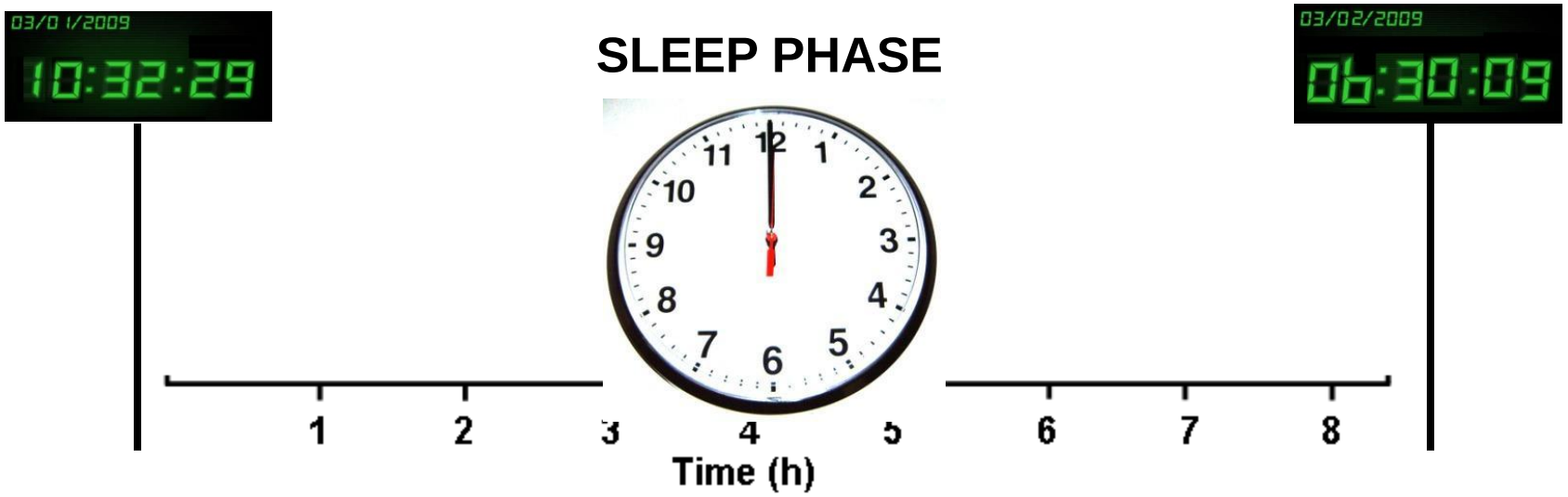
Lights Out Time: 9:28:33 PM
Lights On Time: 6:01:45 AM

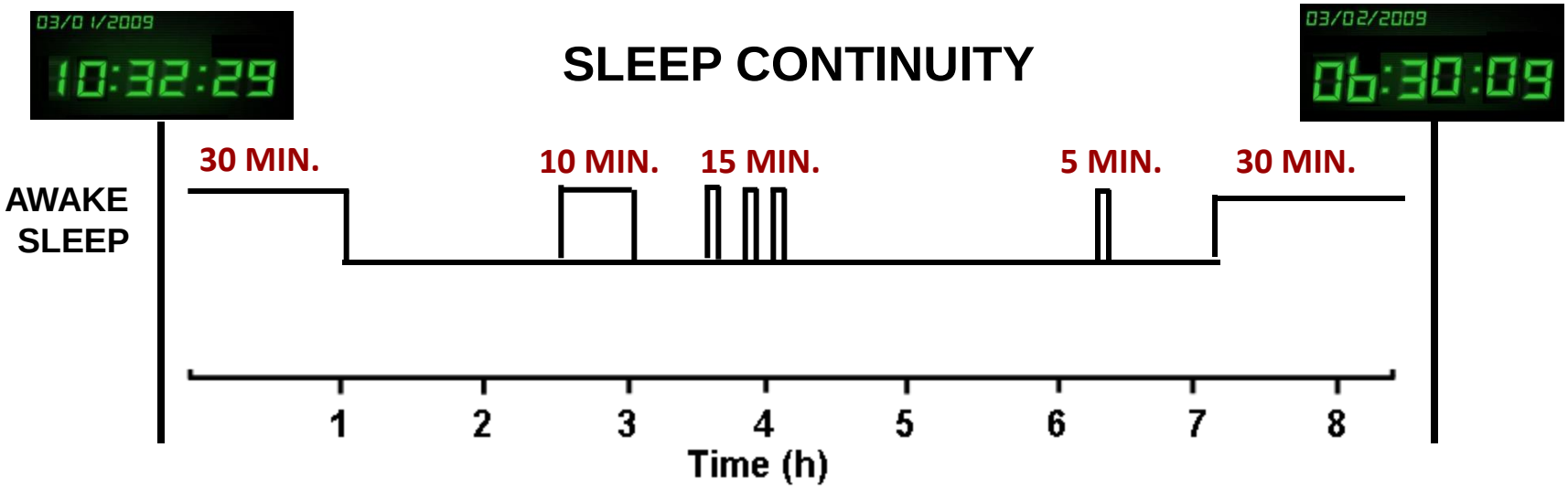
Total Recording Time (Minutes): 513.2
Total Sleep Time (Minutes): 399.4

Sleep Architecture

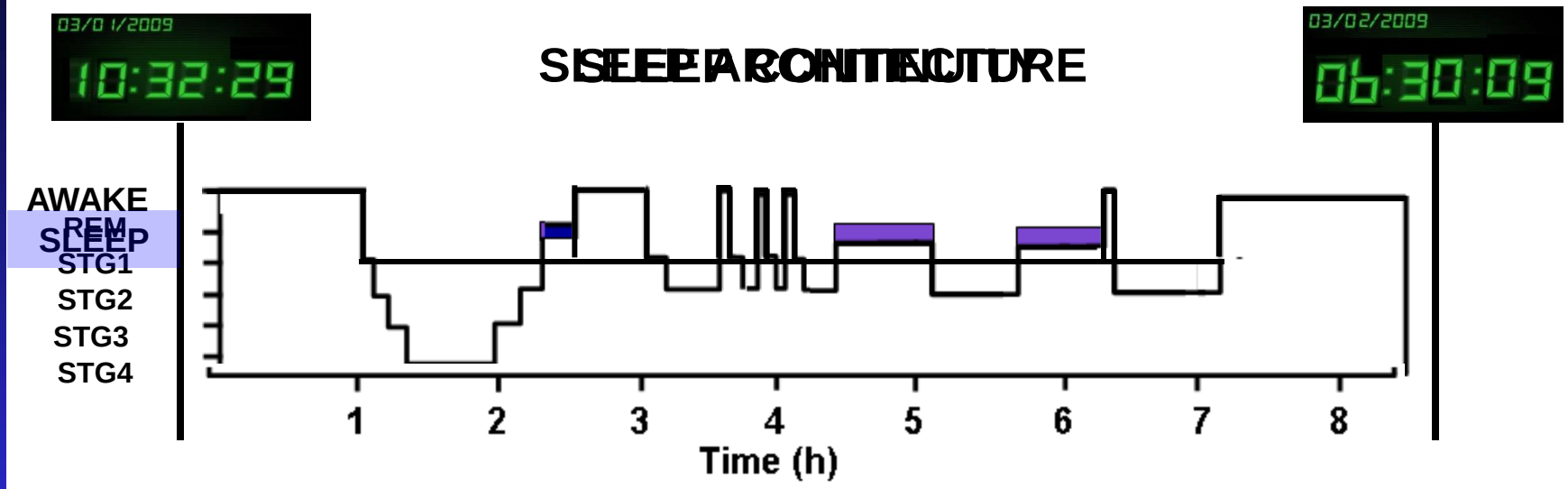
Start Time :	9:28:33 PM	STAGES	TIME (min.)	TST (%)
End Time :	6:01:46 AM			
Total Recording Time (minutes) :	513.2			
Sleep Onset Latency (minutes) :	32.4	Stage N1:	23.0	5.8%
WASO:	81.5	Stage N2:	262.4	65.7%
Total Sleep Time (minutes) :	399.4	Stage N3	27.0	6.8%
Sleep Efficiency (%)	77.8%	REM:	87.0	21.8%
		Number of REM Periods :		6
		REM Latency :		76.5

LET'S REVIEW


03/01/2009
10:32:29
SLEEP PHASE
03/02/2009
06:30:09
1
2
3
4
5
6
7
8
Time (h)



SLEEP CONTINUITY MEASURES	
TIME IN BED (TIB)	478 MIN (~ 8hrs)
SLEEP LATENCY (SL)	30 MIN
NUMBER OF AWAKENINGS (NWAK)	6
WAKE AFTER SLEEP ONSET (WASO)	60 MIN
TOTAL SLEEP TIME (TST)	388 MIN (~6.5 hrs)
SLEEP EFFICIENCY (SE%)	82%

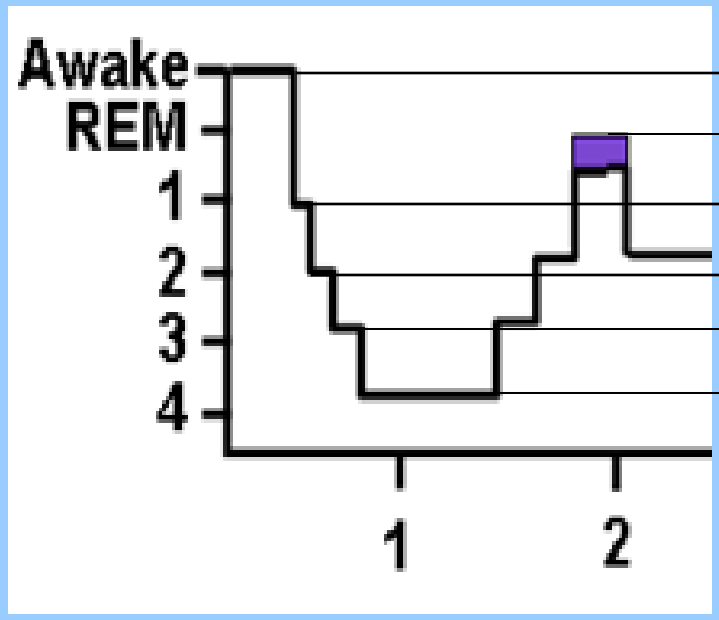


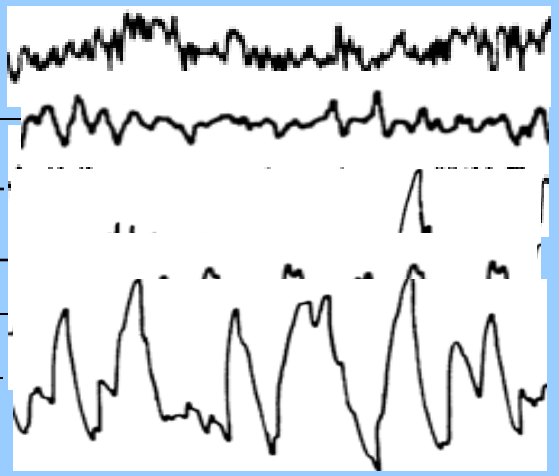
SLEEP ARCHITECTURE MEASURES

STG1	10%
STG2	60%
STG3	3%
STG4	7%
REM	20%

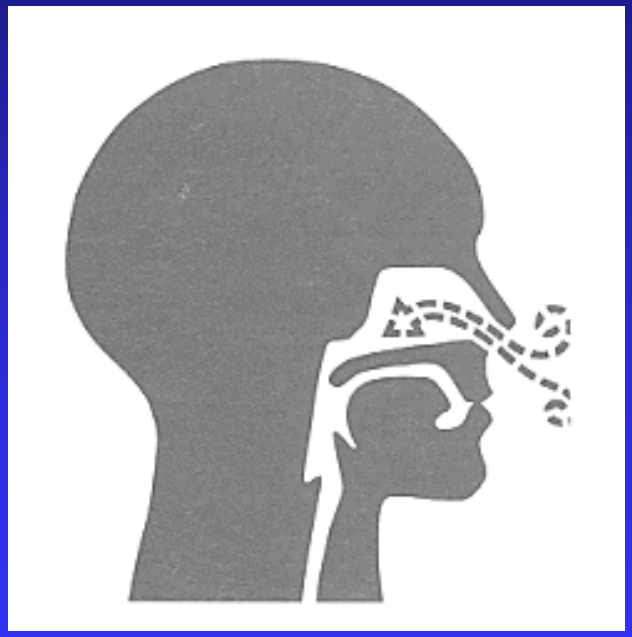
NOTE: RL AND SWS-L

STAGES OF SLEEP BY EEG





PSG ASSESSMENT OF SLEEP DISORDERED BREATHING



PSG ASSESSMENT OF SLEEP DISORDERED BREATHING

APNEA

OBSTRUCTIVE

CENTRAL

MIXED

HYPOPNEA

UARS

PERIODIC BREATHING

BIOTS / CHEYNE STOKES

FORMAL PSG DEFINITION OF SLEEP APNEA

CESSATION OF AIRFLOW
10 SECONDS IN DURATION
≥ 5% O_2 DESATURATION

WITH or WITHOUT EEG AROUSALS

Journal of Clinical Sleep Medicine, 5(3),263-276. 2009.
Journal of Clinical Sleep Medicine, Vol. 8, No. 5, 2012

FORMAL PSG DEFINITION OF SLEEP HYPOPNEA

> 50% REDUCTION IN AIRFLOW
10 SECONDS IN DURATION
≥ 3% O_2 DESATURATION

WITH or WITHOUT EEG AROUSALS

Journal of Clinical Sleep Medicine, 5(3),263-276. 2009.
Journal of Clinical Sleep Medicine, Vol. 8, No. 5, 2012

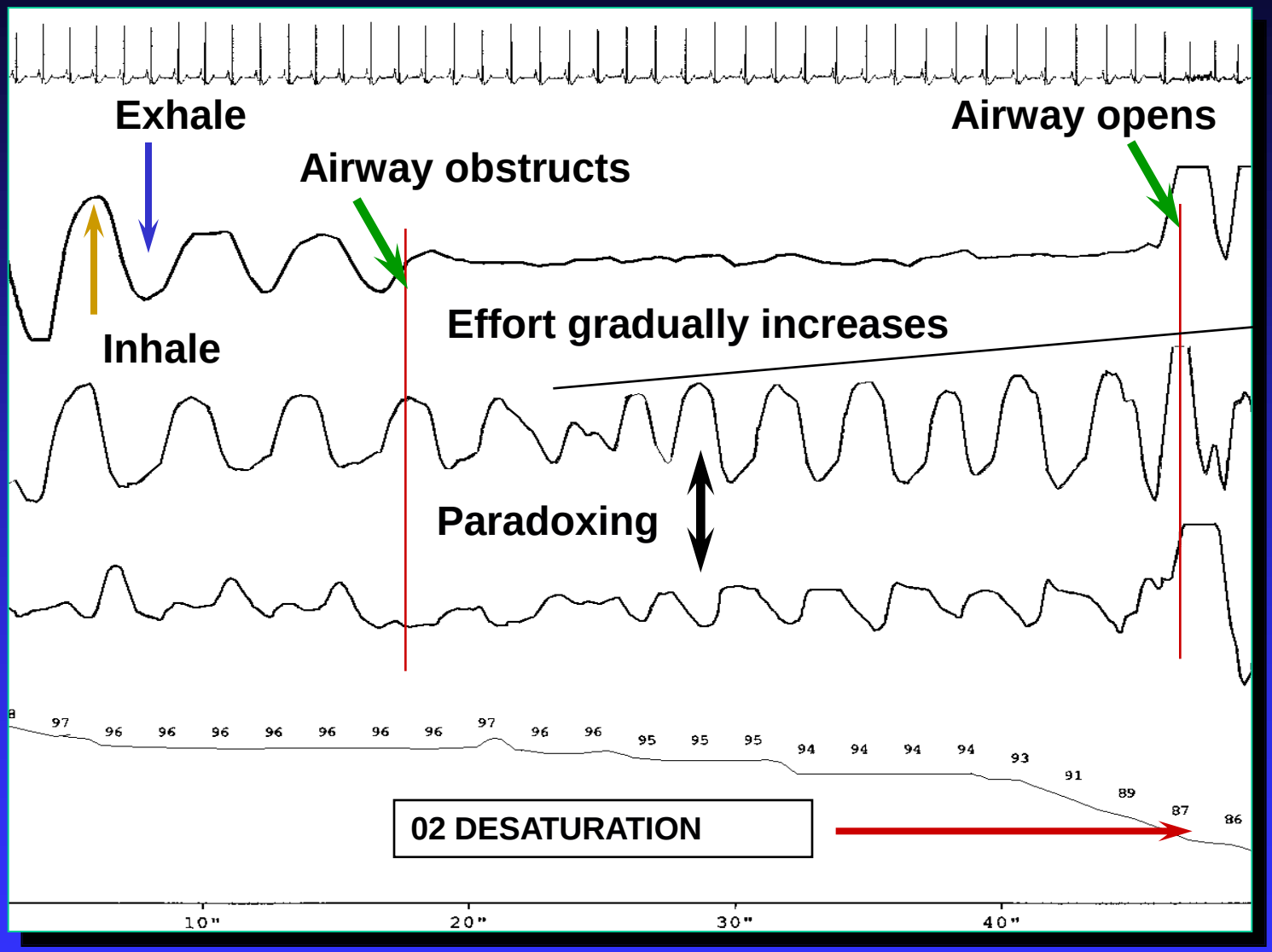
EKG

AIRFLOW

THORACIC EFFORT

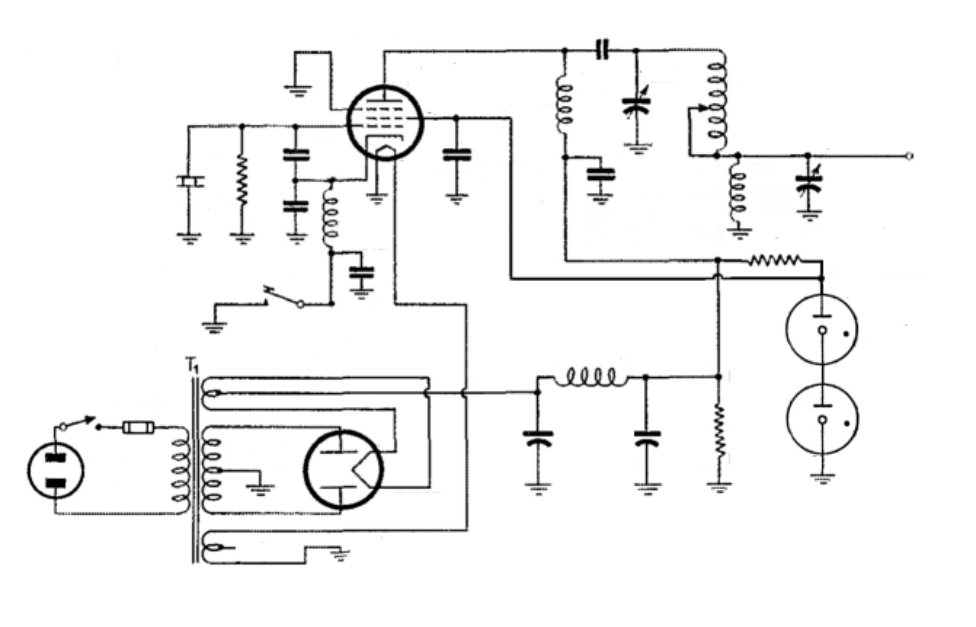
ABDOMINAL EFFORT

SAO_2



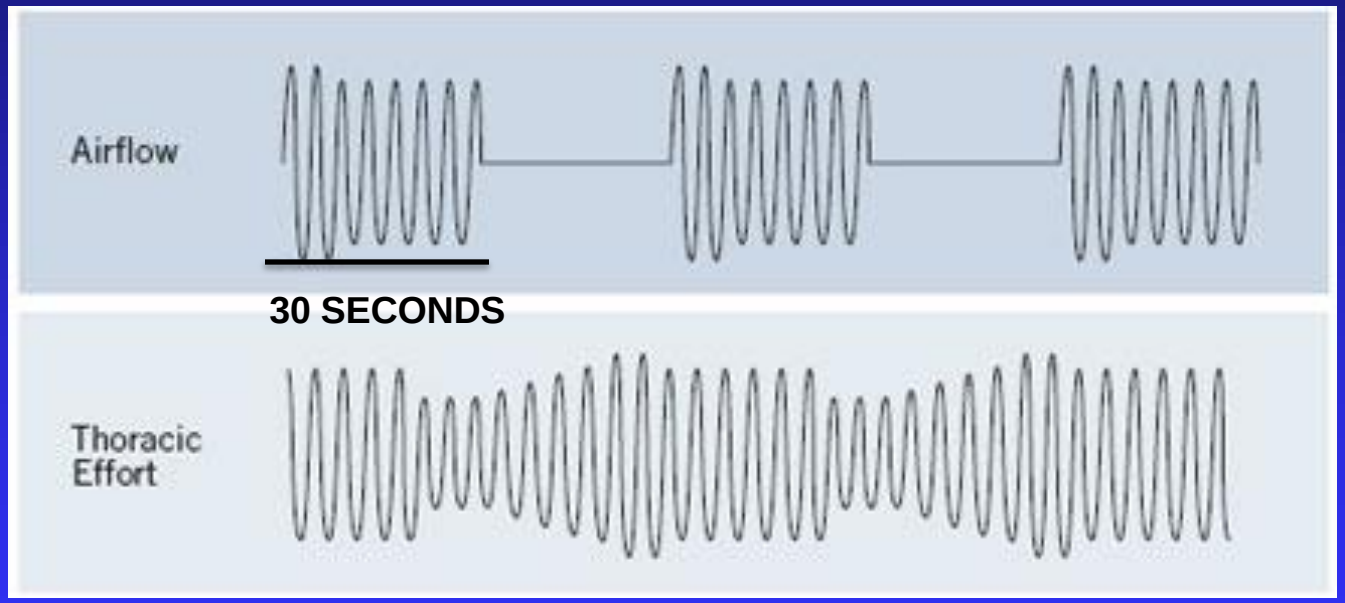
SLEEP APNEA

SCHEMATIC REPRESENTATIONS



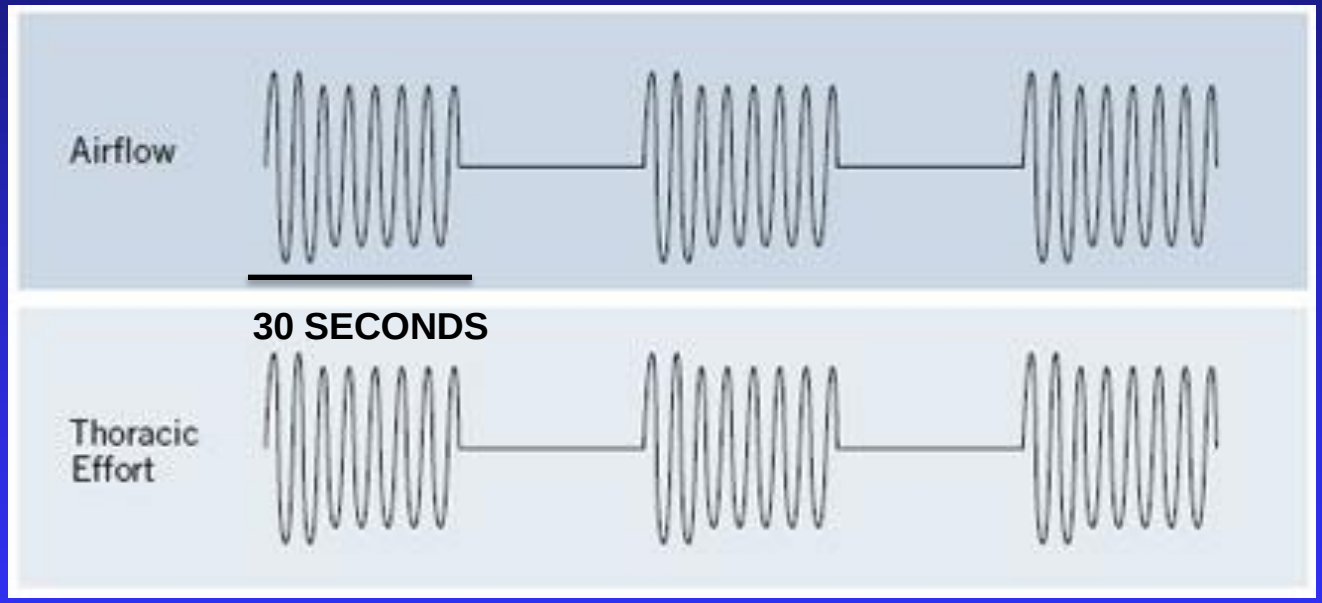
SLEEP APNEA

OBSTRUCTIVE SLEEP APNEA



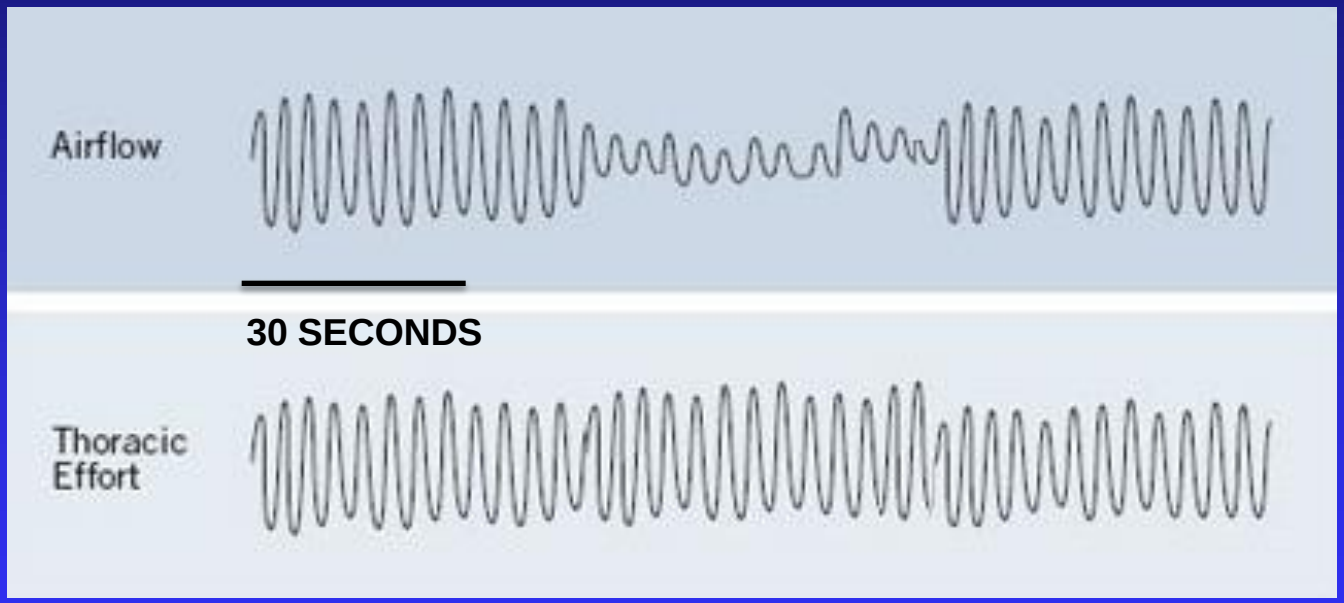
SLEEP APNEA

CENTRAL SLEEP APNEA



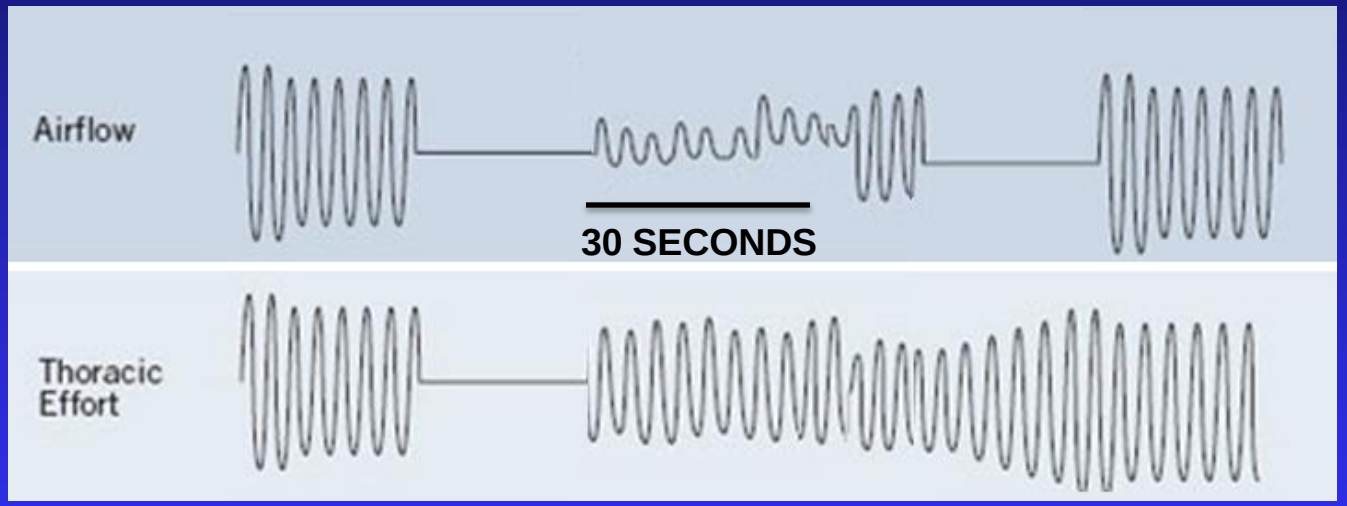
SLEEP APNEA

HYPOPNEA

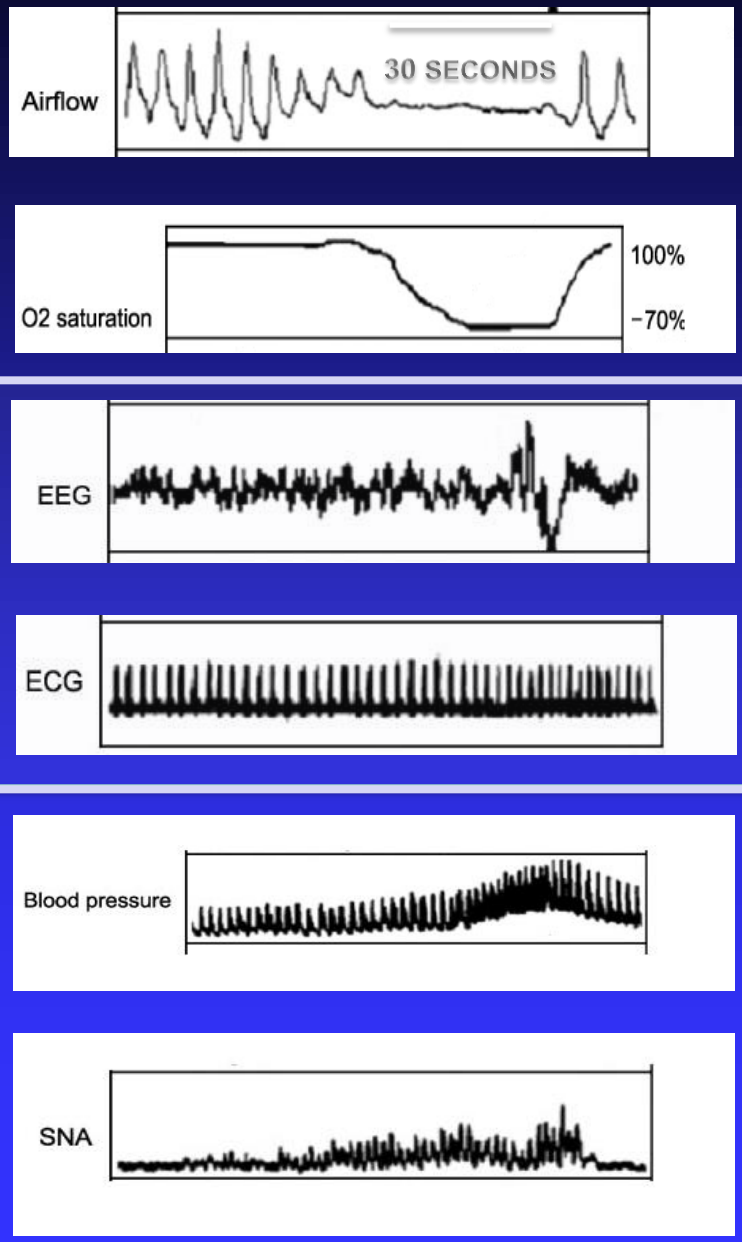


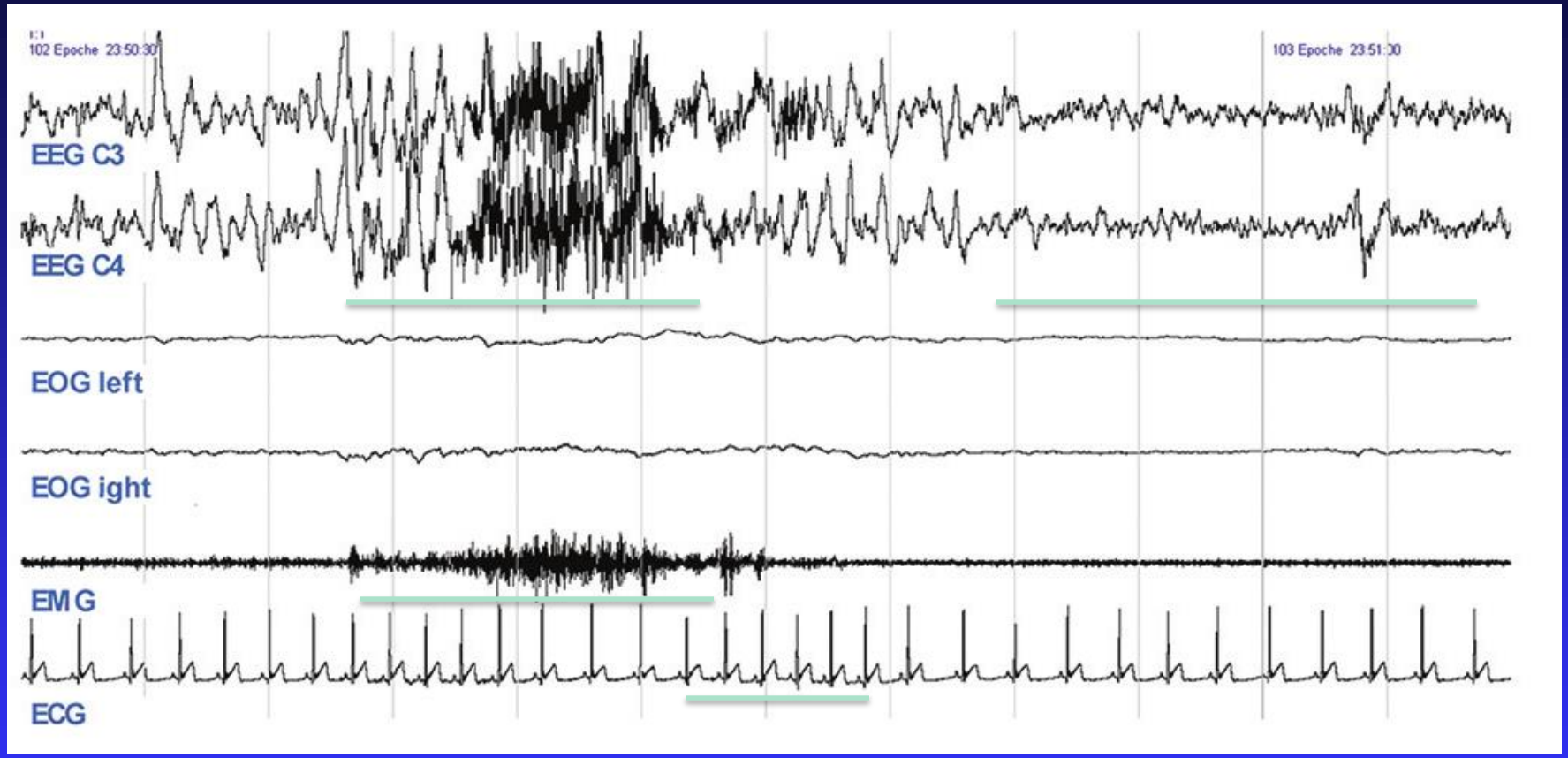
SLEEP APNEA

MIXED APNEA



CONSEQUENCES OF SDB




102 Epoche 23:50:30
103 Epoche 23:51:00
EEG C3
EEG C4
EOG left
EOG ight
EM G
ECG

INDICES AND THRESHOLDS

APNEA INDEX (AI, AHI, RDI)

(AV. # EVENTS / HOUR)

RANGE 0-80 (MORE REASONABLE 0-60)

5-15 IS MILD

15-30 MODERATE

> 30 SEVERE

WITH OR WITHOUT AROUSALS

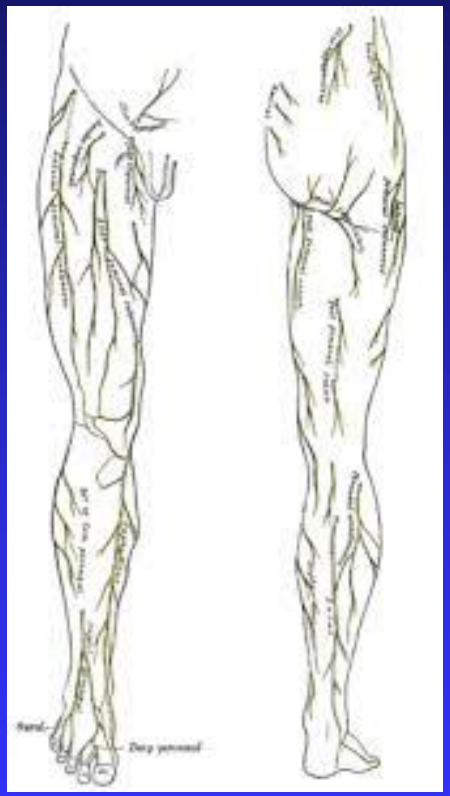
WITH OR WITHOUT DESATURATIONS

BY BODY POSITION AND STAGE OF SLEEP

Journal of Clinical Sleep Medicine, 5(3),263-276. 2009.

Journal of Clinical Sleep Medicine, Vol. 8, No. 5, 2012

RLS AND/OR PLMS

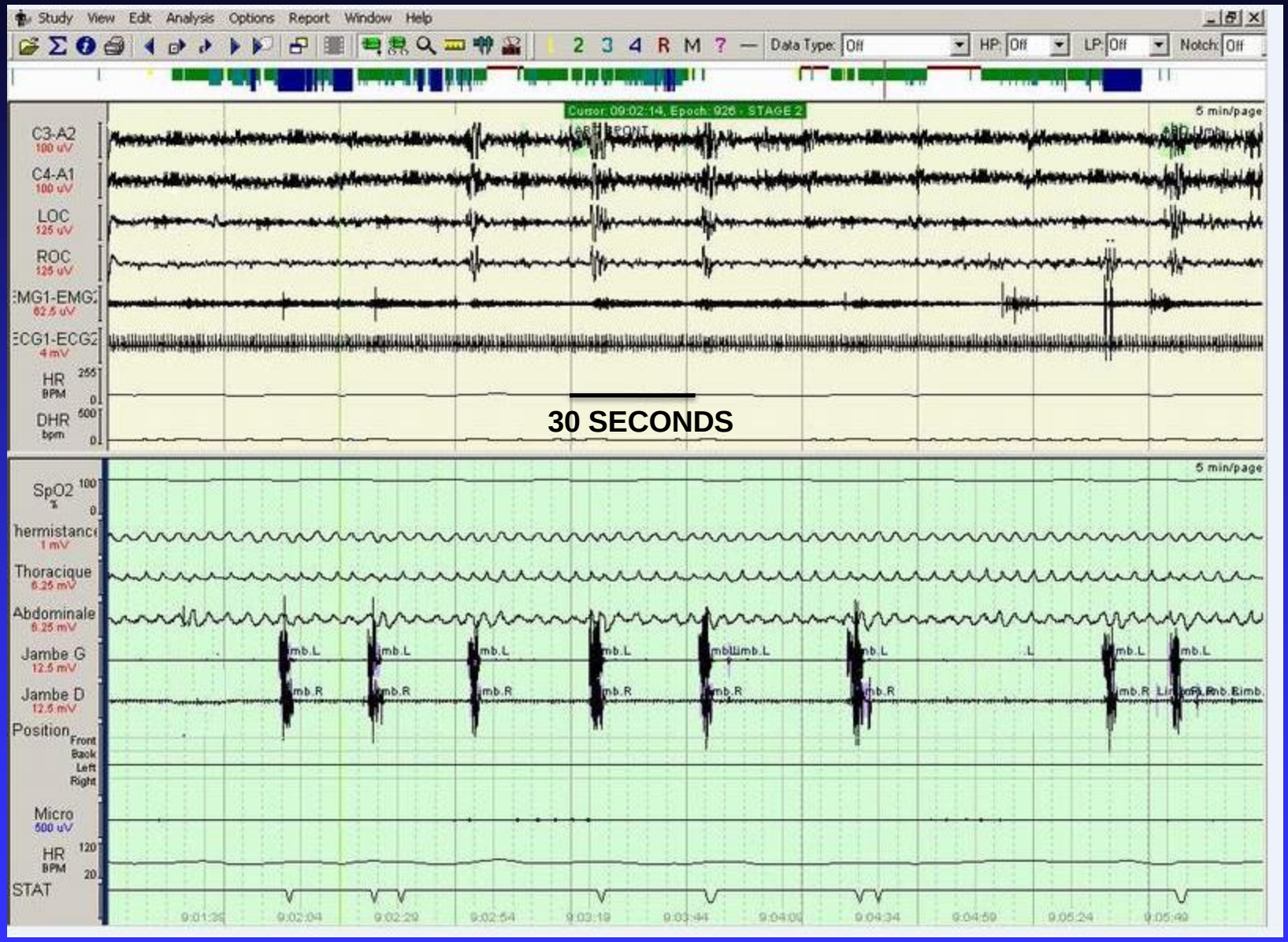


FORMAL PSG DEFINITION OF PLMs

- BURSTS OF ANTERIOR TIBIALIS MUSCLE ACTIVITY LASTING 0.5-10 SECS
- AMPLITUDE OF AT LEAST (8 μV) FROM RESTING EMG
- 4 PLMS SEPARATED BY AT LEAST 5 SECS BUT NOT MORE THAN 90 SECS (STEREOTYPED AND REPETITIVE)

PRIMARY CONSEQUENCE

SLEEP FRAGMENTATION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Data Type: Off
HP: Off
LP: Off
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Cursor: 09:02:14, Epoch: 926 - STAGE 2
5 min/page
C3-A2
C4-A1
LOC
ROC
HR
BPM
DHR
bpm
30 SECONDS
SpO2
Thoracique
Abdominale
Jambe G
Jambe D
Position
Front
Back
Left
Right
Micro
STAT

INDICES AND THRESHOLDS

PERIODIC LEG MOVEMENTS OF SLEEP

(AV. # EVENTS / HOUR)
RANGE 0-240 ? (MORE REASONABLE 0-60)

0-5 IS MILD
5-25 MODERATE
25-50 SEVERE

WITH OR WITHOUT AROUSALS
BY STAGE OF SLEEP

Principles and Practice of Sleep Medicine, 5th edition 2010

TWO TYPES

PSG DATA SUMMARY
GRAPHS AND TABLES

LETTER / FORM
INTERPRETATION
SUMMARY STATS ?

EXAMPLE #1
DATA SUMMARY

Penn Medicine

Penn Sleep Center

Hospital *of the* University *of* Pennsylvania

Patient Name: Subject Code: Study Date:

BASELINE REPORT

Lights Out Time: 9:28:33 PM
Lights On Time: 6:01:45 AM

Total Recording Time (Minutes): 513.2
Total Sleep Time (Minutes): 399.4

Sleep Architecture

Start Time :	9:28:33 PM	STAGES	TIME (min.)	TST (%)
End Time :	6:01:45 AM	WASO:	81.5	
Total Recording Time (minutes) :	513.2			5.8%
		Stage N1:	23.0	
Total Sleep Time (minutes) :	399.4	Stage N2:	262.4	65.7%
Sleep Efficiency (%) :	77.8%	Stage N3	27.0	6.8%
Sleep Onset Latency (minutes) :	32.4	REM:	87.0	21.8%
Number of REM Periods :	6			
REM Latency :	76.5			

Snoring Levels

Position	Baseline
Supine :	Moderate
Lateral :	Moderate
Prone :	N/A

Position	Time	% TST
Supine:	4:45:57	71.6%
Left:	1:53:25	28.4%
Right:	0:00:00	0.0%
Prone:	0:00:00	0.0%

Apnea & Hypopnea* Events

PARAMETER	CENTRAL	OBSTRUCTIVE	MIXED	TOTAL	HYPOPNEAS
Number:	0	65	1	66	71
Index:	0.0	9.8	0.2	9.9	10.7
Mean Duration (sec):	N/A	14.1	10.0	14.0	15.7
Longest Duration (sec):	N/A	25.4	10.0	25.4	31.4
Occur In REM:	0	53	0	53	24
Occur In Non-REM:	0	12	1	13	47
REM Index:	0.0	36.6	0.0	36.6	16.6
Non-REM Index:	0.0	2.3	0.2	2.5	9.0

Respiratory Events and Body Position

PARAMETER	INDEX	TOTAL
Apneas & Hypopneas:	20.6	137
NREM	11.5	60
REM	53.1	77
Supine Events:	25.0	119
Lateral Events:	9.5	18
Prone Events:	N/A	N/A
Left Events:	9.5	18
Right Events:	N/A	N/A

Penn Medicine

Hospital *of the* University *of* Pennsylvania

Penn Sleep Center

Patient Name: Subject Code: Study Date:

BASELINE REPORT

PLM Events	Total		Events with Arousals		Events w/o arousals	
PARAMETER	Index	Total	INDEX	TOTAL	INDEX	TOTAL
Total Events:	0.0	0	0.0	0	0.0	0
Non-REM Events:	0.0	0	0.0	0	0.0	0
REM Events:	0.0	0	0.0	0	0.0	0

All Arousals

PARAMETER	INDEX	TOTAL
Total Events:	21.9	146
Non-REM Events:	19.4	101
REM Events:	31.0	45

Oxygen Saturation

PARAMETER	AWAKE	NREM	REM	Total Sleep Time
Mean SaO2 % :	95.7	95.2	95.2	95.2
Min. SaO2 % :	75.0	88.0	85.0	85.0
Max. SaO2 % :	100.0	99.0	99.0	99.0
% Duration of SaO2 In Range :				
90 – 100 % :	96.8%	96.6%	93.5%	95.9%
80 – 89 % :	1.7%	0.1%	6.5%	1.5%
70 – 79 % :	0.1%	0.0%	0.0%	0.0%
60 – 69 % :	0.0%	0.0%	0.0%	0.0%
50 – 59 % :	0.0%	0.0%	0.0%	0.0%
Below 50 % :	0.0%	0.0%	0.0%	0.0%

** Column totals less than 100% indicate the presence of "**Bad Data**" markers.*

Pulse Rate

PULSE RATE RESULTS	Wake	Non-REM	REM	TST	TIB
Max. HR (bpm):	95.0	89.0	78.0	89.0	95.0
Mean HR (bpm):	73.9	67.5	63.6	66.7	68.3
Min. HR (bpm):	52.0	54.0	50.0	50.0	50.0

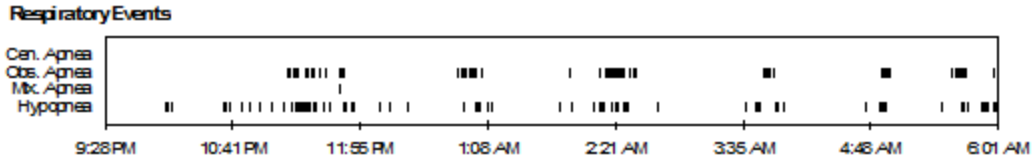
Penn Medicine

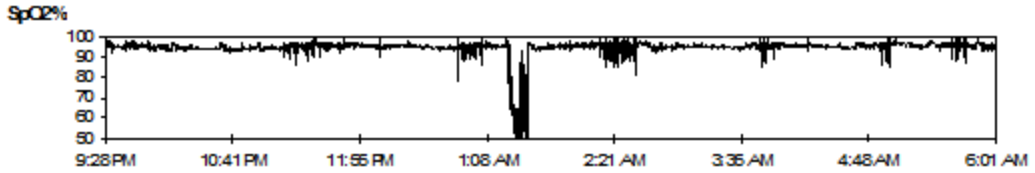
Penn Sleep Center

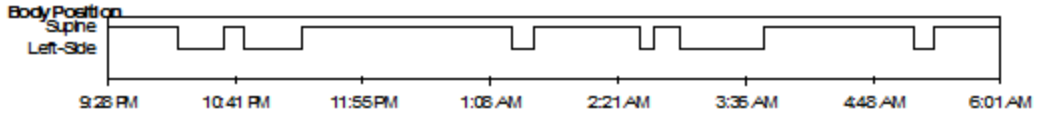
Hospital *of the* University *of* Pennsylvania

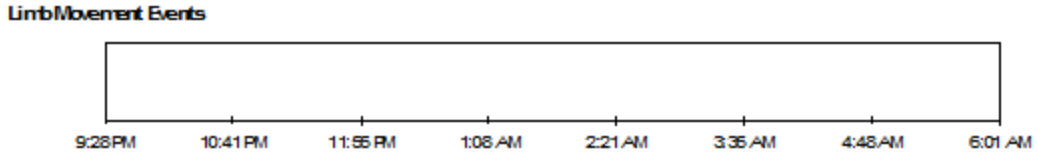
Patient Name: Subject Code: Study Date:

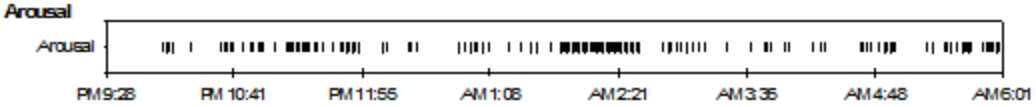
BASELINE REPORT











EXAMPLE #1
LETTER

Penn Medicine

Penn Sleep Center

Hospital *of the* University *of* Pennsylvania

Patient Name: Subject Code: Study Date:

BASELINE REPORT

Patient Name :		**BP :**	140/90
MR # :		**Height :**	72.0in
Sleep Center ID :		**Weight :**	190.0lbs
Study Date :	1/13/2013	**B.M.I. :**	25.8
Sex :	Male	**Referring Physician :**	
D.O.B. :	7/30/1936	**Sleep Specialist :**	
Age :	77	**Report date:**	2/23/13

CLINICAL HISTORY: The patient is a 50 year old gentleman with a history of hypertension, trach and diverticular disease. BMI is 25.8. The Epworth Sleepiness Scale is 12 (normal <10). The study was performed to evaluate the patient for obstructive sleep apnea with possible CPAP titration.

TECHNICAL DESCRIPTION: The patient underwent full overnight polysomnography during which the following parameters were monitored: EEG (C3-M2, C4-M1, F3-M2, F4-M1, O1-M2, O2-M1), EOG, submental and leg EMG, ECG, oxyhemoglobin saturation by pulse oximetry, respiratory effort, nasal/oral airflow, and snoring.

INTERVENTIONS: none

SLEEP-DISORDERED BREATHING:

Total apnea hypopnea index (AHI):	21
Supine AHI:	25
Lateral AHI:	9
REM AHI:	53
Oxyhemoglobin desaturation nadir:	85%
Arousal Index	22

PHYSICIAN INTERPRETATION:

The patient underwent attended nocturnal polysomnography. Sleep latency was 32.4 minutes and sleep efficiency was 78%. REM latency was 76.5 minutes (normal range ~90-120 min). All sleep stages were attained including delta/deep sleep. During the study, there were 22 EEG arousals/hour (normal lab range: 8-12/hour). Arousals were often related to sleep-disordered breathing. There were no periodic limb movements.

The patient slept in the lateral and supine positions. Moderate snoring was noted. There were episodes of obstructive apneas/hypopneas, more frequent in REM, which were associated with oxygen desaturations and with arousals. The baseline apnea hypopnea index (AHI) was 21 (normal range: 0-5; mild range: 5-14; moderate range: 15-30; severe range: >30), and the REM AHI was 53. The oxyhemoglobin desaturation nadir was 85%. There was sinus rhythm without ectopy.

There was not adequate time for CPAP titration.

FINAL DIAGNOSIS: Obstructive Sleep Apnea (327.23)

EXAMPLE #2
DATA SUMMARY

Penn Medicine

Penn Sleep Center

Hospital *of the* University *of* Pennsylvania

Patient Name: Subject Code: Study Date: 2/3/2013

Date Scored: 2/02/2013

Patient Name :		BP :	
MR # :		Height :	70.0in
Sleep Center ID :		Weight :	210.0lbs
Study Date :		B.M.I. :	30.1
Sex :	Male	Referring Physician :	EPELBOIM
D.O.B. :	2/3/1974	Sleep Specialist :	EPELBOIM
Age :	40		

Lights Out Time:	11:53:37 PM	Total Recording Time (Minutes):	380.7
Lights On Time:	6:14:17 AM	Total Sleep Time (Minutes):	184.5

Cardiac Arrhythmias: Bradycardia

Sleep Architecture

Start Time :	11:53:37 PM	STAGES	TIME (min.)	TST (%)
End Time :	6:14:17 AM	WASO:	174.5	
Total Recording Time (minutes) :	380.7	Stage N1:	11.0	6.0%
Total Sleep Time (minutes) :	184.5	Stage N2:	114.0	61.8%
Sleep Efficiency (%) :	48.5%	Stage N3	4.5	2.4%
Sleep Onset Latency (minutes) :	21.6	REM:	55.0	29.8%
Number of REM Periods :	1			
REM Latency :	132.5			

Snoring Levels

Position	Baseline
Supine :	Moderate
Lateral :	Moderate
Prone :	N/A

Position	Time	% TST
Supine:	0:01:00	0.5%
Left:	3:03:30	99.5%
Right:	0:00:00	0.0%
Prone:	0:00:00	0.0%

Apnea & Hypopnea* Events

PARAMETER	CENTRAL	OBSTRUCTIVE	MIXED	TOTAL	HYPOPNEAS
Number:	0	1	0	1	57
Index:	0.0	0.3	0.0	0.3	18.5
Mean Duration (sec):	N/A	10.0	N/A	10.0	15.7
Longest Duration (sec):	N/A	10.0	N/A	10.0	32.9
Occur in REM:	0	0	0	0	3
Occur in Non-REM:	0	1	0	1	54
REM Index:	0.0	0.0	0.0	0.0	3.3
Non-REM Index:	0.0	0.5	0.0	0.5	25.0

***AASM:**
Hypopneas are scored on the basis of a >30% decrease in nasal pressure or thermistor excursion from baseline, lasting at least 10 seconds and associated with a ≥ 4% desaturation or arousal.

***Medicare:**
Hypopneas are scored on the basis of a >30% decrease in nasal pressure or thermistor excursion from baseline, lasting at least 10 seconds and associated with a ≥ 4% desaturation.

Penn Medicine

Hospital *of the* University *of* Pennsylvania

Penn Sleep Center

Patient Name: Subject Code: Study Date: 2/3/2013

Respiratory Events and Body Position

PARAMETER	INDEX	TOTAL
Apneas & Hypopneas:	18.9	58
NREM	25.5	55
REM	3.3	3
Supine Events:	0.0	0
Lateral Events:	19.0	58
Prone Events:	N/A	N/A
Left Events:	19.0	58
Right Events:	N/A	N/A

PLM Events	Total		Events with Arousals		Events w/o arousals	
PARAMETER	Index	Total	INDEX	TOTAL	INDEX	TOTAL
Total Events:	54.3	167	2.0	6	52.4	161
Non-REM Events:	77.4	167	2.8	6	74.6	161
REM Events:	0.0	0	0.0	0	0.0	0

All Arousals

PARAMETER	INDEX	TOTAL
Total Events:	23.4	72
Non-REM Events:	30.1	65
REM Events:	7.6	7

Oxygen Saturation

PARAMETER	AWAKE	NREM	REM	Total Sleep Time
Mean SaO2 % :	95.4	94.5	94.8	94.6
Min. SaO2 % :	90.0	90.0	91.0	90.0
Max. SaO2 % :	99.0	98.0	99.0	99.0
% Duration of SaO2 In Range :				
90 – 100 % :	96.1%	100.0%	100.0%	100.0%
80 – 89 % :	0.0%	0.0%	0.0%	0.0%
70 – 79 % :	0.0%	0.0%	0.0%	0.0%
60 – 69 % :	0.0%	0.0%	0.0%	0.0%
50 – 59 % :	0.0%	0.0%	0.0%	0.0%
Below 50 % :	0.0%	0.0%	0.0%	0.0%

** Column totals less than 100% indicate the presence of "Bad Data" markers.*

Pulse Rate

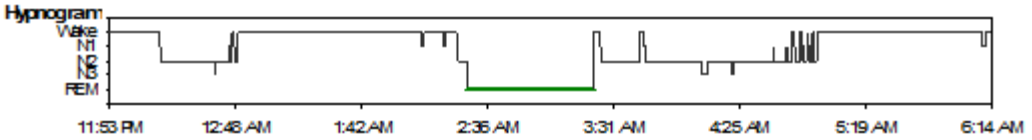
PULSE RATE RESULTS	Wake	Non-REM	REM	TST	TIB
Max HR (bpm):	80.0	69.0	75.0	75.0	80.0
Mean HR (bpm):	52.0	50.2	49.6	50.0	51.0
Min. HR (bpm):	5.0	45.0	42.0	42.0	5.0

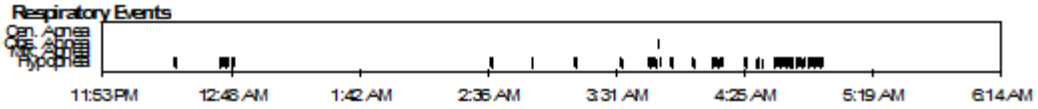
Penn Medicine

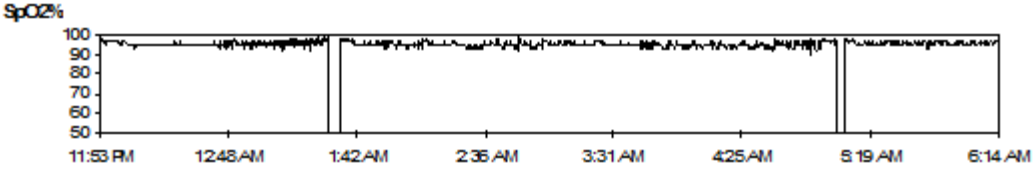
Penn Sleep Center

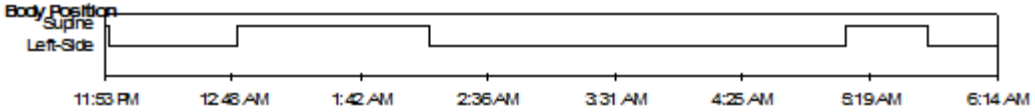
Hospital *of the* University *of* Pennsylvania

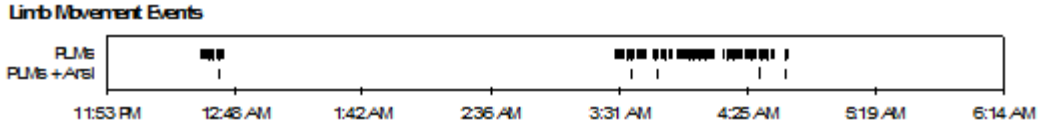
Patient Name: Subject Code: Study Date: 2/3/2013

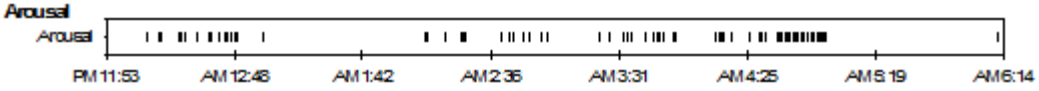












EXAMPLE #2
LETTER

Penn Medicine

Penn Sleep Center

Hospital *of the* University *of* Pennsylvania

Patient Name: Subject Code: Study Date: 2/3/2013

BASELINE SLEEP STUDY REPORT

Patient Name :		**D.O.B. :**	2/3/1974
MR # :		**Age :**	40
Sleep Center ID :		**B.M.I. :**	30.1
Study Date :	1/13/2013	**Referring Physician :**	
Sex :	Male	**Location :**	Malvern

CLINICAL HISTORY: The patient is a 40 year old man with hypertension, hyperlipidemia, obesity and prostate cancer who complains of snoring, tiredness and non-restorative sleep. A sleep study was arranged to evaluate the patient for obstructive sleep apnea syndrome

TECHNICAL DESCRIPTION: The patient underwent full overnight polysomnography during which the following parameters were monitored: EEG (C3-M2, C4-M1, F3-M2, F4-M1, O1-M2, O2-M1), EOG, submental and leg EMG, ECG, oxyhemoglobin saturation by pulse oximetry, respiratory effort, nasal/oral airflow, and snoring. The raw polysomnography data were reviewed by Dr. J. Epelboim.

SLEEP-DISORDERED BREATHING:

Total Apnea/Hypopnea Index (AHI):	18.9
Supine AHI:	0.0
Lateral AHI:	19.0
REM AHI:	3.3
NREM Oxyhemoglobin Desaturation Nadir:	90.0%
REM Oxyhemoglobin Desaturation Nadir:	91.0%

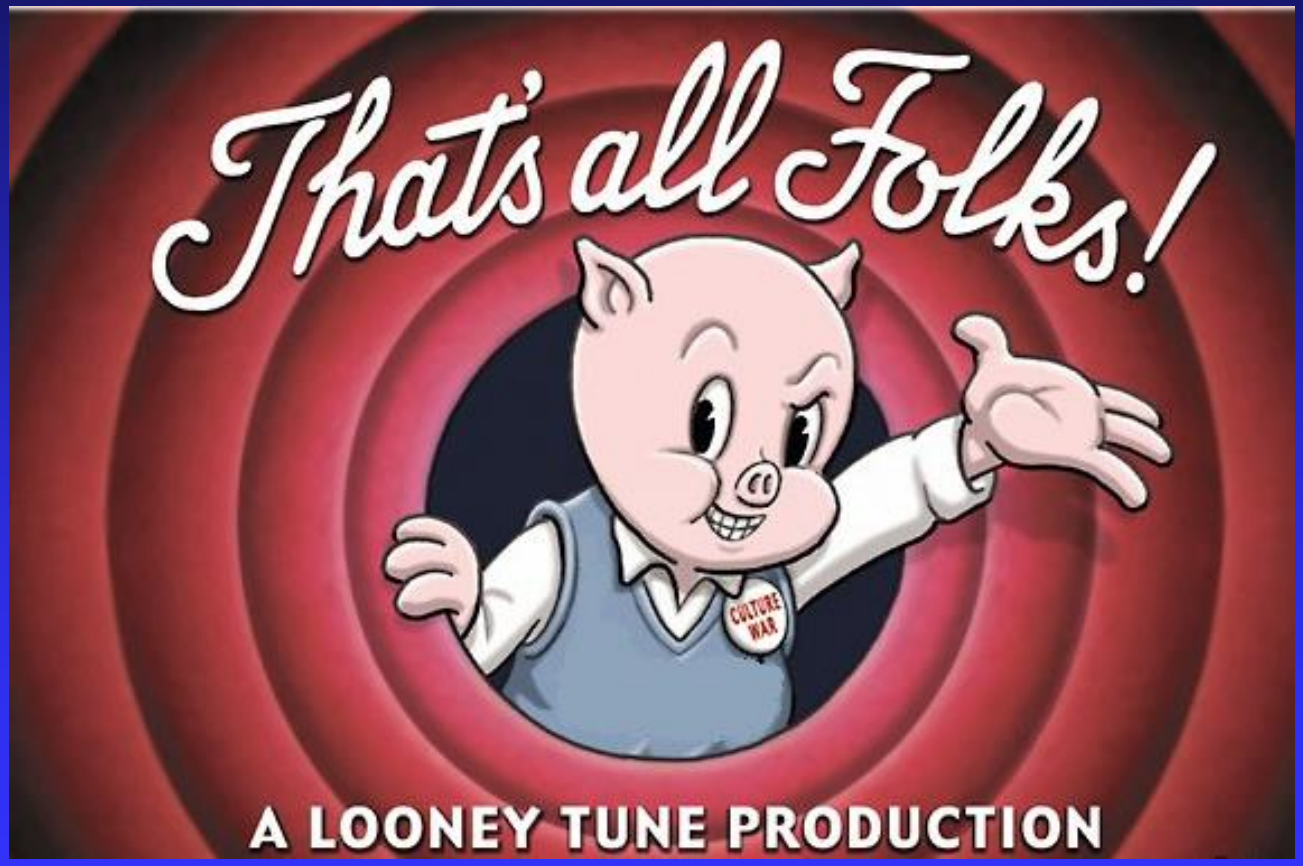
FINDINGS: Sleep efficiency was significantly reduced at 48.5% with a latency to sleep of 21.6 minutes and a long wake after sleep onset. Sleep was mostly in the lateral position. Distribution of sleep stages was as follows: 6.0% stage N1 sleep; 61.8% stage N2 sleep; 2.4% stage N3 sleep; 29.8% REM sleep. The REM Sleep latency was 132.5 minutes (normal 90-120 minutes). There were 23.4 arousals per hour. In our laboratory the normal number of arousal is 8-12/hr. There were 54.3 periodic limb movements per hour with an associated periodic limb movement arousal index of 2.0 per hour. EKG demonstrated no significant arrhythmias.

Snoring was moderate. There were 0 central apneas, 1 obstructive apnea and 57 hypopneas producing an apnea/hypopnea index (AHI) of 18.9 events per hour in total, and a REM-related AHI of 3.3 events per hour. Oxyhemoglobin desaturation reached a nadir of 90.0% during non-REM sleep and 91.0% during REM sleep. Respiratory events were scored according to AASM criteria.

FINAL DIAGNOSIS: 1. Obstructive sleep apnea (327.23) ---moderate
2. Periodic limb movements of sleep

COMMENTS AND RECOMMENDATIONS: The patient has evidence for obstructive sleep apnea and snoring. However, the severity of his sleep apnea may have been underestimated as his sleep efficiency was poor and most of his sleep was in lateral position. Therapeutic options to treat his sleep-disordered breathing could include CPAP, an oral appliance or upper airway surgery. In addition, the patient should be encouraged to lose weight. Treatment of possible periodic limb movement disorder should be postponed until after adequate treatment of obstructive sleep apnea. These treatment options will be discussed with the patient when he is reevaluated. Follow-up will/should be with me in the Penn Sleep Centers outpatient practice as well as with the patient's private physician, Dr. Soffer.

WITHOUT FURTHER ADO



BREAK

The University of Pennsylvania

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