Clinical Policy Bulletin: Noninvasive Positive Pressure Ventilation

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Policy

Aetna considers noninvasive positive pressure ventilation (NPPV) with bi-level positive airway pressure (bi-level PAP, BIPAP) devices or a bi-level PAP device with a backup rate feature medically necessary durable medical equipment (DME) for members who have restrictive thoracic disorders, severe chronic obstructive pulmonary disease (COPD), central sleep apnea, or obstructive sleep apnea (bi-level PAP without backup rate feature only), and who meet the medical necessity criteria for these conditions:

I. Restrictive Thoracic Disorders:

A. COPD does not contribute significantly to the member's pulmonary limitation; and
B. Member has a progressive neuromuscular disease (e.g., amyotrophic lateral sclerosis, etc.) or a severe thoracic cage abnormality (e.g., post-thoracoplasty for tuberculosis, etc.), and
C. Member has symptoms of sleep-associated hypventilation (nocturnal hypoxemia), such as daytime hypersomnolence, excessive fatigue, dyspnea, morning headache, cognitive dysfunction, etc., and
D. Member has clinically significant hypoxemia, as indicated by any of the following:
   1. An arterial blood gas PaCO2, done while awake and breathing the member's usual FIO2 (fractional inspired oxygen concentration), is greater than or equal to 45 mm Hg; or
   2. Sleep oximetry demonstrates oxygen saturation less than or equal to 88 % for at least 5 continuous minutes, done while breathing the member's usual FIO2; or
   3. For progressive neuromuscular disease only, maximal inspiratory pressures less than 60 cm H20 or forced vital capacity (FVC) less than 50 % predicted.

II. Severe Chronic Obstructive Pulmonary Disease:

A. Member has symptoms of sleep-associated hypoventilation (nocturnal hypoxemia), such as daytime hypersomnolence, excessive fatigue, dyspnea, morning headache, cognitive dysfunction, etc.; and
B. Member has severe COPD, as indicated by either of the following:
1. An arterial blood gas PaCO2, done while awake and breathing the member's usual FIO2, is greater than or equal to 55 mm Hg; or
2. An arterial blood gas PaCO2 of 50 to 54 mm Hg and either of the following:

   a. Sleep oximetry demonstrates oxygen saturation less than or equal to 88 % for at least 5 continuous minutes, done while breathing oxygen at 2 liters per minute (LPM) or the member's usual FIO2, whichever is higher, or
   b. Hospitalization related to recurrent (greater than or equal to 2 in a 12-month period) episodes of hypercapnic respiratory failure; and

C. Prior to initiating therapy, obstructive sleep apnea (OSA) (and treatment with continuous positive airway pressure (CPAP)) has been considered and ruled out.

If all of the above criteria for members with COPD are met, a bilevel PAP device without a backup rate feature will be considered medically necessary. A bilevel PAP device with a backup rate feature will only be considered medically necessary for COPD if the member continues to meet the criteria set forth in B.2. above, despite at least 2 months of compliant use (an average of 4 hours use per 24-hour period) of a bilevel PAP device without a backup rate feature.

III. Central Sleep Apnea (CSA) or Complex Sleep Apnea (CompSA) (see Appendix for definitions):

Prior to initiating therapy, a complete inpatient, attended polysomnogram must be performed documenting the following:

   A. The diagnosis of CSA or CompSA (see Appendix); and
   B. The ruling out of CPAP as effective therapy if either OSA or CSA is a component of the initially observed sleep-associated hypoventilation; and
   C. Significant improvement of the sleep-associated hypoventilation with the use of NPPV device on the settings that will be prescribed for initial use at home, while breathing the member's usual FIO2.

IV. Obstructive Sleep Apnea:

   A. Member meets the criteria for CPAP, as set forth in the CPB 0004 - Obstructive Sleep Apnea in Adults or CPB 0752 - Obstructive Sleep Apnea in Children and
   B. CPAP has been tried and proven ineffective or is not tolerated.

If all of the above criteria are met, a bilevel PAP device without a backup rate feature will be considered medically necessary for members with OSA. A backup rate feature for a bilevel PAP device is of no proven value for the primary diagnosis of OSA and therefore will be considered experimental and investigational.

V. Tracheomalacia

Aetna considers continuous positive airway pressure medically necessary for the treatment of tracheomalacia.

VI. Continued Coverage Criteria Beyond the First Three Months of Therapy:

Members should be re-evaluated after 2 to 3 months to evaluate their continued medical necessity for NPPV. For establishment of continued medical necessity beyond 3 months, the medical records should document that the member has been compliantly using the device (an average of 4 hours per 24-hour period), and that the member is
benefiting from its use.

Aetna considers NPPV experimental and investigational for all other indications (e.g., acute lung injury, asthma, pneumonia, as an alternative to endotracheal intubation following esophagectomy; not an all-inclusive list) because of insufficient evidence in the peer-reviewed literature.

Note: Either a heated or non-heated humidifier is considered medically necessary for use with NPPV.

For policy on medical necessity of a second ventilator, see CPB 0298 - Non-invasive Negative Pressure Ventilation: Body Ventilators and Poncho Wrap.

**Single-Breath Tests for Determining Airway Closure Volume:**

Aetna considers single-breath nitrogen testing (also known as single-breath oxygen testing) experimental and investigational because the value of this test in the management of persons with pulmonary disorders/diseases has not been established. Single-breath tests for determining airway closure volume that are performed using other tracer gases such as xenon, argon, or helium are also considered experimental and investigational because of insufficient evidence in the peer-reviewed literature.

Notes: Electrical generators to power respirators, bilevel PAP devices, etc. do not meet Aetna’s definition of DME because they are not primarily medical in nature, and they are of use in the absence of illness and injury.

**Background**

Over the past decade, noninvasive positive-pressure ventilation (NPPV) delivered by a nasal or facemask has gained increasingly widespread acceptance for the support of both chronic and acute ventilatory failure. The development of improved masks and ventilatory technology made this mode of ventilation acceptable. This policy focuses on the use of the bilevel PAP ventilator, and is based on Medicare policy and on the conclusions of a consensus conference on noninvasive positive pressure ventilation (NAMDRC, 1999).

According to Durable Medical Equipment Medicare Administrative Carrier (DME MAC) policy, noninvasive positive pressure respiratory assistance provided by a respiratory assist device is the administration of positive air pressure, using a nasal and/or oral mask interface which creates a seal, avoiding the use of more invasive airway access (e.g., tracheostomy). It may be applied to assist insufficient respiratory efforts in the treatment of conditions that may involve sleep-associated hypoventilation. It is to be distinguished from the invasive ventilation administered via a securely intubated airway, in a patient for whom interruption or failure of ventilatory support would lead to imminent demise of the patient.

**NPPV for Restrictive Thoracic Diseases:**

A wide variety of restrictive thoracic diseases have been successfully treated with NPPV, including thoracic cage abnormalities (e.g., chest wall deformities, kyphoscoliosis, thoracoplasty, etc.) in addition to both rapidly and slowly progressive neuromuscular disorders (e.g., amyotrophic lateral sclerosis (ALS), neuropathies, myopathies, dystrophies, sequelae of polio, spinal cord injury, etc.). These conditions result in derangement of hypoventilation, and oxygen therapy alone is not only usually ineffective in relieving symptoms, but may also be dangerous and lead to a marked acceleration of carbon dioxide (CO₂) retention. Noninvasive positive pressure ventilation is generally not indicated for patients who cannot cooperate with NPPV treatment or who need a protected airway to handle excessive secretions. (Patients who have impaired ability to protect the upper airway or excessive secretions are usually better
managed with tracheostomy). The availability of a full face mask, however, has made it possible to use NPPV even in patients with significant bulbar weakness.

Indications for NPPV are based on symptoms attributable to nocturnal hypoventilation and objective findings of nocturnal de-saturation. The most common symptoms of chronic respiratory failure are associated with nocturnal sleep disruption, and include daytime hypersomnolence, excessive fatigue, morning headache, cognitive dysfunction, and even dyspnea. A consensus conference suggested that any PaCO₂ greater than or equal to 45 mm Hg or abnormal nocturnal oxygen de-saturation is a sufficient indication for NPPV. Clinically significant hypoxemia during sleep has been defined as an oxyhemoglobin saturation of less than or equal to 88 % for at least 5 minutes. This criterion for clinically significant nocturnal hypoxemia was favored because it is relatively simple to determine and is consistent with established guidelines for determination of hypoxemia for oxygen therapy.

For patients with progressive neuromuscular disorders, the consensus panel concluded that pulmonary function test results may be an additional indicator of nocturnal de-saturation. Most amyotrophic lateral sclerosis patients have a forced vital capacity (FVC) below 50 % predicted before either the physician or patient actually becomes aware of any respiratory system involvement. Other measurements like maximal inspiratory pressure with a magnitude less than 60 cm H₂O have been shown to be highly sensitive albeit less specific indicator of nocturnal de-saturation.

What type of equipment and what specific ventilator settings should be chosen are controversial. Most studies of long-term NPPV for patients with neuromuscular disease have used volume-targeted rather than pressure-targeted devices. More recent reviews have cited the advantages of pressure-targeted devices for comfort and in their ability to compensate for leaks. Volume-targeted equipment may be favorable for patients simply because triggering mechanisms are more adjustable and pressure-targeted systems are not able to guarantee a minimum minute ventilation. The need for NPPV with a mandatory backup rate (e.g., Adaptive-Servoventilation), however, is more generally accepted because of the profound rapid eye movement (REM) de-saturation that often occurs in patients with respiratory muscle weakness.

Physician re-assessment of patient benefit and adherence to NPPV therapy should occur within 60 days of initiation of therapy. The specific methods used may be as simple as a patient interview to assess compliance but usually involve some assessment of awake arterial blood gas values and overnight oximetry while using the designated NPPV therapy.

**Noninvasive Positive Pressure Ventilation (NPPV) for Chronic Obstructive Pulmonary Disease (COPD):**

During the 1980s, investigators used negative-pressure ventilators, mainly of the tank or "wrap" type, to provide intermittent respiratory muscle rest in patients with severe COPD. However, a number of long-term controlled clinical studies showed negative-pressure ventilation to be of no benefit in pulmonary function, daytime gas exchange, or functional capability. Furthermore, patients tolerated negative-pressure ventilators poorly.

Clinical studies of NPPV in patients with COPD (e.g., chronic bronchitis, emphysema, bronchiectasis, cystic fibrosis, etc.) have shown that NPPV is better tolerated than negative-pressure ventilation. In addition, advantages of ease of administration and portability as well as the ability to eliminate obstructive sleep apnea (OSA) make NPPV the first choice of non-invasive modes.

Although the evidence is conflicting and far from definitive, the consensus conference concluded that patients with substantial daytime CO₂ retention, particularly those with nocturnal oxygen de-saturation, appear most apt to respond favorably to nocturnal NPPV. Patients with little or no CO₂ retention, regardless of the severity of airway obstruction, appear to gain little or no benefit from NPPV.
Struik et al (2014) stated that the effects of nocturnal NPPV in patients with stable COPD remain controversial. The Cochrane Airways group Register of Trials, MEDLINE, EMBASE and CINAHL were searched up to August 2012. Individual patient data from RCTs on NPPV outcomes were selected for 2 separate meta-analyses: the first with follow-up of 3 months and the second with 12 months of follow-up. Additionally, subgroup analyses within the NPPV group comparing inspiratory positive airway pressure (IPAP) levels, compliance and levels of hypercapnia on change in PaCO2 after 3 months were performed. A total of 7 trials (245 patients) were included. All studies were considered of moderate to high quality. No significant difference was found between NPPV and control groups after 3 or 12 months of follow-up when looking at PaCO2 and PaO2, 6-minute walking distance, health-related quality-of-life, FEV1, FVC, maximal inspiratory pressure and sleep efficiency. Significant differences in change in PaCO2 after 3 months were found for patients ventilated with IPAP levels of at least 18 cm H2O, for patients who used NPPV for at least 5 hours per night as well as for patients with baseline PaCO2 of at least 55 mm Hg when compared to patients with lower IPAP levels, poorer compliance or lower levels of hypercapnia. The authors concluded that at present, there is insufficient evidence to support the application of routine NPPV in patients with stable COPD. However, higher IPAP levels, better compliance and higher baseline PaCO2 seem to improve PaCO2.

NPPV for Other Respiratory Disorders Associated with Nocturnal Hypoventilation:

A variety of other respiratory disorders have been shown to predispose patients to nocturnal hypoventilation. These include central (non-obstructive) sleep apnea, complex sleep apnea, and OSA.

Most reports covering the effect of non-invasive ventilation on hypoventilation have focused on neuromuscular/chest wall disorders and patients with COPD. In contrast, there are few reports on non-invasive ventilation in patients with other disorders leading to nocturnal hypoventilation that may be treated with NPPV. Furthermore, although there are many reports demonstrating the benefits of continuous positive airway pressure (CPAP) in patients with OSA, there are only limited data supporting the use of NPPV in these types of patients who fail to respond to CPAP therapy.

Based on available literature, certain general statements regarding indications for non-invasive positive pressure ventilation for other nocturnal hypoventilation syndromes can be made. Patients considered for this therapy should have the following: a disease known to cause hypoventilation; symptoms and signs of hypoventilation; failure to respond to first-line therapies in mild cases of hypoventilation (i.e., treatment of primary underlying disease with bronchodilators, respiratory stimulants, weight loss, supplemental oxygen, CPAP); or have moderate-to-severe hypoventilation.

A polysomnogram is required for diagnosis of sleep apnea. A CPAP trial is recommended if OSA is documented unless a previous CPAP trial was unsuccessful.

Potential side effects from NPPV include gastric distention, aspiration of gastric contents, conjunctivitis, facial abrasions from tight-fitting masks, hypotension, and mask dislocation leading to transient hypoxemia.

NPPV for Respiratory Failure after Extubation/Acute Hypoxemic Respiratory Failure:

The need for re-intubation after extubation and discontinuation of mechanical ventilation is not uncommon and is associated with increased mortality. Noninvasive positive pressure ventilation has been suggested as a treatment for individuals with respiratory failure following extubation. In a multi-center, randomized, controlled trial (n = 221), Esteban et al (2004) examined the effect of NPPV on mortality in this clinical setting. These investigators concluded that NPPV does not prevent the need for re-intubation or reduce mortality in unselected patients who have respiratory failure following extubation. This is in agreement with the
findings of Keenan et al (2002) who reported that the addition of NPPV to standard medical therapy does not improve outcome in heterogeneous groups of patients who develop respiratory distress during the first 48 hours after extubation.

Furthermore, in a recent review, Keenan et al (2004) evaluated the effect of NPPV on the rate of endotracheal intubation, intensive care unit and hospital length of stay, and mortality for patients with acute hypoxemic respiratory failure not due to cardiogenic pulmonary edema. The authors concluded that randomized trials suggest that patients with acute hypoxemic respiratory failure are less likely to require endotracheal intubation when NPPV is added to standard therapy. However, the effect on mortality is less clear, and the heterogeneity found among studies suggests that effectiveness varies among different populations. As a result, the literature does not support the routine use of NPPV in all patients with acute hypoxemic respiratory failure.

In a Cochrane review, Shah and colleagues (2005) stated that acute hypoxemic respiratory failure (AHRF) is an important cause of morbidity and mortality in children. Currently, positive pressure ventilation is the standard of care, although it is known to be associated with complications. Continuous negative extra-thoracic pressure ventilation (CNEP) or continuous positive airway pressure ventilation delivered via non-invasive approaches (Ni-CPAP) have demonstrated certain benefits in animal as well as uncontrolled human studies. These investigators evaluated the effectiveness of CNEP and Ni-CPAP in children with AHRF due to non-cardiogenic causes. They concluded that there is a lack of well-designed, controlled studies of non-invasive modes of respiratory support in pediatric patients with AHRF.

NIPPV for Tracheomalacia:

Tracheomalacia refers to softness or weakness of the trachea. It may occur in an isolated lesion or can be found in combination with other lesions that cause compression or damage of the airway. Tracheomalacia is usually benign, with symptoms due to airway obstruction. Conservative treatment is preferred in milder cases, since the outcome is usually favorable within the first 2 years of life. The clinical utility of non-specific treatments (e.g., anti-inflammatory agents, bronchodilators, antibiotics, physiotherapy) has not been proven by clinical trials. Airway surgery should be avoided, and non-invasive ventilation may be employed as a temporary measure. In very severe cases, aortopexy, trachostomy or stent placement are the preferred treatments (Fayon and Donato, 2010).

Davis et al (1998) stated that CPAP is used to minimize airway collapse in infants with tracheomalacia. Forced expiratory flows (FEFs) at functional residual capacity (FRC) increase with increasing CPAP in infants with tracheomalacia, and it has been suggested that CPAP prevents airway collapse by "stenting" the airway open. Since FEF is greater at higher than at lower lung volumes, these researchers evaluated whether the increase in flow measured at FRC (V FRC) with CPAP could be explained by the increase in FRC with CPAP. They measured full FEF-volume curves at CPAP levels of 0, 4, and 8 cm H2O in 6 infants with tracheomalacia and 5 healthy control infants. In both groups of infants, FVC did not change with CPAP; however, inspiratory capacity (IC) decreased and thus FRC increased with increasing CPAP. FEFs at FRC increased with increasing levels of CPAP; however, the FEFs at 50 % and 75 % of expired volume were not different for the 3 levels of CPAP for both groups of infants. These findings indicated that FEFs measured at the same lung volumes did not differ for the different levels of CPAP indicates that CPAP affects forced flows primarily by increasing lung volume.

In a prospective, randomized, controlled study, Essouri et al (2005) evaluated the efficacy of CPAP ventilation in infants with severe upper airway obstruction and compared CPAP to bilevel positive airway pressure (BIPAP) ventilation. A total of 10 infants (median age of 9.5 months, range of 3 to 18) with laryngomalacia (n = 5), tracheomalacia (n = 3), tracheal hypoplasia (n = 1), and Pierre Robin syndrome (n = 1) were included in this analysis. Breathing pattern and
respiratory effort were measured by esophageal and trans-diaphragmatic pressure monitoring during spontaneous breathing, with or without CPAP and BIPAP ventilation. Median respiratory rate decreased from 45 breaths/min (range of 24 to 84) during spontaneous breathing to 29 (range of 18 to 60) during CPAP ventilation. All indices of respiratory effort decreased significantly during CPAP ventilation compared to un-assisted spontaneous breathing (median, range): esophageal pressure swing from 28 to 10 cm H(2)O (13 to 76 to 7 to 28), esophageal pressure time product from 695 to 143 cm H(2)O/s per minute (264 to 1,417 to 98 to 469), diaphragmatic pressure time product from 845 to 195 cm H(2)O/s per minute (264 to 1,417 to 159 to 1,183). During BIPAP ventilation a similar decrease in respiratory effort was observed but with patient-ventilator asynchrony in all patients. The authors concluded that this short-term study showed that non-invasive CPAP and BIPAP ventilation are associated with a significant and comparable decrease in respiratory effort in infants with upper airway obstruction. However, BIPAP ventilation was associated with patient-ventilator asynchrony.

Masters and Chang (2005) noted that tracheomalacia, a disorder of the large airways where the trachea is deformed or malformed during respiration is commonly seen in tertiary pediatric practice. It is associated with a wide spectrum of respiratory symptoms from life-threatening recurrent apnea to common respiratory symptoms such as chronic cough and wheeze. Current practice following diagnosis of tracheomalacia include medical approaches aimed at reducing associated symptoms of tracheomalacia, ventilation modalities of CPAP and BiPAP and, surgical approaches aimed at improving the caliber of the airway (airway stenting, aortopexy, tracheopexy). In a Cochrane review, these investigators evaluated the efficacy of medical and surgical therapies for children with intrinsic (primary) tracheomalacia. The Cochrane Central Register of Controlled Trials (CENTRAL), the Cochrane Airways Group Specialized Register, MEDLINE and EMBASE databases were searched by the Cochrane Airways Group. The latest searches were performed in February 2005. All randomized controlled trials of therapies related to symptoms associated with primary or intrinsic tracheomalacia were included in this analysis. Results of searches were reviewed against pre-determined criteria for inclusion. No eligible trials were identified and thus no data were available for analysis. No randomized controlled trials (RCTs) that examined therapies for intrinsic tracheomalacia were found. Eight of the more recent (last 11 years) non-RCTs reported a benefit from the various surgical interventions. The success was however not universal and in some studies severe adverse events occurred. The authors concluded that there is currently an absence of evidence to support any of the therapies currently utilized for management of intrinsic tracheomalacia. It is unlikely that any RCT on surgically based management will ever be available for children with severe life-threatening illness associated with tracheomalacia. For those with less severe disease, RCTs are clearly needed. Outcomes of these RCTs should include measurements of the trachea and physiological outcomes in addition to clinical outcomes.

An UpToDate review on "Tracheomalacia and tracheobronchomalacia in adults" (Ernst et al, 2012) states that "[c]ontinuous positive airway pressure (CPAP) can maintain an open airway and facilitate secretion drainage. This is often initiated in the hospital during an acute illness. The patient initially receives continuous CPAP and is gradually transitioned to intermittent CPAP as tolerated. Patients may use intermittent CPAP as long-term therapy. However, CPAP does not appear to have a long-term impact on dyspnea or cough. Positive airway pressure other than CPAP (e.g., bilevel positive airway pressure) may be used instead if hypercapnic respiratory failure exists".

Also an eMedicine article on "Tracheomalacia Treatment & Management" (Schwartz) states that "[s]upportive therapy is provided to most infants. Most respond to conservative management, consisting of humidified air, chest physical therapy, slow and careful feedings, and control of infection and secretions with antibiotics. The use of continuous positive airway pressure (CPAP) has been recommended in patients having respiratory distress and may be successful in patients requiring a short-term intervention as the disorder spontaneously resolves."
NPPV for Other Conditions:

Chermont et al (2009) examined the effects of CPAP on exercise tolerance in outpatients with chronic heart failure (CHF). Following a double-blind, randomized, cross-over, and placebo-controlled protocol, 12 patients with CHF (8 males and 4 females; age of 54 +/- 12 years; body mass index 27.3 +/- 1.8 kg/m2, New York Heart Association Class II, III) underwent CPAP via nasal mask for 30 mins in a recumbent position. Mask pressure was 3 cm H2O for 10 mins, followed by individual progression up to 4 to 6 cm H2O, whereas placebo was fixed 0 to 1 cm H2O. A 6-min walk test was performed after placebo and CPAP. Continuous positive airway pressure decreased the resting heart rate (pre = 80 +/- 17 bpm; post = 71 +/- 15 bpm; p = 0.001) and mean arterial pressure (pre = 103 +/- 14 mm Hg; post = 97 +/- 13 mm Hg; p = 0.008). During exercise test, CPAP increased the distance covered (CPAP: 538 +/- 78 m; placebo: 479 +/- 83 m; p < 0.001) and the peak heart rate (CPAP: 98 +/- 17 bpm; placebo: 89 +/- 12 bpm; p = 0.049) but did not change the peak mean arterial pressure (p = 0.161). The authors concluded that non-invasive ventilation with CPAP increased exercise tolerance in patients with stable CHF. They stated that future clinical trials should investigate if this effect is associated with improved clinical outcome.

Keenan and Mehta (2009) summarized randomized controlled trials (RCTs) on non-invasive ventilation (NIV) for acute respiratory failure (ARF). These researchers conducted an extensive literature search and selected RCTs from that search. The results were presented primarily by etiology of respiratory failure, but they also included a short section on NIV for ARF in immunocompromised patients. The latter studies included patients with various etiologies of respiratory failure but with the common co-morbidity of immunocompromised. Most of the RCTs have studied NIV for exacerbation of COPD or cardiogenic pulmonary edema. In general, the RCTs have been small and used endotracheal intubation or NIV failure rate as primary outcomes. These investigators concluded that NIV for ARF is supported by strong evidence from patients with COPD, but there is only weak support for NIV in other patient groups, such as immunocompromised patients. For other groups, such as patients with asthma, pneumonia, or acute lung injury, RCT-level evidence is lacking or does not suggest benefit.

In a single-center RCT, Menesese et al (2011) examined if early nasal intermittent positive-pressure ventilation (NIPPV) compared with nasal continuous positive airway pressure (NCPAP) decreases the need for mechanical ventilation in infants with respiratory distress syndrome. Infants (gestational ages of 26 to 33/7 weeks) with respiratory distress syndrome were randomly assigned to receive early NIPPV or NCPAP. Surfactant was administered as rescue therapy. The primary outcome was the need for mechanical ventilation within the first 72 hours of life. A total of 200 infants, 100 in each arm, were randomly assigned. Rates of the primary outcome did not differ significantly between the NIPPV (25 %) and NCPAP (34 %) groups (relative risk [RR]: 0.71 [95 % confidence interval (CI): 0.48 to 1.14]). In post-hoc analysis, from 24 to 72 hours of life, significantly more infants in the NIPPV group remained extubated compared with those in the NCPAP groups (10 versus 22 %; RR: 0.45 [95 % CI: 0.22 to 0.91]). This difference was also noted in the group of infants who received surfactant therapy, NIPPV (10.9 %), and NCPAP (27.1 %) (RR: 0.40 [95 % CI: 0.18 to 0.86]). The authors concluded that early NIPPV did not decrease the need for mechanical ventilation compared with NCPAP, overall, in the first 72 hours of life. Moreover, they stated that further studies are needed to to evaluate the potential benefits of non-invasive ventilation, especially for the most vulnerable or preterm infants.

Najaf-Zadeh and Leclerc (2011) examined the effectiveness of NPPV in children less than 1 month of age with ARF due to different conditions. These researchers noted that mechanical respiratory support is a critical intervention in many cases of ARF. In recent years, NPPV has been proposed as a valuable alternative to invasive mechanical ventilation (IMV) in this acute setting. Recent physiological studies have demonstrated beneficial effects of NPPV in children with ARF. Several pediatric clinical studies, the majority of which were non-controlled or case
series and of small size, have suggested the effectiveness of NPPV in the treatment of ARF due to acute airway (upper or lower) obstruction or certain primary parenchymal lung disease, and in specific circumstances, such as post-operative or post-extubation ARF, immunocompromised patients with ARF, or as a means to facilitate extubation. Noninvasive positive pressure ventilation was well-tolerated with rare major complications and was associated with improved gas exchange, decreased work of breathing, and endo-traheal intubation avoidance in 22 to 100 % of patients. High FiO2 needs or high PaCO2 level on admission or within the first hours after starting NPPV appeared to be the best independent predictive factors for the NPPV failure in children with ARF. However, many important issues, such as the identification of the patient, the right time for NPPV application, and the appropriate setting, are still lacking. The authors concluded that further RCTs that address these issues in children with ARF are recommended.

NPPV Following Esophagectomy:

Raman et al (2015) noted that respiratory complications occur in 20 % to 65 % of patients who have undergone esophagectomy. While NPPV is associated with fewer complications than endotracheal intubation (ET), it is relatively contraindicated after esophagectomy due to potential injury to the anastomosis. These researchers created ex-vivo and in-vivo pig models to determine the pressure tolerance of an esophagectomy anastomosis and compared it to esophageal pressure during NPPV. These investigators created a stapled side-to-side, functional end-to-end esophago-gastric anastomosis. With continuous intraluminal pressure monitoring, they progressively insufflated the anastomosis with a syringe until an anastomotic leak was detected, and recorded the maximum pressure before leakage. These researchers performed this experiment in 10 esophageal specimens and 10 live pigs. They then applied a laryngeal mask airway (LMA) to 5 live pigs and measured the pressure in the proximal esophagus with increasing ventilatory pressures. The perforation was always at the anastomosis. The ex-vivo and in-vivo anastomoses tolerated a mean of 101 ± 44 cm H2O and 84 ± 38 cm H2O before leak, respectively. There was no significant difference between the pressure thresholds of ex-vivo and in-vivo anastomoses (p = 0.51). When 20, 30, and 40 cm H2O of positive pressure via LMA were delivered, the esophagus sensed 5 ± 4 cm H2O (25 %), 11 ± 11 cm H2O (37 %), and 15 ± 9 cm H2O (38 %), respectively. The authors concluded that the findings from their ovine model suggested that an esophagectomy anastomosis can tolerate a considerably higher pressure than is transmitted to the esophagus during NPPV. They stated that NPPV may be a safe alternative to ET after esophagectomy. These preliminary findings need to be validated in well-designed clinical trials.

Adaptive-Servoventilation:

Adaptive servo-ventilation (ASV), a bilevel PAP system with a backup rate feature, uses an automatic, minute ventilation-targeted device (VPAP Adapt, ResMed, Poway, CA) that performs breath-to-breath analysis and adjusts its settings accordingly. Depending on breathing effort, the device will automatically adjust the amount of airflow it delivers in order to maintain a steady minute ventilation. Most studies on the use of ASV have investigated its use for heart failure patients with central apnea or Cheyne-Stokes respiration (Teschler et al, 2001; Pepperell et al, 2003; Topfer et al, 2004; Pepin et al, 2006; Kasai et al, 2006; Zhang et al, 2006).

Banno et al (2006) evaluated 3 patients with idiopathic Cheyne-Stokes breathing (CSB) and examined the feasibility of using ASV to treat them. The patients had a periodic breathing pattern resembling CSB. During polysomnography, the abnormal breathing pattern was present while patients were both awake and asleep. The patients were first tested on CPAP and/or oxygen; however they did not respond well to either of these treatments. They were then assessed on ASV. The mean abnormal breathing events index decreased from 35.2 to 3.5 per hour of sleep on ASV. There was a significant reduction in the mean number of arousals caused by abnormal breathing events: from 18.5 to 1.1 per hour of sleep. After 6 to 12 months of using ASV, the patients had maintained significant improvement in subjective
daytime alertness and mood. The authors concluded that a trial of ASV for patients with idiopathic CSB is recommended if they do not have improvement in sleep respiration or daytime performance on CPAP and/or oxygen.

Morrell et al (2007) stated that hypercapnic cerebral vascular reactivity (HCVR) is reduced in patients with CHF and sleep-disordered breathing (SDB) and that this may be associated with an increased risk of stroke. These researchers tested the hypothesis that reversal of SDB in CHF patients using ASV would increase morning HCVR. A total of 10 CHF patients with SDB, predominantly OSA, were included in this study. The HCVR was measured from the change in middle cerebral artery velocity, using pulsed Doppler ultrasound. Hypercapnic cerebral vascular reactivity was determined during the evening (before) and morning (after) 1 night of sleep on ASV and 1 night of spontaneous sleep (control). Compared with the control situation, ASV decreased the apnea-hypopnea index (AHI) (group mean +/- SEM, control: 48 +/- 12, ASV: 4 +/- 1 events per hour). Hypercapnic cerebral vascular reactivity was 23 % lower in the morning, compared with the evening, on the control night (evening: 1.3 +/- 0.2, morning: 1.0 +/- 0.2 cm/sec per mm Hg, p < 0.05) and 27 % lower following the ASV night (evening: 1.5 +/- 0.2, morning: 1.1 +/- 0.2 cm/sec per mm Hg, p < 0.05). The effect of ASV on the evening-to-morning reduction in HCVR was not significant, compared with the control night (0.02 cm/sec per mm Hg, 95 % confidence interval: -0.28 to 0.32; p = 0.89). The authors concluded that in CHF patients with SDB, HCVR was reduced in the morning compared with the evening. However, removal of SDB for 1 night did not reverse the reduced HCVR. The relatively low morning HCVR could be linked with an increased risk of stroke.

Morgenthaler et al (2007) compared the efficacy of ASV versus NPPV for central, mixed, and complex sleep apnea syndromes in a prospective randomized cross-over clinical trial. A total of 21 patients (6 with central sleep apnea/Cheyne-Stokes respiration, 6 with predominantly mixed apneas, and 9 with complex sleep apnea) with initial diagnostic AHI +/- standard deviation 51.9 +/- 22.8/hr and RAI 45.5 less than or equal to 26.5/hr completed the study. Following optimal titration with CPAP (n = 15), disturbed breathing and disturbed sleep remained high with mean AHI = 34.3 +/- 25.7 and RAI = 32.1 +/- 29.7. AHI and RAI were markedly reduced with both NPPV (6.2 +/- 7.6 and 6.4 +/- 8.2) and ASV (0.8 +/- 2.4 and 2.4 +/- 4.5). Treatment AHI and RAI were both significantly lower using ASV (p < 0.01). The authors concluded that in patients with central sleep apnea/Cheyne-Stokes respiration, mixed apneas, and complex sleep apnea, both NPPV and ASV are effective in normalizing breathing and sleep parameters, and that ASV does so more effectively than NPPV in these types of patients.

Hastings et al (2010) assessed the use of ASV in CHF patients with all types of sleep apnea. A total of 11 male patients with stable CHF and sleep apnea (AHI greater than 15 events/hr) were treated with 6 months optimized ASV and compared to 8 patients not receiving ASV. At baseline, both groups were comparable for New York Heart Association class, left ventricular ejection fraction (LVEF), plasma brain natriuretic peptide (BNP) concentrations and AHI. All patients were receiving optimal medical therapy. At 6 months, the authors reported that ASV significantly reduced AHI with improvement in LVEF and aspects of quality of life.

**Single Breath Nitrogen Test:**

The single breath nitrogen test (SBNT) is a pulmonary function test that provides information on the evenness of distribution of ventilation and on closing volume. The test utilizes resident nitrogen (N₂) in the lung as the tracer gas, and a single inhalation of 100 % oxygen to cause a change in the N₂ concentration in the lungs. It is performed by having the subject breathe air normally through a mouthpiece, and after a single vital capacity inspiration of 100 % O₂, expire slowly and smoothly to residual volume. Expired N₂ concentration is then plotted against expired volume (single breath nitrogen washout curve). From this, information about the distribution of ventilation can be obtained. Similar measurements may be made using other tracer gases such as xenon, argon, or helium.
There are usually 4 phases to the single breath nitrogen washout curve -- phase I represents dead space gas containing zero N₂; phase II is mixed dead space and alveolar gas; phase III is gas from the alveoli; and phase IV represents a sharp increase in N₂ concentration. In normal persons in whom the alveoli empty synchronously, phase III shows a plateau during which N₂ concentration rises only slowly. The slope of phase III (change in N₂ concentration per 500 ml of expired air) should be less than 1.5 %. The lung volume at which phase III changes to phase IV is closing volume (the volume at which closure of airways occur in the lower part of the lungs). An increase in closing volume, especially when it is larger than functional residual volume, indicates premature closure of intra-pulmonary airways as a result of the narrowing of small airways or reduced elastic recoil.

It was thought that the SBNT might detect chronic airway disease before it is clinically apparent. However, it has not been demonstrated conclusively to be more sensitive than other tests.

Most patients with established disease and an abnormal slope of phase III do not produce single breath tests from which closing volumes can be measured. The American Thoracic Society (ATS) Standards for the Diagnosis and Care of Patients with Chronic Pulmonary Disease (1995) notes that small airways (i.e., less than 2 mm in diameter) are important sites of airflow obstruction, and that the relative contribution of peripheral airway disease and loss of elastic recoil from emphysema may vary. However, the ATS Standards states that indices such as the closing capacity and the slope of the alveolar plateau derived from a SBNT are unable to identify individuals susceptible to chronic airway obstruction with cigarette smoke exposure.

The ATS Standards notes that tests reflecting emphysema (e.g., single-breath diffusing capacity, functional residue capacity, total lung capacity) predict survival in a relatively minor way.

Fraser et al (1999) concluded that the SBNT has not been shown to be useful in identifying patients at risk for developing COPD. Fraser explained that, although epidemiological studies have demonstrated that the results of the SBNT is abnormal in many asymptomatic smokers, there is controversy regarding the value of this measurement, as it appears that this test may not offer advantages over simple spirometry in detecting the progression of airflow obstruction. Fraser et al explained that one reason SBNT has been less discriminating than was originally hoped in identifying smokers at risk for the development of progressive disease is the marked inter-subject and intra-subject variability in test results. In addition, these investigators noted that it has not been convincingly shown that the rate of decrease in forced expiratory flow in smokers correlates with abnormalities in small airway function.

A number of empirical studies have documented the limited clinical value of SBNT. Teculescu et al (1988) noted that the SBNT did not detect any effect of involuntary smoking in a limited sample of children. Vestbo and Rasmussen (1990) reported that indices of the SBNT (e.g., closing volume, closing capacity, and slope of phase III) have no predictive value concerning overall mortality and cancer incidence. Vestbo et al (1990) concluded that in a random population sample indices from only one SBNT do not provide prognostic information concerning hospitalization in addition to that provided by forced expiratory volume in 1 sec (FEV1). Viegi et al (1988) stated that the place of SBNT in large scale epidemiologic testing has not been justified. Detels et al (1982) reported that the SBNT yielded less specific or different information than spirometry, the flow-volume curve, and the ratio of FEV1 to forced vital capacity (FVC) in identifying abnormal lung function. Reporting on SBNT and FEV1 in a cohort of individuals followed over a 9- to 11-year period, Vollmer et al (1990) concluded that SBNT variables are less reproducible than FEV1. Dahlqvist (1995) reported on the results of an 8-year correlational study involving 24 healthy subjects, and concluded that the "prognostic value of an abnormal single-breath nitrogen wash-out seems to be limited" in predicting an accelerated decline in FEV1. Moreover, Bourgkard et al (1997) reported that subjects with dust exposure and roentgenologic pneumoconiosis noddulation were unable to adequately perform SBNT; however, these subjects were able to performed spirometry satisfactorily. Thus, the
SBNT has not been proven to be useful in detecting early lung dysfunction and selecting persons at risk for appropriate measures to prevent progression to advanced disease.

Appendix

Definitions:

Apnea is defined as the cessation of airflow for at least 10 seconds.

Apnea-hypopnea index (AHI) is defined as the average number of episodes of apnea and hypopnea per hour of sleep without the use of a positive airway pressure device. If the AHI is calculated based on less than 2 hours of continuous recorded sleep, the total number of recorded events used to calculate the AHI must be at least the number of events that would have been required in a 2-hour period (i.e., greater than or equal to 10 events).

Central sleep apnea (CSA) is defined as:

1. An AHI greater than 5; and
2. Central apneas/hypopneas greater than 50 % of the total apneas/hypopneas; and
3. Central apneas or hypopneas greater than or equal to 5 times per hour; and
4. Symptoms of either excessive sleepiness or disrupted sleep.

Complex sleep apnea (CompSA) is a form of central apnea specifically identified by the persistence or emergence of central apneas or hypopneas upon exposure to CPAP or a bilevel PAP device without a backup rate feature when obstructive events have disappeared. These individuals have predominantly obstructive or mixed apneas during the diagnostic sleep study occurring at greater than or equal to 5 times per hour. With use of CPAP or bilevel PAP without a backup rate feature, they show a pattern of apneas and hypopneas that meets the definition of CSA described above.

FIO2 is the fractional concentration of oxygen delivered to the member for inspiration. The member's usual FIO2 refers to the oxygen concentration the member normally breathes when not undergoing testing to qualify for coverage of NPPV. That is, if the member does not normally use supplemental oxygen, their usual FIO2 is that found in room air.

Hypopnea is defined as an abnormal respiratory event lasting at least 10 seconds associated with at least a 30 % reduction in thoraco-abdominal movement or airflow as compared to baseline, and with at least a 4 % decrease in oxygen saturation.

Polysomnography is the continuous and simultaneous monitoring and recording of various physiological and pathophysiological parameters of sleep with physician review, interpretation, and report. It must include sleep staging, which is defined to include a 1 to 4 lead electroencephalogram (EEG), an electrooculogram (EOG), and a submental electromyogram (EMG). It must also include at least the following additional parameters of sleep: airflow, respiratory effort, and oxygen saturation by oximetry. It may be performed either as a whole-night study for diagnosis only or as a split-night study to diagnose and initially evaluate treatment. For indications other than OSA, polysomnography studies must be performed in a sleep study laboratory, and not in the home or in a mobile facility. According to DME MAC policy (NHIC, 2008), arterial blood gas, sleep oximetry and polysomnographic studies may not be performed by the DME supplier.

Table: Usual Medically Necessary Quantities of Supplies for Use With a NPPV:

<table>
<thead>
<tr>
<th>Supply</th>
<th>Quantity Usually Medically</th>
</tr>
</thead>
</table>

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## Noninvasive Positive Pressure Ventilation

<table>
<thead>
<tr>
<th>Item</th>
<th>Necessary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubing with integrated heating element</td>
<td>1 per 3 months</td>
</tr>
<tr>
<td>Combination oral/nasal mask</td>
<td>1 per 3 months</td>
</tr>
<tr>
<td>Oral cushion for combination oral/nasal mask</td>
<td>2 per 1 month</td>
</tr>
<tr>
<td>Nasal pillows for combination oral/nasal mask (pair)</td>
<td>2 per 1 month</td>
</tr>
<tr>
<td>Full face mask</td>
<td>1 per 3 months</td>
</tr>
<tr>
<td>Cushion for use on nasal mask interface</td>
<td>2 per 1 month</td>
</tr>
<tr>
<td>Pillow for use on nasal cannula type interface (pair)</td>
<td>2 per 1 month</td>
</tr>
<tr>
<td>Nasal interface (mask or cannula type), with or without head strap</td>
<td>1 per 3 months</td>
</tr>
<tr>
<td>Headgear</td>
<td>1 per 6 months</td>
</tr>
<tr>
<td>Chinstrap</td>
<td>1 per 6 months</td>
</tr>
<tr>
<td>Tubing</td>
<td>1 per 3 months</td>
</tr>
<tr>
<td>Filter (disposable)</td>
<td>2 per 1 month</td>
</tr>
<tr>
<td>Filter (nondisposable)</td>
<td>1 per 6 months</td>
</tr>
<tr>
<td>Water chamber with humidifier</td>
<td>1 per 6 months</td>
</tr>
</tbody>
</table>


### CPT Codes / HCPCS Codes / ICD-9 Codes

#### CPT codes covered if selection criteria are met:

- **94002 - 94004** Ventilation assist and management, initiation of pressure or volume preset ventilators for assisted or controlled breathing
- **94660** Continuous positive airway pressure ventilation (CPAP), initiation and management

#### CPT codes not covered for indications listed in the CPB:

- **94726** Plethysmography for determination of lung volumes and, when performed, airway resistance

#### Other CPT codes related to the CPB:

- **82800 - 82810** Gases, blood
- **94760 - 94762** Noninvasive ear or pulse oximetry for oxygen saturation
- **95782 - 95783, 95808 - 95811** Polysomnography

#### HCPCS codes covered if selection criteria are met:
Noninvasive Positive Pressure Ventilation

A7027 Combination oral/nasal mask, used with continuous positive airway pressure device, each
A7028 Oral cushion for combination oral/nasal mask, replacement only, each
A7029 Nasal pillows for combination oral/nasal mask, replacement only, pair
A7030 - A7039 Full face mask, each, face mask interface replacement, each, replacement cushion for nasal application, each, replacement pillows, pair, nasal interface (mask or cannula type), with or without head strap, headgear, chinstrap, tubing filter, disposable or filter non-disposable, used with positive airway pressure device
A7044 Oral interface used with positive airway pressure device, each
A7045 Exhalation port with or without swivel used with accessories for positive airway devices, replacement only
A7046 Water chamber for humidifier, used with positive airway pressure device, replacement, each
E0461 Volume control ventilator, without pressure support mode, may include pressure control mode, used with non-invasive interface (e.g. mask)
E0464 Pressure support ventilator with volume control mode, may include pressure control mode, used with non-invasive interface (e.g. mask)
E0470 Respiratory assist device, bi-level pressure capability, without backup rate feature, used with non-invasive interface, e.g., nasal or facial mask (intermittent assist device with continuous positive airway pressure device)
E0471 Respiratory assist device, bi-level pressure capability, with back-up rate feature, used with noninvasive interface, e.g., nasal or facial mask (intermittent assist device with continuous positive airway pressure device) [*note - device with backup rate not covered for obstructive sleep apnea]
E0561 Humidifier, non-heated, used with positive airway pressure device
E0562 Humidifier, heated, used with positive airway pressure device
E0601 Continuous positive airway pressure (CPAP) device

ICD-9 codes covered if selection criteria are met:

138 Late effects of acute poliomyelitis
327.21 Primary central sleep apnea
327.23 Obstructive sleep apnea (adult) (pediatric)
327.27 Central sleep apnea in conditions classified elsewhere
335.0 - 335.9 Anterior horn cell disease
353.0 - 353.9 Nerve root and plexus disorders
358.0 - 359.9 Myoneural disorders, muscular dystrophies, and other myopathies
Noninvasive Positive Pressure Ventilation

490 - 492.8  Chronic obstructive pulmonary disease and allied conditions
494.0 - 496

518.81 - 518.89  Other diseases of lung
519.19  Other diseases of trachea and bronchus [tracheomalacia]
737.30 - 737.39  Kyphoscoliosis and scoliosis
738.3  Acquired deformity of chest and rib
748.3  Other congenital anomaly of larynx, trachea, and bronchus [tracheomalacia]
780.79  Other malaise and fatigue
786.03  Apnea
786.09  Other dyspnea and respiratory abnormalities
799.02  Hypoxemia
907.2 - 907.3  Late effect of spinal cord injury or injury to nerve root(s), spinal plexus(es), and other nerves of trunk

**ICD-9 codes not covered for indications listed in the CPB:**

428.0  Congestive heart failure, unspecified
428.22  Systolic heart failure, chronic
428.23  Systolic heart failure, acute on chronic
428.32  Diastolic heart failure, chronic
428.33  Diastolic heart failure, acute on chronic
428.42  Combined systolic and diastolic heart failure, chronic
480 - 488  Pneumonia
493.00 - 493.92  Asthma
861.20 - 861.32  Injury to lung

**Other ICD-9 codes related to the CPB:**

327.00 - 327.20, 327.22, 327.24 - 327.26, 327.29 - 327.8
780.50 - 780.59  Sleep disturbances

**The above policy is based on the following references:**


62. Fayon M, Donato L. Tracheomalacia (TM) or bronchomalacia (BM) in children:


64. Ernst A, Carden K, Gangadharan SP. Tracheomalacia and tracheobronchomalacia in adults. Last reviewed March 2012. UpToDate Inc. Waltham, MA.


