SLEEP DISORDERS

Opinionated Thoughts And Questions
A Potpourri

Robert G. Hooper, M.D.

Who am I?

The Potpourri

"Old age is when you know all the answers but nobody asks you the questions."

BK Smith

Since someone asked, here are the answers - IN MY OPINION

The Potpourri

Obstructive Sleep Apnea – Keeping the Big Picture in Mind

- Why me??
- AHI – The time to move on
- PAP failure – what?

The mystery of Periodic Limb Movement Disorder and the PLMI on the PSGs

Why Me - the Patients Ask

- Why so common - How common is it?
- What is the big picture?
- How does age contribute
- How does weight contribute.
- What is normal throat anatomy

Prevalence of OSA

- Pub Med August 2025 13,434 papers on prevalence of OSA
- Reports vary
    - Methods use
    - Criteria used
    - Hawkins corollary to Sturgeons Law
- Common Finding
    - Few comprehensive studies
    - Very few with individual over 65 y/o
    - Overall (all ages) prevalence very high reported 15-50 %
- OSA is a common problem - 20-30% of all adults (AHI>5)

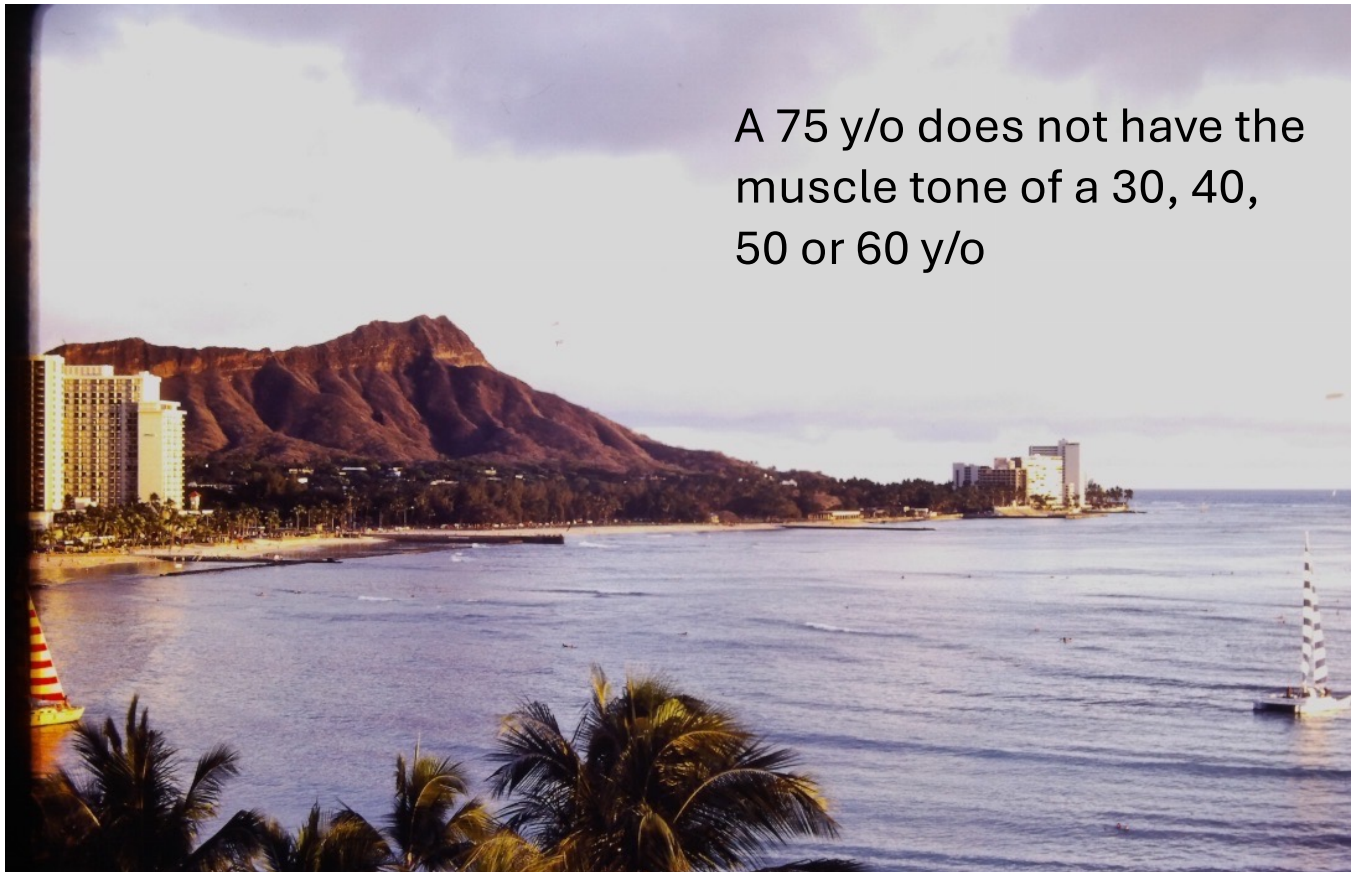
Important non-medical concept

- Sturgeons Law – Theodore Surgeon is noted for the adage
  - ‘Ninety percent of everything is crap’
- Hawkins corollary to Sturgeons law
  - ‘Ninety percent of medical literature is crap’

Prevalence of OSA over 65 y/o

- Pub Med August 2025 13,434 papers on prevalence of OSA
- Reports vary
- Common Finding
    - Few comprehensive studies
    - Very few with individual over 65 y/o
    - Overall (all ages) prevalence very high reported 15-50 %
    - Age related increase to 50y/o and sex related
- I aware of three reasonable studies with individuals over 65 y/o
    - Prevalence in those three studies –
    - 70-90% over 65 y/o have OSA

The Waikiki Syndrome -
A corollary of the Obstructive Sleep Apnea Syndrome

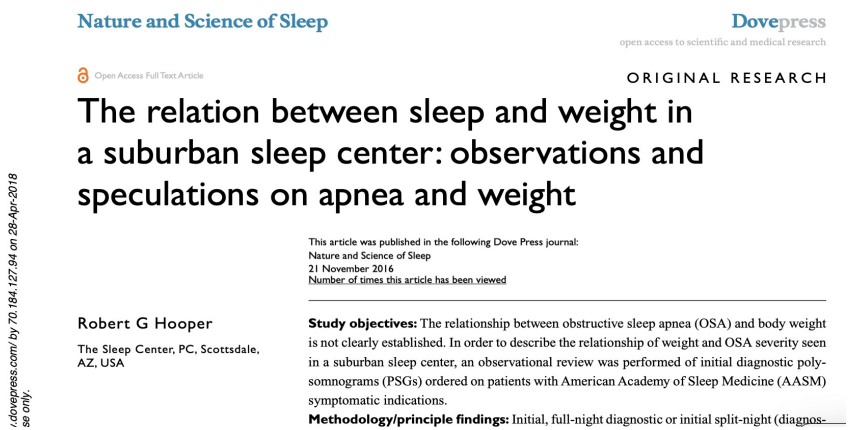


Why Me - the Patients Ask

- When the patients ask why me?
  - Why so common - How common is it?
    - 20-30% of all adults
  - How does age contribute.
    - Extremely common in over 65 y/o 60-90%
  - How does weight contribute

“Why Me?” - the Patients Ask
“What if I lose weight?”

- How frequent is the OSA patient obese at the time of diagnosis?
  - Approximately 50-60% of newly diagnosed OSA are Obese
  - My report 59%
- Study ….
  - 397 Males
  - 232 Females
  - Total 629 PGS
  - **450 AHI >5**
    - **BMI < 30 -41%**
    - **BMI > 30 -59%**



Nature and Science of Sleep

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ORIGINAL RESEARCH

The relation between sleep and weight in a suburban sleep center: observations and speculations on apnea and weight

This article was published in the following Dove Press journal:
Nature and Science of Sleep
21 November 2016
Number of times this article has been viewed

Robert G Hooper

The Sleep Center, PC, Scottsdale, AZ, USA

Study objectives: The relationship between obstructive sleep apnea (OSA) and body weight is not clearly established. In order to describe the relationship of weight and OSA severity seen in a suburban sleep center, an observational review was performed of initial diagnostic polysomnograms (PSGs) ordered on patients with American Academy of Sleep Medicine (AASM) symptomatic indications.

Methodology/principle findings: Initial, full-night diagnostic or initial split-night (diagnos-

- **2016**

OSA and Obesity

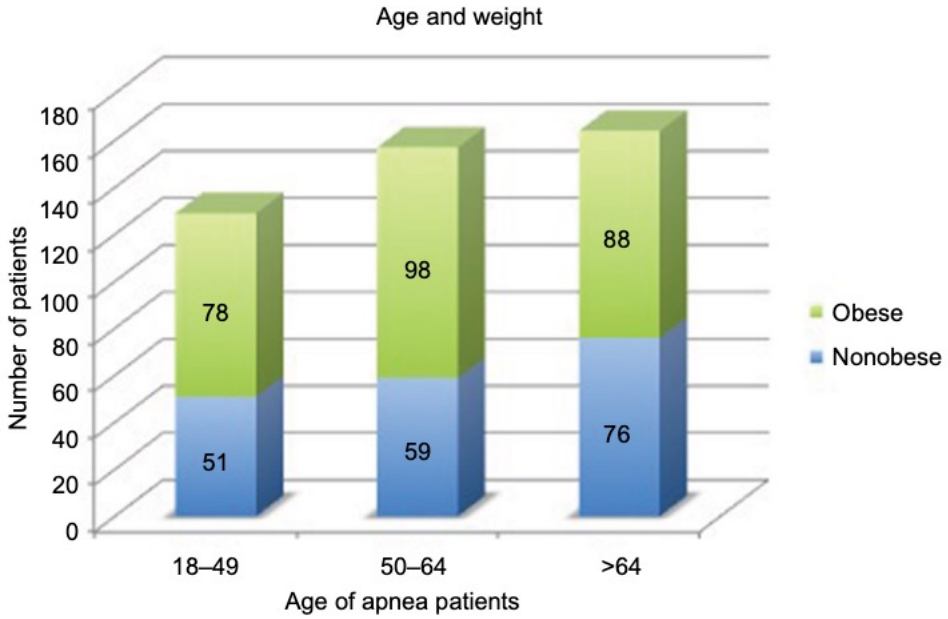


Figure 2 The distribution of patients by age and weight.

Percent non-obese	39%	37%	46%

OSA and Obesity

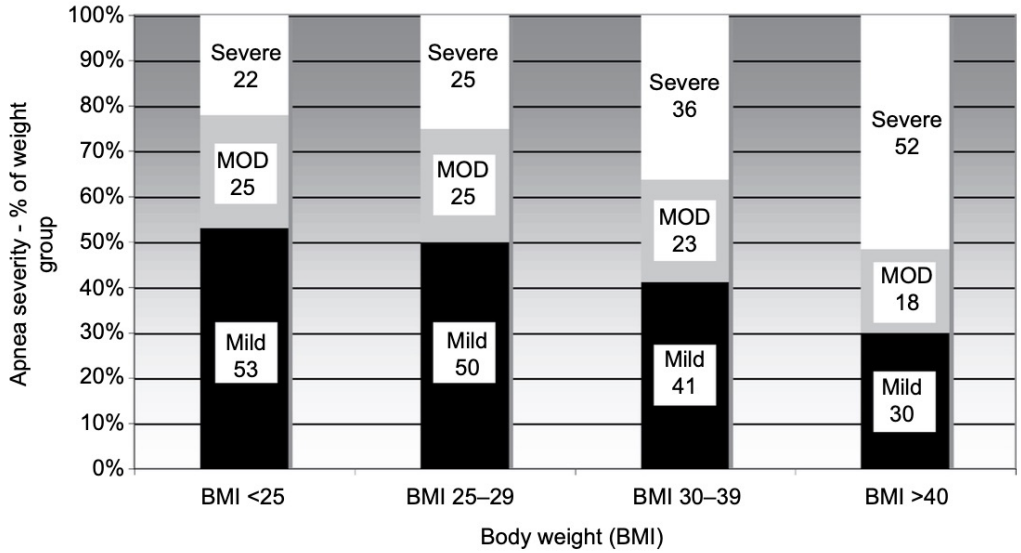


Figure 3 Columns represent the distribution of apnea severity for each weight group. Black represents the percentage of mild (AHI 5–14), gray represents moderate (MOD) (AHI 15–29), and white represents severe and very severe (AHI ≥30) apnea. The number of patients the distributions reflect are 45 (BMI <25), 141 (BMI 25–29), 204 (BMI 30–39), and 60 (BMI ≥40).

Abbreviations: BMI, body mass index; AHI, apnea hypopnea index.

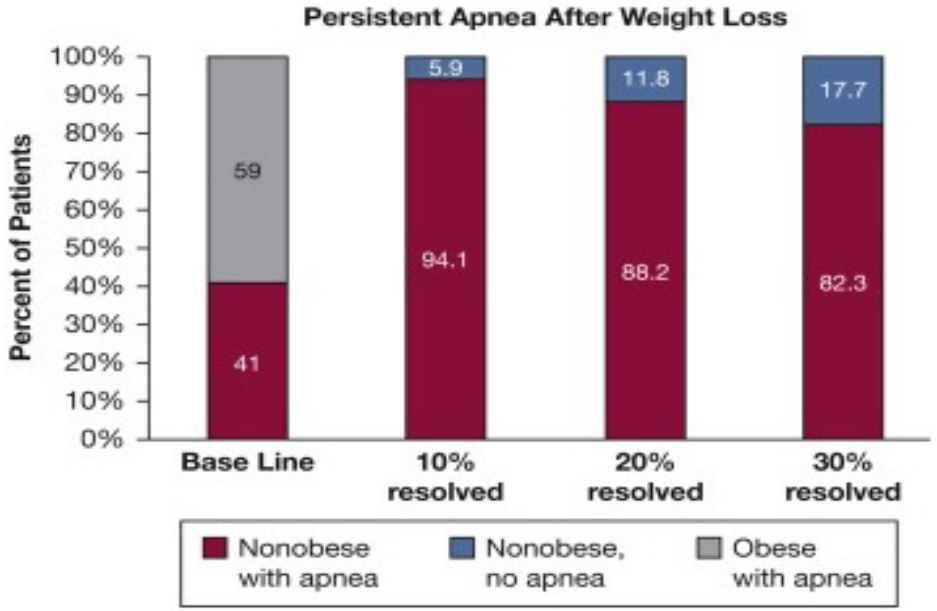
OSA and Obesity

- Conclusions
    - All weight categories can have OSA
    - Moderate and Severe apnea occurs at all weight categories
    - Obesity increases the frequency of diagnosed severe OSA
    - The frequency of OSA with BMI >40 and symptoms is extremely high

“Why Me?” - the Patients Ask
“What if I lose weight?”

- Effect of weight loss - Pub med Aug 2025 1,429 papers
- Massive agreement – **Weight loss helps.**
- Does weight loss eliminate OSA?
  - Very few studies use testing data after weight loss
  - Criteria for success varies
  - Reduction of AHI to less that 5/hr at best **occurs in 20% who lose weight.**
  - Adherence to weight loss programs are less than ideal
- Let’s do the math

“Why Me?” - the Patients Ask
“What if I lose weight?”



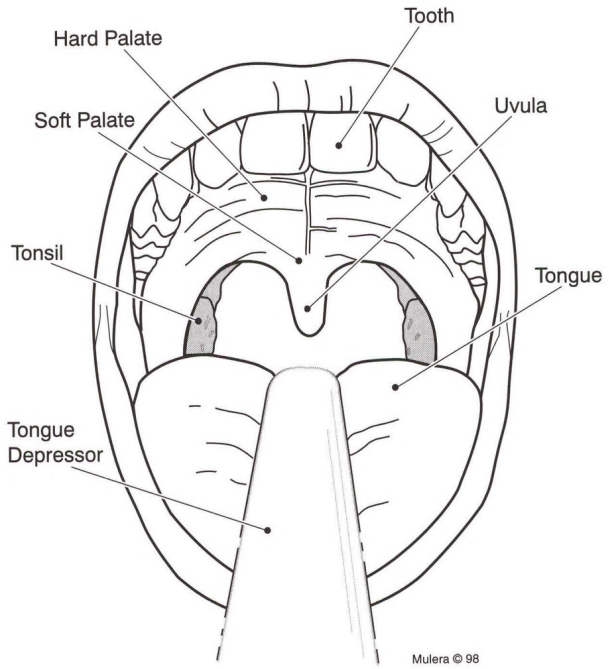
Hooper: Chest 2018

“Why Me?” - the Patients Ask
“What if I lose weight?”

- Conclusions…
- Measurable apnea persist in the vast majority of patients after weight loss
- Should advise patients
  - **Weight loss is good**
  - **OSA is usually a life long condition.**
  - Should be aware –

    OSA diagnosed patients will need long term attention

One more thought on causation…



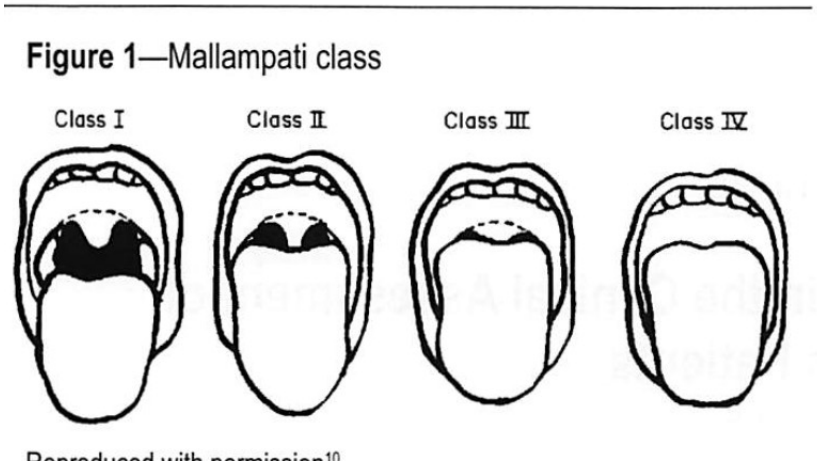
Mouth and Throat

Figure 8-2

One more thought on causation…

- What is normal anatomy?

- Is it type 1, 2 or ???
- Aren't they all normal??



- Is the normal anatomy configuration of the throat fixed or variable?
- If variable, is the number of configurations finite or infinite??

Why me? - My opinionated answer

- A combination of factors
  - Age
  - Weight
  - Genetics
- Probable a life long condition.
- Live long enough, practically everyone will have some degree of measurable OSA

Time to move on - AHI

- The world-wide measure of OSA severity.
  - Origin – a practical tool
  - Current –
    - Still a practical tool
    - Now a regulatory tool
    - Not a good predictor/research tool –
- What does it measure?
  - All breathing events with a saturation drop
- What does it not measure?

Problems with AHI as indicator of severity

- Significantly low 02 saturations (Desaturation to <90%) vs just a drop (Desaturation of 3 or 4 %) – Time less than 90%
- Effects of Hypopneas verses Apnea
- Duration of events
- Effects of events on sleep (arousals verses no arousals)
- Total exposure to events – Effect of TST
- And probably more…

Effect of Total Sleep Time on OSA exposure

- Sleep tests
  - Your experience…
  - Equipment used
  - Position limitation.
  - Time frame for testing
    - Limited start and stop PSG
    - Fixed recording time
    - Number of nights studied
- What would be ideal?
- What are the effects of a person’s average TST on exposure?

Effect of Total Sleep Time on OSA exposure

- What would be ideal –the best collected data to use for OSA
  - Multiple nights
  - Comfortable environment – Home
  - Comfortable testing equipment
- What is needed - probably all of above
- Let’s look at sleep duration and the number of apnea/hypopnea events experienced

Effect of Total Sleep Time on OSA exposure
(One Night)

Table 1

Apnea and hypopneas experienced (Apnea Load) based on untreated sleep - one night

APNEAS AND HYPOPNEAS PER HOUR (AHI)	SLEEP DURATION IN HOURS				
	6	7	8	9	10
5	30	35	40	45	50
15	90	105	120	135	150
30	180	210	240	270	300
50	300	350	400	450	500
70	420	490	560	630	700

Legend: Examples of changes in Apnea Load with increasing total sleep time. Apnea Load is the total apneas and hypopnea for the AHI and duration of sleep indicated. AHI is the apnea hypopnea index.

Effect of Total Sleep Time on OSA exposure
(Multiple Nights)

Apnea Load with 8 hours sleep per night for multiple durations

AHI	1 WEEK	1 MONTH	1 YEAR	5 YEARS	10 YEARS
5	280	1,200	14,600	73,000	146,000
15	840	3,600	43,800	219,000	438,000
30	1,680	7,200	87,600	438,000	876,000
50	2,800	12,000	146,000	730,000	1,460,000
70	3,920	16,800	204,400	1,022,000	2,044,000

Notes: The Apnea Load over increasing nights of exposure. Apnea load is the total apneas and hypopneas at the AHI for the duration indicated. For emphasis the AHI levels of 17.12 and 34.25 are added as they represent threshold of Fifty thousand and one hundred thousand events at 1 year and one-half million and one million events at 10 years.

Change in Total Apnea Load (TAL) with varying TST

AHI		6 hours	7 hours	8 hours	9 hours
10	TAL	60	70	80	90
	% change at one hour		116.7	114.3	112.5
	% change at two hours			133.3	128.6
	% change at three hours				150
20	TAL	120	140	160	180
	% change at one hour		116.7	114.3	112.5
	% change at two hours			133.3	128.6
	% change at three hours				150

Change in Apnea Event Exposure between 7 hours and 9 hours sleep per night over multiple sleep cycles

AHI	Hrs Sleep	Night	Week	Year	5 years
10	7	70	490	25,200	126,000
10	9	90	630	32,400	162,000
Change %	128.6	128.6	128.6	128.6	128.6

AHI	Hrs Sleep	Night	Week	Year	5 years
30	7	210	1470	75,600	378,000
30	9	270	1890	97,200	486,500
Change %	128.6	128.6	128.6	128.6	128.6

Effects of Partial Treatment with PAP

AHI	TREATMENT HOURS	TST	APNEA LOAD Nightly	APNEA LOAD Yearly	APNEA LOAD 5 Years
20	None	8	160	58,400	292,000
20	4	8	80	29,200	146,000
20	6	8	40	14,600	73,000
20	8	8	0	0	0

Untreated OSA with AHI of 5 has the same TAL as AHI of 20 treated for 6 out of 8 hours per night

Problems with AHI as indicator of severity

- Significantly low 02 saturations vs just a drop (Desaturation below 90% or other desaturation measurement)
- Effects of Hypopneas verses Apnea
- Duration of events
- Effects of events on sleep (arousals verses no arousals)
- Total exposure to events
- And probably more…

Refinement of Apnea-Hypopnea measurement needed

Refinement of OSA measurements

- TMN system for solid tumors
  - T tumor size, M distance metastatic disease, N lymph node involvement
  - Quite valuable in making decision for patient care and research on treatments and the diseases.
  - Originated in 1960s. Has been in evolution ever since.
  - Quite valuable in treatment assessments and outcome evaluations
- How related to OSA
  - OSA measure of AHI is similar to defining a cancer as a small, medium, or large tumor.
  - Maybe a staging system for OSA should be adopted.

Suggestions for Staging OSA -HAHA

HAHA or HADA

Hypopnea, Apnea, Hypoxemia, Arousal or

Hypopnea, Apnea, Desaturation, Arousal

$H^{\#d}A^{\#d}H^{\#d}A^{\#d}$ where

$^{\#}$ = number

^{D} = standard of measurement (minutes, hours, days, weeks or ?).

Similar to other staging system the HAHA groups could be lumped together into stages.

Important non-medical concept

"Details do not make perfection,
but perfection is made of details"

Attributed to Multiple Sages

What about CPAP Failure

- What is it?
- How often does it occur?
- Why is it important?
- Is there a differentiation diagnosis?

What about ‘CPAP Failure’

- How often does it occur?
  - Very common for patients to stop PAP therapy
  - What are reasons
- What is it?
  - Is stopping PAP therapy same as ‘CPAP Failure’
- Why is it important? It is more than a medical description.
  - Regulatory definitions –
  - Insurance payment issues
- Is there a differentiation diagnosis? There should be….

What about ‘CPAP Failure’ - My DDx

- **Failed to start PAP**
- **Had problems with therapy**
- **Had problems with mask**

- **Had no benefit from therapy**
- **Had improved or loss weight and decided they did not need**

- **Had problems with providers (medical and/or DME)**
- **Had payment problems**

- **Had personal problems**
- **Had significant other who did not like it**
- **Has attitude problem****

What about ‘CPAP Failure’ - The DDx

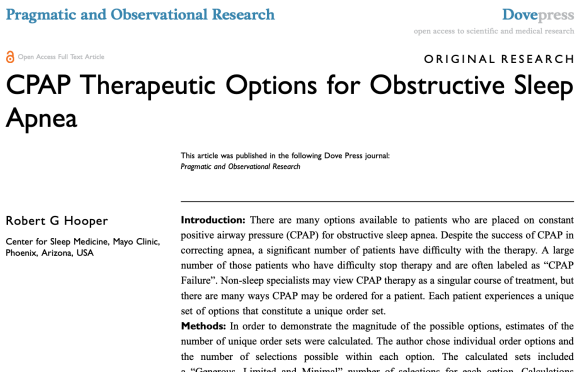
- **Had problems with mask**
  - A day, week or month
  - No help or lots of help trying to correct
  - Number of mask tried
- **Had problems with therapy**
  - Breathing symptoms
  - Anxiety
  - ?? Settings??
    - How many ways can PAP therapy be ordered

List of possible problems or issues with therapy –Technical issues

- Did the patient receive the correct machine and correct type of machine.
- Where appropriate orders made for the patient?
- Does the machine setting match the ordered setting?
- Is the pressure setting appropriate? Should it be changed
- Is an expiratory pressure release being used and to what degree?
- Is a Ramp feature being used?
- Has a change in mode (CPAP vs auto adjusting vs bi level) been tried?
- Is a humidifier being used?
- Is it heated appropriately?
- Is the mask the one ordered by the provider?
- Is the mask the one the patient agreed to use?
- Is the mask comfortable?
- Is the mask leaking?
- Is the patient experiencing a mouth air-leak
- Is the patient wearing the mask correctly?
- Does the patient need a chinstrap? If has one, has it been tried?
- Has a change in mask size or style been tried?
- What attempts were made to help the patient when the problems occurred?

What about ‘CPAP Failure’ - The DDx

- Possible orders for PAP therapy 2020



Pragmatic and Observational Research

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ORIGINAL RESEARCH

CPAP Therapeutic Options for Obstructive Sleep Apnea

This article was published in the following Dove Press journal:
Pragmatic and Observational Research

Robert G Hooper

Center for Sleep Medicine, Mayo Clinic, Phoenix, Arizona, USA

Introduction: There are many options available to patients who are placed on constant positive airway pressure (CPAP) for obstructive sleep apnea. Despite the success of CPAP in correcting apnea, a significant number of patients have difficulty with the therapy. A large number of those patients who have difficulty stop therapy and are often labeled as “CPAP Failure”. Non-sleep specialists may view CPAP therapy as a singular course of treatment, but there are many ways CPAP may be ordered for a patient. Each patient experiences a unique set of options that constitute a unique order set.

Methods: In order to demonstrate the magnitude of the possible options, estimates of the number of unique order sets were calculated. The author chose individual order options and the number of selections possible within each option. The calculated sets included

- Standard CPAP - 49,152 order possibilities
- Auto adjusting CPAP - 3,072 order possibilities

What about ‘CPAP Failure’ - The DDx

- Had no benefit from therapy
  - Does patient understand goals of therapy
  - Goals of therapy with PAP
    - Improved quality of sleep
    - Keep AHI controlled
  - **Therapy may work for OSA, but not for patients’ symptoms!**
- Had improved or loss weight and decided they did not need**
  - **Need testing after weight loss if there are plans to stop therapy**
  - **Even if therapy can be stopped. Long term follow up will be needed**

What about ‘CPAP Failure’ - The DDx

- Had problems with providers (medical and DME)
- Had payment problems

- Had personal problems
- Had significant other who did not like it
- Has attitude problem**
  - “I can’t define it, but I know it when I see it.”

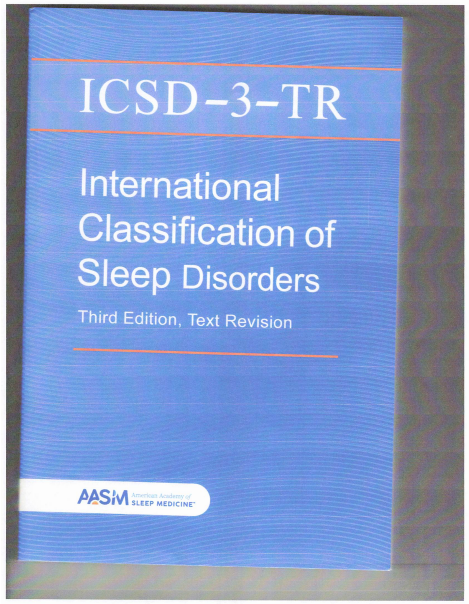
    With reference to obscenity – Supreme Court Justice Potter Stewart

    With reference to CPAP failure – Philip Lyng MD

What about ‘CPAP Failure’ – The DDx

- Technical
  - Failed to Start
  - Problems with therapy
  - Mask problems
- Goals
  - No benefit from Therapy
  - Improved/lost weight
- Provider
  - Provider problems
    - Medical or DME
  - Payment problems
- Personal
  - Personal
  - Significant other
  - Attitude

Lets talk Periodic Limb movements



Periodic Limb Movement Disorder

ICD-10-CM code: G47.61

Alternate Names

Periodic leg movement disorder, periodic movement disorder of sleep, sleep myoclonus syndrome, nocturnal myoclonus syndrome.

Diagnostic Criteria

Criteria A-D must be met

A. Polysomnography demonstrates periodic limb movements during sleep (PLMS).[1]

B. The frequency is > 5/hour in children or > 15/hour in adults.[2]

C. The PLMS cause clinically significant sleep disturbance or impairment in mental, physical, social, occupational, educational, behavioral, or other important areas of functioning.[3,4,5]

D. The PLMS and the symptoms are not better explained by another current sleep disorder, medical disorder, or mental disorder (e.g., PLMS occurring with apneas, hypopneas, and respiratory effort-related arousals (RERAs) should not be scored).[6,7]

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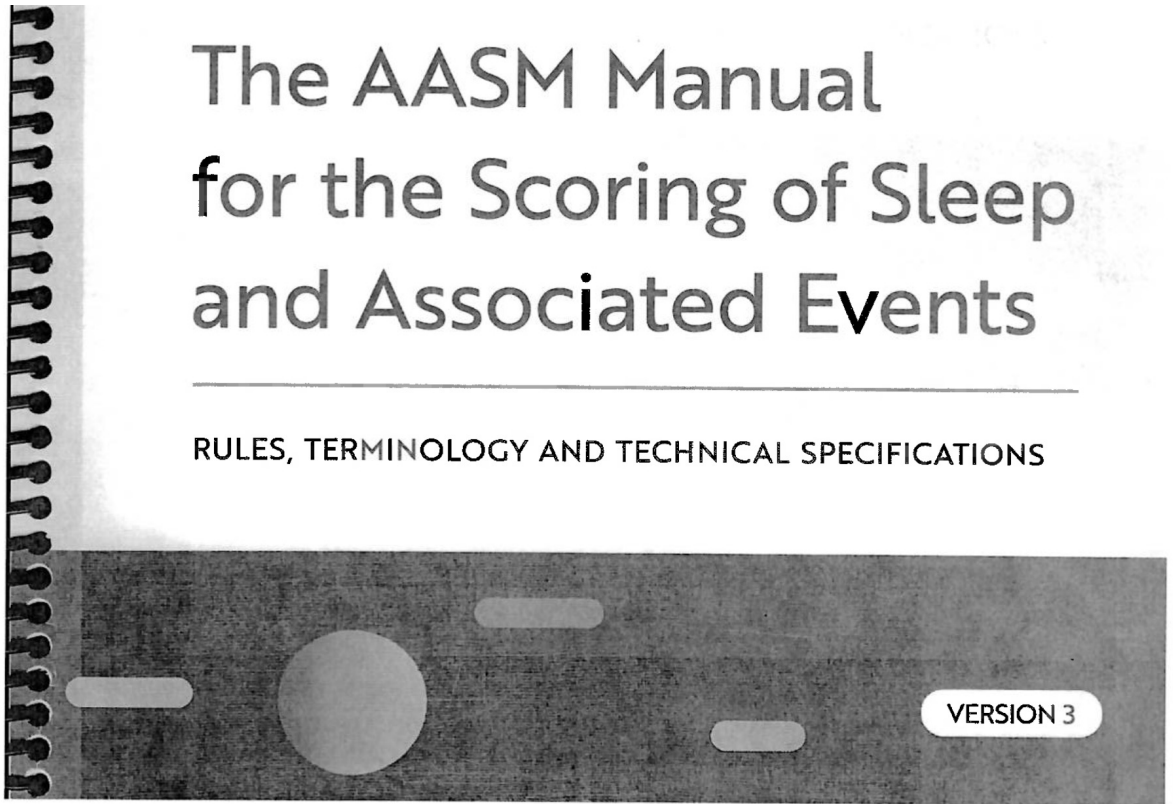
PLM and definitions



PLM and definitions

VII. Movement Rules

A. Technical Specifications [1]

1. For monitoring leg movements (LMs), surface electrodes should be placed longitudinally and symmetrically in the middle of the anterior tibialis muscle so that they are 2–3 cm apart or one-third of the length of the anterior tibialis muscle, whichever is shorter. Both legs should be monitored for the presence of leg movements. Separate channels for each leg are strongly preferred. Combining electrodes from the 2 legs to give 1 recorded channel may suffice for some clinical settings. (see Figure 1) RECOMMENDED

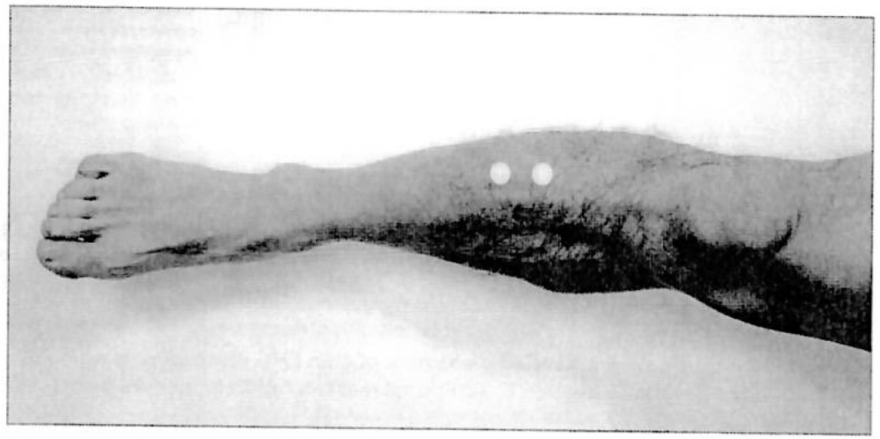


Figure 1. Placement of electrodes on the anterior tibialis muscle for monitoring leg movements. Illustration may not be to scale.

PLM and definitions

B. Scoring Periodic Limb Movements in Sleep (PLMS)

1. **The following define a candidate leg movement (LM) event for possible inclusion in a PLMS series:** [N1] RECOMMENDED
   a. The duration of the LM event is 0.5–10 seconds.
   b. The minimum amplitude of a LM event is an 8 μV increase in EMG voltage above resting EMG for at least 0.5 seconds.
   c. The timing of the onset of a LM event is defined as the point at which there is an 8 μV increase in EMG voltage above resting EMG.
   d. The timing of the ending of a LM event is defined as the start of a period lasting at least 0.5 seconds during which the EMG does not exceed 2 μV above resting EMG.
   e. A portion of, or the entire, LM event occurs in an epoch scored as sleep.

2. **The following define a PLMS series:** [N2] RECOMMENDED
   a. The minimum number of consecutive LM events needed to define a PLMS series is 4 LMs.
   b. The period length between LMs (defined as the time between onsets of consecutive LMs) to include them as part of a PLMS series is 5–90 seconds.
   c. Leg movements on 2 different legs separated by <5 seconds between movement onsets are counted as a single leg movement. The period length to the next LM following this group of LMs is measured from the onset of the first LM to the onset of the next. (see Figure 6)

Let's talk Periodic Limb MOVEMENTS

Open Access Full Text Article

ORIGINAL RESEARCH

The level of observed physical movement accompanying periodic limb movements measured in a clinical sleep population

Robert G Hooper

The Sleep Center, Scottsdale, AZ, USA

Study objectives: Periodic limb movements (PLMs) are routinely measured during polysomnogram (PSG) testing. During the early years of sleep testing, physical movements were identified and over time, consensus ultimately led to the current definitions of movement disorders including criteria used to measure PLMs on PSG testing. There has been considerable debate about the clinical importance of the PLMs measured during PSG testing. Over the last decade, the author has observed significant variations in the actual visible physical movements observed with a PLM event. This report is the result of work to quantify the amount of movement and the frequency of movements observed among individuals who have PLMs.

2018

Reviewed by 12,745 and cited 1

Let’s talk Periodic Limb movements

- Did a retrospective review of 646 patient’s studies – 460 included
  - >18 y/o.
  - Diagnostic study
  - Good video reviewed at 10 f/s
  - Clinical history not reviewed
- Observed for visual physical movements with recorded EMG PLMs
- Rated movements based on increasing levels observed
- From 0 to 4.
  Zero for no observable movements
- One representing movement of one extremity
- Two, three and four representing movement in 2, 3 & 4 extremities

Let's talk Periodic Limb movements –Study of 460 PSGs

- Results No AT EMG PLMs – 48% - 223
  Any PLMI <1
  AT EMG PLMs recorded – 52% - 237
  Any PLMI > 1
- Observed in the 237 With PLMI >1
  - No movements 38% - 90 recording
  - Movements in 62% - 147 recordings
- PLMIs - Increased with age
- - Movement rating increased with age

Let's talk Periodic Limb movements - Study of 460 PSGs

Physical Movements with Measured PLM Index >1 (450 studies reviewed)

PLMI	Number of studies	Physical Movements Obsereved				
		No Movement	Level 1	Level 2	Level 3	Level 4
1-5	92	51	18	12	8	3
5-15	58	22	19	11	5	1
15-30	41	9	20	5	5	2
>30	46	8	8	16	7	7
Totals	237	90	65	44	25	13
% of All PLMI > 1		38.0	27.4	18.6	10.5	5.5

Let's talk Periodic Limb movements –Study of 460 PSGs

Conclusions

- AT EMG measurements of electrical activity – does not necessarily mean muscle movement.
- Significant movements observed at all levels of PLMI > 1.
- Absence of movements observed at all levels of PLMIs
- Significant movements occur:
  - In only 16% of my patients with PLMI>1
  - In 7.5 % of all the studies reviewed (with and with out PLMI>1)

Let's talk Periodic Limb movements

- What is AT EMG measuring? Electrical activity
- What are we using the AT EMG for??? To Identify PLMovements and PLMDisorder
- What is the sensitivity and specificity of AT EMG for Movements
  - Sensitivity – the ability of a test to correctly identify individuals who have a specific condition.
  - Specificity – the ability to accurately identify individuals who have a specific condition.
- The Specificity of AT EMGs for muscle movements in my experience appears to be low.

PLM and definitions

EMG – a recording of electrical activity produced by
Skeletal muscle – Not physical movement
Anterior Tibialis EMG activity –
Does not equal – the physical movements of
Periodic Limb Movements Disorder!
Anterior Tibialis EMG activity per hour –
Currently labeled PLM Index
Should be labeled AT EMG Index

PLM and definitions - Elevated PLMI

The Spectrum of Periodic Limb movement Index

- Elevated PLMI>1 (AT EMGI) and no movements (38%) – No movement disorder
- Elevated PLMI >1(AT EMGI) and movements (62%)
  - Elevated PLMI (AT EMGI)and movements, but no symptoms (Unknown %) – ??
  - Elevated PLMI (AT EMGI)and movements and symptoms (Unknown %) –PLMDisorder

und to hear it, does it make a sound?" is a philosophical question that explores the relationship between observation and reality. It raises the debate about whether sound exists without a conscious

What is Periodic Limb Movement Disorder

- Is measuring electrical activity in muscle the same as a movement, an abnormality, a disorder? **NO**
- If there is electrical activity but no movement, does it qualify as a movement? **NO**
- If there is muscle movement but no one is awake or awakens to note it, does it qualify as a disorder?

Maybe, maybe not, needs defining

SLEEP DISORDERS
Opinionated Thoughts And Questions
A Potpourri - **In my opinion**

PLMI – **Should be renamed Anterior Tibials EMG Index**

Periodic Limb Movements

The specificity and sensitivity of AT EMGs need clearer identification

Measurement of movements – **Need new technics**

Visual – **Should be viewed by reader when AT EMG show PLMI - unlikely to happen**

Accelerometer Probably a viable approach

SLEEP DISORDERS
Opinionated Thoughts And Questions
A Potpourri - **In my opinion**

OBSTRUCTIVE SLEEP APNEA - Why me…

- Age – Weight - Genetics
- Probable a life long condition.
- Live long enough, practically everyone will have some degree of measurable OSA

SLEEP DISORDERS
Opinionated Thoughts And Questions
A Potpourri - **In my opinion**

OBSTRUCTIVE SLEEP APNEA Other…

- The AHI needs attention –
  - Sleep Duration
  - Desaturation –
  - HAHA Staging anyone?

PAP failure –

- Needs a differential diagnosis approach.
- Needs renaming generally (~~failure~~ to cessation) and specifically (technical, goals, provider, or personal)

Definitions

- Definitions are very important –
  - All discuss the same thing.
  - What are we measuring
  - What are we talking about.

"A definition is the enclosing the wilderness of an idea within a wall of words."

Samuel Butler

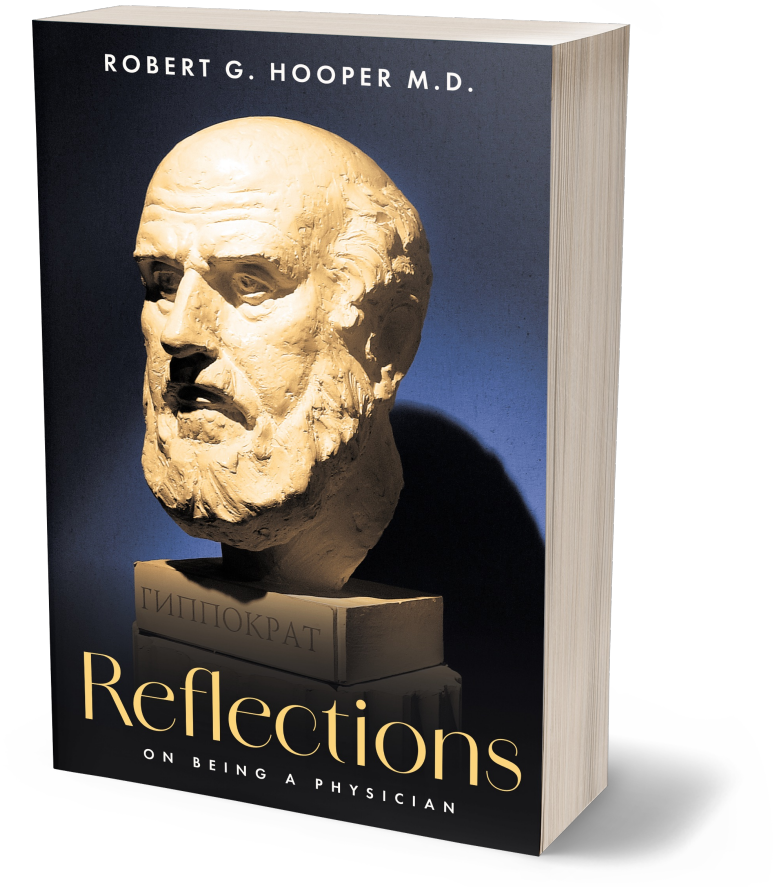
Important non-medical concept

Understand the definitions being use

- Know what they mean or fail to describe
- Question, question, question

"Details do not make perfection,
but perfection is made of details."

Multiple Sages



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