Diagnostics in Sleep Medicine

Various Sources
Diagnostic Tools of Sleep Medicine
Part 1

- Polysomnography
- Multiple Sleep Latency Test
- Maintenance of Wakefulness Test
- Actigraphy
Polysomnography

- Int. 10-20 EEG
- EOG
- Chin EMG
- Thermistor/Pressure
- Microphone
- ECG
- Posture sensor
- Respiratory belts
- Oximeter
- Ant. Tib. EMG

Diagram of Polysomnography equipment placement.
Placement of electrodes
STAGE 1 SLEEP
STAGE 2 SLEEP
SLOW WAVE SLEEP
Sleep Hypnogram

Provides a summary of the continuity and distribution of sleep states
Polysomnographic findings in OSA
Profound hypoxia of sleep apnea putatively contributes to morbidity & mortality.
Adult Obstructive Sleep Apnea

• **Tests:**
  - Polysomnogram
    • RDI: 5-15 (mild), 15-45 (mod.), >45 (sev.)
    • Hypoxic Burden (SpO2 < 90%) for >10% of study
    • Desaturations and Arousals
    • Reduced SWS and/or REM sleep
  - Epworth sleepiness score
    • Often > 10
Polysomnographic findings in PLM’s
Assessment of Sleepiness - Multiple Sleep Latency Test

• The MSLT is a well-validated test of the physiologic tendency to fall asleep during usual waking hours.

• It is performed under very controlled conditions.

• An all night in-laboratory PSG must precede the MSLT.
Assessment of Sleepiness - Multiple Sleep Latency Test

- Five 20-minute nap opportunities are given at two-hour intervals.
- The patient is asked to fall asleep!
- Parameters measured are:
  - average latency to sleep onset
  - appearance of REM sleep
Assessment of Sleepiness

Average Latency

- Early Adolescents
- Adults
- Elderly

Multiple Sleep Latency Test
MAINTENANCE OF WAKEFULNESS TEST

20 or 40 minute duration
• Room is quiet and dimly lit
• Subject is not allowed to engage in physical activity
• Subject is seated reclining, and instructed to keep eyes open and remain awake!
• Calculate mean latency to sleep onset
Psychomotor Vigilance Test
(Reaction time)
Summary of measures of “Sleepiness”

“Objective”
sleep/wake behavior

- Electrophysiological
  - Multiple Sleep Latency Test
  - Maintenance of Wakeful Test
  - Pupillometry

- Behavioral Observations
  - Yawning frequency
  - Eye lid closures

- Performances tests
  - Reaction time tests
  - Driver simulators

“Subjective”
self-reported somnolence

- Self-reported Rating scales
  - Stanford Sleepiness Scale
  - Visual analog

- Global level of sleepiness
  - Self-reported sleepiness problems
  - Self-reported sleep propensity
  - Epworth Sleepiness Scale

“State”
(instant)

“Trait”
(stable)

From: Hyon Kim, PhD
Actigraphy

• Actigraphy is the recording of movement using a motion sensor, either a single or multi axis accelerometer.

• An accelerometer creates an electrical voltage with every movement. The bigger the movement, the greater the voltage created.

• Actigraphy has been validated against PSG for and generally has an accuracy of greater than 90% when worn on the wrist.

• An accelerometer can be worn continuously for multiple days and nights at no additional cost.
Actigraphy Uses

- Actigraphy is used to determine activity-inactivity profiles to assess circadian rhythm or other sleep disorders.

- Actigraphy can also be used to determine the effect of treatment for sleep-wake disturbances.

- Cognitive Behavior Therapy for Insomnia is possibly enhanced by the use of Actigraphy.
Actigraphy Can Estimate:

- Normal Sleep
- Insomnia
- Circadian Disorder: Delayed Sleep Phase
- Circadian Disorder: Advanced Sleep Phase
- Circadian Disorder: Non 24 hour or non-entrained type
- Circadian Disorder: Irregular Sleep/Wake
- Shift work sleep disorder
- RLS/PLMD (when worn on the ankle)
Characteristics

- Humans typically display a decrease in activity during rest.
- Rest periods are characterized by small intermittent movements while active periods show significant, constant movement.
- For normal sleepers, rest and activity shown together display a relatively stable pattern over the 24 hour day.
- Variations may occur on weekends.
Normal Sleep Actogram
Insomniac Sleeper Characteristics

- Rest and activity data displays an unstable pattern, easy to see on an actogram
- Activity depicts elevated levels at just about any time of day
- Rest periods are variable in length and timing
Insomniac Example
Circadian Disorder: Advance Sleep Phase Characteristics

- An actigraphy record of 7 or more days can help identify Advanced Sleep Phase patients that would be helped by interventions such as light therapy, chronotherapy or melatonin.
- Actigraphy can track changes in the patient’s sleep/wake pattern once a treatment has been initiated.
Circadian Disorder: Advance Sleep Phase Example
Circadian Disorder: Delayed Sleep Disorder Characteristics

- Occurs in 7%-16% of adolescent/young adults and in 10% of patients with chronic insomnia.
- Typified by sleep/wake pattern where sleep onset and wake times are delayed 3-6 hours relative to normal sleep/wake times and may be due to circadian function or behaviorally induced sources.
- An actigraphy record of 7 or more days can help identify DSP patients for treatment such as light therapy, chronotherapy or melatonin.
- Actigraphy can track document changes in the patient’s sleep/wake pattern once these treatments have been initiated.
Circadian Disorder: Delayed Sleep Disorder Example
Non 24 hour or Non-Entrained Free Running Characteristics

• This is most commonly found in blind patients
• Typified by the lack of a stable relationship between the 24-hour light-dark cycle and the circadian pacemaker.
• Actigraphy can easily show where the rest periods recur at a period that is greater than 24 hours resulting in a shifting of the rest periods later each day.
• An actigraphy record of 7 or more days can help identify these patients for treatment with melatonin.
• Actigraphy can track changes in the patient’s sleep/wake patterns once treatment is initiated.
Non-Entrained Free Running Example
Shift Worker

Sleep Disorder Characteristics

• Typified by altered patterns of sleep/wake in order to work at jobs with variable hours.
• Actigraphy can track these patterns.
• Actigraphy easily shows the fragmentation of consolidated sleep periods surrounding shift changes.
• “Weekends” and days off are easily identified by definite changes in sleep/activity patterns.
Shift Worker Example
Pediatric Sleep Actogram
Reimbursement I

• General coverage guidelines:
  ✓ Actigraphy studies may be covered for the diagnosis and treatment of sleep disorders.
  ✓ Coverage and reimbursement for actigraphy services still vary by payer.
  ✓ CMS has not yet issued coverage guidelines for Actigraphy.
Coding guidelines:

✓ Actigraphy services are currently using a Category I CPT code.

✓ As the case with newly established codes, some payers may not recognize this code and provide instructions on alternate or potentially outdated coding guidelines.

✓ It is important to submit claims using the new Category I CPT code 95803 for reporting actigraphy services.
CPT Coding

• Actigraphy, testing, recording, analysis, interpretation and report (minimum of 72-hours to 14 consecutive days).

• There are additional codes that may be used to report actigraphy-related services (available upon request).

• It is recommended that healthcare providers verify recommended coding guidelines with payers prior to submitting claims for these services.
Types of currently available actigraphy devices for sleep monitoring
Tools of Sleep Medicine
Part 2

• Monitoring of PLMs for RLS
• Neuroimaging (CT and MRI and Angiography)
• Lumbar Puncture
Diagnostic tools for sleepiness attributed to restless legs - paroxysmal limb movements during sleep

- Full polysomnography typically **not** indicated.
- Neither is MSLT nor MWT (because preceding PSG absent)
- Use Epworth or other subjective measure followed by quantitative measure of limb movement
Neuroimaging

Diagnostic imaging techniques

• Rapidly growing
• Increasing important in chronic and acute stages stroke
• Accuracy is essential
CT Scan – Computed Tomography

- Provide “slice” images of brain and spinal cord
- Axial X-ray beams pass through the head
- Amount of radiation is essentially harmless
- Degree to which the tissue attenuate the X-ray beams are primarily important for differentiation
Computed tomography

• X-ray attenuation of the skull, CSF, cerebral gray and white matter, blood vessels
• 30,000 beams of x-ray directed at several axial or coronal levels
• Differing densities of bone and intracranial
• Indications
  – Infraction
  – Hemorrhages, AVM, aneurysm
  – Edematous tissue
  – Changes in cranial structures

Useful for patients are neurologically/medically unstable, uncooperative, clasutrahoibc with pacemakers
• CT angiography
  – Widely available
  – Less Specialized skill requirement
  – Less invasive intravenous administration
Kinds of CT

• Contrast enhanced CT (CECT)
  – Detect lesions that involve breakdown of blood brain barrier
  – Used to rule out brain tumors and abscesses

• Intravenous contrast medium
  -based on iodine
CT findings

• Low attenuation – appear black
  – Air (darkest)
  – Fat
  – CSF and water

• Medium attenuation – Gray
  – Edematous/infraction
  – Normal brain
  – Subacute hemorrhage

• White
  – Hemorrhage
  – Intravenous contrast material
  – Bone or metal
CT scan

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Easily detecting:</td>
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<tr>
<td>• Masses</td>
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<tr>
<td>• Parenchymal bleed</td>
<td>posterior circulation vascular disease</td>
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<td>• Stroke, hemorrhage</td>
<td>bone related artifacts</td>
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<td>• Pressure effects</td>
<td>limited views</td>
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<tr>
<td>• Aneurysm</td>
<td>suboptimal brain resolution</td>
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<td>• Readily available</td>
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<td>• Less expensive than MRI</td>
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• Complications
  – For contrast phase: caution among patients with renal problems
  – Normal creatinine level
Magnetic resonance imaging

- Images displayed as maps of tissue signal intensity values
- Spatial localization
MRI

• Provides thin slice images of the brain and spinal cord
• Better resolution than CT
• Magnetic field aligns the protons of tissues and CSF in the orientation of the field
• Radio frequency pulse causes the proton to resonate and change their axis
MRI

• Indications
  – Hemorrhages
  – Ischemic/occlusive strokes (lacunes, brainstem and cerebellum)
  – Demyelinating disease
  – Tumors
  – Hypertensive encephalopathy
  – Vascular anomalies
• Advantages
  – Select any plane
  – Does not need radiation
  – No bone artifacts
  – Brainstem lesions

• Disadvantages
  – Claustrophobia
  – Bone imaging limited to display of marrow only
  – Cannot use with pacemakers
  – No ferromagnetic implants
T1 images

- Best for showing anatomy
- CSF and bone appears black
- Normal brain is gray
- Flat and subacute hemorrhage appear (>48 hours) white
T2 images

- Best for showing pathology
- CSF and brain appear white
- Normal brain=gray
- Bone will appear black
• **MR angiography**
  – Produces images of intracranial and extracranial cerebral circulations
  – Adequate dose evaluation of large lesions

• **MR venography**
  – Provides subtraction images of major venous sinuses
  – Useful in dural sinus thrombosis
  – Less sensitive than angiography
Angiography

- Provide high resolution images of the extra/intra cranial cerebaral vasculature
- Small cathther is threaded into extracranial vessels through the femoral artery
Angiography – 4 vessel

• Functional imaging test
• Injection of contrast material
• Flowing blood to produce signals
  – Occlusions, stenosis (narrowing), anuerysm
  – angitis
Identifying the following

- Occluded or stenotic vessel
- Arterial dissection
- Aneurysm
- AVM
- Vasculitic narrowing
- Venous sinus thrombosis
complications

1. Stroke
   1. Most important complication
   2. 1-2%
   3. Results in emboli generated by catheter
   4. Occurs more frequently in elderly with atherosclerosis dieses

2. Bleeding
Transcranial Doppler (TCD)

- Detects blood velocities (pattern of blood flow)
- Temporal and Suboccipital window (VA, BA)
- Temporal window (post cerebral, PCOM)
Terms

- ACA
- MCA
- BIFUR – siphon
- PCA
- BA
- VERTebral artery
- OPH
- SIPHON – internal carotid hook up give branches to MCA and ACA
sensitivity

- Detect for occlusions
- Stenosis
Lumbar puncture

- To get CSF sample for diagnosis and treatment purposes, spinal needle – medium sized
- Interspace: L4-L5 (infants), adults: L3-4
- Side lying position
- Fetal like position
- ASIS – anatomic landmark
- Ensure bleeding parameters
Preparations

• Aseptic technique
• Spinal needle
• Test tubes
• Manometer (pressure readings = opening and closing)
• Sterile sheet
• Sterile gloves
• Cotton and Betadine
• Band-aid, gauze
Indications

- Pressure measurements
- Procure sample of CSF
  - Cellular, chemical and bacteriologic examination
- Administer antibiotics, chemotherapeutic agents, spinal anesthetics
- Detecting disease:
  - CNS infection (Meningitis)
  - Subarachnoid hemorrhage (SAH)
  - Neoplasms (no signs of impending herniation)
Lumbar Puncture

- CSF pressure measurement
- CSF collection
- CSF appearance – traumatic vs SAH
- CSF analysis
  - Bacteriological (RBC, WBC, gm stain, AFB, india ink)
  - Biochemical (protein and glucose)
  - Special tests (Cell cytology – extension of cancer in the CNS, LJ culture – Lowenstein Jensen detect presence of CB, CALAS, oligoclonal bands – demyelinating process, Sabauraud’s culture)
Normal

Opening pressure = 80-180mm H20
RBC = 0-5cumm ideally none
WBC = 0-5cumm all lymphocytes
Lumbar Puncture

• NPO and flat on bed for 4 hours
• Complications:
  – Headache
  – Radicular pain
  – Vomiting