OSA/OHS

Obstructive sleep apnea

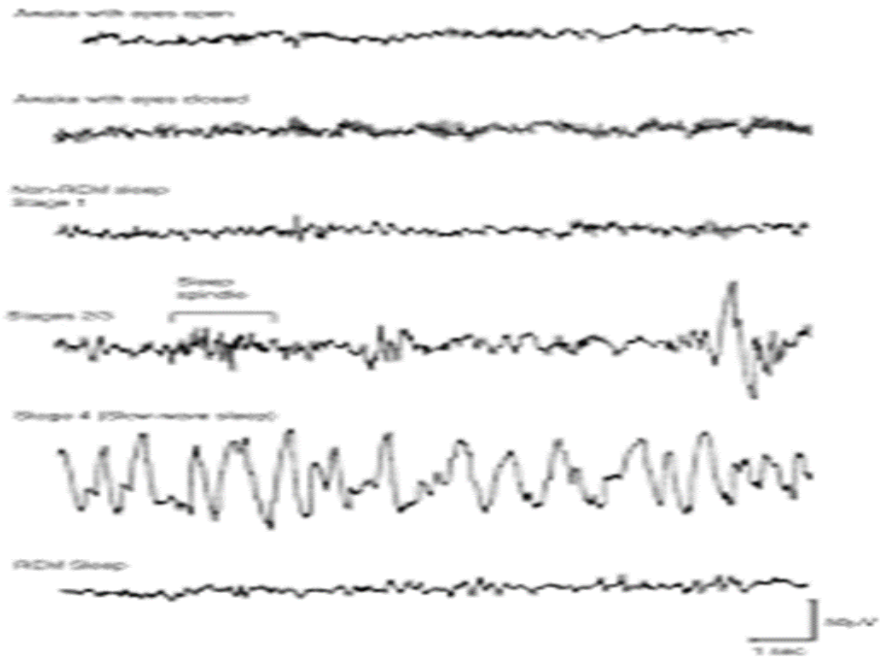
Obesity hypoventilation syndrome

Objectives

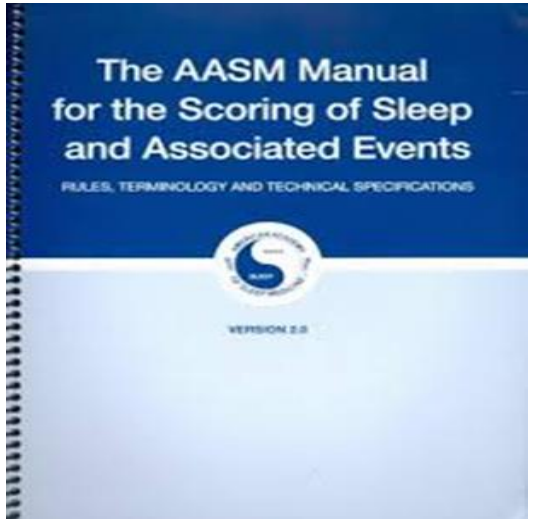
- History of sleep medicine.
- Sleep architecture.
- Polysmnography(PSG).
- OSA
- OHS

History of sleep

IN 1937 Loomis and colleagues noted fragmentation and fallout of alpha rhythm with sleep onset, and subsequent onset of sleep spindles, K complexes and high amplitude slow waves.
Sleep was divided into 5 stages .



In 2004,(AASM): Introduced new sleep scoring manual that would address sleep staging as well as the scoring of arousals, respiratory, cardiac, and movement events



Sleep Stage Nomenclature

	R&K	AASM
Wake	Stage W	Stage W
NREM	Stage 1	N1
	Stage 2	N2
	Stage 3	N3
	Stage 4	
REM	Stage REM	Stage R

AASM = American Academy of Sleep Medicine2; NREM = non–rapid eye movement;

R&K = Rechtschaffen and Kales A1; REM = rapid eye movement; stages 3 and 4 are combined into stage N3.

Sleep architecture

Why do we sleep ?

Why sleep is important ?

ANIMAL STUDIES

Juvet (67) deprived cats of sleep by putting them on a floating island in a pool so that when they fell asleep they fell in and woke up.

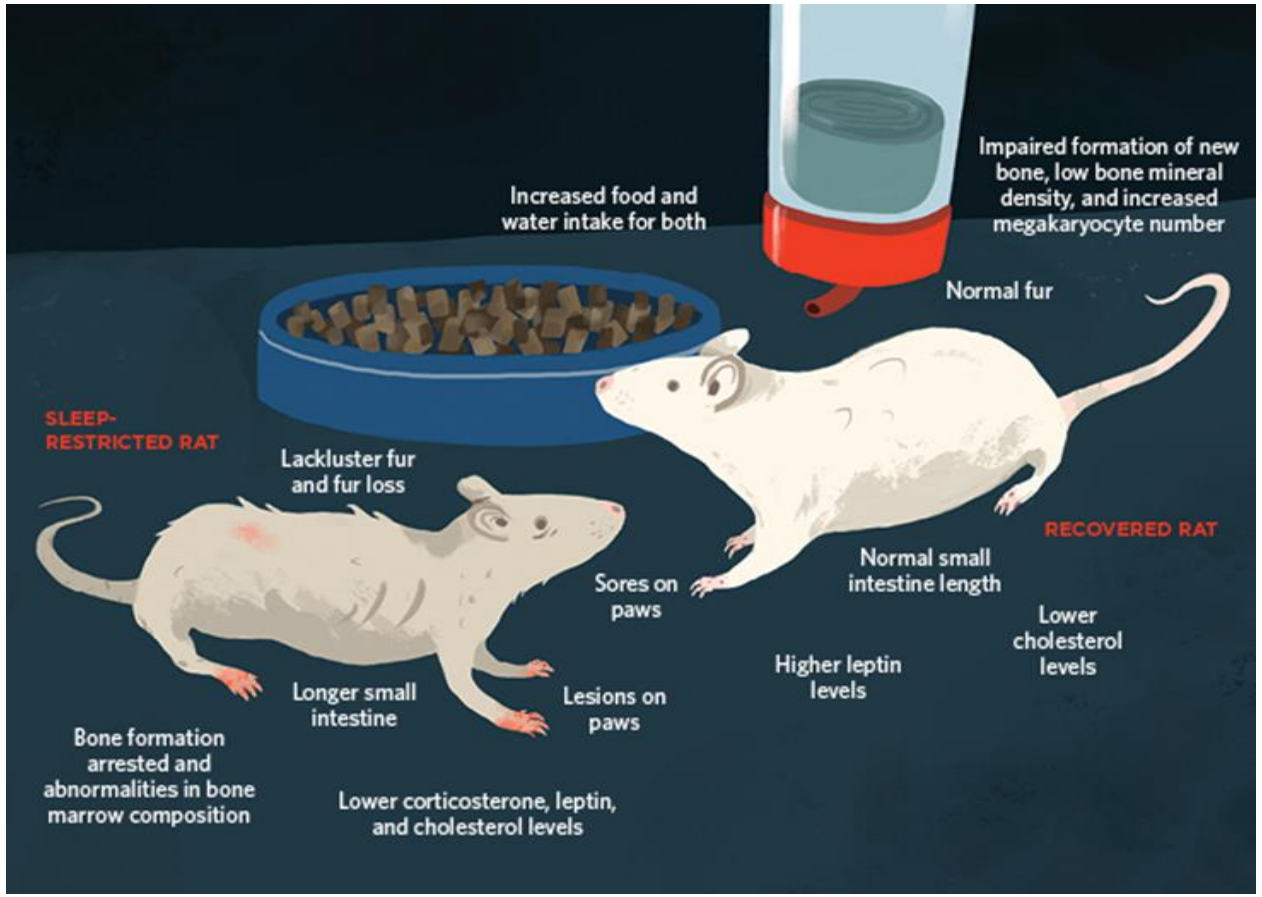
They developed abnormal behaviours and died

Rats lived on a flat circular disk above a pool of shallow water. The experimental rat was hooked up to an EEG and when it showed sleep patterns the carousel would move, causing rat to walk or fall into the water.

As long as the experimental rat was awake the other could sleep. The experimental rat died after several days.

http://henrynicholls.com/2017/05/06/the-horrors-of-sleep-deprivation/

Sleep is necessary for survival.



Sleep importance

In human studies.

- Metabolic activity of the brain decreases significantly after 24 hours of sustained wakefulness.
- A decrease in immune system function as measured by white blood cell count.
- Impairment of memory and physical performance and reduced ability to carry out mathematical calculations
- Release of growth hormone in children and young adults takes place during deep sleep
- Sleep deprivation can also cause increased heart rate variability
- Most cells of the body show increased production and reduced breakdown of proteins during deep sleep
- Maintain optimal emotional and social functioning while we are awake.

Sleep deprivation and human errors /Disasters

Chernobyl – Two drowsy plant workers died that night, 28 more in the following weeks, and over 130 were confirmed with radiation poisoning.

Three Mile Island – Sleepy shift workers didn't notice as the plant lost coolant, resulting in the overheating of the reactor's core and almost causing a melt down.

Challenger – Working long hours raised questions about critical decisions, as the space shuttle exploded seconds after launch, killing all 7 crew members.

Exxon Valdez – 1989: Supertanker runs aground, destroying wildlife and spilling 258,000 barrels of crude. Captain was allegedly sleeping at the helm.

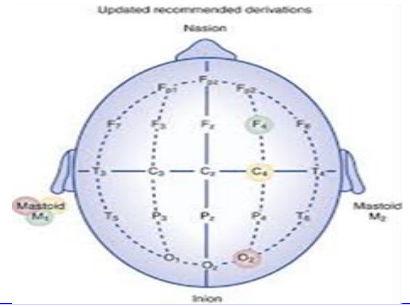
Flight 1420 – "Impaired performance from fatigue" was blamed for overshooting the runway in Little Rock, killing 11 and injuring 105 crew and passengers.

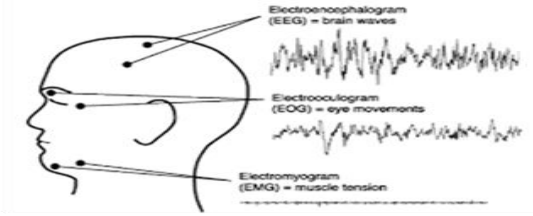
Clarkston Railway Accident – Both the engineer and conductor of train 533 had untreated symptoms of obstructive sleep apnea.

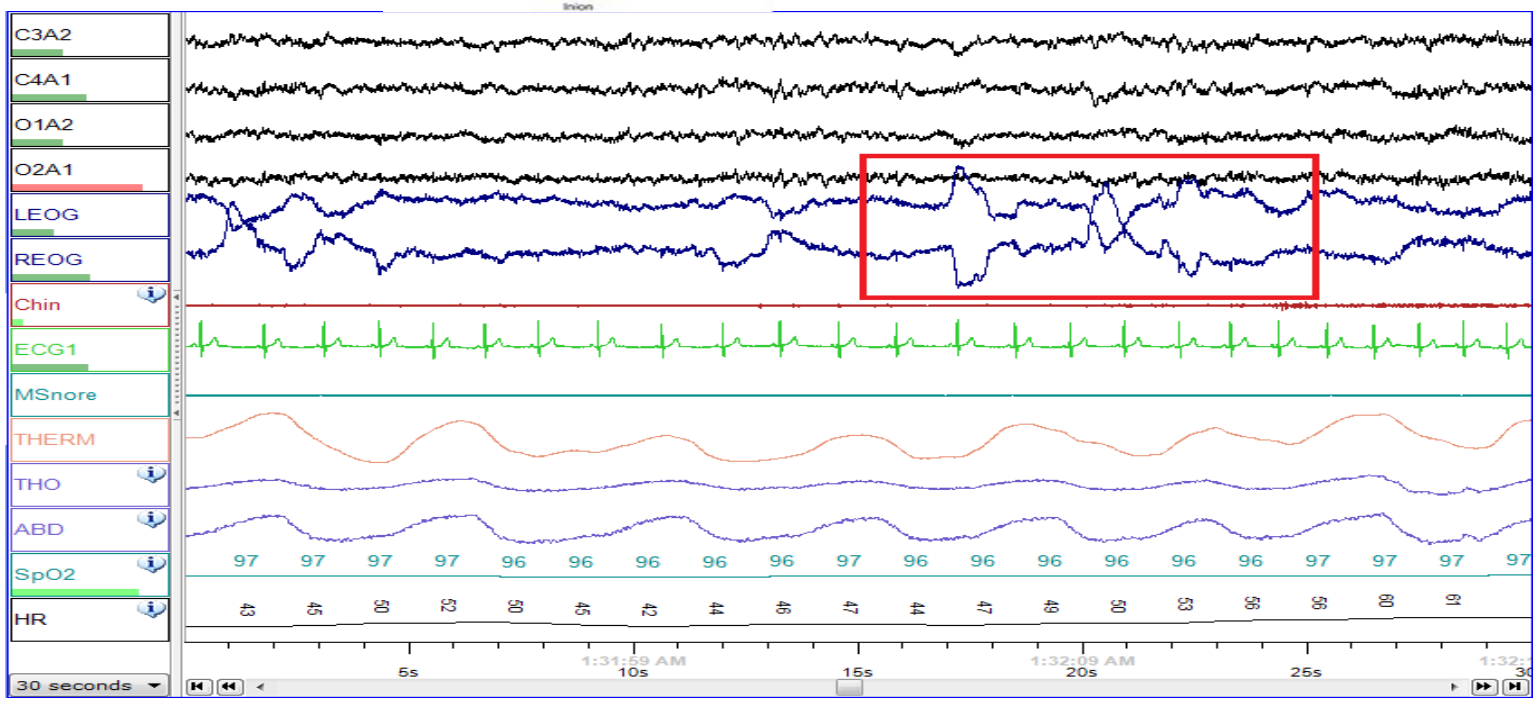
PSG

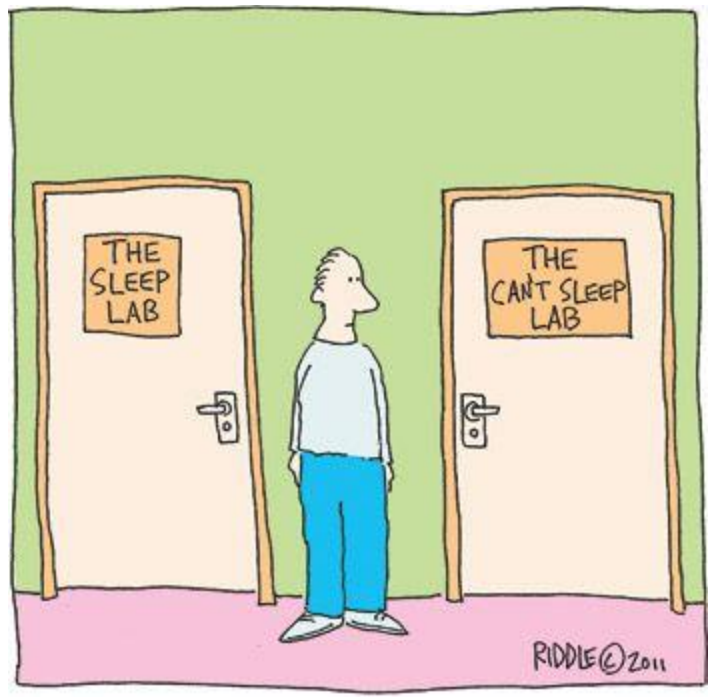
Set up and data obtained

Sleep is analyzed in 30-second epochs, each of which is categorized as rapid eye movement (REM) sleep or non-rapid eye movement (NREM) sleep.



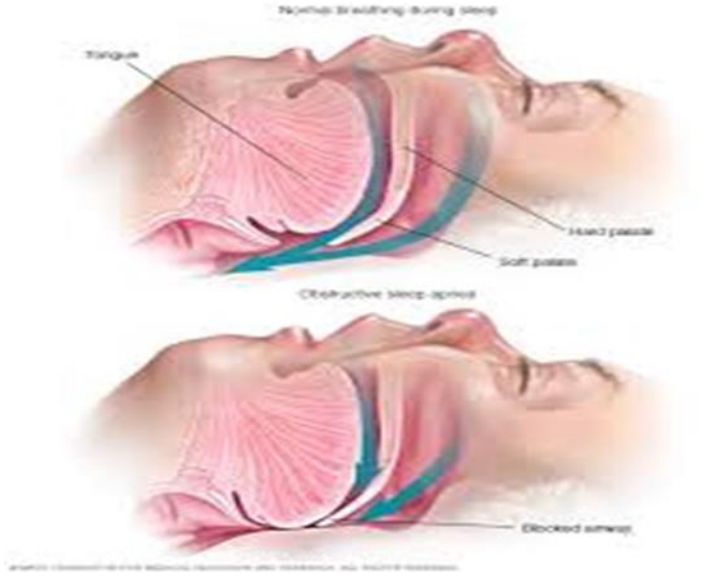


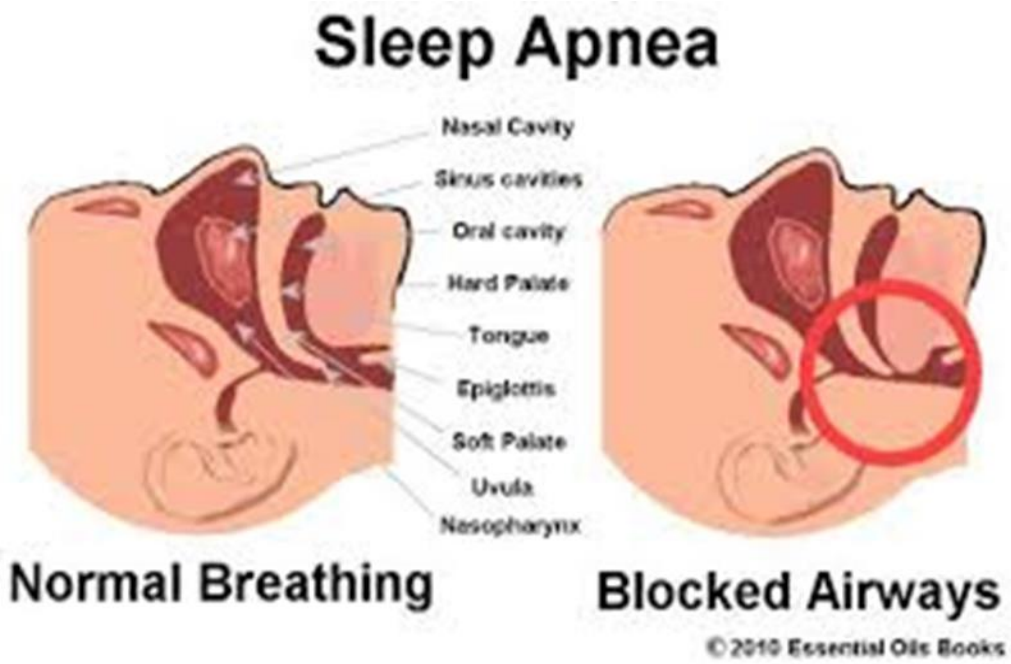




Definition

Obstructive sleep apnea (OSA) is a disorder that is characterized by obstructive apneas, hypopneas, and/or respiratory effort-related arousals caused by repetitive collapse of the upper airway during sleep. causing acute disruptions to blood oxygen levels, heart rate, blood pressure, intrathoracic pressure, and sleep quality.



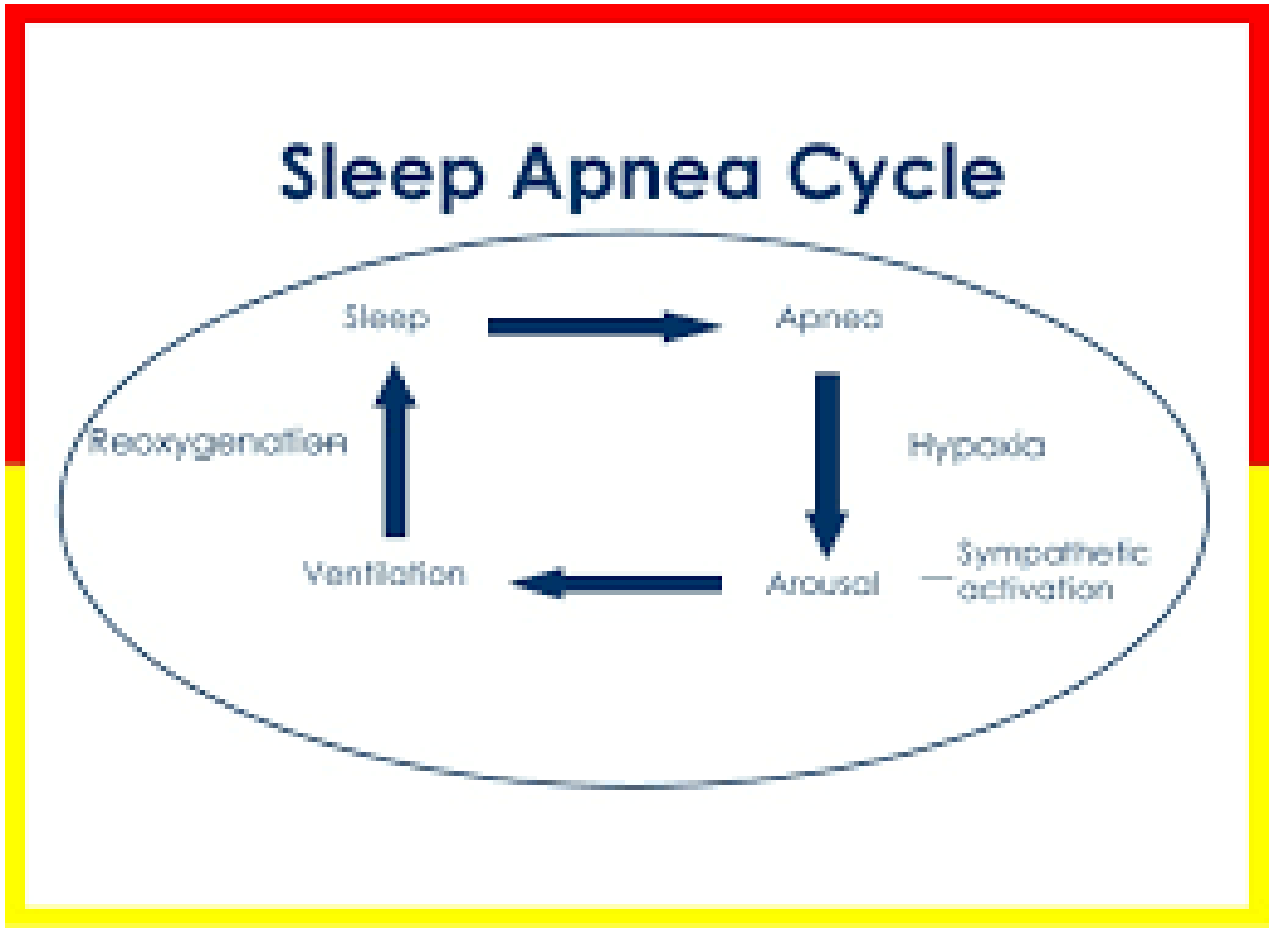


Is it common ?

- Recent estimates indicate that from 3% to 23% of women and 9% to 49% of middle-aged men have moderate to severe sleep-disordered breathing as defined by an apnea-hypopnea index (AHI) > 15 events/h.
-

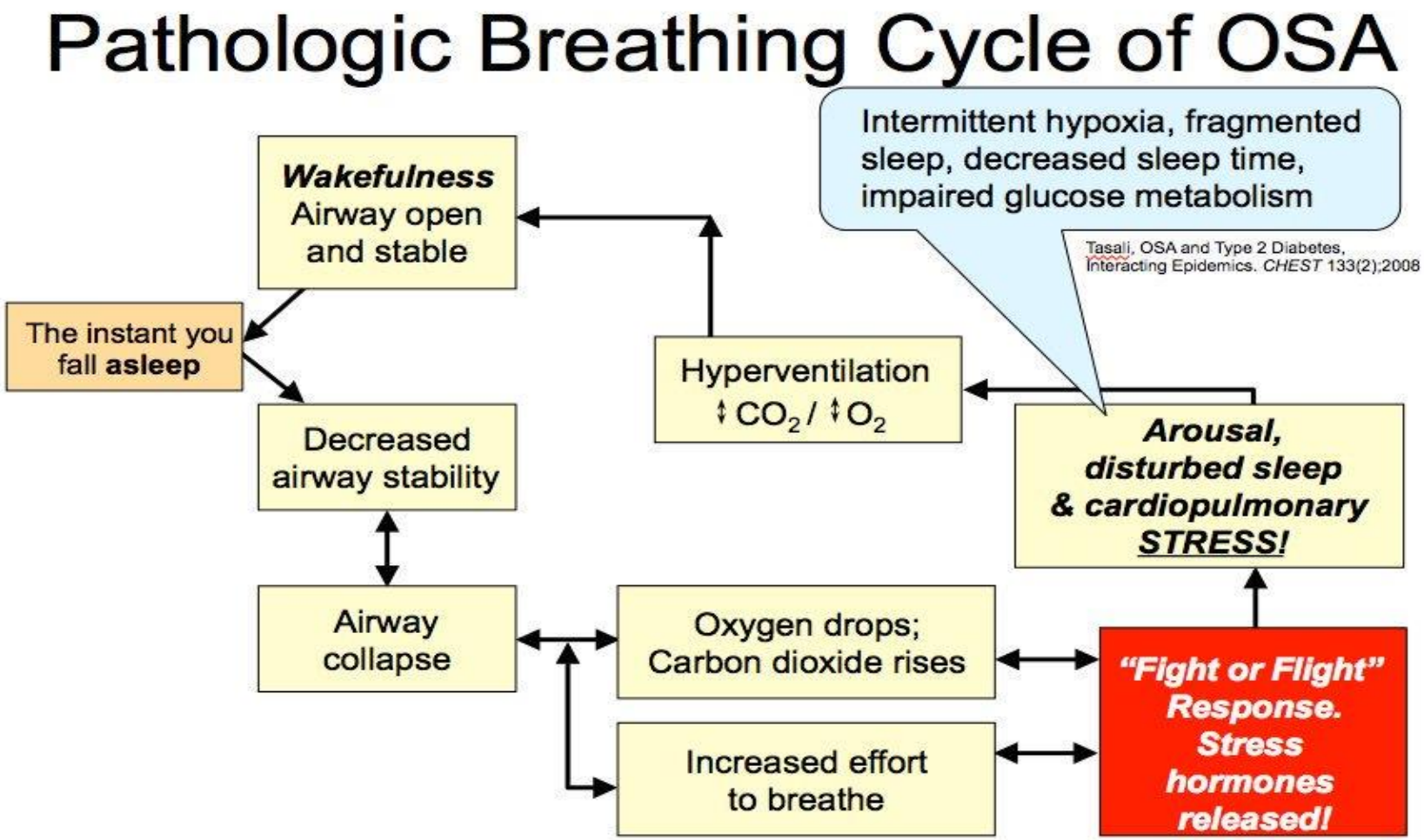
1. Heinzer R, Vat S, Marques-Vidal P, et al. Prevalence of sleep-disordered breathing in the general population: the HypnoLaus study. Lancet Respir Med. 2015.

- 2. Peppard PE, Young T, Barnet JH, Palta M, Hagen EW, Hla KM. Increased prevalence of sleep-disordered breathing in adults. Am J Epidemiol. 2013

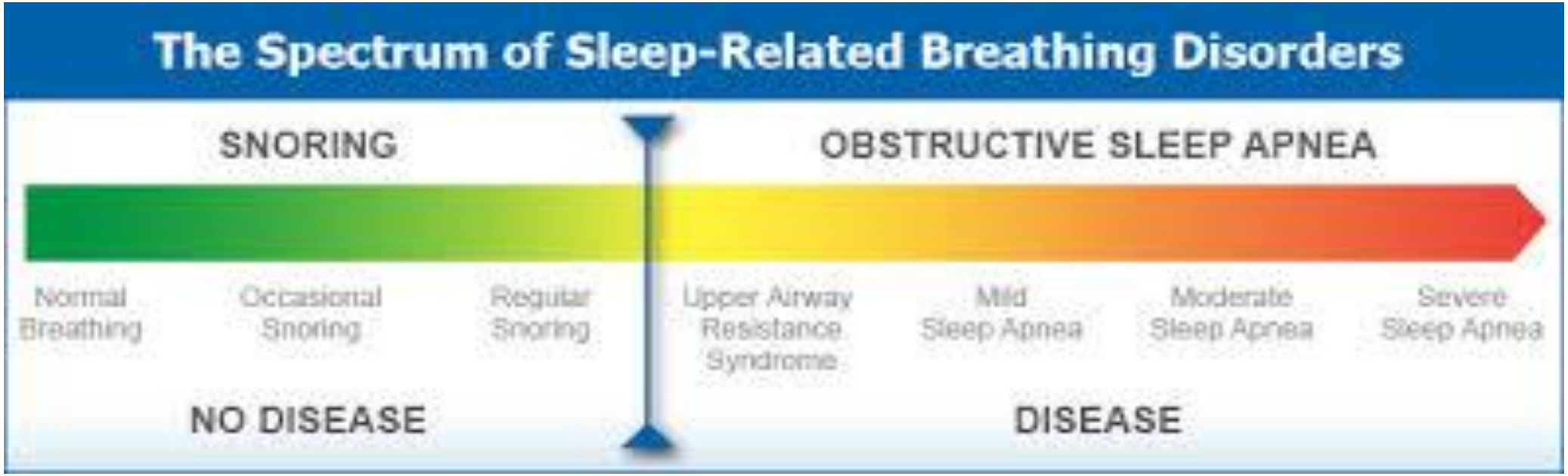


"I'm the Apnea Fairy. I have orders to give you a wake up call at 10:30, 10:47, 10:53, 11:02, 11:17, 11:26..."

Health effects

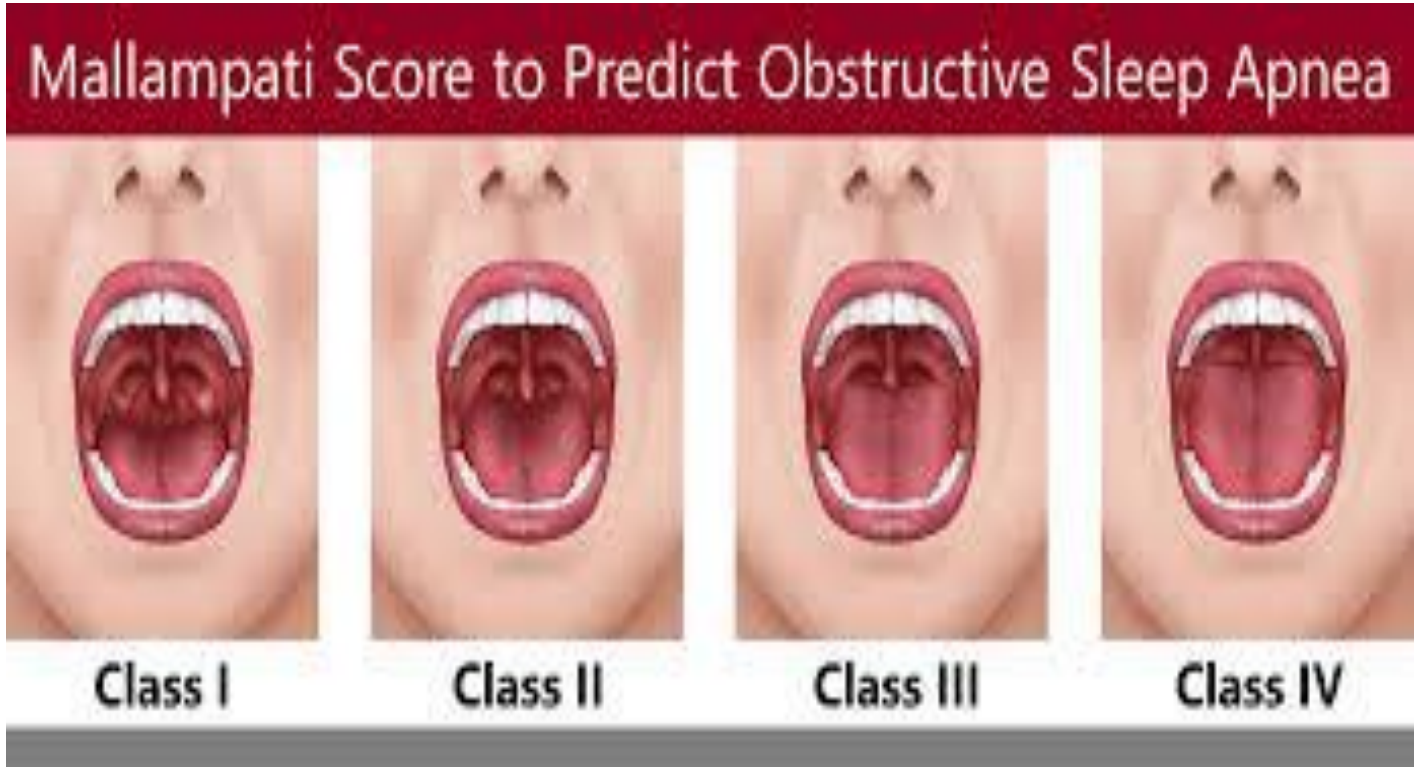


Adapted from: Leung and Bradley, Sleep Apnea and Cardiovascular Disease. *Am J Respir Crit Care Med*; 164; 2147–2165; 2001

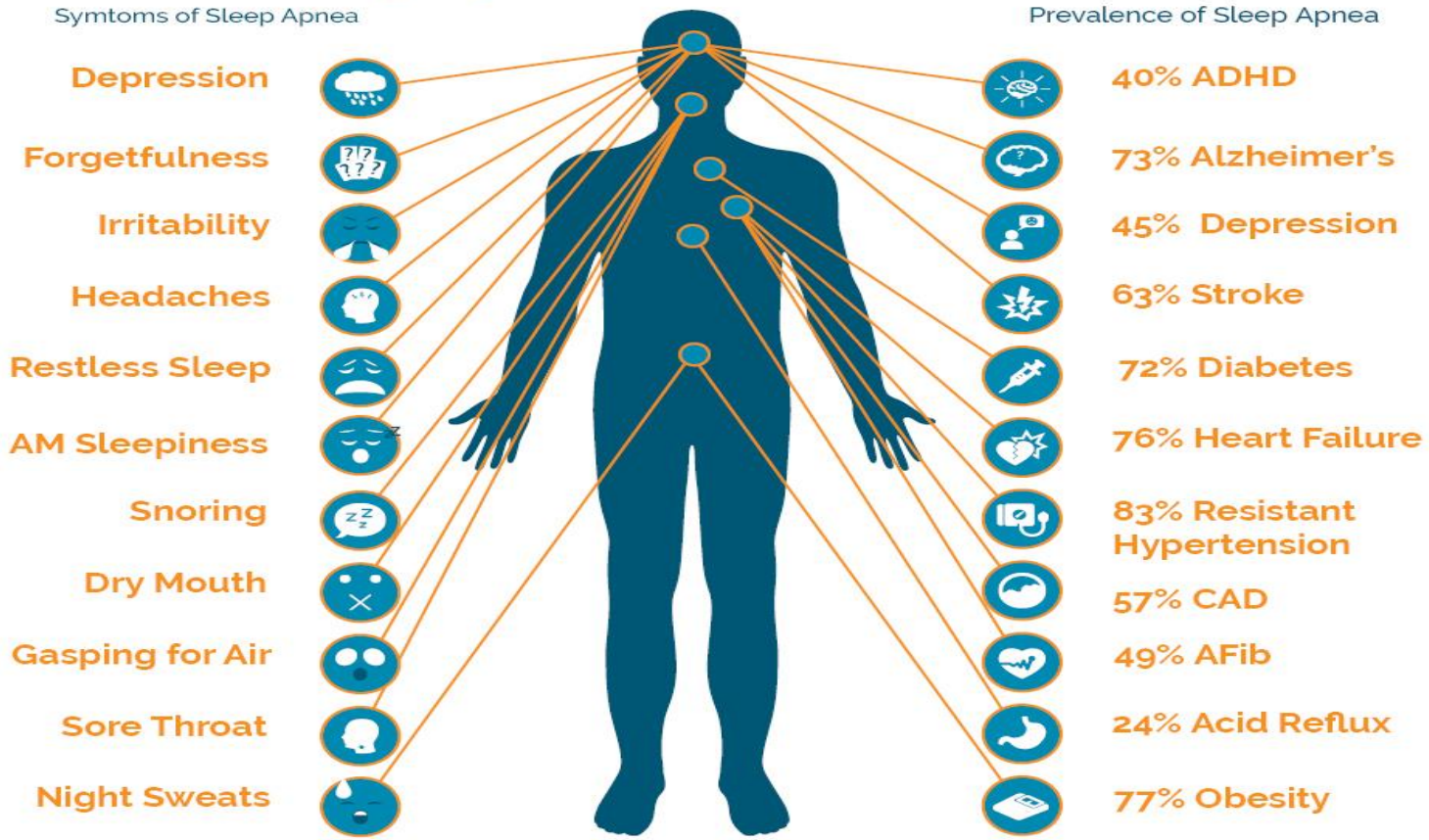

The Spectrum of Sleep-Related Breathing Disorders
SNORING
OBSTRUCTIVE SLEEP APNEA
Normal Breathing
Occasional Snoring
Regular Snoring
Upper Airway Resistance Syndrome
Mild Sleep Apnea
Moderate Sleep Apnea
Severe Sleep Apnea
NO DISEASE
DISEASE

Risk factors

Each unit increase in mallampati score has the odds of having OSA by 2.5, A study in 2006 found



Obstructive Sleep Apnea (OSA)
Common Symptoms & Associated Conditions



Statistic sources available at dreamsleep.rest/resources

Epworth sleepiness scale

Epworth Sleepiness Scale

Name: _____ Today's date: _____

Your age (Yrs): _____ Your sex (Male = M, Female = F): _____

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired?

This refers to your usual way of life in recent times.

Even if you haven't done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the **most appropriate number** for each situation:

0 = would **never** doze
1 = **slight chance** of dozing
2 = **moderate chance** of dozing
3 = **high chance** of dozing

It is important that you answer each question as best you can.

Situation	**Chance of Dozing (0-3)**
Sitting and reading	___
Watching TV	___
Sitting, inactive in a public place (e.g. a theatre or a meeting)	___
As a passenger in a car for an hour without a break	___
Lying down to rest in the afternoon when circumstances permit	___
Sitting and talking to someone	___
Sitting quietly after a lunch without alcohol	___
In a car, while stopped for a few minutes in the traffic	___

THANK YOU FOR YOUR COOPERATION

Situation	Chance of dozing			
Sitting and reading	0	1	2	3
Watching TV	0	1	2	3
Sitting inactive in a public place (e.g. movie theatre or a meeting)	0	1	2	3
As a passenger in a car for an hour without a break	0	1	2	3
Lying down to rest in the afternoon when circumstances permit	0	1	2	3
Sitting and talking to someone	0	1	2	3
Sitting quietly after lunch	0	1	2	3
Sitting quietly after lunch	0	1	2	3

STOPBANG

STOP Questionnaire

- Snoring
- Tiredness
- Observed you stop breathing
- Blood Pressure

BANG

- BMI >35
- Age >50
- Neck circumference >40 cm (>15.7")
- Gender male

High risk: Yes to ≥3 items → Refer for sleep testing

STOB BANG questionnaire

Sensitivity of STOPBANG score of 3 or more to detect moderate to severe OSA is 93% and severe OSA is 100%.

NPP are 90% and 100% .

0-2: low risk for moderate to severe OSA

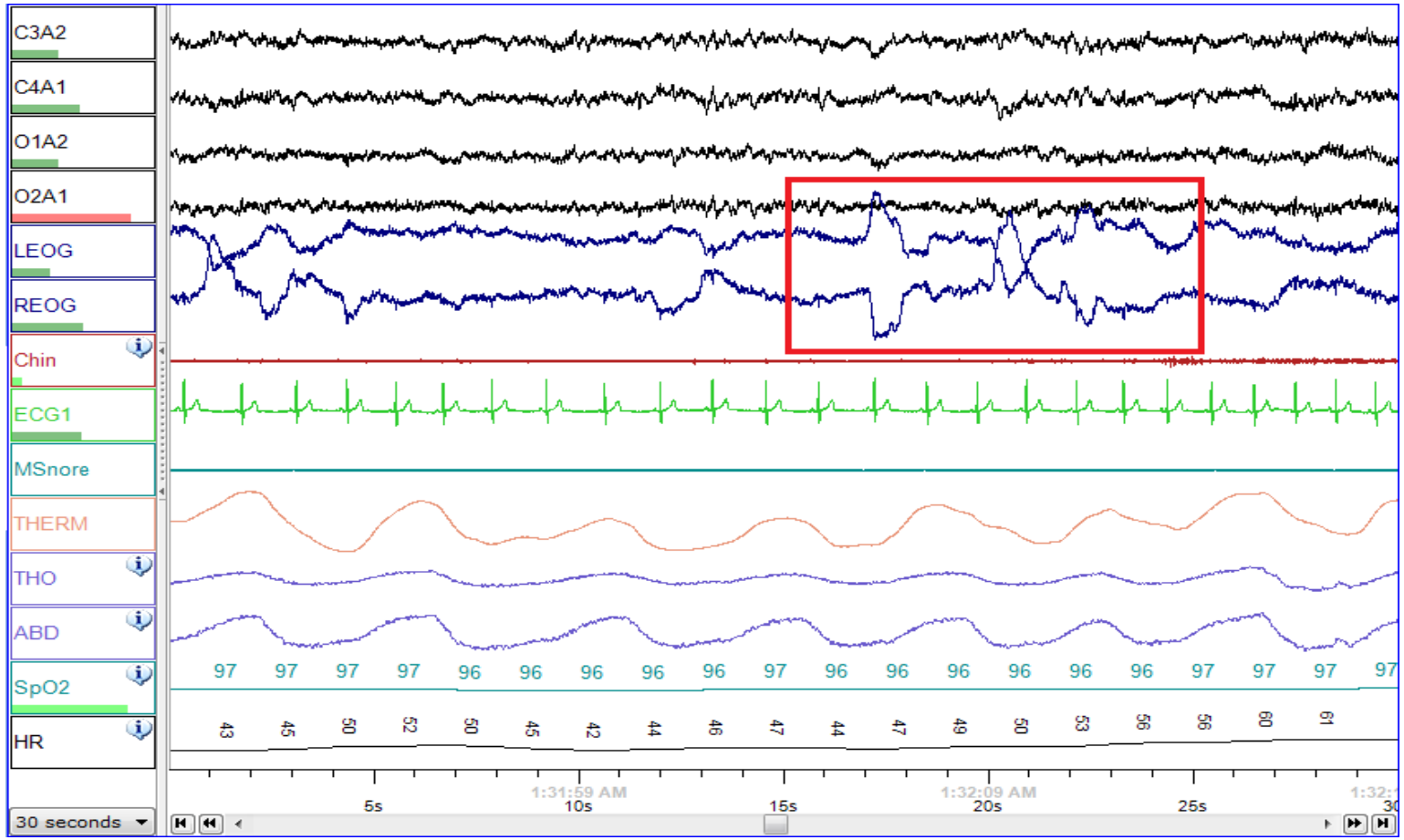
5-8 : high risk for moderate to severe OSA

3-4 :Further criteria are required like if BMI is more than 35 then risk increases .

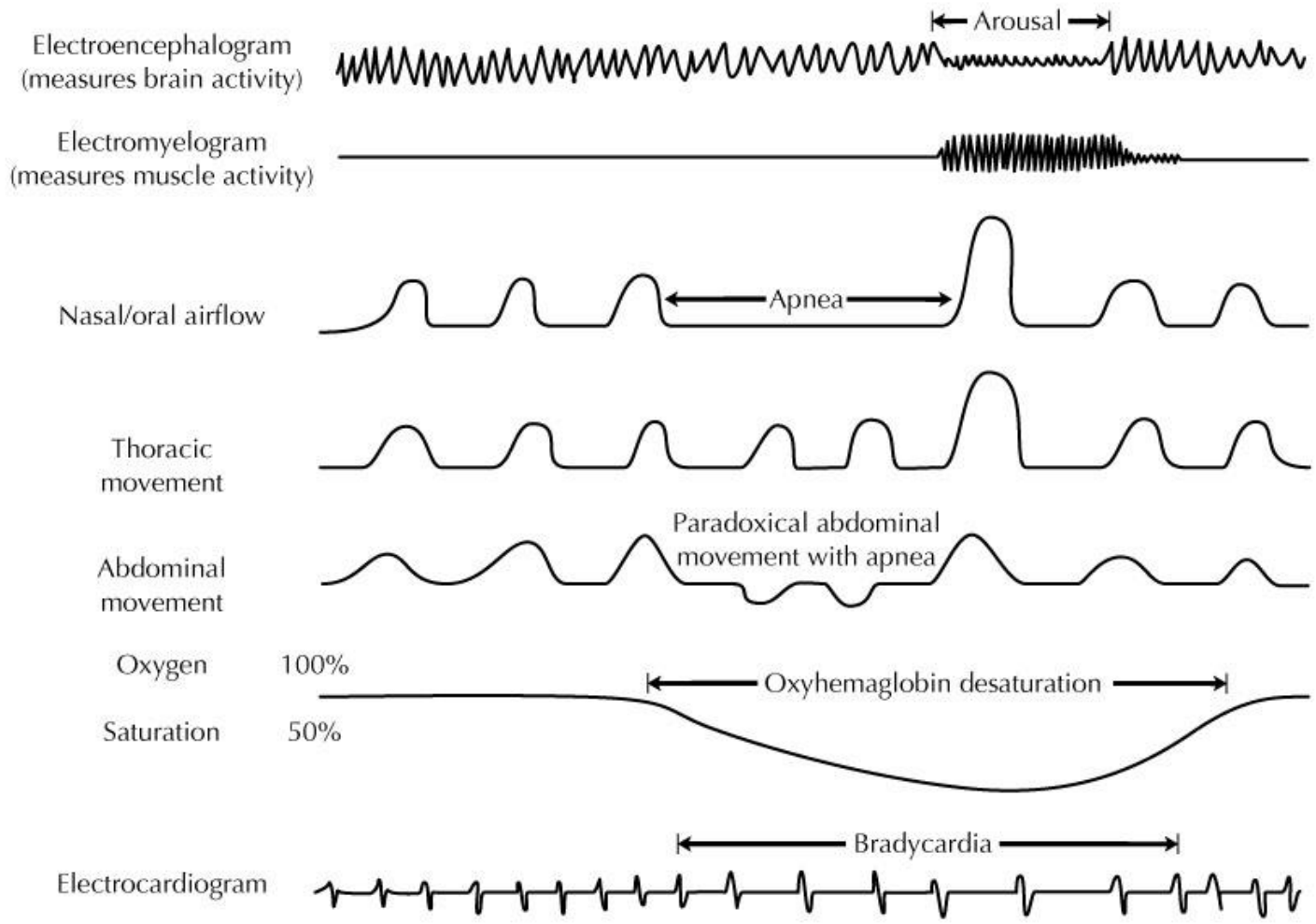
Diagnosis

- Polysymnography .PSG
- Home sleep test
- Oximetry

PSG


C3A2
C4A1
O1A2
O2A1
LEOG
REOG
Chin
ECG1
MSnore
THERM
THO
ABD
SpO2
HR
30 seconds
97 97 97 97 96 96 96 96 96 97 96 96 96 96 96 96 97 97 97 97
43 45 50 52 50 45 42 44 46 47 44 47 49 50 53 56 56 60 61
1:31:59 AM
1:32:09 AM
5s
10s
15s
20s
25s

Polysomnogram (PSG)



Warvedaker NV et al. Best Practice of Medicine. Sept. 1999

Scoring respiratory events

- **Apnea** : 90% or more reduction in airflow or complete cessation of air flow for 10 seconds.

  Oxygen desaturation is not a criteria.

- **Obstructive apnea**: Apnea with evidence of continued respiratory effort i.e, Chest movement persists
- **Central apnea** : Apnea with absent respiratory effort .i.e, No chest movement .
- **Mixed apnea**: if inspiratory effort is absent at the beginning of the event but resumes in the second portion of the event .

Scoring Criteria: Respiratory Events

- Hypopnea definition
- ↓ 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.

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

✓ *Requires EEG monitoring*

AASM Scoring Manual Version 2.1, 2014

In-lab PSG Data

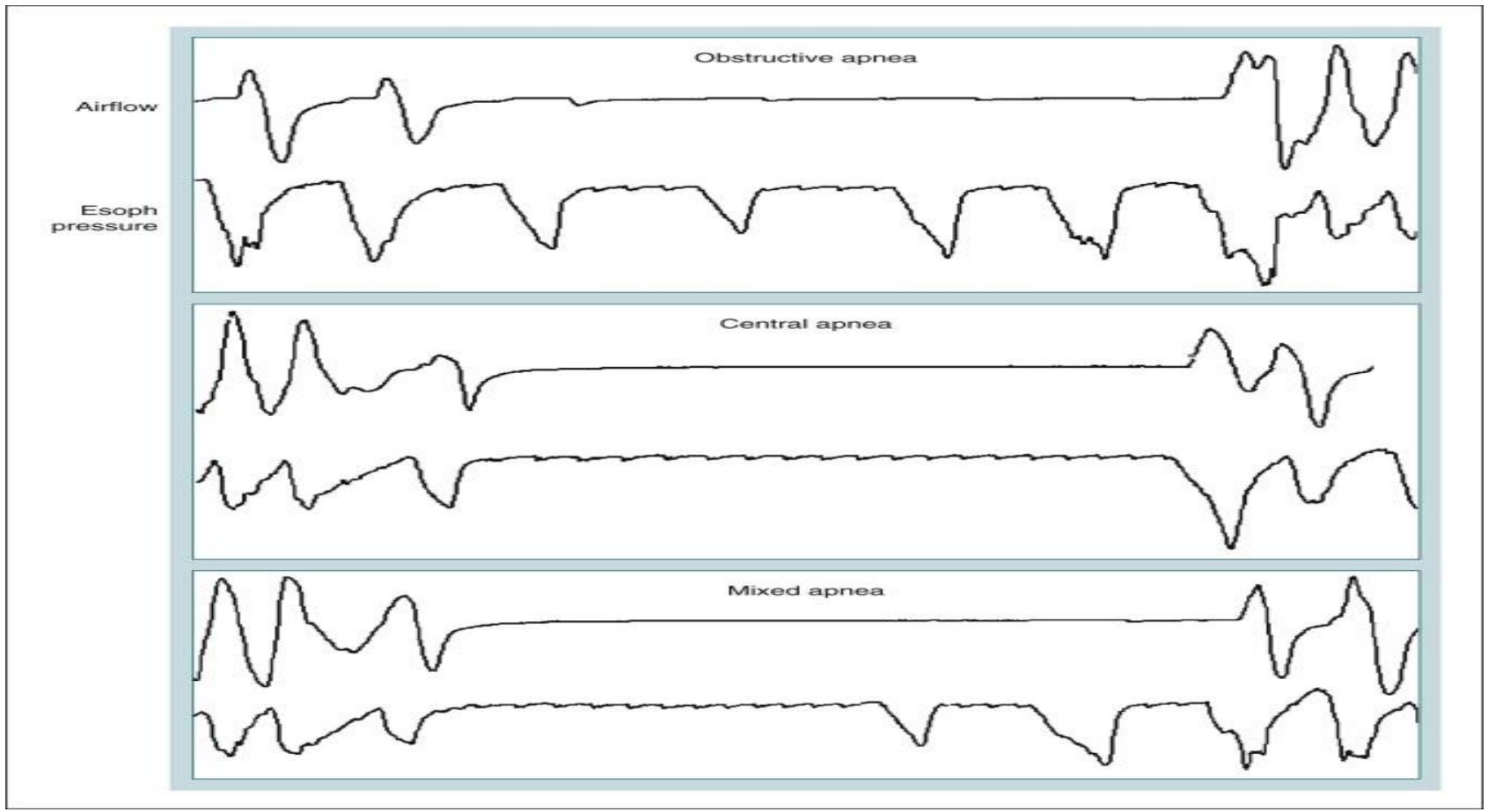
EEG Data:

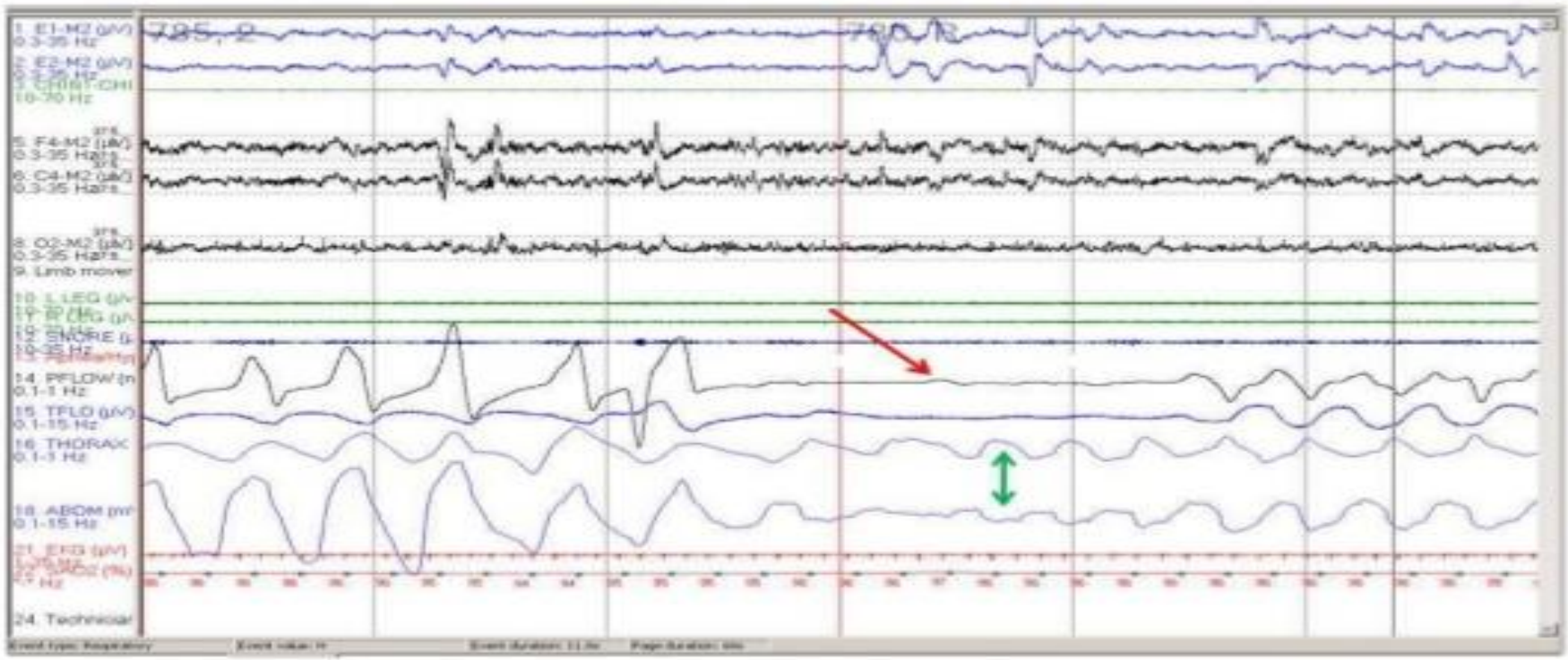
- Sleep efficiency & latency
  - Normal 80% efficient.
- Sleep stages & architecture
  - Normal about 5% stage N1, 50% N2, 20% N3 (slow wave sleep) and 20-25% REM
- Arousal Index (AI): sleep disruption
  - Normal AI < 10-25 (large variation by age)

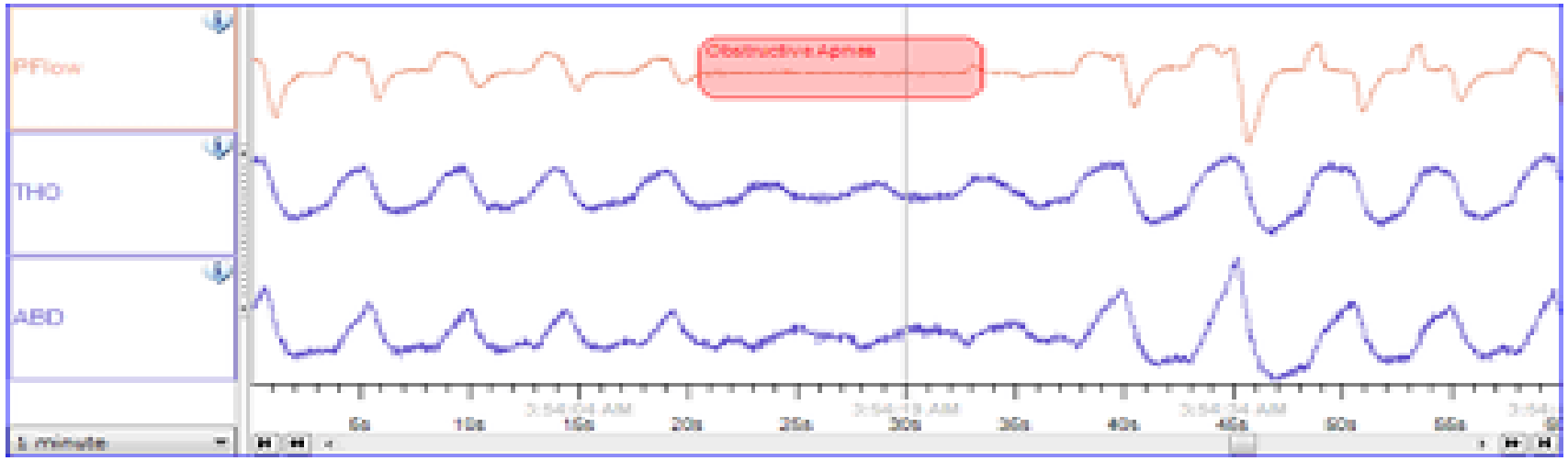
Apnea Hypopnea Index

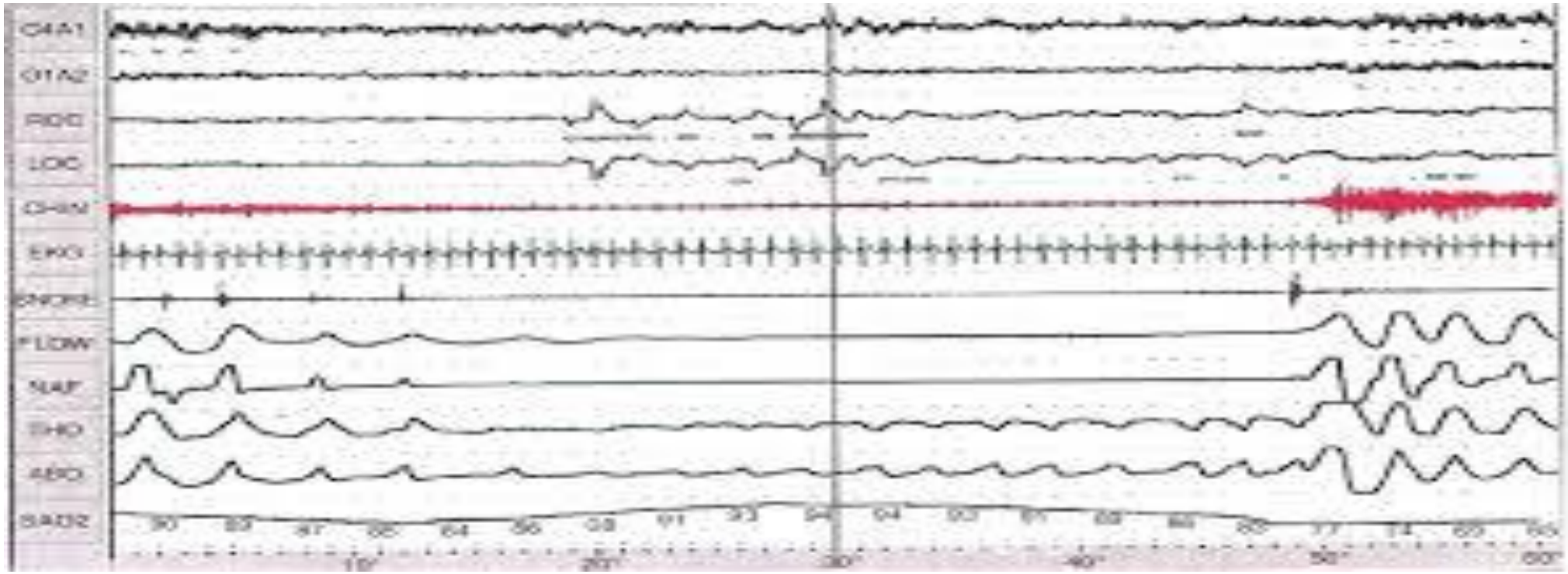
- AHI = (# apneas + # hypopneas) / sleep hours
  - AHI < 5: normal
  - AHI 5 – 15 :mild
  - AHI 15 –29 :moderate
  - AHI 30 or above : severe

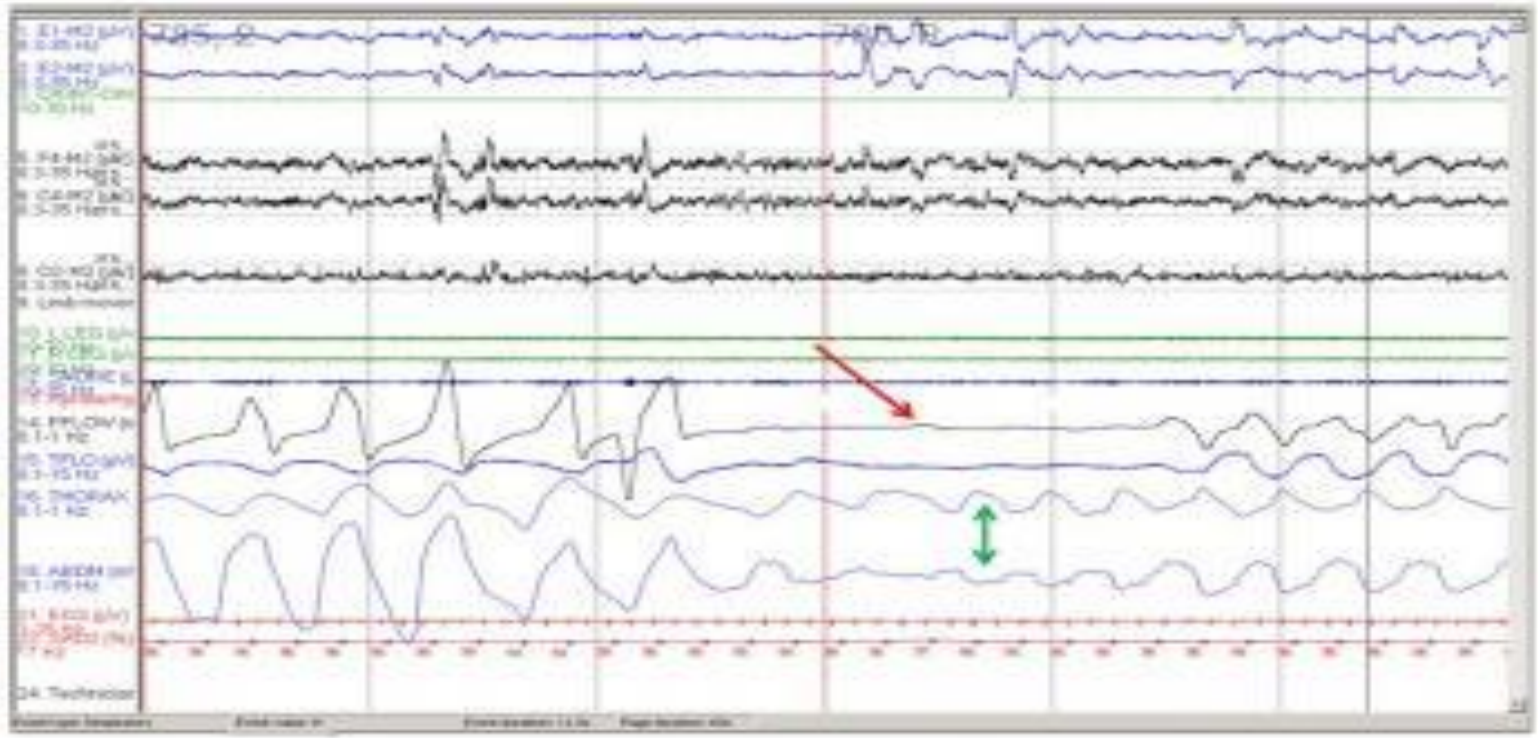
- RDI = (# apneas + # hypopneas + # RERAs) / sleep hours

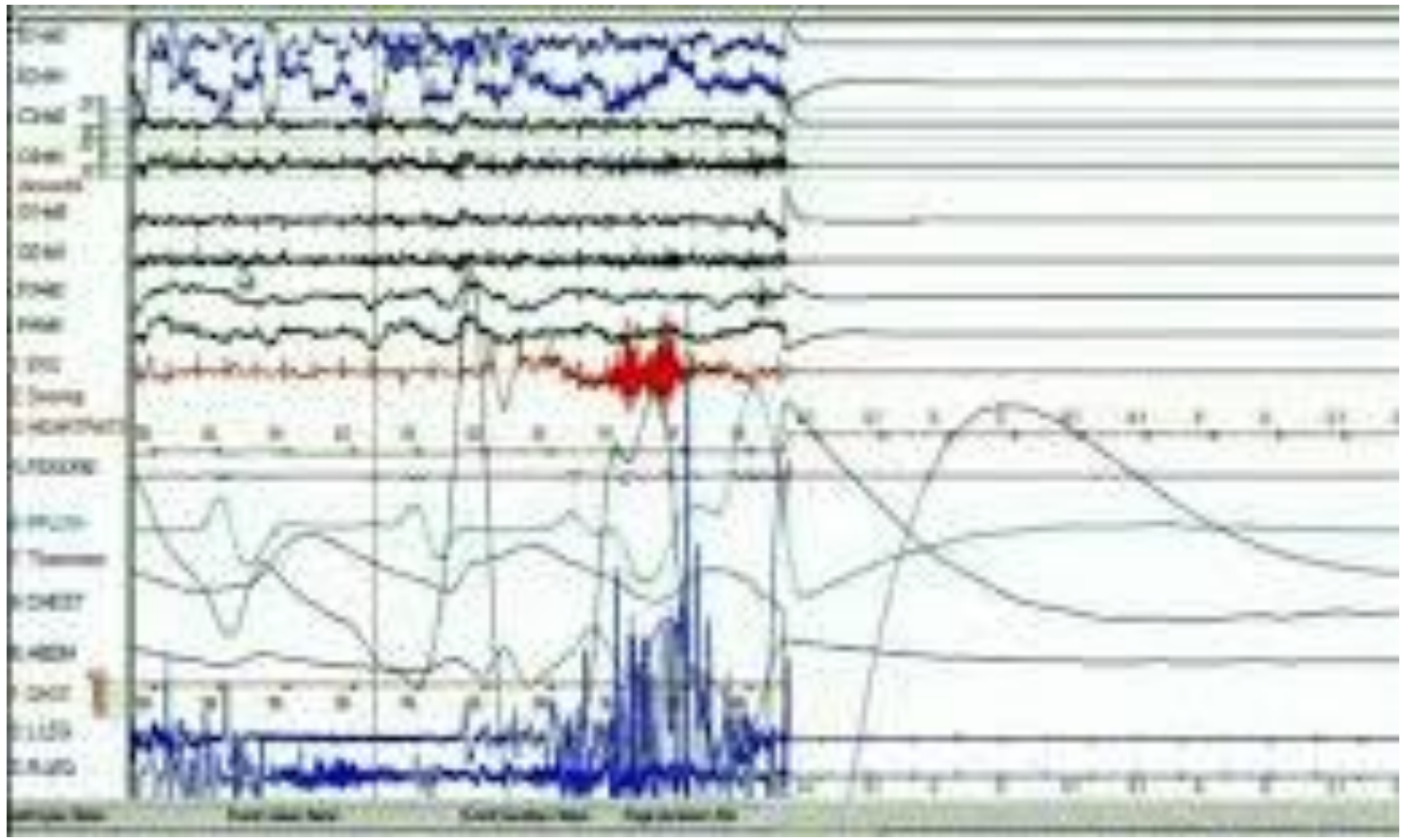

Airflow
Esoph pressure
Obstructive apnea
Central apnea
Mixed apnea

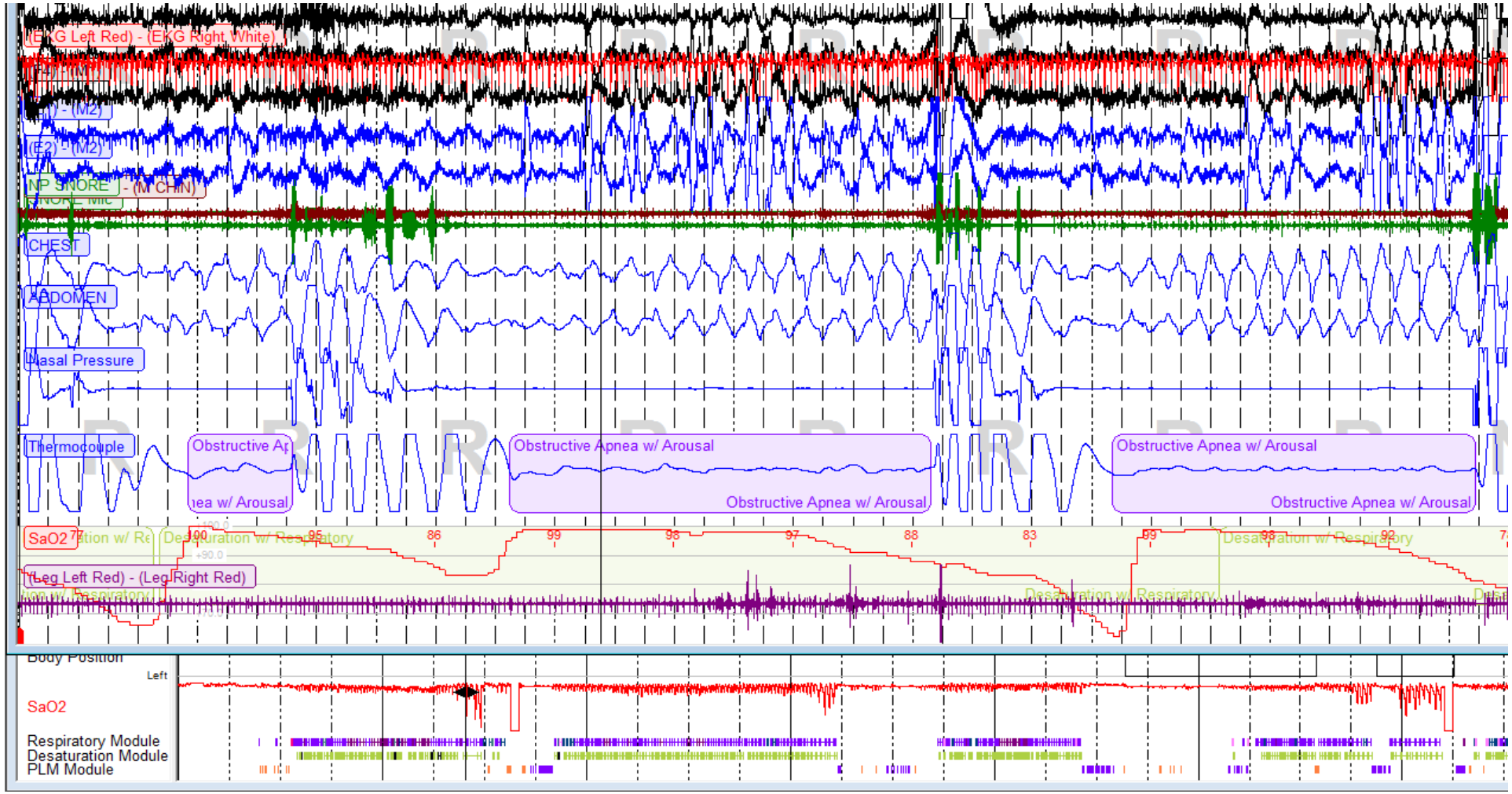

1. E1-M2 (µV)
0.3-35 Hz
2. E2-M2 (µV)
0.3-35 Hz
3. CHIN1-CHI
10-70 Hz
5. F4-M2 (µV)
0.3-35 Hz
6. C4-M2 (µV)
0.3-35 Hz
8. O2-M2 (µV)
0.3-35 Hz
9. Limb mover
14. PFLOW (n
0.1-1 Hz
15. TFLO (µV)
0.1-15 Hz
16. THORAX
0.1-1 Hz
18. ABDM (nr
0.1-15 Hz
21. EKG (µV)
24. Technician


PFlow
THO
ABD
Obstructive Apnea
1 minute


C4A1
O1A2
ROC
LOC
CHIN
EKG
SNORE
FLOW
NAF
THO
ABD
SAO2

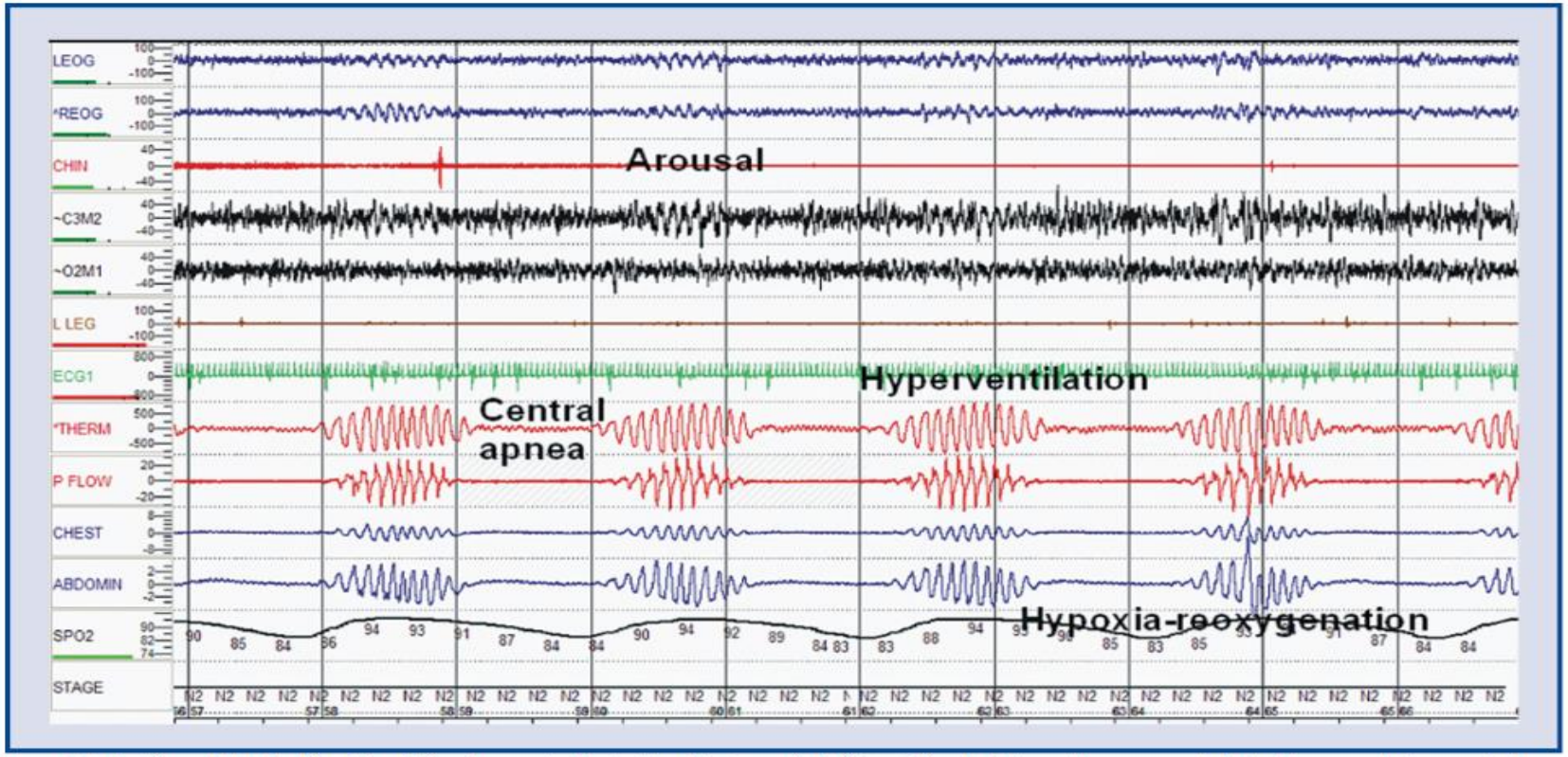





(EKG Left Red) - (EKG Right White)
(E1) - (M2)
(E2) - (M2)
NP SNORE - (M CHIN)
CHEST
ABDOMEN
Nasal Pressure
Thermocouple
Obstructive Apnea w/ Arousal
Obstructive Apnea w/ Arousal
Obstructive Apnea w/ Arousal
Obstructive Apnea w/ Arousal
SaO2
Desaturation w/ Respiratory
(Leg Left Red) - (Leg Right Red)
Desaturation w/ Respiratory
Body Position
Left
SaO2
Respiratory Module
Desaturation Module
PLM Module

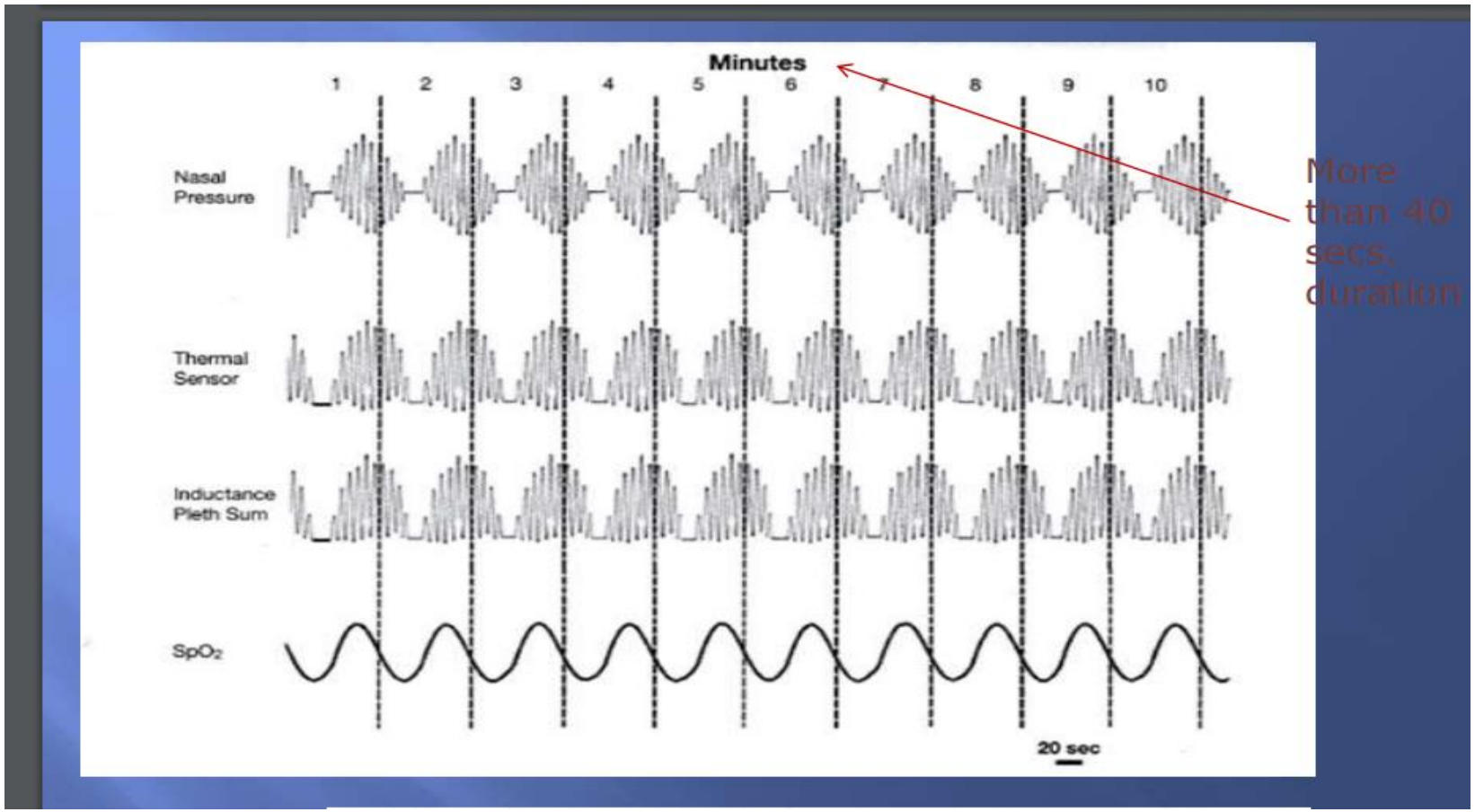
crescendo decrescendo changes in tidal breathing which sandwich central apneas.

note that arousals occur at the peak of hyperventilation. This contrasts with the arousals occurring at the termination of obstructive apneas

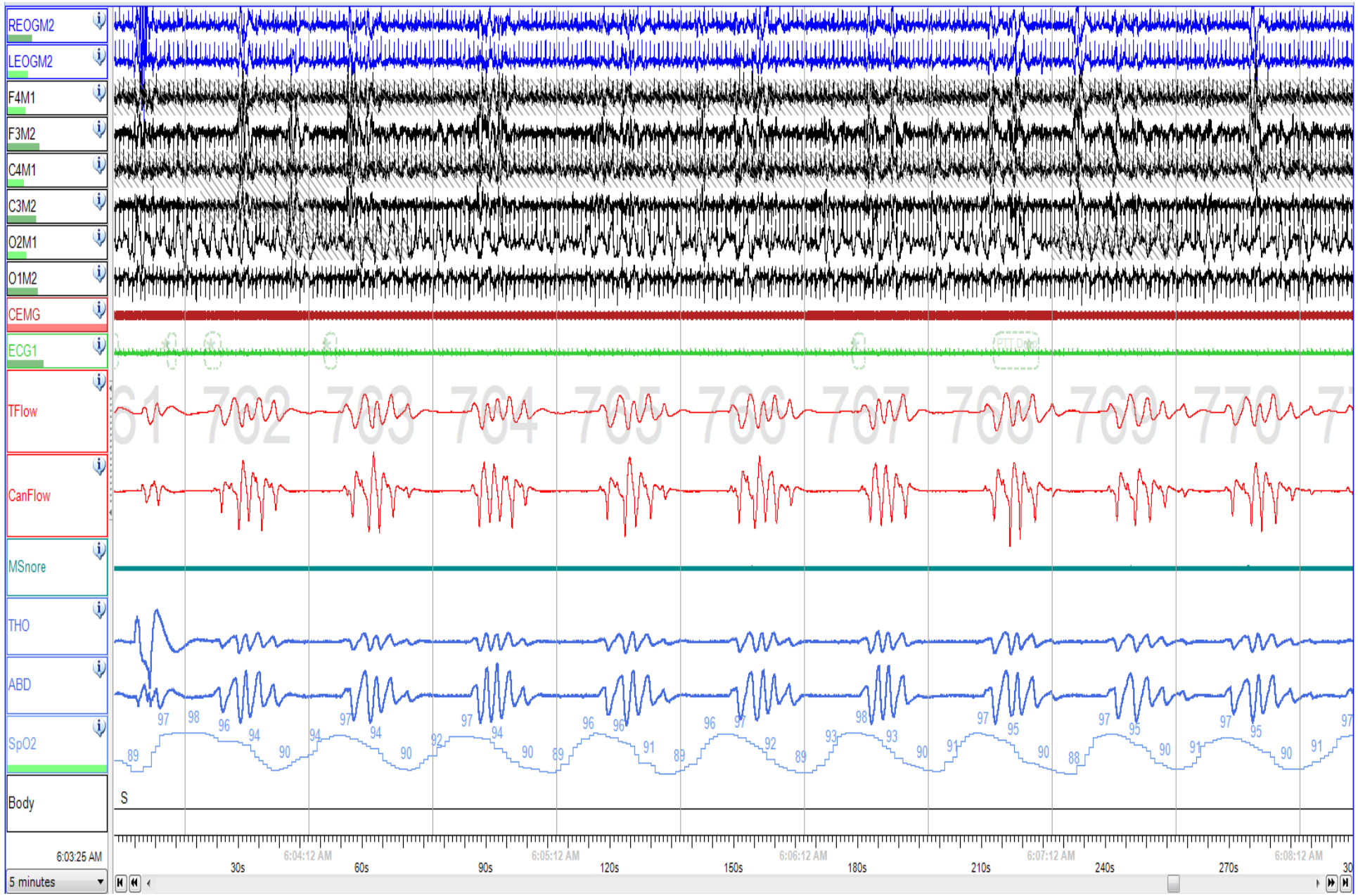


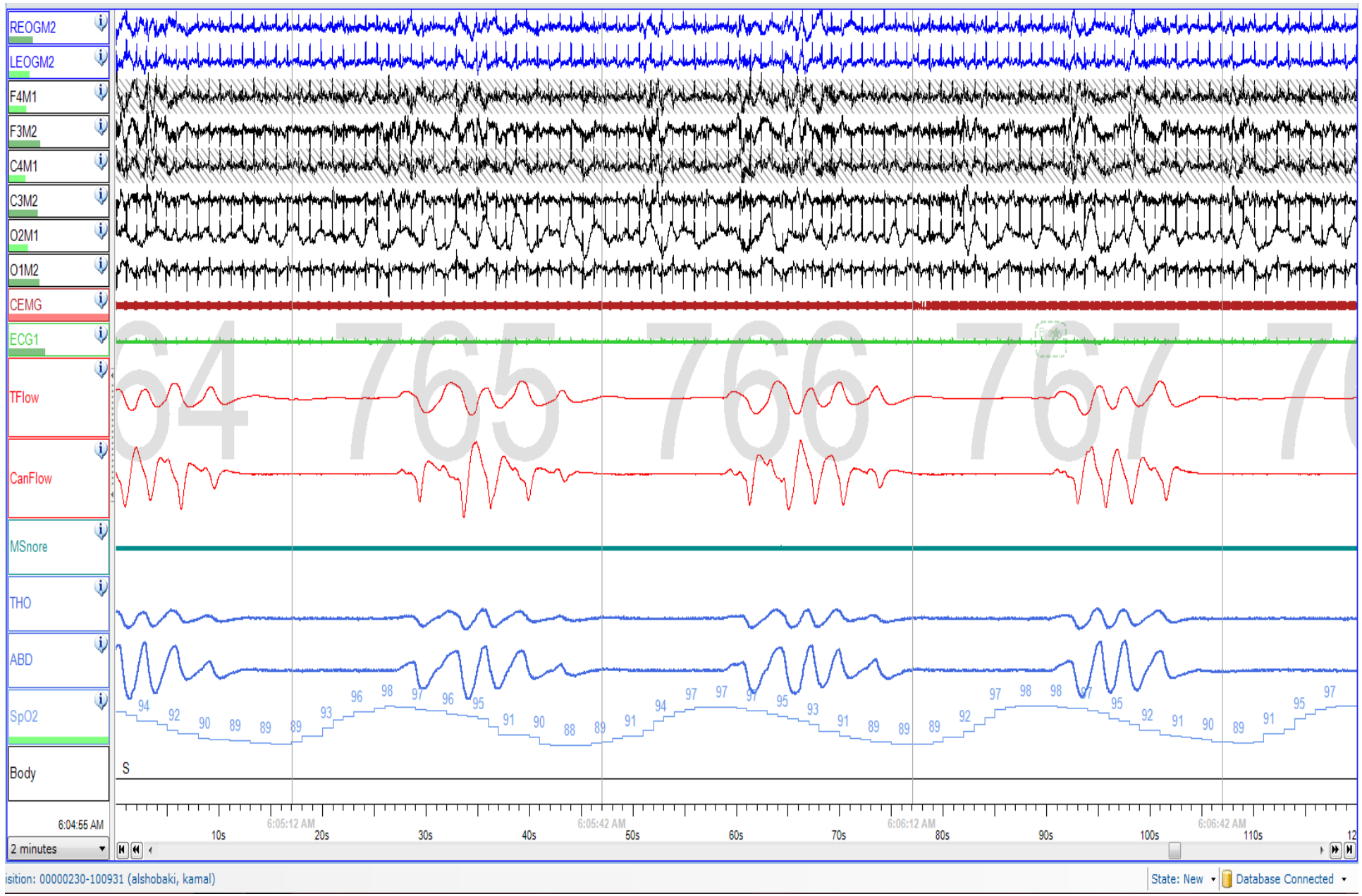
Cheyne-Stokes Breathing

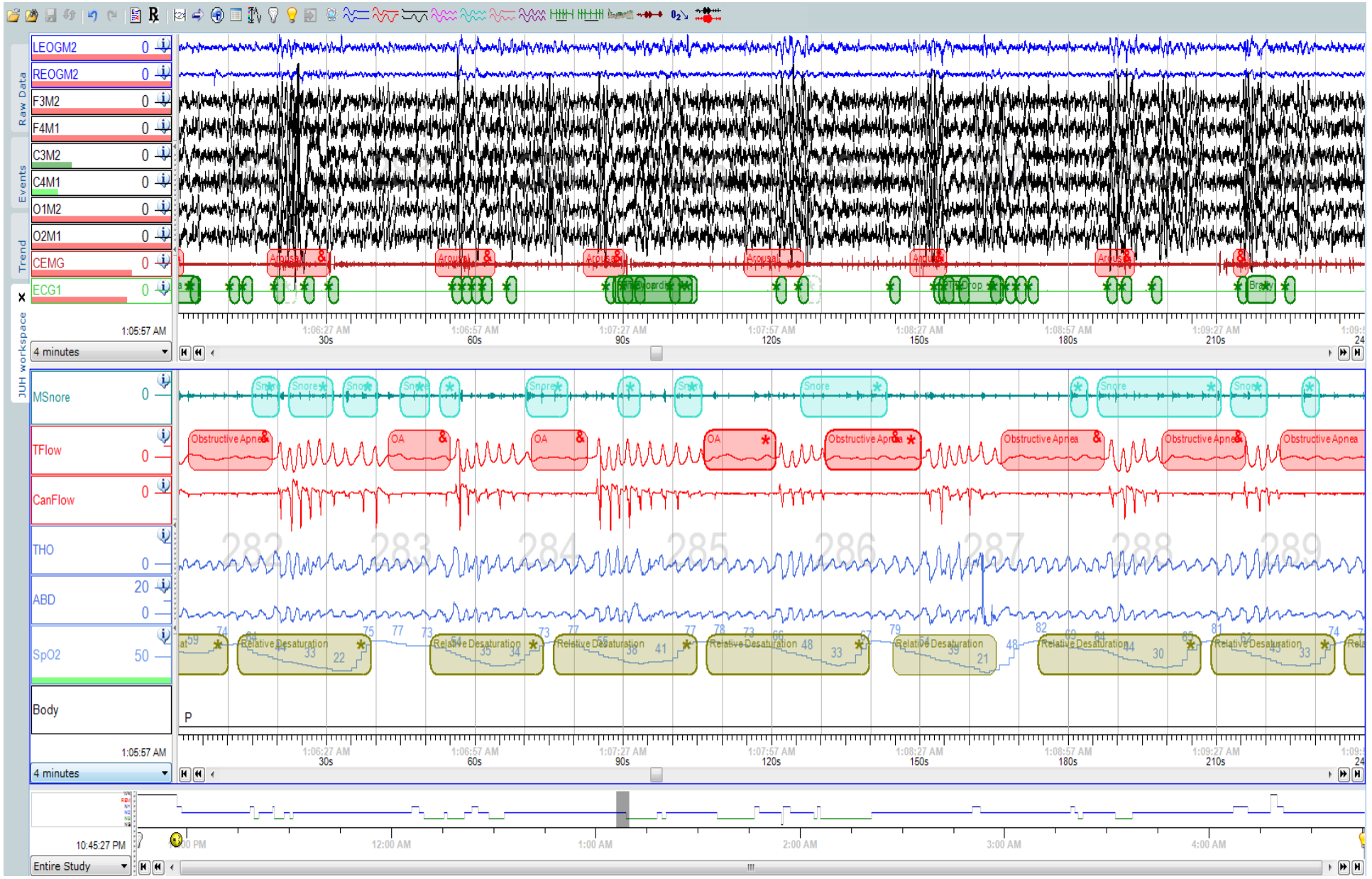
- pisodes of ≥3 consecutive central apneas and/or central hypopneas separated by a crescendo and decrescendo change in breathing amplitude .
- ≥5 central apneas and/or central hypopneas per hour of sleep associated with the crescendo/decrescendo breathing pattern recorded over ≥2 hours of monitoring with a cycle length of ≥40 seconds.

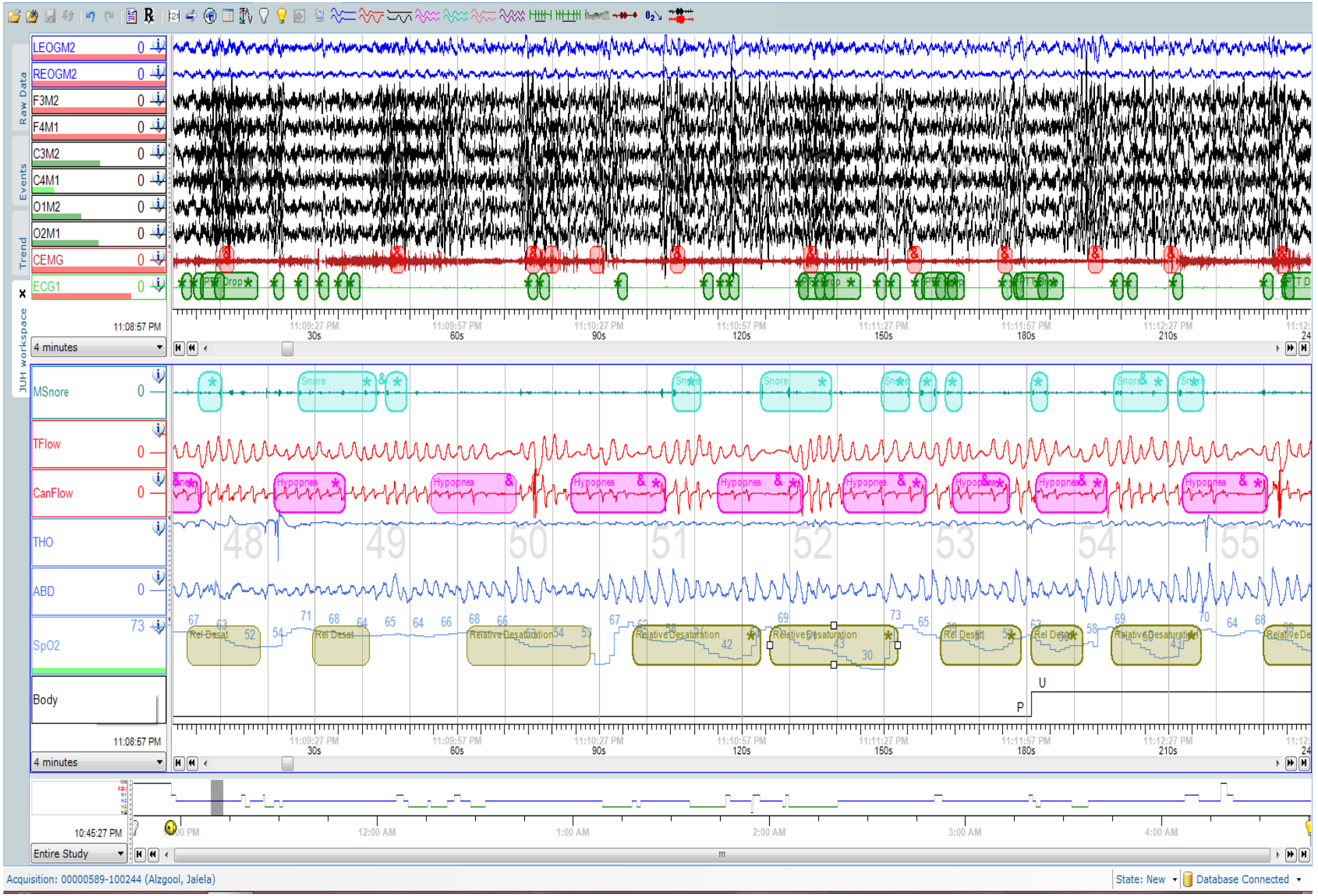

Minutes
1
2
3
4
5
6
7
8
9
10
Nasal Pressure
Thermal Sensor
Inductance Pleth Sum
SpO2
20 sec
More than 40 secs. duration

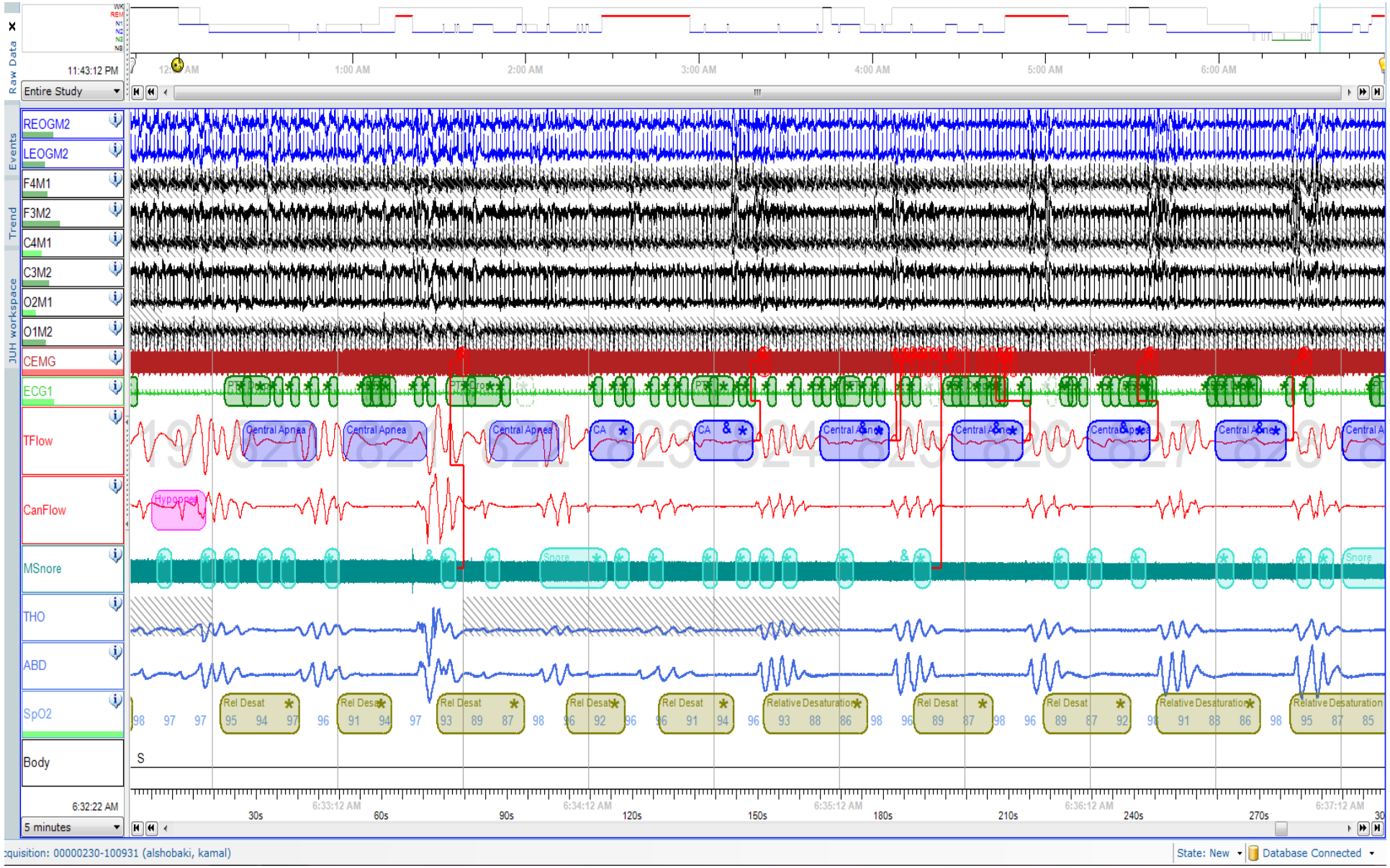
Data from JUH sleep lab


REOGM2
LEOGM2
F4M1
F3M2
C4M1
C3M2
O2M1
O1M2
CEMG
ECG1
TFlow
CanFlow
MSnore
THO
ABD
SpO2
Body
S
6:03:25 AM
5 minutes
30s
60s
90s
120s
150s
180s
210s
240s
270s
6:04:12 AM
6:05:12 AM
6:06:12 AM
6:07:12 AM
6:08:12 AM


REOGM2
LEOGM2
F4M1
F3M2
C4M1
C3M2
O2M1
O1M2
CEMG
ECG1
TFlow
CanFlow
MSnore
THO
ABD
SpO2
Body
S
6:04:55 AM
2 minutes
6:05:12 AM
6:05:42 AM
6:06:12 AM
6:06:42 AM
10s
20s
30s
40s
50s
60s
70s
80s
90s
100s
110s
State: New
Database Connected


Raw Data
Events
Trend
JUH workspace
LEOGM2 0
REOGM2 0
F3M2 0
F4M1 0
C3M2 0
C4M1 0
O1M2 0
O2M1 0
CEMG 0
ECG1 0
1:05:57 AM
4 minutes
MSnore 0
TFlow 0
CanFlow 0
THO 0
ABD 20 0
SpO2 50
Body
1:05:57 AM
4 minutes
10:45:27 PM
Entire Study
Arousal
Snore
Obstructive Apnea
OA
Relative Desaturation
P


LEOGM2
REOGM2
F3M2
F4M1
C3M2
C4M1
O1M2
O2M1
CEMG
ECG1
Raw Data
Events
Trend
JUH workspace
11:08:57 PM
4 minutes
MSnore
TFlow
CanFlow
THO
ABD
SpO2
Body
Snore
Hypopnea
Rel Desat
Relative Desaturation
10:45:27 PM
Entire Study
Acquisition: 00000589-100244 (Alzgool, Jalela)
State: New
Database Connected

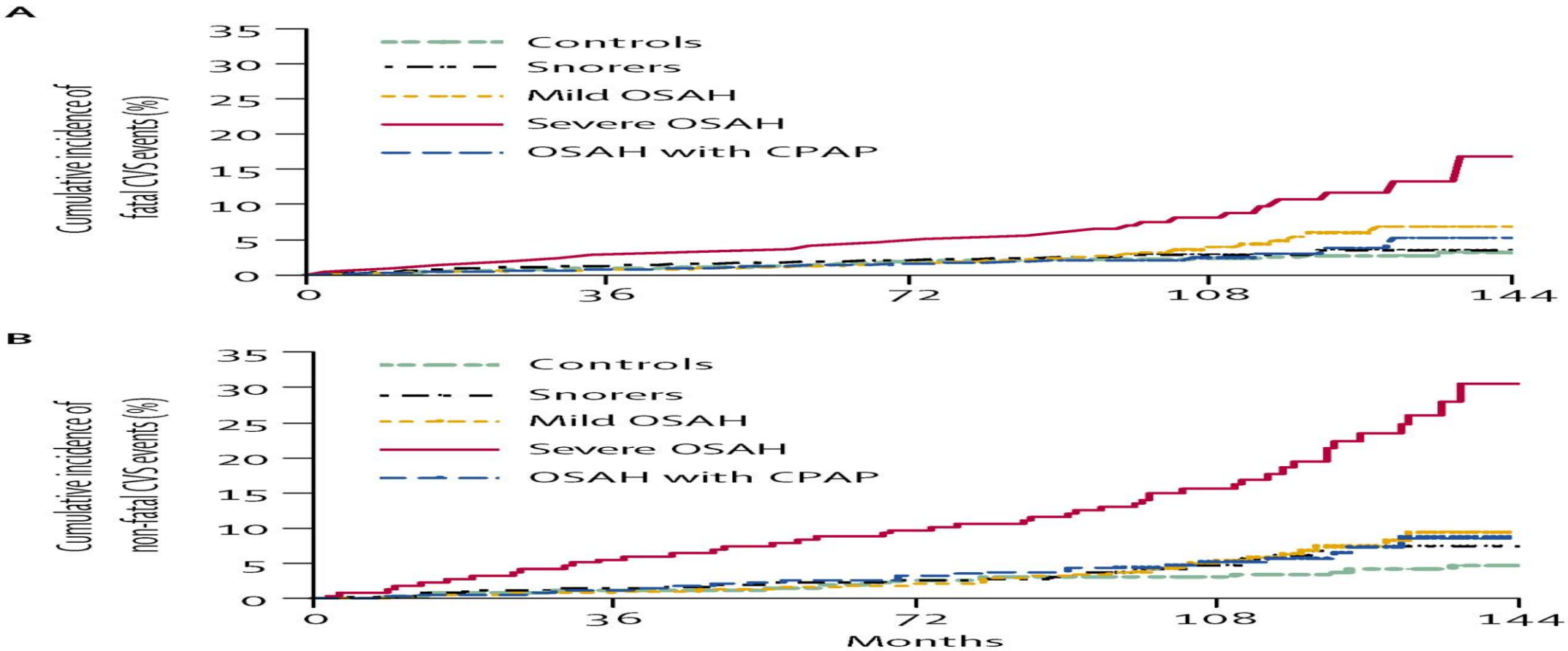

Raw Data
Events
Trend
JUH workspace
11:43:12 PM
Entire Study
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
REOGM2
LEOGM2
F4M1
F3M2
C4M1
C3M2
O2M1
O1M2
CEMG
ECG1
TFlow
CanFlow
MSnore
THO
ABD
SpO2
Body
6:32:22 AM
5 minutes
Central Apnea
CA
Hypopnea
Snore
Rel Desat
Relative Desaturation
S
6:33:12 AM
6:34:12 AM
6:35:12 AM
6:36:12 AM
6:37:12 AM
30s
60s
90s
120s
150s
180s
210s
240s
270s
State: New
Database Connected

Treatment

- Weight loss ,avoid sedatives and alcohol
- Stop smoking
- CPAP
- Surgery
- Dental appliances

CPAP(continuous positive airway pressure)

- Flow generator with tubing and mask.
- Takes air from the room and push it into airways .
- It Pushes air out under pressure which keeps airways open and non collapsible .



Numbers at risk				
Controls	264	262	259	258
Snorers	377	372	361	232
Mild OSAH	403	401	392	264
Severe OSAH	235	229	221	167
OSAH with CPAP	372	364	361	229

Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study.AUMarin JM, Carrizo SJ, Vicente E, Agusti AG SOLancet. 2005

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 SEPTEMBER 8, 2016 VOL. 375 NO. 10

CPAP for Prevention of Cardiovascular Events in Obstructive Sleep Apnea

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ABSTRACT

The primary composite end point was death from cardiovascular causes, myocardial infarction, stroke, or hospitalization for unstable angina, heart failure, or transient ischemic attack.

CONCLUSIONS:
Therapy with CPAP
plus usual care, as compared
with usual care alone,
did not prevent
cardiovascular events
in patients with
moderate-to-severe
OSAand established
cardiovascular disease.

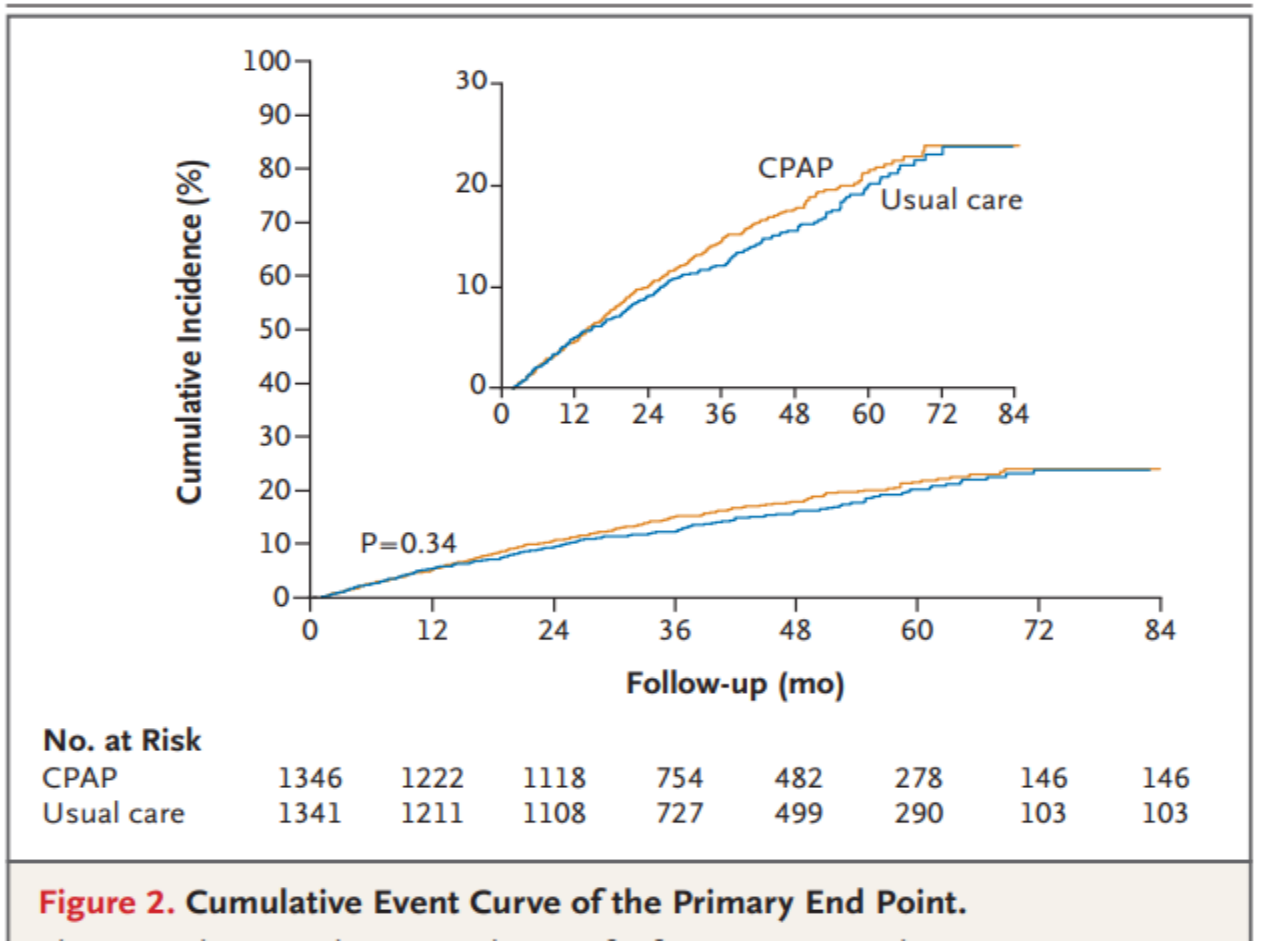


Figure 2. Cumulative Event Curve of the Primary End Point.

- Measures the main outcomes were a composite of acute coronary syndrome (ACS) events, stroke, or vascular death (major adverse cardiovascular events); cause-specific vascular events; and death.

- **Meta-analysis** of 10 randomized clinical trials including 7266 patients.
- Conclusions : The use of PAP, compared with no treatment was not associated with reduced risks of cardiovascular outcomes or death for patients with sleep apnea.
- Beneficial effects on anxiety, depression, daytime sleepiness and physical function .

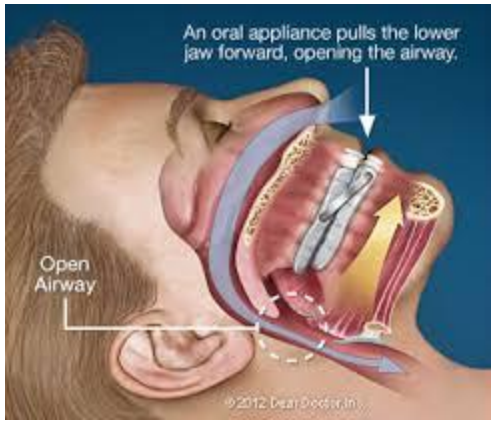
Association of Positive Airway Pressure With Cardiovascular Events and Death in Adults With Sleep Apnea: A Systematic Review and Meta-analysis. AUYu J, et al, JAMA. 2017.

Compliance

- Mask
- Humidifier
- Ramp
- Autotitartion
- Bilevel

Dental appliances

- Proper patient selection

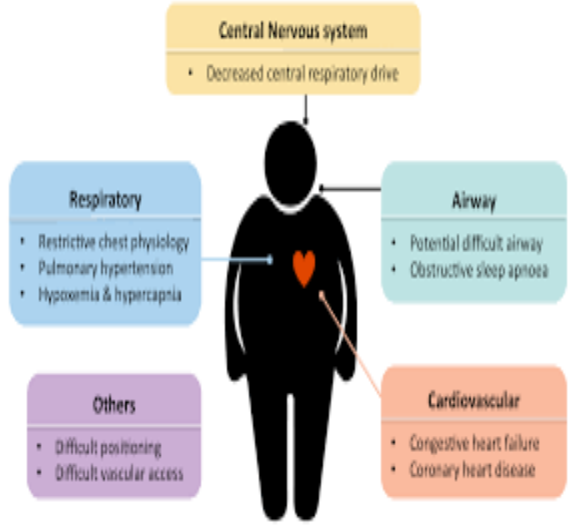


Surgery for OSA

- Surgery 30-40% effective and lost after years

Definition of OHS

- Obesity hypoventilation syndrome (OHS) is defined as a combination of obesity (body mass index ⩾30 kg·m−2 **AND**
- daytime hypercapnia (arterial carbon dioxide tension ⩾45 mmHg) occurring in the absence of an alternative neuromuscular, mechanical or metabolic explanation for hypoventilation .



Clinical presentations

- Acute on top of chronic type 2 respiratory failure .
- Referral to respiratory clinic for

  Suspected OSA

  Unexplained dyspnea .

  Pulmonary hypertension

They usually have HTN,DM or other comorbidities .

- The prevalence of OHS is similar in men and women

OHS

Nearly 75% were misdiagnosed and treated for obstructive lung disease (most commonly chronic obstructive pulmonary disease) in spite of having no evidence of obstructive physiology on pulmonary function testing

Make sure

- No obstructive lung disease.
- No Musculoskeletal disease

Marik PE, Desai H. Characteristics of patients with the “malignant obesity hypoventilation syndrome” admitted to an ICU. J Intensive Care Med 2013.

OSA and OHS

- Approximately 90% of patients with OHS have obstructive sleep apnoea (OSA) defined by an apnoea/hypopnoea index (AHI) ⩾5 events/h).

- 70% of patients have concomitant severe OSA (AHI ⩾30 events/h)
- The remaining patients have non-obstructive sleep hypoventilation with no or mild OSA.

OHS with sleep hypoventilation

- The American Academy of Sleep Medicine (AASM) has arbitrarily defined **sleep hypoventilation** in adults by the following criteria:

- PaCO2 >55 mmHg for >10 min or
- An increase in PaCO2 (or surrogate as end-tidal carbon dioxide tension or TcCo2) >10 mmHg compared to an awake supine value to a value >50 mmHg for >10 min .

TcCo2

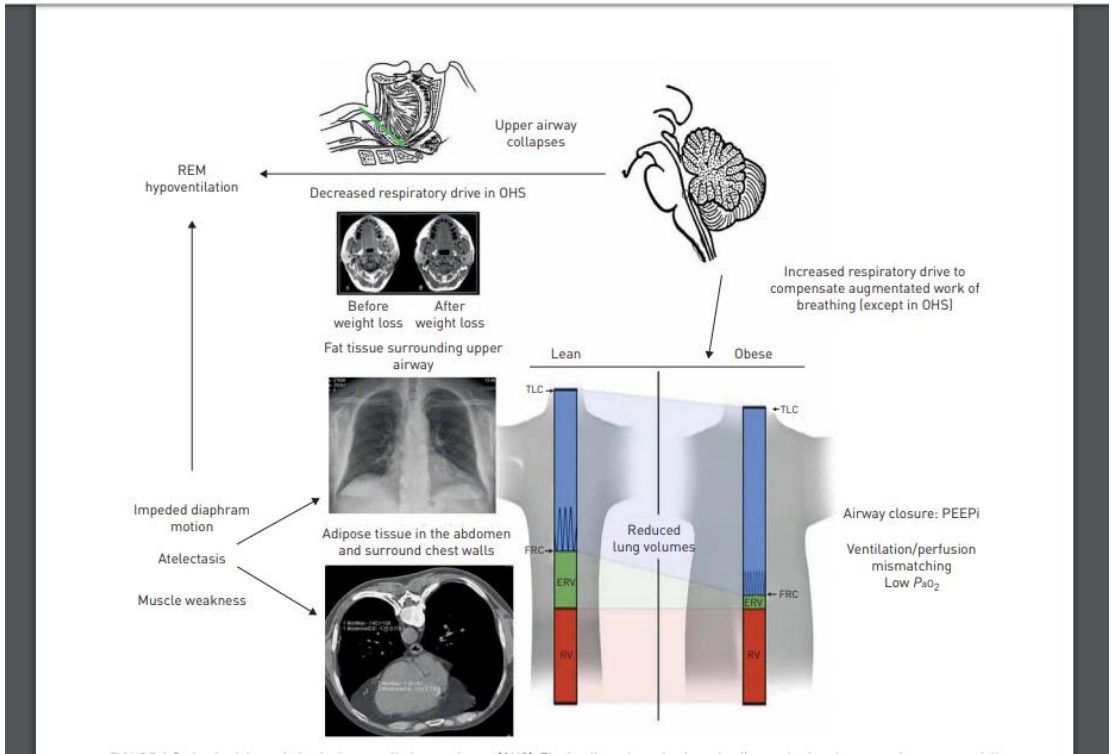
Transcutaneous carbon dioxide

Pathophysiology of obesity hypoventilation syndrome (OHS).

Obesity-related changes in the respiratory system

Central hypoventilation.

Obstructive sleep apnoeas and hypoventilation during sleep, mainly during rapid eye movement

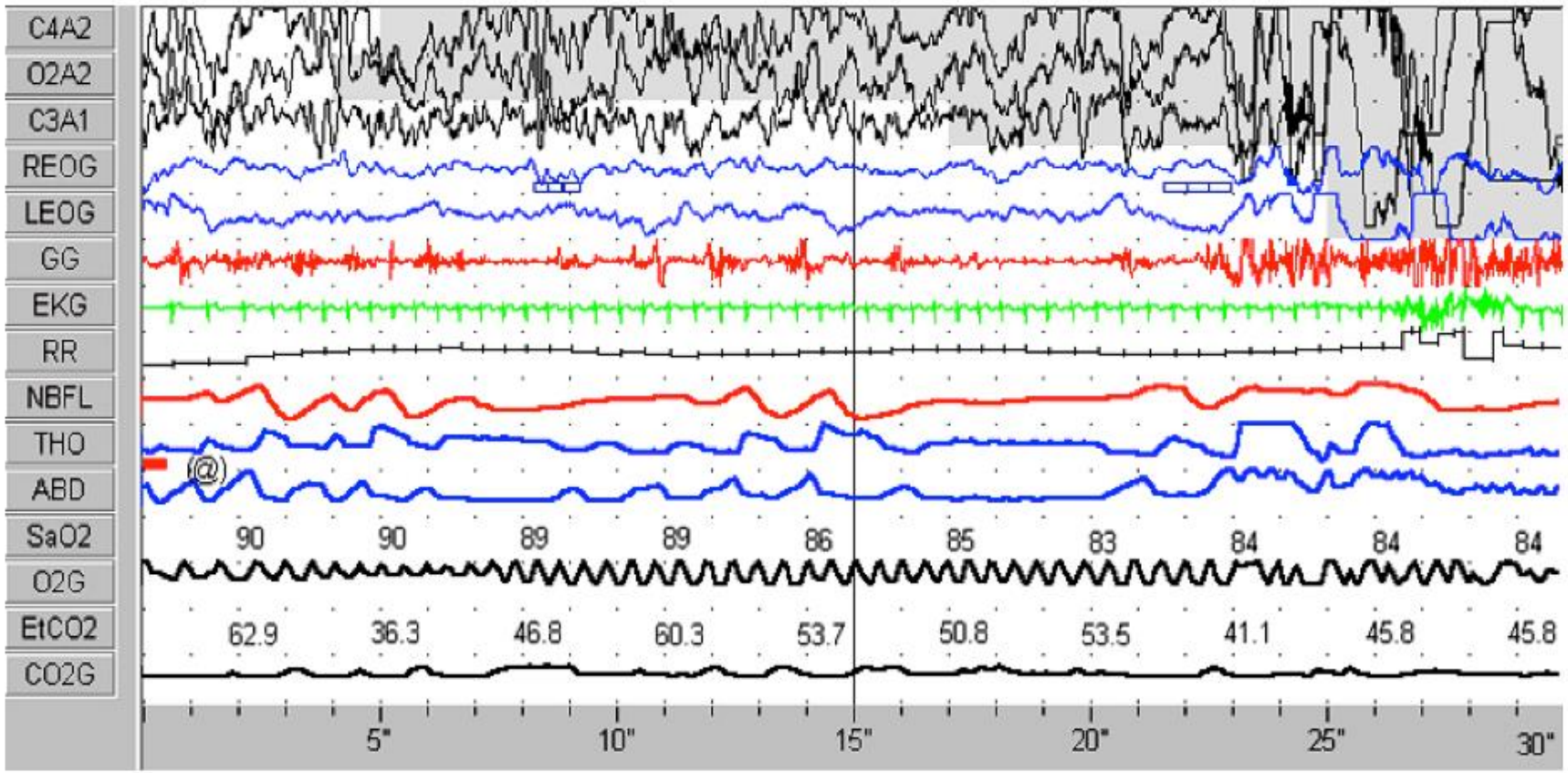


Criteria for diagnosis

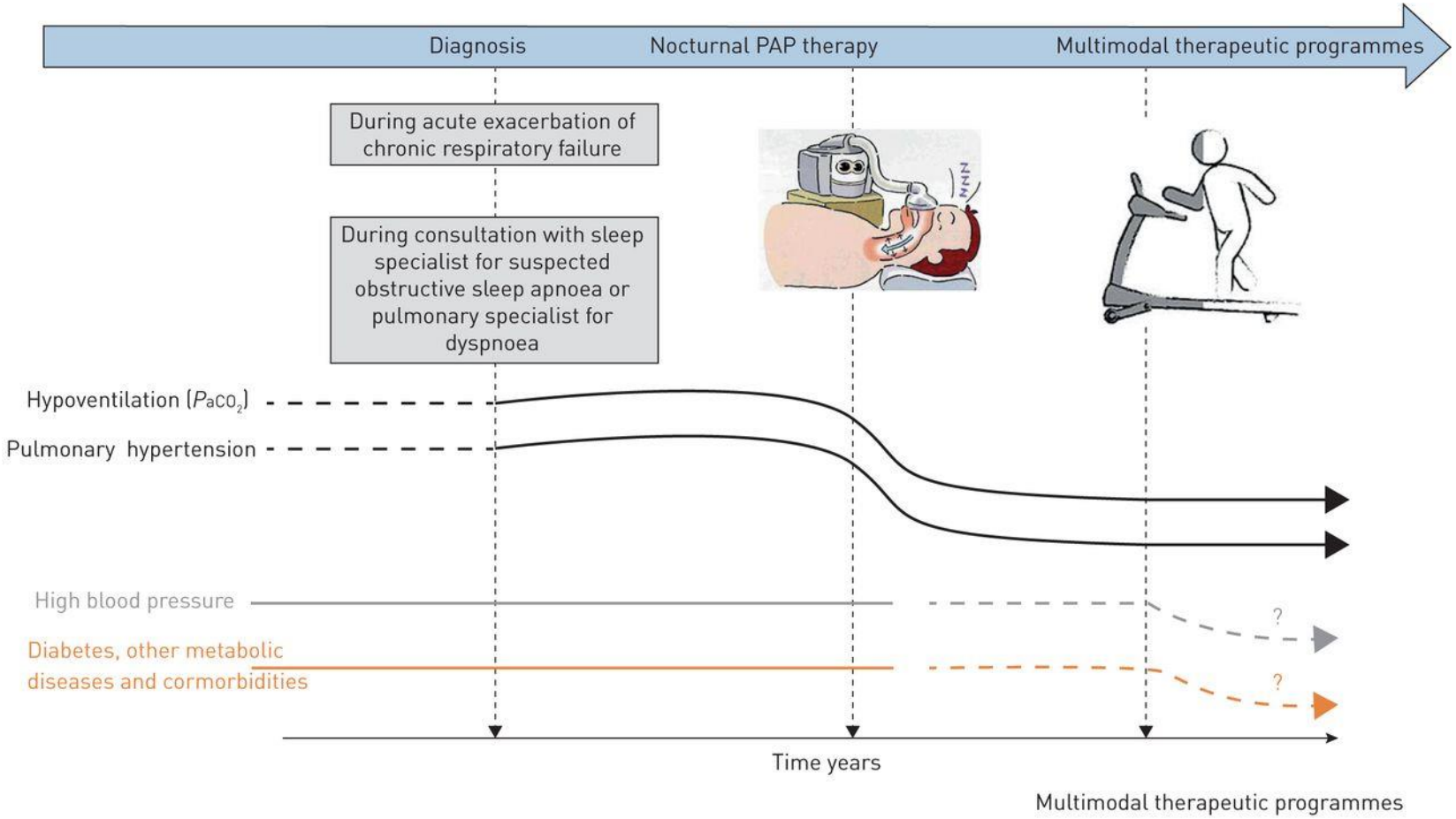
- Room air arterial blood gas.

Supportive tests for diagnosis :

- Elevated serum bicarbonate levels >27 mmol/L….? **Early stage** . NPPV
- And hypoxaemia

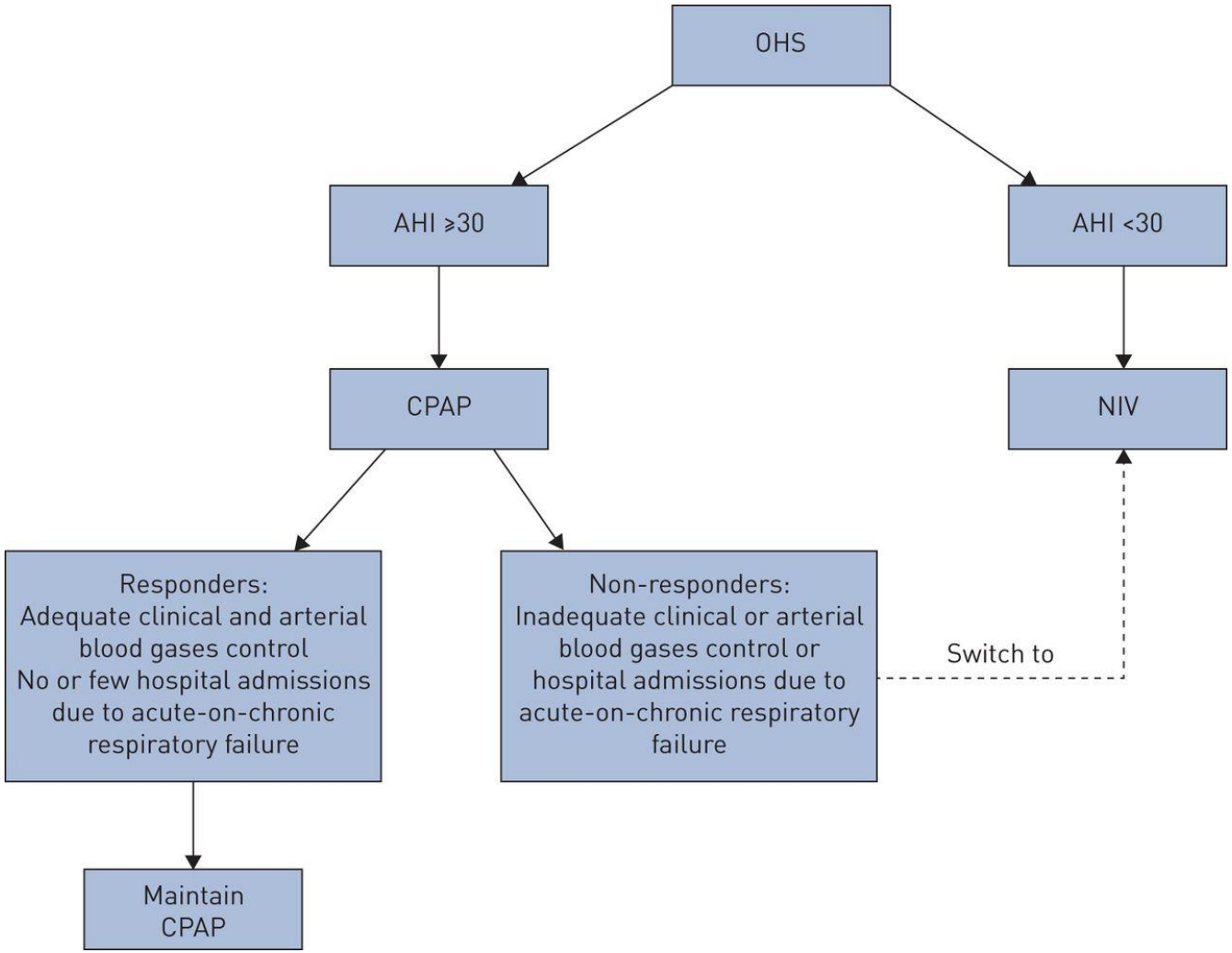

C4A2
O2A2
C3A1
REOG
LEOG
GG
EKG
RR
NBFL
THO
ABD
SaO2
O2G
EtCO2
CO2G
90 90 89 89 86 85 83 84 84 84
62.9 36.3 46.8 60.3 53.7 50.8 53.5 41.1 45.8 45.8
5" 10" 15" 20" 25" 30"

Management of patients with obesity hypoventilation syndrome (OHS) from diagnosis to integrated care to modify health trajectories.



Juan F. Masa et al. Eur Respir Rev 2019;28:180097

Obesity hypoventilation syndrome (OHS) management strategy.



Juan F. Masa et al. Eur Respir Rev 2019;28:180097

Thank you

References

References are attached in individual slides