

# Sleep: Health and Disease

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# Objectives

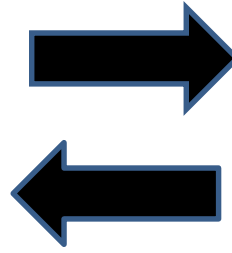
- Alternative model for Health and Disease (*complex systems*)
  - Describe the role of complexity in health and disease
- Sleep Basics
  - Describe the functional and behavioral definitions of sleep
  - Characterize cycle/sleep architecture
  - Describe physiological changes associated with sleep
- Diseases associate with poor sleep
  - Discuss the cost of sleep disturbance
  - Review common diseases closely associate with sleep



# Introduction



Sleep - Health



Disease

- My background
- Close association between Physiological Sciences and Osteopathic practice
  - Homeostasis
  - Primary focus on the dynamic processes involved in homeostasis (complex system)
- Complexity view of disease
- Goal of presentation
  - Alternative view of sleep and its relationship to disease

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**Coupling, Complexity, Health, and Disease**

Heart - Lungs - Nervous - Kidney - Endocrine

**Synchronization of  
Metronomes**

starring Daniel

*Manipulating variables - minimal impact on recoupling*

*Exercise and sleep – big role in recoupling*

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# Rule of thumb



Healthy



Disease

Because the body is a complex system:

When the body is healthy physiological mechanisms protect the healthy state

When the body is diseased physiological mechanisms protect the disease state

# Sleep Basics



## Matthew Walker quotes

Why we Sleep: Unlocking the Power of Sleep and Dreams

- “Every single disease that’s killing us in the developed world has causal links to a lack of sleep”
- “The shorter you sleep, the shorter your life”
- “Sleep is a life support system and it’s mother nature’s best effort yet at immortality”
- “There is no physiological system that we’ve been able to measure that isn’t enhanced by sleep when you get it demonstrably impaired when you don’t get enough”
- “Sleep is the swiss army knife of health. No matter what the ailment, there is something more than likely in sleep’s toolbox that will deal with it”



# Behavioral Definitions



## Wakefulness

- A state in which the person is aware of and responds to sensory input from the environment.



## Sleep

- A state of behavioral quiescence accompanied by an elevated arousal threshold and a species specific body posture (recumbent).
- Sleep is a state of reversible unconsciousness in which the brain is relatively more responsive to internal than external stimuli.



# Sleep Function

- Memory consolidation
- Energy conservation
- Body growth
- Regulation of immune function
- “CNS homeostasis”
- “Couples physiological systems”



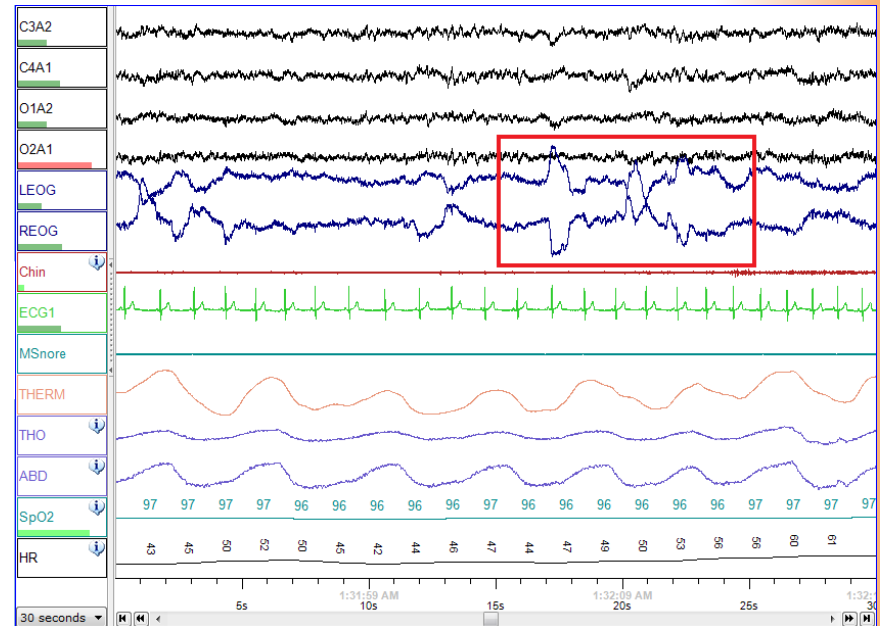
# Sleep Architecture

- A term used to describe the divisions of sleep among the different sleep stages using specific EEG, EOG, and EMG criterion
- Types of sleep
  - NREM
    - subdivisions – Stages N1, N2, N3
    - 75-80% of sleep
  - REM
    - Also called paradoxical or desynchronized sleep
    - 20-25% of sleep



# Polysomnography

- Is the standard for diagnosing obstructive sleep apnea syndrome (OSAS), determining the severity of the disease, and evaluating various other sleep disorders that can exist with or without OSAS.
- Recording of multiple physiologic parameters related to sleep and wakefulness.
- Home-based, limited-channel sleep studies are being used, but they have some limitations.
- PSG can directly monitor and quantify the number of respiratory events (ie, obstructive, central, or complex) and the resultant hypoxemia and arousals related to the respiratory events or even independent of the respiratory events.
- PSG is used to evaluate abnormalities of sleep and/or wakefulness and other physiologic disorders that have an impact on or are related to sleep and/or wakefulness.



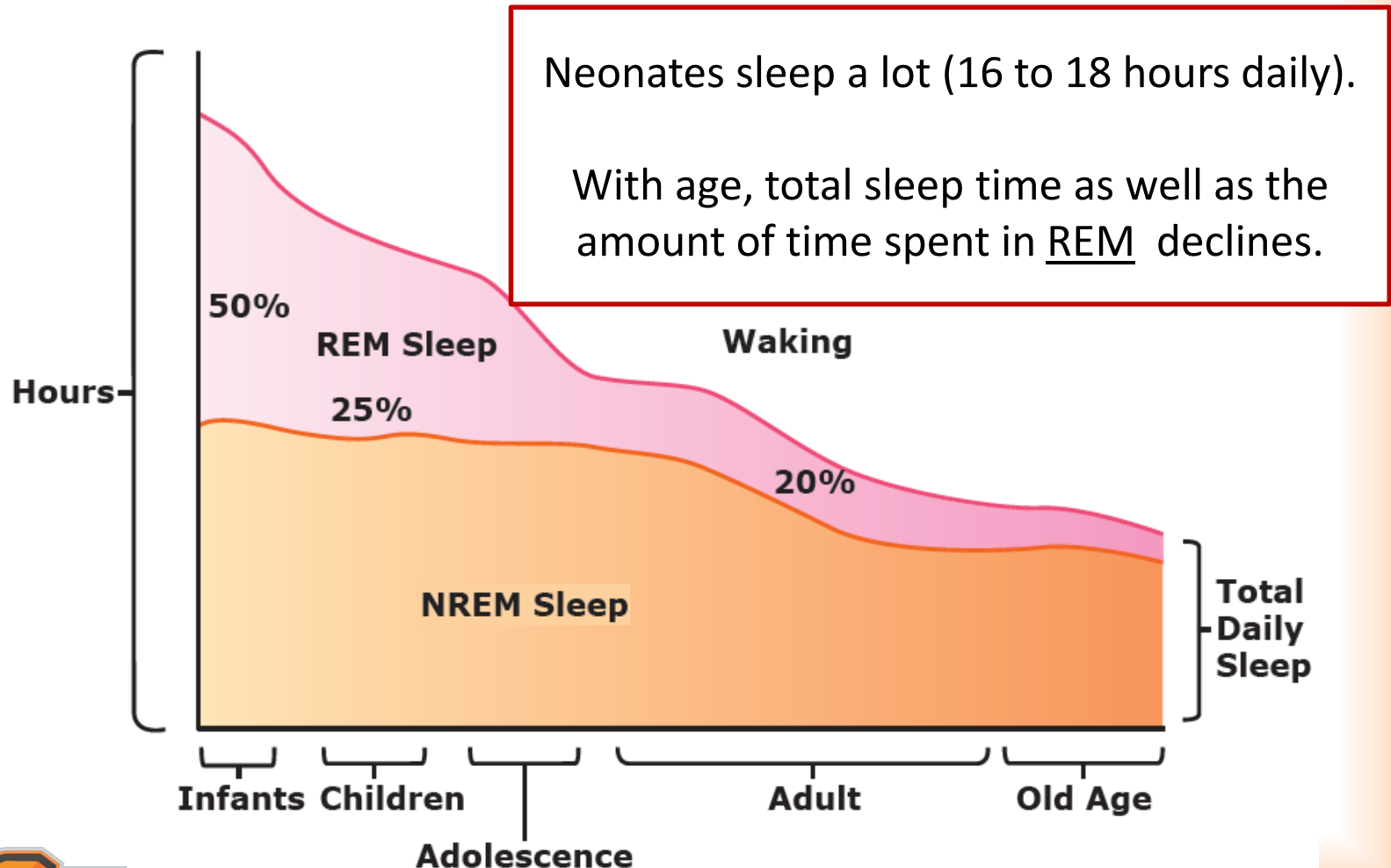
# Sleep Stages

## Sleep Stage Nomenclature

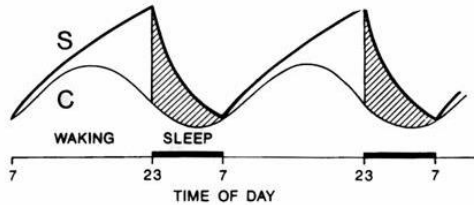
	R&K	AASM
Wake	Stage W	Stage W
NREM	Stage 1	Stage N1
	Stage 2	Stage N2
	Stage 3	Stage N3
	Stage 4	
REM	Stage REM	Stage R
AASM = American Academy of Sleep Medicine <sup>2</sup> ; NREM = non-rapid eye movement; R&K = Rechtschaffen and Kales A <sup>1</sup> ; REM = rapid eye movement; stages 3 and 4 are combined into stage N3.		



# Changes in sleep pattern with age



# Two-Process model of sleep regulation



Borbely, A. A. In *Principles and Practice of Sleep Medicine*, 1994

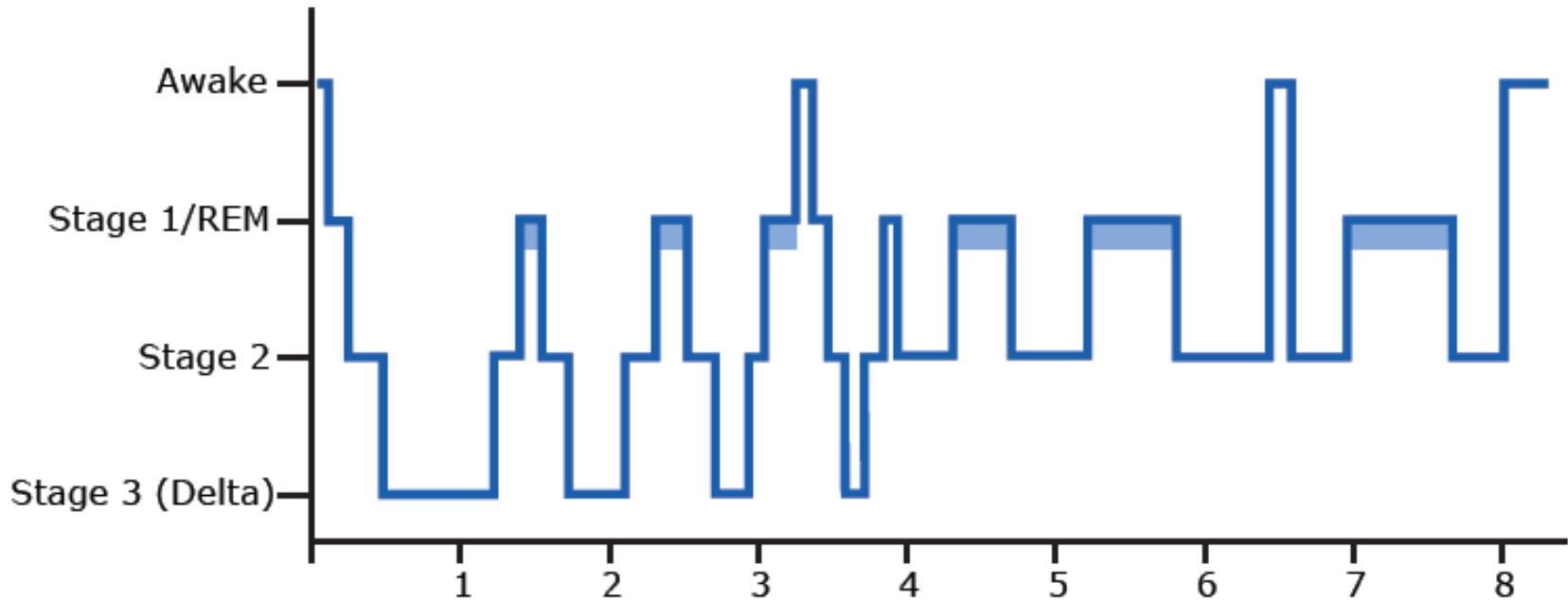
20

- Rocks in your backpack
  - Add 1 rock every waking hour
  - Remove two rocks every sleeping hour
- *Note:*
  - *You cannot bank sleep*
  - *Humans – the only species that purposefully deprives sleep*

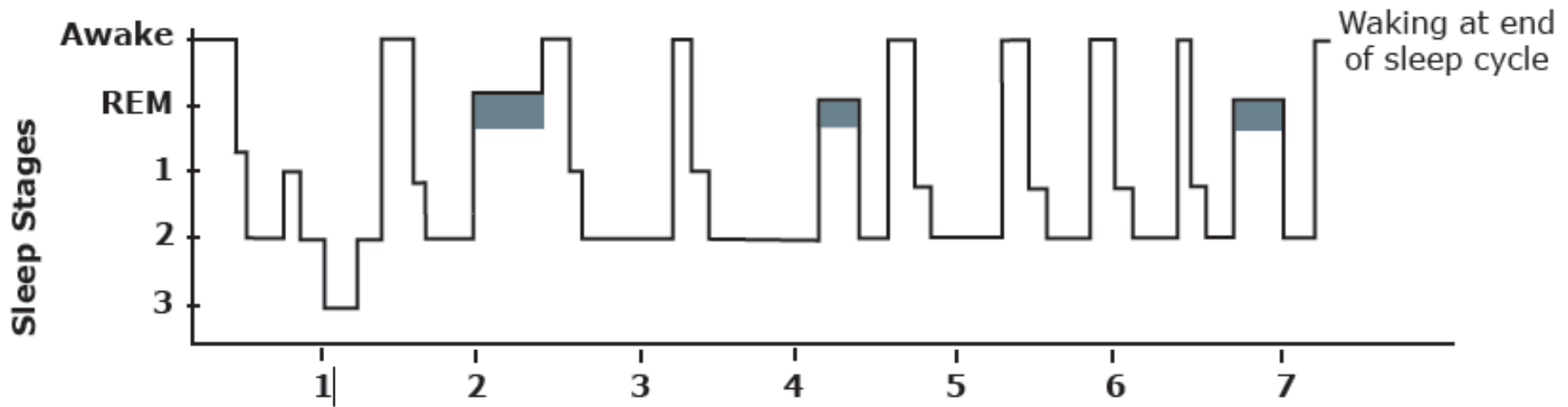


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# Young Adult



# Older Adult



With age: less time is spent in slow wave deep sleep and more time in Stage 2 sleep.



# Physiological Changes with Sleep

PHYSIOLOGICAL PROCESS	NREM	REM
Brain activity	↓	<ul style="list-style-type: none"><li>• ↑ in motor and sensory areas</li><li>• ↓ in other areas</li></ul>
Heart rate	↓	↑ and varies
Blood pressure	↓	↑ (upto 30%)
Sympathetic nerve activity	↓	↑
Muscle tone	Similar to wakefulness	Absent
Respiratory rate	↓	<ul style="list-style-type: none"><li>• ↑ and varies from NREM.</li><li>• May show brief stoppages.</li><li>• Coughing suppressed.</li></ul>
Airway resistance	↑	↑
Body temperature	↓ (Shivering initiated at lower temp)	<ul style="list-style-type: none"><li>• Not regulated</li><li>• Temperature drifts towards local environment</li></ul>
Blood flow to brain	↓	↑



# Respiratory Changes

## **Changes in ventilation:**

- Minute ventilation falls by 0.5-1.5L/min
- Secondary to reduction in TV
- Changes in blood gases:
  - PCO<sub>2</sub> rises by 2-8 mmHg
  - PO<sub>2</sub> falls by 3-10mmHg
  - Due to fall in minute ventilation

## **Respiratory rate and rhythm:**

- RR decreases during NREM sleep and increases during REM sleep
- RR becomes irregular during REM sleep
- **Chemosensitivity**
  - Hypoxic ventilatory response is decreased
  - Increased upper airway resistance to airflow
  - Decreased chemosensitivity
  - Hypercapnic ventilatory response is also decreased
- Increased upper airway resistance



# Diseases Associate with Sleep Disturbances



# Comments from the Field

- Sleep technicians
  - Frequently see AF in patients with sleep apnea.
  - AF frequently resolves with CPAP treatment
  - Frequently observe central sleep apnea with heart failure
  - Just by looking at polysomnography many patients with substance abuse can be identified
- Educators
  - Sleep deprived students have trouble assimilating new information.
  - Sleep deprivation decreases cognitive abilities
  - Sleep deprivation impairs memory consolidation
  - Sleep deprivation increase risk for accidents in trucking industry
- Medical curriculum
  - 3<sup>rd</sup> and 4<sup>th</sup> year students

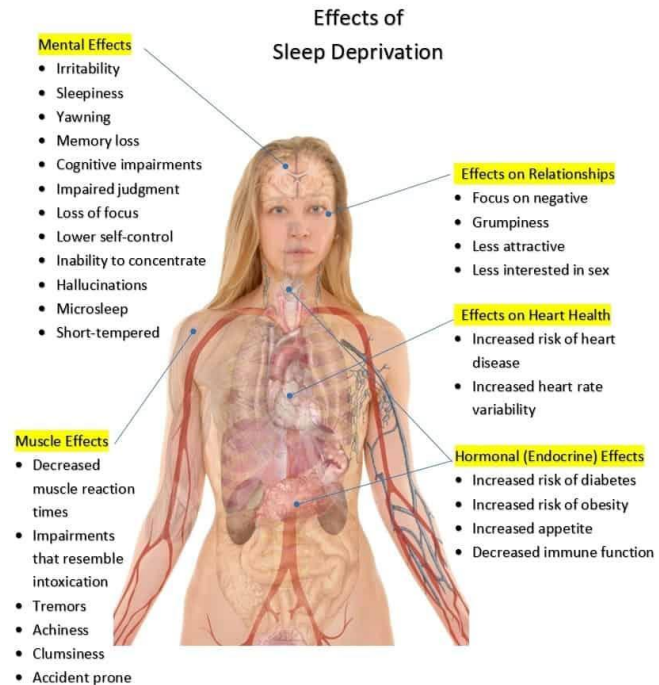
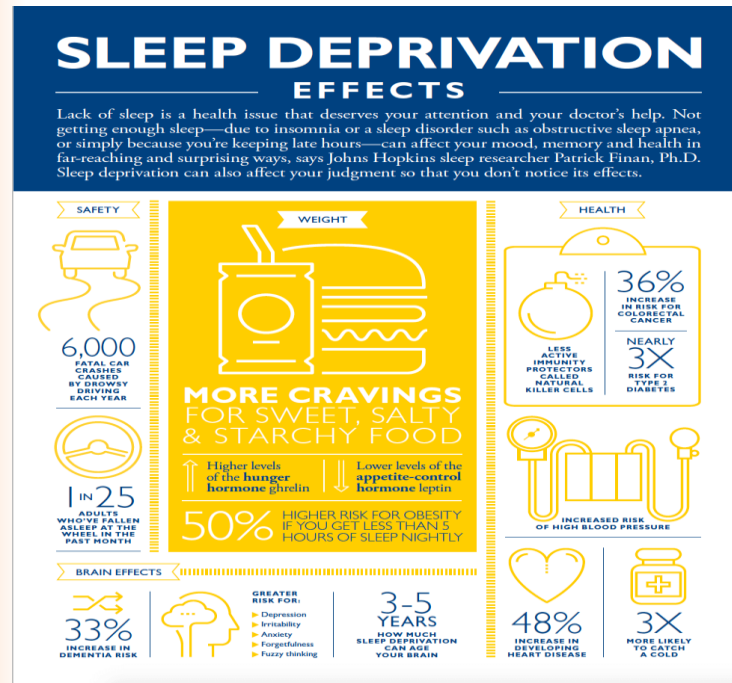


# Sleep Deprivation

- Increased risk of mental health conditions, especially anxiety
- Excessive daytime sleepiness
- Poor diet
- Reduction in both desire to exercise and participation in exercise
- Weaker physical health and depressed immune system
- Impaired cognitive control
- Impaired attention and memory retention
- Increased risk-taking behavior
- Diminished control of attention and behavior
- Poor emotional control and increased risk of loneliness
- Increased risk of Alzheimer's disease
- Altered physiological control system (ANS, hormones, ventilation)



# Sleep Deprivation

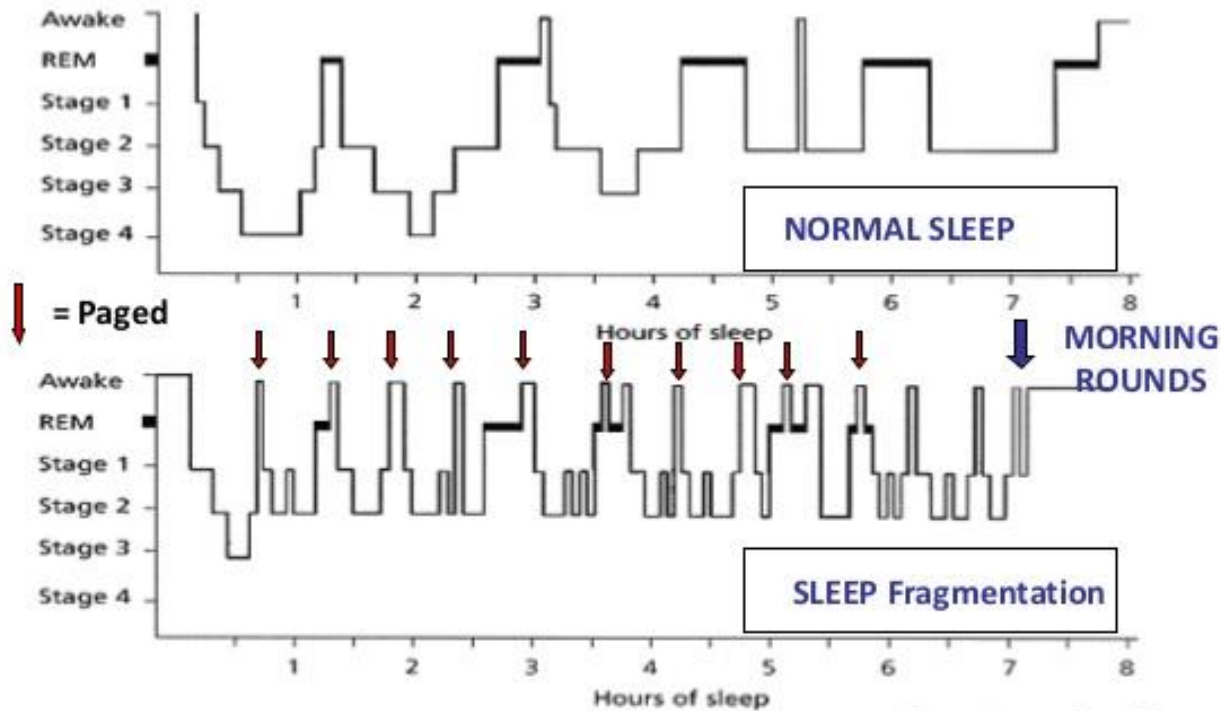


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American Academy of Sleep Medicine

## Sleep Fragmentation Affects Sleep Quality

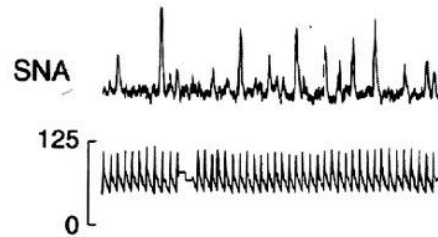


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# Sympathetic-Nerve Activity during Sleep in Normal Subjects

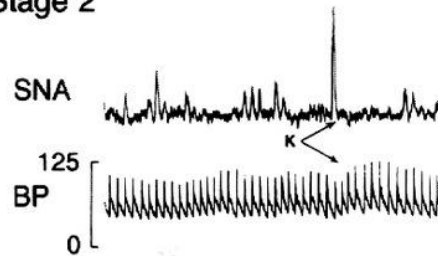
Awake



Stage 4



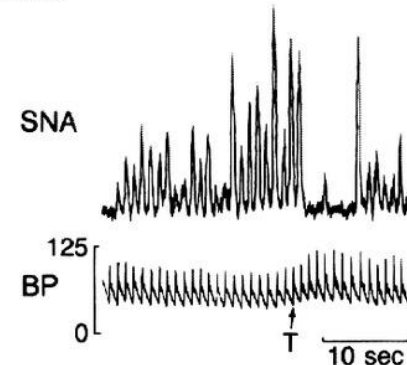
Stage 2



Stage 3



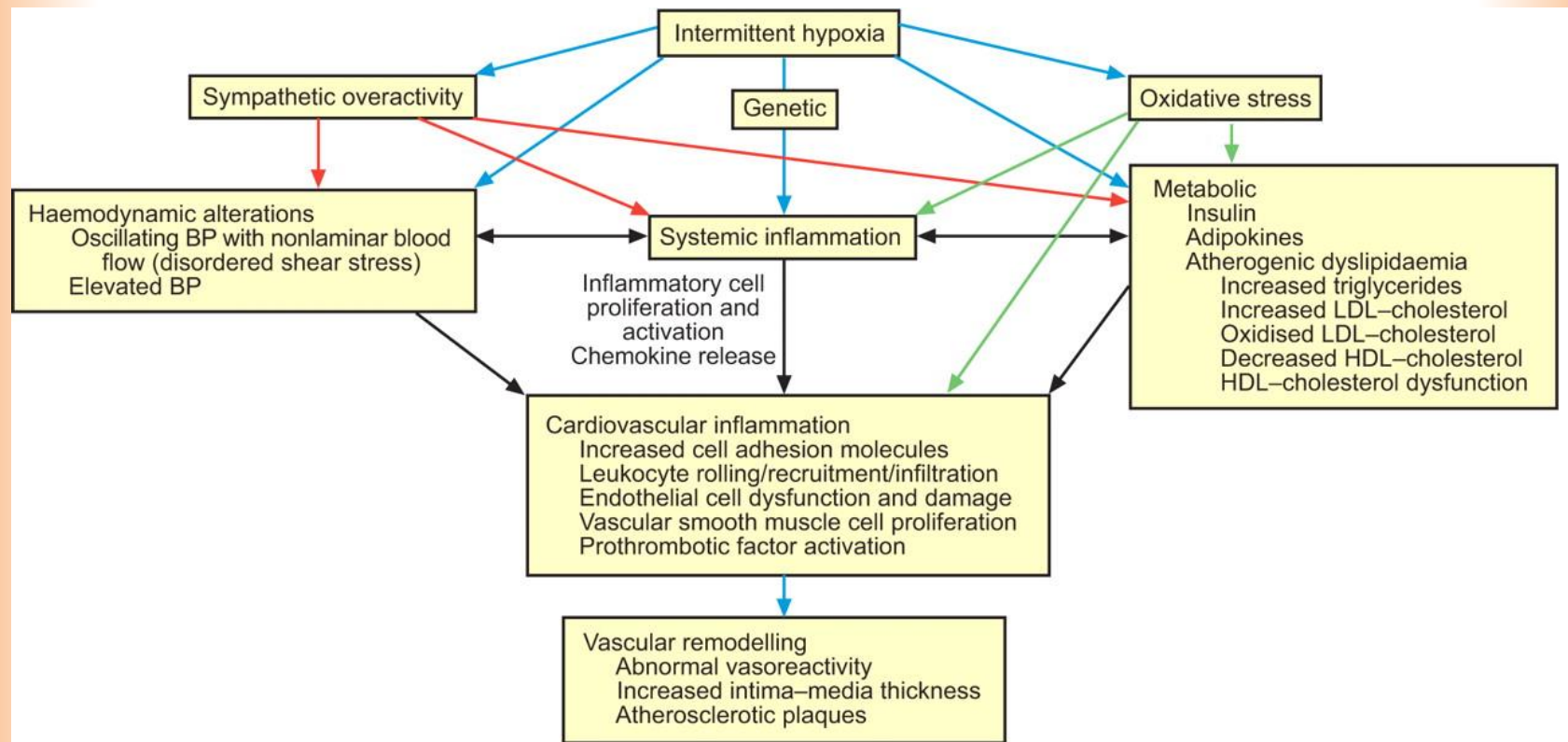
REM



N Engl J Med 1993; 328:303-307



# Intermittent hypoxia and sleep-disordered breathing: current concepts and perspectives



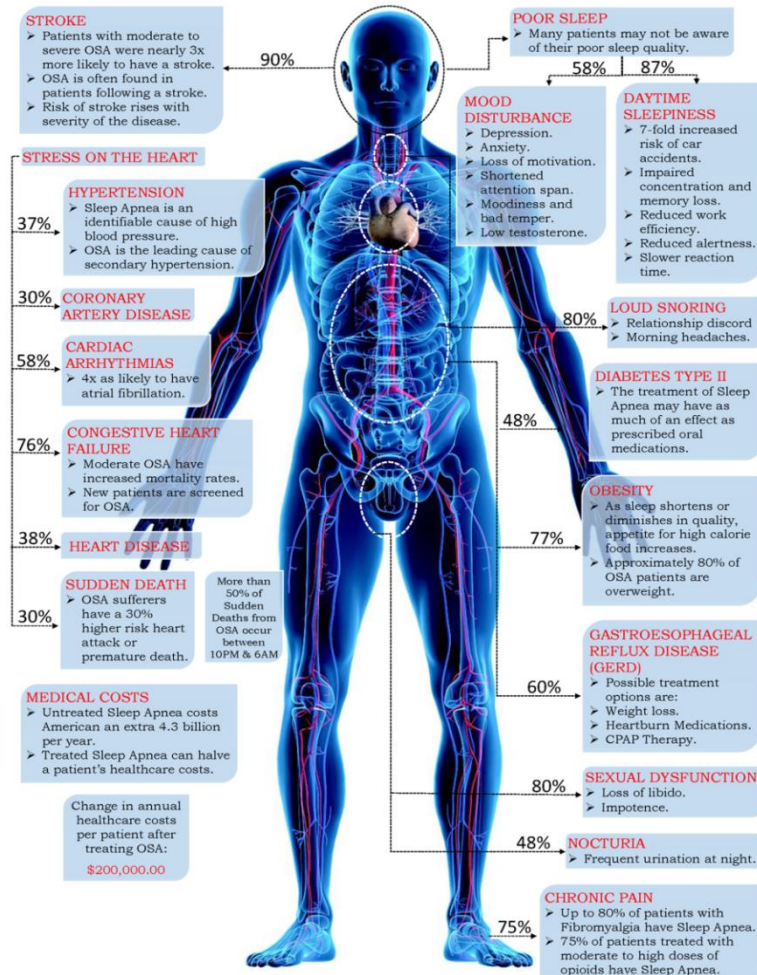
European Respiratory Journal 2008 32: 1082-1095

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## The Consequences of Obstructive Sleep Apnea

Obstructive Sleep Apnea afflicts 1 in every 5 Americans.  
What other problems arise for OSA Patients?

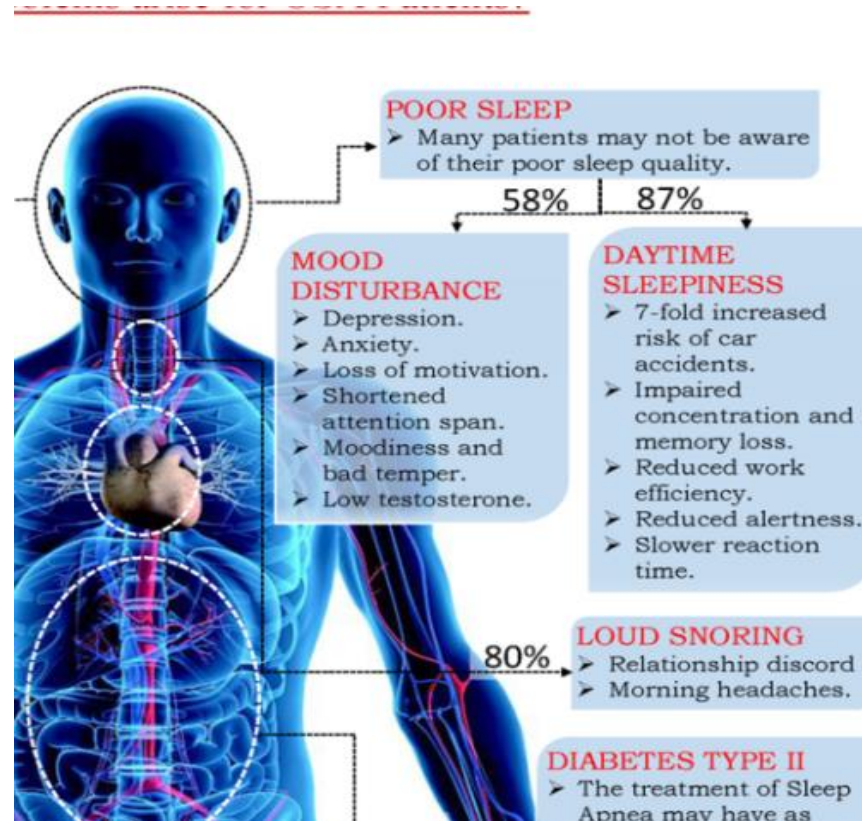


If you suffer from any of the conditions above consult your physician about getting tested for Sleep Apnea

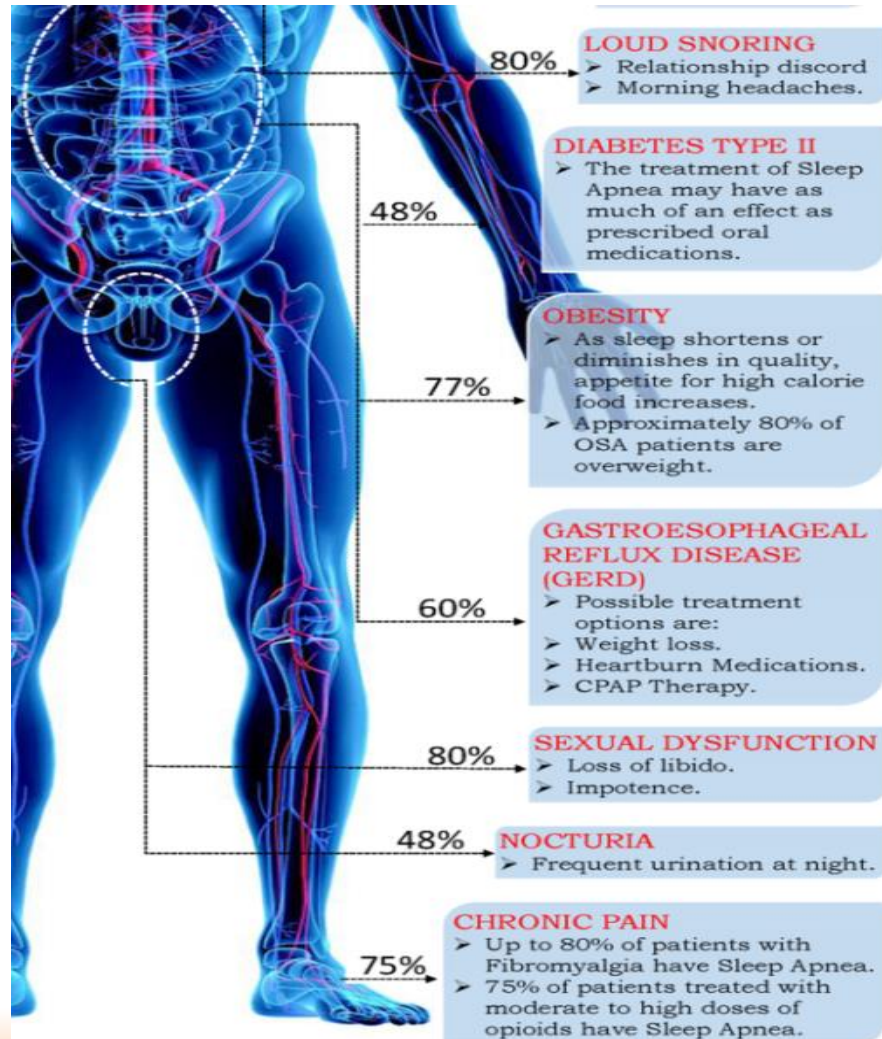
Sources: Medscape, Pubmed.gov, BioMed Central



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## The Consequences of Obstructive Sleep Apnea

Obstructive Sleep Apnea afflicts 1 in 5 Americans  
What other problems arise for C

### STROKE

- Patients with moderate to severe OSA were nearly 3x more likely to have a stroke.
- OSA is often found in patients following a stroke.
- Risk of stroke rises with severity of the disease.

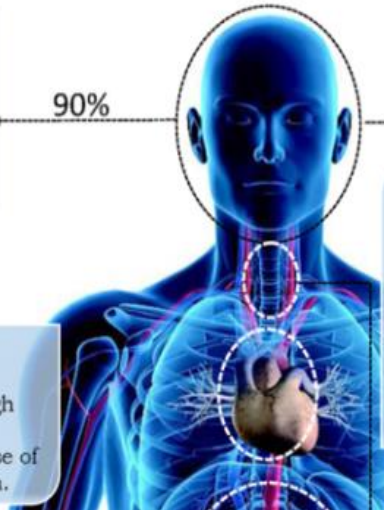
90%

### STRESS ON THE HEART

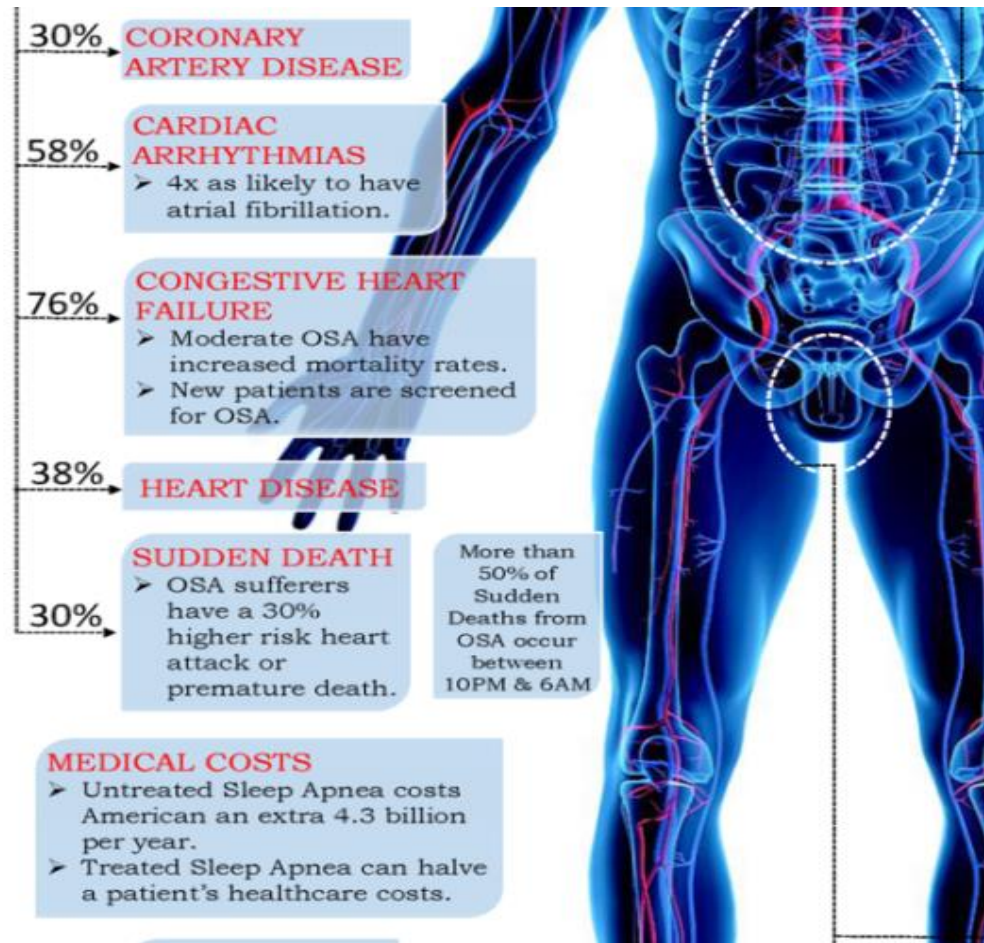
#### HYPERTENSION

- Sleep Apnea is an identifiable cause of high blood pressure.
- OSA is the leading cause of secondary hypertension.

37%



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# Summary

- The body is a complex system. Health is based on coupling of these systems. Disease in many instances is caused by decoupling.
- Optimal treatment plans would include interventions that recouple systems. Two examples are exercise and sleep.
- Many chronic diseases negatively impact sleep architecture.
- It is now clear that poor sleep can cause disease.
- Generally accepted that smoking, drinking too much, lack of exercise, poor nutrition, and social isolation negatively impact health.
- Proper sleep must be part of a prevention model.



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