Sleep Science: Sleep, Sleepiness, and Sleeplessness

Kenneth Lichstein, Ph.D.
Professor Emeritus
Department of Psychology
The University of Alabama
sleeplessness II

a lot can go wrong
topics (among 70 sleep disorders)

- sleep apnea
- narcolepsy
- restless legs
- periodic limb movements
disorders we won’t talk about

- exploding head syndrome
- sexsomnia
- sleep-related epilepsy
- catathrenia
sleep apnea
if left untreated, sleep apnea is a slow moving terminal illness
Pickwickian syndrome (now called obesity-hypoventilation syndrome)

- obesity, daytime labored breathing, daytime sleepiness

- Burwell et al., 1956

10 years later

Sleep apnea

- “Nocturnal polygraphic registrations disclosed respiratory pauses…”

- Gastaut et al., 1966
invisible sleep apnea

science advances by two processes
- steady, incremental, systematic research
- abrupt, accidental discovery

- Between 1956 and 1966, 10s of thousands of PSGs had been performed world wide and no one noticed some people had quit breathing.
- Bed partners were not complaining that their partner had quit breathing.

when you don’t know what you are looking for, you don’t see the obvious
benign snoring and sleep apnea

moderate and severe snoring

sleep apnea
benign snoring I

- snoring without breath cessation
  - occurs in 10-15% of population
  - sleeping on back increases likelihood of snoring
  - snorer usually has no knowledge of condition
  - more troublesome to bed partner
  - at 5-year follow-up, benign snoring (without weight gain) is not a risk factor for sleep apnea

- physiology
  - partial airway obstruction
  - on continuum of obstruction with sleep apnea
  - usually occurs on the inhale
  - occurs with natural breathing, ≈ every 4 sec
benign snoring II

- risk factors
  - obesity, male, older adults
- aggravating factors
  - alcohol, sleeping pills
- treatment
  - weight loss
  - OTC nasal dilator, usually ineffective
  - wedge pillow, may be effective but uncomfortable
  - sleep on side
  - any treatment effective for sleep apnea (e.g., CPAP) will be effective for snoring
2 types of sleep apnea
(ICSD III lists 17 distinct diagnoses)

中央型睡眠呼吸障害 (CSA)
- 大脳の呼吸信号の欠如、呼吸努力の欠如
- 間欠的で、醒素期間、REM睡眠期間に起こらない
- 慢性型睡眠呼吸障害の約5-10%を占める
- 脳の障害や化学的バランス異常（例えば、脳卒中、多発性硬化症）で誘発される
- 危険因子: 年齢、男性
- 治療: CPAPまたはPAP（適応呼吸気流制御（ASV）、CSAに対する圧力の低下）

阻塞型睡眠呼吸障害 (OSA)
- 呼吸器の圧力の低下（口咽頭）
- 呼吸努力がある
- 間欠的で、醒素期間、REM睡眠期間に起こらない

複合睡眠呼吸障害
- 阻塞性と中央型の両方を含む
- 約3分の1のOSA患者に一部のCSA事件が見られる

2つの睡眠呼吸異常型
(ICSD IIIでは17の異なる診断がリストされています)
<table>
<thead>
<tr>
<th>Type of Apnea</th>
<th>CENTRAL</th>
<th>OBSTRUCTIVE</th>
<th>MIXED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airflow</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
</tr>
<tr>
<td>Diaphragmatic Excursions</td>
<td><img src="image4" alt="Graph" /></td>
<td><img src="image5" alt="Graph" /></td>
<td><img src="image6" alt="Graph" /></td>
</tr>
<tr>
<td>Arterial Oxygen Saturation ($S_0_2$)</td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
<td><img src="image9" alt="Graph" /></td>
</tr>
</tbody>
</table>
sleep apnea characteristics I

- **Apnea/hypopnea events**
  - Apnea: ≥ 10 seconds of not breathing
  - Hypopnea: ≥ 10 seconds of partial breathing (airflow decreased 50% + oxygen desaturation 3%)
  - Most frequent in REM

- **Apnea/hypopnea index, AHI**
  - Respiratory disturbance index, RDI (includes arousals)
  - Events/hour
  - Arousal: abrupt shift to lighter sleep
    - May be instigated by an apneic event
    - May abbreviate REM & N3
    - May cause a brief awakening
  - Normal: AHI < 5
  - Mild: AHI 5-14
  - Moderate: AHI 15-30
  - Severe: AHI > 30

- **Prevalence**
  - 3:1 ratio of men to women in middle-aged people
  - All ages, AHI > 15: 13% of men; 6% of women
  - After menopause, AHI in women ↑
sleep apnea characteristics II

- Apneic usually has no knowledge of condition
  - 85% of cases are undiagnosed
  - AHI can reach 100
  - Apnea event can reach 60 sec
  - Arousals (abrupt shift to N2 or lighter) attenuate N3 and REM

- Risk factors
  - Obesity (neck circumference), male, older adults
  - Small anatomical oropharynx opening
  - 30% genetic factor

- Clinical features
  - Primary: insomnia, heavy snoring and snorting/gasping, excessive daytime sleepiness (EDS)
  - Morning headaches, nocturia, nocturnal sweating, GERD
aggravating factors

- weight gain
- alcohol
- sleeping pills
- opioid pain medications
strong health risk

- EDS
- depression
- hypertension
- congestive heart failure
- coronary artery disease
- arrhythmia
- stroke
- all-cause mortality ↑ 46%

There is no clear evidence that sleep apnea causes SIDS.
behavioral morbidity of EDS

• decreased attention
• undesired sleep episodes
• loss of energy
• decreased sexual drive
• lack of motivation
• irritability
EDS risk factors

- car wrecks ↑
- accidents at home & work ↑
- productivity ↓
- socializing ↓
treatment options

- **weight loss**
  - potential for great effect

- **positional treatment**
  - sleep on side
  - helpful with 50% of mild-moderate OSA

- **dental appliance**
  - mandibular advancement device (lower jaw)
  - mild-moderate OSA
  - downside: altered bite, temporal mandibular joint (TMJ) pain, excessive salivation

- **surgical interventions**
  - 50% success rate

- **Inspire**
  - hypoglossal nerve stimulation moves the tongue forward
  - 50-70% success rate

- **continuous positive airway pressure (CPAP)**
CPAP is usually the best option

- some patients experience immediate, dramatic symptomatic relief
- bed partner enjoys a quiet night’s sleep
CPAP masks

- nasal
- nasal pillow
- full face
- total face
CPAP

- introduced in 1981
  - air splint; not a cure
  - originally, CPAP was bulky, noisy, and uncomfortable
  - currently, CPAP is small, quiet, and more comfortable

- pressure titration
  - pressure setting (centimeters of water pressure, cm H\(_2\)O) is usually in the 6-14 range
  - determined during the night to completely or mostly (AHI < 5) resolve apnea
  - home study, formulaic determination of pressure (based on BMI, AHI) may not work as well

- modern technology
  - devices are sensitive to air flow resistance
    - mask on or off
    - mask leak
    - presence of apneic events
  - devices can record/transmit time of use and AHI
CPAP resistance

- uncomfortable breathing against pressurized air
- allergic reaction, congestion
- claustrophobia
- tight mask to prevent mask leak
- skin irritation
- not romantic
PAP variations

- **BiPAP**
  - expiratory pressure relief
  - expiratory pressure lower than inspiratory pressure

- **APAP**
  - Automatic Positive Airway Pressure
  - real time pressure adjustment

- **other adjustments**
  - humidified, warmed air
  - treated insomnia: CBTi or hypnotics
CPAP adherence

• adherence defined as \( \geq 4 \) hours of use
• subjective adherence rates vary between 65% and 90%
• objective adherence rates 40%-85%
• patient education and follow-up increase the adherence rate
• partial use of CPAP is still beneficial
after successful treatment:

- long-term follow-up shows inconsistent health benefits
  - EDS, quality of life, & cardiovascular deficits sometimes persist
- example of hypertension
  - caused by multiple factors—e.g., obesity
  - sleep apnea was likely present for years, even decades, before discovery and treatment
  - brain cells are lost during oxygen deprivation and may result in permanent cognitive/physiology changes
sleep apnea assessment, impact, and treatment: summary findings from thousands of studies over 50 years of research

*breathing is good for your health*
narcolepsy
excessive daytime sleepiness (EDS)-
variations in severity

low: sluggishness

medium: tendency to fall asleep in quiet situations

high: irresistible naps

severe: sleep attacks
EDS types

- symptom of another sleep disorder (e.g., sleep apnea)
- idiopathic hypersomnia
- narcolepsy
EDS assessment

- interview
- questionnaires
- MSLT
- MWT
narcolepsy: diagnosis

- disabling daytime sleepiness: classic tetrad
  1. sleep attacks or chronic sleepiness
  2. cataplexy
     - present: Type 1 (most common)
     - absent: Type 2
  3. hypnagogic hallucinations
  4. sleep paralysis
- all characteristics of sleep onset REM
person with severe narcolepsy

video

https://www.youtube.com/watch?v=C0GyhVN-HwU
narcolepsy: characteristics

- uncommon neurologic disorder
  - prevalence: 1 in 2,000, equal gender
  - typical onset, teens & 20s
  - does not remit
  - usually accompanied by insomnia

- cause
  - hypocretin (orexin) deficiency in hypothalamus
  - multiple contributory genes
  - triggered by emotion, often laughter
  - secondary narcolepsy
    - may be caused by concussion or TBI
narcolepsy: treatment

planned naps
- ½ hour nap at same time each day
- more refreshing than sleep attack
- helps entrain circadian rhythm

medications
- amphetamines (Adderall, Ritalin)
  - severe side effects - loss of appetite, nervousness, depression, psychosis
- modafinil (Provigil)
  - side effects - headache, anxiety, depression
- armodafinil (Nuvigil) *
  - longer half-life, milder side effects
- sodium oxybate (Xyrem, also called GHB)
  - specific for cataplexy
  - intensified when mixed with alcohol - amnesia, unconsciousness
- antidepressants
  - specific for cataplexy
restless legs
(Willis-Ekbom Disease)
Jon Stewart "Jimmy Legs"

video

Key RLS Diagnostic Criteria

Essential Criteria*

✓ Urge to move the legs — caused by uncomfortable leg sensations
✓ Temporary relief with movement — partial or total relief from discomfort by walking or stretching
✓ Onset or worsening of symptoms at rest or inactivity, such as when lying or sitting
✓ Worsening or onset of symptoms in the evening or at night

Supportive Features*

— Sleep disturbances
— Periodic leg movements
— Positive family history for RLS

* Diagnostic criteria developed by the International RLS (IRLS) Study Group in collaboration with the National Institutes of Health (NIH).

How Patients Describe Their Symptoms

- Pulling
- Crawling
- Creepy
- Tingling
- Aching
- Painful
- Burning
- Throbbing

restless legs syndrome

- Uncomfortable sensation provoking movement
  - Most common in legs
  - Most common at night
  - Most common when sitting or reclined
  - Movement produces temporary relief

- Prevalence
  - 5-10% of population
  - Twice as common in women
  - Any age onset, increases with age

- Cause
  - Possible dopamine disturbance
  - Genetic influence
  - Low iron (blood)
  - Low ferritin (brain)
restless legs syndrome: associated features

aggravating factors
- alcohol
- caffeine
- antihistamines
- inactivity
- pregnancy (20% of women)

consequences
- 50% of RLS patients have sleep onset or sleep maintenance insomnia
- 20% of RLS patients complain of pain
- 90% have periodic limb movements
- quality of life is impacted
- 3× risk of depression
restless legs syndrome: FDA approved drugs

dopaminergic agonists

- Requip (ropinirole), available 1997
  - side effects:
    - dizziness/fainting
    - sedation
    - augmentation
- Mirapex (pramipexole)
- Neupro patch (rotigotine)

antiepileptic

- Horizant (gabapentin enacarbil)
restless legs syndrome: treatment

- medications
  - dopaminergic agonists
    - fewer side effects than carbidopa/levodopa (Sinemet, augmentation)
  - oral iron
  - opioids, benzodiazepines, antiepileptics

- behavioral management
  - good sleep practices, minimize sleepiness
  - active lifestyle, exercise
  - avoid alcohol, caffeine
  - avoid long sitting - plane/car trips
periodic limb movements
(formerly nocturnal myoclonus)
periodic limb movements

video

https://www.youtube.com/watch?v=hTTcMcx5O6k
periodic limb movement disorder: characteristics

- leg jerks during sleep
  - movements may be:
    - twitches of toe
    - ankle flexion
    - knee flexion
    - hip flexion
  - more common in N2

- prevalence
  - greatly increases with age
  - 45% prevalence in people over 65
periodic limb movement disorder: sleep effect and treatment

- PLMs usually don't disturb sleep
  - PLM index, movements/hour > 5
  - clinically significant?
    - arousal index
    - nonrestorative sleep
    - insomnia
    - EDS

- sedative/hypnotic agents
The End
sleep well