



# COMMON SENSE RESPIRATORY

## “Sleep Disordered Breathing”



*“Nocturnal oxygen desaturations in COPD patients is fairly common and often unrecognized. ...Front line physicians should evaluate each [COPD] patient’s oxygenation using oximetry.”*

Thomas Petty MD, Master FCCP  
Frontline Treatment of COPD

### **Learning Objectives**

“Common Sense Respiratory” is a series of articles written for the Respiratory Clinician and non-Respiratory Care Practitioner with the purpose of conveying concepts and terminology of respiratory medicine in everyday language. Increasing understanding of these areas will allow Rotech personnel to provide a higher level of service to the patients, families, physicians, nurses, respiratory care practitioners, discharge planners, and other markets we serve.

In “**Sleep Disordered Breathing**,” we will endeavor to answer the following questions:

- **What Is Sleep Disordered Breathing?**
- **What Happens To Breathing During Sleep?**
- **What Are The Various Types Of Sleep Disordered Breathing?**
- **What Changes Occur In Specific Diseases?**
- **How Is Sleep Disordered Breathing Identified?**
- **What Type of Testing is Performed?**
- **How Is Sleep Disordered Breathing Treated?**

All words shown **emboldened and italicized** will be defined at the end of the chapter in the “Glossary of Terms” section. You may also notice the abbreviations used in parentheses: e.g. - “for example”; i.e. - “that is”; aka - “also known as.”

### **What Is Sleep Disordered Breathing?**

Sleep Disordered Breathing (SDB) is a general term describing significantly abnormal breathing during sleep. Until the last two decades, clinicians paid very little attention to what occurs to breathing during sleep. Once they began recording what happens to breathing during sleep, clinicians have begun to realize that abnormal breathing during sleep may play an important role in many disease processes. There is some evidence that suggests SDB may even play a causative role in the development of diseases such as heart disease and **stroke**. In many conditions, SDB may contribute to the progression of the disease and the patient’s survival.



### **What Happens To Breathing During Sleep?**

Even in people without disease, several changes occur that affect breathing during sleep. While resting, the body has a lower rate of **metabolism** and thus has less demand for ventilation.

Changes in breathing patterns occur depending on the stage of sleep. During the shallower stages of sleep (referred to as **Non-Rapid Eye Movement or Non-REM Sleep**) the changes are less pronounced. During the deeper stages of sleep (referred to as **Rapid Eye Movement or REM Sleep**) changes in breathing may become more significant. Changes that occur during sleep include:

- **Decreased Depth of Breathing** - During Non-REM sleep, our breathing may be shallower. During REM Sleep, the size of individual breaths (aka, **tidal volume**) can be quite variable with periods of even more shallow breathing. Overall, breathing is diminished during sleep, especially during REM sleep.

- **Changes in Breathing Rate** - During non-REM sleep, the breathing rate is regular but can become variable during REM sleep.
- **Decreased Drive to Breathe** - Our drive to breathe comes from respiratory centers within the brain. The respiratory centers typically are stimulated to increase breathing if the blood **oxygen** levels drop or **carbon dioxide** increases. During sleep, these centers are less responsive to changes in oxygen and carbon dioxide. This is most noticeable during REM sleep.



- **Changes in Upper Airway Muscle Tone** - Loss of muscle tone in the upper airway (especially during REM sleep) may cause the upper airway to be more prone to collapse, resulting in more resistance to **airflow** in and out of the **lungs**. In many people this causes snoring.
- **Decreases in Airflow in Small Airways** - Airflow in our small airways reaches its lowest level during sleep. This is due to natural body rhythms resulting in changes in blood **hormone** levels that affect airflow. Patients with **asthma** may demonstrate

drops as high as 50% or more compared to 8% in normal individuals. This can be partially explained by the fact that patients go for longer periods without medication during sleep.

- **Loss of Accessory Muscle Contribution** - Our major muscles of ventilation are the muscles that make up the **diaphragm**. During non-REM sleep, the lesser muscles of ventilation (accessory muscles) which are located in the chest and abdomen become more involved in assisting the diaphragm. During REM sleep, the contribution of the accessory muscles is diminished. For patients who are dependent on accessory muscle contribution, such as in **COPD**, this loss can result in profound loss of tidal volume and significant under-ventilation (aka, **hypoventilation**) and drops in oxygen levels (aka, **desaturations**).
- **Loss of Lung Volume** - A modest but significant drop in volume of the lungs is noted during sleep. In healthy individuals this loss of volume is not clinically significant, but in patients with chronic lung disease it can result in poor matching of blood flow to ventilation in the air sacs (i.e. **alveoli**), a condition referred to as a **V/Q mismatch**. This lowers the lungs ability to get oxygen into, and carbon dioxide out of, the blood.
- **Blood Flow Changes** - During sleep, the distribution of blood flow (aka, **perfusion**) in the lungs changes. This is due to the changing effects of gravity on blood flow. When the patient is upright during the day, most blood flow goes to the lower parts (aka, bases) of the lungs. When the patient lies down, blood flow goes to the part of the lung that is lowermost. That is, if the patient is lying on their back (aka, **supine**), more blood flow goes to the back of the lungs.

The overall effect of these changes during sleep is a reduction in ventilation compared to when awake, especially during REM sleep. In people with normal lung function, these changes result in relatively minor and insignificant changes in blood oxygen and carbon dioxide levels. However, in patients who have conditions that compromise breathing, these changes may result in profound effects on breathing resulting in significant hypoventilation and severe reductions in their ability to maintain adequate oxygen and carbon dioxide levels during sleep.

## What Are The Various Types Of Sleep Disordered Breathing?

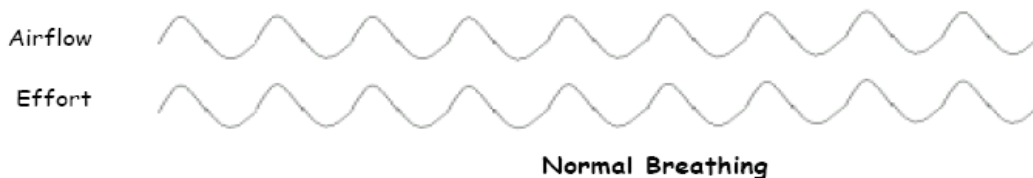
There are several types of sleep disordered breathing. It may include periods of **apnea** (i.e. no airflow), periods of abnormal ventilatory patterns, or breaths of abnormal depth and rate. Different types of sleep disordered breathing often appear together in the same patient.

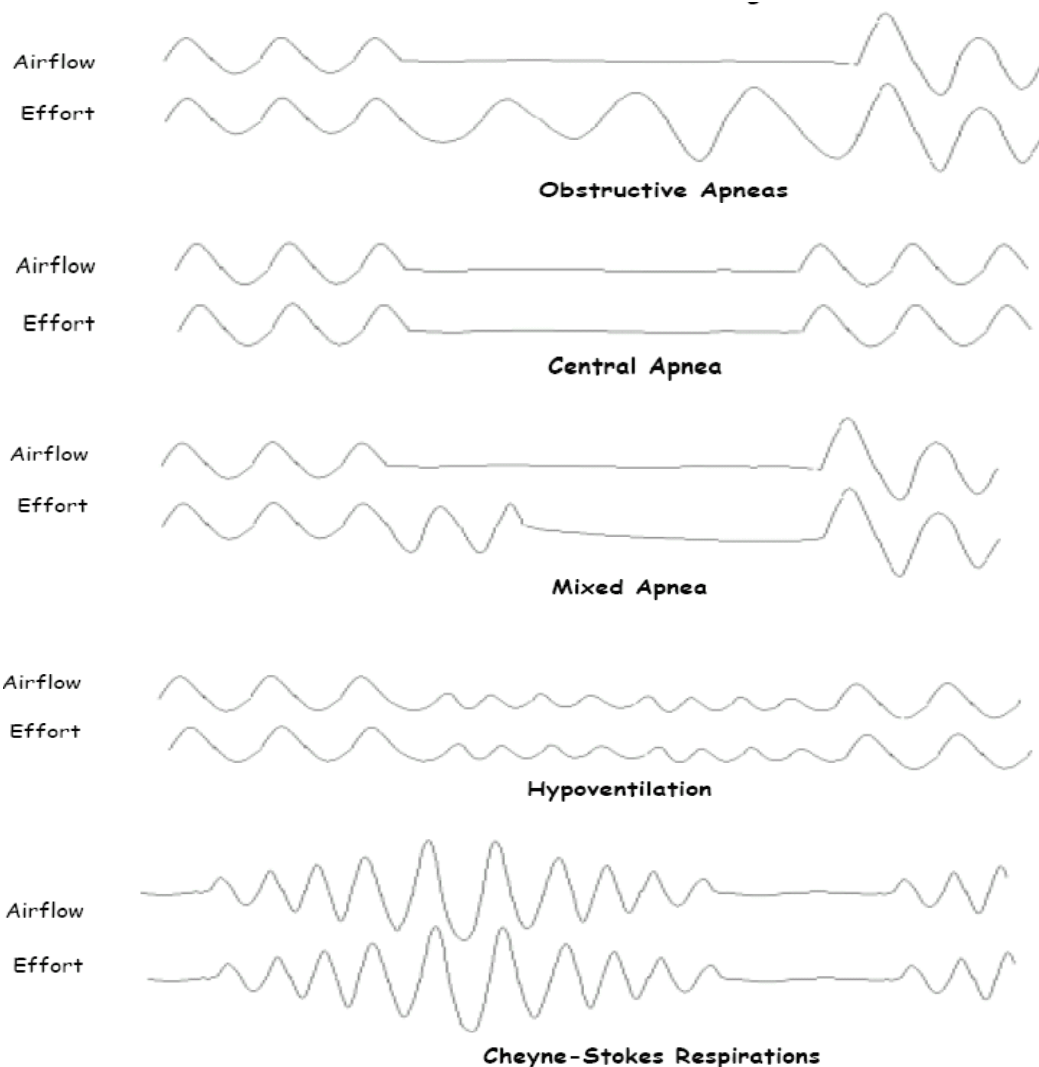
- **Obstructive Apneas** - Apnea is generally defined as a period of little (less than 25% of their normal airflow) or no airflow for at least 10 seconds. Obstructive apneas occur when the upper airway collapses during sleep, blocking airflow in and out of the lungs. Despite the patient's continuing effort to breathe, little or no airflow is occurring. These apneas are more likely to occur in patients whose upper airways are smaller due to obesity (i.e. added tissue in the throat), who have a deep set chin, who have a large tongue and/or enlarged tonsils; but it can occur in patients with none of these features.
- **Central Apneas** - In some disease states (e.g. CHF, stroke, neuromuscular diseases), central apneas may occur. Central apneas are periods (typically 10-15 seconds or longer) during which the patient makes no effort to breathe.
- **Mixed Apneas** - Mixed apneas are periods when both obstructive and central apneas occur together. That is, a central apnea (no effort and no airflow) is followed by an obstructive apnea (effort to breathe but no airflow) or visa versa.



## Types of Sleep Disordered Breathing

“Airflow” is the movement of air in and out of the lungs and “Effort” is the patient’s effort to breathe (movement of the diaphragm).



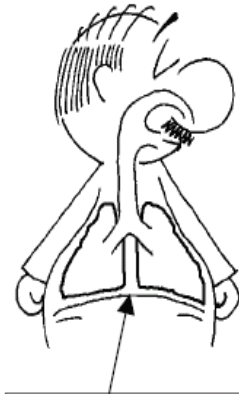


- **Nocturnal Hypoventilation** - In some conditions such as COPD, the patient may not have actual apneas (i.e. periods of no airflow), but periods in which breathing is significantly reduced, called **hypopneas**. There is no standardized definition of hypopnea, which often causes much confusion in this area. One commonly used definition is a decrease in the measured airflow reading to less than 70% of their normal reading. Some clinicians don't consider the hypopnea as significant unless there is corresponding drop in the patient's oxygen level (i.e. desaturation).
- **Cheyne-Stokes Respirations** - Cheyne-Stokes Respirations are an abnormal breathing pattern characterized by a repetitive pattern of increasing rate and depth of breathing followed by a period of decreasing rate and depth of breathing and then a period of central apnea. This is common in CHF (occurs in about 50%) and is predictive of poorer outcomes in these patients. It may also occur in other disease states.

- **Upper Airway Resistance Syndrome** - In some people, the upper airway may partially collapse resulting in the patient having to work much harder to get a breath into the lungs. Although they don't have a complete obstruction, the increased effort results in the patient having multiple arousals from sleep and a poor quality of sleep.

### What Changes Occur In Specific Diseases?

- **COPD** - Because patients with COPD have difficulty getting air out of their lungs, air is trapped in their lungs (**air trapping**) and the lungs are in a state of over-inflation (**hyperinflation**). The diaphragm, which normally is dome-shaped, gets pressed flat, and it cannot move sufficiently to adequately **ventilate** the lungs. The body compensates by enlisting the help of the accessory muscles of **ventilation**. The patient uses these muscles located in the chest, shoulders, and abdomen in an effort to maintain adequate ventilation. This is often observed in the COPD patient who is sitting with elbows on the table or with hands on knees, stabilizing his shoulders so he can better use his accessory muscles. Often, the upper chest is moving up and down as the patient breathes. During REM sleep, all **skeletal muscles**, including the accessory muscles of ventilation cease contributing to ventilation and all the work of breathing falls back on the "flattened" diaphragm.



*Patient with over-inflated lungs and a flattened diaphragm*

During REM sleep, ventilation may decrease to about half of daytime levels as the diaphragm is unable to maintain adequate ventilation. As blood flows to the lungs and breathing patterns change during sleep, there may be areas of the lungs where ventilated air sacs do not match up well with blood flow and where air sacs that have good blood flow do not have proper ventilation. This condition is known as a V/Q mismatch. When this occurs, the lungs lose some of their ability to maintain adequate gas exchange and oxygen levels may decrease while carbon dioxide levels rise during sleep. Patients with COPD may also have obstructive sleep apnea, a condition referred to as "**Overlap Syndrome**." It is not felt, however, that obstructive sleep apnea is significantly more common among patients with COPD than in the general population.

- **Other Respiratory Disease** - Breathing during sleep is also affected in other respiratory disease. In asthma, airflow may reach its lowest level during sleep due to changes in blood hormone levels affecting airflow and due to patients going several hours without medication. Airflow may drop to 50% or less of daytime levels and nocturnal coughing and wheezing is common in asthma. This can be further aggravated by increased exposure to **allergens** such as dust that occur in increased amounts in the mattress and pillows.

Other respiratory diseases such as **cystic fibrosis** and **pulmonary fibrosis** may also show abnormalities in breathing during sleep. It is important to recognize the potential for SDB in all patients with respiratory illness and to monitor for signs and symptoms indicating its presence.

- **Heart Disease** - Studies indicate that there is a high prevalence of SDB in patients with heart disease. As discussed earlier, patients with **CHF** may have a high incidence of Cheyne-Stokes Respirations. Other heart disease has also been associated with SDB including obstructive sleep apnea (OSA). It has been suggested that OSA may play a role in the development of heart disease in some patients. Patients with OSA have a higher prevalence of high blood pressure, which puts them at increased risk for heart disease.
- **Stroke/Transient Ischemic Attacks (TIA)** - Patients with stroke and/or TIA's have a greatly increased incidence of obstructive sleep apnea. Studies have revealed that more than 50% of stroke/TIA patients have obstructive sleep apneas. As with heart disease, it has been suggested that OSA may have a role in the development of stroke.
- **Obesity** - Patients who are obese are at increased risk of having OSA. Due to additional tissue in the back of the throat, the throat is more prone to collapse and obstructive episodes during sleep. The chance of SDB increases as the patient's weight increases.

People who are **morbidly obese** may have a condition known as **obesity hypoventilation syndrome** (aka, **Pickwickian Syndrome**). These patients are not only prone to severe apnea and hypoventilation at night, their hypoventilation continues throughout the day, resulting in low blood oxygen and increased carbon dioxide even during waking hours.

- **Neuromuscular Disease** - Patients with neuromuscular disease, such as post-polio syndrome, muscular dystrophy, ALS, and other conditions affecting the nerves or muscles of breathing, are also more prone to abnormal breathing during sleep. Their SDB may consist of obstructive apneas, central apneas, hypoventilation, or any combination of these.
- **Other Conditions** - Sleep disordered breathing has been recognized to occur in other conditions including chronic liver disease, diabetes, and dialysis patients. It is evident that we are only beginning to understand the significance of SDB's role in a variety of illnesses.

## How Is Sleep Disordered Breathing Identified?

Physicians and other healthcare workers should monitor patients with conditions prone to SDB for **signs** and **symptoms** of SDB. If any of the below are noted, the clinician should consider the need for sleep testing:

- **Restless/Poor Sleep** - Drops in oxygen and elevations in carbon dioxide during sleep cause **arousals** and prevent good quality sleep from occurring.
- **Excessive Daytime Sleepiness** - Due to the poor quality of sleep, patients often complain of being excessively sleepy or fatigued during the day.



- **Orthopnea** - Patients may complain of increased shortness of breath when lying down compared to when they are seated or standing.
- **Paroxysmal Nocturnal Dyspnea (PND)** - PND is waking up suddenly short of breath. It can occur in CHF, OSA, and COPD.
- **Morning Headaches** - Changes in oxygen and carbon dioxide levels during sleep may cause headaches upon awakening.
- **Observed Pauses in Breathing** - Healthcare workers sometimes forget to ask the spouse about the patient's quality of sleep. They may have observed periods of apnea or abnormal breathing patterns during sleep.
- **Severe Snoring** - Once again, the bed partner is the best source for information. In some patients, snoring is so severe the spouse sleeps in a separate room.

When these signs and symptoms are noted, more definitive testing should be considered to help make the appropriate diagnosis.

### What Type of Testing is Done?

Sleep testing is a relatively new field of medicine. In the last 20 years a new specialty has developed in sleep medicine, and now physicians and technicians are being credentialed specifically in sleep medicine.

Sleep testing generally occurs in a hospital-based sleep laboratory, although freestanding sleep labs are gaining in popularity. In fact, it is becoming more commonplace for testing to occur in the patient's home. Because it is generally less expensive and more comfortable for the patient to do the test in the home, many feel that in the future, more and more testing will occur at the patient's home.

Sleep testing can be as simple as monitoring a single thing as in overnight oximetry recording or as complex as measuring 16 or more types of patient information (referred to as "channels" on a sleep test) with many alternatives for testing in between these two extremes.

A **sleep study** refers to four or more channels of testing which generally includes:

- **ECG** (aka, **electrocardiogram** or **EKG**) - This is a measurement of the electrical activity of the heart.
- **Airflow** - Airflow is measured at the nose and mouth. This is generally accomplished by measuring changes in temperature or pressure with a probe placed at the nose and mouth.
- **Respiratory Effort** - Sensors are generally applied on the chest and abdomen to measure chest and abdominal movement (i.e. "diaphragm movement").



- **Oximetry** - Oximetry measures the oxygen level in the blood as breathing changes during sleep.

**Polysomnography** (aka, **PSG**) is a more detailed sleep test in which the channels listed above are monitored along with several more. Other channels that are included during polysomnography include:

- **EEG** (aka, **electroencephalogram**) - Measurements of brain activity are used to determine the patient's stage of sleep (e.g. REM-sleep vs. non-REM) and any abnormal brain activity (e.g. seizure disorders).
- **EMG** (aka, **electromyelogram**) - Measurements of muscle activity are taken at the jaw to assist in staging sleep and in the legs to monitor for abnormal leg "jerks" called **nocturnal myoclonus**.
- **EOG** (aka, **electrooculogram**) - Measurements of eye movements are used to determine whether "rapid eye movements" are occurring indicating the patient is in REM sleep.

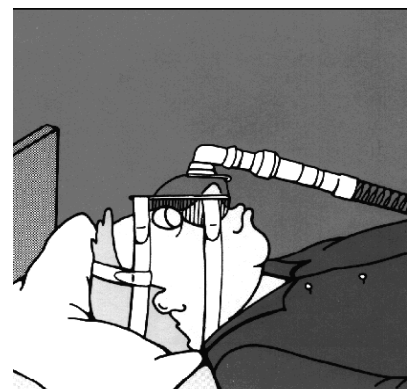
Other special channels (e.g. **end-tidal CO<sub>2</sub>**, **esophageal pH**) may also be included, depending upon the patient's signs and symptoms or the doctor's suspicions.

Many sleep labs have focused almost exclusively on the identification and treatment of obstructive sleep apnea. Their knowledge in the identification and management of other types of SDB may be limited. As the importance of sleep disordered breathing in other diseases is recognized, it is important that physicians and the sleep lab personnel become knowledgeable in these areas as well. Sleep testing may play a very important role in the management of large patient groups such as COPD and CHF. Education of the sleep lab's clinicians in these areas will be a real challenge if we are to appropriately manage these conditions.

## How Is Sleep Disordered Breathing Treated?

Treatment differs depending upon the type of sleep disordered breathing being managed. Therapies used may include:

- **Oxygen** - Oxygen therapy is used to treat drops in oxygen level for patients with COPD, CHF, and other cardiac and respiratory disorders.
- **CPAP** - Continuous Positive Airway Pressure or CPAP (pronounced SEE-pap) is used to treat obstructive apneas. The patient wears a mask over the nose, which is connected to the CPAP device. A constant pressure is applied to the patient's airway through the mask. This pressure inside the airway creates an air "splint" which keeps the airway from collapsing, thus preventing obstructive apneas.
- **Bilevel PAP** - Bilevel Positive Airway Pressure (aka, BiPAP™) is similar to CPAP except that two different pressures are applied to the airway. During inspiration a higher pressure is used (called inspiratory positive airway pressure



or IPAP) and during exhalation a lower pressure is applied (called expiratory positive airway pressure or EPAP). Bilevel PAP is used in treating obstructive sleep apnea, especially when patients require greater pressure settings that may be uncomfortable when using CPAP. Bilevel PAP can also be used to assist ventilation in some patients that hypoventilate (e.g. COPD) when a backup breathing rate is not required (see below).

- **Noninvasive Positive Pressure Ventilation** - NPPV is similar to Bilevel PAP except that the NPPV device also provides the patient with a backup rate. If the patient has periods where there is no effort to breath (i.e. central apnea), the machine will automatically deliver a breath. NPPV is used to manage hypoventilation and central apneas that may occur in COPD, CHF, neuromuscular disease, and chest wall restriction.

Sleep Disordered Breathing plays an important role in many cardiopulmonary conditions. It is becoming obvious that clinicians involved in the management of patients with illnesses prone to SDB should have adequate knowledge of their incidence, identification, and management.

## Glossary of Terms

These definitions, although written to be accurate, are simplified and may be incomplete. For a more complete (and complicated) definition, refer to an acceptable medical dictionary (e.g. Dorland's). Abbreviations used may include aka - "also known as," e.g. - "for example," and i.e. - "that is." Words that appear in italics within the definition are also defined elsewhere within the glossary.

**Accessory Muscles** – Muscles within the chest, shoulders, and abdomen can act as a "backup system" to the diaphragm when it is not able to maintain adequate breathing. Patients who use their accessory muscles often sit with their arms resting on a table or with their hands on their knees in an attempt to better use these muscles for breathing.

**Apnea** – A state of no airflow in or out of the lungs is said to be an apnea.

**Air Trapping/Hyperinflation** – Patients with diseases that make it difficult to get air out of the lungs (e.g. COPD, asthma) begin to trap excess air in the chest. Air is trapped in the lungs as airways are narrowed by swelling, excess mucous, airway muscle spasms, and destruction of the lungs themselves. This is analogous to a balloon that is over-inflated.

**Airflow** – Airflow is the movement of air in (inspiratory flows) or out (expiratory flows) of the airways. It is usually measured in liters per minute (l/m) or liters per second (l/s).

**Allergens** – A substance that causes an allergic reaction is an allergen.

**Alveoli** – Microscopic air sacs in the lungs that are responsible for getting oxygen into, and carbon dioxide out of, the bloodstream.

**Amyotrophic Lateral Sclerosis (ALS)** – Also known as motor neuron disease or "Lou Gehrig's Disease," ALS is characterized by progressive loss of muscle use, and it eventually results in respiratory failure and death.

**Asthma** – Asthma is a condition characterized by periods of decreased airflow through the airways. This is due to blockage of the airways from swelling, spasm of the muscle around the airway, and increased secretions in the airways.

**Bilevel Positive Airway Pressure (aka, Bilevel PAP or BiPAP™)** – Bilevel Positive Airway Pressure is similar to CPAP except that two different pressures are applied to the airway. During inspiration a higher pressure is used (called inspiratory positive airway pressure or IPAP), and during exhalation a lower pressure is applied (called expiratory positive airway pressure or EPAP).

**Bradypnea** – The occurrence of a slower than normal breathing pattern.

**Carbon Dioxide (CO<sub>2</sub>)** – Carbon dioxide is a waste gas that is produced by our bodies as energy is burned. It is normally carried to the lungs by the blood where it is exhaled.

**Central Apnea** – Central apnea differs from obstructive apnea in that the absence of airflow in or out of the lungs for a period of time is due to the patient's lack of respiratory effort.

**Cheyne-Stokes Respirations** – An abnormal breathing pattern characterized by gradually deeper breaths, followed by gradually shallower breathing with periods of hypopnea and periods of central apnea.

**Chronic Obstructive Pulmonary Disease (COPD)** – COPD is a diagnosis that includes conditions such as emphysema, chronic bronchitis, and asthmatic bronchitis, which produce chronic reduction of the airflow out of the lungs. Because these conditions may coexist to some degree, it is often easier to group patients under COPD rather than saying “emphysema with some chronic bronchitis” or “chronic bronchitis with an asthmatic component.”

**Congestive Heart Failure (CHF)** – Fluid may begin to “back up” or accumulate in the lungs and other parts of the body as the heart is unable to pump blood effectively. This is typically seen when a heart attack or some other cardiac disease has damaged the heart. It can also result from pulmonary diseases that cause chronic hypoxemia.

**Continuous Positive Airway Pressure (CPAP)** – A continuous pressure applied to the airway through a nasal mask. Typically used to prevent upper airway collapse that occurs in obstructive sleep apnea.

**Cystic Fibrosis** – This is a genetic condition that results in excessive production of thick mucus in the airways.

**Desaturate/Desaturation** – The occurrence of an abnormal drop in blood oxygen levels – typically indicated by a drop of at least 4-5% in oxygen saturation.

**Diaphragm** – The diaphragm is the dome-shaped muscle under the lungs. When it contracts, it causes the size of the chest cavity to expand, drawing air into the lungs (inhalation). When it relaxes, it returns to its natural dome shape and exhalation occurs.

**Electrocardiogram (ECG or EKG)** – The recording of the heart's electrical activity.

**Electroencephalogram (EEG)** – The recording of the brain's electrical activity. EEG is used to determine which stage of sleep the patient is in during a sleep study (polysomnography).

**Electromyogram (EMG)** – The recording of the electrical activity of a muscle. In polysomnography studies, an EMG of the jaw, legs, and eyes may be recorded.

**Electrooculogram (EOG)** – The recording of the movement of the eye muscles. This is used to help determine when rapid eye movements occur during sleep.

**End-Tidal CO<sub>2</sub> (ETCO<sub>2</sub>)** – The amount of carbon dioxide in exhaled air. From this measurement, it is possible to estimate the amount of carbon dioxide in arterial blood.

**Esophageal pH** – The measurement obtained when the pH in the tube leading to the stomach. If this measurement shows drops, it indicates that stomach acid is moving up into the esophagus (aka, gastro-esophageal reflux).

**Hormone** – A chemical substance that is formed in one organ or part of the body and carried in the blood to another organ or part of the body where it produces a specific effect.

**Hypoventilation** – Less than normal ventilation due to hypopnea (smaller sized breaths), bradypnea (slower breathing), or a combination of the two.

**Hypopnea** – The occurrence of smaller than normal sized breaths.

**Hypoxemia** – The occurrence of low blood oxygen levels.

**Lungs** – The lungs are the organs of gas exchange in the body. Composed of millions of tiny alveoli (air sacs), they are designed to get oxygen into the bloodstream and carbon dioxide out of the blood. Each alveolus is bordered by an accompanying capillary (or capillaries), allowing red blood cells to flow in very close proximity to the fresh air inside the alveoli. This allows for ready movement of oxygen into, and carbon dioxide out of, the blood stream.

**Lung Volume** – This measurement of size is referred to as volume. In spirometry, lung volume is typically measured in liters—one liter equal to about a quart.

**Metabolism** – Processes occurring in the body that change materials from large molecules to smaller (e.g. “burning” fats, carbohydrates, or proteins to produce energy) or smaller molecules to larger (e.g. joining simple sugars together for storage). All of these processes require energy and most require oxygen.

**Mixed Apnea** – Periods when both obstructive and central apneas occur together. That is, a central apnea (no effort and no airflow) is followed by an obstructive apnea (effort to breathe but no airflow) or visa versa.

**Morbid Obesity** – Morbid obesity is obesity sufficient to prevent normal activity or physiologic function, or to cause the onset of a pathologic condition.

**Muscle Tone** – The tension (i.e. “firmness”) present in resting muscles.

**Muscular Dystrophy** – A group of genetically determined, painless conditions characterized by muscle wasting without nervous system involvement.

**Neuromuscular Disease** – Diseases characterized by loss of nervous system or muscular function.

**Nocturnal** – Happening at night.

**Non-Rapid Eye Movement (aka, Non-REM) Sleep** – Stages of sleep when rapid eye movements (REM) are not occurring. These tend to be “shallower” stages of sleep.

**Noninvasive Positive Pressure Ventilation (NPPV)** – A therapy using a small bilevel pressure support ventilator and a noninvasive interface (usually a nasal mask) to augment the patient’s spontaneous breathing. It is used in patients with chronic respiratory failure to treat chronic or periodic hypoventilation.

**Obesity** – Overweight, usually greater than 20% over ideal body weight.

**Obesity Hypoventilation Syndrome** – Also known as “Pickwickian Syndrome,” severe restriction of ventilation secondary to obesity that results in daytime hypoventilation and impairment of gas exchange (i.e. reduced oxygen level and/or increased carbon dioxide levels).

**Obstructive Sleep Apnea (OSA)** – A condition characterized by repetitive episodes when the upper airway collapses during sleep, resulting in no airflow to the lungs despite the fact that the patient has made an effort (i.e. diaphragm movement) to breathe.

**Orthopnea** – Increased shortness of breath when laying down compared to standing or sitting.

**Overlap Syndrome** – A condition in which COPD and obstructive sleep apnea occur together.

**Oximetry/Oximetry Recording** – This is a noninvasive (i.e. does not require insertion through the skin or a body orifice) measurement of the oxygen saturation of hemoglobin. That is, if 97% of the hemoglobin in blood is completely saturated with oxygen, the oximetry reading (i.e. SpO<sub>2</sub>) would be 97%. Oximetry is a useful tool because it allows for continuous recording (18 hours or more) of the blood oxygen level during periods of sleep and activity, when other measurements (i.e. ABG’s) would be very difficult to perform.

**Oxygen (O<sub>2</sub>)** – An element required by the body to metabolize or “burn” energy. Air that we inhale contains 21% oxygen.

**Paroxysmal Nocturnal Dyspnea (PND)** – Sudden awakening during the night due to shortness of breath.

**Perfusion** – Blood flow through the vessels of a tissue or organ.

**Polysomnography (PSG)** – Testing performed while the patient sleeps, which includes monitoring EKG, chest movement, air movement out of the lungs, SpO<sub>2</sub>, EEG, EMG, and other measurements.

**Post-Polio Syndrome** – A syndrome in which patients that previously had polio, have symptoms of respiratory failure later in life.

**Pulmonary Fibrosis** – A condition that occurs when the lungs lose their normally elasticity (i.e. stretchiness), and become stiff which restricts their volume and may impede the movement of oxygen into the blood. This may occur secondary to other diseases (e.g., rheumatoid arthritis, rheumatoid lung), exposure to damaging agents (e.g. certain drugs or inhaled agents) or for unknown reasons (i.e. idiopathic pulmonary fibrosis).

**Rapid Eye Movement (aka, REM) Sleep** – The deepest stage of sleep, so called because when it occurs the eyes begin to move back and forth rapidly, which is measured during polysomnography. Dreaming also occurs during REM sleep. This is the period during which many types of sleep disordered breathing tend to be at their most severe.

**Signs** – Signs are abnormal physical findings identified by the clinician as indicators of disease. Signs can include items such as cyanosis (a bluish discoloration of the skin), increased work of breathing, or digital clubbing (bulbar enlargement of the finger tips).

**Skeletal Muscles** – These are the muscles that are used for movement. They are voluntary; that is, their movement requires a conscious effort.

**Sleep Disordered Breathing** – A term used to describe abnormal breathing during sleep. This may include obstructive, mixed, or central apneas; Cheyne-stokes respirations; hypoventilation; etc.

**Sleep Study** – A modified polysomnography test using fewer channels, typically 4-8 channels (e.g. EKG, oximetry, airflow, respiratory effort, etc.) are used. Brain activity (i.e. EEG) is not measured in a sleep study.

**Small Airways (aka, bronchioles)** – Airways generally less than 1 mm in diameter, and having no cartilage in its wall, but relatively abundant in smooth muscle and elastic fibers.

**Stroke** – Loss of brain function secondary to a broken or blocked blood vessel in the brain.

**Supine** – Body position lying down, face up.

**Symptoms** – Abnormal physical findings identified by the patient as possible indicators of disease. This may include items such as cough, shortness of breath, or weakness.

**Tidal Volume** – The volume of air in a normal breath. It is normally about 500 cc's (i.e., 2 cups).

**Transient Ischemic Attack (aka, TIA)** – A sudden loss of brain function due to a short period of inadequate blood flow to the brain. There is generally a full recovery in less than 24 hours.

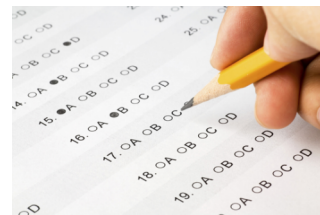
**Upper Airway** – This is the portion of the respiratory tract that extends from the nostrils or mouth to, and including, the larynx (voice box).

**Upper Airway Resistance Syndrome** – In some people the upper airway may partially collapse resulting in the patient having to work much harder to get a breath into the lungs. Although they don't have a complete obstruction, the increased effort results in the patient having multiple arousals from sleep and a poor quality of sleep.

**Ventilate/Ventilation** – The act of moving air in (inhalation) and out (exhalation) of the lungs.

**Ventilation/Perfusion (aka V/Q) Mismatch** – An alveoli that is not receiving normal blood flow, or an alveoli that is receiving normal blood flow that is not being properly ventilated.

## Questions/Assignments



1. Changes to breathing that occur during sleep include:
  - a. shallower breathing, especially during REM sleep
  - b. increased drive to breathe
  - c. a decrease in breathing rate during non-REM sleep
  - d. All of the above
  
2. The overall affect of sleep on breathing is:
  - a. no change
  - b. a decrease in ventilation that is worse during non-REM sleep
  - c. an overall increase in total ventilation
  - d. a decrease in ventilation that is worse during REM sleep
  
3. During periods of poor ventilation in sleep, how are blood CO<sub>2</sub> and O<sub>2</sub> levels affected?
  - a. Both increase
  - b. Both decrease
  - c. CO<sub>2</sub> increases and O<sub>2</sub> decreases
  - d. CO<sub>2</sub> decreases and O<sub>2</sub> increases
  
4. Periods during which there is a good effort to breathe and little or no movement of air in and out of the lungs are called:
  - a. Central apneas
  - b. Obstructive apneas
  - c. Hypopneas
  - d. Cheyne-Stokes Respiration
  
5. Periods during which there is no effort to breathe and no movement of air in and out of the lungs are called:
  - a. Central apneas
  - b. Obstructive apneas
  - c. Hypopneas
  - d. Cheyne-Stokes Respiration

6. Repetitive periods of no airflow followed by periods of increasing then decreasing rate and depth of breathing are called:

- a. Central apneas
- b. Obstructive apneas
- c. Hypopneas
- d. Cheyne-Stokes Respiration

7. Breaths during which there is shallower movement of air in and out of the lungs are called:

- a. Central apneas
- b. Obstructive apneas
- c. Hypopneas
- d. Cheyne-Stokes Respiration

Please match the illness with the type of sleep disordered breathing most likely to occur.

- |                  |                               |
|------------------|-------------------------------|
| 8. _____ COPD    | A. Obstructive Sleep Apnea    |
| 9. _____ CHF     | B. Cheyne Stokes Respirations |
| 10. _____ Stroke | C. Decreased airflow          |
| 11. _____ Asthma | D. Hypopneas                  |

12. Symptoms of sleep disordered breathing include

- a. Morning headaches
- b. Excessive daytime sleepiness
- c. Waking up short of breath
- d. All of the above

13. A sleep study generally includes which measurements?

- a. EKG
- b. EEG
- c. Oximetry
- d. All of the above
- e. A and C

14. **True** or **False** - Polysomnography includes channels of EEG to determine whether the patient has abnormal leg jerks.

15. Treatment using two levels of pressure via a nasal mask with no backup rate is called

- a. CPAP
- b. Bilevel PAP or BiPAP™ S
- c. BiPAP™ S/T
- d. NPPV

**Assignment:** Ask your local respiratory care department for permission to spend some time with them in the Sleep Lab. This would give you good exposure to more advanced sleep testing and provide a great opportunity to build a better relationship with the sleep technicians.

### **Reference List, Supplemental Reading, and Answers to Questions**

Frontline Treatment of COPD, A Monograph for the Primary Care Physician. Murray JF and Petty TL. Snowdrift Pulmonary Conference Booklet written by 8 pulmonologists to guide the primary care physician in the diagnosis and management of COPD. An excellent resource and strong reference for using spirometry and oximetry for identifying early disease.

McNicholas, W.T. "Impact of Sleep in Respiratory Failure." European Respiratory Journal 1997; 10:920-933.

ATS Board "Indications and Standards for Use of Nasal Continuous Positive Airway Pressure (CPAP) in Sleep Apnea Syndromes" American Journal Respiratory Critical Care 1994;150:1738-1745

ATS Board "Indications and Standards for Cardiopulmonary Sleep Studies" Amer Rev Respiratory Disease 1989;139:559-568

### **Answers to Test Questions:**

- |      |       |           |
|------|-------|-----------|
| 1. A | 6. D  | 11. C     |
| 2. D | 7. C  | 12. D     |
| 3. C | 8. D  | 13. E     |
| 4. B | 9. B  | 14. False |
| 5. A | 10. A | 15. B     |