Sleep Studies

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The most accurate way to measure what is going on in your sleep is with a *Nocturnal Polysomnogram* (NPSG or PSG). It is also called a “Level 1” sleep study. The term polysomnogram is derived from the Greek *polus* for “many”, the Latin somnus for “sleep”, and the Greek *graphein* “to write”. This is because the polysomnogram monitors and graphs a number of physiological parameters when you sleep. This overnight "sleep study" is conducted in the sleep lab. It is monitored by a trained technician. There are tiny electrode cups glued with a water-soluble paste on the scalp to monitor brain waves (EEG-electroencephalogram). The EEG enables the technician to determine when you go to sleep, how deeply you sleep, and how often you wake up. There are electrodes glued beside the eyes (EOG-electrooculogram) to monitor eye movement. This tells us when you go into REM or Rapid Eye Movement sleep which is when you do your most vivid dreaming. When your eyes are moving, you are probably watching a dream. There are electrodes on the chin to monitor muscle tone. This helps us determine when you fall asleep because your muscles will relax. It also helps us determine when you go into REM. In REM your voluntary muscles become paralyzed so you don’t act out your dreams. There is a sensor that monitors airflow through the nose and mouth. Elastic belts around the chest and abdomen monitor breathing movement. A sensor on a finger monitors blood oxygen. Electrodes glued on the chest monitor heart rate and rhythm (ECG-electrocardiogram). Electrodes glued on the legs (EMG-electromyogram) monitor leg movements and twitching. There is an infrared camera and a microphone so the technician can see and hear you. If you need assistance during the night, such as getting up to go to the bathroom, pushing the call-bell button will immediately summon the technician in to help.

During the nocturnal polysomnogram, if we see the chest and abdomen going up and down trying to breathe but there is no airflow through the nose or mouth and the blood oxygen is going down, then we know you are having an obstructive apnea. If we see no airflow and the oxygen is dropping down but there is also no respiratory effort by the chest or abdomen, then you are having a *central apnea*. In central apnea your Central Nervous System (CNS) is not telling you to breathe. More information about this can be found in the section on *Central Sleep Apnea*.

A Level 2 study is an “unattended” Nocturnal Polysomnogram. It monitors the same

physiological parameters but is a portable test done at home or sometimes in a hospital ward but without a technician to monitor you. The morning after the study you return the equipment to the lab. Then, the data is downloaded on a computer, scored by a technician and interpreted by a physician just like the attended Level 1 study performed overnight in the lab.

The advantage of a Level 2 over a Level 3 or 4 is that it monitors sleep with an EEG just like a Level 1. Because it is unattended, if any of the wires come off or sensors malfunction, there is no technician there to recognize and fix it at the time. Sometimes the studies are inconclusive or have to be repeated. The Level 2 study is not performed very often currently except perhaps in research settings mostly due to lack of funding for it.

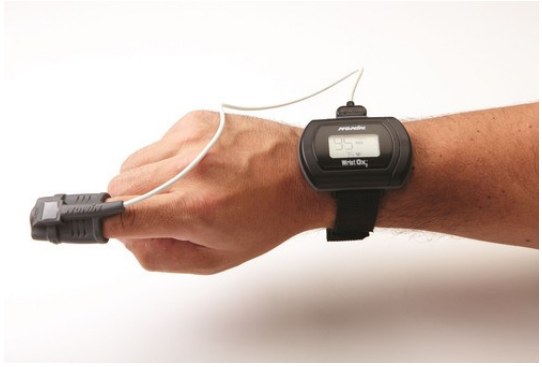
A Level 3 study is sometimes called a “cardio-respiratory study” or a "Home Sleep Anea Test" (HSAT). This is because it monitors heart rate and respiratory function but usually little else. It is also an ambulatory study that the patient usually takes home. Although it is done overnight, it is not really a sleep study because it does not have an EEG to actually monitor sleep. It monitors at least 4 channels including blood oxygen, nasal airflow, chest breathing movement and snoring. Some machines may monitor body position and/or limb movement as well.

The advantage of a Level 3 over a Level 1 or 2 is that the patient can hook themselves up fairly easily with instructions. The fewer physiological parameters being monitored also make it much quicker to score by the technician and interpret by the physician. This makes it much less expensive than a Level 1 or Level 2 study. The advantage of the Level 3 over the Level 4 is that the changes in airflow help confirm the respiratory disturbance even if the oxygen levels do not drop very far with apneic events. This makes the Level 3 much more sensitive than the Level 4 for diagnosing sleep apnea assuming that it is scored by a technician, not just auto-scored by the manufacture’s software. The Level 3 can also differentiate between obstructive and central apnea whereas the Level 4 cannot. However, this is only if the chest effort belt is used to monitor breathing movement. The disadvantage of the Level 3 over a level 1 or 2 is that without an EEG, it does not actually monitor sleep. This makes the study useful only for diagnosing sleep apnea. It is also not as sensitive as a level 1 or 2 and may significantly underestimate the severity of sleep apnea in some patients. This is because subtle respiratory disturbances with minimal changes in airflow or oxygen saturation require an EEG arousal to confirm the event is disturbing sleep. Another limitation with the Level 3 study is that if your are awake for long periods in the night, it can significantly underestimate the severity of the sleep apnea. Thus, a symptomatic patient with snoring and fatigue who has a negative or borderline Level 3 will need a Level 1 to rule

out significant sleep apnea or other sleep disorders.

The few Level 3 machines that monitor limb movement can also help identify *Periodic Limb Movement Disorder*. However, this diagnosis should still be confirmed with a Level 1 or 2 study to see if there are brain arousals associated with the limb movement.

Nocturnal Oximetry or a Level 4 study just monitors blood oxygen saturation with an oximeter sensor from which heart rate is also determined. Because it is simple and cheap to use it is often used to screen for sleep apnea. The problem is that although it is fairly specific, it is not a sensitive test and can significantly underestimate the severity of sleep apnea. Thus, it can be used to diagnose sleep apnea but should not be used to screen for it.



The characteristic saw-tooth wave abnormalities seen on nocturnal oximetry in patients with sleep apnea are quite diagnostic. Without a chest belt to see if the patient is making any respiratory effort or not, we cannot differentiate between obstructive and central sleep apnea. However, if the apnea resolves on treatment with CPAP along with resolution of the symptoms of snoring, snorting and fatigue, this confirms that the diagnosis of obstructive sleep apnea was correct. This is because central apnea does not resolve on CPAP.

However, if a patient is symptomatic with snoring and pauses in breathing or fatigue, and the nocturnal oximetry is borderline or negative, then this test does not rule out sleep apnea or other sleep disorders. In this situation, more definitive testing is required with a Level 3 or preferably a Level 1 study.