"NPPV"

Learning Objectives

Common Sense Respiratory is a series of articles written for the "non-Respiratory Care Practitioner" with the purpose of conveying concepts and terminology of respiratory medicine in every-day 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 "**NPPV,**" we will endeavor to answer the following questions:

What is NPPV?

What is Chronic Respiratory Failure?

How does NPPV work?

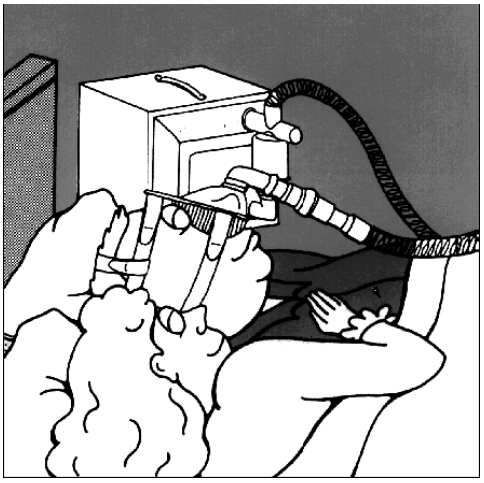
What are the possible benefits of using NPPV?

Why do people benefit most from nighttime use?

Who may benefit from NPPV?

How do you know if a patient is a candidate for NPPV?

What monitoring should be performed?



"Quality of life with oxygen plus [NPPV] was significantly better than with oxygen alone."
DJ Meecham Jones

All words shown ***bold and italicized*** will be defined at the end of the chapter in the "Glossary of Terms" section. You may also notice the abbreviations e.g. - "for example", i.e. - "that is", and aka - "also known as" used in parenthesis.

What is NPPV?

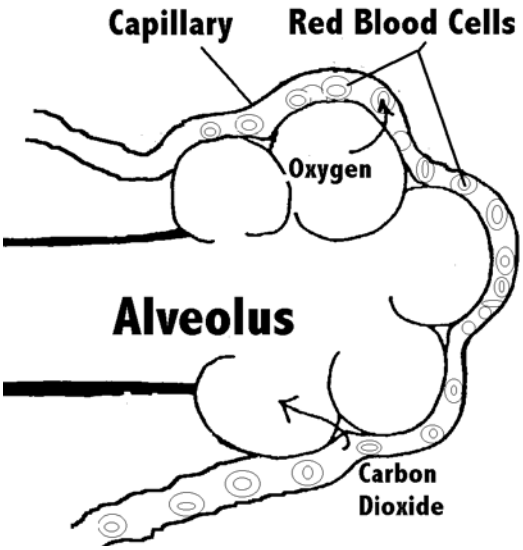
NPPV stands for ***Noninvasive Positive Pressure Ventilation***. As with some other medical terms, NPPV is known by a variety of acronyms and titles including Noninvasive or Nasal Intermittent Positive Pressure Ventilation (NIPPV), Noninvasive Intermittent Ventilation (NIV), Mask Support Ventilation (MSV), Quantum PSV™ (Pressure Support Ventilator), VPAP S/T®, or BiPAP S/T®. A few years ago, experts on noninvasive ventilation met together at the first ***consensus conference*** and decided that NPPV would be the appropriate term to use.

No matter what the name, the idea is the same: to provide assistance to the patient's own breathing when it becomes insufficient to maintain adequate ***ventilation***. It is not intended for use as ***life-supporting*** ventilation (i.e., 24 hours per day), but rather for periods of the day, mainly during sleep.

What is Chronic Respiratory Failure?

The ***lungs*** serve two primary purposes. The first is to get ***oxygen*** into the blood. Our body requires a constant supply of oxygen to live. Oxygen is needed to allow the body to use the ***calories*** we take in from the food we eat, much the same way a candle needs oxygen to burn. Without the oxygen, our body is unable to produce the energy needed to move muscles, think, breathe, or perform other functions. Because our body doesn't store oxygen well, the lungs must provide a constant supply of oxygen to the bloodstream.

The second function of the lungs is to remove ***carbon dioxide*** from the blood. Carbon dioxide or ***CO2*** is a waste gas produced by the body as energy is produced, again much in the same way a candle produces smoke. If carbon dioxide is not removed from the body, it begins to build up and has bad effects on the body's systems.



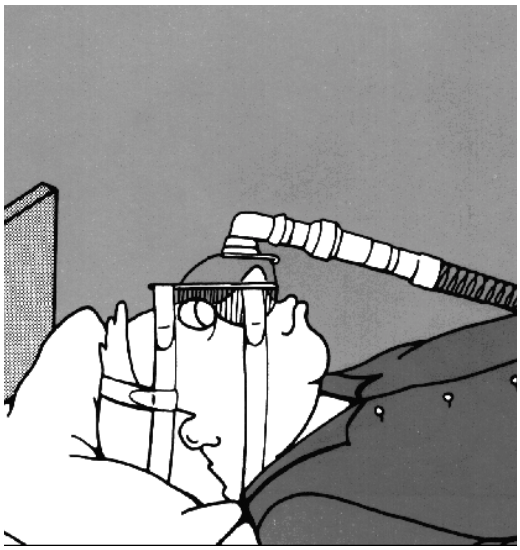
When the lungs are not able to function as well as they should due to disease they begin to loose their ability to carry out these two functions. Oxygen levels become too low in the bloodstream. In some conditions such as COPD, patients are given extra oxygen to compensate for their low oxygen level.

As breathing continues to worsen, the lungs may not be able to get enough carbon dioxide out of the blood and levels may begin to increase. The normal level of carbon dioxide in the blood (called ***PCO2*** or ***PaCO2***) is 35-45 mm Hg. When the level goes over 45 mm Hg it is called ***hypercapnia***.

When breathing becomes impaired to the point that ventilation is inadequate (i.e., unable to get enough air in and out of the lungs) and CO2 levels begin to rise, it is known as ***hypoventilation***. When hypoventilation becomes constant, it is called ***chronic respiratory failure***.

Some patients hypoventilate all the time. That is, their CO2 levels are elevated at all times. Other patients hypoventilate only at night. Both patients may be candidates for NPPV. We will discuss this more later.

How does NPPV work?



NPPV works by augmenting or supporting the patient's own breathing efforts. Although the patient is still breathing, the breaths have become ineffective due to the disease. The patient wears a small ***nasal mask*** over the nose. Occasionally a mask that fits over the nose and mouth (full-face mask) or just a mouthpiece is used. This ***"interface,"*** as it is often called, is attached by tubing to a small ***ventilator.***

As the patient ***inhales***, the ventilator provides a "pressure boost" through the mask. The pressure boost helps the patient to take a deeper, more effective breath while using less effort and energy. This pressure is referred to as the ***IPAP***, which stands for ***Inspiratory Positive Airway Pressure***.

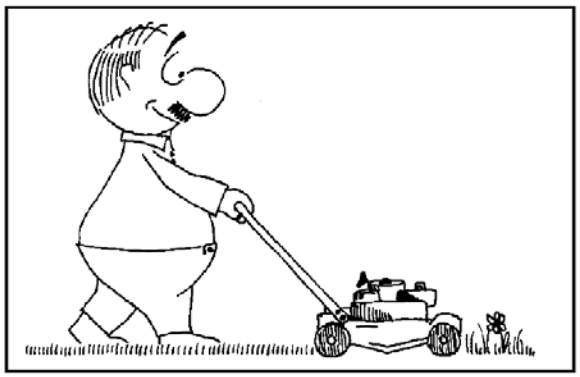
As the patient ***exhales***, the ventilator applies a lower pressure through the mask. This pressure is the ***Expiratory Positive Airway Pressure (EPAP)*** pressure. The EPAP pressure helps to keep the airways from collapsing during exhalation (a common problem in COPD) and allows the patient to exhale more of the stale air that tends to be trapped in their lungs. This pressure mimics what happens during ***pursed-lipped breathing,*** a common breathing technique used by COPD patients.

The ventilator can also be set to deliver extra breaths if the patient is experiencing periods of ***central apnea*** (periods of time when the patient quits breathing). By setting a ***backup rate***, the ventilator will automatically give a breath if the patient quits breathing for a set period of time.

Because the patient's hypoventilation tends to worsen during sleep, it is typically most beneficial to the patient to wear the device during sleep. We will discuss this in more detail later.

What are the possible benefits of using NPPV?

By improving ventilation, (i.e., by getting more fresh air in and more stale air out) the lungs are able to get rid of more carbon dioxide and get more oxygen into the bloodstream. Some studies have shown significant decreases in blood carbon dioxide levels (i.e., PaCO2) and increases in blood oxygen levels (i.e., PaO2).



For the patients, improving their CO2 or O2 levels doesn't really mean much. They just want to feel better. Several studies have reported improvements in symptoms and quality of life. Decreased shortness of breath, less daytime fatigue, fewer morning headaches, and improved activity levels have been reported; but the results may vary greatly from patient to patient, even patients with the same diagnosis. Fewer hospitalizations and increased survival have also been reported within certain patient groups.

When patients wear the device during sleep, ***nocturnal*** hypoventilation may improve and they may have improved sleep quality. Patients often report feeling more rested during the day, with fewer awakenings during the night.

> *"Quotable Quotes"*
>
> *"There were significant improvements in daytime arterial P_aO_2 and P_aCO_2, total sleep time, sleep efficiency, and overnight P_aCO_2 following 3 months of oxygen plus [NPPV] as compared with [oxygen alone]. Quality of life with oxygen plus [NPPV] was significantly better than with oxygen alone."*
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> DJ Meecham Jones
> Amer J of Resp and Crit Care Med 1995; 152:538-544

Why do people benefit most from nighttime use?

Within many diseases that affect breathing, sleep may play an important role. Patients with daytime impairments in their breathing often have further deterioration in breathing during sleep. This is due to a variety of changes that occur during sleep.

During sleep, even in normal individuals, ventilation decreases. This is especially true during the deeper stages of sleep-- referred to as ***rapid-eye movement*** or ***REM*** sleep. In some disease states, these changes are exaggerated.

In COPD, due to ***obstruction*** in the airways, patients have difficulty getting air out of their lungs. Air is trapped in the lungs (***air trapping***), and their lungs are in a constant state of over-inflation (***hyperinflation***). The ***diaphragm***, which normally is dome-shaped, becomes flattened and unable to move sufficiently to adequately ***ventilate*** the lungs. The body compensates by enlisting the help of the ***accessory muscles*** of ventilation. These muscles located in the chest, shoulders, and abdomen are used by the patient 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 their shoulders so they can better use their accessory muscles. Often, the upper chest is moving up and down as the patient breathes.

During REM sleep, the accessory muscles of ventilation cease contributing to ventilation and all the work of breathing falls back on the flattened diaphragm. Ventilation may fall to about half of daytime levels as the diaphragm is unable to maintain adequate ventilation.

These periods of nocturnal hypoventilation are often recognized by symptoms such as morning headache, poor sleep quality, daytime sleepiness, waking up short of breath (called ***paroxysmal nocturnal dyspnea*** or ***PND***), and shortness of breath while laying down (called ***orthopnea***). Nocturnal ***oximetry recordings*** may reveal ***desaturations***, even while the patient is using oxygen therapy. Nocturnal hypoventilation can be confirmed by performing overnight studies of the patient's breathing-- called ***sleep studies*** or ***polysomnography***.

Other changes in breathing may also occur during sleep. Blood flow through the lungs changes, airflow decreases, lung volume decreases, drive to breathe is diminished, and central apneas may occur. Changes in breathing during sleep will be addressed in more detail in a later "Common Sense Respiratory" chapter on sleep disordered breathing.

Because of these changes during sleep, ventilation is often significantly depressed, especially during REM sleep. Ventilation may actually drop to only 50-60% of daytime levels. However, nocturnal hypoventilation should not be confused with ***obstructive sleep apnea*****,** which is treated with ***CPAP*** or ***Bi-level Positive Airway Pressure*** therapy.

By using NPPV during sleep, these nighttime changes can be corrected or at least improved. The symptoms of nocturnal hypoventilation mentioned previously (e.g., morning headaches, daytime fatigue, etc.) may disappear or diminish, improving the patient's quality of life.

Although a goal is to wear NPPV during sleep to correct nighttime ventilation problems, some patients may not tolerate use during sleep. There is evidence that patients may still benefit from daytime-only use, as long as it is used for significant periods of time (e.g., 3-4 hours per day).

Who may benefit from NPPV?

Patients with chronic respiratory failure, nocturnal hypoventilation, and other sleep disorders that don't respond to lesser therapies (e.g., central apneas) may be candidates for NPPV. There is currently an effort to better define which patients are most likely to benefit. In general, patient groups with the potential to benefit include:

- **Neuromuscular Disease –** Diseases which impair nerve and muscle function have the potential the result in respiratory failure. ***ALS, post-polio syndrome, muscular dystrophies, muscle atrophies, myasthenia gravis*****,** and other neuromuscular conditions have shown promising outcomes with the use of NPPV.
- **Chest Wall Disorders –** Conditions in which chest wall movement is affected may benefit. The conditions may include ***sequelae of tuberculosis, kyphoscoliosis, thoracoplasty*****,** and other conditions that limit movement of the ***spine*** and/or chest wall. In some ways, ***obesity hypoventilation syndrome*** falls within this area due to the effects of ***morbid obesity*** on chest wall and diaphragm movement.
- **Obstructive Lung Disease –** Patients with obstructive lung disease such as COPD and bronchiectasis may benefit. This is especially true in those patients with severely

elevated PaCO2 levels (> 50-55 mm Hg) or patients with significant nocturnal hypoventilation.

- **Certain Sleep Disordered Breathing**- As discussed previously, certain types of sleep disordered breathing which have not responded, or are unlikely to respond, to lesser positive pressure therapy (e.g., CPAP, Bi-level Positive Airway Pressure) may benefit as well. This would include nocturnal hypoventilation, central sleep apneas, and mixed apneas. There is some evidence that NPPV may be effective in treating an abnormal breathing pattern referred to as ***Cheyne-Stokes Respirations*** that occur in as many as 50% of patients with CHF**.**

How do you know if a patient is a candidate for NPPV?

Patients with an appropriate diagnosis who have symptoms of chronic respiratory failure or nocturnal hypoventilation should be evaluated by objective measures to determine if a trial of NPPV is indeed warranted. Experts in this area have proposed objective criteria as a part of a consensus conference on the use of NPPV. Possible indications for the use of NPPV include the following:

For Neuromuscular or Chest Wall Disease

One or more of the following:

- ***Forced Vital Capacity (FVC)*** < 50% predicted
- ***Maximum Inspiratory Force*** (***MIF,*** aka ***Negative Inspiratory Force*** or ***NIF***) – unable to achieve at least –50 cm H2O
- Oximetry desaturations to < 88% for 5 continuous minutes on room air
- PaCO2 > 45 mm Hg

For Obstructive Lung Disease

One or more of the following should be present:

- PaCO2 > 55 mm Hg
- PaCO2 50 to 55 mm Hg with one of the following to support
    - Desaturations while on oxygen for at least 5 continuous minutes while on oxygen at 2 l/m or higher
    - Two or more hospitalizations for ***acute respiratory failure*** in the last 12months

For Sleep Disordered Breathing

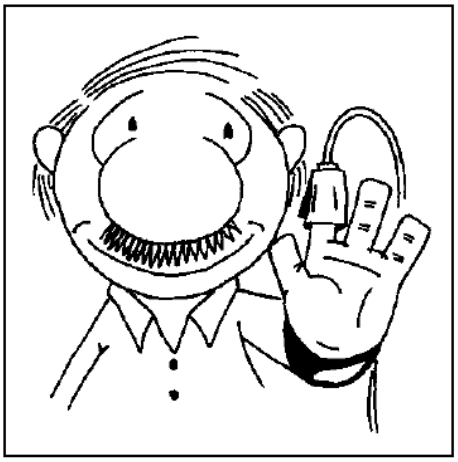
Nocturnal hypoventilation or other sleep disordered breathing (e.g., central apnea, mixed apneas) confirmed by polysomnography or sleep studies that do not, or are unlikely to, respond to lesser positive pressure therapy (e.g., CPAP, Bi-level Positive Airway Pressure).

Before establishing NPPV, it is wise to obtain appropriate objective measures of one of these conditions. In fact, it is likely that fiscal intermediaries (e.g., Medicare) will require this for reimbursement.

What monitoring should be performed?

Once patients are placed on the therapy, they should be monitored for their response to the therapy. Monitoring should be appropriate to each individual patient and by established guidelines (i.e., Rotech's Protocols). Monitoring should be regular and ongoing. If problems occur, they should be related to the patient's physician in a timely manner and appropriate interventions should be made to correct these problems.

Monitoring should include:



- **Patient's Physical Monitoring –** Physical monitoring (e.g., lung sounds, BP) should be performed in accordance with established guidelines (i.e., Rotech's Protocols) and reported to the physician. If any complications or adverse reactions to the therapy occur, they should be reported to the physician in a timely manner.
- **Patient Outcomes –** Monitoring for subjective (e.g., decreased shortness of breath) and/or objective (e.g., PaCO2) benefits in the patient's condition should be performed and documented to justify ongoing use.
- **Patient Compliance**- The patient should maintain an acceptable level of compliance with the therapy. This should be somewhere near 20 hours/week or more.

When applied correctly, NPPV has the potential to benefit many patients. One final emphasis is that the personnel charged with applying the therapy must be knowledgeable in its provision. The likelihood of success is largely dependent upon the clinicians (e.g., doctor, therapist, nurse) involved in the setup and the close follow up required.

Questions/Assignments

1. NPPV stands for:
    a. Nocturnal Positive Pressure Ventilation
    b. Nocturnal Partial Pressure Ventilation
    c. Noninvasive Positive Pressure Ventilation
    d. Normal People Play Violins

2. The two primary purposes of the lungs are to:
    a. Get oxygen into the blood and carbon dioxide out of the blood
    b. Get carbon dioxide into the blood and oxygen out of the blood
    c. Get oxygen into the blood and correct for pH imbalances
    d. Inhale and exhale

3. When the PCO2 is greater than 45 mm Hg, it is called:
    a. Hypoxemia
    b. Hypoxia
    c. Hypocapnia
    d. Hypercapnia

4. NPPV works by:
    a. Increasing the rate at which people breathe
    b. Taking over the breathing of the patient
    c. Decreasing the depth of the patient's own breathing
    d. Supporting the natural breathing of the patient

5. True or False – While using NPPV, pressure delivered during inspiration is higher than during exhalation

6. Objective benefits of NPPV include:
    a. Decreased CO2 in the blood
    b. Decreased oxygen in the blood
    c. Bronchodilation
    d. All of the above

7. Subjective benefits of NPPV may include:
    a. Improved sleep
    b. Less shortness of breath
    c. Improved activity levels
    d. All of the above

8. Causes of hypoventilation during sleep may include:
    a. Loss of support from accessory muscles during REM sleep
    b. Decreased airflow during sleep
    c. Increased lung volumes during sleep
    d. A and B

9. Which disease(s) may benefit from using NPPV?
    a. COPD
    b. Neuromuscular disease
    c. Chest wall disease
    d. All of the above

10. Indications for NPPV use in COPD may include:
    a. $PaCO_2 > 55$ mm Hg
    b. $PaO_2 < 55$ mm Hg
    c. Negative Inspiratory Force < -50 cm H_2O
    d. All of the above

11. True or False – There is no benefit to using NPPV during daytime hours.

12. Follow-up monitoring in NPPV use should include:
    a. Documentation of patient compliance
    b. Documentation of patient improvement
    c. Documentation of physical response
    d. All of the above

Answers to Test Questions

1. C	4. D	7. D	10. A
2. A	5. T	8. D	11. F
3. D	6. A	9. D	12. D

Glossary of Terms – NPPV Chapter

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 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 using their accessory muscles are often noted to sit with their arms resting on a table or with their hands on their knees in order to use these muscles for breathing.

Acute Respiratory Failure – A short period when the patient is unable to maintain adequate oxygen and/or carbon dioxide levels in the blood due to inadequate ventilation.

Air Trapping/Hyperinflation – Patients with diseases which 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.

Airway – Airways are the tubes that provide a path for air movement from the atmosphere to the alveoli (air sacs) in the lungs.

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

Backup Rate – A setting on the ventilator, the backup rate will give the patient a breath if they experience a period of no breathing (i.e., central apnea).

Bi-level Positive Airway Pressure – By connecting a bi-level device to a nasal mask, bi-level PAP gives the patient two different pressures- one during inspiration (i.e., IPAP) and a lower pressure during exhalation (i.e., EPAP).

Carbon Dioxide (CO2) – 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 – A period of time when the patient makes no attempt to breathe.

Chest Wall Disorders – Chest wall disorders include conditions which may restrict movement of the thoracic cavity (ribs and spine). Conditions such kyphoscoliosis (kyphosis- abnormal front to back curvature, scoliosis- abnormal sideways curvature of the spine) restrict the volume of the lungs by reducing the normal movement of the chest wall.

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

Chronic Respiratory Failure – A constant state of the patient being unable to maintain adequate ventilation resulting in a low oxygen level and/or a high carbon dioxide level.

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 the heart has been damaged by heart attack or other cardiac disease.

Consensus Conference – When a group of experts come together to determine the terms and standards surrounding a particular area of care.

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

Desaturation – An abnormal drop in blood oxygen levels. This is typically defined 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.

Exhale or Exhalation – The part of the breathing cycle when air is flowing out of the lungs.

Expiratory Positive Airway Pressure (EPAP) – During NPPV, the pressure applied to the airways while the patient is exhaling.

Forced Vital Capacity (FVC) – This is a measurement of the total amount of air you can forcibly exhale (i.e., by blowing as hard as you can for as long as you can) after you have taken as deep a breath in as possible. It is typically measured in liters and a reduction in this measure may indicate a restrictive defect (i.e., a reduction in the volume of the lungs).

Full-Face Mask – A mask can be used to deliver NPPV, Bi-level PAP, and CPAP that covers both the nose and mouth.

Hypercapnia – A high level of carbon dioxide, also referred to as hypercarbia. Hypercapnia is a sign of hypoventilation.

Hyperinflation – See "Air Trapping"

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

Inhale/Inhalation – That part of the breathing cycle when air is flowing into the lungs.

Inspiratory Positive Airway Pressure (IPAP) – During NPPV, the pressure applied to the airways during the period when the patient is inhaling.

Interface – The part of the apparatus worn by the patient to deliver CPAP, Bi-level PAP, and NPPV. The most common are the nasal mask, the full-face mask, or the mouthpiece.

Kyphoscoliosis – Kyphosis is an abnormal front to back curvature of the upper spine (e.g., hump-back) and scoliosis is an abnormal sideways curvature of the spine. These conditions can restrict the volume of the lungs by reducing the normal movement of the chest wall.

Life-Supporting – A device which if the patient stopped using, death would be imminent within a short time.

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 its accompanying capillary, which allows 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.

Maximum Inspiratory Pressure (MIP) aka, Negative Inspiratory Force (NIF) – A measurement of the maximum amount of negative pressure that a patient can generate during a forced inhalation.

Morbid Obesity – Obesity is typically defined as being more than 20% over ideal body weight. Morbid obesity is being more than 100 pounds overweight. Obesity can cause restriction of chest wall movement by pulling down on the rib cage and restriction of movement in the diaphragm by abdominal contents. Severe obesity may even result in chronic hypoventilation (i.e., under ventilation), a condition referred to as Obesity Hypoventilation Syndrome.

Mouthpiece – An interface placed in the mouth to deliver therapy.

Muscular Atrophy – A disease of the muscles characterized by muscle tissue wasting.

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

Myasthenia Gravis – A condition of fatigue and exhaustion of the muscles marked by progression paralysis of the muscles.

Nasal Mask – A mask placed over the nose to deliver pressure to the airway during CPAP, Bi-level PAP, or NPPV.

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

Nocturnal – Happening at night.

Noninvasive Positive Pressure Ventilator (NPPV) – A therapy using a small bi-level pressure support ventilator and a noninvasive interface (usually a nasal mask) to augment the patient's sponstaneous breathing. It is used in patients with chronic respiratory failure to treat chronic or periodic hypoventilation.

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).

Obstruction – When there is an impairment in how quickly the air is able to move out of the lungs, this is an obstructive defect. It is indicative of obstructive diseases such as asthma, COPD, and bronchiectasis. A reduction in the FEV1/FVC ratio is the best indicator of an obstructive defect.

Obstructive Lung Disease – Diseases such as COPD, asthma, and bronchiectasis which are characterized by a reduced airflow through the airways.

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 effort (i.e., diaphragm movement) to breathe.

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

Oximetry Recording – This is a noninvasive (i.e., does not require insertion through the skin or a body orifice) measure 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., SpO2)

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 measures (i.e., ABG's would be very difficult to perform).

Oxygen (O2) – An element required by the body to metabolize or "burn" energy.

PaCO2 or PCO2 – The measurement of how much carbon dioxide is in the arterial blood when taken during an arterial blood gas measurement. P stands for partial pressure and little "a" stands for arterial. The little "a" is sometimes omitted.

PaO2 or PO2 – The measurement of how much oxygen is in the arterial blood when taken during an arterial blood gas measurement. P stands for partial pressure and little "a" stands for arterial. The little "a" is sometimes omitted.

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

Polysomnography – Testing performed while the patient is asleep that may include monitoring EKG, chest movement, air movement out of the nose and mouth, SpO2, 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.

Pursed-Lipped Breathing – A technique in which the patient exhales through pursed lips to create back pressure into the airways, preventing early closure of the airways.

Rapid-Eye Movement (REM) Sleep – The deepest stage of sleep, so called because when it occurs the eyes begin to move back and forth rapidly, which can be measured during sleep testing (i.e., polysomnography).

Sequelae of Tuberculosis – The aftermath of an active tuberculosis infection which may include scarring of the lungs and deformation of the chest cavity.

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

Sleep Study – A modified polysomnography test using fewer channels, typically 6-8 channels are used.

Spine – The backbone or vertebral column.

Thoracoplasty – Surgical removal of a rib or ribs.

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

Ventilator – A device which performs a part of, or all of, the patient's breathing for them.