Understanding the results of a polysomnogram (sleep study)

This guide provides a brief explanation of what is included in the results by the interpreting physician. If there are further questions regarding specific results, families should discuss them with their provider; and health professionals may follow up with Children's Sleep team.

Four main reasons to order an overnight polysomnogram (PSG)

1. **Concern about breathing during sleep.** The most common cause is obstructive sleep apnea, where the upper airway temporarily closes in on itself. Occasionally a PSG is completed to look for central sleep apnea, which is when the signal from the brain to the muscles controlling the lungs temporarily stops and the body makes no effort to breathe. Finally, a PSG may be ordered to check for normal gas exchange (breathing in oxygen and breathing out carbon dioxide).
2. **Concern for seizures during sleep** or transitioning into or out of sleep.
3. **Concern for abnormal** behaviors during sleep.
4. **In conjunction with a hypersomnia workup** (evaluation for excessive daytime sleepiness).

We are often asked if one night in the sleep lab will effectively and accurately show what is occurring at home on a regular basis. The answer in brief is yes. While sleep habits may vary from night to night, it is very uncommon to have *significant* differences between nights.

How to read the results of your polysomnogram
A brief description of what's provided in each section

Study summary: Provides an overview of the PSG in regards to quality of the study and any significant findings. It may also note whether the patient or parent/guardian thought it was a typical or representative night for sleep and breathing.

Sleep architecture: The multiple parameters related to the quality, consolidation, and duration of sleep:

- **Sleep latency**: How many minutes it takes for the individual to fall asleep once "lights off" has occurred. A normal value is typically between 10-30 minutes. Keep in mind, children who are awake past their bedtime in order to prepare for the study may have shorter sleep latencies. Alternatively, children who are uncomfortable in new settings may experience anxiety, which can prolong sleep latencies.

- **REM latency:** How many minutes it takes after sleep has started until the child reaches the dream stage of sleep (REM sleep). This number will vary depending on age and medications. Younger children (less than 10 years of age) will typically have REM sleep anywhere between 85-

155 minutes after sleep onset. Older children may have REM onset anywhere between 135-155 minutes after sleep onset.

- **Sleep efficiency:** How many minutes the patient was sleeping compared to how many minutes he/she was in bed. A normal sleep efficiency is 85% or higher.

- **Arousals:** An arousal is an uptick in brain activity during sleep. It can last for 3-15 seconds. Most often the patient does not wake up with arousals. The arousal index (how many arousals per hour during sleep) changes with age. It can be an indicator of disrupted sleep.

- **Wake after sleep onset (WASO)**: This is the amount of time the patient was awake after falling asleep until they "get up" for the day from their study. Generally this number is thought to be normal if near or below 30 minutes. It can also be an indicator for disrupted sleep for a variety of sleep disorders.

- **Distribution of the sleep stages:** The percentage of each stage varies by age and medications. It is also important to realize that it is only one "snapshot" in time. Underlying sleep disorders may increase lighter stages of sleep (N1) and decrease others (N3, REM). The field of sleep medicine does not attempt to change percentages of sleep stages with medications. Treating underlying sleep disorders will likely have a positive effect on sleep stage distribution.

Respiratory events: Discusses the number of breathing events that were seen throughout the study. Breathing events can include:

- **Obstructive Apnea:** Temporary collapse of the upper airway

- **Central Apnea:** Temporary pauses in the brain's signals telling the lung muscles to contract and allow the lungs to breathe

- **Mixed Apnea:** A combination of both obstructive and central apnea

- **Hypopnea:** Temporary partial collapse of the upper airway

- **Total Apnea Index:** Amount of apneas per hour of sleep

- **Total Hypopnea Index:** Amount of hypopneas per hour of sleep

- **Apnea-hypopnea index (AHI):** The addition of both indexes together

- **Periodic Breathing (PB):** Normal variation of breathing found in premature and full term infants. It occurs when the infant has pauses in breathing for no more than 10 seconds at a time

followed by a series of rapid, shallow breaths. Then the breathing returns to normal without any stimulation or intervention. The scoring criteria for PB are not as straight forward as the above definition. Up to 5% of PB is thought to be within acceptable limits. PB is more common in young infants and decreases with age.

- **Paradoxical Breathing:** This is when the chest moves inward during inhalation instead of moving outward. This abnormal chest movement affects the patient's breathing pattern and can affect oxygen levels. It is often seen in conjunction with obstruction of the upper airway. It can be a normal finding in children up to approximately three years of age.

- **Respiratory Rate:** The amount of breaths per minute. The normal values change with age.

Gas exchange: Discusses the patient's ability to inhale oxygen and exhale carbon dioxide. Oxygen saturation levels monitored with a pulse oximeter. Normal levels for oxygen at this elevation (above sea level) are 95% saturation or higher. However, 90-94% is considered "low normal."

- **Oxygen nadir:** The lowest oxygen saturation during the study.

- **Normal/abnormal oxygenation:** There is some debate in the medical field as to what constitutes an abnormal amount of time below 90% saturation. In this lab, 10 minutes below 90% or 5 minutes below 85% is considered abnormal. Lower oxygen levels can be related to both obstructive and central sleep apnea, or to other primary lung or heart diseases and causes.

- **Normal ventilation/hypoventilation:** Ventilation refers to ability to exhale carbon dioxide. Hypoventilation means that carbon dioxide levels are elevated. We monitor for hypoventilation by two different methods. One is called end tidal CO2, and is measured near the patient's nose. It is usually the more reliable marker. The other method is called transcutaneous CO2. This is placed on the patient's chest or back. Hypoventilation can be present in a variety of different diseases.

Miscellaneous data: This section includes other parameters that are monitored overnight.

- **EKG:** In the sleep lab we observe the electrical activity of the heart using one EKG lead. This allows for some degree of evaluation of the rate and rhythm of the heart. It does not allow for a comprehensive look at the heart.
    - **Normal sinus rhythm:** indicates a normal rate and rhythm of the heart
    - **Sinus arrhythmia:** a normal physiological phenomenon, most commonly seen in young, healthy people. The heart rate varies depending on whether the individual is inhaling or exhaling.

- **Limb movements:** Measures how often limbs are moving on average per hour. This helps quantify the "degree" of restlessness during sleep. There is a wide spectrum of restless sleep. This information can help support a clinical diagnosis of restless leg syndrome. It should not be interpreted alone without the appropriate context. The current American Academy of Sleep Medicine (AASM) scoring criteria calls "normal" 5 events per hour or less for children.

- **Periodic limb movement arousal index:** This indicates how many limb movements were associated with arousals (an uptick in your brain activity during sleep). This can be a more telling indicator of disrupted sleep associated with limb movements.

- **EEG:** This allows us to monitor electrical activity of the brain. We do partial EEG monitoring in order to score the various stages of sleep. We also look for any abnormal (epileptiform) discharges. Occasionally we will do a "full" or complete EEG monitoring. This is interpreted separately by a neurologist.

- **pH Probe:** This is occasionally used to monitor for reflux (acid produced by the stomach can move up into the esophagus). This is interpreted separately by a gastroenterologist.

- **Video:** Noteworthy events from the overnight video. Common comments will include presence or absence of snoring, presence or absence of hyperextension (sleeping with the head positioned towards the back), degree of comfort while breathing, and presence or absence of abnormal behaviors.

- **Data:** Urine tests, blood tests, actigraphy (non-invasive method to help objectify sleep/wake patterns) and sleep logs may be included in this section.

- **PAP Titration:** Reviews the various devices (such as CPAP) and pressures monitored throughout the study. It usually includes final pressures and whether or not this is considered an adequate/good/optimal study per the AASM criteria.

Impression: Explains the overall significant findings of the study.