Sleep and Home Sleep Studies

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- No current monetary disclosures
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Outline

- History and Introduction to sleep, stages, problems
- History of polysomnography
- Aspects of sleep testing
- Uses
- Home sleep testing, overview, types
- Insurance (Medicaid/Health Choice)
- Comparisons
- Verdict
Sleep

• Essential and wonderful
• Interesting theories as to why we need it and what causes it:
  • 500BC Alcmaeon: Sleep is the loss of consciousness occurring when blood drains from the vessels on the surface of the body
  • 350BC Aristotle: Sleep is a time of physical renewal. “Sleep is a seizure of the primary sense organ, rendering it unable to actualize its powers; arising of necessity for the sake of its conservation.”
Stages of Sleep

- Non REM
  - Stage 1
  - Stage 2
  - Stage 3
- REM
Stages of Sleep

- Non REM
  - Stage 1:
    - Not quite asleep, not quite awake
    - In this stage, the muscles are active and the eyes move slowly
    - Alpha waves predominate
Stages of Sleep

- Non REM
  - Stage 2:
    - Theta activity
    - Becomes more difficult to rouse the sleeper
    - Alpha waves interrupted by sleep spindles and K complexes
Stages of Sleep

- Non REM
  - Stage 3:
    - Previously Divided into stage 3 and 4
    - Slow wave sleep
    - Delta Activity
    - Majority of environmental stimuli (within reason) produce no physical response in the sleeper
Stages of Sleep

- REM
  - *Paradoxical sleep*
  - Sleeper is hardest to awaken
  - EEG demonstrates brain function similar to being awake
  - Oxygen consumption by brain is higher than wakeful state
  - Cycles every 90 minutes
  - Muscles are paralyzed... good... and bad
  - OSA is worst during this stage
Stages of Sleep

- REM continued
Too good to last?

- Sleep disorders
  - Insomnia
  - Bruxism
  - Narcolepsy
  - Idiopathic
  - Night terrors
  - Restless legs
  - Sleepwalking
  - Somniphobia
  - Kleine-Levin Syndrome
  - Periodic limb movement disorders
  - Circadian rhythm disorders
  - Sleep disordered breathing
Sleep Disordered Breathing

- Simple snoring to obstructive sleep apnea
  - Objective studies are required to definitively distinguish
Polysomnography

- Poly ("Much" – i.e. many channels) + Somnus ("Sleep")
- Initially started with the EEG
  - First successfully used on a human brain by the German neurologist Hans Berger
    - Coined term "Elektrenkephalogramm"
- From the EEG, additional measurements were added
  - Eye Movements (EOG)
  - Heart rhythm (EKG)
  - Muscle activity (EMG)
  - Respiratory airflow
  - Respiratory effort
  - Pulse oximetry
Polysomnography

Setup

Generally 12 leads with 1 or more devoted to the following

- EEG
- Airflow monitors
- Chin muscle tone sensors
- Leg movement sensors
- Eye movement sensors (EOG)
- Heart rate/rhythm
- SpO₂
- Chest wall motion sensor
- Upper abdominal motion sensor
Grading PSG

- AHI = \[((\text{Number of apneic episodes} + \text{number of hypopneic episodes}) \times 60) / \text{total sleep time}\]
- RDI = \[((\text{Number of apneic episodes} + \text{hypopneic episodes} + \text{RERAs}) \times 60) / \text{total sleep time}\]

i.e. the average number of _____ events per hour of sleep

- RERAs – respiratory effort related arousals
- Total sleep time is represented in minutes
Polysomnography

- **Respiratory Criteria**
  - **Adults**
    - Apnea is defined as 90% decrease in respiratory flow rate for 10+ seconds
    - Hypopnea is poorly defined, 50-75% decrease in respiratory flow for 10+ seconds, +/- 2-4% decrease in O2 saturation
    - Many insurance companies will only cover treatments for AHI (apnea-hypopnea index) >15, or >5 with 2+ comorbidities
    - AHI 5-14 Mild, 15-29 Moderate, >30 severe
Polysomnography

- Adults
  - Respiratory Criteria
    - Comorbidities
      - HTN
      - CHF
      - Afib
      - CAD
      - Asthma
      - Stroke
      - DM
      - Obesity
      - Nocturia
      - GERD
Polysomnography

- Respiratory Criteria
  - Children
    - Respiratory rate is greater than that of adults
      - Duration of apnea between 6-8 seconds
    - No poorly defined as to what criteria is for children
      - Generally accepted that AHI $\geq 1$ is a positive result (prepubescent)
Types of PSG

- **“Whole night study”**
  - Defacto Gold standard for sleep studies, most common type of PSG
  - Diagnostic PSG and CPAP titration are performed on 2 separate nights
- PSG is often performed in “**split night studies**”
  - ½ the night is diagnostic, ½ the night is CPAP titration
  - This practice has never been definitively validated when compared to “whole night studies”
  - If the first half of the split night study is inconclusive for OSA, it is recommended to be converted to full night
  - Decreases latency to CPAP treatment
  - Decreases load on testing infrastructure

- **Multiple Sleep Latency Test**
  - Patient is observed falling asleep multiple times
    - 4-5 20 minute nap opportunities spread out by 2 hours each
    - Narcolepsy testing, gauge of sleepiness
    - Should take the full 15-20 minutes, <5 minutes is severe sleepiness
Contraindications to PSG

- There are no absolute contraindications
- Things to consider
  - Is the patient medically stable to transfer for a study?
  - Adhesive allergies?
  - Seizures?
Home Sleep Testing

- **Components**
  - Oximetry
  - Chest/Abdominal belts
    - Used to determine central vs. obstructive
      - Chest/Abd effort but no airway flow – obstructive apnea
      - No Effort, no airway flow – central apnea
  - No EEG*

- Patients sleep in their own bed!
Home Sleep Testing

- Is (rightly) compared directly to PSG
- Like the attended PSG, home equipment may allow for CPAP titration: **autoPAP**
  - CPAP titration sets a pressure to be used (often for years) based on ~4 hours of poor sleep
  - AutoPAP machines use complex algorithms to titrate the appropriate pressure on a moment-by-moment basis
The Process

- Technician reviews the nature of the test and shows the patient how to attach the apparatus
- Patient must start the recording before going to bed and stop it when they awaken
- They bring the machine back, data is downloaded into computer where data is analyzed
  - Autoscore vs. Manual
    - Autoscore often sufficient
    - Manual correction does not require advanced degrees or excessive training, expert vs amateur K 0.83 in diagnosing OSA
      - Nigro ApneaLink study
    - Medicaid is not satisfied with autoscore
The process

- Mysleeptest.com and NovaSom have a slightly different approach (paired with dentists who make dental appliances)

- [http://www.youtube.com/watch?v=fKp_FRdVBk8](http://www.youtube.com/watch?v=fKp_FRdVBk8)

- NovaSom is a recording device with 5 channels and no up front clinic costs
Types of Home Sleep Studies

- ApneaLink
- Apnoscreen
- Compass
- Edentec
- Embletta
- Lifeshirt
- MESA M IV
- Poly-MESAM
- Remmers Sleep recorder
- Sandman
- SNAP
- Somnocheck
- Somté
- Stardust
- WatchPAT
- ...and many more!
Types of Home Sleep Studies

- Embletta
  - ResMed
  - Recording device with 14 channels
    - Chest/abd position sensors
    - Pulse oximetry
    - Nasal airflow
    - etc.
  - Cost: $7 disposables, $3500 for device
Types of Home Sleep Studies

- ApneaLink
  - ResMed
  - Recording device with 4 channels
    - Respiratory effort
    - Pulse/oximetry
    - Nasal airflow
- Cost: $10 disposables, $2490 for device
Types of Home Sleep Studies

- Somté Sleep Recorder
  - Multiple available signal inputs (13 channels)
    - EEG
    - EMG
    - Pressure
    - Airflow
    - Thoracic/abdominal effort
    - Limb Position
    - O₂ Sat%
    - Pulse rate/waveform
    - Etc.
  - Cost: $9 disposables, $4500 for device
Types of Home Sleep Studies

- Somté is not entirely unique nor are the other aforementioned data recorders
- Proprietary software
- Find one that you are comfortable with
- All require a nasal cannula to measure airflow except...
Types of Home Sleep Studies

- **WatchPAT**
  - Unique
  - No nasal cannula required
  - Measures Peripheral Artery Tone
    - Mirrors changes in autonomic system
    - Allows for detection of apneas/hypopneas, REM, approximation of sleep architecture
    - Allows for calculation of RDI and AHI using sleep time rather than test time
      - RDI with a smaller denominator will tend to be larger and result in fewer false negatives
  - Cost: $60 disposables, $4400 for device
#1 Obstructive apnea

#2 Paradoxical breathing

#3 Oxyhemoglobin desaturation

#4 Arousal

#5 Leg movement
Coverage of various sleep studies is constantly changing
Current Medicaid

- As of 2006 portable studies were not reimbursable through Medicare/Medicaid
- Updated 4/1/2013
  - Specific considerations for **attended** polysomnography includes:
    - *May* be considered medically necessary as a diagnostic test in patients presenting with: Narcolepsy, sleep apnea, snoring, parasomnias, periodic limb movement disorder, chronic insomnia
    - Specific criteria are listed partly to define and partly as exclusion
      - Sleep apnea – witnessed cessation of breathing, apnea defined as cessation of airflow for ≥10s. Hypopnea is an abnormal breathing event lasting ≥10s and at least 4%O2 desaturation
      - Snoring – Must meet at least one of the following: disturbed sleep, daytime somnolence, excessive fatigue, apneic breathing, hypercapnea
Current Medicaid

- Unattended sleep studies must:
  - Use appropriate device
  - Interpreter must have certification or subspecialty certification in sleep medicine and be an active staff member of an accredited sleep lab (by American Academy of Sleep Medicine or Joint Commission)
  - All of the raw data will be interpreted by the physician/interpreter
  - Test MUST gather 6 hours of data during the patient’s usual sleep period
Current Medicaid

- Patient must have high pretest probability of positive test including 4 of the following:
  - Habitual snoring
  - Witnessed apneas
  - Gasping
  - Morning headaches
  - Daytime somnolence
  - BMI>35, i.e. severe obesity
- No sleep disorders other than OSA must be suspected
- Age >18y (younger is considered purely investigational)
Advantages

- Patients sleep in their own bed, fewer wires
  - More closely approximates patient’s actual sleep cycle
- Uses the same sensors/equipment as PSG
  - Respiratory/oximetry equipment and analysis
  - Chest/Abdomen position sensors
- Report results in familiar format
  - RDI, AHI
- Improves access to sleep study in places w/o labs (or interpreters)
- Cost?
Shortcomings

- Not to be used when evaluating patients who may have:
  - Central sleep apneas
  - Insomnia
  - Periodic limb movement disorder
  - Narcolepsy

- Or patients with significant comorbidity:
  - Neuromuscular disease
  - Congestive heart failure
  - Moderate-severe pulmonary disease
Shortcomings

- Children make for unpredictable patients
  - Young/small children may not have the respiratory volume to accurately drive the meters
  - Age cutoff has been informally set at 4y; however, this is subject to specific equipment and the comfort level of the interpreting professional
Laboratory vs. Portable?

- 2006 Ghegan, Gillespie et al performed meta analysis
  - Prospective Cohort studies
  - Investigated:
    - RDI, Mean low spO2, sleep time(?) , average cost per examination
  - 27 studies examined using 14 different devices
    - All but 1 device (watchPAT) measured respiratory flow, and 9 allowed for measurement of chest wall effort
    - 2-7 different channels per device
    - Compared to in-laboratory PSG values
Results, 12 studies deemed sufficient quality to directly compare RDI and spO2 endpoints
- 9 of the studies indicated no difference in PSG and home sleep study RDI
- 3 studies demonstrated lower home sleep study RDI than PSG
- Pooled results yielded statistically significant answer that home sleep study tends to supply RDI 10% lower than PSG
- Study found no difference in the spO2 between home sleep study and PSG
Ghegan, Gillespie et al

Cost

- Analysis was done for home sleep studies in 4 different countries
- Portable studies are invariably cheaper
  - Ranged from 38%-88% less expensive than in-lab PSG
  - Maximum sleep lab cost was $1800 (American lab)!!!
Ghegan, Gillespie et al

- Poor sleep [time] skewing results?
  - Within this analysis, the amount of estimated sleep time was actually larger in the in-lab PSG group
    - Highly influenced by a single large study
    - Lower portable estimated sleeping times would actually raise the reported portable RDIs
Summary Verdict

- Home sleep study provides similar diagnostic information to attended sleep studies
  - May underestimate severity of disease
  - Not for diagnosis of less common sleep disturbances
- The landscape of medicine is changing
  - Insurances are shifting coverage of a number of previously supported procedures/tests
  - It is not for insurance to determine medical necessity
Summary Verdict

- Home sleep testing reduces cost
- Home sleep study *improves access*

- Home sleep study should be viewed as a viable diagnostic modality... which is awaiting broad acceptance
Bibliography

Bibliography

- Medicaid and Health Choice Sleep Studies and Polysomnography Clinical Coverage Policy No.: 1A-20, revised 4/1/13