Presented By:
Dennis R. Bailey, DDS

Course Outline and Plan

- Morning Session – 8 AM to Noon
  - Introduction to Sleep Medicine and Sleep Disorders
  - Health Consequences of Sleep Disorders – Overview
  - The Role of the Dentist – Importance of Nasal Airway
- Afternoon Session – 1 to 4 PM
  - Sleep Bruxism – The Unknown Sleep Disorder
  - Basics of Pediatric Sleep Disorders
  - Oral Appliance Therapy – Splints vs Oral Appliances

Introduction and Basics of Sleep Medicine

Dennis R. Bailey, DDS, FAGD, D,ABDSM, FAAOP

Private Practice: Denver, Colorado

Co-Director: UCLA - Sleep Medicine Mini-Residency

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Past Chair (2012-2016): Sleep Medicine Committee – AAOP

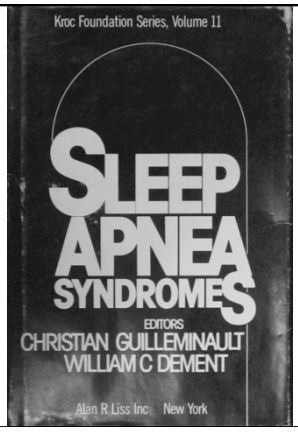
Disclosures

(non-financial)

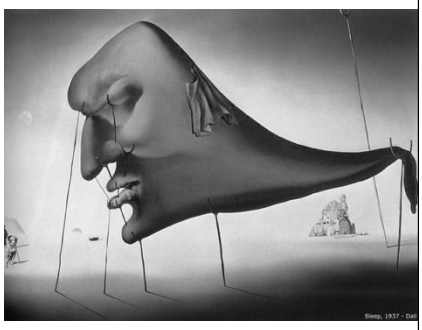
<u>Consultant</u>:
CareCore / MedSolutions
Now: eviCore healthcare
<u>Co-author:</u>
Dental Management of Sleep Disorders
<u>Consultant</u>:
RhinoMed (Mute)

In the Beginning

July 1977



Le Sommeil (Sleep) 1937 Salvador Dali
Body's collapse into sleep
Imagined sleep as a heavy monster that was "held up by the crutches of reality"



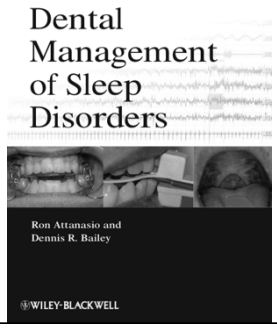
History and Sleep

- Based on "Wild Nights" by Benjamin Reiss professor of English – Emory Univ.
- Sleep pre and post the Industrial Revolution around 1800
- Late 1800s the unions mandated 8 hours work, 8 hours rest and 8 hours for what you will
- Pre-Industrial Revolution sleep was not contiguous but was in four hour blocks

Roger Ekirch (Historian) Reports

Prior to the Industrial Revolution we had "segmented" sleep – First four hours was "dead sleep" and second four hours "morning sleep" was separated by 1+ hours of quiet wakefullness called "the watching". This persisted into the early part of the 20th century in some cultures.

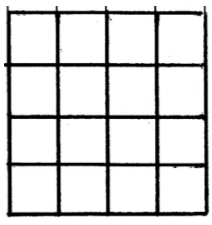
Text on Dental Sleep Medicine



Aoccdrnig to rseaecrh at Hravard Uinervtisy, it deosn't mttaer waht oredr the ltteers in a wrod are, the olny iprmoatnt tihng is taht the frist and lsat ltteer be in the rghit pclae.

Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe.

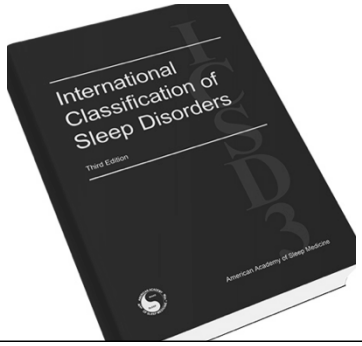
What Do You See? How many squares?



Introduction to the Course Sleep Medicine and the Dentist

- NOT *Dental* Sleep Medicine – Consider Sleep Medicine in Dentistry
  Oro-Sleep Medicine or
  Oro-Facial Sleep Medicine
- It is all about the Dentist's Role in Sleep Medicine
- Focus is on the Oral Appliance therapy
- It is also about other sleep disorders that may impact the patient

ICSD-3 - What Does This Say?



ICSD-3

- Insomnia – Chronic and Short Term
- Sleep Related Breathing Disorders
- Central Disorders of Hypersomnolence
- Circadian Rhythm Sleep-Wake Disorders
- Parasomnias
- Sleep Related Breathing Disorders
- Other Sleep Disorder
- Appendix: A & B

Earliest link between Sleep and Performance

Nathanial Kleitman in the 1930's

Showed the link between sleep and performance

Sleep Deprivation negatively effects mood, ability to focus and our ability to access higher level cognitive function

How Do We Define Performance? Related to Sleep and Sleep Deprivation

- Cognitively
- Functionally
- Behaviorally
- Socially
- Athletically

Insufficient Sleep and Accidents

Examples of Sleep Deprivation:

- Exxon Valdez
- Three Mile Island
- Chernobyl
- Challenger space shuttle

Ref: The Promise of Sleep
William Dement, MD, PhD

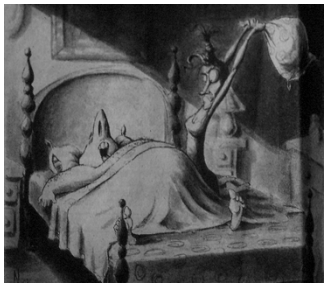
Sleep Medicine Alert, 1999

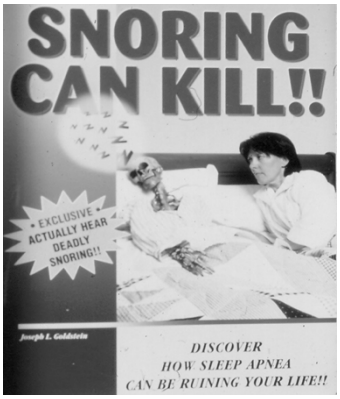
We Sleep 25% Less
Than Our Forefathers

SUSTAINED WAKEFULLNESS

17 Hours can Lead to a Decrease in Performance Equivalent to a Blood Alcohol Level of 0.05

Snoring – The Universal Sleep Disorder





Treatments Can Vary

Sleep Disorders

25% of Americans Complain of Trouble Sleeping

25% of Americans Complain of Excessive Fatigue

According to a Gallup Survey

Over 29%

With Sleep Problems

Use OTC Medications

"Getting the Sleep You Need"

Average American Gets
243 Hours Less Sleep
Per Year than they did in 1969

Sleep Research Institute
"Getting the Sleep You Need"
Washington, D.C. Feb/ March1999

13% of young adults
Ages 18 - 29

complain of falling asleep at work

National Sleep Foundation's Sleep In America Poll

51% Report that Sleepiness

Interferes with the Amount of Work

They Get Done

The Morning Commute

National Commission on Sleep Disorders, 1993

40 Million Americans have
Some Type of Chronic Sleep Disturbance

20-30 Million have Intermittent Sleep Related Problem

Falling Asleep On The Job

911 Operator Falls Asleep On A Call
(Anne Arundel County, Maryland)

On July 24, 2004, a woman was startled awake
She thought someone was breaking into her home
She called 911 – as she described the situation the operator fell asleep to the point of snoring

100 Million

The Number of Americans Every Night
Who Fail to Get a Good Night's Sleep

Estimated by the American Academy
of Sleep Medicine

What Wives Like Least About Sleeping With Their Husbands

1. Snoring
2. Hog the Bed
3. Steal the Covers
4. Kick the Bed-Partner
5. Bruxism

From: USA Today, 1993

Sleep Disorders
Sleep Deprivation
Excessive Daytime Sleepiness

Add $16 Billion
to Healthcare Costs

Sleep Disorders
Sleep Deprivation
Excessive Daytime Sleepiness

Result in $50 Billion
In Lost Productivity

Sleepiness Kills

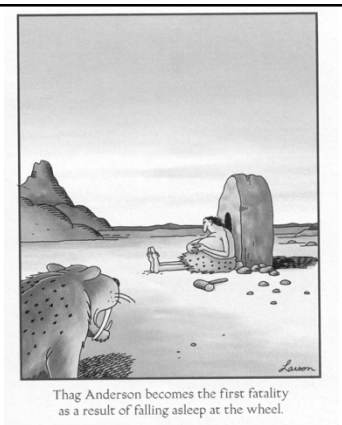
One In Five

Adult Americans Who Admit to Falling Asleep Behind the Wheel in the Last Year

From: National Sleep Foundation Study 2002

Results of Drowsy Driving Annually

1,550 Deaths
76,000 Injuries
100,000 Police Reported Crashes
$12.5 Billion in Monetary Losses
Source: National Highway Traffic Safety Administration



Thag Anderson becomes the first fatality as a result of falling asleep at the wheel.

National Sleep Foundation Sleep in America Poll 2009

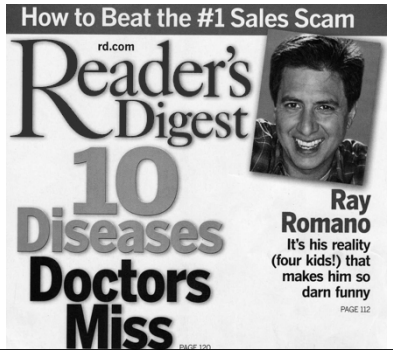
- 105 million (54%) have driven drowsy in the past year
- 54 million (28%) have driven drowsy at least once in the past month

2009 Sleep in America Poll

- 20 % report sleeping less than 6 Hrs on average - a decrease since 2001
- 27% have disturbed sleep a few nights a week in the past month
- 7 Hrs 24 mins optimum sleep - usually get 6 Hrs 40 mins on typical workday

www.sleepfoundation.org (NSF)

February 2004



10 Diseases Doctors Miss

- Celiac Disease
- Hypothyroidism
- Lyme Disease
- Lupus
- Sleep Apnea

More Facts

- Sleep is just as important as diet and exercise
- The body NEVER adjusts to shift work
- Snoring is the primary cause of sleep disruption in 90 million adults (37 million on a regular basis)
- Do not sleep enough - bigger appetite / more hungry (lower leptin level)

Ref: National Sleep Foundation

Random Facts About Sleep

- Man is the only mammal that willingly delays sleep
- Exercise regularly and sleep better
- 6 out of 10 health care providers feel they do not have adequate time to discuss Insomnia with patients
- Caffeine - "most popular drug in the world" Coffee beans 2nd most traded commodity
- Naturally feel tired at 2PM and 2AM

What is This Thing Called Sleep ?

Overview of Sleep

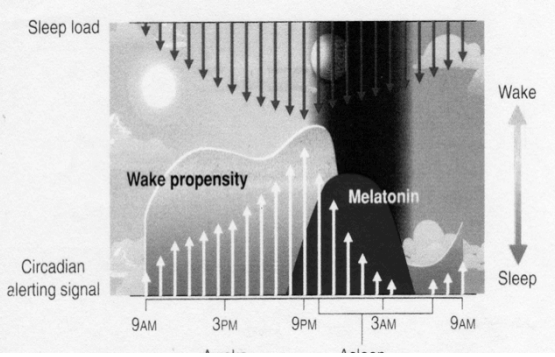
Overview of Sleep Disordered Breathing (Snoring & Sleep Apnea)

Length of Human Cycles

Circadian: About One Day (24.2 Hrs ["tau"])
Sleep / Wake Cycle - Temperature
(present thru history – plants have a rhythm)

Infradian: Greater than every 24 hour
Longer than a Circadian Rhythm
(Menstrual Cycle, Depression)

Ultradian: Biologic Rhythms (variations) that occur more frequent every 24 hours - more than one time a day (heart rate, thermo-regulation, nostril dilation)



Two Circadian Rhythms

Independent of the Sleep-Wake Cycle

- Main Function: Promote Wakefullness
- Related to peaks in alertness
  late morning & early evening
- Related to troughs in alertness
  early morning & early afternoon

Basics of Sleep & Circadian Rhythm

Zeitgeber

- Time Keeper
- Time ques - light - dark - noise - social interaction that allows people to entrain to the 24 hour cycle

Entrainment

- Methods by which sleep / wake cycle is controlled
- Synchronization of a biologic rhythm

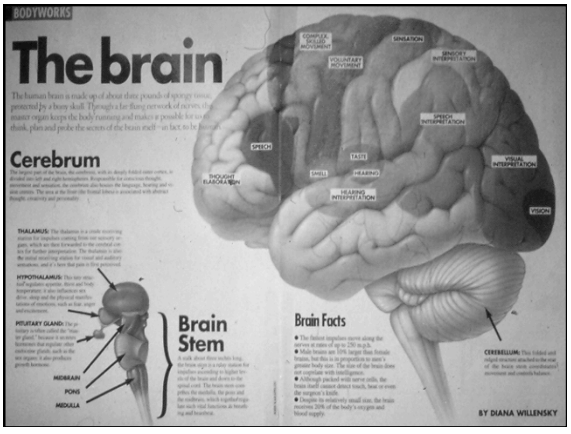
Free Running Clock

- No schedule
- Fluctuating sleep wake cycle
- Examples:
  Unemployed
  Retired
  Summer Break

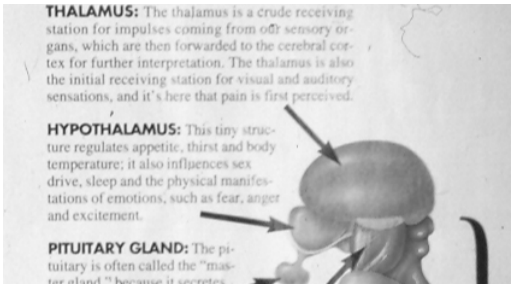
Sleep Is Work !

Brain Activity shifts into New Areas

Brain Chemistry Changes
The Brain Uses More Oxygen While Asleep
Than Awake !



The Brain Stem



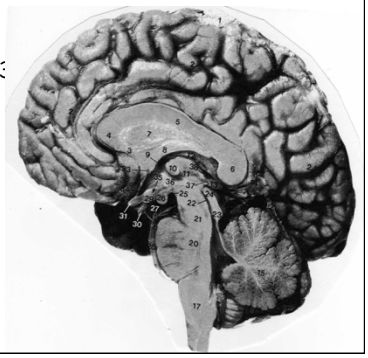
THE BRAIN AND SLEEP

Pineal Gland (#13

Hypothalamus (#36)

Optic Nerve (31)

Area of the SCN (#29)



Neurotransmitters and Wakefulness

- The Excited / Stimulated Awake circuitry
  Brainstem Monoamines
  - Norepinephrine (NE)
  - Serotonin (5HT)
  - Dopamine (DA)
  - Acetylcholine (Ach)
  - Hypocretin (Orexin)
  - Glutamate (CNS excitatory neurotransmitter)
- Calm / Quiet Wakefulness from Hypothalamus
  Histamine

Additional Neurochemical Wake Promoting

- Cortisol
  Wake promoting
  Increased in Insomnia

Neurobiolgy of sleep

- Acetylcholine: REM sleep neurotransmitter (decreased in NREM)
- GABA: Main central nervous system neurotransmitter - CNS inhibitory neurotransmitter
- Adenosine: Sleep neurotransmitter (blocked by caffeine) accumulates as the day progresses
- Glycine: inhibitory neurotransmitter in the spinal cord (causes muscle atonia in REM)

Also For Sleep

- **Melatonin** (a hormone)
- Entrainment of the Circadian cycle

Initiate Sleep – Derived from Tryptophan
➔ Serotonin – Released From Pineal Gland

- Potent Anti-inflammatory
- Levels altered by altered influence of light – especially at night

Melatonin

Study done with the Zebrafish

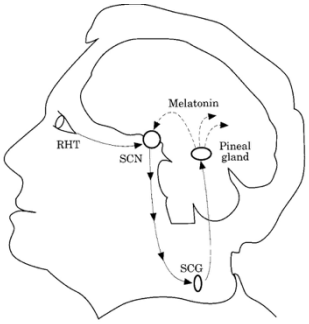
- More produced at night (regardless if animal nocturnal or diurnal)
- Production and effect related to a gene "aanat2"
- Action: "turns on Adenosine" thus regulates the homeostatic pathway

J Neuron

March 5, 2015

LIGHT AND THE EFFECT ON THE PINEAL GLAND

Optic Nerve → SCN → Spinal Cord →Superior Cervical Ganglion ➔ Pineal Gland



Being Sleepy / Tired - 13.5% report related difficulties

- 23.2% have difficulty concentrating
- 18.2% have difficulty remembering things
- Difficult to work on hobbies
- Hard to perform employment or volunteer work

Ref: CDC:Weekly Morbidity & Mortality Report

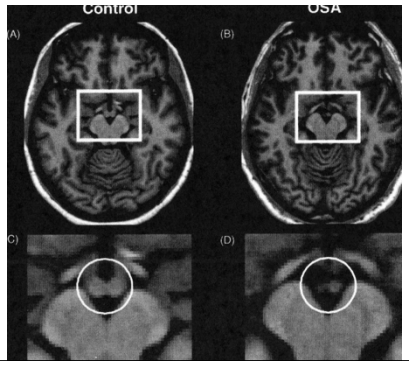
Sleep and Memory

- Sleep is involved in memory consolidation
- Process of changing new memory into more permanent form
- Begins with encoding - represents stored experience in the brain

Memory Recall and Sleep Deprivation

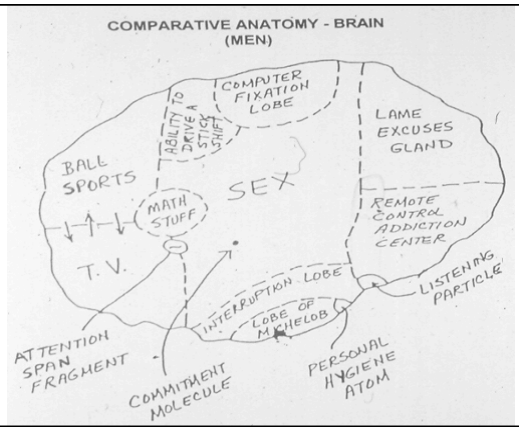
- Sleep Deprivation led to more difficulty with memory encoding performance (recall)
- Resulted in lower predictive ability of performance
- Sleep important both before learning and after - helps with memory formation and encoding

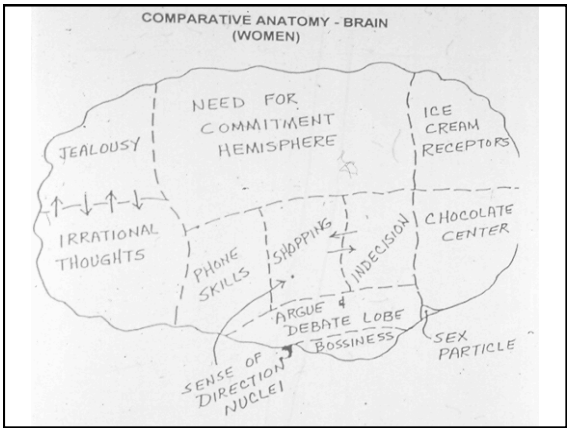
Learning and Memory

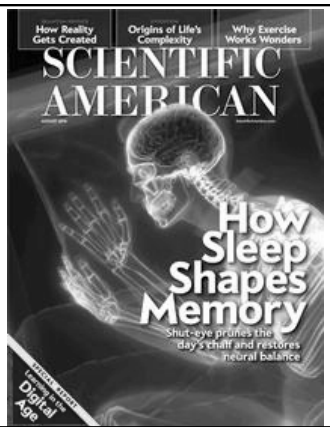


Mamillary Bodies

- Associated with memory
- Damage associated with memory loss
- Common in OSA - may be related to hypoxia
- Associated with Thiamine (B1) deficiency similar to chronic alcoholism (Korsakoff's syndrome)

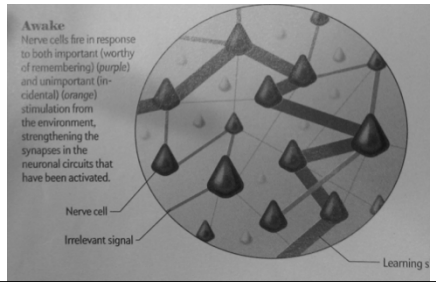






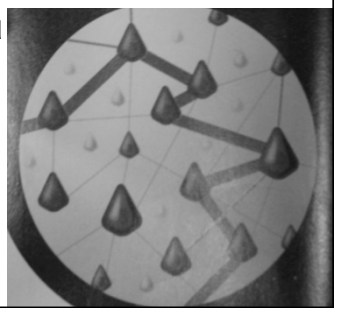
Why We Sleep
Scientific American – Aug 2013

- When awake neurons strengthen their links



When asleep

- Weakens neuronal links – conserves energy
- Newly formed memories now "stick"



Plasticity

- In humans the brain accounts for 20% of the body's energy budget
- Synaptic weakening during sleep restores brain circuitry to baseline – reduces excess energy use
- Sleep – restores brain "to a state where it can learn and adapt while awake"

Brain Chemistry

- Awake – "soup of signaling chemicals" includes acetycholine, norepinephrine, dopamine, serotonin, histamine, hypocretin
- During NREM soup less concentrated
- Synapses weaken · soup less concentrated
- Involves brain-derived neurotropic factor (BDNF) promotes synaptic strengthening and leads to memory acquisition – BDNF present during the awake state and lower during sleep

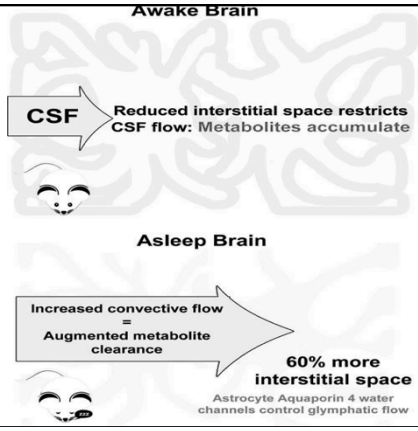
Sleep Drives Metabolic Clearance from the Brain

- Brain lacks a conventional lymphatic system – instead CSF circulates through the brain – interchanges with interstitial fluid (ISF) and removes interstitial proteins (β-amyloid)
- CSF influx around arteries and ISF exists along veins
- Termed the *glymphatic system* ➔

Sleep Drives Metabolic Clearance cont.

- Interstitial space during sleep is 60% greater – thus an influx of CSF
- ISF increases removal of β-amyloid removal and other toxins
- Lack of sleep allows these toxins to accumulate
- Called the "dishwasher effect"

Science Vol 342 Oct 18, 2103



Sleep Facilitates Clearance of Metabolites from the Brain: Glymphatic Function in Aging and Neurodegenerative Diseases

Rejuvenation Research

AR Mendelson and JW Larrick

Vol 16, No 6, 2013

Brain Glymphatic Transport

A Rodent Study

- Transport controlled by the brain's arousal system during sleep
- Using MRI transport most effective in the lateral position – not as effective in supine or prone position
- Lateral position has "evolved" to optimize waste removal

J of Neuroscience Aug 2015

35(31):11034-11044

SirT3 (Sirtuin3) Protein

- Protects neurons in the Locus Coeruleus (related to alertness, attention, regulates sleep/wake cycle and cognition)
- Upregulates this protein when there is sleep loss for mitochondrial energy production – Reduces reactive oxidative species (ROS)
- Only related to short-term sleep loss
- Extended wakefullness = SirT3 missing results in cell death due to increased ROS

J of Neuroscience March 2014 From: Univ of Penn

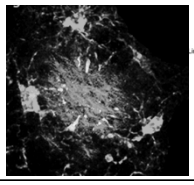
TREM2

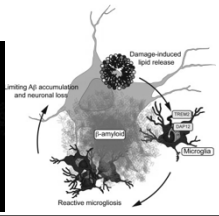
Triggering Receptor Expressed on Myeloid 2

- Microglial surface receptor that triggers the intracellular protein tyrosine phosphorylation
- Deficiency augments the accumulation of beta amyloid

In: Cell

2015





SLEEP DISORDERS

BASICS OF SLEEP MEDICINE

Historical Review of Sleep

- 1913 Henri Peiron published "*Le Probleme Physiologique du Sommeil"*
  considered sleep from physiologic perspective – hypnotoxin theory
- 1929 Johannes Berger – father of electroencephalography – described difference in brain activity during sleep and wakefullness

More History

- 1936-1937 - First continuous overnight sleep studies by Loomis and colleagues and gave rise to first sleep stage classification
- 1935 – Bunning coined the term "biological clock"
- 1953 – Asernisky & Kleitman revised sleep staging – mainly by finding REM sleep

More Recently

- 1972 – Robert Moore's work established circadian pacemaker in the SCN – soon after mapped the retinohypothalamic projection – linked light & darkness to sleep-wake circadian rhythm

DEFINITION OF SLEEP

Mostly Described By
What it is NOT

WHAT IS SLEEP ?

Poorly Understood
Effects Well Recognized

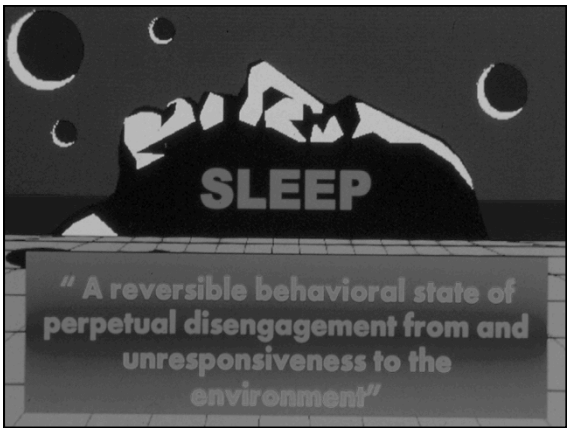
SLEEP

Not An Altered State
Of Consciousness

What Does it Mean To Be Awake

Wake State Instability is a
Cognitive / Memory Manifestation
of Sleepiness

Associated with Slow Wave Energy (SWE)



Another Definition

A complex reversible state characterized by behavioral quiescence, diminished responsiveness to external stimuli, and a stereotypical species-specific posture

Ancient Proverb

Sleep is a Short-Short death
Death is a Long-Long Sleep

A Quiz

Wide Awake
Low Energy
Tired
Drowsy
↘ (time)
Asleep

Partial Theory of Sleep

- Unlikely that Sleep has no Function
- Theories of Sleep Function
  Restorative and Somatic Growth
  Growth Hormone released at N3 sleep
  Metabolic theory
  Regulate body temperature
  Energy conservation
  Remove "toxins"generated while awake

Partial Theories

- Survival Theory
  Protective / Adaptive Behavior
  Immune Defense Function
- Neural Growth & Processing
  Neuronal Plasticity
  Brain Development / Restoration
  Learning / Memory

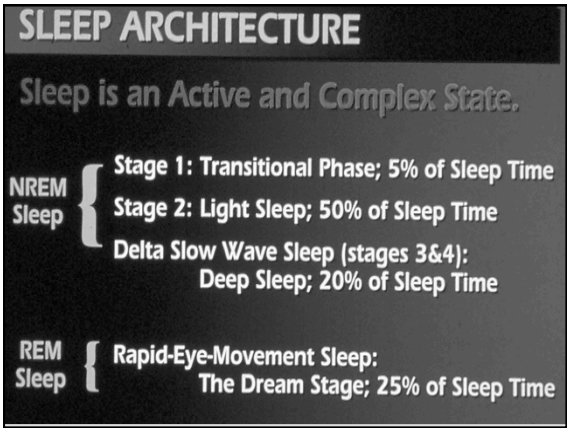
Short Sleep Duration and Obesity

- Decline in sleep duration over the past 50 years = 1.5 to 2 hr (Sleep in America poll 2005)
- Short sleep duration in children
  OR for obesity 1.89
- Short sleep duration in adults
  OR for obesity 1.55

Meta-Analysis of Short Sleep Duration and Obesity in Children and Adults SLEEP 2008;31(5):619-626

NORMAL SLEEP

Sleep Architecture



Sleep Architecture

Previous Scoring

- NREM
  Stage 1 Transition 5%
  Stage 2 Light Sleep 50%
  Stage 3 &4 Deep Sleep 20%
  Restorative Sleep
  Slow Wave Sleep
- REM Dream Sleep 25%

Updated Scoring

- NREM
  Stage N1 (NREM 1)
  Stage N2 (NREM 2)
  Stage N3 (NREM 3&4)
- REM
  Stage R (REM)
- Stage W (Wakefullness)

REM Atonia

- Norepinephrine – Serotonin – Histamine shut down
- Leads to muscle atonia
- Two types of REM: Phasic and Tonic

REM Sleep & Memory

- Effects Procedural and Spatial Memory
- **Procedural memory**: relates to everyday tasks – automatic retrieval like tying shoes
- **Spatial memory**: records information about the environment – driving around and finding your way

NREM & Memory

- **Declaritive memory**:
  Knowledge
  Facts
  Long term memory

Physiology During Sleep

- Compared to awake levels:
  Sympathetic activity diminished
  Parasympathetic activity increased during NREM
  Sympathetic activity increases during phasic REM

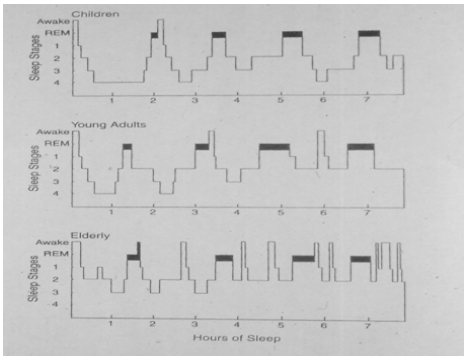
CV System

- Heart Rate, Cardiac output, Blood Pressure, systemic vascular resistance are lower during NREM
- All higher during phasic REM

Other Factors

- Urine production less – less glomerular filtration
- Gastric secretion at peak levels between 10PM and 2AM – least between 5AM and 11AM
- Endocrine system – growth hormone increased in N3 sleep

Sleep Architecture Across the Ages



Meta-Analysis of Quantitative Sleep Parameters From Childhood to Old Age in Healthy Individuals

Ohayaon M, Carskadon M, Guilleminault C, Vitello M
Sleep 2004;27(7):1255-73

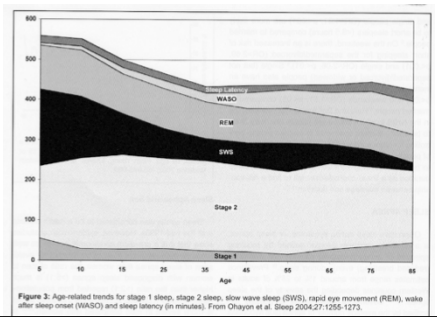
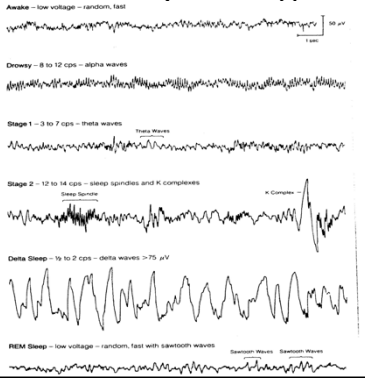


Figure 3: Age-related trends for stage 1 sleep, stage 2 sleep, slow wave sleep (SWS), rapid eye movement (REM), wake after sleep onset (WASO) and sleep latency (in minutes). From Ohayon et al. Sleep 2004;27:1255-1273.

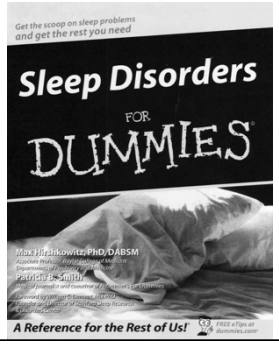
EEG Activity During Sleep



EEG Activity During Sleep

- Alpha Waves: Indicative of being Drowsy or in light sleep
- K Complexes: Component of NREM Stage 2 Sleep. Part of slow wave of activity. They quiet neurons in the brain - at different parts of the brain and not at the same time
- Sleep Spindles: Component of NREM stage 2 (N2). Acts as a filter during sleep to keep environmental noise or other sensations from being perceived during sleep

To Learn More



"Education is a progressive discovery of our ignorance"

James Howard
Univ. of Washington - 1984

Sleep Related Breathing Disorders SRBD

It All Potentially Starts with Mouth Breathing

Snoring

Sleep Apnea

(Obstructive Sleep Apnea Syndrome – OSAS)

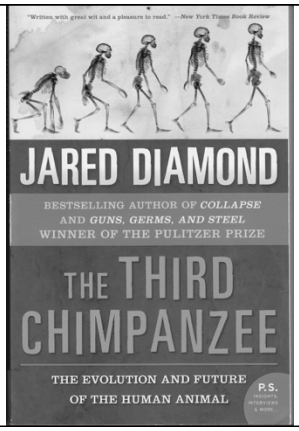
Hypopnea

Upper Airway Resistance Syndrome – UARS

Evolution and Development of the Modern Airway, Speech Acquisition and Obstructive Sleep Apnea

The Great Leap Forward Hypothesis

Davidson TM, Sedgh J, Tran D, Stepnowsky CJ
In: Sleep Med 2005;6(6):497-505



The Great Leap Forward

- Theory developed by Jared Diamond at UCLA in 1992
- Occurred about 40,000 years ago
- Predicated on the pressure to develop voice, speech and language

"The third chimpanzee: the evolution and future of the human animal"

Great Leap Forward

- Anatomic Changes to the Skull Evolved over Time to Facilitate Speech
- As a Result OSA Became More Severe
- The Maxillary & Mandibular Denture Bases were Altered
- The Nasal Airway Became Smaller
- The Tongue now Occupies the Oropharynx

Evolution of Airway Obstruction and SRBD

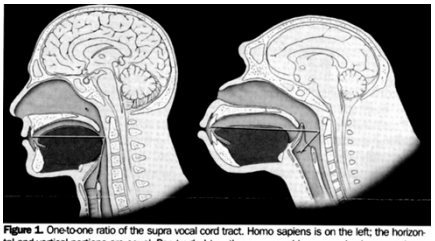
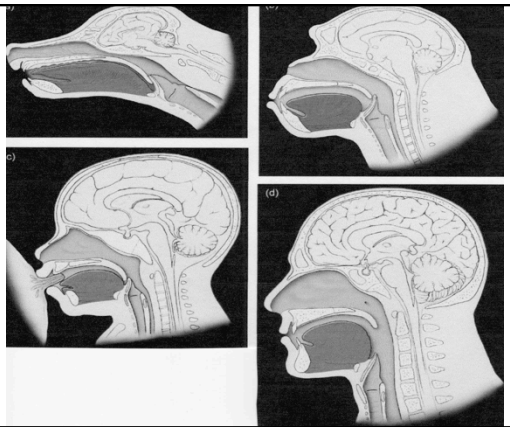
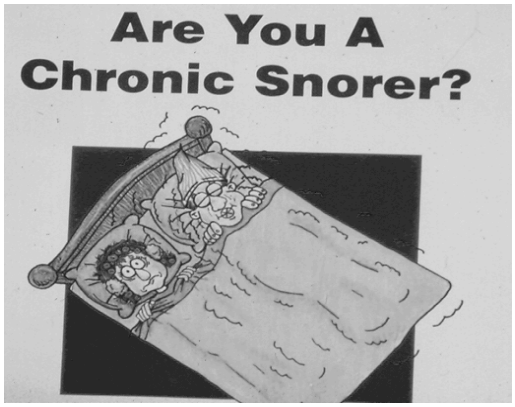


Figure 1. One-to-one ratio of the supra vocal cord tract. Homo sapiens is on the left; the horizontal and vertical portions are equal. Pan troglodytes, the common chimpanzee, is shown on the right. Note that the chimpanzee tongue is smaller and confined to the oral cavity. Note also the high position of the larynx and the overlapping of the epiglottis and the soft palate, known as the epiglottic-soft palate lockup. (Reprinted with permission from Elsevier.[2])

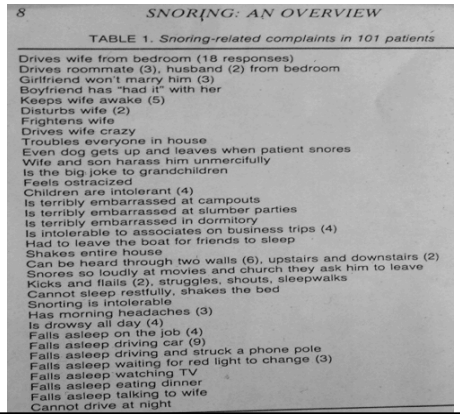




Noise Levels and Snoring In Decibels (dB)

- 30 dB = Whisper
- 40 dB threshold for heavy breathing vs snoring
- 60 dB = Normal Conversation
- 60 – 65 dB = Laughter
- 75 dB = Average radio – Vacuum Cleaner
- 85 – 90 dB = Lawnmower
- 90 dB = OSHA limit - Hearing damage if excessive exposure to levels above this
- 120 dB = Chain saw

Incidence of Snoring

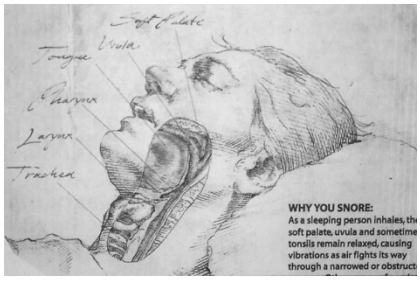


8 SNORING: AN OVERVIEW

TABLE 1. *Snoring-related complaints in 101 patients*

Drives wife from bedroom (18 responses)
Drives roommate (3), husband (2) from bedroom
Girlfriend won't marry him (3)
Boyfriend has "had it" with her
Keeps wife awake (5)
Disturbs wife (2)
Frightens wife
Drives wife crazy
Troubles everyone in house
Even dog gets up and leaves when patient snores
Wife and son harass him unmercifully
Is the big joke to grandchildren
Feels ostracized
Children are intolerant (4)
Is terribly embarrassed at campouts
Is terribly embarrassed at slumber parties
Is terribly embarrassed in dormitory
Is intolerable to associates on business trips (4)
Had to leave the boat for friends to sleep
Shakes entire house
Can be heard through two walls (6), upstairs and downstairs (2)
Snores so loudly at movies and church they ask him to leave
Kicks and flails (2), struggles, shouts, sleepwalks
Cannot sleep restfully, shakes the bed
Snorting is intolerable
Has morning headaches (3)
Is drowsy all day (4)
Falls asleep on the job (4)
Falls asleep driving car (9)
Falls asleep driving and struck a phone pole
Falls asleep waiting for red light to change (3)
Falls asleep watching TV
Falls asleep eating dinner
Falls asleep talking to wife
Cannot drive at night

The Airway



Upper-Airway Inflammation Triggered by Vibration in a Rat Model of Snoring

- Snoring is a source of upper airway injury, inflammation, loss of sensitivity, muscle and nerve dysfunction and sensory neuropathy
- Upper airway vibration triggers a local inflammatory process

Almendros I et al
SLEEP, 2007:30(2);225-227

Incidence of Snoring

By the Age of 40 40% of Males
20% of Females

By the Age of 60 60% of Males
40% of Females

Snoring & Inspiratory Pressure

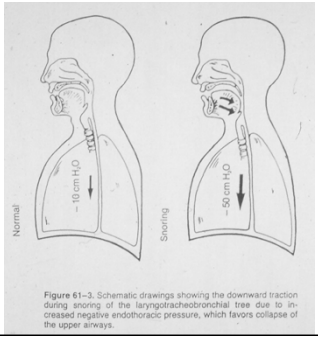


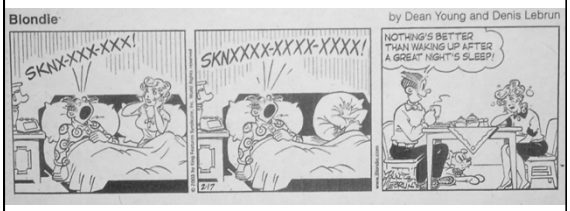
Figure 61–3. Schematic drawings showing the downward traction during snoring of the laryngotracheobronchial tree due to increased negative endothoracic pressure, which favors collapse of the upper airways.

Three Main Principals Related to Sleep Breathing Disorders

- Bernoulli Effect: as flow (velocity) increases so does negative pressure (paper straw)
- Venturi Effect: fluid flows through a tube – less diameter – fluid speeds up (garden hose)
- Variable resistor: as flow (speed) increases so does resistance (seat belt)

Effect of Snoring and OSA on the Sleep quality of Bed-Partners

Mayo Clin Proc 1999;74:955-958



How Likely is a Patient To Have Sleep Apnea ?

Chief Complaint	Odds Ratio
Non-Snorer	1
Snoring Alone	3
Snoring Plus Other Signs of Sleep Apnea	5

Sleep Apnea is Common

- Prevalence: Men 25% - Females 9%
- If Symptoms: Men 4% - Females 2%
- N = 1200 Age 35-60
- From:
  Young NEJM 1993
  Confirmed by Bixler AJRCCM 1997

Sleep Breathing Disorder (SBD) and Prevalence

- Mild to severe sleep apnea (AHI>5) is 26%
- Prevalence when AHI >15 is 13% in men and 6% of women
- !4% of men and 5% of women: AHI >5 with daytime sleepiness (based on ESS)

Increased prevalence of Sleep-Disordered Breathing in Adults Peppard, Yopung, et al Am J Epidem April 2013

The Three Types of Apnea

- Obstructive: Absence of Airflow Despite Respiratory Effort (gasping)
- Central: Absence of Airflow *and* No Respiratory Effort
- Mixed: Combination of Obstructive & Central

APNEA DEFINED

- Apnea: Cessation of Breathing for 10 Seconds or Longer – 80-100% Decrease in Airflow & Thoracoabdominal Movement (now is defined as ≥90% in sensor signal that is ≥10 sec.)
- Hypopnea: Interruption of Breathing by 30% or More & Same Decrease in Thoracoabdominal Movement
- Both Associated with a 4% or More Fall in Oxygen Saturation

AASM scoring for Hypopnea as of Sept 2013

- (1A) At ≥3% O_2 Desaturation:
- Peak signal drops by ≥30%
- Duration ≥ 10 sec.
- And / or is associated with an arousal

- (1B) At ≥4% O_2 Desaturation:
- Peak signal drops by ≥30%
- Duration is ≥10sec
- Arousals not included

Sleep Breathing Disorders Indices

- Apnea Index: The Average Number of Apneas per Hour of Sleep (AI)
- Apnea-Hypopnea Index: The Average Number of Apneas & Hypopneas per Hour of Sleep (AHI)
- Respiratory Disturbance Index: AHI + RERAs (RDI)

Severity

Mild OSA: AHI of 5 to 14

Moderate OSA: AHI of 15 to 29

Severe OSA: AHI of more than 30

What About Oxygen Saturation

- Have to consider hypoxia (hypoxemia)
- Also Intermittent Hypoxia
- As well as Oxygen Desaturation Index (ODI)
- Oxygen desaturation – hypoxia all lead to oxidative stress

Factors other than AHI Hazard Ratio (HR)

- Follow-up over median of 68 months
- Cohort of 1,172 people
- Found to be more pathophysiologically relavent
- O_2 Saturation: <90% (9 mins vs 0 mins) HR = 1.5 Also need to consider desaturation index - ODI
- Sleep Time: 4.9 vs 6.4 Hrs. HR = 1.20
- Awakenings: 35 vs 18 HR = 1.06
- PLMs: 13 vs 0 HR = 1.05
- Heart Rate: 70 vs 56 beats per min. HR = 1.28
- Daytime Sleepiness: HR = 1.13

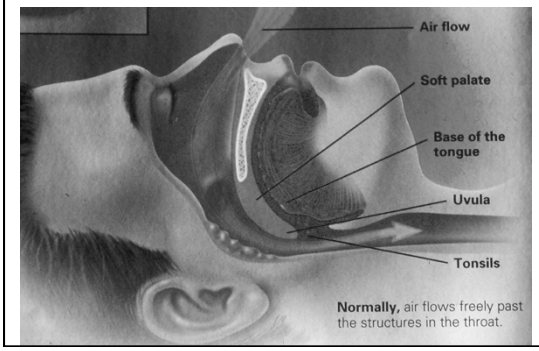
Bottom Line

- AHI became non-significant after controlling for these other variables – particularly ODI and intermittent hypoxia
- These factors considered as "downstream" factors – more predictive of CV disease after controlling for known CV risk factors

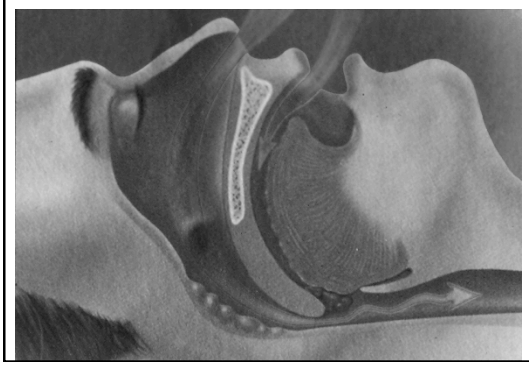
PLOS Medicine Feb 2014 Vol 11 Issue 2

www.plosmedicine.org Institute of Health Policy Univ of Toronto

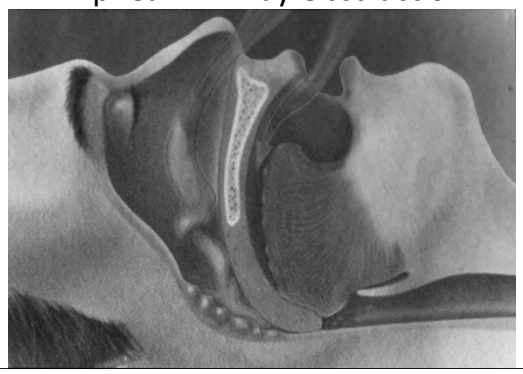
Optimum Airway



Airway Obstruction – Mouth Breathing



Apnea – Airway Obstruction



Most likely to Snore but also be at risk for sleep apnea

Neurologic Basis of Sleep Disordered Breathing

- Some factors lead to small airway – not all patients with small airways have OSA
- Maintain Airway – Upper Airway reflex (UAR)
- Three Components:
  1. Propioception of upper airway tone
  2. Central nervous system processing
  3. Reflex muscular changes

Ref: NY Academy of Sciences 2008
M. Broderick and C. Guilleminault

Neurogenic Polyneuropathy

- OSA patients have neurologic lesions in the pharyngeal musculature
- Abnormal increase of various nerve endings in the mucosal epithelium
- Also have sensory problems

Friberg D et al 1998. Histological indications of a progressive snorers disease in an upper airway muscle. Am J Resp Crit Care Med 157:586-593.

Is OSA a Systemic Disorder?

- Inflammatory disorder
- Oxidative stress disorder
- Atherosclerogenic disorder
- Pro-coagulant disorder
- Metabolic disorder
- Multi-system disorder
- Societal disorder

Summary: Thoughts

Perhaps: Waking, REM sleep and NREM sleep are merely EEG representations of existence?

Lee-Chiong in Sleep Medicine Clinics

Vol 7 #3 2012

"Who you gonna believe
Me or your own eyes"

Chico Marx