Scoring Pediatric Sleep Studies

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About me

• I have worked in sleep since 2004.
• My lab ran 100% adults. The youngest patient I had was 12 years old.
• In 2008 I began scoring adult studies.
• Then in 2010 up until now I was trained to score primarily pediatric studies.

Process of Scoring adults and pediatric studies is similar:

• PATIENT HISTORY
• STAGING SLEEP AND AROUSALS
• RESPIRATORY EVENTS
• PLMS & EKG

For reference:

• YOUR TECHNOLOGISTS' NOTES
• AUDIO/VIDEO is more readily used in pediatric studies than adults.

Assessing patient history

• Healthy vs. medically complex
• Age
• 5 primary indications: OSA, CSA, PLM’s, Oxygen Desaturations, and Hypoventilation,
• Type of study
• Previous PSG

• Complex Medical Hx
  – Brain
    • Previous EEG results can be referenced
  – Lungs
  – Heart
  – Legs

What’s the difference…?

THERE ARE NO CONFLICTS OF INTEREST

• There is nothing to report of Financial Relationships within the past 12 months with commercial entities producing, marketing, re-selling, or distributing health care goods or services consumed by, or used on, patients relevant to the content I am presenting.
Reviewing Patient History

- 2.8 yo Female r/o OSA, pre-op T&A

- Clinical Hx on the Request: Abn PSG in past done in prone; child sleeps in side position, being treated with Flonase and Zyrtec with decrease in adenoids. Now request f/u study before consideration of T&A.

- Nursing Review: Hypoxic ischemic encephalopathy w/ microcephaly, spastic quad, seizure d/o. Many meds listed.

- Previous PSG: Lack of organized awake and sleep state architecture with frequent multi-focal spike and wave discharges. Some semblance of REM/NREM differentiation was seen, but with reduced REM sleep and no slow wave sleep.

- Previous EEG: Sleep architecture is not well formed, however rudimentary sleep spindles are noted. Poorly sustained posterior dominant rhythm.

Adult History

- Aging adults are more likely to have heart problems, COPD etc...

- Pulse oximetry is a valuable tool in assessing severity of events because children have less desaturations.

- Seizure activity is less prevalent in the adult sleep diagnostic population.

Adults vs. Children 5 significant points:

1. Sleep studies in children are potentially more complicated due to medical complexities.
2. Sleep architecture develops as we age.
3. There are several key differences in scoring events.
4. Periodic breathing only occurs in children.
5. CO2 values are added to pediatric studies.

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Sleep Architecture Development as we Age

A Full Term Infant under 6 weeks

- Goes into REM from wake
- No sleep spindles yet
- Trace’ Alternant pattern
- Tips for recognizing REM vs. NREM
THE EVOLUTION OF SLEEP ARCHITECTURE IN A FULL TERM NEWBORN

- 2-3 months: Sleep Spindles
  - Staging distinguished as Active vs. Quiet sleep.
- 4-6 months: K Complexes
- 4-5 months: Slow Wave Activity

Tracé Alternant: Quiet Sleep
Normal burst-suppression EEG rhythm during quiet sleep starting 34 weeks (in utero)
Evolves into mature continuous slow waves by 2 months

Gestational Age is important

- Gestational age is an important factor in determining development in sleep architecture.
- For example, a 5 month old born at 24 weeks (severely premature) will be staged as a full term age 2 months.
- However, the post-natal brain matures faster than prenatal.

Active sleep in 5 mo born at 24 wks

Quiet sleep in 5 mo old born at 24 wks
30 second epoch: sprouting spindles

ACTIVE SLEEP IS ACTUALLY ACTIVE
Sleep Spindles

- Present by 6 weeks of age (full term)
- 12-14 Hz in central region
- Frontal spindles are slower at 10-12 Hz
- Asynchronous
- Duration: may be as long as 6-8 seconds in young infants, then decrease to 1-3 seconds in children, & 0.5-1.5 seconds in adults
- Seen in long chains in newborns vs. riding on k-complex
- Still scoring REM vs. NREM but much easier
- Once spindles are developed in a premature newborn, it is a good indication that staging will soon be able to be NREM vs. REM.

Asynchronous Sleep spindles at 30 sec (16wks old) 10wks gestation

K Complexes

- Seen after age 5 months.
- Tri-phasic morphology, broad field.
- 500 m-second (.5 sec) in duration.
- Followed by an over-riding spindle like activity.
- Indicates N2 sleep

Synchronous Sleep Spindles 30sec (16wks) 10 wks gestation

K Complex at 30 sec

Game Time:

- How many scorers in the audience do we have?
- Of those, how many score or have scored pediatric studies.
- For those who have not scored the next slide shows Hypnagogic Hypersynchrony.
- (show of hands) Is this an arousal or a normal EEG maturational occurrence?
Hypnogogic Hypersynchrony at 30sec 10uv/mm

Hypnogogic Hypersynchrony

- Normal EEG variation seen in children
- Peaks between 6mos-6yrs
- Paroxysmal bursts of 3-5hz high voltage (as high as 350µv) at sleep onset
- May be notched
- Seen maximally in pre-frontal-central areas
- Can be seen up to 13 yrs of age, but uncommon after age 10 years (2%).

Hypnogogic Hypersynchrony at 30 sec and 30uv/mm

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Respiratory Patterns

- Paradoxical Breathing
- Periodic Breathing
- Normal central pauses
- Obstructive Apnea/hypopnea
- RERA's
- Central Apnea

Normal irregular breathing pattern in REM

Variable breathing
Paradoxing belts
Centrals
Regular breathing in NREM 8wk old

Paradoxical Breathing

- Reversal of normal breathing movements (chest wall is moving opposite of abdomen wall)
- Normal in infants
- Usually is gone by 2-3 years; occurs in REM more often than in NREM sleep
- Can be seen in children with respiratory distress and obstruction
- Can be recognized in the belts or the video

Paradoxical breathing in NREM 90sec
Normal in a 3 month old

Paradoxical breathing in REM 90sec
Normal in a 3 month old

Paradoxing with OSA

Image withheld.

Periodic Breathing

Defined as greater than 3 central apneas lasting >3 seconds separated by no more than 20 seconds of normal breathing
Periodic Breathing (of infancy)

• 4 episodes of central apnea lasting >3sec
• Peaks at 2 wks and resolves by 1-2 mos
• Typically seen in REM sleep
• Can be scored and calculated
• Calculated into % in Quiet vs. Active sleep
• 5% for term 15% for pre-term upper normal limits

Central Apnea

• Event lasts 20 seconds or longer
  ~10 seconds for adults~

OR

• Event lasts for the duration of two missed breaths and is associated with an arousal, an awakening or a desaturation of 3% or greater

Normal REM Central pauses in infants

Central Apnea

• Event lasts for duration of 2 missed breaths
• ~Event lasts for 10 seconds in adults~
• Event demonstrates a 90% decrease in flow signal for 90% or greater of duration of event
• Event demonstrates equal or increase in effort signal for entire event period
• Apnea event does not need to cause an arousal, awakening or oxygen desaturation to be scored
Apnea in a 2 yo with Severe OS

Hypopnea

- Event demonstrates a decrease in flow signal of 50% or greater
  "30% decrease for adults"
- Event lasts for duration of two missed breaths
  "10 seconds for adults"
- Decrease in flow signal last for 90% or greater of event duration
- Event is associated with an arousal, awakening or desaturation of 3% or greater
  "desaturation of 4% or greater for adults"

RERA
(Respiratory Related Arousal)

ETCO2 and SpO2 can be used to identify REM

PLMs 6 yo male

EKG RECOGNITION
Occasionally you will see something like this:

Snore channel showing moderate snoring – video review necessary

Snoring?

Video withheld.

ETCO2

- Measurement of Carbon Dioxide
- Children have higher oxygen saturations
- Measuring ETCO2 is more likely to pick up subtle changes in breathing than the SPO2 will.
- Restrictive lung disease/hypoventilation

LOOK AND LISTEN

Images withheld.

THANK YOU!